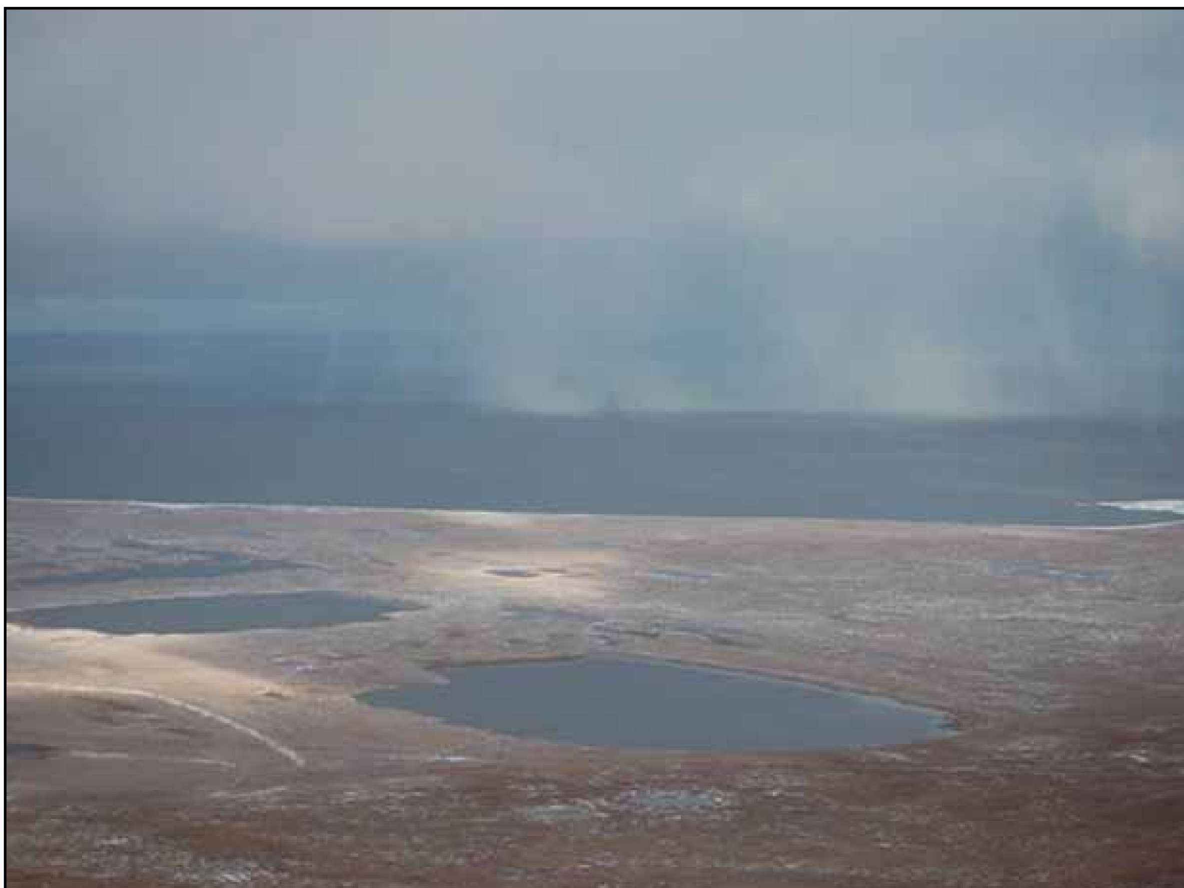
The Oil and Gas Resource Evaluation & Exploration Proposal for the Arctic National Wildlife Refuge 1002 Area



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Contents

Abbreviations

1002 Area	Alaska National Wildlife Refuge, Section 1002
ACES	Alaska's Clear and Equitable Share oil and gas tax
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADLWD	Alaska Department of Labor and Workforce Development
ADNR	Alaska Department of Natural Resources
ADOR	Alaska Department of Revenue
ANILCA	Alaska National Interest Lands Conservation Act
ANS	Alaska North Slope
ANWR	Arctic National Wildlife Refuge
AOGA	Alaska Oil and Gas Association
AOGCC	Alaska Oil and Gas Conservation Commission
APDES	Alaska Pollutant Discharge Elimination System
APSC	Alyeska Pipeline Services Company
ASRC	Arctic Slope Regional Corporation
BBO	Billion barrels of oil
BIF	Best Interest Finding, Final Finding of the Director of the Division of Oil and Gas, for State of Alaska Areawide Oil and Gas Lease Sales
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management (formerly MMS)
BS	Beaufort Sea, State of Alaska
CBO	U.S. Congressional Budget Office
CCP	Comprehensive Conservation Plan
CFR	Code of Federal Regulations
CWA	Clean Water Act
DPS	Distinct Population Segments, under the Endangered Species Act
DO&G	Division of Oil and Gas
DOI	U.S. Department of the Interior
EFH	Essential Fish Habitat
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
KIC	Kaktovik Inupiat Corporation

LEIS	Legislative Environmental Impact Statement
MBBO	Million barrels of oil
MLW	Division of Mining, Land & Water, ADNR
MMS	Minerals Management Service, U.S. Department of the Interior
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPR-A	National Petroleum Reserve – Alaska
NS	North Slope, State of Alaska
NSB	North Slope Borough
NSBMC	North Slope Borough Municipal Code
NSFH	North Slope Foothills, State of Alaska
OHA	Alaska Office of History and Archaeology; Alaska Department of Natural Resources
OIP	Oil-in-place
OPMP	Office of Project Management and Permitting, State of Alaska
PLO	Public Land Order
PPT	Petroleum Profits Tax
RCA	Regulatory Commission of Alaska
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office, Alaska Department of Natural Resources
SOA	State of Alaska
TAPS	Trans-Alaska Pipeline System
TCF	Trillion Cubic Feet
TLUI	Traditional Land Use Inventory
UIC	Underground Injection Control Program
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
2-D	Two-dimensional seismic survey
3-D	Three-dimensional seismic survey

Executive Summary

A. Introduction

The U.S. Arctic National Wildlife Refuge (ANWR) expands across the eastern portion of the northern tier of Alaska and is managed by the U.S. Fish and Wildlife Service (USFWS). A small portion of ANWR along the coastal plain has been specifically set aside to assess its oil and gas potential in the Alaska National Interest Lands Conservation Act (ANILCA) Section 1002 (the 1002 Area). This document consists of a compilation of existing information and a proposed Exploration Plan for the oil and gas resources in the 1002 Area.

Accurately defining the oil and gas resource potential is a critical part of understanding the value of the 1002 Area to the nation. It is also a critical factor in understanding the human environment associated with ANWR and Alaska's North Slope. Life in this area has changed dramatically with the discovery and development of Prudhoe Bay and the enactment of the Alaska Native Settlement Claims Act (ANCSA). However, the positive impacts of responsible development were not thoroughly considered in the 2011 Draft ANWR Comprehensive Conservation Plan/Environmental Impact Statement (CCP/EIS). This omission is contrary to the requirements of the National Environmental Policy Act (NEPA).

The North Slope of Alaska is one of the world's great hydrocarbon basins. Alaska oil production has been contributing to the economic prosperity and energy security of our nation for decades. Despite repeated efforts to access federal lands for oil and gas exploration and development within Alaska's borders, the overwhelming majority of federal lands on the North Slope of Alaska remain off limits, including the 1002 Area. The oil and gas resource potential of the ANWR 1002 Area is estimated to be in the billions of barrels of recoverable oil. Since the passage of ANILCA in 1980, the authority to allow oil and gas development in ANWR has resided with the U.S. Congress. Given that the federal government refuses to take the lead on fully understanding the resource potential of the 1002 Area, the State of Alaska has developed an Exploration Plan to accomplish this federal directive in ANILCA.

The State of Alaska's "Oil & Gas Resource Evaluation & Exploration Proposal for the ANWR 1002 Area" is a reasonable proposal that will help foster a cooperative effort between the State, local, and federal governments and private parties to responsibly assess and explore the 1002 Area. This work can be accomplished with little to no impact on the environment -- based on Alaska's high resource development and environmental protection standards -- using state of the art technology currently available on Alaska's North Slope. As stated in Governor Parnell's accompanying letter to Secretary of the Interior Jewell, the State of Alaska is willing to provide tens of millions of dollars of funding to help implement this Exploration Proposal. The goal of the State's Exploration Proposal is to provide updated and comprehensive information regarding the oil and gas resources in the 1002 Area. This will engender transparent and sound public policy decision-making by Congress regarding the management of this critically important area of the United States and State of Alaska.

B. Chapter-by-Chapter Overview

Chapter 1 provides a brief history of petroleum resource exploration in ANWR to date, along with a statewide perspective on oil and gas discoveries that have driven responsible petroleum resource exploration and development in the Alaskan Arctic. Oil and gas exploration in ANWR was authorized in 1980 when Congress passed ANILCA. USFWS subsequently issued regulations that would avoid significant adverse effects as required by ANILCA Section 1002(h). The previous limited 2-D seismic surveys conducted in 1983-85 in northern portions of ANWR and a single exploration well on Kaktovik Inupiat Corporation (KIC) lands have comprised the only petroleum assessment actions in ANWR. This review culminated in a legislative report to Congress that recommended oil and gas leasing in the coastal plain (Clough, et al., 1987). The areas of highest oil and gas potential in the coastal plain were not explored in detail, and efforts to definitively determine the oil and gas potential in the 1002 Area have since met with a myriad of issues and delays. Current planning efforts embodied in the CCP/EIS have not adequately addressed options to investigate oil and gas resources potential as a CCP alternative.

Chapter 2 discusses existing habitat, wildlife, fish, and subsistence uses in the 1002 Area. The two ecoregions in the 1002 Area, the Arctic coastal plain and the northern foothills of the Brooks Range, host a diverse network of terrestrial, wetland, and freshwater habitats. Resident and migrating wildlife and fish are present on the coastal plain, with highest population numbers present during summer months. Terrestrial habitats are used by a diversity of animals for grazing, nesting, breeding, and migration. The freshwater habitats of the coastal plain are important for spawning, rearing, and overwintering for migrating and resident fish populations.

The fish and wildlife of the coastal plain provide the resources for subsistence harvests, and for general fishing and hunting. ANILCA directs that subsistence activities for customary and traditional uses are part of the acceptable human uses of ANWR's coastal plain and are to be allowed by USFWS. Subsistence harvests are essential to many rural residents, who are able to access wide ranges and long seasons with modern equipment. General fishing and hunting are allowed within approved seasons. Protection of habitats and fish and wildlife populations during exploration is identified as a critical priority, and mitigation measures essential to preventing negative impacts to habitat, wildlife, fish, and subsistence uses during exploration operations are discussed.

Chapter 3 addresses the currently available data and interpretations of the geology and petroleum potential in ANWR. The 2-D seismic surveys from 1983-1985 are the only data available, and lack quality and statistical stability in the spatial context to make detailed assessments of the oil and gas resources in the area. Several federal agency assessments were published in 1987 (USDOI: Clough, et al.), 1988 (USFWS), and 1998 (USGS), that attempted to characterize the potential plays containing oil and gas.

This document discusses the possibilities provided by modern technology to definitively assess the locations and volumes of hydrocarbon resources, and provides an economic analysis of feasible oil and gas production scenarios. Without definitive seismic and drilling data, an adequate determination of technically and economically recoverable resources cannot be made. Only additional 3-D seismic surveys and exploration drilling will yield the necessary data and provide new information for important long term management decisions about ANWR. Bottom line: we have the ability with new technology to undertake a detailed exploration program that will have minimal impact on the environment.

Chapter 4 opens with descriptions of the historic exploration efforts using 2-D seismic surveys and geophysical investigations for some areas of ANWR. These prior exploration activities did not provide enough detailed information about potential oil and gas resources in ANWR, but were a positive first step. Chapter 4 goes on to describe the typical exploration methods currently used to understand subsurface zones of interest and to estimate the shape, extent and character of potential oil and gas resources. Geophysical and 3-D seismic surveys have improved significantly since the 1983-85 program, and can provide more accurate resource assessments with minimal surface impact. Winter drilling using ice roads and ice pads has minimal impact on the surface and surrounding environment. Ice-based facilities (roads, pads, airstrips) provide low to no impact access. Proven and new technologies, many in common use in Arctic regions, can accurately maximize the ability to assess the oil and gas resource potential with minimal surface impacts.

Chapter 5 presents a framework for a primarily winter-based exploration alternative for collecting information about petroleum potential, the subsurface geology, and the geographic extent of potential and recoverable resources. The proposed exploration program encompasses three phases over a seven-year life cycle with each phase determining the value of and need for the next phase. Field activities would include winter 3-D seismic surveys (Phase 1), summer site clearance activities to meet exploration permitting requirements (Phase 2), and construction and use of ice-based roads and pad facilities for winter-only exploration drilling (Phase 3). Expected activities and methodologies are described for 3-D seismic acquisition, construction of ice-based roads, pads, and airstrips, and seismic data evaluation to definitively assess the oil and gas resources of the ANWR 1002 Area. The exploration proposal uses the proven technological advances for the Arctic with minimal, if any, impacts, based on the extent of surveys, site evaluation, and exploratory drilling. Importantly, the State of Alaska is willing to support these activities through existing exploration tax credits and other means.

Chapter 6 provides a detailed consideration of impacts expected from an exploration program similar to one previously authorized by Congress in the early

1980s, but improved with current technology and the highest environmental standards – which currently exist in Alaska. Exploration activities are primarily proposed for winter, when wildlife populations are absent or not present in large numbers. Coordination with local and rural residents reduces conflicts with subsistence, fishing, and hunting uses. Planning and approved permitting of these activities ensures the proposed exploration methods, timing, and locations optimize data collection and timing and significantly reduce the potential for negative effects. Project plans will determine the necessary regulatory permits, methods, and site locations for the actual exploration program (Phase 3). This resource study provides evidence that multiple land uses and definitive oil and gas exploration can occur concurrently in the 1002 Area with minimal impacts, given the use of proven Arctic technologies and strategies.

Chapter 7 identifies and evaluates the benefits to the nation and the State of Alaska that a thorough study of ANWR's resources would provide. Increased domestic oil and gas production supports the possibility of achieving domestic energy independence. Revenues from development support Alaska's economic health, and are critical to maintaining the social health of communities at modern day levels. Development provides opportunity and sustained commerce throughout Alaska and the nation. A published economic budget report from the Congressional Budget Office (CBO) estimated $5 billion from leasing for a mid-case scenario over the life of development in ANWR, depending upon commercial interests (CBO, 2012). The State's further analysis presents a projected income from leasing revenues ranging from $1.3 to $8.3 billion. Royalties from oil and gas production for one scenario can be projected to realize ranges near $78 billion for the United States (CBO, 2012).

In addition to these economic benefits, increased oil and gas production could provide increased employment, the growth of goods and services, and an additional multiplier effect for the industry and support sectors. Trade, transportation, and service industries are integral components of the Alaskan economic network. It is estimated that for every oil company job, nine other jobs are generated in the state, and that for each dollar earned by oil company employees, three and a half payroll dollars are generated in Alaska. Increased employment would provide positive impacts for the national, state, and local community workforce. Further, increased oil production is critical to prolonging the operational life of the Trans-Alaska Pipeline System (TAPS). TAPS is essential to bring Alaska's petroleum resources to market and its continued operation is critical to Alaska's future.

Chapter 8 provides a summary of the outcomes that may result from exploration and resource assessment. These include, and are not limited to: increasing domestic supply of crude oil to bolster energy security and independence; added oil throughput for TAPS; increased national, state, and local economic benefits through financial revenues; increased demand for goods and services, employment and national networks for commodity transport, and advancement of viable Arctic technologies for locating and developing conventional and unconventional oil and gas resources; and potential increase in natural gas resources for export.

As this exploration proposal details, oil and gas exploration resulting in a much more certain resource assessment will provide solid scientific evidence that Congress should consider when making decisions about ANWR. Oil and gas development that meets national energy objectives and provides sustained economic returns for the U.S. should be a viable use of these lands. The path forward for the long-term, multiple use of the ANWR 1002 Area will depend upon balanced policies and planning. Social and economic aspects of the human environment must be considered during the federal, state, and local project reviews, permitting, and authorizations that are part of this planning process.

Congress and land managers in the mid-1980s recognized the unassessed potential and values this northern tier of Alaska holds. ANILCA provided the foundation for wise stewardship of the area's natural resources, and the opportunity to fully evaluate and realize the benefits within the 1002 Area. Understanding the subsurface oil and gas resource potential underlying the 1002 Area is an integral part of any decision making regarding the management of the area. By completing this study, management decisions can be aligned with the original intent of ANILCA and consistent with the requirements of NEPA. Without completing a more thorough study of the oil and gas potential of ANWR, the decisions being considered in the CCP/EIS will ignore valuable scientific information and will not comply with ANILCA and NEPA.

Chapter 1
Introduction

Final Environmental Impact Statement and Preliminary Final Regulations, Proposed Oil and Gas Exploration Within the Coastal Plain of the Arctic National Wildlife Refuge, Alaska, 1983:

"The coastal plain has been identified by the U.S. Geological Survey (USGS) and the oil and gas industry as highly prospective for significant accumulations of oil and gas (Mast and others, 1980). Exploration activities to be conducted on ANWR will be designed to identify those areas having oil and gas production potential and to estimate the volume of potential resources. The results of these exploratory activities should provide valuable information for evaluating how the potential oil and gas resources of ANWR relate to the national need for domestic sources of energy."

(USDOI, 1983 p. I-1)

Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment Report and Recommendation to the Congress of the United States and Final Legislative EIS, 1987, Purpose and Need:

"3. To prepare a "Report to Congress" which describes the fish and wildlife resources of the 1002 Area; identifies and estimates the volume and areal extent of potential hydrocarbon resources; assesses the potential impacts of development; discusses transportation of oil and gas; discusses the national need for domestic sources of oil and gas; and recommends whether further exploration, development, and production of oil and gas should be allowed."

(Clough, et al., 1987; USDOI, p. 3)

"I recommend that the Congress direct the Secretary of the Interior to conduct an orderly oil and gas leasing program for the entire 1.5-million-acre 1002 Area at such a pace and in such circumstances as he determines will avoid unnecessary adverse impacts on the environment."

(USFWS 1988, citing to Donald Paul Hodel, Secretary of the Interior, p. 475)

A. A Brief Factual Chronology

In 1987, the U.S. Department of the Interior published its recommendation regarding the coastal plain under the 1002 Area. This report was the result of more than a decade of debate, years of studying the landscape and biology of the area, and analyzing whether it was possible to balance oil and gas development with other uses of the area. In this report, “The 1987 Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment Report and Recommendation to the Congress of the United States and Final Legislative EIS” (1002(h) Report), the U.S. Department of the Interior (USDOI) recommended oil and gas development of the coastal plain area of ANWR (Clough, et al., 1987).

Since 1987, technological advancements have supported the foresight demonstrated in the Secretary’s 1987 recommendation. Through improved data analysis, the U.S. Geological Survey (USGS) has been able to estimate greater volumes of technically recoverable oil and gas reserves than previously believed to be present. Today, improved drilling technology and mitigation measures significantly minimize environmental impacts of oil and gas exploration and development. Winter exploration programs are the industry norm in Alaska. These kinds of innovations continue to allow oil companies to produce more oil and gas in challenging environments with fewer and less impacts.

The role of oil in economics, global stability and national security is increasingly significant and complex because international demand has increased and crude oil prices have reached unprecedented highs. International production of crude oil is not always controlled by U.S. allies, a situation that continues to jeopardize the steady flow of petroleum products to the American market and threaten economic security. In short, our country’s need for secure energy resources has increased while the potential for adverse environmental impacts has decreased.

In the last quarter century, circumstances have also changed in Alaska. When the USDOI recommended conducting “an orderly oil and gas leasing program” in the 1002 Area in 1987, Alaska was experiencing record levels of oil production. Today, Alaska is focused on filling the Trans-Alaska Pipeline System to levels adequate to retain future operations. Alaska’s oil production in 2012 is approximately one fourth of 1988 levels (ADNR, 2012b).

Despite the critical energy issues facing the nation and the State of Alaska, the USDOI ignores its own 1987 recommendation to Congress to authorize oil and gas leasing in the 1002 Area. The options considered by the draft Comprehensive Conservation Plan/Environmental Impact Statement (CCP/EIS) would permanently foreclose the opportunity to even understand the potential resources underlying the 1002 Area, let alone develop oil and gas resources there.

1. Alaska Oil and Gas History and Current Needs for Increased Production

Interest in oil and gas exploration started in Alaska in the late 1890s as oil claims began to be filed and Alaska's first exploration well was drilled. Decades passed as several major oil companies and the federal government (the United States Navy and United States Geological Survey) attempted to strike major oil finds on the North Slope and in southcentral and southeastern Alaska without success. In 1957 and 1959, major oil discoveries in the Swanson River area hastened a rush of oil companies to Alaska's Cook Inlet and contributed greatly to Alaska becoming the 49th state. Nearly a decade later, Alaska changed dramatically and permanently with the discovery of North America's largest oil field at Prudhoe Bay in 1967. Huge amounts of money began to flow into the state with the start of the construction of the Trans-Alaska oil pipeline in 1974, and production in the field beginning in 1977. Since that time, smaller connected fields have added to the production on the North Slope. For over two decades, Alaska's North Slope produced about 20 percent of the domestic oil used in the United States, with peak production of 2.2 million barrels per day in 1988.

Since that time, Alaska oil production has been declining. Most of the 1988 peak was from North Slope production. The giant Prudhoe Bay and Kuparuk oil fields have matured and been in decline for years. Few new fields have been brought to production in the last two decades. Today, Alaska's daily production hovers around 575,000 barrels per day. Alaska's oil revenues accounted for about 93 percent of the state government's unrestricted revenues in FY 2012 (ADOR, 2012a). Oil production is critical for private sector business and employment and is critical to the many state and federal agencies that conduct business in Alaska. Without oil revenues, Alaska would become significantly more dependent on the federal government.

Several federal areas in Alaska along the highly prospective Barrow Arch, stretching east from Wainwright, AK to the Canadian border, have been closed to oil and gas activities, even as this production decline has continued. Even in the context of high oil prices, lands in the National Petroleum Reserve – Alaska (NPR-A) are just beginning to be explored, in part because of delays and uncertainty related to permitting. Furthermore, areas within NPR-A that are considered the most prospective have been deferred from oil and gas leasing, with even more lands closed to leasing in the final NPR-A Integrated Activity Plan issued December 28, 2012 (USDOI, 2012).

2. History of ANWR's Land Status

In 1943, the entire North Slope of Alaska was withdrawn from all types of entry by the federal government for unspecified war purposes by Public Land Order (PLO) 82. That PLO was revoked for a portion of the withdrawn land, including the future 1002 Area, in 1957, just two years prior to Alaska gaining statehood. These actions would have allowed the possibility of commercial oil and gas development. However, also in 1957, Fred Seaton, Secretary of the Department of the Interior, filed an application to preserve the northeast corner of the North Slope, thereby segregating the lands from disposal and transfer of ownership. When Alaska was formally admitted into the union in 1959, the lands detailed in the application, including the submerged lands under rivers and near shore, could not be transferred to the new state.

Despite opposition by the new State of Alaska and the USGS, in 1960, PLO 2214 set aside 8.9 million acres in the northeast corner of Alaska, establishing the Arctic National Wildlife Range. In 1972, the State of Alaska and the USDOI attempted to exchange sensitive waterfowl habitat elsewhere in Alaska for the prospective acreage within the Range; however, that effort was unsuccessful.

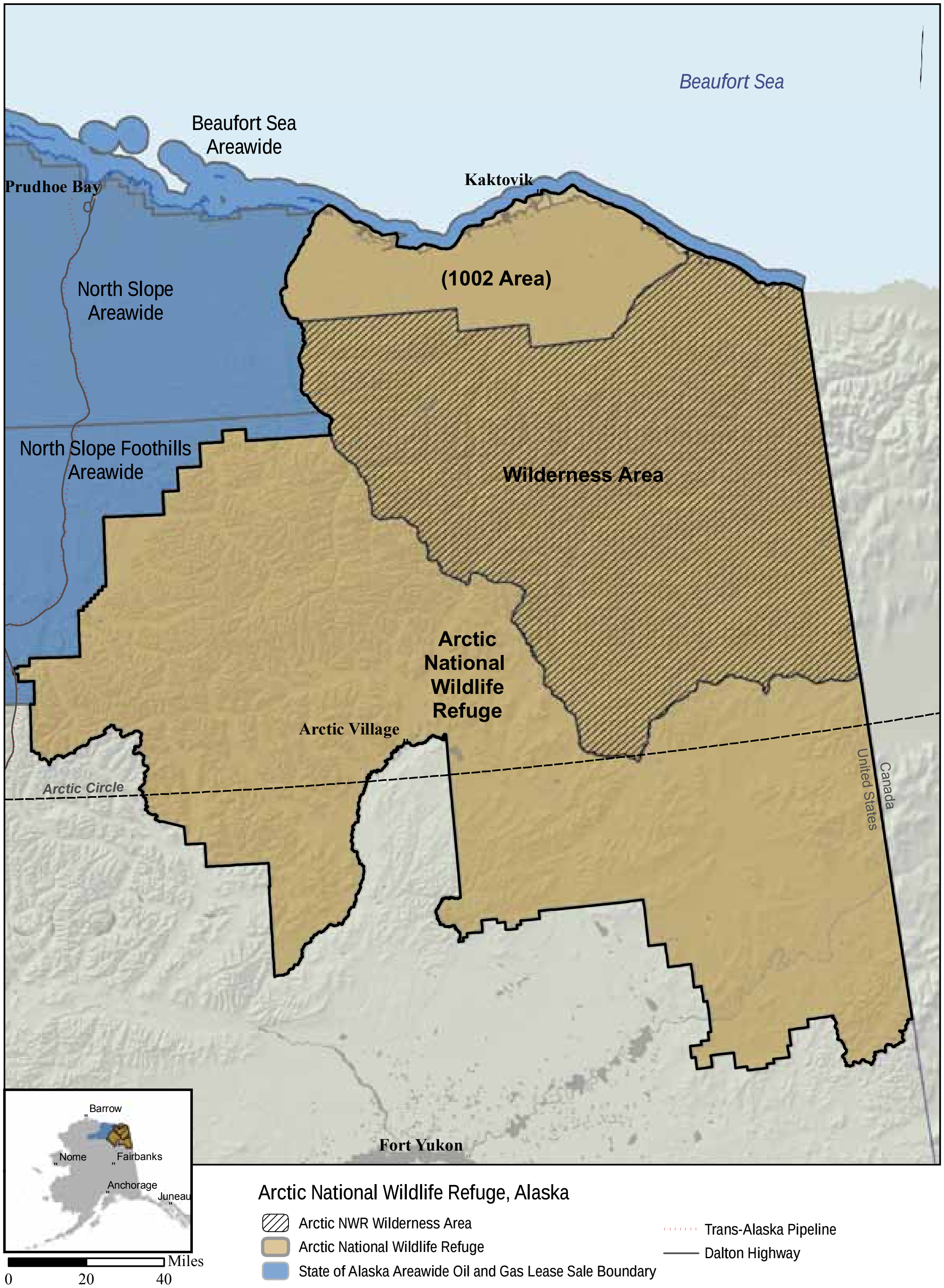
In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) established the Arctic National Wildlife Refuge (ANWR), which consisted of the original Range and over nine million acres of additional public lands. Section 702(3) of ANILCA designated approximately eight million acres of the original Range as Wilderness. Section 1002 of ANILCA provided for "*a comprehensive and continuing inventory and assessment of the fish and wildlife resources of the coastal plain….; an analysis of the impacts of oil and gas exploration, development and production, and to authorize exploratory activity within the coastal plain….*" Pursuant to this direction, the Secretary of Interior prepared the 1002(h) report and recommended that Congress authorize oil and gas development in the 1002 Area. However, to date, Congress has not acted on the recommendation and, pursuant to Section 1003 of ANILCA, only Congress can authorize oil and gas leasing or development in the 1002 coastal plain (Clough, et al., 1987).

The only opportunity for industry to assess oil and gas resources was a limited seismic survey and a single well drilled on Kaktovik Inupiat Corporation (KIC) lands after the Chandler Lake land exchange between the Arctic Slope Regional Corporation and the U.S. Fish and Wildlife Service. Since the late 1980s, members of Congress have introduced dozens of bills to open the 1002 Area to leasing and development. In 1995, President Clinton vetoed a bill passed by both bodies of Congress to develop the 1002 Area. Since then, no other bills to authorize oil and gas leasing and development or designate wilderness have been approved by Congress. However, technology has greatly advanced in the almost 20 years since President Clinton's veto. The surface impacts of exploration have significantly decreased. Three-dimensional (3-D) seismic surveys are regularly used to obtain subsurface data. Drilling has become more efficient, and directional and extended reach technology have greatly increased the reach of wells from each surface location. Despite these developments, information about the oil and gas resources of the 1002 Area have not been updated since the 1987 study.

Over the last 20 years, every Alaska Legislature has passed bills and resolutions supporting the opening of ANWR. Recently, in 2011, two Senate bills and one House bill that would open the coastal plain to oil and gas leasing and development were before Congress: The American Energy and Security Act of 2011, S.

Fig 1-1:

Arctic National Wildlife Refuge, Alaska



Source: ADNR-DO&G, 2012

352; the No Surface Occupancy Western Arctic Coastal Plain Domestic Energy Security Act, S. 351; and the American Energy Independence and Price Reduction Act, H.R. 49, would allow exploration, leasing, development, and production of oil and gas from all or portions of the 1002 Area. A recent Gallup opinion poll shows that Americans' support for oil exploration in ANWR is steadily increasing, joining the over 75 percent of Alaska residents who have consistently favored responsible exploration and development in the 1002 Area. (Saad, 2011; Arctic Power 2013).

3. 2009-current USFWS Comprehensive Conservation Plan (CCP)

On April 7, 2010, the U.S. Fish and Wildlife Service (USFWS) issued a Notice of Intent to develop a revised CCP/EIS for the Arctic National Wildlife Refuge (75 FR 17765). The notice indicated the revised plan would include a wild and scenic river review and a wilderness review for the purpose of potentially recommending new wild and scenic rivers and designated wilderness, but would not consider oil and gas development in the 1002 Area. Even though Congressional authorization is required for all three actions - to designate wilderness, designate wild and scenic rivers, and authorize oil and gas development in the 1002 Area - the notice only cites the need for Congressional authorization as the justification for not considering oil and gas development in the EIS.

The draft CCP/EIS analyzed six alternatives, two of which recommend designating the 1002 Area as Wilderness and two that recommend designating a wild and scenic river within the 1002 Area. Citing both ANILCA and the National Environmental Policy Act (NEPA), the State strongly opposed new wilderness and wild and scenic river reviews and advocated for including an oil and gas alternative in the CCP. Public comments on the draft plan included a broad range of perspectives regarding wilderness designations, wild and scenic river designations, and oil and gas development authorizations.

Only Congress can designate wilderness and wild and scenic rivers. While ANILCA Section 1003 currently prohibits oil and gas leasing or exploration until authorized by Congress, designation of the coastal plain as wilderness would effectively foreclose the opportunity to assess oil and gas resources permanently. Any future Congressional action to allow oil and gas activities would have to overturn a wild and scenic river designation or a wilderness designation, and the public perceives these designations as permanent.

B. ANILCA and NEPA Considerations

1. Alaska National Interest Land Conservation Act Issues

Through ANILCA, Congress established ANWR and designated approximately eight million acres as Wilderness. Congress explicitly set aside ANWR's 1002 Area for a continuing inventory and assessment of fish and wildlife resources, an analysis of the potential impacts of oil and gas exploration and development, and a report based on explicitly authorized oil and gas exploration activities. The resulting 1987 Coastal Plain Resource Assessment 1002(h) Report, which evaluated a range of alternatives from opening the entire 1002 Area for oil and gas development to wilderness designation, recommended that Congress authorize oil and gas development in the coastal plain. ANILCA Section 1002(c) required the report be completed within a specified time frame but also provided that DOI "... *shall thereafter publish such revisions thereto as are appropriate as new information is obtained.*" In spite of these requirements and the Secretary's recommendation to conduct an orderly oil and gas leasing program, the draft CCP/EIS does not include an oil and gas alternative nor does it meaningfully address the negative economic and resource development consequences of a potential wilderness designation in the 1002 Area. This is contrary to ANILCA's emphasis on an "analysis of the impacts of oil and gas exploration, development, and production and to authorize exploratory activity within the coastal plain gas resources" in Section 1002. Also contrary to ANILCA, the draft CCP/EIS includes proposals for new wilderness and wild and scenic river reviews in the 1002 Area. Such reviews are contrary to ANILCA Section 1317, which provided for a one-time wilderness review of ANWR, and Section 1326(b), which prohibits further studies for the single purpose of establishing Conservation System Units (CSU) or for similar purposes, unless authorized by Congress.

Modern resource evaluation is continually improved by advancing technology and the findings would add value to ANWR management decisions. But unlike review of many of the environmental and surface values of ANWR, which can be monitored by remote sensing from air and space, oil and gas exploration requires on-the-ground activities. With modern technology these activities could occur with minimal impact, and scientific information could be gathered on all of ANWR's resources, both above and below ground.

2. National Environmental Policy Act (NEPA)

NEPA sets out clear guidelines for the consideration of alternatives when an agency undertakes a significant federal action (42 USC 4321-4347; 4371). These alternatives are considered in an EIS. The draft CCP/EIS for ANWR ignores key NEPA requirements including the need to consider "all reasonable alternatives," to acknowledge "incomplete or unavailable information" and address "foreseeable significant adverse effects on the human environment" (40 CFR 1502.14, 1502.22).

While some impacts on the human environment are considered in the draft ANWR CCP/EIS, NEPA's regulatory definition of "human environment" includes situations where the "economic or social and natural or physical environmental effects are interrelated" (40 CFR 1508.14). These economic and social effects are not discussed in the draft CCP/EIS.

For example, North Slope oil development supports the economic and social health of the residents of the North Slope Borough while protecting a traditional subsistence lifestyle and the natural environment. The Alaska Native Claims Settlement Act (ANCSA, 43 USC 33.1601 et seq.) supported the ability of local residents to make their own decisions about development and its benefits by vesting landownership in regional and village corporations. These events have enabled the culture on the North Slope to include a cash economy with improved public services.

It is not known what economic and social benefits development in ANWR could provide because there is no definitive scientific assessment of the oil and gas resources. The draft CCP/EIS does not provide an alternative to obtain this information and does not even acknowledge its absence. These defects are inconsistent with NEPA and may deny local residents real social and economic opportunities.

A primary residential "human environment" that would be affected by federal management decisions for ANWR is the village of Kaktovik, the only settlement in the 1002 Area (ASRC, 2013). Kaktovik residents have lived on Barter Island using a barter economy and subsistence lifestyle for centuries. A prehistoric village on the island was a seasonal home for nomadic ancestors of the present day Kaktovikmuit people (Jacobson and Wentworth, 1982). The island was an important commercial whaling and trading post, and grew as an important bartering center among the Alaska Iñupiat and Canadian Inuit (ADCRA, 2012). It became a permanent settlement in 1923. The U.S. Coast Guard and Geodetic Survey brought some wage employment to the island in 1945, and a Distant Early Warning (DEW Line) system was built. The U.S. Air Force built an airport in 1947. Kaktovik's history has shown a growth of lifestyles that blend subsistence and wage economies.

USFWS ignores the effects the draft CCP/EIS may have on the village of Kaktovik and its ANCSA landholdings. ASRC and Kaktovik Iñupiat Corporation (KIC) own 92,000 subsurface and surface acres in the Coastal Plain - a small but significant portion of ANWR's 19.8 million acres. This acreage surrounds the village of Kaktovik and is presently leased to Chevron, Texaco and BP with the intent to generate returns for the ASRC and KIC shareholders. Planning and management decisions that ignore the potential for oil and gas development within ANWR severely limits the ability of these Alaska Native corporations to develop their own lands and to provide business opportunities for residents and corporation shareholders. Failure to consider these effects are contrary to NEPA and its regulations, and additionally violate the public interest policies of Alaska's Constitution.

C. Purpose of the ANWR Resource Evaluation and Exploration Proposal

The State of Alaska Department of Natural Resources, Division of Oil and Gas (ADNR-DO&G), manages the state's oil, gas, and geothermal resources and encourages responsible development of these resources. Its mandate stems from Article VIII of the Alaska State Constitution, which governs the State's natural resource responsibilities. Article VIII, Section 1, requires "the development of [the state's] resources by making them available for maximum use consistent with the public interest." The Department has drawn on its expertise to prepare this document to address the federal administrative and management deficiencies discussed above. ADNR-DO&G has compiled publicly available information to provide a more balanced discussion and fully inform Congress in their deliberations. This document includes:

- Information on ANWR oil and gas resources;
- Potential production levels and economic benefits;
- A proposed exploration program; and
- An environmental impact analysis.

The proposal is intended to provide Congress with information not disclosed in the ANWR draft CCP/EIS nor considered by the Department of the Interior when it developed alternatives that would designate the coastal plain as Wilderness. Such action would effectively close the 1002 Area to oil and gas exploration activities without knowing the extent and potential value of the resources that are in the ground. Without a full assessment, the valuable economic opportunities that development may provide remain unknown. Furthermore, the residents of the North Slope Borough could receive substantial social and economic benefits if it was determined that oil and gas activity in the 1002 Area was appropriate. These kinds of economic activities are an essential part of the "human environment" that must be considered under NEPA.

The ANWR Resource Evaluation and Exploration Proposal draws on ADNR-DO&G's 2003 report entitled Oil and Gas in the ANWR? It's Time to Find Out! (ADNR, 2003) and was developed in a manner similar to the 1987 USDOI 1002(h) Report. The ANWR Resource Evaluation and Exploration Proposal is presented in the style of the documents used for Final Findings of the Director for State of Alaska oil and gas lease sales. The proposal presents and assesses factual information relative to the coastal plain, including:

- Property description and location;
- The petroleum potential of the area;
- Fish and wildlife species and their habitats in the area;
- Current and projected uses of the area, including uses and value of fish and wildlife;
- Governmental powers to regulate the exploration, development, and production of oil and gas;
- Reasonably foreseeable effects of exploration, development and production of oil and gas, including effects on subsistence uses, fish and wildlife habitat and populations, and historic and cultural resources;

- Potential mitigation measures to prevent and mitigate releases of petroleum products and discussion of the protections offered by these measures;
- Method(s) most likely to be used to transport oil or gas from the area, and the relative advantages and disadvantages of each;
- Reasonably foreseeable fiscal effects of any future development on the state and affected communities;
- Reasonably foreseeable effects of exploration, development, production and transportation of oil and gas on communities within or near the area.

This proposal presents oil and gas exploration as a critical alternative to consider for the CCP/EIS, and outlines a plan to assess the current resource potential in the 1002 Area. It provides a foundation of information that is already available and technologies that are currently in use to lay out a path for the activities that are needed for this definitive assessment. Without solid knowledge of the oil and gas potential of the 1002 Area, federal management decisions will not be consistent with NEPA, ANILCA, or the policy interests of Alaska and the United States. Furthermore, the Congressional debate on ANWR will be based on preliminary and outdated information that is almost 30 years old.

Chapter 2
Habitats, Wildlife, Fish, and Human Uses

A. Habitats, Wildlife, and Fish

This chapter focuses on the wildlife, fish, natural habitats and the seasonal cycles that are associated with the 1002 Area. It does not address wildlife, fish, habitats, or human activities in the Beaufort Sea or the uplands, foothills and higher elevations of the Brooks Range that are not located near the area of the proposed exploration program.

This document presents only some of the large volume of publicly available information addressing the habitats of the Alaska Arctic coastal plain and its wildlife and uses. This summary is based on substantiated data and reviewed publications that emphasize protections for habitats, populations, and Endangered Species Act (ESA) listed and overwintering species. Continued successful subsistence hunts and other human uses are directly influenced by sustained wildlife and fish populations of the coastal plain.

The discussion that follows establishes a foundation for moving forward with management of the resources of the coastal plain through understanding of its surface. With this foundation in place, policy makers can move forward to develop comparable levels of information and understanding of the geology and the oil and gas resources beneath the 1002 Area.

1. Ecoregions

The habitats in the 1002 Area can be divided into two ecoregions: the Arctic coastal plain and the northern foothills. Additionally, wetland habitats occur across the North Slope and throughout ANWR, and their characterization is of

Photo: Gil Mull

DEW Line (Distant Early Warning) site, Kaktovik

key interest to scientists, ecologists, government, and industry. Freshwater rivers, streams, and lakes flow north toward the Arctic Ocean. Habitat types in the 1002 Area of the Arctic coastal plain are wetlands, tussock meadows, and riverine corridors that provide food, nesting, and shelter for a wide variety of resident and migrating populations.

a) Arctic Coastal Plain

The Arctic coastal plain ecoregion of the ANWR 1002 Area is bounded on the north by the Arctic Ocean and Beaufort Sea, and is a poorly drained, treeless plain underlain by permafrost (Gallant et al., 1995). It gradually slopes from the ocean to the foothills of the Brooks Range to the south. Networks of ice-wedge polygons and pingos are common at the surface. There is about 5 inches (0.13 m) of precipitation annually, including a snowfall averaging 20 inches (0.5 m) (ADCRA 2012). Winds are persistent and strong year round (Gallant, et al., 1995).

Along the Beaufort Sea coast, adjacent to the ANWR boundary, saltwater-dependent habitats merge into freshwater habitats. Salt water intrudes in soils and groundwater flows. Coastal vegetation is influenced by sea spray two to three miles inland. Stream slope and freezing action in winter generally determine the distance at which salt water reaches upstream (ADGC, 1985).

The Arctic coastal plain is poorly drained, and thaw lakes cover 20 to 50 percent of the surface. The tundra surface is marked by lakes, thaw ponds, frost cracks, and polygonal ground formations. Successive freezing and thawing of moisture-laden soils causes frequent draining and reforming of lakes and surface peat. The soil beneath the tundra freezes each winter, thaws in spring, and is saturated with salt water or fresh water throughout the summer. The freeze-thaw process causes these lakes to reform each year. Tundra and grasses of the barrier islands are also exposed to freeze-thaw processes (AEIDC, 1975).

Streams originate in the south and flow toward the coast. Most streams dry up in winter, exposing sand or gravel streambeds (Gallant, et al, 1995). Some of the coastal river corridors from west to east include the Canning, Staines, Tamayariak, Katakturuk, Hulahula, Akutoktak, Okpilak, Jago, Angun, Aichilik, and Kongakut rivers, and Marsh, Carter, and Nataroarok creeks. ANWR and coastal plain waterway habitats are discussed in more detail later in this chapter.

The distribution of vegetation types on the Arctic coastal plain is strongly associated with microtopographic features which affect soil drainage. Wet soil conditions support wet graminoid herbaceous communities dominated by sedges or grasses. Dwarf scrub communities grow where soil conditions are drier, such as at thaw lake margins, along river bluffs, or other more elevated areas which provide a rooting zone above the standing water table (Gallant, et al., 1995).

Most sedge communities are dominated by *Carex aquatilis* and *Eriophorum angustifolium* (narrow-leaf cottongrass). Mosses (usually *Scorpidium spp*. or *Drepanocladus spp*.) may be common (Gallant, et al., 1995). Grass communities on the Arctic plain are dominated by *Dupontia fischeri* and *Alopecurus alpinus* (mountain foxtail); however, *Arctophila fulva* (pendent grass) dominates in surface waters of 6 to 79 inches (15-200 centimeters) in depth. Dwarf scrub communities include *Dryas integrifolia, Vaccinium vitis-idaea, Cassiope tetragona, Arctostaphylos alpina, Arctostaphylos rubra, Salix reticulata,* and *Salix phlebophylla* (Gallant et al., 1995). Secondary species include common names of lousewort and buttercup in the wetter sites, and heather and purple mountain saxifrage in the raised, drier habitats (AEIDC, 1975).

Photo: Gil Mull

Tundra ponds, ANWR coastal plain

The coastal plain joins the Beaufort Sea in the Arctic coastal zone. The near-shore area support waterfowl and shorebird nesting habitats, caribou calving and feeding grounds, and polar bear denning sites. Caribou also are influenced by availability of food in their preferred summer habitat on the coastal plain (ADGC, 1985). The coastal zone provides important spawning habitats for marine fish and invertebrates that provide waterfowl and marine birds with plentiful sources of food (ADGC, 1985). Rivers flowing into the Beaufort Sea host species that are indirectly influenced by the coastal zone. The coastal plain also includes coastal wet tundra habitat (ADGC, 1985).

b) Northern Foothills

The northern foothills consist of rolling hills and plateaus that extend from the Arctic plain to the Brooks Range (Gallant et al., 1995). The region is underlain by permafrost reportedly less than 3.3 feet (1 meter) thick. The permafrost is less thick under rivers prone to deeper thawing. Ice-related surface features include pingos, ice-wedge polygons and beaded stream drainages (Gallant et al., 1995). Smaller streams dry up or freeze to the bottom in winter. Flooding and channel shifting occur during spring snow melt and river breakup. Lake shores may experience ice-push pressure ridges up to 6.5 feet (2 meters) high. The foothills' southern extent is generally delineated at the 1,960 feet (600 meters) elevation contour of the Brooks Range. The transition environments are generally alpine tundra ecosystems (Gallant et al., 1995).

The distribution of vegetation in the northern foothills region of ANWR is also affected by soil conditions, elevation, and drainage. The region hosts tussock-sedge, dwarf-shrub, moss tundra (ARCUS, 2012). Major streams flowing from the Brooks Range are controlled by bedrock. Plant communities in lakes form concentric bands that correspond with water depth. Lakes deeper than 5 feet (1.5 meters) do not usually support aquatic plant life (Gallant, et al., 1995).

Plant communities are commonly dominated by mesic graminoid herbs and dwarf scrub. Mesic graminoid herbaceous communities are commonly dominated by tussock-forming sedges, and include *Eriophorum vaginatum* and *Carex bigelowii*. Low shrubs, such as *Betula nana* (dwarf Arctic birch), *Empetrum nigrum* (crowberry), *Ledum decumbens* (Labrador tea), and *Vaccinium vitis-idaea* (mountain cranberry) may also dominate plant communities along with sedges. Mosses and lichens are common between tussocks (Gallant, et al., 1995).

Dwarf scrub communities are dominated by *Dryas spp*., ericaceous species, and *Salix reticulata* and *Salix phlebophylla* (prostrate willows). Low scrub communities are dominated by *Alnus crispa* (alder), and *Salix lanata*, *Salix planifolia*, and *Salix glauca*. Mosses are commonly abundant (Gallant, et al., 1995). These plant communities provide an important source of nutrition for caribou as they forage on their summer range.

Waterbirds depend on or prefer certain habitat types, and attempts have been made to rank the value of these habitats. Large ungulates (caribou, muskoxen) are equally dependent on all of the vegetation habitats of the North Slope.

c) Wetlands

Wetlands are lands where saturation with water is the dominant factor in determining the nature of soils and the types of plant and animal communities living in the soil and on the surface. Wetlands occur where the water table is at or near the surface, the land at least periodically supports plants that grow partly or entirely in water (hydrophytes), and the substrate or surface is saturated with water or covered by water at some time during the growing season each year (Cowardin, et al., 1979).

For the purposes of carrying out the provisions of Section 404 of the Clean Water Act, Cowardin et al. (1979) developed a wetlands classification system for the U. S. Fish and Wildlife Service (USFWS). Subsequently, a U.S. Army Corps of Engineers (USACE) Wetlands Delineation Manual was developed for use by USACE field inspectors who make wetland determinations (USACE, 1987:7). A supplement to the manual was issued in 2007 (USACE, 2007). Since 1979, numerous classification systems have been developed for wetland habitat characterization. Today, the USACE may use many classification systems in making wetland determinations. More information and detail on site-specific characteristics would improve USACE's ability to make wetland determinations (Carpenter 1997).

Bergman, et al. (1977) identified eight wetland designations related to birds. Meehan and Jennings (1988) studied the distribution and behavior of birds on the Colville River delta, and derived nine habitat classes for large waterbirds (tundra swan, greater white-fronted goose, Pacific loon, yellow-billed loon, and brant).

They ranked the importance of habitat classes relative to usage by key bird species. Discrete lakes were used the most, followed by wet-moist polygons, brackish flats, wet graminoid, and wet-moist flooded tundra. Tapped lakes and shrub-dominant areas received an equal amount of use after the top six, followed by sedge-tussock tundra and barrens which were used the least. The authors caution that although the classes may apply to habitats across the North Slope, the ranking should only be applied to the Colville River delta, located west of the 1002 Area. For this document's purposes, it can be interpreted as a representative habitat in the Arctic coastal plain.

In a remote sensing study of snow goose brood-rearing habitat on the nearby Sagavanirktok River delta, also located to the west of ANWR, researchers Burgess and Ritchie (1988) followed the classification scheme of Walker and Weber (1980) to derive a similar habitat classification.

More complex vegetation classification systems have been developed for oil and gas development proposals; some are species-specific and some focus on terrain types. Field surveys are expensive, and increased complexity in project proposal documents provides agencies with more information to make permitting decisions. For example, in the Alpine Development Project, habitats on the Colville River delta are described with 24 habitat types, a system developed by Viereck, et al. (1992) and modeled after Cowardin, et al. (1979).

Regardless of the habitat or wetland classification system used in planning, the important points to consider are which plant species are associated with various life stages of important animals (feeding, nesting, incubation, brood rearing, etc.), and what is the most appropriate and practical way to identify those terrains and important species. For caribou, some plant species may provide greater nutritional value for migrating, gestating, and newborn animals. Because nearly all of the North Slope is wetland habitat, uplands are rare and may become more valuable to species like caribou, especially during the insect season. Non-wetland habitats include pingos, high-top polygons, steep riverbanks, gravel bars, and dunes (Carpenter, 1997). The following section discusses the habitats in the 1002 Area and some of the fish and wildlife that utilize them.

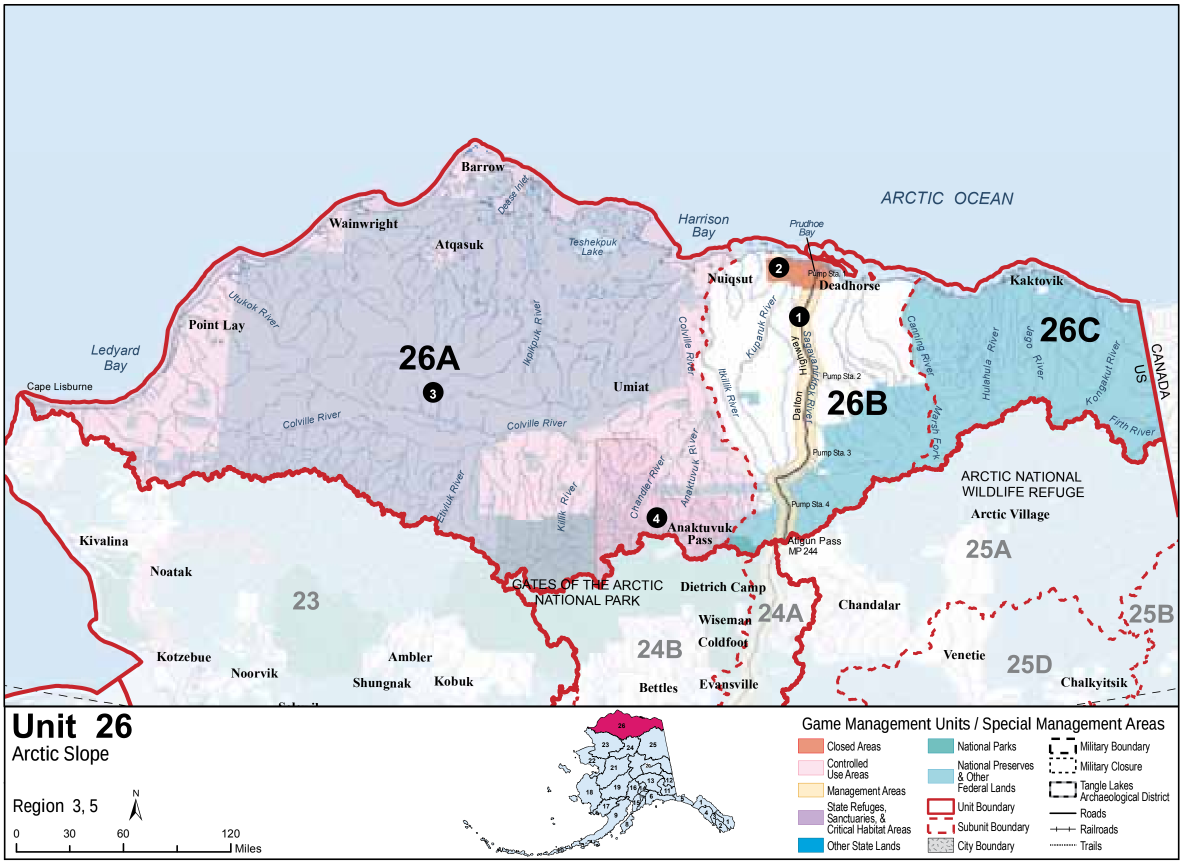
2. Terrestrial Habitats and Wildlife

The terrestrial habitats in ANWR's 1002 Area provide important habitat for wide-ranging mammal species including caribou, moose, brown bear, polar bear, muskoxen, and other furbearers. Several species of birds also find nesting habitat for migrating, and several resident bird populations are also found in the area. While ANWR is managed by the USFWS as a National Wildlife Refuge, the ADF&G manages general hunting in ANWR's Game Management Unit (GMU) 26C, which is bounded in the south by the uplands of the Brooks Range in GMU 25A.

The Federal Subsistence Board is a decision-making body that oversees the Federal Subsistence Management Program on federal lands in Alaska. The board is made up of regional directors from U.S. Fish and Wildlife Service, National

Figure 2-1

Game Management Units Arctic Region



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Source: ADF&G 2012b, Game Management Unit (BMU) information, Unit 26

Park Service, Bureau of Land Management, Bureau of Indian Affairs, the U.S. Forest Service, and three public members appointed by the Secretaries of the Interior and Agriculture (USFWS, 2013). The program provides for public participation through the Board and ten Regional Advisory Councils. While most of the subsistence harvest on federal lands in Alaska is managed under ANILCA, other federal laws also govern the harvest of some species. For example, the harvest of waterfowl and other migratory birds is co-managed by the USFWS and Alaska Natives under the Migratory Bird Treaty Act (USFWS, 2013).

a. Caribou habitats

Caribou (*Rangifer tarandus*) are members of the deer family. Two of the four North Slope caribou herds use the coastal habitats within and adjacent to ANWR, the Porcupine and the Central Arctic caribou herds. A herd is defined as a group of caribou which establishes a calving area distinct from any other group and calves there repeatedly (ADF&G, 1994). The Porcupine caribou herd ranges in ANWR, south from the Beaufort Sea coast, from the Canning River eastward into Canada (Figure 2-2; USGS, 2002). The range of the Central Arctic caribou herd extends from the southern foothills of the Brooks Range to the Beaufort Sea and from the Colville River to east of the Canning River (Figure 2-2; USGS, 2002).

Photo: Steve Schmitz, ADNR-DO&G

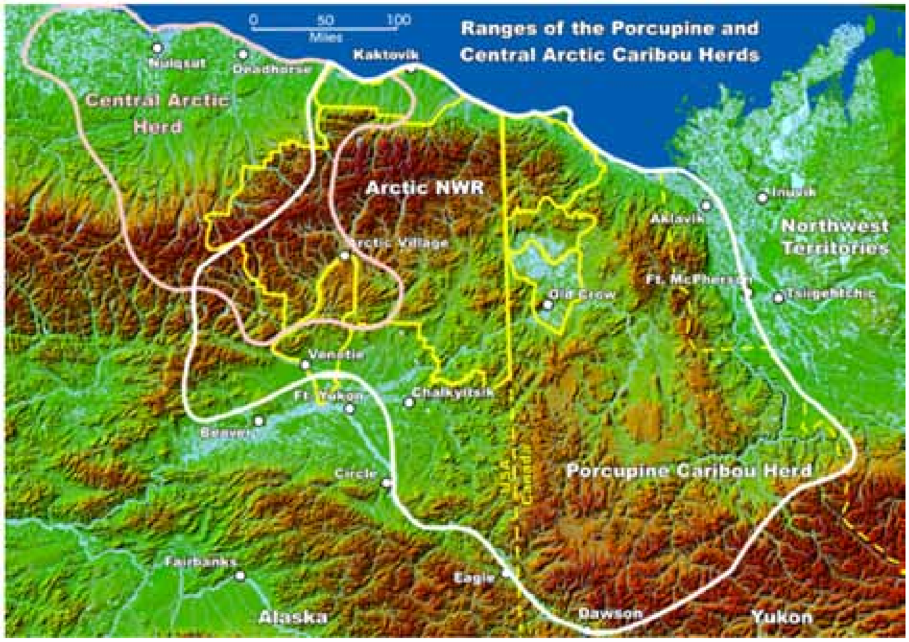
North Slope Caribou.

Caribou must keep moving to find adequate food. This distributes feeding pressure and tends to prevent overgrazing. Caribou are great wanderers and very efficient at moving across both boggy and rugged terrain. They commonly travel vast distances to reach suitable foraging sites on widely separated seasonal ranges. Feeding opportunities are limited in windswept insect relief areas, so caribou move inland to better foraging areas whenever insect harassment temporarily subsides, and return to the coast when harassment increases. In summer, caribou eat a wide variety of plants, apparently favoring the leaves of willows, grasses, sedges, and herbaceous and flowering plants. During winter, they use windswept upland areas or areas of lighter snow cover where they can dig through the snow to feed on lichens, "reindeer moss," and dried sedges (ADF&G, 1994).

Caribou normally move toward the coast to calve and escape the predators of their winter range. Caribou summer on the Arctic coastal plain. Calving occurs in late May or early June mostly within 30 miles of the coast. Coastal areas seem to be preferred calving habitats, but calving occurs further inland as well (Baker, 1987). Newborn calves can walk within an hour of birth. After a few days, they can outrun a man and swim across lakes and rivers.

In midsummer, from mid- to late June through July, caribou are often harassed by hordes of mosquitoes, warble flies, and bot flies (or nose bot flies). Movement during the summer is closely tied to insect harassment. In response, caribou move from inland feeding areas to windswept, vegetation free coastal areas where the insects are limited. Sometimes the animals run in frenzies for long distances, stopping to rest only when exhausted or when wind offers relief from the insects (ADF&G, 1994). Most insect relief areas are found within two miles of the coast (ADF&G, 1986b); however, caribou also tend to congregate on gravel drilling pads and roads which are generally raised above the tundra and more exposed to the elements (USACE, 1984).

Figure 2-2 *Ranges of the Porcupine and Central Arctic Caribou Herds*



Source: USFWS 2012a

Porcupine Caribou Herd (PCH)

The PCH migrates from uplands in Alaska and central Yukon to the coastal plain of the Yukon and ANWR (ADF&G, 2009a). In 2008, field observations located caribou from the Babbage River, Yukon, to the Konagakut River, Alaska, during calving. No radio-collared cows were located in the 1002 Area of ANWR. Previous observations in the 1980s and 1990s located PCH caribou calving that included areas in the 1002 Area (ADF&G, 2009a). It was also reported that during 2002-2008 calving on the coastal plain occurred primarily in the Yukon between the Alaska-Canada border and Babbage River, Yukon. In summary, since 2002, important calving areas are from the Jago River, Alaska to the Babbage River, Yukon, and may be weather-dependent as a result of deep snow that delays migration.

Summer range of the PCH is annually variable but includes the coastal plain and the foothills and mountains of the Brooks Range on both sides of the continental divide. The PCH fall migration occurs from August through November and results in caribou distribution extending from summer range to winter range. The winter distribution of PCH is annually variable but primarily includes the south side of the Brooks Range in Alaska, the Old Crow Flats and Ogilvie Mountains in Yukon Canada, and the Richardson Mountains in Northwest Territories, Canada. The PCH is rarely found in the 1002 Area during the winter when most exploration activities would take place.

The most recent photocensus of the PCH occurred in 2010 which resulted in a population estimate of 169,000 caribou (Caikoski, 2011, pre-publication).

Central Arctic Caribou Herd (CAH)

CAH calving occurs in late May or early June mostly within 30 miles of the coast of the Beaufort Sea. The CAH spends June through mid-August near the Arctic coast primarily between the Colville and Canning rivers, located to the west of ANWR (Whitten, 1995)(Map Figure 2-2). Since 2008, the CAH has expanded its summer range (particularly during the first 2 weeks of July) into ANWR as far east as the Canadian border.

The CAH fall migration south begins in late August and ends by late November. During both the spring and fall migrations, the CAH tends to move along or near major river drainages.

Since 2001, most of the CAH wintered in the southern foothills of the Brooks Range, east of the Dalton Highway. Small groups of the CAH remain on the coastal plain during winter. The CAH is not found in the 1002 Area during the winter when most exploration activities would take place.

Caribou calf survival and adult mortality are primary factors affecting the size and growth of caribou herds. The ADF&G reported that the Central Arctic caribou herd (CAH) has grown sharply in numbers since 2002. This herd occupies areas in the Prudhoe and Kuparuk oil fields, and population estimates grew from 32,000 animals in 2002 to 67,000 animals in 2008 (RDC, 2009). A photocensus conducted in July 2010 resulted in a count of 70,034 caribou with an annual rate of increase of 9.4 percent between 1995 and 2001 (Lenart, 2011a).

b. Moose

Moose (*Alces alces gigas*) are currently distributed across the North Slope region, but concentrated along riparian habitat of major rivers flowing north from the Brooks Range. Following the snow melt, usually in May, moose may disperse across the tundra coastal plain. Many move into small tributaries and upland hills surrounding riparian habitat.

Photo courtesy of Alaska Division of Tourism

Moose occur sporadically on the North Slope.

Moose breed annually and calves are born anytime from mid-May to early June (ADF&G, 1994). Rutting occurs during the fall between late September and early October. During this period, moose may aggregate in groups of up to 30 bulls and cows, with movement of individuals between the groups (ADF&G, 1986a). During late fall, as snow cover accumulates, moose move to riparian corridors of the large river systems, such as the Canning, on the west boundary of ANWR (ADF&G, 2010a; ADF&G, 1986a). Moose may not be observed in large numbers on the Arctic coastal plain in winter.

Moose eat a variety of plants, particularly sedges, equisetum (horsetail), pond weeds, and grasses. During summer, moose feed on forbs, vegetation in shallow ponds, and the leaves of birch, willow, and aspen. Willow stands along rivers and streams provide essential habitat for moose. These riparian areas are especially important during winter when forage is mainly confined along major drainages where shrubs will not be covered by drifting snow (Sousa, 1992).

Following the snow melt, usually around the beginning of May, moose occasionally disperse across the tundra, but are mainly found at varying elevations in the foothills. Calving also occurs at this time. Deep, crusted snow that can lead to malnutrition, and predation by wolves and bears can combine to limit the growth of moose populations in Alaska (ADF&G, 1994).

The North Slope habitat also sharply limits the potential size of moose populations (ADF&G, 2010a). Moose in the ANWR region are generally associated with narrow strips of shrub communities along drainages, and may undertake extensive movements within or between these drainages (Lenart, 2004). The distribution of moose on Alaska's North Slope has historically been characterized as sporadic, or at low densities (ADF&G, 2010a). Moose were scarce in Arctic Alaska prior to the early 1950s (LeResche, et al., 1974).

Historic moose population estimates for GMU 26B and 26C, the central and eastern coastal plain on the North Slope, reportedly peaked during the late 1980s, estimated at about 1,400 animals (ADF&G, 2010a, citing to Lenart 2004, Martin and Garner 1984, Mauer and Akaran 1994). Dramatic declines in moose populations noted during the early 1990s were probably due to a combination of factors including disease, weather, habitat limitations, insect harassment, and heightened predation by wolves and brown bears. No actual surveys were conducted in the 1990s, but estimates from anecdotal observations suspected very low numbers (ADF&G, 2010a). By 2003, state biologists observed increases in moose populations over much of the region, and surveys found concentrations of moose along the Canning River, along the western ANWR boundary (Lenart, 2004). Surveys in the 2000s in the coastal plain of central GMU 26C indicated about 50 to 60 moose (ADF&G, 2010a). In 2011, 339 moose were observed in eastern Unit 26C in the northern foothills of the Brooks Range, in the upper Kongakut and Firth Mancha rivers (ADF&G, 2011a, unpublished files). The moose survey and population information support that moose may, therefore, be found in limited numbers on the Arctic coastal plain in winter.

c. Brown Bear

Brown bears (*Ursus Arctos*) travel major river corridors in the spring and summer and frequently den along riverbanks in the fall. The bears feed extensively in riparian areas in spring and summer because these areas provide them with the greatest diversity of foods.

In the winter, when food is unavailable or scarce, brown bears enter dens to hibernate. Brown bears enter their dens from mid-October through November where they may spend 5 to 7½ months (Ott, 1997). On the coastal plain, bears den in low hills, dry lake margins, pingos, and stream banks to within at least 20 miles of the coast (Ott, 1991). Recent ADF&G brown bear research confirms that some of the bears in the vicinity of the oil fields den within a mile of the coast (Ott, 1997). On the eastern North Slope, male bears emerge from their dens during April, and female brown bears with cubs emerge from mid-May through the end of May.

Photo courtesy of Alaska Division of Tourism

Brown bears frequently den along riverbanks.

Except for females with offspring and breeding animals, bears are typically solitary and avoid other bears. Exceptions to this occur where food sources are concentrated, such as marine or terrestrial mammal carcasses. In the spring, brown bears are commonly found in major river valleys. They later move to small tributaries and poorly drained areas to feed.

Mating takes place from May through July with the peak of activity in early June. The young are born the following January or February in a winter den. Bear populations vary depending on the productivity of the environment. In areas of low productivity, studies have revealed bear densities as low as one bear per 300 square miles (ADF&G, 1994).

Brown bears consume a wide variety of foods including berries, grasses, sedges, horsetails, cow parsnips, fish, ground squirrels, ungulates (especially neonate ungulates), and roots of many kinds of plants. On the eastern North Slope, brown bears also prey on adult and calf muskoxen, particularly during April through June. Bears also eat all types of carrion as well as garbage in human dumps. Brown bears have an especially good sense of smell and under the right conditions may be able to detect odors more than a mile distant (ADF&G, 1994). During the summer bears most frequently feed in wet sedge meadows, late snow bank areas, and tussock tundra, concentrating on grasses, sedges, and the fruiting and vegetative stems of horsetails. In the fall, bears use the floodplains of large creeks and rivers, dry ridge areas or mountain slopes to feed on roots, berries, and ground squirrels (ADF&G, 1986a).

The population of brown bears in GMU 26C, in the eastern coastal plain of ANWR, is estimated to be about 390 bears and is based on a 1993 estimate. The availability of habitat in the area has not changed substantially since 1993. Harvest has been below a sustainable yield of 5 percent since 1993 and most harvest has been male bears and likely did not affect the size of the bear population (ADF&G, 2009c).

d. Polar Bear

Polar bears (*Ursus maritimus*) are found in both the terrestrial and marine habitat types in and off the coast of ANWR. They are marine mammals and are protected under the Marine Mammal Protection Act of 1972, as well as listed as a threatened species under the federal Endangered Species Act (ESA).

Polar bear numbers have dramatically increased over 30 years as a result of conservation measures enacted through international agreements and the Marine Mammal Protection Act. According to the International Union for Conservation of Nature and Natural Resources (IUCN), it is estimated that there are currently 20,000 to 25,000 polar bears, a substantial increase from the early 1970s. Although no Distinct Population Segments (DPS) have been identified across the Arctic circumpolar region, the IUCN has established 19 management units for purposes of research and management (IUCN, 2006). Two of these overlap Alaska, the Southern Beaufort and the Chukchi Sea sub-populations.

Polar bears breed from late March to May (ADF&G, 1994). During late October and November, pregnant females search for banks, slopes, or rough ice in which to dig a den, either on land or on sea ice (ADF&G, 1994). Litters of one to three cubs are born in December or January (Smith and Walker, 1995). In late March or early April, polar bears emerge from the den with their cubs and begin making excursions to drifting sea ice (ADF&G, 1994).

Photo by Robert Angell, Alaska Division of Tourism

Polar bears have increased significantly in numbers as a result of conservation measures.

Polar bears from the South Beaufort Sea are not dispersed evenly throughout their range (USFWS, 2010a, citing to Stirling et al., 1999, Durner, et al., 2004, Durner, et al., 2006, and Durner, et al., 2009). Radio collar surveys indicate that the Beaufort Sea population dens locally, and is not dependent on reproduction from other known denning areas outside of the region (Amstrup and Garner, 1994). Polar bears have historically denned on both the sea ice and land (USFWS, 2010a), and do not exhibit site fidelity in denning, but return only to the general substrate and geographic area upon which they had previously denned: on ice or on land, and in the eastern or the western Beaufort respectively. The most preferred region for land denning is located in the northeast corner of Alaska and adjacent to Canada (Amstrup and Garner, 1995). The reported main terrestrial denning areas for the Southern Beaufort Sea population in Alaska is reported to be on the barrier islands from Barrow to Kaktovik and along the sea coast up to 25 miles inland in ANWR (USFWS, 2010a, citing to Amstrup and Garner, 1994, Amstrup, 2000, Durner, et al., 2001, Durner, et al., 2006).

Polar bears' primary food is reported as the ringed seal that inhabits the Arctic ice areas (ADF&G, 1994). The presence of the ringed seal attracts polar bears to the coastlines and the southern edge of sea ice, and they may make extensive seasonal movements related to the ice edge (ADF&G, 1994). Other prey include bearded seals, walruses, and beluga whales, and polar bears will eat small mammals, bird eggs, and vegetation. Polar bears also feed on whale, walrus and seal carcasses (ADF&G, 1994).

Beaufort Sea polar bear population ranges between 1,500 and 1,800 bears from data collected from 1986 through 2006. (Regehr et al., 2006, USFWS, 2010a). These populations, as with other polar bears across the Arctic, are being studied for the risk of population decline due to melting sea ice.

e. Muskoxen

Alaska's muskoxen (*Ovibos moschatus*) are well adapted to the Arctic climate. The original populations disappeared in the mid- or late 1800s as a result of a combination of over-hunting and climate factors. They were re-introduced into the Arctic National Wildlife Refuge (ANWR) in 1969 (51 animals) and in 1970 (13 animals).

Muskoxen are not migratory, but they may move in response to seasonal changes in snow cover, vegetation, and natural behavior. Riparian habitat is preferred by muskoxen for virtually their entire annual cycle. River systems that provide diverse low shrub forbs and tall willow communities in proximity to relatively snow free uplands, hillsides, and plateaus are important to muskoxen (Sousa, 1992). Bare cover was selected as habitat for all seasons, except spring. Mountain terrain was avoided in all seasons (USGS, 2002, citing to Reynolds, 1998).

Photo: Christina Holmgren-Larson, ADNR

Muskoxen right outside Deadhorse, North Slope.

Muskoxen are relatively sedentary in the winter (October — May), possibly as a strategy for conserving energy. Muskoxen tend to remain in one location for winter, and form larger groups of 6-60 animals in size (ADF&G, 2011b). Many bull muskoxen move from mixed-sex groups during the summer to bull groups during the winter. Females calve from early April to mid-June. The rutting season generally begins in August (Sousa, 1992).

Muskoxen eat a wide variety of plants, including grasses, sedges, forbs, and woody plants. In summer and fall, both sexes may be found along major river drainages where they feed on willows and forbs. In winter and spring, muskoxen groups of 10 to 20 animals may be found in uplands adjacent to river drainages, which afford forage of tussock sedges and have less snow cover (Clough, et al., 1987). Muskoxen are poorly adapted for digging through heavy snow for food, so winter habitat is generally restricted to areas with shallow snow accumulations or areas blown free of snow (ADF&G, 1994).

During the 1980s and 1990s, the muskoxen herd grew substantially and expanded their range both to the west into Units 26A and 26B and to the east into Canada. The muskox herd peaked in the 1990s to about 800 muskoxen, including the 100 animals that had moved into Yukon, Canada (Lenart, 2011a). Beginning in 1999, the muskox population in ANWR began to decline; by 2003 muskoxen numbers in ANWR had fallen to about 29 muskoxen, and counts of one to 44 animals in years 2004-2008 (ADF&G, 2011b, citing to Reynolds, 2008). In 2012 ADF&G reported that 17 muskoxen were observed on the Canning River, on the west boundary of ANWR (ADF&G, 2012e). Muskoxen declines may have been caused by brown bear predation, disease, mineral deficiencies, adverse weather conditions, and long snow seasons that reduce access to winter forage (ADF&G, 2011b; USFWS, 2005).

f. Furbearers

Other species that may be found in the area include arctic fox, red fox, wolf, and wolverine. Information on the abundance and distribution of these species is limited.

Arctic foxes (*Alopex lagopus*) are found within ANWR, and the southern boundary of the known habitat on the North Slope is the southern extent of the coastal plain (Burgess, 2000, citing to Smits and Slough, 1993). Arctic foxes may move long distances over sea ice. A fox tagged along the coast of Russia was captured a year later near Wainwright, Alaska (ADF&G, 1994).

Arctic fox pups are born in dens excavated by the adults in sandy, well-drained soils of low mounds and river cut banks. Most dens have southerly exposure. They extend from 6 to 12 feet underground. Enlarged ground squirrel burrows with several entrances are often used as dens (ADF&G, 1994).

Mating occurs in early March through early April. Pups emerge from the den at about three weeks old and begin to hunt and range away from the den at about three months. Arctic foxes attain sexual maturity at nine to ten months, but many die in their first year (ADF&G, 1994).

Arctic foxes have increased in the Prudhoe Bay oil fields, where their population densities are greater than in surrounding undeveloped areas. They commonly feed, den, and rest around development sites (BLM, 2005). Arctic foxes are omnivorous. In summer, they feed primarily on small mammals, including lemmings and tundra voles. They sometimes eat berries, eggs, and scavenged remains of other animals. Many foxes venture onto the sea ice during winter to eat the remains of seals killed by polar bears. In areas where lemmings and voles are the most important summer prey, fox numbers often rise and fall with cyclic changes of their prey. Fewer pups are successfully reared to maturity when food is scarce. There is evidence that competition for food among young pups accounts for some of the heavy mortality in this age group (ADF&G, 1994).

Photo: Christina Holmgren-Larson, ADNR

Red Fox, North Slope

Wolves (*Canis lupus*) are adaptable and exist in a wide variety of habitats including the Arctic tundra along the Beaufort Sea. Wolves are members of the family Canidae. They are highly social animals and usually live in packs averaging six to seven animals (ADF&G, 1994).

Wolves normally breed in February and March, and litters averaging about five pups are born in May or early June. Pups are usually born in dens dug as deep as 10 feet into well-drained soil. Adult wolves generally center their activities near dens, but may travel as far as 20 miles in search of food, which is regularly brought back to the den. Wolf pups are weaned gradually during mid-summer. In mid- or late summer, pups are usually moved some distance away from the den and by early winter are capable of traveling and hunting with adult pack members. Wolf packs often travel 10 to 30 or more miles in a day during winter. Dispersing wolves have been known to move from 100 to 700 miles from their original range (ADF&G, 1994).

In spite of a generally high birth rate, wolves rarely become abundant because mortality is high. In much of Alaska, hunting and trapping are the major sources of mortality, although diseases, malnutrition, accidents, and particularly preying by other wolves act to regulate wolf abundance (ADF&G, 1994).

Wolves are carnivores, feeding primarily on moose and caribou. During summer, small mammals including voles, lemmings, ground squirrels, snowshoe hares, beaver, and occasionally birds and fish are supplements in the diet. Wolves are opportunistic feeders; very young, old, or diseased animals are preyed upon more heavily than other age classes. Under some circumstances, however, such as when snow is unusually deep, even animals in their prime may be vulnerable to wolves (ADF&G, 1994).

Wolf populations fluctuate according to changes in prey populations (caribou and moose), and hunting by humans. Some of the highest wolf densities on the

Photo by Robert Angell, Alaska Division of Tourism

Wolves are adaptable and live in a wide variety of habitats.

North Slope occur along the riverine systems, such as the Colville River. The ADF&G reports that wolf populations in ANWR appear to be stable (ANWR GMUs 25A, 25B, 25D, 26B, and 26C) (ADFG, 2009b).

Wolverines (*Gulo gulo*) are primarily found in Alaska's wilder and more remote areas (ADF&G, 1994). They frequent all types of terrain and often utilize rivers as territorial boundaries (Clough, et al., 1987). Wolverines occur throughout the Arctic coastal plain but are considered more common in the mountains and foothills of the Brooks Range (BLM, 2005). Wolverines travel extensively in search of food. They are opportunistic; eating about anything they can find or kill and are well adapted for scavenging. Wolverines can survive for long periods on little food. Their diet varies from season to season depending on food availability. In the winter, wolverines rely primarily on the remains of moose and caribou killed by wolves and hunters, or animals that have died of natural causes (ADF&G, 1994). Wolverine harvests have not been reported in GMU 26C on the Arctic coastal plain in the hunter harvest surveys conducted in 2006 through 2008 (ADF&G, 2010b).

g. Birds and Waterfowl

Major concentrations of birds have been documented to occur in and near portions of ANWR's 1002 Area during several months of the year (see Table 2-1). Several habitat categories listed in Table 2-1 are located outside the proposed exploration program area. These habitat categories are presented only as informational, representative data for the bird populations found on the North Slope of Alaska. A variety of bird species are found among the several habitat types within the coastal plain, mostly in the summer months. However, the reported migration lifecycles of these birds show evidence that most of these species are not present in the Arctic coastal plain in winter.

The discussion below is presented to demonstrate the large volume of publicly available information of migrating and resident bird species and their habitats. This information is sufficient for proceeding with a plan for balanced management of the 1002 Area that could include oil and gas resource exploration. The discussion is general in scope for various habitats and the birds found on the Arctic coastal plain. However, the proposed exploration program will occur primarily in winter, and data supports that very low numbers of birds will be present during winter activities in the 1002 Area.

Table 2-1 Birds and Bird Habitats Common to the Alaska North Slope and ANWR

Common Name	Scientific Name	Offshore Areas[a]	Barrier Islands/ Lagoons[b]	Estuary	Wetlands Tide flat[c]	Rivers, Lakes, Streams	Uplands
Yellow-billed loon	*Gavia adamsii*	X	X	X	X	X	
Pacific loon	*Gavia arctica*	X	X	X	X	X	
Red-throated loon	*Gavia stellatastellate*	X	X	X	X	X	
Tundra swan	*Cygnus columbianus*			X	X	X	X
White-fronted goose	*Anser alibifrons*			X	X	X	X
Snow goose	*Chen caerulescens*			X	X	X	X
Canada goose	*Branta Canadensis*			X	X	X	X
Black brant	*Branta bernicla*		X	X	X	X	X
Mallard	*Anas platyrhynchos*				X	X	X
Pintail	*Anas acuta*				X	X	X
Green-winged teal	*Anas crecca carolinensis*				X	X	X
American wigeon	*Anas Americana*				X	X	X
Northern shoveler	*Anas clypeata*				X	X	X
Greater scaup	*Aythya marila*				X	X	X
Lesser scaup	*Aythya affinis*				X	X	X
Common eider	*Somateria mollissima*	X	X	X	X	X	
King eider	*Somateria spectabilis*	X	X	X	X	X	
Steller's eider	*Polysticta stelleri*	X	X	X	X	X	
Spectacled eider	*Somateria fischeri*	X	X	X	X	X	
Long-tailed duck	*Clangula hyemalis*	X	X	X	X	X	
Surf scoter	*Melanitta perspicillata*	X	X	X	X	X	
White-winged scoter	*Melanitta deglandi*	X	X	X	X	X	
Red-breasted merganser	*Mergus serrator*			X	X	X	
Rough-legged hawk	*Buteo lagopus*			X	X		
Northern Harrier	*Circus cyaneus*				X		X
Golden eagle	*Aquila chrysaetos*				X		X
Gyrfalcon	*Falco rusticolus*				X		X
Peregrine falcon	*Falco peregrinus*				X		X
Willow ptarmigan	*Lagopus lagopus*						X
Rock ptarmigan	*Lagopus mutus*						X
Semipalmated plover	*Charadrius semipalmatus*		X		X	X	X
American golden plover	*Pluvialis dominica*		X		X	X	X
Killdeer	*Charadrius vocifeurs*		X		X	X	X
Black-bellied plover	*Pluvialis squatarola*		X		X	X	X
Bar-tailed godwit	*Limosa lapponica*				X	X	X
Buff-breasted sandpiper	*Tryngites subruficollis*		X		X	X	X
Long-billed dowitcher	*Limnodromus scolopaceus*				X	X	X

Ruddy turnstone	*Arenaria interpress*		X		X	X	X
Common Name	Scientific Name	Offshore Areas	Barrier Islands/ Lagoons	Estuary	Wetlands Tide flat	Rivers, Lakes, Streams	Uplands
Common snipe	*Capella gallinago*		X		X	X	X
Whimbrel	*Numenius phaeopus*		X		X	X	X
Spotted sandpiper	*Actitis macularia*		X		X	X	X
Pectoral sandpiper	*Calidris melanotos*		X		X	X	X
Rufus-necked sandpiper	*Calidris ruficollis*	X		X	X	X	
White-rumped sandpiper	*Calidris fuscicollis*		X		X	X	X
Dunlin	*Calidris alpinaalpine*		X		X	X	X
Baird's sandpiper	*Calidris bairdii*		X		X	X	X
Sanderling	*Calidris alba*		X		X	X	X
Semipalmated sandpiper	*Calidris pusilla*	X		X	X	X	
Red phalarope	*Phalaropus fulicaria*	X	X	X	X	X	X
Northern phalarope	*Phalaropus lobatus*	X	X	X	X	X	X
Parasitic jaeger	*Stercorarius parasiticus*	X	X		X		X
Pomarine jaeger	*Stercorarius pomarinus*	X	X		X		X
Long-tailed jaeger	*Stercorarius longicaudus*	X	X		X		X
Glaucous gull	*Larus hyperboreus*	X	X	X	X	X	X
Thayer's gull	*Larus thayeri*	X	X	X	X	X	X
Herring gull	*Larus argentatus*	X	X	X	X	X	X
Mew gull	*Larus canus*	X	X	X	X	X	X
Black-legged kittiwake	*Rissa tridactyla*	X					
Sabine's gull	*Xema sabini*	X	X	X	X	X	X
Arctic tern	*Sterna paradisaea*	X	X	X	X	X	X
Thick-billed murre	*Uria lomvia*	X					
Black guillemot	*Cepphus gryllegrille*	X	X				
Short-eared owl	*Asio flammeus*				X		X
Snowy owl	*Nyctea scandiaca*				X		X
Horned lark	*Eremophila alpestris*				X		X
Common raven	*Corvus corax*				X		X
Black-billed magpie	*Pica pica*				X		X
Robin	*Turdus migratorius*				X		X
Gray-cheeked thrush	*Catharus minmus*				X		X
Northern shrike	*Lanius exubitor*				X		X
Wheatear	*Oenanthe oenanthe*				X		X
Bluethroat	*Luscinia avacica*				X		X
Arctic warbler	*Phylloscopus borealis*				X		X
Yellow wagtail	*Motacilla flava*				X		X
Water pipit	*Anthus spinoletta*			X	X		
Wilson's warbler	*Wilsonia pusilla*				X		X
Hoary redpoll	*Carduelis hornemanni*				X		X
Common redpoll	*Carduelis flammea*					X	X
Savannah sparrow	*Passerculus sandwichensis*					X	X

Common Name	Scientific Name	Offshore Areas	Barrier Islands/ Lagoons	Estuary	Wetlands Tide flat	Rivers, Lakes, Streams	Uplands
Tree sparrow	*Spizella arborea*						X
White-crowned sparrow	*Zonotrichia leucophrys*					X	X
Fox sparrow	*Passerella iliaca*					X	X
Dark-eyed junco	*Junco hyemalis*					X	X
Lapland longspur	*Calcarius lapponicus*					X	X
Snow bunting	*Plectrophenax nivalis*					X	X

Source: Ott, 1992; ADNR, 1990.
a , b , c - Note: Several habitat categories listed are located outside the proposed exploration program area (offshore areas, barrier islands/lagoon, wetlands/tide flats). These habitat categories are presented only as informational, representative data for the bird populations found on the North Slope of Alaska.

Very important nesting and breeding areas for waterfowl include river deltas, including the Canning River (MMS, 1996). These river deltas provide brood-rearing habitats for tundra swans, black brant, snow geese, and Canada geese. As an example, Howe Island, located in the Sagavanirktok River delta, west of ANWR, is the location of one of the few known snow goose nesting colonies in the United States (Sousa, 1992). Several Beaufort Sea islands are important for nesting common eider. Thousands of long-tailed ducks concentrate near Flaxman Island, near northwest ANWR, to molt (Bright, 1992). Greater white-fronted geese are also found nesting and rearing in the major river deltas and other coastal plain areas (Ott, 1997).

The most abundant marine and coastal species of birds on the North Slope include red phalarope, northern pintail, long-tailed duck, glaucous gull, and king and common eider. Nearly all of these species are migratory and are found in the Arctic seasonally, generally from May through September. Shortly after spring migration, most shorebird and waterfowl populations disperse to nesting grounds, primarily on tundra and marshlands of the Arctic slope. Beginning in late June, large concentrations of long-tailed ducks and eider occur in coastal waters inshore of islands where the birds feed and molt before fall migration. Use of lagoons and other coastal habitats peaks in August to late September before and during the fall migration (MMS, 1996). Additionally, the Steller's eider and the spectacled eider are listed as threatened under the ESA and may be found in ANWR.

Northern pintails are among the Arctic coastal plain's most common duck species (BLM, 2005). Numbers fluctuate from year to year and, though no significant population trends have been reported in the Arctic coastal plain, declines in northern pintail populations have been documented in the lower 48 states and Canada (BLM, 2005, citing to USFWS, 2003). Northern pintails winter in other locations distant from the Arctic coastal plain area (BLM, 2005).

Long-tailed ducks are common and together with northern pintails make up about 85 percent of the total Arctic coastal plain duck population (BLM, 2005). Nests consist of small, cup-like hollows. In the Beaufort Sea area, most eggs hatch from July 16 to July 28. Male long-tailed ducks begin moving in late June to protected coastal areas in lagoons and large lakes and form massive molting flocks (Ott, 1997). Fall migration away from the coastal plain begins in late September or early October (Johnson and Herter, 1989).

Red phalaropes are common migrants and breeders throughout the Beaufort Sea coast. They appear in late May or early June. Nesting takes place in hummocky, moss-sedge tundra interspersed with numerous ponds. The fledging period is 16 to 18 days. Males then abandon the young and depart the breeding area. Adult migration commences from early June to mid-August. The young depart the nesting areas from mid-August to early September (Johnson and Herter, 1989). Phalaropes winter in locations distant from the ANWR coastal plain (BLM, 2005).

Glaucous gulls are common migrants and breeders in the Beaufort Sea area. They usually arrive during May. Glaucous gulls select several types of nesting sites, depending on availability. Pairs nest either on low islands and sandbars near the coast, or on inland river bars or small islands in lakes. They are most common on barrier islands immediately offshore from rivers that flood in the spring and thereby protect the nests from foxes. On level terrain, nests may be as much as a meter high and are composed of vegetation. Occasionally, nests consist of a simple depression in the beach and have little or no lining material. Egg-laying begins in mid-June and continues through late June. Hatching begins in the second week of July. Chicks are attended by both parents until they fledge in 45 to 50 days. During the breeding season these gulls prey heavily on the eggs and chicks of other birds. Fall migration away from Alaska habitats begins in mid-September with the young remaining somewhat later than most adults (Johnson and Herter, 1989).

King eiders remain the Arctic coastal plain's most abundant eider species even though counts of migrating birds passing Point Barrow suggest the king eider population has declined by approximately 56 percent since 1976 (BLM, 2005). Despite reports of earlier declines, Larned et al. (2003) recorded an increasing trend between 1993 and 2003 for king eiders on the Arctic coastal plain during summer seasons. King eiders winter as far north as open water is available in the Bering and Chukchi Seas and through the Aleutian Islands to Kodiak Island (BLM, 2005).

Common eiders are abundant in the Beaufort Sea area. Sometimes called Pacific eiders, these sea ducks arrive from late May to early June. Nearshore coastal distributions conducted on the Arctic coastal plain during nesting surveys suggest that breeding pairs are most numerous along the coast between the Colville River delta and the Canadian border (BLM, 2005). Common eiders most frequently nest on barrier islands and spits from mid- to late June. Nests are usually placed in well-protected areas near logs, in driftwood, between rocks, or in thick vegetation. Young are usually led directly to water soon after they hatch. Fledging occurs from 6 to 12.5 weeks after hatching. Males then leave nesting areas for molting areas in the vicinities of Point Lay, Icy Cape, and Cape Lisburne in western Alaska. Females and their young begin the fall migration in late August or early September (Johnson and Herter, 1989). Most Beaufort Sea common eiders likely winter from the Bering Sea pack ice south to the Aleutian Islands and Cook Inlet (BLM, 2005), and are not present on the ANWR coastal plain in winter.

Tundra swans are common breeders on the coastal plain of the North Slope. The Colville River delta supports densities of breeding tundra swans that are three to five times greater than other Arctic areas of Alaska. Tundra swans begin nesting during the last week of May and the first two weeks of June. Nests are large (approximately 1 meter high and up to 2 meters in diameter) and widely scattered. The nests are generally located on sedge tundra. After hatching in late June or early July, broods are reared in nesting territory (Smith, et al., 1993). Adults molt from mid-July through August. Fall migration occurs from late September to early October, and these birds are not found on the coastal plain in winter (BLM, 2005).

Black brant are common migrants and breeders along the Beaufort Sea coast. These small, coastal geese nest on islands in the deltas of the Colville and Sagavanirktok Rivers. Nesting takes place in June. Newly hatched goslings leave the nest within 48 hours and move to nearby tidal flats where they spend the brood-rearing period. Brood-rearing ends and the fall migration begins around the second week of August. Some brant remain in the Beaufort Sea area until late September or early October, but are not found in the Beaufort over winter (Johnson and Herter, 1989).

Photo: Steve Schmitz, ADNR-DO&G

King eider, North Slope

Snow geese may frequent ANWR, but nest in three colonies in Alaska in locations west of ANWR. Snow geese arrive in the Arctic coastal plain, specifically in the Sagavanirktok River delta to the west of ANWR, during the last week of May and occupy nesting habitat on the coastal Howe Island for the first days of June. They lay their eggs within four days to a week after they arrive in nests of grass and bits of willow built on high ground. Eggs usually hatch during the last week of June or the first week of July. Goslings fledge at about seven weeks. They leave the brood-rearing areas by approximately August 15 to August 20 and congregate in immense flocks on the coastal tundra to feed almost continuously. Snow geese from the Howe Island colonies often move to the Kadleroshilik River delta to rear in the salt marshes, also located west of ANWR (Ott, 1992). Half of the snow geese from the Howe Island colony take their broods to the Kadleroshilik River salt marshes for the months of July and August (Sousa, 1992). Fall migration begins in the second or third week of September (Johnson and Herter, 1989). These birds are reportedly not present during winter months.

Canada geese arrive along the Arctic coast during the last two weeks of May and the first week of June. They nest primarily away from the sea coast, on bluffs along the Colville River. However, some isolated pairs have been found nesting in moderate densities in coastal wetlands near Prudhoe Bay. They usually lay their eggs during the first or second week of June. Eggs hatch within the first two weeks of July. After the goslings have fledged in mid-August, flocks begin dispersing along the Beaufort Sea and begin their southward migration away from the coastal plain (BLM, 2005). They are not expected to be found in ANWR.

Greater white-fronted geese are common breeders along the Beaufort Sea coast. They reach Beaufort Sea breeding areas from the second week of May to the first week of June. Females usually select nest sites on well-vegetated scrub willow tundra and well-elevated habitat near lakes or rivers. Eggs are laid during the last half of May or the first two weeks of June. Fall migration may begin as early as August 10 with the last greater white-fronted geese leaving the Alaska coastal plain area by the end of September (Johnson and Herter, 1989).

Pacific loons are the most abundant loon species of the Arctic coastal plain; aerial surveys conducted over the past decade indicate the region's population is stable. Pacific loons frequently return to nest at the same lake or pond in successive years (BLM, 2005). Egg incubation period is about 23-25 days, and young birds fledge in 60-65 days (Ehrlich, et al., 1988). These birds are not found on the coastal plain during winter months.

Red-throated loons are less abundant than Pacific loons on the Arctic coastal plain. Although recent surveys conflict, Mallek, et al., (2003) reported increasing trends while Larned et al., (2003) observed decreasing trends in the regional population — the birds are relatively common on the Colville River delta (BLM, 2005). Young birds fledge in 49-51 days (Ehrlich, et al., 1988). These birds are reportedly not found on the coastal plain in winter.

Yellow-billed loons are the least abundant loon species on the Arctic coastal plain, and are not expected to be found there in winter (BLM, 2005). The greatest yellow-billed loon concentrations in Alaska are found on the North Slope, with the highest densities in locations west of ANWR, between the Meade and Ikpikpuk Rivers, on the Colville River Delta, and in areas near Teshekpuk Lake in the NPR-A (USFWS, 2006).

Yellow-billed loons arrive in the coastal plain in late May. They may frequent ANWR, but concentrate during spring with other species of loons in early-melting areas off the deltas of the Sagavanirktok, Kuparuk, and Colville Rivers, located west of ANWR. Yellow-billed loons prefer gently sloping shores of deep tundra lakes as nest sites. The nest is usually a built-up mound of turf and mud on the shoreline of a lake or occasionally on the shoreline of a large river. Egg laying begins as early as the second week of June and hatching takes place in July and early August. The age at which yellow-billed loons fledge has not been recorded precisely but may be similar to common loon chicks, which is 45 days. The peak fall migration for yellow-billed loons is in late August or early September (Sousa, 1995; Johnson and Herter, 1989).

The population in the Arctic coastal plain has been stable since at least 1986 (BLM, 2005). A Conservation Agreement has been developed as a cooperative effort among local, state, and federal resource agencies for the conservation of this species. The purpose of this agreement is to protect yellow-billed loons and their breeding, brood-rearing, and migrating habitats in Alaska, such that current or potential threats in these areas are avoided, eliminated, or reduced to the degree that they do not cause the species to become threatened or endangered from these threats in the foreseeable future (USFWS, 2006). The USFWS has determined that listing the yellow-billed loon as a threatened or endangered species is warranted under the ESA, but that listing is precluded by other higher-priority species.

Endangered Species Act (ESA) Threatened Bird Species

Steller's eiders were listed as threatened under the ESA on June 11, 1997 because of a reduction in the number of breeding birds and a suspected reduction of breeding range in Alaska (BLM, 2005). The birds are known to breed in Arctic Russia and Alaska. Their range on the Arctic coastal plain is thought to have once extended from Wainwright east to Canada's Northwest Territories. Steller's eiders are currently reported to range east at least as far as Prudhoe Bay, though no recent records place them east of the Sagavanirktok River. Very few sightings are currently reported east of the Colville River, which includes the 1002 Area (BLM, 2005).

Steller's eiders nest on tundra habitats often associated with polygonal ground near the coast and inland. The nest is a deep cup in the tundra; it consists of curly, coarse grasses and various mosses and lichens and is well lined with down and feathers. Females incubate their eggs for about three weeks. Hatching along the Beaufort Sea apparently begins during the first or second week of July. Most young are probably ready to fly by August. Steller's eiders migrate away from the Beaufort Sea and coastal plain during late September and early October (Johnson and Herter, 1989).

Spectacled eiders have a reported historic breeding range that includes the coastal tundra areas of the North Slope from Barrow to the U.S.-Canada border (Sousa, 1992). The species is listed as a threatened species under the ESA and has critical habitat designation on the North Slope from Point Lay to Prudhoe Bay as well as in western Alaska (USFWS, 2001). Causes for the declines are not known but may include some combination of reduced food supplies, pollution, over-harvest, lead shot poisoning and increased predation.

Spectacled eiders occur predominantly in areas located to the west of ANWR, in areas of the coastal Beaufort, Bering and Chukchi Seas. Important habitats for Arctic-breeding spectacled eiders include large river delta, tundra rich in lakes, and wet coastal plains with numerous water bodies (USFWS, 1996). Fall migration from the Beaufort Sea by males may begin in midsummer. Most spectacled eiders have left the coastal plain area by September 20th each year (Johnson and Herter, 1989).

3. Freshwater Habitats

The freshwater habitats of ANWR consist of several large river systems, lakes, streams, and wetlands. These areas provide habitat and vegetative cover for spawning, rearing, and overwintering; and are frequently used as corridors and migration routes for wildlife (ADF&G, 2006). The size of these freshwater habitats range from small, intermittent streams to large rivers, and from small ponds to large lakes. Water sources for these habitats include glacial melt, snowmelt, precipitation, and groundwater such as springs and upwelling areas. Lake and pond habitats are influenced by substrate, bathymetry, and geologic structures (ADF&G, 2006).

Nearshore waters and lagoon systems provide migration corridors and important feeding habitat for the amphidromous and anadromous fish (Clough, et al., 1987). Summer river runoff combined with melting coastal ice creates warm, brackish conditions in nearshore areas, particularly near the mouths of rivers (BLM, 2005). These warmer nearshore waters contain an abundance of amphipods, isopods, euphausids, coelenterates, and chaetognaths (Gertler, 1988), which provide important food sources for amphidromous and anadromous fish.

Table 2-2

ANWR coastal plain - List of Anadromous Rivers and Creeks, west to east

1	Staines River	14	Siksik River
2	Canning River	15	Sikrelurak River
3	Tamayariak River	16	Angun River
4	Nulvarik River	17	Kogotpak River
5	Katakturuk River	18	Aichilik River
6	Lower Marsh Creek	19	Egaksrak River
7	Carter Creek	20	Ekaluakat River
8	Nataroarok Creek	21	Matsutnak River
9	Hulahula River	22	Siksikpalak River
10	Okpilak River	23	Kongakut River
11	Akutoktak River	24	Pagilak River
12	Jago River	and several unnamed streams	
13	Kimikpaurauk River		

Source: ADF&G Fish Resource Monitor - Interactive Mapping Online
http://gis.sf.adfg.state.ak.us/FlexMaps/fishresourcemonitor.html?mode=awc
From Johnson and Klein, 2009, Anadromous Waters Catalog. Accessed 12/17/2012.

Representative of nearby North Slope rivers, the Colville to the west of ANWR discharges fresh water into the Beaufort Sea, forming a zone of warmer brackish water along the coast. This zone is an important factor affecting the distribution and abundance of all Beaufort Sea fish because of its importance to several species for feeding and migrating.

A lack of overwintering habitat is the primary factor limiting Arctic fish populations. Rivers freeze to the bottom over much of their lengths, leaving only the deeper sections available for overwintering fish habitat (Sousa, 1992). The overwinter lifecycle factors are important for protection and continued success of these fish populations.

The identified anadromous waters in the ANWR 1002 Area are, from west to east, the Staines, Canning, Tamayariak, Nulvarik, Katakturuk, Hulahula, Okpilak, Akutoktak, Jago, Kimikpaurauk, Siksik, Sikrelurak, Angun, Kogotpak, Aichilik, Egaksrak, Ekaluakat, Matsutnak, Siksikpalak, Kongakut and Pagilak Rivers, and Lower Marsh, Carter, and Nataroarok Creeks (Table 2-2). Other major waterways are located in ANWR, but have not been established as anadromous waters as part of the ADF&G anadromous waters catalog.

The type of habitat provided by streams and rivers is defined by the substrate, which ranges from large boulders, cobble, gravel, glacial silt, clay, and mud. Stream and river morphology also contributes to defining the habitat, including such characteristics as straight, meandering, or braided; and morphologic complexity is an important contributor to habitat quantity and quality (ADF&G, 2006).

a. Fish

Important fisheries are found in the coastal plain. Freshwater fish present include Arctic grayling, lake trout, northern pike, burbot, and several species of whitefish and ciscoes (Ott, 1995). Area fish species are anadromous, amphidromous or resident types.

Anadromous fish are those fish that spend most of their lives at sea, and return only to spawn. These fish mature in the sea and enter freshwater rivers and streams to spawn. Examples are some Pacific salmon species, i.e. pink, chum, Chinook and coho (Reynolds, 1997).

Amphidromous fish are those that spawn and overwinter in rivers and streams, but migrate during the ice-free summer from freshwater into coastal waters to feed. Some examples of these fish are Dolly Varden, Arctic char, Arctic cisco, and broad whitefish (Reynolds, 1997).

Fish that reside in freshwater for their entire lifecycle are called resident fish, such as Arctic grayling, burbot and lake trout (Reynolds 1997). Stream-resident Arctic char occur in the Sagavanirktok and Colville drainages, to the west, but are not known to be amphidromous in these systems. Dolly Varden may occur as both amphidromous and resident forms (Ott, 1997).

Many of the fish that winter in freshwater habitats and river deltas of the coastal plain disperse along the coast to feed in the prey-rich nearshore waters, which may extend several miles offshore (BLM, 2005). The amphidromous fish of the coastal plain typically leave rivers and enter the nearshore waters of the Beaufort Sea during spring breakup, from mid- to late June. They initially occupy open-water leads near shore before dispersing along the coast to feed as the ice cover melts and recedes. Small fish tend to remain near overwintering rivers such as the Colville, while larger fish may migrate distances of 80 miles or more in search of feeding habitat. It is during this summer period that coastal fish achieve most of their annual growth and accumulate fat and protein reserves needed to survive the Arctic winter (BLM, 2005, citing to Fechhelm and Griffiths, 1990). Migration back to rivers varies by species, but most amphidromous fish return to fresh water, where they spawn, by mid-September (ADNR, 1991).

As with most amphidromous fish species, whitefish spend much of their life cycle in salt water. They feed in salt water during the summer, but, unlike other amphidromous fish, generally remain in freshwater plumes extending out from river mouths and in marine waters of lower salinity. As with Arctic char, these species move upriver around mid-August and spawn in late September or October (Roguski, et al., 1971).

Arctic cisco are among the most abundant anadromous fish captured in the Prudhoe Bay and Sagavanirktok delta areas, located to the west of ANWR. Arctic cisco inhabit the nearshore environment and spawn in the fall. The Colville River to the west is a major overwintering area for Arctic cisco. During the ice-free period Arctic cisco undertake extensive migrations through the nearshore area (NSBCMP, 1984). No spawning areas for Arctic cisco have ever been identified in Alaska (BLM, 2005). Arctic cisco of the Colville River are migrants from natal streams and tributaries of the Mackenzie River delta system in Canada. Newly hatched Arctic cisco from Canada move westward into the Alaska Beaufort Sea during late July to early August, especially in years with a prevalence of easterly winds. Thus, these fish must pass through the area of coastal development associated with the Prudhoe Bay and Kuparuk oil fields. Arctic cisco of the Colville River delta spend most of the summer feeding in nearshore coastal waters, and then return to the river's channels and lakes in September and October to overwinter (Fechhelm and Griffiths, 1990).

Non-migratory freshwater fish inhabit fresh water year-round. Virtually all Arctic grayling are found exclusively in fresh water throughout the year (Ott, 1997). Dolly Varden and broad and humpback whitefish are amphidromous (BLM, 2005) and remain in fresh water for several months or years, depending on the species, before migrating to coastal waters, returning to inland waters to spawn and overwinter (ADNR, 1990). Broad whitefish also use ephemeral stream systems to move into lake habitats of adequate depth for overwintering (Morris et al., 2006).

As mentioned previously, a critical and limiting habitat factor affecting the freshwater fish populations is the available suitable habitat in the winter (Sousa, 1992). Fish overwinter areas represent a small percentage (about 3 percent) of the total water volume available during the summer (Schmidt, et al., 1989). Fish that overwinter in Arctic freshwaters rely on these protective havens for the success of their populations. The fish of all stages may crowd into the same unfrozen river area for the entire winter (Schmidt et al., 1989). Different fish species overwinter in dissimilar habitat types. For example the Arctic char are found in the middle and upper rivers, as compared to other anadromous species that prefer deep pools and river deltas for overwintering habitats (Schmidt, et al., 1989, citing to Craig

Table 2-3 *Fish Common to the Alaska North Slope and ANWR*			
Freshwater Species		**Anadromous Species**	
Common name	*Scientific name*	Common name	*Scientific name*
Sheefish	*Stenodus leucichthys*	Least cisco	*Coregonus sardinella*
Round whitefish	*Prosopium cylindraceum*	Arctic cisco	*Coregonus autumnalis*
Lake trout	*Salvelinus namaycush*	Broad whitefish	*Coregonus nasus*
Arctic char	*Salvelinus alpinus*	Humpback whitefish	*Coregonus pidschian*
Northern pike	*Esox lucius*	Pink salmon	*Oncorhynchus gorbuscha*
Lake chub	*Couesius plumbeus*	Chinoook salmon	*Oncorhynchus tshawytscha*
Longnose sucker	*Catostomus catostomus catostomus*	Chum salmon	*Oncorhynchus keta*
Trout-perch	*Percopsis omiscomaycus*	Coho salmon	*Oncorhynchus kisuctch*
Burbot	*Lota lota*	Rainbow smelt	*Osmerus mordax dentex*
Ninespine stickleback	*Pungitius pungitius pungitius*	Arctic lamprey	*Lethenteron japonicum*
Slimy sculpin	*Cottus cognatus*	Dolly Varden	*Salvelinus malma*
Threespine stickleback	*Gasterosteus aculeatus aculeatus*		
Alaska blackfish	*Dallia pectoralis*		
Arctic grayling	*Thymallus arcticus arcticus*		

Source: USFWS 2010b

and McCart, 1974). The anadromous fish populations have reduced risk of extinction by spreading their members over different overwintering sites (Schmidt et al. 1989, citing to Craig, 1989).

B. Foreseeable Human Uses of ANWR Habitats, Wildlife, and Fish

The fish and wildlife of the coastal plain area provide the resources for subsistence fishing and hunting, small sport fisheries, and general hunting and fishing. The community of Kaktovik is located on the coast, and residents utilize this area for year-round subsistence hunting and harvesting. Other residents who may also subsistence hunt and fish on the coastal plain of ANWR may travel from the villages of Anaktuvuk Pass, Venetie, Chaklyitsik, Fort Yukon, Beaver, and Arctic Village. There are also recreation, tourism, and Arctic research uses in the coastal plain and throughout ANWR. Permitted uses and activities must comply with federal, state, and local requirements. This section discusses those foreseeable uses of the Arctic coastal plain.

1. Subsistence Uses

Subsistence is an important component of the multiple uses of the North Slope environment (Bryner, 1995). Title VIII of ANILCA, which addresses Subsistence

Management and Use, defines subsistence usage 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" (16 U.S.C. Section 3113). ANILCA finds that the continuation of the opportunity for subsistence uses by rural residents of Alaska, including both Natives and non-Natives, on the public lands and by Alaska Natives on Native lands is essential to Native physical, economic, traditional, and cultural existence and to non-Native physical, economic, traditional, and social existence (P.L. 96-487, Section 810 (1)).

The Alaska Board of Game and the Alaska Board of Fisheries are responsible for developing regulations that provide subsistence harvest opportunities consistent with sustained yield management (AS 16.05.258 (b)). They must set the amount reasonably necessary for subsistence uses, based upon the sustained yield principle (ADF&G, 2012c). The Division of Subsistence within the Alaska Department of Fish and Game provides information and recommendations to these boards to ensure that these opportunities are available (AS 16.05.094). The Division of Subsistence also serves a critical role in sustaining subsistence hunting and fishing which are economically and culturally important for many Alaskans (ADF&G, 2012d).

Residents of the North Slope of Alaska live in a mixed subsistence-cash economy that includes both a reliance on subsistence resources and wage employment. Subsistence resources are obtained by hunting, fishing, and gathering. Subsistence equipment, such as boats, all-terrain vehicles, snow machines, fuel, and gear are generally purchased with cash. Kruse (1991) reports that there is an increase in labor force participation, and an increase in household income on the North Slope. The study findings also suggest that continued subsistence activity "is not simply a matter of necessity; it is also a matter of individual choice. Subsistence harvest and distribution activities may offer benefits well beyond nutrition that are less commonly available in wage jobs" (Kruse, 1991).

Many traditional hunting, fishing, and gathering sites are on federally or state managed land. Private and public ownership of lands and waters can determine where, when, and how people may hunt. To assure subsistence opportunities are protected, harvest locations and traditional use areas must be identified and considered for prevention of negative impacts. Also, it is essential and legally mandated that healthy populations of fish and wildlife be conserved. When it is necessary to restrict the taking of fish and wildlife, subsistence uses are given priority over all other consumptive uses. For a discussion on the potential effects of the proposed exploration program on subsistence uses, see Chapter 6.

Kaktovik Subsistence Harvests

Kaktovik (population 247, ADCRA 2012) is on the north shore of Barter Island, between the Okpilak and Jago rivers, to the north off the coast of ANWR. Residents of Kaktovik have a unique set of natural resources available for subsistence, and have hunting and fishing opportunities year round. Because of Kaktovik's location, hunters have access to terrestrial, riparian, and marine resources. Subsistence harvest areas range from east of the Canada border to Camden and Mikkelson Bays. Important locations in the Kaktovik Traditional Land Use Inventory (TLUI) in the ANWR area include Flaxman Island, Brownlow Point, and Tigutaaq at the confluence of the Tamayariak and Canning Rivers. Primary early winter camps are located along the Hulahula and Sadlerochit Rivers (Jacobson and Wentworth, 1982).

Subsistence activities, particularly those surrounding the bowhead whale hunt, are central to the structural organization and cultural identity of Kaktovik residents. The bowhead whale is the primary marine mammal subsistence species; seals and polar bears are also important food sources. Whales are hunted in spring and fall, and seals are hunted year round. Residents harvest both marine and freshwater fish. The species of fish harvested are Arctic cisco, Dolly Varden, sculpin, Arctic cod, Arctic flounder, Arctic grayling, and chum salmon (Brower et al., 2000).

Kaktovik residents conduct subsistence hunting throughout the year, and travel to the mountains and along rivers to hunt and fish (ADF&G, 1986). Caribou are the most important terrestrial subsistence resource, but sheep, muskoxen, and grizzly bears are also harvested (Galginaitis and Koski, 2002). Bird species harvested include geese and ptarmigan (URS Corp., 2005). The residents of Kaktovik primarily hunt caribou during summer months following the calving period, and the annual harvest likely is not greater than 200 caribou (ADF&G, 2009a). Caribou hunting is unlikely to occur on the coastal plain during the winter months.

In a 1998 study, subsistence resources made up at least half the food consumed for 83 percent of households. This decreased to 69 percent of households in 2003 (URS Corp., 2005 citing to Shepro et al., 2003). Residents have noted that they are involved in a wider range of activities and responsibilities, and that they travel away from the village more often for a wide variety of reasons. These lifestyle changes may limit their subsistence activities and constrain the timing of subsistence activities. Some residents prefer seasonal work because it allows them to participate more fully in subsistence activities (EDAW/AECOM, 2007). These changes reflect a balancing of a traditional lifestyle with a partial cash economy and modern conveniences such as motorized access and air travel.

2. Sport Fishing

Sport fishing in the interior region of Alaska is lighter than in other regions of the state (ADF&G, 2007f). Sport fishing on the coastal plain focuses on Dolly Varden and Arctic grayling, with smaller harvests of salmon, trout, whitefish, northern pike, and burbot (NRC, 2003, citing to Howe, et al, 2001).

Dolly Varden and Arctic char are grouped together for sport fishing regulatory purposes because of the difficulty in distinguishing the species based on external characteristics (Scanlon, 2008). Dolly Varden and Arctic char populations can generally support only low rates of exploitation. Anglers can access the coastal plain rivers through various means and access locations. The nearby Sagavanirktok River, to the west of ANWR, is the only specific location for which sport effort and harvest estimates are available: effort averaged 1,232 angler-days, harvest of Dolly Varden averaged 272 fish, and harvest of Arctic grayling averaged 205 fish from 1998-2007. Harvest statistics are for the entire Sagavanirktok River.

Increases in catch and harvest are expected from increased visitors floating rivers of the ANWR, particularly the Kongakut, Hulahula, and Canning rivers (Scanlon, 2008). Fishing effort and harvest of Arctic char, Dolly Varden, Arctic grayling, and lake trout were expected to increase on the North Slope when the entire Dalton Highway was opened to the public in 1994, and again when improvements were made to the road south of Atigun Pass in 2001 and 2002. However, effort and harvest statistics show that this has not occurred (Scanlon, 2008).

3. General Hunting and Trapping

Alaska resident (local and non-local) and nonresident harvest of big and small game in ANWR is managed by federal and state agencies. Hunting seasons and guidelines are determined by the Alaska Board of Game, and administered by ADF&G. As described previously, the ANWR 1002 Area is entirely within the GMU 26C. Hunting harvest statistics collected by ADF&G are not specific to the 1002 Area, but are estimates of the harvest by GMU or combined areas of several GMUs (ADF&G, 1996). During the regulatory year 2007-2008, the general reported harvest in the eastern coastal plain GMU 26C included 11 brown bear, 2 wolves, 69 Dall sheep, and 41 caribou (ADF&G 2009b; 2011a; 2012e). The general reported harvest in GMU 26C includes harvest mostly by non-local Alaska residents or nonresidents. Harvest by local residents of Unit 26C is described in the section “Kaktovik Subsistence Harvests”.

C. Conclusion

The management of both habitat protection and surface land uses associated with oil and gas exploration will encompass the balancing of:

- protection and conservation of habitat;
- encouragement of oil and gas exploration priorities;
- continued successful subsistence and general hunting and fishing.

Awareness of current and foreseeable uses of land and water in the 1002 Area can provide information necessary to foster coordinated exploration, while reducing negative impacts through prevention and mitigation. There is a long history of how oil and gas exploration and development on the North Slope has moved forward in a coordinated manner with concurrent successful subsistence seasons and successful exploration seasons without conflict. Chapter 3 discusses the available information about the probable oil and gas resources that may be found within the 1002 Area in the coastal plain of Alaska. Oil and gas exploration must take a balanced approach to provide comprehensive information on the resources underlying ANWR given what is known about the flora, fauna, and people that inhabit its surface.

Chapter 3

Assessment of Oil and Gas Resources

The petroleum potential of the North Slope's coastal plain, including that of ANWR, has been the object of speculation and geological exploration since roughly 1906. Oil seeps and exposed oil-stained rocks across the North Slope long hinted of the area's petroleum potential. Within the 1002 Area of the ANWR coastal plain, several oil seeps and surface exposures of oil-stained rocks occur along the Katakturuk and Jago rivers and at Manning Point and Angun Point on the sea coast. According to the most recent comprehensive assessment, most geologists regard the area as the most prospective unexplored onshore area in North America. It is in the interest of ADNR to effectively characterize the 1002 Area, as it is adjacent to the prolific Badami-Point Thomson area. ADNR manages these state lands according to the "maximum use for the public interest" principle embedded in Article VIII of the Alaska Constitution, and the 1002 Area should be similarly managed in a way that supports the best interests of Alaskans and the United States.

The 1002 Area consists of 1.5 million acres of highly prospective terrain in the northeastern portion of the North Slope along the northern coast of ANWR. The region is situated between the prolific North Slope oil fields to the west and the petroleum-rich Canadian Mackenzie Delta province to the east. Both areas have proven reserves of interest to each nation. In the United States, a gas field with a significant volume of recoverable liquid hydrocarbons is being developed at Point Thomson just west of the ANWR boundary.

A. Geology and Petroleum Potential

For an accumulation of hydrocarbons to be recoverable, the geology of the subsurface must have certain physical attributes formed in a location and at a time to allow petroleum formation, migration, and storage. All of the key geologic elements needed to produce major hydrocarbon accumulations — a structure, reservoir rock, and source rock — occur beneath the coastal plain of the ANWR. More significantly, these ingredients of effective petroleum systems are all present and connected to each other in the necessary spatial and temporal relationships.

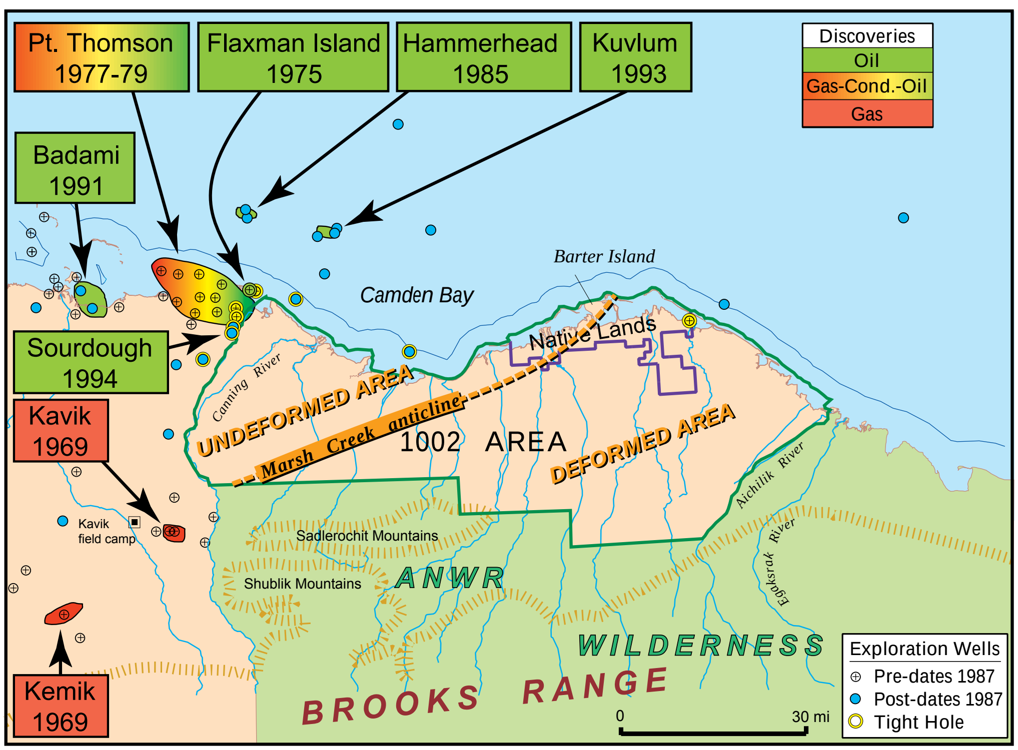
Based upon field observations of oil seeps and oil-stained reservoir rocks at surface outcrops in the area, as well as from regional subsurface data trends, it is evident that oil has been generated and perhaps has been trapped within reservoir rocks in these prospective features. Geological studies and seismic, gravity and magnetic geophysical data suggest thick successions of potential reservoir rocks, especially in the Brookian turbidite and topset sandstone plays. These are similar to those found in the oil rich Prudhoe-Kuparuk area to the west and the gas bearing Mackenzie Delta area to the east, and are inferred to be present in the subsurface of the ANWR coastal plain.

Interpretation and re-interpretation of the 2-D seismic data collected in the 1980s has identified numerous prospective structures and structural and stratigraphic leads beneath the surface of the ANWR coastal plain. Many stratigraphic and combination traps can be inferred from the subsurface knowledge of the Brookian sequence underlying the 1002 Area. The geologic history of the area is favorable for hydrocarbon generation and expulsion from pods of thermally mature source rocks in areas generally referred to as "kitchens." Source rocks are thought to have expelled much of their oil and gas after the reservoirs and traps were in place to receive and contain the hydrocarbon charge.

Interpretation of seismic data shows that the structural style of the area becomes increasingly complex from west to east and that the region can be divided into two structural zones, the undeformed zone and the deformed zone.

Figure 3-1

Undeformed/deformed zones



Source: USGS, 1998; Bird, 1999

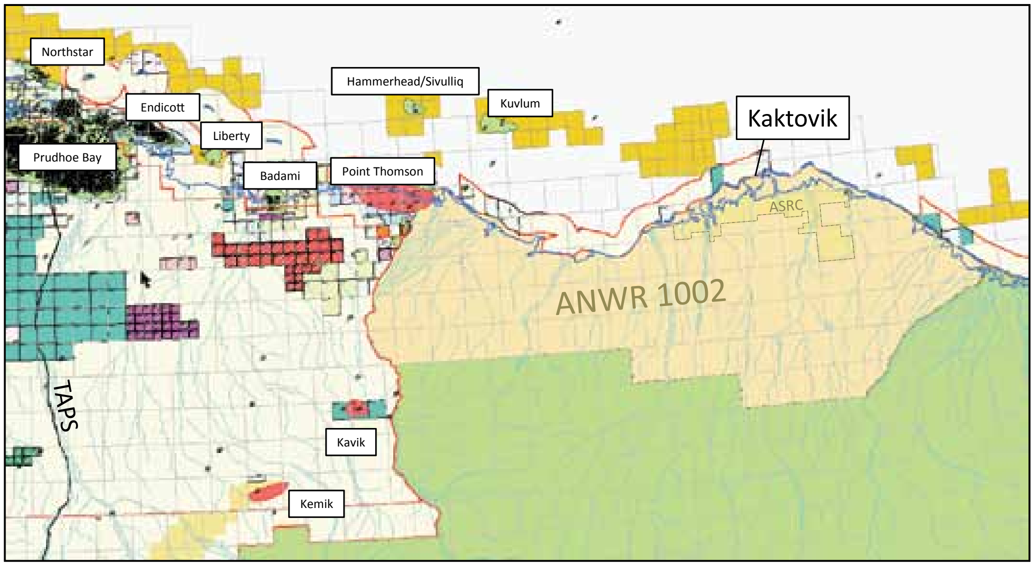
The boundary between the two zones lies along the Marsh Creek anticline. Rocks in the undeformed zone in the northwest part of the coastal plain are characterized by nearly flat-lying strata cut by faults with only small displacements. Fault-block traps and subtle anticlinal traps may be present in this area.

Figure 3-2

Area map of current development and communities

ANWR Coastal Plain

Land Status, Fall 2012



Source: ADNR-DO&G 2012

The deformed zone is characterized by thrust-faulted basement highs overlain by northeast-trending, complexly deformed structures. Within both zones the probability of encountering stratigraphic traps is moderate to high. However, such subtle features are extremely difficult to locate and identify with the existing 2-D seismic grid. Identification of the potential resources available will require an exploratory program including 3-D seismic to identify drillable prospects, and, based on those, based on findings, exploration wells.

Oil accumulations are concentrated in “plays” or rock volumes exhibiting similar geological characteristics and which are conducive to entrapment of petroleum. These plays occur at different depths and have different sizes and different petroleum potential. Several major accumulations are known to adjoin the western boundary of ANWR’s coastal area. Directly abutting the northwest boundary of ANWR is the Point Thomson Unit, where development of production facilities and a pipeline is underway. This field is expected to produce 8 TCF of natural gas and perhaps as much as 400 MMB of natural gas liquids, the latter potentially transportable through the nearby Badami facilities to the Trans-Alaska Pipeline System (TAPS). In the 1990s, British Petroleum Alaska and Chevron-Texaco announced discovery of a 100 million barrels of oil (MMBO) field at their Sourdough field, also within the Point Thomson Unit. Offshore, north of the undeformed area, industry has shown interest in what may be undiscovered or discovered and undisclosed large fields. Although costly to develop offshore in the Beaufort Sea, fields of a large size would more quickly and more likely be brought on line were they located onshore. Most significant, however, is the probability that the geology in the undeformed zone within the 1002 Area is very similar to that of the Point Thomson, Sourdough, Hammerhead, and Kuvlum accumulations to the west and to the north, where oil and gas are known to occur in large quantities.

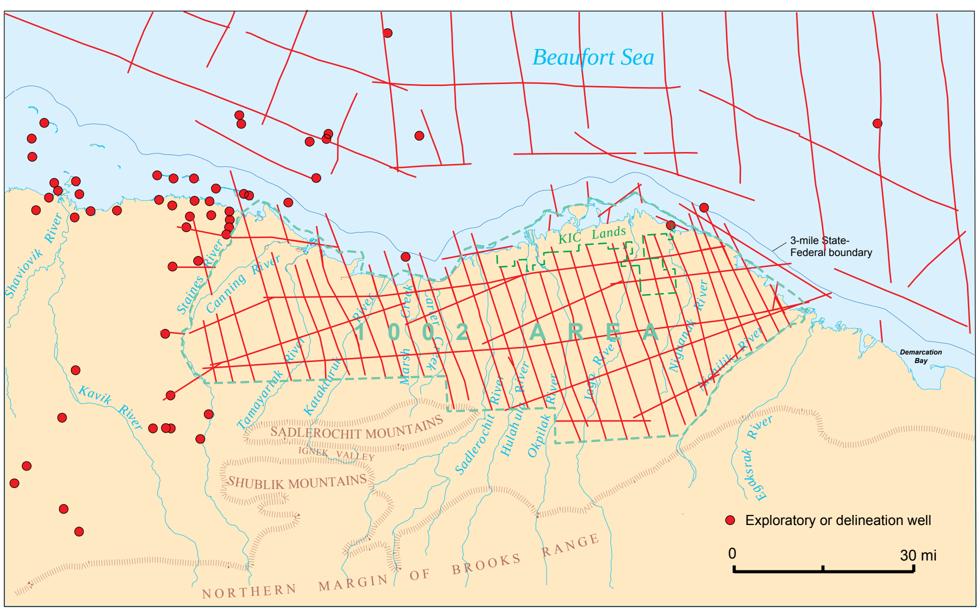
Whether petroleum reserves exist in these plays as they extend under the 1002 Area remains the primary reason for proposing exploration. It is reasonable to assume that the same reservoirs are likely to occur beneath the ANWR coastal plain which would make the area the most prospective unexplored onshore area in North America.

B. History of Exploration

ANILCA Section 1002(d) instructed the Secretary of the Interior to "…establish initial guidelines governing the carrying out of exploratory activities…" and that the guidelines "…shall include such prohibitions, restrictions, and conditions on the carrying out of exploratory activities as the Secretary deems necessary or appropriate to ensure that exploratory activities do not significantly adversely affect the fish and wildlife, their habitats, or the environment…" These guidelines were subsequently codified as regulations for an exploration program for the 1002 Area (50 CFR 37, 1983, as amended 1984, 2002).

Figure 3-3

Seismic lines from 1983-1985 programs.



Source: USGS, 1998; Bird, 1999

To that end, a group of twenty-two oil companies joined to conduct a widely-gridded (3 miles by 6 miles) 2-D seismic, gravity and shallow geology survey of the 1002 Area during the winters of 1983-84 and 1984-85. Approximately 1,450 line-miles of seismic and gravity data were acquired all across the coastal plain and adjacent lands. In addition, individual companies also conducted surface geology studies within ANWR during the summer months, accessing the area by helicopter.

In a separate proprietary program, Chevron and predecessor companies of BP Amoco conducted a smaller geophysical survey of the Kaktovik village selection lands in the north-central area of the ANWR coastal plain. Subsequently this group drilled the "KIC-1" well in 1985, the only exploration well drilled within the 1002 Area to date. Results of the geophysical survey and the well have been kept confidential and are unavailable for public resource assessments.

Industry submitted the collected 2-D seismic data to the U.S. Department of Interior (USDOI) for its use in preparation of the petroleum potential assessment of the 1002 Area. This data was the basis for the 1987 Report to Congress required by section 1002(h) of ANILCA that recommended oil and gas leasing in the 1002 Area. Since 1985, no additional seismic exploration has been conducted within the 1002 Area.

2-D and reprocessed 2-D seismic data are useful to map out large-scale structures, but inadequate to identify stratigraphic traps. Acquiring an extensive 3-D survey is necessary to map prospective plays, identify potential hydrocarbon accumulations, and locate potential drilling sites.

3-D seismic field acquisition and processing methods have evolved to the point where potential reservoirs and traps as thin as several hundred feet wide can be identified at substantial depths. Modern digital seismic recording and processing methods allow certain attributes to be extracted from the data and analyzed to better locate and characterize the exploration target.

Furthermore, experienced exploration professionals have come to recognize various seismic attributes from 3-D surveys in specific oil fields that are characteristic of reservoir potential in the area. These seismic attribute interpretation techniques have also advanced to the point where repeated 3-D seismic surveys (4-D seismic) can be used to design and monitor secondary recovery programs.

The use of 3-D seismic, and other technological advances such as extended-reach drilling, have substantially increased the probability of commercial success, thereby lowering finding costs significantly. From 1995 to 2001 inclusive, the commercial success rate on the North Slope was at least 32 percent (at least 8 of 25 exploration wells). Statistics published by ADNR-DO&G indicate that the commercial success rate between 1959 and 1995 (prior to the use of 3-D seismic as an exploration tool and the advent of modern directional drilling technology) was only 3.3 percent. The ten-fold increase between 1995 and 2001 is attributable to the improved subsurface knowledge now attainable from 3-D seismic data and the advances in drilling methods.

In addition to the lack of 3-D seismic surveys in the 1002 Area, federal authorities have not even considered the proposal to conduct a 3-D survey with modern technologies and in compliance with modern regulations and mitigation measures. The result of such a survey would contribute significantly to a more definitive assessment of the 1002 Area's petroleum potential. Combined with modern directional drilling engineering methods, 3-D seismic allows selection of drill-sites having the least environmental impact within a prospective area.

C. Resource Assessments

At least eight assessments of the hydrocarbon potential of the 1002 Area have been released since 1986 – one by ADNR-DO&G, one by the Energy Information Administration, three by the BLM, and three by the USGS. Results of these resource assessments differ somewhat because, over time, additional data have become available on surrounding lands. In addition, analytical methods have changed, lower-cost technology has evolved, and significant technical data-collection and data-processing advances have occurred. Some assessments were restricted to only the 1002 Area and others encompassed broader regions, including surrounding onshore and offshore areas owned by the State of Alaska and Native tribes. Consequently, there is not a common denominator for all of the assessments. The two most pertinent assessments are summarized below.

1. 1987 – BLM - Coastal Plain Resource Assessment

The first comprehensive resource assessment of the coastal plain of ANWR was the result of the initial exploration program permitted by USDOI in 1983-1985, pursuant to ANILCA 1002(d) and the regulations at 50 CFR 37 (Clough, et al., 1987).

The details of this assessment will not be discussed in detail here, as more recent assessments are believed to portray a more accurate representation of the petroleum potential of the area. As previously stated, the differences in more recent assessments reflect the capabilities of improved seismic processing and analytical methods and the inclusion of geological analogs derived from recent drilling results near the 1002 Area. Furthermore, modern understanding of the geohistory of the ANWR 1002 Area suggests that the deformed zone, underlain by more thermally mature sediments than the undeformed zone, may be more prospective for gas than for oil.

2. 1998 - USGS - ANWR 1002 Petroleum Assessment

The USGS's most recent comprehensive assessment of undiscovered oil and gas resources in ANWR was prepared in 1998 (Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998; OFR 98-34) (USGS, 1998). The assessment encompassed the federally managed 1002 Area, Native corporation lands of the coastal plain, and the adjacent State-owned submerged lands under the Beaufort Sea. Other parts of ANWR, including the original Range boundaries and the millions of acres added by the passage of ANILCA were not assessed. It is important to note that in this assessment the resources are quantified as "technically recoverable," which is generally defined as the volume of hydrocarbons that can be recovered with existing technology without consideration of commodity price.

The 1998 assessment cannot be meaningfully compared to many of the earlier 1002 Area assessments because the methods used in some of the earlier studies are not documented. However, both the BLM assessment submitted in the 1987 Report to Congress and the 1998 USGS assessment did attempt to similarly quantify the estimated oil-in-place (OIP) resource.

The 1998 USGS assessment addressed the uncertainty of predicting undiscovered resources by adopting a probabilistic approach, using statistical distributions to capture the range of possible outcomes. Results were reported with a range of probabilities including the 95 and 5 percent probabilities as well as the expected, or mean, probability. The 95 and 5 percent numbers represent reasonable maximum and minimum values that could be expected.

One significant difference between the 1987 and the 1998 studies, which is discussed in detail below, is the distribution of the resource. The 1987 assessment approximated 75 percent of the estimated mean OIP to be in what is now identified as the deformed zone in the eastern portion of the 1002 Area, while the 1998 assessment assigns only 15 percent of the mean OIP to the deformed zone. The 1987 assessment approximated the remaining 25 percent of the OIP to be in the undeformed zone on the northwestern coastal plain. Current thinking is that 85 percent of the OIP occurs in the undeformed zone.

The 1998 assessment also shows an increase in the absolute volume of the estimated OIP. The 1987 study concluded that the range of OIP in the 1002 Area alone is between 4.8 and 29.4 billion barrels of oil (BBO), with a mean estimate of 13.8 BBO. The lower number signifies the amount of OIP assessed with 95 percent probability; the higher number the amount of OIP estimated with 5 percent probability. The 1998 assessment estimates the OIP to be between 11.6 BBO (95 percent probability) and 31.5 BBO (5 percent probability), with a mean estimate of 20.7 BBO.

Table 3-1

Estimates of oil in place (OIP) in different parts of the assessment area, in billions of barrels.

Study Area	95% probability	Mean probability	5% probability
Entire Assessment Area	15.6	27.8	42.3
Federal 1002 Only	11.6	20.7	31.5

Source: USGS, 1998

D. Technically Recoverable Oil

In 1998, the USGS estimated that the entire assessment area, including State and Native interests, contains between 5.7 and 16 BBO of technically recoverable oil, with a mean (expected value) of 10.4 BBO (USGS, 1998). Most of this volume of oil, 74 percent, was ascribed to the federally controlled 1002 Area, with the range of predicted technically recoverable oil between 4.3 and 11.8 BBO, with a mean of 7.7 BBO. For comparison, the Prudhoe Bay field, the largest oil field in North America, was originally estimated to hold 9.6 BBO that was deemed technically recoverable by its primary operator, BP. Cumulative production to date has exceeded 12 billion barrels of oil. The Prudhoe Bay field was the impetus for the construction of TAPS and sent Alaska oil production to a peak level of 2.2 million barrels per day in 1988. Alaska daily production has dropped below 600,000 barrels per day in 2012.

Table 3-2

Estimates of technically recoverable oil in different parts of the assessment area, in billions of barrels.

Study Area	95% probability	Mean probability	5% probability
Entire Assessment Area	5.7	10.4	16.0
Federal 1002 Only	4.3	7.7	11.8

Source: USGS, 1998

These estimates of technically recoverable oil represent approximately one-third of the OIP in both the entire assessment area and the federally controlled 1002 Area.

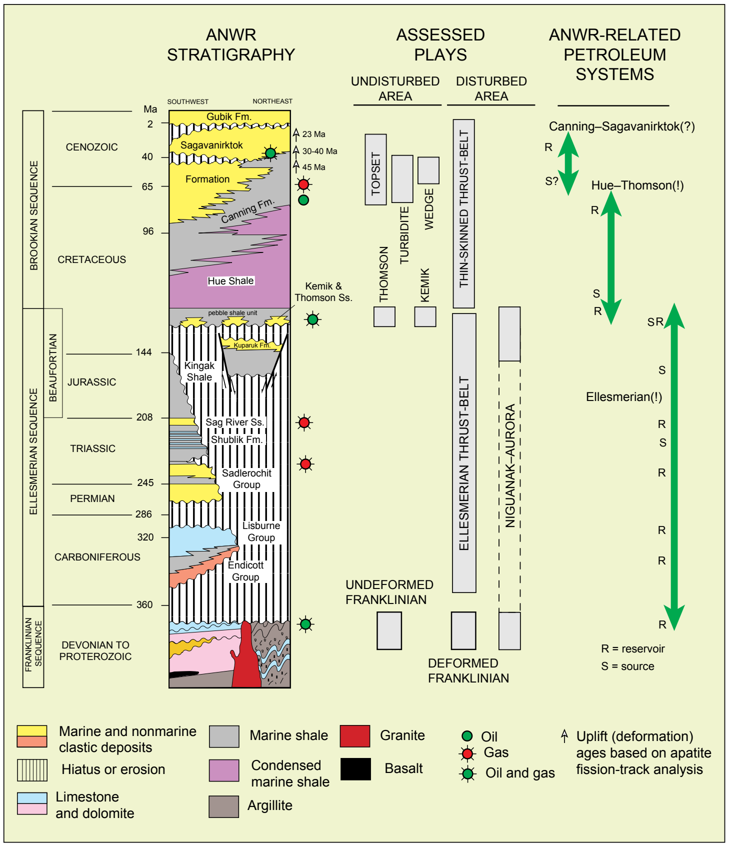
As stated above, the 1998 estimates were somewhat different than earlier estimates because the existing 2-D seismic data had been reprocessed and re-evaluated using more modern processing and analytical techniques, and the results of nearby wells drilled since the earlier assessments were incorporated in the evaluation. Although these estimates were developed using all the data and standardized assessment methods available at the time, they are still inherently speculative in nature. Accurate estimates can only be obtained by systematic exploration of the subsurface through the drilling of exploration and delineation wells.

E. Distribution

Unlike earlier assessments, the 1998 study estimates that the quantities of technically recoverable oil are not expected to be uniformly distributed throughout the federally controlled portion of the 1002 Area (USGS, 1998). Because reprocessed seismic data and recent well data were incorporated and more rigorously evaluated than in the past, the USGS was able to better identify the distribution of plays

Figure 3-4

Stratigraphy and relationship to analog fields outside of the 1002.Area



Summary of ages, names, and rock types present in the ANWR 1002 Area. The occurence of recoverable petroleum in these rock formations outside the ANWR 1002 Area is indicated by green and red circles. Grey bars at right indicate the ten petroleum plays evaluated in the assessment and their corresponding rock formations (to the left). Note the grouping of plays according to deformed and undeformed areas as shown in figure 3-1. The names and stratigraphic extent of petroleum systems in the 1002 Area are also shown.

Source: USGS, 1998

across the 1002 Area. The 1998 USGS assessment distributes the potential of the 1002 Area among ten prospective plays, each an extension of a play type known to exist in neighboring petroleum-bearing areas and, on the basis of geological and geophysical data, thought to extend beneath the study area. While earlier assessments generally assumed uniform distribution of plays and resources across the coastal plain, the 1998 study concludes that the play type, the number of prospects, potential field size and potential technically recoverable resource are differentially distributed across the undeformed and deformed zones because of the differing geologic histories of the undeformed and deformed zones.

The undeformed zone, the northwestern one-third of the 1002 Area, is estimated to contain over 80 percent of the technically recoverable resource, between 3.4 and 10.2 BBO with a mean of 6.4 BBO. This area is defined as containing sedimentary rocks that are likely to host petroleum systems which have remained nearly undeformed since their deposition. 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. 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. This play is analogous to the known offshore accumulations at Hammerhead and Kuvlum, among others.

Additional plays analyzed in the undeformed zone include the Turbidite, Wedge, Thomson, Undeformed Franklinian, and Kemik plays, most of which are analogous to known offshore and onshore reservoirs such as Flaxman Island, Badami, Point Thomson, and possibly Sourdough (Bird, 1999; Schuenemeyer, 1999). The undeformed zone also lies closer to existing infrastructure, a significant technical and economic advantage.

The deformed zone, the southeastern two-thirds of the 1002 Area, is estimated to contain a much smaller share of the recoverable oil resource between zero and 3.2 BBO with a mean of 1.2 BBO. 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 oil may have been detained in early-formed structures and stratigraphic traps, perhaps to be spilled as those traps were disrupted by younger deformation. Most of the resources in the deformed zone are thought to be structurally trapped in reservoir rocks deposited from erosion of the ancestral Brooks Range. The Thin-skinned Thrust-belt play is expected to contain the majority of oil resources in the deformed zone. However, the thermal history of the rocks in this part of the coastal plain makes it more prospective for natural gas than for oil.

Table 3-3

Estimates of technically recoverable oil in different zones of the assessment area, in billions of barrels

Study Area	95% probability	Mean	5% probability
Undeformed Zone	3.4	6.4	10.2
Deformed Zone	0	1.2	3.2

Source: USGS,1998

F. Number and Size of Expected Fields

The 1998 USGS assessment provides statistics regarding the size distribution of technically recoverable oil and gas fields. The assessment concludes that the expected mean of 7.7 BBO recoverable for the 1002 Area, as a whole, will be distributed among approximately 35 accumulations. Note that this refers to all of the federal 1002 Area lands in the 1998 assessment area, but does not include the adjacent state waters or Native lands included in that assessment.

The undeformed portion of the 1002 Area is expected to have as many as 30 oil accumulations, with technically producible volumes ranging from 10 or 20 MMBO in small fields up to giant fields potentially able to produce 1 or 2 BBO. These volumes are akin to 2-4 fields the size of the North Slope's Alpine field. Most accumulations are expected to be in the 50 to 250 MMBO range, and most of the resource is likely to be in fields larger than about 100 MMBO.

The deformed zone is likely to contain only three to five oil fields, with most of the recoverable resource in reservoirs between 250 MMBO and 2 BBO in size. About 85 percent of the technically recoverable oil will occur in fields smaller than about 1 BBO.

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 significant fields. The USGS Open File Report 98-34 offers a comprehensive overview of the methods used and results achieved in the 1998 study.

G. Economically Recoverable Volumes

The USGS defines *economically recoverable resources* as the portion of the technically recoverable resource for which the costs of finding, development, production, and transportation to market including a return to capital, can be recovered by production revenues at a given price. The fraction of *technically* recoverable oil that would be *economic* to produce depends on numerous technical and economic variables, including the value of oil; the finding costs; the productivity, depth, and thickness of the reservoir; the proximity to and cost of infrastructure; the cost of applicable technology; royalty payments; transportation tariffs; regulatory costs; and tax structure. Recent dramatic changes in oil prices make it clear that prospects must be evaluated across a range of prices and that, in a fluctuating oil market, the expectation for what is economically viable for any given price represents only a snapshot in time.

The proximity of the undeformed zone to existing infrastructure suggests that relatively smaller field sizes will be economically developable there. Today, satellite fields with recoverable reserves of less than 30 MMBO are being developed near the major North Slope fields. With investment in a pipeline from Badami to the Point Thomson Unit, just a few miles away from the 1002 Area, infrastructure will be available for development of comparable size fields. Availability of facilities in this area also make it possible to develop offshore discoveries.

Unless development proceeds east across the 1002 Area, the deformed zone's greater distance from now-existing infrastructure suggests that fields there will have to be larger than those in the undeformed zone if they are to prove commercial. Geological structures there are large and complex so the traps and the field sizes could be large. However, success in the undeformed zone to the west may provide the facilities to support development in the deformed zone and, as a result, fields smaller than otherwise required might eventually prove economical in the deformed zone.

1. 1998 – USGS – ANWR 1002 Petroleum Assessment

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 MMBO. More than 60 percent of the recoverable oil resource may lie in accumulations larger than about 260 MMBO. Many discoveries of this magnitude have now been developed in other areas of the onshore North Slope. The 1998 USGS assessment did consider the sensitivity of ANWR production to crude oil price. Economics become positive for large accumulations at about $13 per barrel. Smaller fields might not be economic at prices less than $24 per barrel. At a market price of $30 per barrel in 1996 dollars (the equivalent of $44.51 in 2013 dollars according to the U.S. Bureau of Labor Statistics CIP Inflation Calculator) the assessment suggests that virtually all technically recoverable oil is also economically recoverable.

2. 2005 – USGS – Economic Update

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 in 2003 dollars (Attanasi, 2005a). These functions are based on a host of assumptions, and the uncertainty of the model is not easily quantified. However, many of the assumptions are readily justifiable, e.g., that development would use highly efficient horizontal production wells, that larger fields will shoulder the economic burden in the initial stages of development, and that clusters of smaller nearby accumulations (satellites) will become economic to develop later on. Estimates for both the entire study area (the 1002 Area, Native lands, and State lands within the 3 mile limit) as well as only the federally-controlled 1002 Area were developed.

Among the economic update's key findings were that at $30 per barrel 70 to 82 percent of the technically recoverable oil in the federally controlled 1002 Area could be economically produced. Based on the mean estimate of 7.7 BBO of technically recoverable oil in this area, these percentages translate to approximately 5.4 to 6.3 BBO of economically recoverable oil. Although potentially distributed in dozens of accumulations, these volumes are the equivalents of one and one-half to two times the total oil recoverable from the Kuparuk River field, or about one-third to one-half that of the greater Prudhoe Bay field.

Additionally, in the entire assessment area including Native and State interests, 73 to 82 percent of the technically recoverable oil 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 10.4 BBO in the study area, the model predicted 9.5 BBO could economically be developed in this scenario.

3. 2012 – State of Alaska – Economic Analysis

In 2012, ADNR-DO&G created models to estimate economically recoverable volumes. Unlike the USGS estimates, which were evaluated with time independent incremental cost curves, ADNR-DO&G's scenario-based approach tied the economic estimates to specific time frames and used revenue and production estimates that are readily available. Also, unlike the previous USGS estimates, ADNR-DO&G's analysis incorporated other factors such as the possibility of high transportation tariffs through TAPS, which fluctuate based on the pipeline's cumulative throughput from all sources.

Using the same field size and distribution estimates from the 1998 USGS assessment and ADNR-DO&G's time specific scenario, ADNR-DO&G's model updated the different costs incurred in exploration and field development and increased the range of prices per barrel to reflect more recent ranges of oil price. This updated analysis by ADNR-DO&G estimates that 90 percent of the known technically recoverable oil would be economically recoverable at $100 per barrel. In this scenario, only fields less than 100 MMBO are uneconomic. One hundred percent of the technically recoverable oil could be produced economically if the price was $165 per barrel. This analysis assumes that the largest of the 1002 Area's fields would be the first to be developed, followed by successively smaller fields being developed every couple of years benefitting from the existing infrastructure in place.

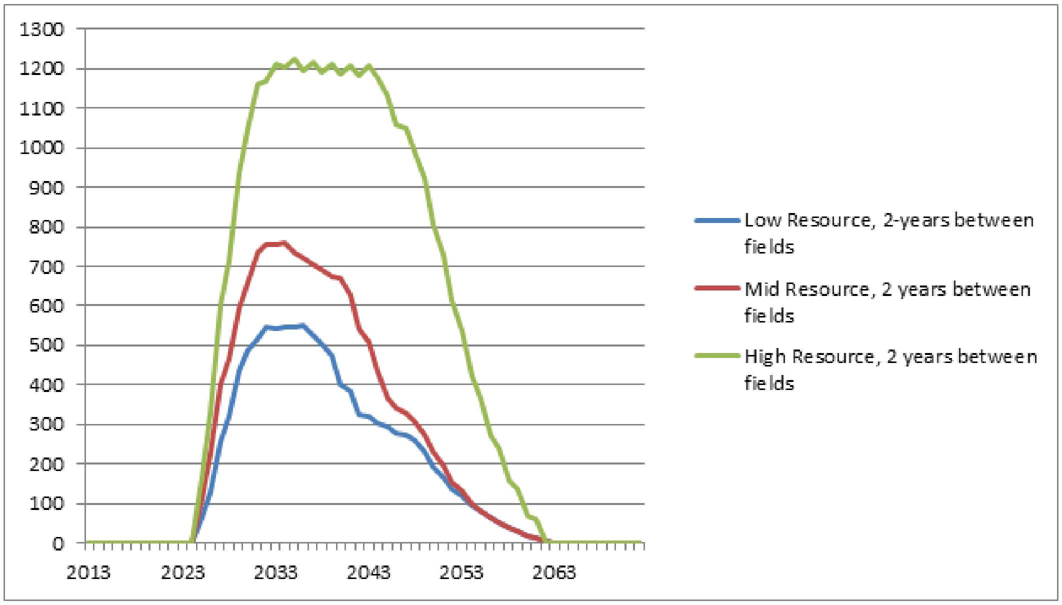
Timing is also an important aspect of forecasting economically recoverable volumes. A 100 MMBO field starting up after 2045 would need a substantially higher oil price to be economically viable, given the increases that are expected in TAPS tariffs at that time, or significant infrastructure investment prior to development.

H. Economically Recoverable Production Volumes

In addition to the previous discussion of OIP, technically recoverable volumes, and economically recoverable volumes, a metric worth considering is the production volumes per day at different field development levels through the expected life of each field. In addition to the importance of production volume in determin-

Figure 3-5

Production Forecast from the 1002 Area in thousands of barrels a day. Comparison of the Low, Mid, and High Resource EIA cases with 2 years between developments, mid-price case.



Source: CBO 2012; EIA 2008; ADNR-DO&G 2012

ing revenue streams from royalties and taxes, which are discussed in Chapter 7, volumes contribute significantly to the cost to produce and transport the product. In particular, with the cost of running and maintaining TAPS being relatively constant, the volume of oil throughput significantly affects the price per barrel tariff.

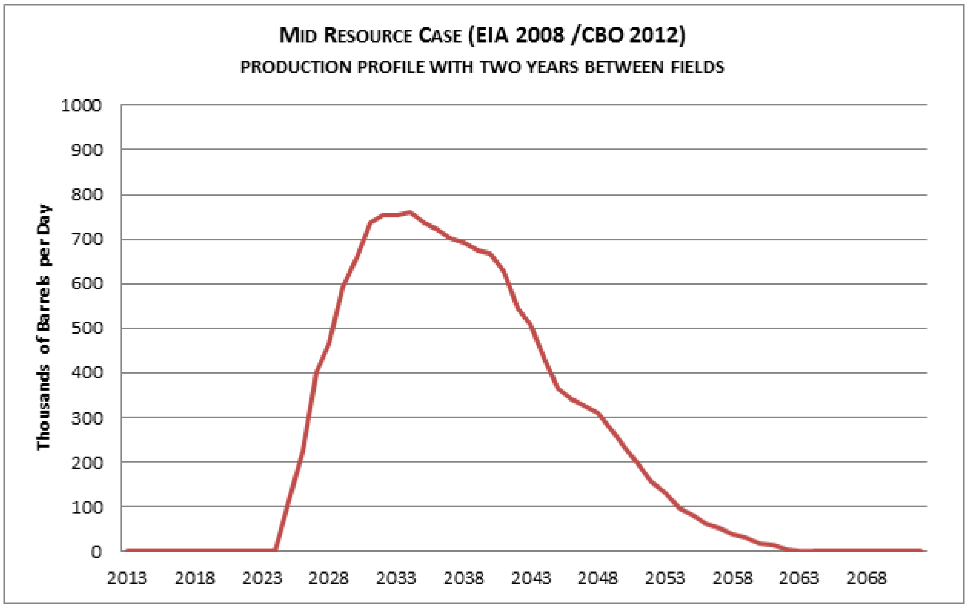
Production curves for individual oil wells follow a similar pattern of rapid growth, peak, and gradual, steady decline. Full field development typically commences with development of the largest known pool and then smaller satellite fields are brought online as the technology and economic conditions permit.

In 2012, the Congressional Budget Office (CBO) issued a report analyzing potential budgetary effects of immediately opening most federal lands to oil and gas leasing (CBO, 2012). Revenues from opening ANWR's 1002 Area were examined based on the technically recoverable reserves estimated in the 1998 USGS assessment and a 2008 Energy Information Administration (EIA) scenario in which production would commence 10 years after leasing was permitted to occur, larger fields would be developed before smaller fields, and with a new field coming on line every two years (EIA, 2008). The CBO assessed varying production rates based on whether the high, mid-case, or low resource assessment by the 1998 USGS comes closest to being true.

Using this CBO/EIA scenario as a model, ADNR-DO&G developed a series of economically recoverable production curves to illustrate low, medium, and high

Figure 3-6

Mid Resource Case production forecast from the 1002 Area in thousands of barrels a day.



Source: CBO 2012; EIA 2008; ADNR-DO&G 2012

volume estimates at a $100 per barrel price. The high volume scenario estimates production peaking in 2035 at 1.24 MMBO per day. The medium volume scenario estimates a production peak in 2034 at 760,000 barrels per day. The low volume scenario estimates a peak level of 550,000 barrels per day in 2036. In each of these scenarios, economically viable production ceases in the early 2060s.

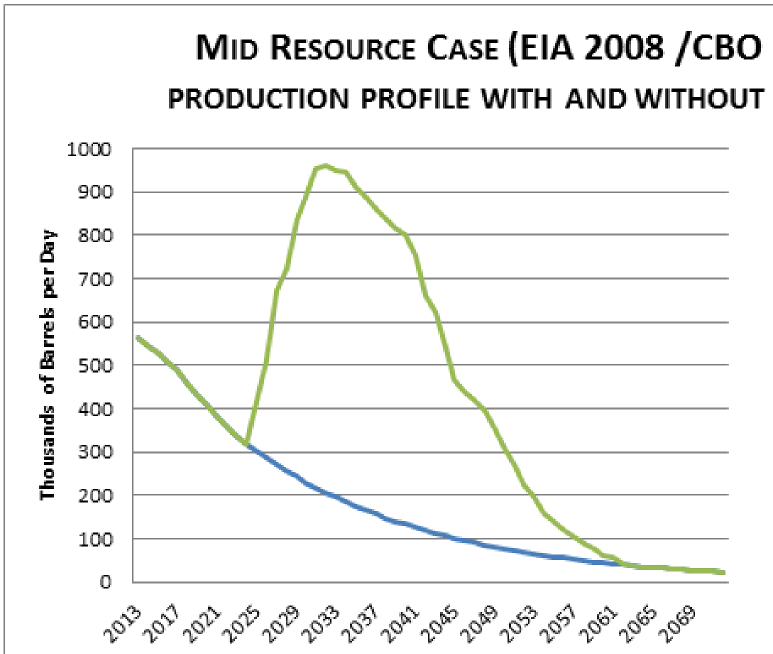
The production peak for the 1002 area of ANWR in the Mid Resource Case occurs in the 10th year of production. At 760,000 barrels a day, this peak production exceeds current ANS production levels, and is over twice the production volumes expected from current North Slope fields at the time the peak production level is reached.

Based on the Alaska Department of Revenue's (ADOR) Fall 2012 Revenue Sources Book (RSB), Alaska North Slope production is forecasted to decrease nearly 40 percent in the next 10 years (ADOR, 2012a). Extrapolating a 5 percent annual decline, TAPS throughput would be approximately 300,000 barrels per day by 2025.

Maintaining TAPS throughput at minimum levels is critically important for the pipeline's structural integrity and the economics of transporting oil from Alaska's North Slope. If ANWR production were to come on line in 2025, it would add throughput to TAPS at a time when low flow issues would be a major concern, and could ultimately increase flow to levels not seen since the early 2000s.

Figure 3-7

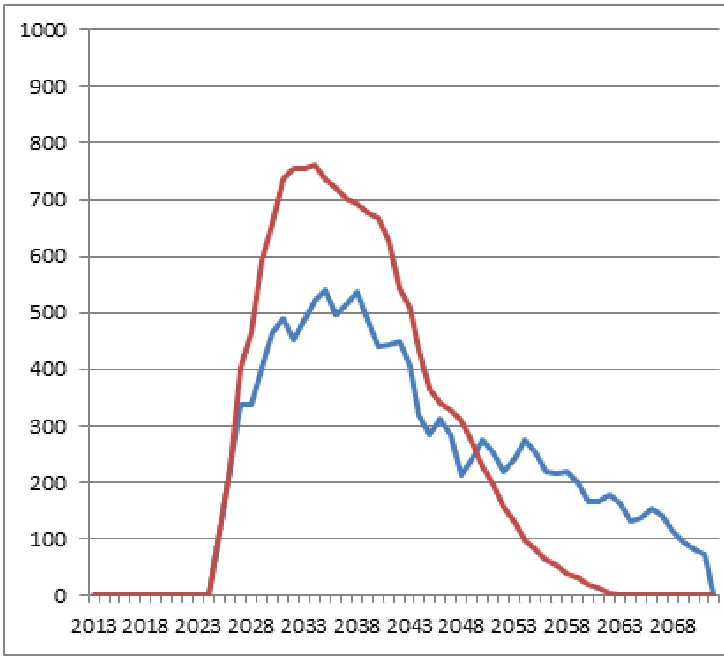
Production forecast from the 1002 Area using CBO mid-case scenario, in thousands of barrels per day, compared with existing production forecasts from North Slope fields.



Source: ADOR, 2012a

Figure 3-8

ANWR 1002 Area production forecast in thousands of barrels a day. Comparison of the Mid Resource EIA cases with a different assumption about years between fields.



Source: CBO 2012; EIA 2008; ADNR-DO&G 2012

Of course, the amount of oil produced from the 1002 Area will vary from the CBO medium case volume based on variables such as the actual resource base, the years between field start-ups, and oil prices. However, the resource base cannot even be established until modern practices such as 3-D seismic surveys and exploration wells are permitted to occur in this area.

If field start-ups are spaced differently than the two year time span estimated by the CBO, the yearly production volumes at a medium resource case would be different, as would the span of years of production above threshold levels for TAPS. For example, if a new field was brought online every four years instead of every two years, the peak production would likely not surpass 600,000 barrels per day, but would maintain a production volume of above 200,000 per day for nearly 20 years beyond the field-every-two-years CBO scenario.

I. Natural Gas

In addition to vast oil resources predicted in the 1998 USGS assessment described above, non-associated natural gas deposits within ANWR could also prove to be significant. In the entire assessment area, including Native and State interests, the estimated volume of gas ranged from zero to 14.5 trillion cubic feet (TCF) with a mean of 5.1 TCF. Considering only the 1002 Area, estimates ranged from zero to 13.4 TCF, with a mean of 4.6 TCF. Technically recoverable volumes of natural gas in the 1002 Area were estimated between zero and 10.0 TCF, with a mean of 3.5 TCF. Unlike the majority of the predicted oil resources, most of the natural gas reserves are expected to occur in the deformed zone in the eastern portion of the 1002 Area.

Table 3-4

Estimates of technically recoverable gas in different zones of the assessment area, in trillion cubic feet (TCF)

Study Area	95% probability	Mean probability	5% probability
Entire Assessment Area	0	5.1	14.5
Federal 1002 Only	0	4.6	13.4
Federal 1002 Only, technically recoverable	0	3.5	10.0

Source: USGS,1998

At the time of the 1998 assessment, non-associated gas was not considered to be a likely exploration objective, and the resource was not as rigorously evaluated by the USGS as was the oil resource. The 2005 economic analyses also developed by the USGS did not evaluate non-associated natural gas because those resources were not expected to be targets for exploration in the near future.

Many things have changed since the 1998 and 2005 assessments. Natural gas has become a more environmentally and economically desirable fuel objective. Additionally, extraction technology for natural gas has advanced considerably in recent years. Consequently, the 1998 estimates for both in-place and technically recoverable gas resources may have resulted in undeservedly conservative values. From the economic perspective, changes in demand, technology, supply and transportation potential all suggest that a refreshed look at natural gas potential is needed.

1. Use of Natural Gas on Site

To maximize oil recovery, natural gas, water, and other miscible fluids are often injected to maintain formation pressure in producing fields. In addition to the benefit of enhanced oil recovery (EOR), produced natural gas is put to beneficial use instead of contributing to the air emissions that would result from flaring excess gas. The use of natural gas in enhanced oil recovery is a widely adopted practice on Alaska's North Slope, particularly in aging fields where production levels are in decline. Enhanced oil recovery using natural gas collected during oil production can decrease the number of wells (and their associated waste) by increasing the efficiency of existing well production.

Natural gas extracted at other existing oil production facilities is also used on site to power operations and provide fuel for living and working quarters.

2. Commercializing Alaska Natural Gas

There are currently two state-backed efforts to commercialize the North Slope's immense natural gas resources.

The first effort began in 2007 when the Alaska Legislature passed the Alaska Gasline Inducement Act (AGIA) to expedite construction of a natural gas pipeline and facilitate gas commercialization. AGIA created a state license for a pipeline and offered the licensee substantial financial incentives to facilitate project development, including up to $500,000,000 in matching funds during the initial planning and permitting stages when a development project is most at risk.

In August 2008, the State of Alaska issued the AGIA license to TransCanada, which formed the Alaska Pipeline Project in 2010 with ExxonMobil. The project was originally focused on supplying North America, but shale gas development has driven gas prices down and dramatically increased supply in these markets. Due to this change, TransCanada and the North Slope producers has shifted their focus to LNG exports. Progress was made on this option throughout 2012 and a project concept that pursues LNG exports was selected in early 2013.

In 2010, the Alaska Legislature provided start-up money for an instate gasline developed by the Alaska Gasline Development Corporation (AGDC) to accelerate bringing Alaska's gas to Alaskans first. In 2013, the Legislature passed legislation that authorized AGDC to act as a stand-alone corporation and provided it with an additional $350 million to advance work on a pipeline.

Ultimately, there may be opportunities for these two efforts to merge and consolidate Alaska's gas commercialization efforts. They both continue to make important progress, and demonstrate the serious commitment the State has made to this effort. Infrastructure that supports gas commercialization will continue to be a critical priority for Alaska in the future.

J. Conclusion

The quantity of oil and gas that lies beneath the tundra of the ANWR 1002 Area, and how much is technically and economically recoverable has been speculatively estimated for years. These estimates are primarily based on seismic data acquired in the 1980s, almost 30 years ago. Despite repeated sophisticated analyses by government and industry geoscientists, only additional and more advanced seismic surveys and an exploration drilling program will reveal what lies beneath the permafrost. The 3-by-6 mile seismic grid acquired during the assessment phase in the 1980s served its initial reconnaissance purpose, but prospects of substantial size may have been missed by such a large grid.

Analysis of ANWR's resource potential may slightly improve with science over time, while it will greatly improve with exploration. Conclusively knowing the oil and gas resource potentially available is in the public's interest and is consistent with the intent of Congress expressed in ANILCA and NEPA.

Chapter 4
Oil and Gas Exploration History and Technological Advances

A. Introduction

Oil and gas exploration has occurred in many areas throughout the state of Alaska. The first exploration wells were drilled more than 100 years ago. Exploration wells have been drilled offshore and onshore; on federal, state, and private lands; on man-made islands and bridges; from ice pads and causeways; and in sensitive habitat, subsistence resource areas, and recreational areas. On Alaska's North Slope, the oil and gas industry has become adept at minimizing environmental impacts, conducting winter exploration on ice roads and pads, and ensuring non-interference with subsistence resources and endangered or threatened species and their habitats.

Oil and gas resources are accessed, explored, and developed over many years. The lease-related activities proceed in phases from leasing to exploration, development and production, transportation, and, in some cases, storage. Each phase's activities depend on the initiation or completion of the preceding phase. While geophysical exploration activities can generally be conducted with or without an issued oil and gas lease, exploration activities in the ANWR 1002 Area can only be authorized by Congress. This section is designed to assist in describing existing and advancing methods currently used in Arctic exploration.

The objectives of exploration are to obtain and evaluate information about petroleum potential, the subsurface geology, and the geographic extent of potential and recoverable resources. Historical exploration activities can inform the locations and activities to be considered in future exploration efforts.

1. Historical Exploration of ANWR

Historical exploration was fully detailed in Chapter 3, with supporting maps. This section discusses the specifics of how the historical exploration was conducted. Almost 30 years ago, 2-D seismic was utilized and an exploratory well drilled safely and without significant or lasting environmental impact. Today, under more stringent regulations and with new advanced technology, exploration of the 1002 Area poses minimal risk, but offers the substantial benefit of obtaining a thorough resource assessment of the 1002 Area's marginally known and highly anticipated oil and gas reserves.

Oil and gas exploration in ANWR was authorized under ANILCA Section 1002(a) utilizing practices that would avoid significant adverse effects on fish, wildlife, and other resources (Clough, et al., USDOI 1987). ANILCA, Section 1002(h)(3) requires identification of areas within the coastal plain that have oil and gas production potential; an estimate of the volume of oil and gas concerned; a description of the fish and wildlife, their habitats, and other resources in the area; and an evaluation of the adverse effects that the carrying out of further exploration for, and the production of, oil and gas within such areas will have on the resources described above.

Historical ANWR exploration included surface geological and geophysical work, but not exploratory drilling. From 1983-85, exploration efforts using field observation, surface measurements, mapping and collection of rock samples were allowed, with access by helicopters to reduce surface impacts. Additional geochemistry, biostratigraphic and geochronologic age control, porosity and permeability were analyzed from the sections sampled. This reconnaissance effort made important advances, but only exploratory drilling can accurately establish how much producible oil the ANWR coastal plain might provide.

2. Typical Exploration Activities

During the exploration phase, activities are conducted to obtain information about the petroleum potential of an area by examining surface geology, researching data from existing wells, and performing environmental assessments. Operators may conduct geophysical surveys and drill exploratory wells, after obtaining the proper permits. The surface analyses include the study of surface topography and natural surface features, and the near-surface structures revealed by examining and mapping nearby exposed rock layers. Geophysical surveys, primarily seismic, help reveal the characteristics of the subsurface geology. Geophysical exploration and exploration drilling can both be conducted in winter without lasting impact to ANWR's surface resources.

3. Exploration Methods

The scope and scale of oil and gas exploration activities depend on several factors. Understanding the subsurface stratigraphy assists in prioritizing zones of interest. The geologic setting is analyzed for structural and stratigraphic traps. Depth, extent, and accessibility are estimated and maximized for best return on investment. The identification of petroleum traps, porosity, permeability, and geography direct the extent of the exploration program. During the early stages of exploration, resources are evaluated using non-invasive techniques with topographical maps, aerial photography, sound waves, 3-D projections and other tools to estimate the shape, extent and character of the oil and gas resources (BP, 2012). Environmental studies are conducted, data compiled and evaluated, and resource mapping initiated. Planning incorporates minimizing impacts balanced with resource access viability.

The current and emerging exploration practices commonly include seismic surveys, resource delineation and modeling, construction of temporary ice roads, drilling exploration wells and reservoir testing.

4. Activities Subsequent to Exploration

Follow-up activities and the timing of subsequent development will depend upon where the petroleum resources are located, and their location with respect to delineation, access, processing, storage, and transportation systems. Discovery of the resource may not prompt development until much later. It can take up to ten years to develop an oil field after a commercially viable petroleum resource is discovered. Economic potential, existing or lack of infrastructure, industry priorities, and competitive risks combine to impact the level of interest and the length of the development timeline on lands in Alaska.

B. Geophysical Exploration Programs

1. Seismic Surveys

Photo: ADNR-DO&G

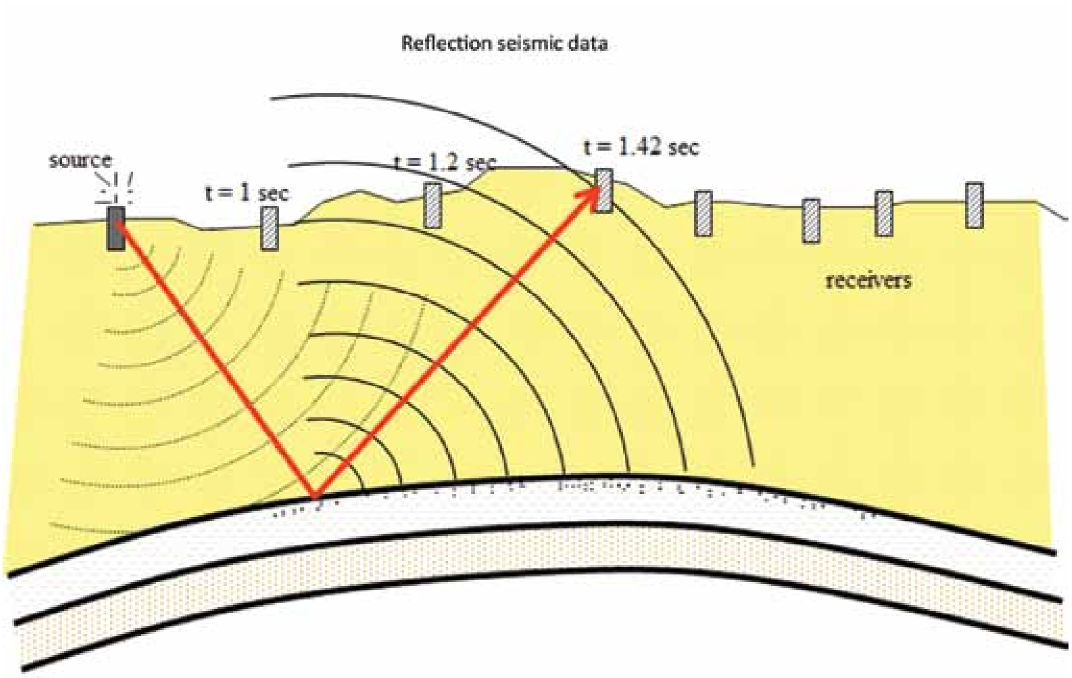
Seismic train in the field, Prudhoe Bay Unit.

The most common type of geophysical exploration is the seismic survey, designed to measure the amplitude and timing of reflected energy. At a survey location, a pulse of acoustic energy is emitted into the subsurface and reflected or refracted seismic waves are recorded at the surface by vibration-sensitive geophones and/or hydrophones. Different rock layers beneath the surface reflect different amplitudes and velocities due to differing densities. Cables or nodes transmit signals to a processing center, where the data is analyzed and recorded. The characteristics of the measured waves provide data to interpret the subsurface formation structures. This process results in a unique seismic profile that can be analyzed by geophysicists to interpret subsurface structures and petroleum potential. Both 2-dimensional (2-D) and 3-dimensional (3-D) data can be generated. Geophysical, magnetic, electric, gravitational, thermal, and elasticity data are used to deduce the elastic properties of the subsurface materials in order to delineate formations for potential additional exploration. (OilandgasIQ, 2012; E&P/UNEP, 1997).

Seismic surveys are typically conducted by geophysical exploration companies under contract to leaseholders, or as multi-client and speculative surveys run directly by the seismic contractors. Seismic source and receiver locations are surveyed using GPS (Global Positioning Systems) and follow predesigned patterns. For land or ice 2-D data, the receivers and sources lie in a straight line (as topographic and ice conditions permit), and can extend for many tens of miles. 3-D data is collected over a much wider swath, and can cover tens to hundreds

Figure 4-1

Reflection seismic data use sound energy to illuminate the subsurface of the earth.



Source: ADNR-DO&G 2012

of square miles. 3-D seismic "shoots" can have greater surface impacts than 2-D surveys (Gelb, et al., 2006). 2-D seismic programs also usually have fewer crew members and employ much less equipment than 3-D programs.

Seismic data can be collected after the ground is frozen and covered with a protective snow layer. Seismic in shallow water can be collected on the ice in winter, or by using bottom cables in the summer months. Ice-based seismic programs are dependent on ice thickness and stability. Collecting data in the winter months may minimize effects to fish and wildlife habitats, and avoids conflicts with migrating marine mammals.

Multiple seismic sources can be used on land or ice surveys, but vibrator trucks (or, on the tundra, rolligons) are the most common sources using the vibroseis method. A group of three to five heavy vibrator trucks lower and vibrate heavy pads or plates along a series of lines at measured intervals across the study area (E&P/UNEP, 1997). The entire weight of the truck rests on the plate as it puts energy of continuously varying frequency into the ground. The vibration typically lasts 4 to 16 seconds. This energy source is less destructive than an explosive source, where all of the energy is imparted in an instant. Less commonly, air guns can be lowered through holes drilled in the ice to provide the acoustic energy source.

Another seismic method uses small explosive charges placed in narrow holes drilled to a depth of about three to 90 feet. Similar to the vibroseis and air gun methodologies, the explosive blasts produce acoustic waves that are measured and recorded (E&P/UNEP, 1997).

2. Shallow Seismic Reflection

The use of high-resolution, shallow seismic methodology analyzes subsurface depths of less than 1,500 feet depth. It can be used for characterization of unconsolidated sediments for determination of the fluid and mechanical properties of field sites. The data analyses include interpretation to account for interference from groundroll and frequency filtering, and is currently an underdeveloped technology (Bachrach, 1999, citing to Steeples, et al., 1997). High-resolution shallow seismic surveys are specifically designed to image the bottom of the water body and very shallow geology. These are used to look for drilling hazards such as faulting and shallow gas deposits. This methodology employs a lower energy seismic source and a shorter cable than surveys targeting deeper strata.

3. Geophysical Techniques

Additional geophysical techniques can be used to gather specific information about very near surface geology, which is usually done to identify drilling hazards. They include side-scan sonar, fathometer recordings and shallow coring programs.

Geophysical surveys can be conducted without long-term effects. Before proceeding with geophysical exploration, companies must acquire one or more permits from the federal or state agencies, depending on the timing and extent of the proposed activity. Regulators evaluate each permit and may issue an authorization relating to the specifics of the proposed project. Restrictions on geophysical exploration permits depend on the duration, location, timing, and intensity of the project relative to the potential effects the activity may have on fish and wildlife resources or human use in the area.

Seismic surveys provide key information for evaluating oil and gas plays with few impacts to surrounding resources. The process gives geologists and geoscientists important data with which to begin to define a reservoir and identify exploration well positioning. Surveys can be planned to reduce impacts, and may be conducted during times when most wildlife that would be impacted are absent or present in lesser numbers. It was noted in USDOI's 1987 1002(h) report that "proper routing, timing, and sufficient snow cover can effectively reduce and limit adverse environmental impacts" (Clough, et al., USDOI 1987).

Seismic technology has improved vastly since USDOI's 1987 report to the point where seismic surveys conducted in the winter can be conducted without large negative impacts to habitats, wildlife, and fish. Better designed 2-D and 3-D surveys and improved models allow for exploration in areas with little data and limited access (Gelb, et al., 2006).


Photo: ADNR-DO&G

Ice road, North Slope, left. Rollagon bag and drive roller, right.

4. Logistics for Geophysical and Ground Surveys

The lands of the coastal plain of ANWR are far from major transportation services and population centers. ANWR's remote location and Arctic climate can create challenges for transportation, staging, and personnel management. Exploration operations may depend upon the success of transport, maintenance and mobilization of most of the needed personnel, equipment and supplies. During ice free months, marine transport, such as sealifts, may be required to move heavy equipment and large facilities to the selected exploration sites.

Air transport is available to all North Slope communities and industry sites, but may be greatly influenced by prevailing weather conditions. Fixed-wing aircraft and helicopters can provide access to locations in ANWR from the appropriate community or industry sites. This would provide access for seismic surveys, surface-based surveys of geology, wildlife, fish, subsistence, cultural resources and other related surface information. Airstrips and localized helicopter pads are not found throughout ANWR, which may reduce air transport opportunities throughout ANWR.

The Dalton Highway extends from north of Fairbanks, Alaska, to Deadhorse, near Prudhoe Bay. This is open year round, and supports heavy truck cargo transport on the road system. Staging of exploration equipment on the North Slope is possible, with connections by seasonal ice roads, and helicopter transport within ANWR.

Overland transportation is available from late December to May, weather permitting. Low-ground pressure vehicle (LPV) (rolligons, tracked Steigers, tracked and runner sleds) can travel on frozen tundra (BLM, 2006a).

Staging can be established for seasonal or year-round use, as appropriate. Personnel can use staged housing, and facilities can store supplies and fuel. A typical staging ice pad would be approximately 300 feet by 300 feet (est. 2 acres) (BLM, 2006a). Coastal docks could augment capabilities in the future during ice free seasons, if and when built. Kaktovik is located on the coast contiguous with ANWR, and has barge and shallow vessel support facilities (ADEC SPAR, 2004). There are currently no docks in ANWR.

C. Exploration Drilling

Exploration drilling often occurs after seismic surveys are conducted, when the interpretation of the seismic data is incorporated with all available geologic data and indicates possible oil and gas prospects. The drilling process is the only method to confirm the presence of petroleum hydrocarbons, and the thickness and pressures of the reservoir formations (E&P/UNEP, 1997). Exploration drilling, which proceeds only after obtaining the appropriate permits, is the only way to determine whether a prospect contains quantities of oil or gas sufficient to support commercially viable development and production.

Operations to explore require equipment, materials, and may require custom designs. Drilling rigs, drill pipe, personnel camps, and oil drilling supplies, for example, are transported to the exploration sites. The transport of exploration drilling rigs is complex, and custom Arctic drilling programs require added mitigations to prevent surface and habitat impacts. Drilling rigs and support equipment mobilize as modules, and in some cases are deployed months ahead for Arctic field applications (E&P/UNEP, 1997).

During winter operations, supplies, fuel, equipment and personnel may be transported over snow trails or ice roads, or by aircraft. Ice airstrips can be constructed on frozen ground or lake surfaces with a runway that may extend onto approved frozen tundra. Mobilization will occur when surface conditions are suitable to reduce and minimize surface impacts.

Ground and helicopter transport options are critical for accessing remote sites where surface transport options are limited (NPC, 2011). Crew changes necessitate transport options to match shift change intervals, and may be dependent upon air transport methods due to remoteness of sites (BLM, 2012a).

1. Exploration Drilling Methods

Drilling operations collect and evaluate well logs, core samples, cuttings, and a variety of other data. A well log is a record of one or more physical measurements as a function of depth in a borehole, and is achieved by lowering measuring instruments into the well bore. Many types of well logs can now be recorded while drilling. Cores may be cut at various intervals so that geologists and engineers can examine and analyze samples of the sequences of rock that are being drilled.

The drilling process generally proceeds as follows :

- Large diameter steel pipe (conductor casing) is driven or bored tens or hundreds of feet into unconsolidated surficial deposits to provide a stable foundation for deeper drilling.
- A drill bit, connected to the end of the drill pipe, rotates and drills a hole through the rock formations below the surface.
- After a prescribed depth of drilling, the hole is cleaned up and surface

casing, a smaller diameter steel pipe, is lowered into the hole and cemented in place. This keeps the hole from caving in, seals off rock formations, seals the well bore from groundwater, and provides a conduit from the bottom of the hole to the drilling rig.

- After surface casing is set, drilling continues until the objective formation or intermediate casing depth is reached. An intermediate casing string may be needed to allow drilling to deeper objectives, or in wells that encounter unstable formations or high subsurface fluid pressures.
- Excess drilling mud that cannot be reused is stored onsite, and later transported and disposed in an approved injection well.
- The well is typically evaluated by further logging and/or testing to interpret the depth, thickness, and other characteristics of the stratigraphic layers drilled, the type of reservoir fluids encountered, and flow rates obtainable from the well.
- The exploration well is either temporarily suspended or is plugged and abandoned.
- The drilling locations will be cleaned up to meet federal and state requirements.
- The drilling rig is mobilized off the drilling location.

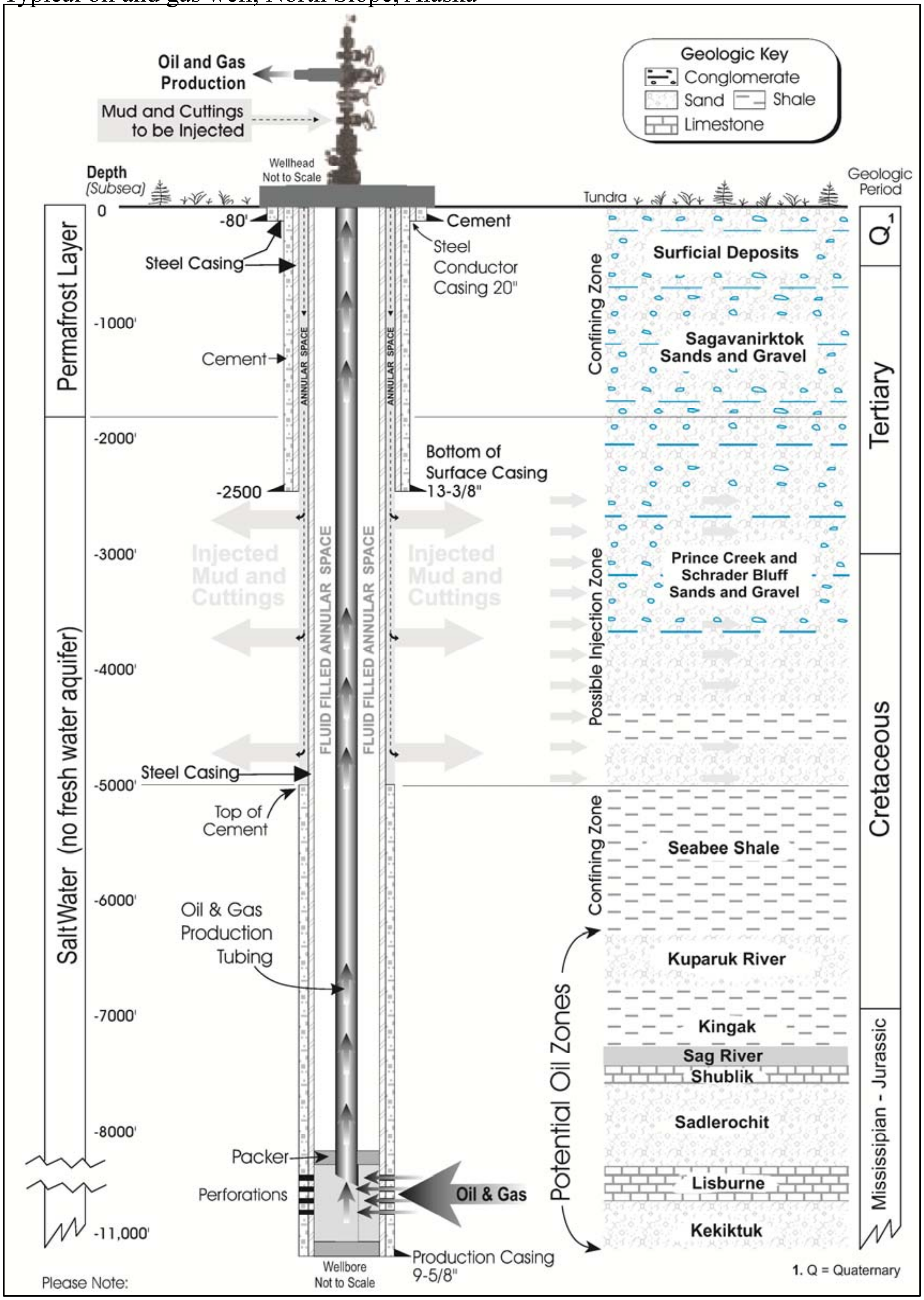
The drilling location is selected to provide access to the prospect and, if possible, is located to minimize the surface area that may have to be cleared or impacted. Temporary winter roads are often constructed of ice and snow, with longer-term roads constructed of sand and gravel placed on a liner for later removal, if necessary.

A typical exploration drilling pad is made of ice placed over a liner and is about 500 feet by 500 feet (est. 5.7 acres) (BLM, 2006a). The pad supports the drill rig, a fuel storage area if necessary, and a camp for workers. If possible, an operator will use nearby existing facilities for housing and feeding its crew. If facilities are not available, a temporary camp of trailers on skids may be placed on the pad. Enough fuel is stored on-site to satisfy the operation's short-term needs. The fuel storage area is a diked gravel pad lined with an 80 mil synthetic membrane to meet regulatory guidelines. Additional amounts of fuel may be stored at the nearest existing facility for transport to the drilling area as needed (Chevron, 1991). After completion of drilling operations, equipment and materials can be removed over ice roads or snow trails for storage in long term staging areas.

An exploratory drilling operation generates drilling cuttings, or fragments of rock cut by the drill bit. These fragments are carried up from the drill bit by the mud pumped into the well (Van Dyke, 1997). Gas, formation water, fluids, and additives used in the drilling process are also produced from drilling operations. The fluids pumped down the well are called "mud" and are naturally occurring clays with small amounts of biologically inert products. Different formulations

Figure 4-2

Typical oil and gas well, North Slope, Alaska



Source: State of Alaska, ADNR, Division of Oil and Gas, 2011, North Slope Foothills Areawide Oil and Gas Lease Sales, Final Finding of the Director, Page 6-14.

of mud are used to meet the various conditions encountered in the well. Chemicals may be added to maximize the effectiveness of drilling and casing. Drilling additives may include petroleum or other organic compounds to modify fluid characteristics during drilling (Lapham, et al., 1997). Additives may be aromatic hydrocarbons, emulsifiers, and metals (Woodward, et al., 1988). Oil-based muds and synthetic-based muds may also be used, depending on the well depth, well diameter, and subsurface formations (NRC,1983; Veil, et al., 1996). Muds are used to cool and lubricate the drilling bit, to prevent the drill pipe from sticking to the sides of the hole, to facilitate the drilling action, to carry cuttings within the well bore to the surface, to seal off cracks in down-hole formations to prevent the flow of drilling fluids into these formations, and to maintain reservoir pressure.

During drilling, produced water comes to the surface mixed with oil and gas, and must be separated before further refining. Drilling muds, fluids, and cuttings produced from the well are separated and disposed of according to federal or state requirements.

Federal and state governments regulate oil and gas wastes under the Clean Water Act (CWA), Safe Drinking Water Act (SDWA), Clean Air Act (CAA) and National Environmental Policy Act (NEPA). The BLM and the Environmental Protection Agency (EPA) have regulations, rules and guidance that mandate practices and standards to address waste management during drilling operations. Administration of many of these programs has been delegated to State of Alaska agencies; for example, the Alaska Department of Environmental Conservation has primacy on Clean Water Act compliance.

For example, during exploration well drilling, residual muds and cuttings are stored on-site in holding tanks. They are then hauled to an approved solid waste disposal site or are reinjected into the subsurface at an approved injection well, in accordance with the Alaska Oil and Gas Conservation Commission’s (AOGCC) regulations at 20 AAC 25.080 and 20 AAC 25.252. The preferred and most common method for disposal of drilling muds and cuttings is by underground injection into a Class II injection well. Disposal of mud, cuttings, and other effluent from the oil and gas industry is regulated by the National Pollutant Discharge Elimination System (NPDES), administered by the Alaska Department of Environmental Conservation (APDES), and the EPA’s Underground Injection Control program (UIC), administered by the Alaska Oil and Gas Conservation Commission under AS 31.05 and 20 AAC 25.

2. Current and Advancing Exploration Technologies

Current technologies are providing drill pad options that can effectively reduce environmental impacts. Drill pads have decreased in size over time. Deviated (directional) drilling is used to reach targets offset from surface drilling pads. Exploration wells can be directionally drilled because of a lack of suitable surface locations directly overlying exploration targets. Directional drilling technology enables the driller to steer the drill stem and bit to a desired bottom hole location.

Directional wells initially are drilled straight down to a predetermined depth and then gradually curved at different points to penetrate one or more given target reservoirs (Van Dyke, 1997). Directional drilling can also allow multiple production and injection wells to be drilled from a single surface location such as a gravel pad or offshore production platform, thus minimizing cost and the surface impact of oil and gas drilling, production, and transportation facilities. Directional drilling can be used to reach a target located beneath an environmentally sensitive area and may offer an economical way to develop offshore oil fields from onshore facilities.

Multi-season ice-based roads and ice pads are emerging as possible technologies. While still in the testing phase for use in long-term oil and gas operations, they are appropriate for winter single-season or multi-season exploratory drilling. Some multi-year ice pads could be used during a subsequent winter season, and require insulation to prevent melting during the summer months. More information about oil and gas ice-based facilities is provided below.

3. Exploration Facilities

Facilities are needed to support exploration activities. Access and supply management are critical aspects for successful exploration. Northern Alaska is both remote and challenging for many components of exploration activities, including building and maintaining roads, water management, and waste disposal.

Exploration well sites will be located on ice pads, which may need to accommodate multiple drilling rigs, personnel camps, fuel storage, and power generation facilities. Ice airstrips can also be constructed to supply remote sites. Water and ice aggregate for ice infrastructure is withdrawn from approved lakes and ground water sources, as necessary. (BLM, 2006a).

4. Ice-Based Facilities

Seismic work and exploratory drilling can be conducted on ice-based infrastructure. Winter conditions facilitate tundra travel and construction and use of ice and snow roads. Ice spur roads will be built to connect drilling and staging pads and authorized water sources (BLM, 2006a). Ice airstrips and ice pad construction can provide seasonal routes and support for heavy equipment, supplies, personnel housing, and exploration drilling.

a. Ice Roads

Ice roads can measure 20 feet wide or wider, depending upon the ground terrain and equipment transport needs. Ice roads can be constructed at a rate of about one mile of road per day, and use approximately one million gallons of water per mile, and 1.25 million gallons per mile for a drilling rig-ready ice road (USACE, 2012). Ice roads and ice pads are similarly constructed. The location is marked, a snow layer is pre-packed, and layers of water, ice chips, and snow are built to a desired thickness (USACE, 2012, citing to ExxonMobil Response to Request for Information #78). Construction of ice roads is dependent on the available water sources, which are assessed during the planning and permitting of the ice road route.

Findings of an ice road study in the NPR-A found that tundra below a single-season ice road will recover naturally with no apparent long-term negative impacts (Guyer and Keating, 2005). Ice roads that are built on wet tundra or wetland locations have little to no evidence of damage. Upland areas did show reduced plant vegetation. However, there was no evidence that the length of time of road placement, the amount of hauled weight, or frequency of road usage caused additional impacts to vegetation. Total recovery from any ice road impacts is estimated to be a maximum of 24 years.

In addition, studies of lakes in the NPR-A where water has been withdrawn for ice road construction have been recharged the next season with no significant adverse effects (BLM, 2006b). A similar recharge process is likely in the 1002 Area, although volumes of water available and recharge rates need further assessment.

b. Ice Pads

Ice pads can be constructed of layers of ice, and can be made with ice chips to speed up the process, similar to ice road specifications. A typical drill pad is made of ice and measures about 500 feet by 500 feet (est. 5.7 acres) (BLM, 2006a). The pad dimensions are marked and crews prepack snow with rolligons and off-road vehicles to enhance the freezing process. Water is applied to form a base layer. Ice chips harvested from pre-approved sites are spread at the location. Ice chips, snow, and water are mixed and laid over the site in layers until the approved pad thickness is achieved (USACE, 2012, citing to ExxonMobil Response to Request for Information #78).

Insulated ice pads can potentially last for multiple seasons. An insulated ice pad is built from ice chips, snow, water, a vapor barrier layer, insulation panels and rig mats. Ice is built to a desired thickness of about 18 inches, and a vapor barrier is placed over the pad area. A 4-inch thick foam insulation mat layer is placed on the barrier material, and a layer of rig mats is installed at the surface. Ongoing inspection and maintenance are required for long term use. (USACE, 2012, citing to ExxonMobil Response to Request for Information #78).

Currently, ice pads are commonly used in exploration drilling, but are not often used for infrastructure intended to endure for multi-season development and long-term transportation systems. Platform and year-round insulated ice pad, and composite all-season pad concepts are in the testing phase.

c. Ice Airstrips

The construction of temporary ice airstrips may be needed for remote locations. Ice airstrips can be constructed in the same manner as ice roads and ice pads. Dimensions will measure about 5,000 feet by 200 feet for large aircraft, or smaller to support smaller aircraft. (BLM, 2006b).

d. Ice Bridges

When winter access routes require crossing waterways, an ice bridge is constructed. The construction must comply with Alaska Department of Fish and Game requirements for fish protection.

D. Conclusion

Overall, the demand for winter facilities can be effectively met using ice-based infrastructure, as described above. The following chapter presents a defined plan for incorporating these types of facilities to support a geophysical and drilling exploration plan to uncover and document the oil and gas resources that lie within ANWR's coastal plain.

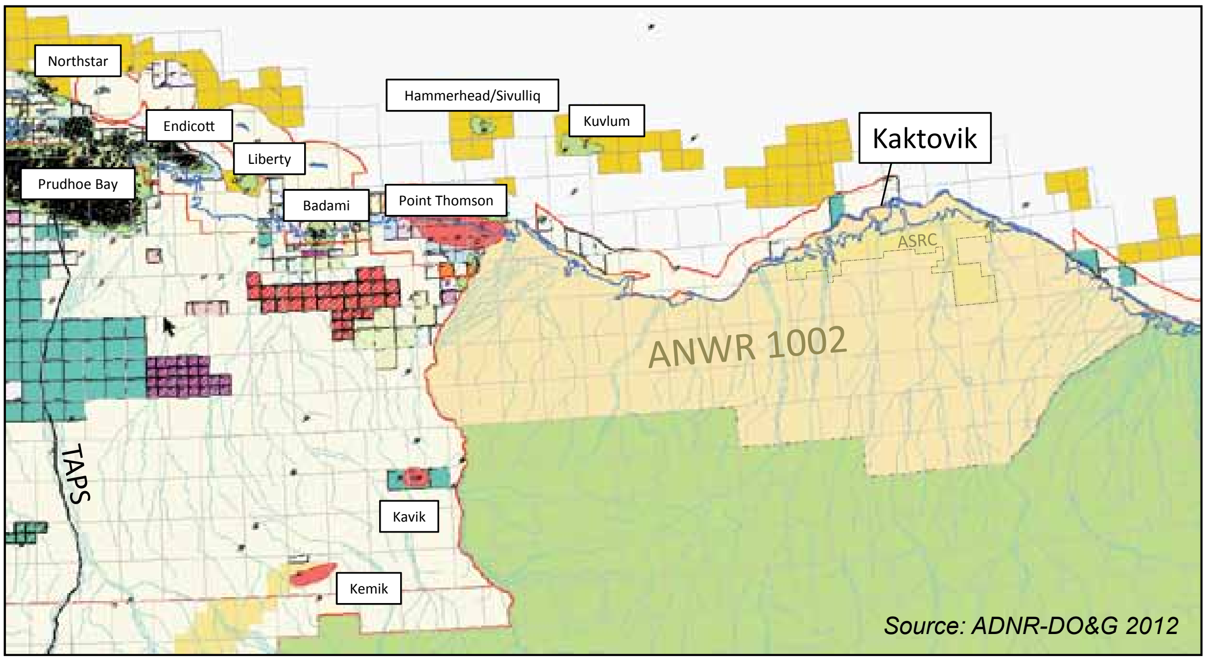
These advanced and proven technologies are already in common use on the North Slope and allow for the exploration needed to accurately assess the oil and gas resource potential with minimal surface impact.

Chapter 5
Proposed Exploration Program

Figure 5-1

ANWR Coastal Plain

Land Status, Fall 2012



Source: ADNR-DO&G 2012

A. Introduction

Long-term management decisions for ANWR must be based on a definitive assessment of the oil and gas resources of the coastal plain. Responsible decisions regarding major changes in land status should carefully weigh the full range of costs and benefits that they generate. There could be significant benefits from oil and gas resource development consistent with the Secretary of the Interior's recommendation in the 1988 CCP/EIS. A cost-benefit analysis will be speculative without definitive knowledge of the resource base, which can only be determined by conducting an exploration program. Today's technology allows exploration to move forward with minimal impacts by using state-of-the-art seismic surveys followed by the drilling of key prospects.

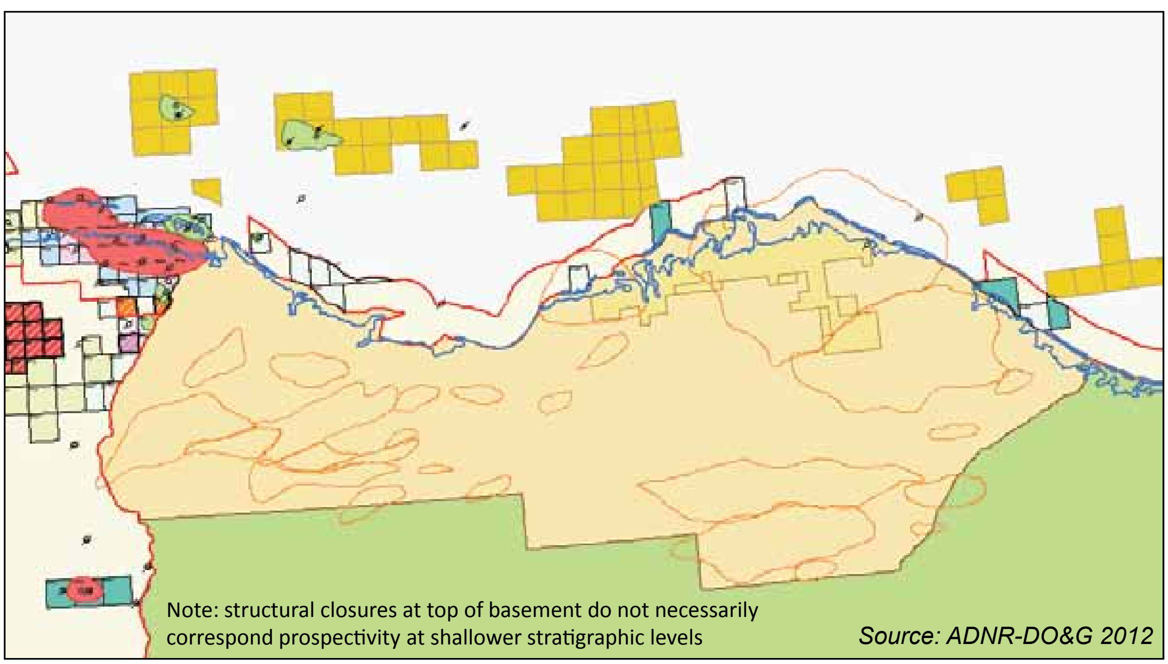
The proposed exploration program described here represents one plausible scenario for conducting a decisive subsurface investigation of the resources of the ANWR coastal plain – one that would definitively establish the area's oil and gas resource endowment with minimal environmental impacts. This vital resource information can and should be acquired, analyzed, and used to make optimal land use decisions with minimal impacts on the region's habitats, natural landscape, and wildlife refuge values. While more can be learned, there is already a great deal known about the flora, fauna, and subsistence activities that occur on the surface of the coastal plain. The same volume and quality of scientific informaiton needs to be gathered regarding the oil and gas resources underlying the 1002 Area.

Current estimates of the area's hydrocarbon endowment are limited to probabilistic resource assessments by the USGS. These resource assessments carry a wide range of uncertainty, expressed through the difference between the high and low estimates, due to the difficulty inherent in estimating recoverable oil and gas resources without actually drilling wells. The most recent assessments were based on 1,450 line miles of 1984-85 vintage 2-D seismic data inside ANWR, combined with outcrop observations and extrapolation of subsurface data from the surrounding region (Bird, 1999; Bird and Magoon, 1987). The 2-D seismic lines used in those studies were spaced three to eight miles apart. While this data has been repeatedly reinterpreted by geologists using the best available methods, the data itself is three decades old. Although valuable for understanding the area's general geologic characteristics, the data fall far short of current possibilities for detailed mapping of structural and stratigraphic prospects. Today, more reliable oil and gas resource estimates can be obtained through a low-impact campaign of carefully planned exploration drilling informed by the best available 3-D seismic technology.

Figure 5-2

ANWR Coastal Plain

Structural closures at Top Pre-Mississippian basement, after USGS, Bruns, et al., 1987



B. Exploration Program Scope

The proposed exploration scenario discussed here envisions 3-D seismic surveys and winter only drilling on both federal and Native lands in ANWR, as well as the possibility of extending seismic acquisition into adjoining state waters. The distribution of oil and gas in subsurface formations does not follow surface and subsurface estate ownership boundaries. An efficient exploration program would include cooperation among resource owners, be accompanied by legal and financial agreements that benefit all impacted parties, and allow for exploration, seismic survey access, and information sharing, irrespective of land ownership.

This exploration program is presented in three successive phases, beginning with multi-year seismic acquisition, evolving into planning and permitting, and concluding with multi-year exploration drilling.

Current exploration technologies, in concert with winter-only exploration, can maximize petroleum resource assessments while minimizing impacts to ANWR's surface values. Vital resource information can be acquired, analyzed, and optimized with little to no impacts on the habitats, wildlife, and uses of ANWR.

1. Phase 1 — Seismic Surveys

A multi-year schedule is proposed to acquire large area 3-D surveys of the coastal plain study area, contiguous Alaska Native inholdings, and adjacent state lands and waters. For this effort, the program will occur exclusively in winter to reduce impacts to both terrestrial and freshwater habitats, wildlife populations, polar bear denning areas, and other ANWR uses and values. A reevaluation of the vintage 2-D seismic data interpretations may be helpful in fine-tuning the focus of the 3-D seismic shoot in certain areas. The proposed methods for acquiring 3-D seismic surveys are discussed in Chapter 4.

It is critical to conduct extensive oil and gas seismic surveys across ANWR to better understand its geology in relation to the other prolific areas of northern Alaska. This exploration proposal includes initial 3-D seismic acquisition for up to 3,305 square miles over 2 to 3 years.

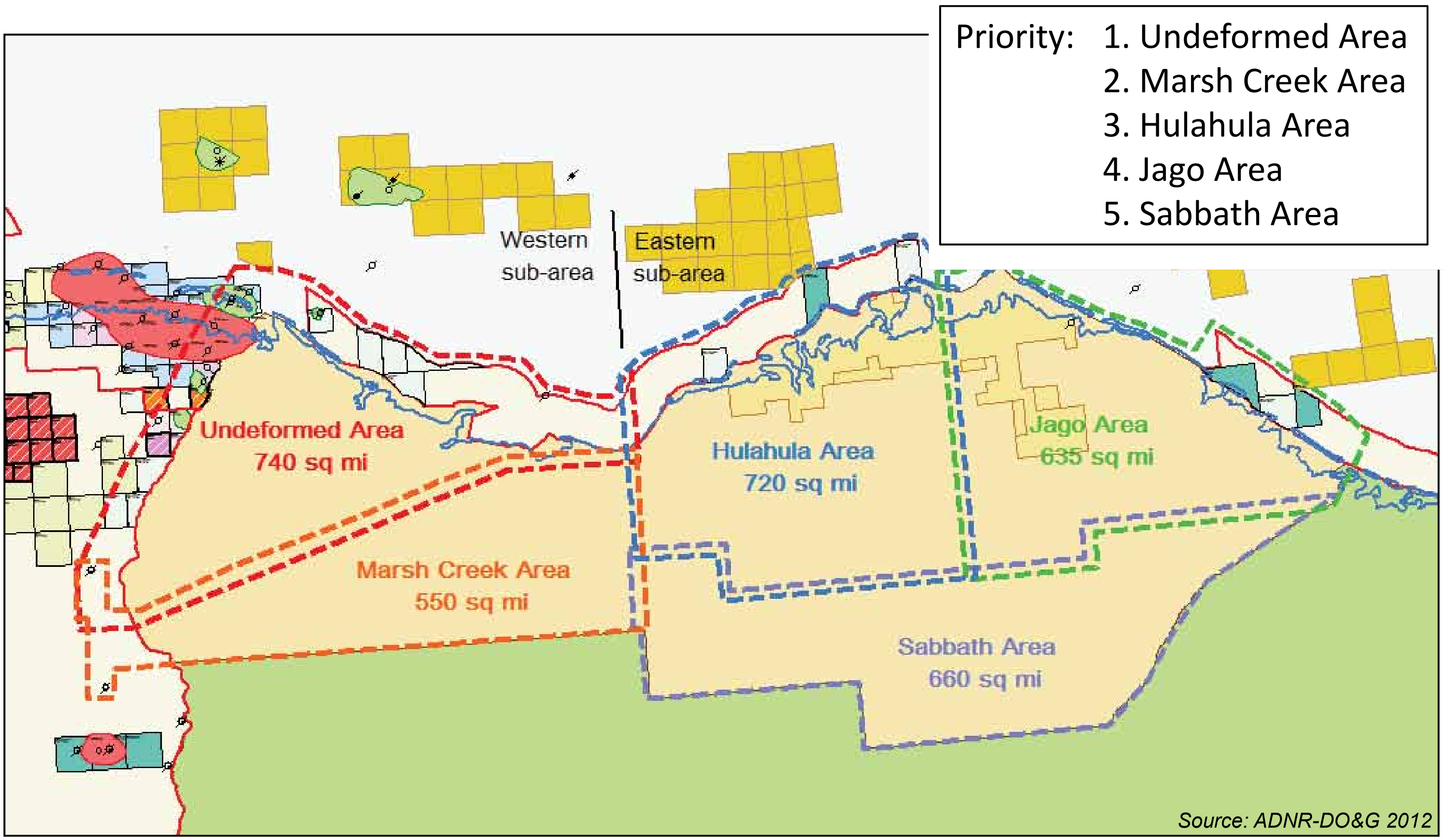
- Seismic acquisition in Year 1 would cover the western sub-area as defined in USGS economic updates (the **Undeformed** and **Marsh Creek** survey areas, see Figure 5-3) to the most recent resource assessment (Attanasi, 2005a, b).
- In Year 2, acquisition would move to the northern tier of the eastern sub-area (**Hulahula** and **Jago** survey area, Figure 5-3).
- Additional seismic surveys would be planned for Year 3 in the **Sabbath** area, unless findings from previous surveys indicate that immediate exploration is not warranted in the Sabbath area of the coastal plain (Bruns, et al. 1987). (See Map Phase 1-Years 1-3, Figure 5-3).

The 3-D seismic program is designed to accomplish several key goals. It would be vital for validating structural closures identified from the existing 2-D data, e.g., the basement-involved structures of Callahan and others (1987) outlined in Figure 5-2. In addition, it would reveal structural closures at shallower, more prospective stratigraphic levels. Finally, new 3-D data would be indispensable for recognizing and mapping stratigraphically trapped prospects, and in predicting reservoir quality and oil versus gas charge. Acquisition and processing parameters

Figure 5-3

ANWR Coastal Plain Exploration Scenario

Phase 1 – Years 1-3: Acquire up to 3,305 square miles 3-D Seismic



would likely vary among surveys to suit geologic differences in an attempt to best image the structurally complex areas. For Years 1-2, it is proposed to employ two distinct crews capable of acquiring 550 to 750 square miles each, per winter season. Seismic surveys would be conducted in January through April each year, depending upon the dates of approved tundra travel. The approved tundra travel dates are determined annually by ADNR's Division of Mining, Land, and Water based upon observed tundra field conditions. Transport of seismic equipment to the North Slope area would occur by barge or air prior to start of the field surveys. Detailed seismic survey plans are provided below. (See Figure 5-3, Map Phase 1-Years 1-3.)

Year 1: The coastal northwest **Undeformed** area survey goal is 740 square miles in Year 1 (including adjacent state waters), to identify stratigraphic traps and subtle structural traps that may be oil prone. The greatest potential is expected in the Tertiary topset formations and turbidites, and in the Thomson/Kemik sandstones. This area should have the highest priority for investigation because of assumptions of reservoir quality, likely oil charge characteristics, and proximity to existing infrastructure to the west. It is crucial to include enough of the adjacent state lands and waters in the seismic study to tie the new 3-D seismic data to all of the information provided by existing wells on state land.

The **Marsh Creek** area survey goal is limited to 550 square miles, to allow higher-confidence mapping of complex structural traps along the Marsh Creek anticline trend in Year 1. This area is directly south of the above referenced Undeformed area, with the highest potential expected in the Tertiary top-sets and turbidites. Acquisition and processing parameters may differ from those employed in the Undeformed area, so the boundary between the two surveys should follow the transitional geologic boundary between them, and should include sufficient overlap to merge the data sets.

Year 2: The survey for the **Hulahula** area, along the coast to the east of the above referenced Undeformed area, is proposed in Year 2 to cover 720 square miles. This area contains a subsurface structural depression called the Hulahula Low. This area preserves some of the youngest and best potential reservoir sandstones on the coastal plain, and is interpreted to be a key "kitchen", or area where oil and gas has been generated from source rocks. The targets are a mixture of stratigraphic and structural trap prospects, to locate the oil and gas prone formations.

Also planned for Year 2 is a seismic survey for the **Jago** area, east of Hulahula, for an estimated area of 635 square miles. This area is characterized by large, internally complex structural highs in the subsurface, with organic shales and oil-bearing sandstone exposed locally at the surface. The intent is to analyze large structural trap prospects that may be oil and gas prone. The Tertiary turbidites are expected to have the greatest resource potential. As in the previous year, acquisition and processing parameters may vary between surveys, and sufficient overlap is needed to effectively merge the two data sets.

Year 3: If warranted, 3-D seismic acquisition in the **Sabbath** area would cover about 660 square miles. This is an area with structurally high subsurface features in in the southeastern portion of the proposed study area, and may host complex structural traps and gas prone prospects. The greatest potential here is expected in the Tertiary turbidites and the Ellesmerian units. This locale has the lowest priority due to structural complexity, reservoir quality risks, likely gas charge attributes and remoteness.

The seismic data acquired would provide the information necessary to proceed to the second phase, planning and permitting. To best evaluate the oil and gas potential, the seismic data would likely be processed to yield pre-stack depth migration, near- and far angle stacks, amplitude versus offset volumes, merged volumes, coherency volumes, and possibly other products. The westernmost areas would be processed in Years 1-2, with the eastern study area processed thereafter. This data would be merged and analyzed during Years 2-3. The results of the interpretation would be selection of the highest potential prospects, with priority given to the western areas, followed by the eastern area prospects.

3-D seismic data allows exploration to target the highest-value potential prospects while optimizing field drilling efforts. Processed data can be used to predict the most prospective locations for recoverable petroleum resources. Properly sited drilling locations partnered with efforts to prevent negative surface impacts can maximize the benefits of the proposed exploration program.

2. Phase 2 — Planning and Permitting

A comprehensive strategic plan that addresses both subsurface and surface features should drive exploration drilling during Years 1-4, and continue through all the follow-on years. The planning foci are project coordination and scheduling; federal, state and local permitting; ice-based and seasonal facility design; equipment, drill rig, and services acquisition; and transportation logistics.

Permitting processes are complex, and require in-field investigations for site clearance, environmental baseline data, ice-based facility design, and other aspects. Additionally, some federal, state, and local permits and authorizations must be in place before field activities begin. For example, permits are required for wetland and habitat protection, fish habitat mitigation, water withdrawal, waste storage and management, and other exploration activities. Appendix C lists permits and authorizations that the proposed exploration program may require.

In Year 3, the initial drilling locations would be selected and verified by field site clearance surveys (Figures 5-4 and 5-5). Future well siting would be done as well data becomes available during the program. Delineation wells would be sited

Winter Tundra Travel Opening and Ice Road Construction Start Dates								
Season	**Tundra Opening Date**	**Julian Opening Date**	**Tundra Closing Date**	**Julian Closing Date**	**Tundra Travel Season Length**	**Prepacking Start Date**	**Julian Prepack Date**	**Ice Road Season Length**
1969 - 1970	13-Nov-69	317	21-May-70	141	189			
1970 - 1971	20-Oct-70	293	27-May-71	147	219			
1971 - 1972*	30-Oct-71	304	20-May-72	140	202			
1972 - 1973	2-Nov-72	306	4-Jun-73	155	214			
1973 - 1974	15-Nov-73	319	20-May-74	140	186			
1974 - 1975	18-Nov-74	322	30-May-75	150	193			
1975 - 1976*	31-Oct-75	305	28-May-76	149	210			
1976 - 1977	unknown	unknown	29-May-77	150	unknown			
1977 - 1978	25-Nov-77	329	3-Jun-78	154	190			
1978 - 1979	4-Nov-78	308	8-May-79	128	185			
1979 - 1980*	unknown	unknown	20-May-80	141	unknown			
1980 - 1981	8-Nov-80	312	9-May-81	129	182			
1981 - 1982	11-Nov-81	315	22-May-82	142	192			
1982 - 1983	4-Nov-82	308	29-Apr-83	119	176			
1983 - 1984*	14-Nov-83	319	18-May-84	139	186			
1984 - 1985	6-Jan-85	6	20-May-85	140	134			
1985 - 1986	4-Dec-85	338	4-Jun-86	155	182			
1986 - 1987	7-Nov-86	311	20-May-87	140	194			
1987 - 1988*	12-Dec-87	347	3-May-88	124	143			
1988 - 1989	17-Nov-88	321	29-May-89	149	193			
1989 - 1990	12-Jan-89	12	14-May-90	134	122			
1990 - 1991	19-Nov-90	323	19-May-91	139	181			
1991 - 1992*	26-Nov-91	331	12-May-92	133	168			
1992 - 1993	22-Nov-92	326	17-May-93	137	176			
1993 - 1994	6-Dec-93	340	20-May-94	140	165			
1994 - 1995	8-Dec-94	342	29-Apr-95	119	142			
1995 - 1996*	3-Dec-95	338	10-May-96	131	159			
1996 - 1997	7-Jan-97	7	9-May-97	129	122			
1997 - 1998	7-Jan-98	7	21-Apr-98	111	104			
1998 - 1999	14-Jan-99	14	12-May-99	132	118			
1999 - 2000*	19-Dec-99	354	11-May-00	132	144			
2000 - 2001	11-Jan-01	11	14-May-01	134	123			
2001 - 2002	25-Jan-02	25	8-May-02	128	103			
2002 - 2003	27-Jan-03	27	19-May-03	139	112			
2003 - 2004*	23-Dec-03	358	13-May-04	134	142	3-Dec-03	338	162
2004 - 2005	10-Dec-04	344	20-May-05	140	161	9-Nov-04	313	192
2005 - 2006	6-Dec-05	340	12-May-06	132	157	25-Oct-05	298	199
2006 - 2007	19-Dec-06	353	10-May-07	130	142	24-Nov-06	328	167
2007 - 2008*	28-Dec-07	363	16-May-08	137	140	17-Nov-07	322	181
2008 - 2009	29-Dec-08	363	28-Apr-09	118	120	6-Nov-08	310	173
2009 - 2010	22-Dec-09	356	7-May-10	127	136	2-Nov-09	306	186
2010 - 2011	4-Jan-11	4	21-May-11	141	137	25-Oct-10	298	208
2011 - 2012*	21-Dec-11	356	20-May-12	141	151	17-Nov-11	322	185
2012 - 2013	2-Nov-12	306						

Explanations: 1) Opening dates are defined by the first date an area is opened to winter off-road travel; 2) prepacking start date refers to the date of the first prepacking approval for ice roads; 3) Season lengths are calculated to take into account leap years (season with an asterix* denotes leap year, note the varying formulas used).

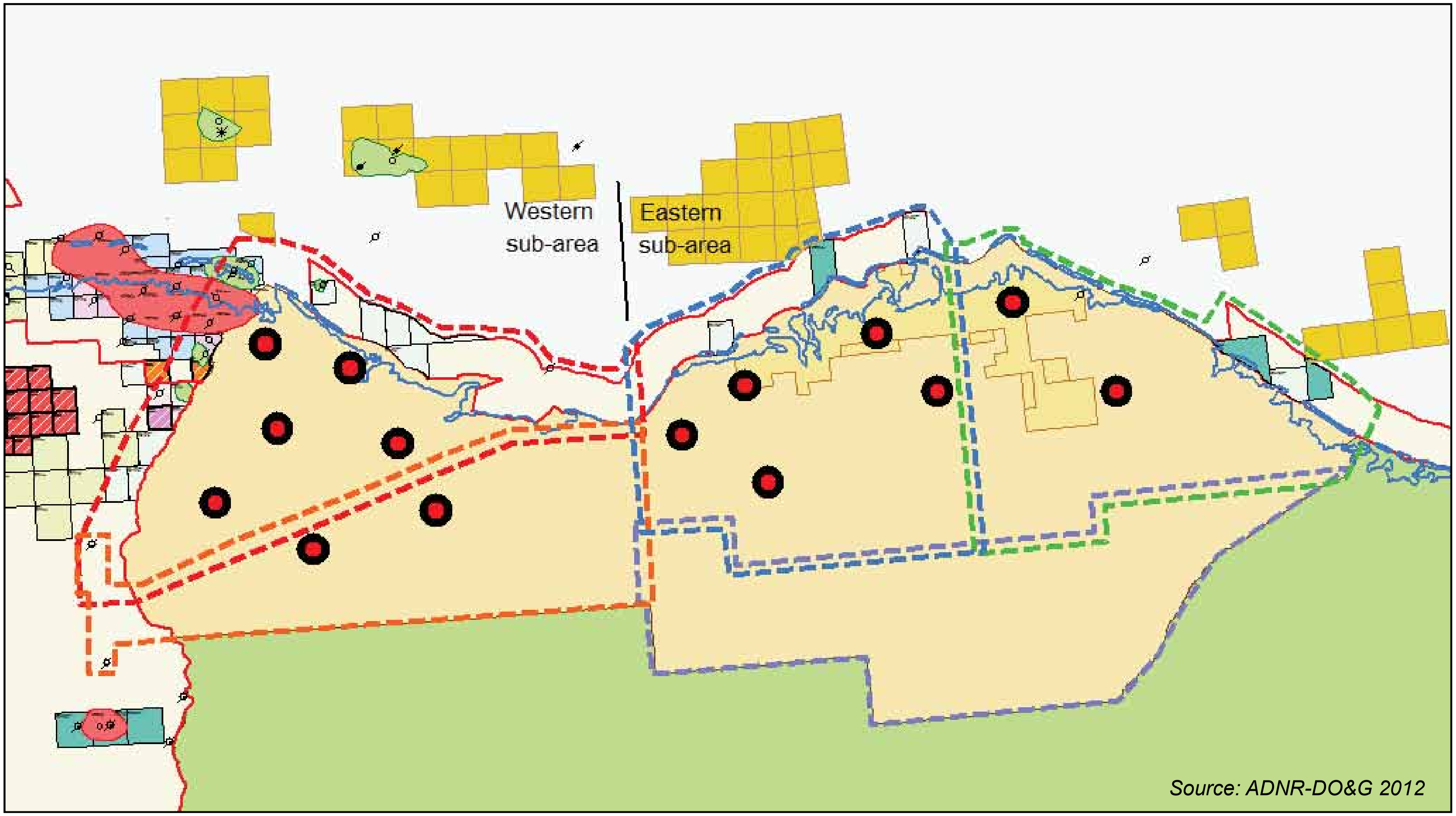
Source: ADNR MLW NRO, 2012

Figure 5-4

ANWR Coastal Plain Exploration Scenario

Phase 3 – Years 4-7: Drill up to 14 key prospects with 4 rigs over 4 seasons

(hypothetical drilling locations, presented for the purposes of illustrating the proposed drilling program)



to better define the extent of potential discoveries. The field studies needed to site these wells would be done using short-term, non-invasive methods to minimize habitat and population impacts.

3. Phase 3 – Exploration Drilling

1. Construction of Ice-based Facilities

The winter drilling program planned for Years 4-7 would use ice-based facilities (Figures 5-5, 5-6, 5-7, 5-8, and 5-9). Drill rigs would travel to sites by ice roads and would operate from ice pads. Ice roads and pads are constructed early each winter when tundra travel is allowed. Although the actual date varies from year to year, this scenario assumes the opening of tundra travel would be on January 1 each year. The table on the next page lists the dates and duration of open tundra travel seasons on the North Slope from 1969 through 2012.

Ice roads are constructed each winter season on the Alaska North Slope using water withdrawal sources approved prior to operations. They afford access to the tundra and can extend access timeframes. Records from the ADNR MLW Northern Regional Office (NRO) show that in 2011, 124 miles of ice roads were authorized, including 94 onshore miles and 30 offshore miles (ADNR MLW NRO, 2012). Included in that distance is a 28-mile ice road that is built from near Deadhorse, at the Sagavanirktok River crossing, to Badami on state land each winter. Records show that use of ice roads, as compared to snow trails, lengthens the timeframe for allowed tundra area access on the North Slope.

Drill rig transport to initial drilling locations will occur by February each year. Drilling may occur from January through April, with the date for drilling shutdown and rig demobilization determined as a function of actual annual weather conditions. Ice-based facilities will be used through April and leave no damage to surface features, terrain, or freshwater environments upon melting each spring.

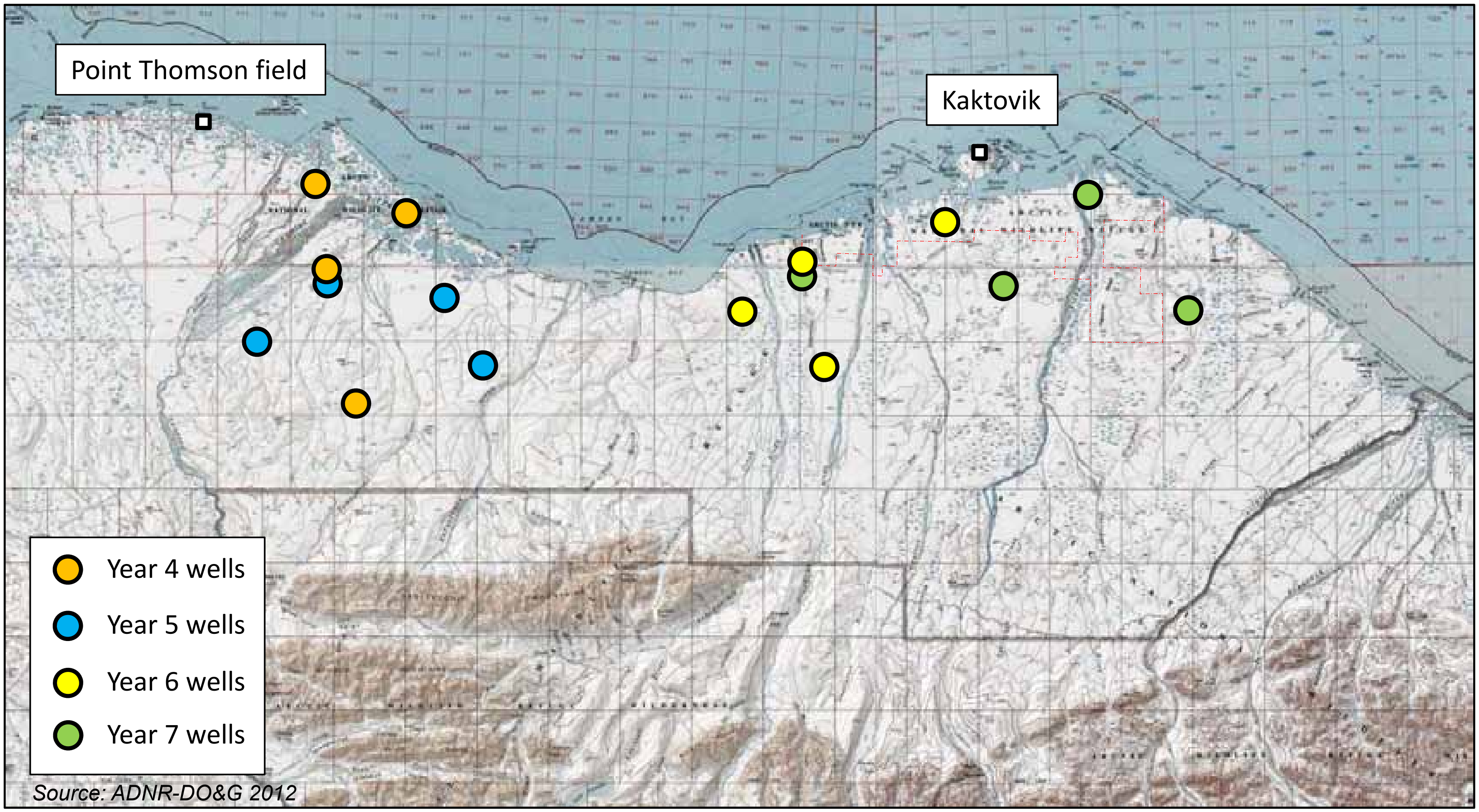
Years 4-5: An ice road will be built to access the **Undeformed** and **Marsh Creek** areas. This road is estimated to be 35 to 43 miles long, and could access four drilling locations depending on analysis of terrain, habitat, water sources, etc. It will likely take about one month to construct all legs of the road, which would operate from January through April. It will begin at the Point Thomson field barge facility and terminate at the proposed drilling locations. (Figures 5-6 and 5-7)

Years 6-7: Different routes would likely be built to access the **Hulahula** and **Jago** areas. A primary ice road, 34 to 53 miles in length, would be constructed, originating at Kaktovik, where drilling equipment and supplies would be staged during the summer barging season. This road would connect to each of four exploration drilling locations. Additionally, a west to east ice road or rolligon trail approximately 52 miles in length, would closely follow the shoreline, beginning at the Point Thomson field and join the other ice road at the westernmost drilling location.

Figure 5-5

ANWR Coastal Plain Exploration Scenario

Phase 3 – Years 4-7: Drill up to 14 key prospects with 4 rigs over 4 seasons



This coastal route would serve as a resupply and contingency access corridor. The total ice road/rolligon trail length for Years 6-7 would be about 86 to 105 miles, and it would operate from January through April annually. (Figures 5-8 and 5-9). Any drilling in the **Sabbath** area to the south would be conducted in Year 7 or later, and would depend on results of earlier seismic and drilling activity.

4. Proposed Drilling Scenario

Four drill rigs would be mobilized for each of the Years 4-7, allocating one rig per prospect each year, resulting in up to 16 wells drilled on 14 prospects (Figure 5-5). Prospects and bottom hole locations would be selected based on interpretation of the fully processed 3-D seismic, and specific surface well sites would be based on field data and site clearance surveys. Crews and equipment would mobilize using ice roads and ice airstrips. Exploration drilling would occur only from seasonal ice pads in January through April. Temporary camps and support facilities would be used during the winter drilling season. Well drilling rates are estimated at an average of 200 to 250 feet per day (including "flat time" during casing, logging, and evaluation), with average well total depth estimated at 9,000 feet.

Since the seismic and drilling phases of the exploration program would occur in winter, most terrestrial wildlife populations would be sparse or altogether absent from the coastal plain. Freshwater populations present in winter would also be protected using conditioned permits and required mitigations. The land use priorities would be to prevent and reduce negative impacts to surface features, and terrestrial and freshwater habitats. Transport of additional drilling equipment and supplies to the North Slope would likely be necessary, and could use a combination of surface trucking on the Dalton Highway, barge, and air transport prior to start of the field drilling season. The hypothetical exploration drilling scenario is as follows:

Year 3: Conduct well siting for Year 4, complete site clearance surveys and environmental monitoring, and authorize field assessments. Short term, non-invasive field techniques would be used.

Year 4: Drill and evaluate four new prospects in the western sub-region of the coastal plain, potentially including three prospects in the western **Undeformed a**rea, and one prospect in the **Marsh Creek** area to the south (Figure 5-6). Four wells would be drilled in total and permitting activities would continue.

Year 5: Drill and evaluate four prospects in the western sub-region of the coastal plain: drill two new prospects in the western **Undeformed** area, drill one new prospect in the **Marsh Creek** area, and drill a delineation well at one of the prospects drilled in Year 4, assuming some exploration success (Figure 5-7). Four wells would be drilled in total and permitting activities would continue.

Year 6: Drill and evaluate four new prospects in the **Hulahula** area, in the eastern sub-region of the coastal plain (Figure 5-8). The technically optimal location for drilling one or more of these wells could be on lands owned by Kaktovik Inupiat Corporation (KIC surface estate) and Arctic Slope Regional Corporation (ASRC subsurface mineral estate). Four wells would be drilled in total and additional permits acquired, as needed.

Year 7: Drill and evaluate four prospects in the eastern sub-region, potentially including one new prospect and one delineation well in the **Hulahula** area. Two wells would target new prospects farther east in the **Jago** area (Figure 5-9). The technically optimal location for drilling one or more of these wells could be on lands owned by Kaktovik Inupiat Corporation (KIC surface estate) and Arctic Slope Regional Corporation (ASRC subsurface mineral estate). Four wells drilled in total. Permitting and site closures would occur. Potential drilling opportunities may arise in the **Sabbath** area toward the latter years of the program. Drilling of up to two test wells may be considered, depending upon the results of the 3-D seismic and nearby drilling data.

Follow-on Years: Ongoing evaluation of drilling results and integration of well data with seismic and other technical data would continue to more definitively assess the oil and gas resources of the ANWR coastal plain. Site closures would be completed.

5. Required Permits, Authorizations and Approvals

The proposed exploration program will provide more definitive information for the oil and gas resources in the proposed study area, but cannot proceed without planning, analysis of previous field work, and prior approvals. A variety of federal, state, and local permits and authorizations must be acquired before field investigations, seismic surveys, and drilling can begin. A summary of the possible permits and authorizations that may be needed is provided in Appendix C, along with the primary agencies with regulatory jurisdiction for permitting. However, this list is not exhaustive. The actual projects, locations, and technologies used will determine what approvals that will be required and any conditions or mitigation measures that may be needed.

C. Conclusion

This proposed exploration program is intended to provide guidelines and a feasible timeframe for seismic exploration leading to a multi-year drilling program in the 1002 Area. This exploration scenario can define and accurately assess the oil and gas resources without comproming the land, water, and wildlife in the 1002 Area. It will provide data that must be considered to comply with the intent of ANILCA and make the fully informed management decisions required by NEPA. Reasonably foreseeable impacts from the exploration activities are discussed in Chapter 6. The potential economic benefits that could result from development in the 1002 Area are discussed in Chapter 7.

Figure 5-6

ANWR Coastal Plain Exploration Scenario

Year 4: Begin drilling 4 new prospects in Western 1002 Area

Source: ADNR-DO&G 2012

Figure 5-7

ANWR Coastal Plain Exploration Scenario

Year 5: Drill 3 new prospects + 1 delineation well, Western sub-area

Source: ADNR-DO&G 2012

Figure 5-8

ANWR Coastal Plain Exploration Scenario

Year 6: Drill 4 new prospects, Eastern sub-area

Source: ADNR-DO&G 2012

Figure 5-9

ANWR Coastal Plain Exploration Scenario

Year 7: Drill 3 new prospects + 1 delineation well, Eastern sub-area

Source: ADNR-DO&G 2012

Chapter 6
Oil and Gas Exploration Program Impacts and Suggested Mitigations

Introduction

This chapter discusses the potential impacts and corresponding mitigations for the proposed ANWR oil and gas exploration program. The goal of this evaluation is to identify and explain how to minimize the potentially negative impacts of exploration, and to maintain intact ecosystems and habitats.

The emphasis of the program in this proposal is placed on exploration activities that have minimal impact on habitats, populations, continued subsistence harvesting, hunting, and fishing. Mitigations for activities on the North Slope have proven effective, and have evolved and improved over the 40 years of exploration and development in Alaska. The State and industry have worked together to successfully prioritize safe and environmentally responsible oil and gas activities. Were ANWR to be explored using modern technology, the federal government will find the lessons learned and mitigations developed to the west on State land to be effective and valuable. These mitigation measures can be utilized and adapted for the environment of the 1002 Area. The discussion that follows describes both the potential impacts of exploration and recommended mitigations to promote the successful management of multiple land uses on the ANWR coastal plain.

A. Summary of proposed exploration program

The proposed exploration program will incorporate seismic surveys and analyses and field investigations (Years 1-3), and construction of ice-based facilities to support a multi-year exploration drilling program (Years 4-7). The program is designed to maximize resource assessment without compromising habitats and other uses.

The proposed exploration scenario combines three phases over an estimated seven-year duration. The program begins with a two to three year seismic acquisition phase that will be done exclusively in the field during the winter. Seismic activities in Year 1 will cover the western sub-area (the Undeformed and Marsh Creek survey areas). In Year 2, the eastern sub-area will be assessed (the Jago survey area). The Sabbath area may be assessed in Year 3, if data from Years 1 and 2 indicate that further seismic surveys are warranted (Refer to Figure 5-3).

The second exploration phase will focus on planning and permitting (Year 3). These important efforts will begin in the early years, and will be the primary focus during the second phase. Field activities in support of permitting will be conducted throughout the year, including summer months on an as-needed basis.

The proposed exploration program requires permit for the protection of terrestrial, wetland, and freshwater habitats; for water withdrawal; for waste storage and management; and for a variety of other exploration activities. Non-invasive, short duration methods can be utilized for summer site clearances, access route determinations, and permitting requirements. Field studies that are necessary would be done using short-term, non-invasive methods to minimize impacts. Appendix C provides a list of the permits and authorizations that may be required for the proposed exploration program.

The third phase, in Years 4 through 7, will occur exclusively in the winter, and will incorporate construction of ice-based facilities, such as roads, pads and airstrips. Drill rigs will be transported, and exploration drilling will assess the petroleum resources. Four drill rigs will be mobilized for each of the Years 4-7, allocating one rig per prospect each year, resulting in up to 16 wells drilled on 14 prospects (Figure 5-4, 5-5). Drilling will occur in January through April from seasonal ice pads, with the dates for drilling shutdown and rig demobilization determined as a function of actual annual weather conditions. Ice-based facilities will be used through April each year. No summer activities are planned for phase three. More details describing the proposed exploration program and the preferred locations under consideration are provided in Chapter 5.

B. Consideration of Impacts

The goal of this chapter is to identify and explain how to minimize potentially negative impacts and maintain the ecosystem functions of habitats. The exploration activities that may cause potential impacts include seismic surveys, field investigations, construction of ice-based or seasonal facilities, and exploration drilling.

This section provides in-depth discussions of potential impacts to surface resources for each phase of the project, and then mitigations to limit these impacts.

Exploration seismic surveys and drilling activities will be limited to winter months when potential impacts are minimal and short-term. Wildlife and migrating bird populations are generally not present in winter. Freshwater habitats can be selectively approved for water use during the winter season to minimize negative effects on overwintering fish populations. Short term, non-invasive field investigations may occur in summer, and may cause low impacts from pre-approved short duration projects associated with site clearances and permitting requirements. The actual impacts for the multiple phases will be dependent upon the specific project plans and the actual approved permitted field activities.

This evaluation focuses on impacts to terrestrial and freshwater habitats for wildlife, birds and fish, and other ANWR uses, with the intent to minimize direct impacts to habitats and species, and avoid the subsequent impacts to ANWR's surface uses.

Exploration's effects on fish and wildlife species, habitats, and their uses, can be avoided, minimized, or mitigated. Impacts to the human environment, such as disturbances to lifestyles, subsistence uses, or economic activities can also be minimized. Evaluation of the subsistence hunting impacts focuses on perpetuating target populations, and maintaining availability of subsistence resources. Taken together, these mitigations will allow for exploration of oil and gas resources in the 1002 Area.

During exploration, activities are subject to federal, state, and local statutes, regulations, permits, and ordinances. Approved methods and mitigations will vary depending on which of these laws apply and on site-specific conditions and customized permit stipulations. Permitting can avoid negative effects on habitats, while allowing efficient access during winter months when populations are present in low numbers. Attention to specific habitat protections can prevent the need to establish expansive blanket protections and land use limitations that are inefficient for exploration activities. Blanket protections often do not have net positive conservation effects on the target populations or uses because they are not appropriately adjusted for an area.

1. Phase 1 - Seismic Survey Impacts and Mitigations:

a. Terrestrial Habitat Impacts

Seismic field surveys will be completed in Years 1 and 2. Field activities will include targeted 3-D seismic surveys with temporary seasonal housing and staging areas. Surveys will be concentrated in areas of highest oil and gas potential as described and displayed in the maps in Chapter 5. Logistics will include transportation of seismic equipment and labor, which will result in non-invasive surface uses and associated air traffic. Intermittent access to the sites may be necessary using air and helicopter transport.

Current seismic technologies have substantially less impact than the surveys that have already been conducted in ANWR in the 1980s. Additionally, today's 3-D seismic survey technologies provide a vastly improved ability to collect and analyze data on the complex attributes of subsurface resources. The processed 3-D surveys can portray the subsurface stratigraphy with higher confidence, and reduce the number of exploration wells required to reach and delineate a target prospect (API, 2012). These efficiencies reduce the need for surface access to remote locations and minimizes impacts to habitats, wildlife, and land uses while providing valuable information.

Critically, exploration seismic surveys will be conducted in the winter when most terrestrial wildlife populations are absent, or are not present in large numbers. The survey equipment configuration would include vibrating and recording vehicles, trucks, fuel tankers, and a personnel camp as discussed in Chapter 4.

i. Surface Disturbances

Seismic equipment can potentially affect tundra vegetation without proper mitigation, even though it is temporary and seasonal. Snow depth, vehicle type, traffic patterns, and vegetation type must be considered during winter operations. Dry vegetation, snowless ridges, and vegetated sand dunes are at higher risk of damage. These areas must be considered during the design and planning of the survey to obtain a permit.

Moving equipment over land during seismic surveys could alter the thermal balance of the land, and increase the risk of thermokarsting (Jorgenson et al., 2002). However, studies of tundra disturbance from seismic surveys showed full or partial recovery over several years duration (Jorgenson and Cater, 1996). In these studies, tundra plots were evaluated for vegetation, trail compression, visibility from the air, and exposed soil. Use of narrow trails and disturbance caused by camp moves showed partial recovery after ten years, while other trails experienced almost full to complete recovery.

3-D seismic methods can have a larger surface footprint than 2-D surveys, as a denser grid of trails is used (Jorgenson and Cater, 1996). The impacts that persisted from surveys included trail subsidence, condition changes, ruts, invasion of grasses, and decreases in shrubs. The surface changes were noted to persist, but no research suggested that the surface changes affected the wildlife (Gibbs, 2001). A study of seismic impacts and recovery in ANWR showed that trails with low levels of disturbance usually improved over time, and medium to high level disturbances recovered slowly (Jorgenson, et al., 2010). Trails on gravel, ice-poor riparian areas recovered better than trails on upland, ice-rich loamy soils. Winter seismic impacts showed short-term, mostly aesthetic impacts, but areas of severe vegetation impacts persisted for two decades under some conditions (Jorgenson, et al., 2010). Based on these studies, 3-D seismic technologies have evolved to minimize impacts and provide for monitoring of overland tracks. Seismic surveys that use ice roads can monitor track damage in compliance with environmental permits.

ii. Wildlife

Seismic surveys can be authorized for the winter season, when the caribou are very rarely present (ADF&G, 2005, 2007a, 2009). A Canadian research study that tracked caribou movements found that seismic lines did not act as barriers to caribou, and that roads were semi-barriers to animal movements. Previous studies showed that caribou avoidance distances from seismic lines and roads were about 250 meters (Dyer, 1999).

Muskoxen also may react to equipment operating within two miles of the herd, and the disturbance may cause animals to move away from the equipment and the sounds emitted. Research has shown that the animals return to the area within one to four weeks after the disturbance (Russell, 1977). It is possible that muskoxen react to visual stimuli rather than the noise of the disturbance source. Aircraft and snow machines, both currently allowed in ANWR, disturbed animals at greater distances than Nodwell vehicles (Beak Consultants Ltd., 1976). On level land, the disturbance was much less than in more rolling terrain, where more sudden appearance of a vehicle caused a disturbance.

Seismic activity that occurs in winter may disturb denning bears. Studies have found that radio-collared bears in their dens were affected by seismic activities within 1.2 miles of their dens, evidenced by an increased heart rate and greater movement within the den. However, no negative effect, such as den abandonment, was documented (Reynolds et al., 1986).

Human activity may disturb denning polar bears if ice roads, seismic tracks, and exploration activities are not properly located to avoid den disturbances. Polar bears are present on the coastal plain, and are found on the landfast ice and throughout the southern limit of the Arctic pack ice off the coast north of ANWR (USFWS, 2010a, citing to Garner et al., 1990, Amstrup et al., 2000; DeMaster and Stirling, 1981). Others have found denning locations for the Southern Beaufort Sea bear populations on coastal barrier islands, and up to 25 miles inland in ANWR, west to Peard Bay (USFWS, 2010a, citing to Amstrup and Garner, 1994, Amstrup, 2000, Durner et al., 2006).

Amstrup (1993) found that in 1981 through 1992, denning polar bears tolerated exposures to anthropogenic disturbances, and that bears may tolerate changes without negative impacts to denning or litters. A study of the effects of roads on brown bears in British Columbia and Montana found that bears used areas within 100 meters of roads significantly less than areas farther from the roads, but this behavior change did not translate into a demonstrable effect on the population (McLellan and Shackleton, 1988). Recommended mitigations to reduce human-bear interactions and negative impacts to denning bears are discussed in the mitigation section below.

b. Freshwater Habitat Impacts

i. Disturbances

The principle impacts to freshwater habitats from seismic surveys are the acoustic energy pulses emitted by vibroseis systems. Seismic surveys typically cover a relatively small area and only stay in a particular area for hours, thereby posing transient disturbances. Winter seismic programs must be reviewed prior to permitting to prevent short- and long-term negative impacts to overwintering fish.

In a study conducted in the Sagavanirktok River west of ANWR, when a vibroseis system was fired in close proximity to the water, the broad whitefish slowed their swimming speed and were observed to school as a group back at the original water location after 2 minutes (Morris and Winters, 2005). Repeated firing of the vibrator source revealed that this pattern was consistent, and fish returned to a sedentary posture at the original water location each time. The study concluded that there was little evidence that energy from the acoustic vibroseis harmed the fish observed (Morris and Winters, 2005). In a related study, the internal conditions of the fish were assessed after vibroseis firing to observe any organ damage that may have occurred from the disturbance. The vibrators were fired in close proximity of Arctic char within a flooded gravel pit at Duck Island mine site on the North

Slope. Results showed that no fish deaths occurred as a direct result of the vibroseis, no bleeding of the gills was noted, but that internal injuries were found in some fish. No swim bladder damage was observed (Morris and Winters, 2005).

Eye injuries were noted at rates ranging from 0.9 to 7.3 percent, and muscle tissue injuries were noted at rates ranging from 2.7 to 12 percent in the fish. Fish eye hemorrhaging was the injury with the highest frequency of occurrence, but no damage to the skeletal structures was observed. (Morris and Winters, 2005). The results indicated that there were no discernible direct physical effects on fish from vibroseis in any trial. The eye injuries observed were likely a result of behavioral response and collisions caused by the cages used in the research (Morris and Winters, 2005).

Popper et al. (2005) measured the effects of seismic airgun firing on broad whitefish and found that the firing of the tested airgun system was not likely to substantially impact broad whitefish. The results also showed that the lake chub species experienced only temporary hearing loss, and the northern pike hearing returned after 18 hours.

In a study of a rocky reef off Scotland, fish response from seismic airguns showed minor behavioral responses to airgun emissions. The researchers found there were no permanent changes in behavior, and no fish appeared to leave the reef habitat. There were no indications of observed damage to the reef animals (Popper and Hastings, 2009, citing to Wardle, et al., 2001).

c. Suggested Mitigations – Phase 1 - Seismic Surveys

i. Terrestrial Habitat Mitigations

Acoustic seismic surveys should be planned in winter months and during times when most wildlife are absent or present in lesser numbers to reduce surface impacts. Surveys on the coastal plain can be authorized for the winter season, when the caribou are not present (ADF&G, 2005, 2007a, 2009). Permit authorizations also need to consider routing, timing, and sufficient snow cover to reduce and limit adverse environmental impacts.

Ice roads and exploration activities need to be properly located to avoid polar bear den disturbances. Federal and state regulations require protections for ESA-listed species such as the polar bear, and compliance is required for all operations. As part of these requirements, operators implement human-bear interaction plans to avoid affecting bears in the field.

Exploration activities using off-road travel across tundra and wetlands should be approved in areas where snow and frost depths are sufficient to protect the ground surface. This limits ground contact. Additionally, low pressure vehicles can be used to further limit impact during travel to areas with ground frost and snow cover. Approvals for cross-country travel must use these measures to minimize negative effects, and associated field monitoring can verify that proper practices are in compliance and effective. Public access to, or use of, the seismic survey area may be restricted for safety requirements.

Air traffic associated with seismic surveys may cause brief disturbance to animals by low flying aircraft. While wildlife may change behavior temporarily as a reaction to aircraft, it is not expected that this will occur frequently in the seismic survey phase. Mitigations to reduce negative effects by limiting air traffic should be implemented during all years of the exploration program. Air traffic impacts are discussed in more detail in sections relating to field investigation impacts from investigations for planning and permitting (Phase 2 – Year 3).

ii. Freshwater habitat mitigations

Preferred locations for conducting acoustic seismic surveys are those where overwintering fish populations are not present. Federal and state regulators will work to minimize fish impacts through avoidance of critical fish overwintering habitats.

Mitigation measures for acoustic seismic surveys will recommend that seismic activities be set back from freshwater fish spawning areas reducing shock waves to safe levels before reaching incubating eggs during sensitive stages of development. All seismic survey activities will require prior permitting and approvals in compliance with federal, state, and local statutes, regulations, and ordinances. Acoustic surveys will be the recommended method for seismic surveys. All work will be in compliance with the approved permitted plans for seismic data collection.

2. Phase 2 – Permitting and Field Activity Impacts

a. Terrestrial Habitat Impacts

i. Disturbances

Program components for the second phase of exploration (proposed for Year 3) that may impact surface terrestrial habitats are related to permitting, environmental surveys, site clearances, and other studies. Site specific, non-invasive site clearance and permitting related field investigations may occur in all seasons, including summer. Follow-on field studies to occur in pre-approved months, will be planned and conducted as necessary for Years 4-7.

ii. Air traffic Disturbances to Wildlife

Access to sites during this phase will be primarily by air and helicopter transport, with no permanent roads needed. There is concern that when caribou and wildlife are present in the area of exploration activities, the animals can be briefly disturbed by low flying aircraft. This can result in disruption of habitat use, with highly variable animal reactions, ranging from none to violent escape. Reactions depend upon: distance from human activity; speed of approaching disturbance source; altitude of aircraft; frequency of disturbance; sex, age, and physical condition of the animals; size of caribou group; and season, terrain, and weather.

Caribou in some herds appear to be habituated to aircraft; other herds respond with panicked running. Flights greater than 2,000 feet above sea level during calving, and flights greater than 1,000 feet above sea level at other times appears to cause little or no caribou reaction (Shideler, 1986). In contrast, Calef, et al. (1976), stated that during the spring and fall migrations, caribou react to aircraft flying less than 200 feet in altitude, and that above this height, disturbances were noted in less than 20 percent of the groups observed. They also found that during calving there were strong panic and escape animal behaviors during overflights of less than 500 feet height (Calef, et al., 1976). Panic reactions can cause animals to collide and injure themselves, with young calves being particularly susceptible to injury (Calef, et al., 1976).

Muskoxen remain relatively sedentary in the winter and during calving periods, enabling them to conserve energy to compensate for reduced forage (Reynolds, et al., 2002). Therefore, disturbances that cause muskoxen to move may be of concern. Mixed groups of muskoxen showed a greater sensitivity to fixed-wing aircraft in winter and during calving than in summer, fall, or during rut. Helicopters and low-flying aircraft have sometimes caused muskoxen to stampede and abandon their calves (NRC, 2003). Muskoxen also may react to equipment that generates visual and audio disturbances, such as seismic survey equipment. As mentioned above, it was found that when seismic equipment operated within two miles from the herd, it moved away from the equipment and sounds. Research has shown that the animals return from one to four weeks after the disturbance (Russell, 1977). Muskoxen may react to visual stimulus rather than the noise of the disturbance source. On level land, the disturbance was much less than in more rolling terrain where more sudden appearance of a vehicle caused a disturbance. Aircraft and snow machines caused a disturbance at greater distances than Nodwell vehicles (Beak Consultants Ltd., 1976).

Bears may be affected by summer activities. Human activity may initially cause bears to avoid an area and can displace bears in the area. The potential winter activity impacts of the seismic surveys may also be pertinent to Phase 2.

b. Freshwater Habitat Impacts

No negative freshwater habitat impacts are expected during Phase 2, as field activities will be short-term, non-invasive investigations related to permitting and well site clearances. It is recommended that only activities that do not impact freshwater habitats are authorized.

c. Suggested Mitigations – Phase 2 – Field Investigations

Field site clearances and environmental studies can use low impact, short duration, and non-invasive methodologies. Approval of specific field methods will reduce the risk of short- or long-term changes during field investigations. Site visits and surface uses will be approved when populations are not present or found in lesser numbers. Exceptions may be recommended and pre-approved in order to meet permitting requirements for siting or environmental studies, when conditions dictate short-term field investigations are necessary. Summer projects will be considered on an as needed only basis. All equipment will be transported in and out of the coastal plain during winter months. No equipment is planned to be staged at field sites within the Section 1002 Area at the end of the field season.

Access to the sites will be by air and helicopter transport, with no permanent roads needed. Air traffic should be conducted to avoid any populations that may be present in winter. Summer air traffic must be permitted and monitored to avoid undue disturbances and habitat displacement caused from increased traffic.

All Phase 2 field activities will require site-specific permitting and approvals to effectively prevent impacts and require use of the proper mitigation measures.

3. Phase 3 – Ice-based Facility Construction and Exploration Drilling Impacts

The Phase 3 exploration program is planned for winter months only, using seasonal ice-based facilities. Ice-based facility construction will be limited to winter months each year of the exploration drilling program, beginning when ice road construction is allowed and ending when ice road closures are expected (Table "Winter Tundra Travel" in Chapter 5). The length of the ice roads built are dependent upon the locations of the approved drill sites, with total road distances ranging from 35 to 100 miles per year. Water demand for ice road construction may be about 1 million gallons of water per mile. A total of four drill pads are planned each of Years 4-7, for a total of 14 wells drilled in total.

Similar Arctic region exploration programs have been approved by U.S. Department of Interior – Bureau of Land Management (BLM), and completed in the National Petroleum Reserve – Alaska (NPR-A). These approved exploration plans in NPR-A planned for five to eleven drill sites, using about 62 to 110 miles of ice roads (BLM 2006a, b). Impacts were mitigated for both these exploration programs that were conducted on NPR-A federal lands. This proposal suggests similar mitigations to those approved in NPR-A for the ANWR exploration program.

a. Terrestrial Habitat Impacts – Phase 3

i. Ice-based Roads and Pads Impacts

Access to drilling sites will primarily be conducted using ice roads. Ice roads and other ice-based facilities, such as pads and airstrips, can cause impacts from construction techniques, off-road transportation, impacts to permafrost, and terrain disturbance (Hanley, et al., 1981).

Proper ice road siting is likely to significantly reduce negative impacts. Correctly placed ice-based roads and pads result in little or no lasting damage to the tundra (API, 2012). Wetlands and other terrain types with specific habitat values require proper management for prevention of negative impacts. Field research has found that siting of ice facilities is less destructive to vegetation in wetland areas, compared to drier upland areas. Studies have been conducted about the impacts of ice roads and ice pads on tundra ecosystems in the NPR-A. These studies found that a single-season ice road will have no apparent long-term negative impacts, and will recover naturally with little to no evidence of damage (Guyer and Keating, 2005). Upland areas did show impacts from ice roads with reduction of plant vegetation. More significant impacts were observed on higher, drier sites, with little to no evidence of damage observed in wetlands (Guyer and Keating, 2005). Damage was also observed to shrubs, forbs, and tussocks in research conducted in 2001 and 2002. There was no evidence that the length of time of road placement, the amount of hauled weight, or frequency of road usage caused additional impacts to vegetation.

Permafrost may respond to surface uses such as ice road, ice pad, and off-road travel, especially in non-winter conditions. Winter road and pad construction for exploration can effectively prevent these impacts. It has been found that during non-winter months, rolligons and other low pressure vehicles may upset the thermal balance of the permafrost beneath the tundra. Based upon research by Jorgenson et al. (2002), differing vegetation types respond differently to the surface use of rolligon vehicles. The amount of time that is predicted for full surface revegetation after rolligon use ranged from three to ten years with differences attributed to type of vegetation, soil moisture characteristics, and level of disturbance. Dwarf shrub tundra generally showed a higher level of disturbance from rolligons than the moist wet sedge tundra vegetation (Jorgenson, et al., 2002), as supported above by Guyer and Keating (2005) in the NPR-A.

Ice road construction and vehicular passage can cause some impacts that alter surface albedo (the reflectivity of sunlight off the earth's surface) or water drainage patterns, resulting in thaw and subsidence or inundation. Such changes can affect regeneration and revegetation of certain plant species, and composition may change after disturbance (Linkins, et al., 1984).

The soil-water content, and the freezing and thawing cycles impact soil strength. Water that freezes in the soils impedes the movement of soil particles. Low soil-water content does not increase soil strength upon freezing (Lilly, et al., 2008). The Lilly study also showed that while freezing, the soil temperatures colder than -2°C did not cause an appreciable increase in frozen soil water, and the difference in frozen soil-water content between -2° C and -5°C in early spring was less than autumn freezing conditions (Lilly, et al., 2008). Dry, snowless ridges and vegetated sand dunes are at a higher risk of damage.

The water from melting ice from roads and pads can also alter drainage patterns, with potential changes in water budgets. Chemical input from ice roads into water bodies can occur upon melting, and may also result in emissions to the airshed, and bioaccumulation in soils. When roads alter habitats, plant species can be changed or removed (NRC, 2003).

In summary, many lessons have been learned about the best use of ice roads and ice pads. Ice roads have proven to be one of the most effective ways to access resources with minimal impact to the tundra. As a result of research and close collaboration between industry and the ADNR, correctly placed ice roads currently demonstrate no lasting significant impacts from construction and use.

ii. Tundra Travel Impacts

During the exploration Phase 3, the most significant disturbances may be caused by cross-country tundra travel and construction (Hanley, et al., 1983). Disruption of the tundra surface may result in thermokarst in Arctic environments (Truett, 2000, citing to MacKay, 1970). Thermokarsting is a result of heat absorption by the tundra soils (McKendrick, 2000, citing to McKendrick, 1987; and Walker, et al., 1987). This causes irregular land formation due to the uneven melting of permafrost. The effects can alter the terrestrial habitat and may cause runoff and siltation of nearby freshwater habitats.

iii. Exploration Drilling Impacts

Exploration drilling activities may cause impacts similar to ice-based facility impacts. Activities may remove the natural insulation, inducing thermal and hydraulic erosion, and thermokarst, particularly in poorly-drained, fine grain sediments. Disturbance from drilling locations may cause melting, erosion, heaving, slumping, and subsidence (Hanley, et al., 1981). The active layer of soil can undergo changes that cause settling, and can cause draining of areas previously frozen. Growth of depressions can cause more thawing and further subsidence, and potential deepening of Arctic lakes.(Hinzman, et al., 1997, citing to Lawson, 1986 and Waelbroeck, 1993).

iv. Wildlife Impacts

Both ice-based facility construction and exploration drilling can impact wildlife present in winter. Ice roads connecting well sites and supply areas provide a source of disturbance to wildlife from vehicles. Ice roads also allow access to animals, such as fox, that may be perceived as a nuisance (Clough, et al., 1987). Use of ice airstrips on the tundra may also cause disturbances from increased air traffic. Reduced numbers of wildlife in winter will reduce negative impacts from exploration related air traffic in the winter season.

Exploration drilling and associated activities may disturb denning polar bears if not properly located to avoid den disturbances. As discussed in the seismic survey impacts section above, polar bears are present on the coastal plain and found on the land fast ice and barrier islands off the coast north of ANWR (USFWS, 2010, citing to Garner, et al., 1990, Amstrup et al., 2000; DeMaster and Stirling, 1981; Amstrup and Garner, 1994; and Durner, et al., 2006). Federal and state regulations require protections, such as human-bear interaction plans, and siting of activity locations away from active den sites. Compliance is required to protect listed species and their habitats.

Muskoxen have a high fidelity to particular habitat areas because of factors favorable to herd productivity and survival, such as food availability, snow conditions, and absence of predators (Reynolds, et al., 2002). Therefore, displacement from preferred habitats could have a negative effect on muskoxen populations. In winter and during calving, muskoxen remain relatively sedentary to conserve energy and compensate for reduced forage (Reynolds et al., 2002). Mixed groups of muskoxen showed a greater sensitivity to fixed-wing aircraft in winter and during calving than in summer, fall, or during rut. Helicopters and low-flying aircraft have sometimes caused muskoxen to stampede and abandon their calves (NRC, 2003).

Foxes may be found in the coastal plain in winter. They readily habituate to human activity, which can lead to human-animal encounters. Foxes can use human structures and are attracted to anthropogenic food sources. Foxes are especially attracted to human activity because of scavenging opportunities (Burgess, 2000, citing to Wrigley and Hatch, 1976; Eberhardt, 1977). Human use of land with denning sites can force animals to move (Eberhardt, 1977). Ice roads connecting well sites and supply areas provide a source of disturbance from vehicles, and access to animals that may be perceived as a nuisance (USFWS, 1987). Foxes have been attracted to camps where workers provided food handouts (Eberhardt, 1977).

Oil and gas exploration activity may attract foraging foxes and wolves, especially to refuse disposal areas. Wolves may also visit the coastal plain in winter. During construction of the Dalton Highway and TAPS, wolves readily accepted handouts from construction workers (McNay, 2002). When wolves approached humans, they were sometimes shot (McNay, 2002). Foxes and wolves are also noted for rabies outbreaks, which increase when population densities are high and add risks to human health.

v. Releases impacts

The potential for a major oil or produced fluid spill containing drilling muds and water is very rare during the exploration drilling of a project. Despite the low probability of a spill, there is still potential for one to occur. The most likely spills consist of drilling mud and produced water. This proposal discusses the impacts and mitigation for such events below.

During exploration well drilling, muds and cuttings are stored on-site, in holding tanks, or in a temporary waste storage area. Mud and cuttings are then hauled to an approved solid waste disposal site or reinjected into the subsurface at an approved injection well. Common drilling fluids contain water, clay, and chemical foam polymers. Drilling additives may include petroleum or other organic compounds to modify fluid characteristics during drilling (National Driller, 2010). The down-hole injection of drilling muds and cuttings have no impact since they are never placed into or in close vicinity to a drinking water aquifer (NRC, 2003). This injection technique for mud and cutting disposal has greatly reduced the potential adverse impacts caused by releases of drilling muds and reserve pit materials (NRC, 2003).

Discharges of drilling muds during operations can introduce contamination if not recovered and removed. Vegetation can be lost or altered, and disturbance can change community composition. The level of impacts is a function of intensity and duration. Long duration impacts can alter permafrost stability and the heat budget that maintains the permafrost (IUCN, 1993). Prudent operations can prevent accidental releases and are fundamental to the permitting requirements for an exploratory well operator.

Oil spills

Oil spilled on the tundra could migrate both horizontally and vertically. The spread of oil is lessened when it is thicker, cooler, or is exposed to chemical weathering. If the ground temperature is less than the pour point of the oil, it would pool and be easier to contain. If the oil is spilled on snow, it may be absorbed by the snow. Spilled oil that is warmer than snow may melt the snow and flow along the ground under the snow (Linkins, et al., 1984, citing to MacKay, 1975).

Dry soils have greater porosity and the potential for vertical movement is greater (Linkins, et al., 1984, citing to Everett, 1978). If oil penetrates the soil layers and remains in the plant root zone, longer-term effects, such as mortality or reduced regeneration, would occur in following seasons (Linkins, et al., 1984). Hydrogen degrading bacteria and fungi can act as decomposers of organic material, and under the right conditions can assist in the breakdown of hydrocarbons in soils. Natural or induced bioremediation using microorganisms can also occur (Linkins, et al., 1984; Jorgenson and Cater, 1996). Tundra recovery from a crude oil spill in Prudhoe Bay showed complete vegetation recovery within 20 years without any cleanup (McKendrick, 2000, citing to McKendrick, et al., 1981). Natural recovery in wet habitats may occur in time durations of 10 years or less, if aided by cleanup activities and additions of fertilizer (McKendrick, 2000).

Any wildlife present could also be directly impacted in the vicinity of the spill through physical contact, ingestion, inhalation and absorption. As food sources are impacted by oil, larger animals, fish, mammals and humans can in turn be affected (USFWS, 2004).

The long-term effects of oil may persist in the sediments for many years. Shifting of population structure, species abundance, diversity and distribution can be long term effects, especially in areas that are sheltered from weathering processes (USFWS, 2004).

Impacts to the terrestrial habitat could also result from disturbances associated with spill cleanup activities, but these disturbances also have positive effects by minimizing animals' and birds' direct contact with oil. The amount of damage to tundra by oil spills and the length of time that the oil persists declines with the site moistness, and increases with oil concentration at the site (McKendrick, 2000, citing to Walker, et al., 1978). Observations of a wet-sedge meadow affected by a crude oil spill showed that complete vegetation recovery occurred in 20 years without cleanup. In contrast, a dry habitat affected by a crude oil spill recovered to only 5 percent of the vegetation cover after 24 years (McKendrick, 2000, citing to McKendrick, 1999). Burning as part of oil spill cleanup immediately after the spill is a very effective cleanup method. Heat from a fire will not penetrate deeply into the soil, and tundra recovery will occur naturally (McKendrick, 2000).

Releases during exploration drilling are not common, and are localized to the drilling locations. An example is a release of drill mud fluids and down hole material were released during exploration drilling on the North Slope in 2012. Drilling penetrated an unexpected shallow gas pocket, and gas and mud fluids were released using a gas diverter onto the drilling pad and onto an area in the immediate vicinity of the ice pad. No injuries were reported as result of this gas blowout. All fluids and materials were cleaned up from the drill pad, and the released water-based mud was cleaned up to the satisfaction of the ADEC and the local oversight panel from the Village of Nuiqsut (ADEC SPAR, 2012). This type of exploration drilling release is not common, but the impacted area is limited to the immediate area of drilling and can be of short duration. Cleanup of fluids from the snow and ice cover in winter can prevent any long term negative impacts to the vegetation and habitats in the area.

Gas blowouts

A gas blowout is caused by encountering deposits of natural gas under pressure that can cause loss of well control. A blowout is defined by International Association of Oil and Gas Producers (IAOGP) as:

> "*An incident where formation fluid flows out of the well or between formation layers after all the predefined technical well barriers or the activation of the same have failed." (IAOGP, 2010).*

A blowout can release natural gas and toxic concentrations of hydrogen sulfide (H_2S), a denser gas that will migrate and accumulate close to the ground. The gas release effects can cause potential harmful explosions, and acute, toxic respiratory problems. Hydrogen sulfide is a colorless, corrosive, flammable gas that can paralyze nerve centers that control breathing for humans and wildlife. Symptoms and reactions range from coughing, eye irritation, loss of smell to unconsciousness, cessation of breathing and death in a few minutes after exposure (Van Dyke, 1997).

The gas that is released in a blowout is flammable and explosive, and creates conditions for a potential explosion and resultant fire that would impact the immediate area. Associated gas vapors may migrate downwind, and ignition of the gas can cause an uncontrolled explosion, drill rig damage, and injury and death to drill rig personnel. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A blowout fire could also deposit a light, short-term coating of particulates over a localized area, impacting nearby habitats. Blowout prevention is critical during exploration drilling (Van Dyke, 1997).

Because of these factors, the oil and gas industry is extremely safety conscious and works to remain in compliance with the most up-to-date and technologically advanced safety requirements to prevent blowouts in every operation.

vi. Air Quality Impacts

Oil and gas exploration activities may also produce emissions that potentially affect air quality. Gases are emitted into the air from power generation, flaring, venting, well testing, leakage of volatile petroleum components, supply activities, and transportation (Arctic Council, 2009). Greenhouse gas emissions (CO_2 and CH_4) are potential sources of air pollution. These emissions come primarily from the burning fossil fuels in generators, vehicles, heavy construction equipment, aircraft, and camp operations, as well as the flaring and venting of natural gas. Fugitive sources account for a significant percentage of CH_4 emissions from oil and gas operations.

ANWR is designated as a Class II area for air quality standards. The reported air quality concentrations of regulated pollutants on the Alaska North Slope are below the maximum allowed under the National Ambient Air Quality Standards (NAAQS).

Vehicles, heavy construction, and drilling equipment could produce emissions from engine exhaust and dust during exploration. Sources of air emissions during drilling operations include rig engines, camp generator engines, steam generators, waste oil burners, hot-air heaters, incinerators, mobilization and demobilization equipment, and well test flaring equipment. Emissions could also be produced by engines, turbines, and heaters. In addition, aircraft, supply boats, personnel carriers, mobile support modules, as well as intermittent operations such as mud degassing and well testing, could produce emissions (MMS, 2008b). Other sources of air pollution include evaporative losses of volatile organic compounds from oil/water separators, tanks, pump, compressor seals, and valves. Venting and flaring could be an intermittent source of volatile organic compounds and sulfur dioxide (MMS, 2008b).

Gas blowouts, evaporation of spilled oil, and burning of spilled oil may also affect air quality. Gas or oil blowouts may ignite and a fire could deposit a light, short-term coating of particulates over a localized area. In-situ burning of spilled oil must be pre-approved by ADEC and EPA and/or the U.S. Coast Guard (ADEC, et al., 2008). Controlled in-situ burning of spilled oil is only allowed if it is located a safe distance from populated areas. Approved burn plans may require mitigation activities to reduce particulates. Other effects of reduced air quality include possible damage to vegetation, acidification of nearby areas, and atmospheric visibility impacts (BLM, 2005).

In summary, the Arctic is very sensitive to air quality concerns and particularly black carbon. Compliance with EPA Class II air quality standards is a recognized standard of performance.

b. Freshwater Habitat Disturbances and Water Withdrawals Impacts

i. Releases Impacts

If an oil spill occurred, the effects on fish habitats would depend on many factors, including the time of year, size of the spill, and water body affected. Fish can be impacted by oil in a variety of ways (USFWS, 2004). The impacts of the toxins in oil to freshwater invertebrates are also of concern (Jorgenson and Cater, 1996). Potential adverse effects include direct uptake of oil by the gills, ingestion of oil, ingestion of oiled plankton or prey, effects on survival of eggs and larvae, and ecosystem changes in freshwater habitats. Adult fish may be affected by reduced growth, enlarged livers, heart and respiration rate changes and effects to reproduction.

Oil weathers over time, and organisms may be able to tolerate the presence of oil while it is naturally degrading (Jorgenson and Cater, 1996). The long term effects of oil may persist in the sediments for many years. Shifting of population structure, species abundance, diversity and distribution can be long term effects, especially in areas that are sheltered from weathering processes (USFWS, 2004). Clean-up measures can cause unintended adverse impacts, such as inducing thermal degradation, use of tundra damaging equipment and manpower activities, and further oil movement during thawing conditions. Active field clean-up can be less beneficial than passive measures that facilitate natural recovery, in the case of small or contained spills (Linkins, et al., 1984).

Impacts to freshwater from releases of drilling muds include direct discharges to wetlands and waterways. Contamination of the ground surface can migrate with surface and ground water interactions (IUCN, 1993).

Releases of drilling muds and produced water may impact fish and benthic organisms (Olsgard and Gray, 1995). Lethal or sub-lethal effects may subtly reduce or impair physiological and reproductive fitness (Davis, et al., 1984). Type and extent of effects depends on a myriad of factors including habitat involved, species, life history stage, migration patterns, nursery areas, season, type of chemical, amount and rate of release, time of release, duration of exposure, measures used for retaining of the chemical, and use of counteracting or dispersing agents (Davis, et al., 1984). Improper siting of drilling operations can increase the likelihood of these potential negative effects to freshwater habitats.

The extent and duration of water quality degradation resulting from accidental spills would depend on the type of product, the location, volume, season, and duration of the spill or leak, and the effectiveness of the cleanup response. Heavy equipment, such as trucks, tracked vehicles, aircraft, and tank trucks, commonly use diesel fuel, gasoline, jet fuel, motor oil, hydraulic fluid, antifreeze, and other lubricants. Spills or leaks from these vehicles may result from accidents, refueling, or corrosion of fluid lines (ADEC, 2007).

Releases to water environments that have concentrations above the level considered acceptable for aquatic life could cause toxic conditions (Woodward, et al. 1988). Significant accumulation of drilling mud in wetlands can potentially impact benthic habitats and can blanket fish spawning grounds (Schmidt, et al., 1999, citing to Falk and Lawrence, 1973; and citing to Sprague and Logan, 1979). Some research shows that bentonite mud may increase and improve the water holding capacity of soil (Schmidt, et al., 1999, citing to Luginbuhl, 1995). Suspended solids in aquatic habitats can have adverse effects on egg and larval development of amphibians (Schmidt, et al., 1999, citing to Richter, 1995). Produced waters may contain hydrocarbon and chemical constituents in volumes that may be toxic to microorganisms and mysid shrimp (Brown, et al., 1992).

In summary, the potential impacts of oil spills on the North Slope are well known and mitigation measures have been developed for oil and gas infrastructure that minimize these risks.

ii. Water Withdrawals Impacts

There may be potential impacts to surface water resources due to the large quantities of water needed for construction of ice-based facilities and drilling. The exploration program's needs for available water will be used for ice roads, ice pads, ice airstrips, potable water, tank cleaning, well drilling and testing. Substantial water volumes are needed for ice-based facilities construction and drilling in Years 4-7. It is estimated that constructing one mile of ice road requires about one million gallons of water. An updated assessment of the water resources of the 1002 Area will be integral to planning and permitting the withdrawal of water and understanding the seasonal cycle of recharging lakes and ponds.

The majority of lakes in the 1002 Area are located at the mouth of the Canning and Jago rivers (Lyons and Trawicki, 1994). In winter, the combination of extreme cold and short days cause these lakes and streams to freeze (Lyons and Trawicki, 1994). The depth of water body ice may reach seven feet. Winter waters are also found in isolated pools and lakes generally deeper than seven feet. Annual snowmelt does not easily penetrate permafrost soils, and water migrates toward stream channels, with most flow occurring in breakup months in spring each year (Lyons and Trawicki, 1994, citing to Clough, et al., 1987, and Sloan, 1987).

According to ADF&G, lakes with depths of five feet may host overwintering species that are tolerant to low dissolved oxygen, but lakes six feet or deeper are more likely to provide overwintering habitat. ConocoPhillips finds that water depths of seven feet or more are considered the minimum for supporting overwintering freshwater fish (ConocoPhillips, 2010). Oxygen depletion, caused by overcrowding or over-demand by biological and chemical processes, can result in fish mortality at limited sizes and depths (Schmidt, et al., 1989; Reynolds, 1997). The Ivishak River, to the west of ANWR, is known to provide consistently available overwintering habitats for anadromous fish in the North Slope area (Viavant, 2007; Viavant, 2009). Fish overwintering areas were also located on the coastal plain of ANWR (USFWS, 1983). The removal of snow from lakes may increase the freeze depth of the ice, impact overwintering and resident fish, and adversely affect the ability of fish to utilize the lake in future years.

Habitat disturbances and water withdrawals may have short- and long-term impacts if improperly done in habitats that are critical for overwintering fish populations. Fish species considered potentially sensitive to water withdrawal activities are Arctic grayling, broad whitefish, least cisco and northern pike (BLM, 2006b). Overwintering habitats were identified in the coastal plain area during evaluations conducted by USFWS as part of the proposed federal oil and gas exploration program planning in 1983, but these areas need to be further researched (USFWS, 1983).

In addition, water withdrawal may have effects on bird habitats, including changes in drainage patterns, thermokarst, and surface disturbance. There may also be some non-invasive, short term impacts to bird habitats during summer month investigations. Migratory birds will not be present during winter months, and therefore, will likely not be directly impacted by winter exploration activities. Resident birds, such as ptarmigan, may experience minor impacts.

Construction of ice-based facilities, breaching of ice bridges, and related water withdrawals can also cause erosion of river banks, siltation, bottom substrate disturbance, reduced water volumes, altered water quality, barriers to fish passage, and elimination of habitats (Hanley, et al., 1983). Water quality characteristics that could potentially be affected by oil and gas activities include: pH, total suspended solids, organic matter, calcium, magnesium, sodium, iron, nitrates, chlorine, and fluoride content. Potential activities that might also affect surface water quality parameters include accidental spills of fuel, lubricants, or chemicals, increases in erosion and sedimentation causing elevated turbidity, and suspended solids concentrations. Crude oil spills could affect water quality depending on the size, scope, and nature of the spill.

Because of the many issues associated with water withdrawal and use, the lessons learned from the North Slope's long history of responsible development and the ADNR's institutional expertise must be carefully utilized to inform permitting decisions in the 1002 Area related to ice roads, pads, and airstrips.

c. Suggested Mitigations - Phase 3 Ice-based Facilities and Drilling

i. Terrestrial Habitat Mitigations

Exploration program activities will primarily be planned for winter months. The primary mitigation objectives are to avoid seasons with high potential for negative effects, to protect habitats, and therefore reduce negative short- and long- term impacts to populations in the ANWR 1002 Area.

There are numerous methods required by state and federal mitigation measures to minimize impacts to terrestrial habitats. The Alaska North Slope lease sale mitigation measures currently in place have been developed in cooperation with native communities, state and federal agencies, local governments, the general public, non-governmental organizations, and other agencies and associations. Identifying impacts of oil and gas activities and providing site-specific mitigation measures to maintain habitats, water and air quality, subsistence activities, and wildlife is an important part of the oil and gas development process. This proposal builds upon these efforts and addresses mitigation measures for the proposed winter exploration program in ANWR's 1002 Area's coastal plain.

Ice-based facilities and exploration drilling mitigations

Construction of ice-based facilities will be conducted only in the winter season. Winter activities will minimize potential noise disturbances and negative impacts to the reduced numbers of wildlife populations present in winter habitats. It is recommended that activities be planned for when most terrestrial populations are not found, or not present in large numbers. These activities cannot begin without approved permits and authorizations that make these restrictions.

Exploration activities must be conducted with practices to reduce disturbances that may damage or destroy vegetation or are known to alter soil characteristics. Travel across tundra is recommended to be restricted to locations and timeframes that comply with federal and state tundra travel approvals. The North Slope area tundra travel season is generally early January through mid-May. The ADNR determines the open and close dates of tundra travel each year, based upon actual observed field conditions (Table "Winter Tundra Travel" in Chapter 5).

Planning and winter maintenance of ice roads should minimize seasonal habitat fragmentation and loss, and cause little to no lasting significant damages to the tundra. Road management efforts are recommended to monitor road integrity and compliance with construction stipulations. Operators should also control excessive water run-off, especially during melting periods in the spring season (Spellerberg and Morrison, 1998). New ice-based roads and pads that incorporate modern technologies are also recommended, such as prefabricated insulating panels to extend the winter drilling season (API, 2012). Proper siting can result in little to no lasting significant tundra damage.

Drilling Mitigations

Exploration drilling is proposed to occur during acceptable field winter conditions with minimal surface disturbances and tundra habitat impacts and when there are a limited number of animals present. Field inventories and site investigations should be conducted prior to activities to select optimal drill sites that prevent habitat degradation and reduction. Air traffic associated with drilling activities may cause some disturbances, but altitude and volume restrictions can decrease these impacts. Construction of gravel structures will be discouraged, and should only be approved on a case-by-case basis. The use of temporary structures with low impacts will be preferred. If used, gravel removal sites may require site rehabilitation to comply with federal and/or state requirements. All drilling must comply with the federal and state drilling permit requirements detailed in Appendix C.

Wildlife and Habitat Mitigations

Proper management and planning can reduce impacts to bear populations and reduce bear-human interactions. Federal and state regulations require protections for ESA-listed species and wildlife habitats, and compliance is required for all operations. These protections are regulated by USFWS and NOAA and limit even incdiental impacts to polar bear populations.

A human-bear interaction plan is needed to comply with federal and state regulations. Proper disposal of garbage and putrescible waste is essential to minimize attraction of wildlife. Waste management practices must comply with proper disposal requirements, consistent with existing USFWS and ADF&G policies. Waste from operations must be reduced, reused, or recycled. Wildlife interaction plans could be required to ensure that wildlife near operations do not encounter human food sources.

Caribou will generally not be present in the area during the proposed winter drilling program. Previous experience with well disturbances and caribou showed that the maximum animal avoidance distances from well sites were reported to be 1,000 meters, (Dyer, 1999). A research perspective by Joly et al. (2006) finds that oil and gas activities and development on Alaska's North Slope have not adversely affected caribou. As discussed in Chapter 2, caribou populations have increased in recent years.

Releases Mitigations

Oil spill prevention is required to minimize impacts, and to comply with federal and state requirements. On state-regulated lands, Contingency Plans authorized by Alaska Department of Environmental Conservation (ADEC) must be obtained. Completed shallow hazard surveys are required by the Alaska Oil and Gas Conservation Commission (AOGCC) prior to exploration drilling to provide information for proper siting of wells to prevent well blowouts. Oil spill prevention is a priority during all activities including maintenance and monitoring procedures.

If released, oil must be removed from ice-based facilities (ice roads, ice pads, ice airstrips) during operations prior to ice melt to prevent any threat of release to the tundra habitat below. If a release occurs, an incident command team can be immediately formed to make site-specific recommendations for the best means to facilitate recovery, remediation, or natural dissipation that minimize adverse effects to habitats (Linkins, et al., 1984).

Drilling wastes must be managed and disposed following federal and state requirements. Operators must adhere to practices and standards in compliance with applicable U.S. Environmental Protection Agency, ADEC, and AOGCC regulations. Reinjection is the preferred method for disposal of drilling fluids, as authorized by AOGCC under the Underground Injection Control (UIC) program for oil and gas Class II wells in Alaska for cuttings and waste fluids that are non-hazardous.

Operators and regulators can work together to consider new technological advances to reduce waste using drill mud systems that are less toxic to the environment. Synthetic muds can be reconditioned for continued use, instead of discharged as waste (Wojtanowicz, 2008). Newer synthetic-based muds produce even less waste, along with improved drilling efficiency. They are reusable, and have advantages in environmental protection over oil or water-based muds.

Fuels, hazardous substances and waste are required to be stored and managed in compliance with federal, state and local requirements. Secondary containment is required for fuel and hazardous substances and for connection points for containers, fuel tanks, and hoses. Drill sites will require use of protections from leaking or dripping, and equipment will be stored using an impermeable liner or other suitable containment mechanism to protect the terrestrial habitat. Spill response equipment must be staged on site, and trained personnel must attend transfer operations at all times.

Upon abandonment of drilling sites, it will be required that all facilities be removed and the sites rehabilitated to meet required federal and state closure compliance.

ii. Freshwater Habitat Mitigations

Operations will be recommended and permitted to minimize impacts to wetlands. Because most exploration activities will take place in winter, impacts to freshwater habitats will be minimal. To further reduce impacts, the following mitigation measures are being planned for winter exploration, and the short-term, non-invasive summer investigation activities. Exploration activities will consider and protect water and wetland habitats and overwintering locations from water withdrawal and other habitat disturbances. Exploration operations will have site-specific mitigation requirements that prevent any adverse impacts to water bodies and wetlands during the program.

Habitat Disturbance Mitigations

Recommended mitigation measures will be focused on avoiding or minimizing potential impacts of winter exploration activities on freshwater habitats. The primary concerns are impacts from disturbances and oil releases related to ice pads and ice roads that are in close proximity to water bodies and wetlands. Recommended mitigations include requirements to contain waters and sediment load from flowing into surface waters, and the use of overpass and fish crossing structures that prevent habitat impacts (Spellerberg and Morrison, 1998). Stipulations with approved permits tailor these requirements to specific projects and sites.

Activities must avoid erosion that causes siltation and sedimentation. These impacts may reduce or alter stream flow, and may adversely affect overwintering habitat availability and the ability for fish to migrate upstream.

While not anticipated for the program in this proposal, gravel removal from rivers and streams must have prior approval to prevent increased sediment loads, changes in streambed courses, destruction of spawning habitats, and obstacles to fish migration. Gravel structures, while not preferred at the exploration stage, can be approved on a case-by-case basis. Gravel removal sites may require significant site rehabilitation to comply with federal and/or state requirements.

Drilling locations can also be restricted by appropriate set-back distances from water bodies for overwintering or spawning areas of the rivers used by Dolly Varden and Arctic char fish.

River and stream crossings must be approved and evaluated by federal or state regulators, based upon current data. A crossing of a fish bearing water body will be preferred where it is not within an overwintering and/or spawning area, or will have no significant adverse impact overwintering fish and habitats.

Oil spills released on ice-based roads, pads, and airstrips will be removed during operations prior to ice melt to remove any threat of release to the tundra or wetlands below (API, 2012).

Water Withdrawal Mitigations

Similar to habitat disturbance mitigations, there are several impacts to consider when water withdrawals are employed. Selection and prior approval by regulators is required for locations, timing, and volumes. Sources of water for industrial and construction use will need to be surveyed for fish and bathymetric characteristics prior to authorization. Water use from deep streams or lakes may be limited by the use of ice chips to construct ice aggregate for ice-based facility construction. These ice chips can be sourced from shallow lakes and along shallow lake margins. Operators must obtain prior written approval for any water and ice withdrawals, and must comply with the specifications and inventory requirements authorized for each water source.

On state land, state regulatory agencies authorize water withdrawal from fish bearing lakes during winter based upon fish species criteria and related habitat limitations. Lakes that are authorized for water withdrawal will be approved based upon habitat sensitivity and lake characteristics, such as depth, dissolved oxygen levels, and winter ice thickness. Ice aggregate removal may be authorized from naturally grounded lakes on a case-by-case basis. Lake volumes can be estimated using bathymetric surveys prior to approval for water withdrawal, if necessary. Management of snow levels over lakes will comply with permits and regulations. Compaction of snow cover overlying fish bearing water bodies is prohibited except for approved crossings. Some streams and rivers may not be able to be used as a water source during winter. New water sources may need to be located and developed from ground water sources, if they are available. If new water wells are needed, water drilling permits must be approved prior to any drilling of water supply wells for exploration operations.

In summary, freshwater mitigation measures emphasize: siting facilities away from fish bearing streams and lakes; managing water use to protect habitats and fish; developing oil spill contingency plans; and providing adequate spill response equipment staging and training.

C. Human Uses and Environment Impacts:

1. Subsistence, Hunting/Fishing, Historic and Cultural Resources Impacts

Subsistence uses within ANWR are dependent upon the area's terrestrial and freshwater habitats. Traditional access and subsistence uses are maintained by many statutes, regulations, and policies. ANILCA (P.L. 96-487, Title VIII, Section 810) ensures that rural residents engaged in subsistence uses have reasonable access to subsistence resources. The USFWS monitors fish, wildlife, and plan populations and their harvests in ANWR.

Traditional subsistence activities include hunting and fishing for caribou, muskoxen, brown bear, moose, and other furbearers; hunting for migratory waterfowl and collecting their eggs; fishing for Dolly Varden, Arctic char, whitefish, salmon, Arctic grayling, rainbow trout, and burbot; collecting berries, edible plants, and wood; and producing crafts, clothing, and tools made from these wild resources. Equally important, subsistence activities include consuming, sharing, trading and giving, cooperating, teaching, and celebration among members of the community. Potential effects to subsistence uses are discussed below.

a. Subsistence Impacts

The primary users of the ANWR coastal plain for subsistence hunting and harvests are residents from Kaktovik and Nuiqsut (Pederson, Kruse, and Braund, 2009). Subsistence hunting is conducted during winter, but less frequently than during other seasons of the year (ADF&G, 1986b). Hunters from Kaktovik occasionally seek freshwater fish, seals, moose, caribou, bears, muskoxen, furbearers, birds and dall sheep in the winter (ADF&G, 1986b). Hunters from Nuiqsut occasionally fish and trap for fish, seals, birds, caribou, bears, and other furbearers, when these populations are present during this season as well (ADF&G, 1986b).

Potential oil and gas exploration activities that could have effects on subsistence uses of the ANWR area include seismic surveys; discharges from drilling; construction of ice-based roads and facilities; and disturbances from vehicle, boat, and aircraft traffic. Accidents such as gas blowouts and oil spills that could potentially occur may also impact subsistence activities. Increased or decreased access to hunting and fishing areas, wildlife interactions with access roads, the safety of subsistence foods, and increased seasonal competition for nearby subsistence resources are also potential effects of exploration.

The timeframe for exploration activities is projected primarily for the winter season. Because of ice roads there the potential for increased subsistence access. Use of these roads may improve access to subsistence areas, but could also increase competition among user groups for subsistence resources.

Regulatory oversight and coordination with local residents can avoid conflicts, and operators can adapt to subsistence uses. This fact was recognized in the 1998 Northeast Integrated Activity Plan for the NPR-A (USDOI, BLM, and MMS, 1998). This balance must be made to support continued harvest at stable quantities in affected communities (Braund and Kruse, 2009; citing to USDOI, BLM, and MMS, 1998). Optimal timing of exploration activities may greatly reduce the potential negative impacts to subsistence hunting on the coastal plain.

Oil spill impacts to subsistence uses

The North Slope area has not experienced any significant oil spills that have created long-term impacts to subsistence over the lifetime of oil and gas exploration and development. However, it is important to recognize that the risk of oil releases at a time of subsistence activity or into a subsistence area are of critical concern to the local population. Subsistence provides food security and a foundation for a traditional way of life and must be understood in this context. Lessons have been learned from major and minor spills in Alaska, including various incidents along TAPS onshore pipeline system, and the offshore groundings of the Exxon Valdez in Prince William Sound and the Selendang Ayu in western Alaska. Close coordination with the local population has proven essential for responding to these events and ensuring the future of a traditional way of life for local communities. A significant benefit of onshore exploration in the the 1002 Area is that impacts of the proposed exploration program are not expected in the marine habitats where subsistence harvests occur, as there are no long-term coastal or marine area activities planned. Transport across marine waters by barges and vessels or travel over coastal ice for delivery of equipment and supplies will be done in compliance with federal and state requirements.

Additional complex factors may compound effects to subsistence from an oil spill, including demographic changes in communities, and increased competition for fish and wildlife resources by other user groups and predators (Fall, 1999). There is limited information available on whether spatial redistribution of a species, such as caribou, affects subsistence harvest and the timing required for a successful hunt (NRC, 2003).

b. General hunting, trapping, and fishing impacts

In addition to subsistence hunting and fishing, fish and wildlife populations in ANWR are used for general hunting, fishing, and trapping. Federal regulations state that these activities “are authorized in a manner compatible with the purposes for which the areas were established” (50 CFR 36.31(a)), while hunting seasons are determined by ADF&G.

Exploration activities that could have effects on these authorized hunting and fishing uses include seismic surveys; discharges from well drilling; construction of ice-based roads and facilities; and vehicle, boat, and aircraft traffic. In addition, gas blowouts and oil spills could potentially cause impacts during exploration. The potential effects of exploration to the area's habitats are discussed in detail in earlier sections.

Oil and gas exploration could result in some increased localized access to winter hunting and fishing areas, potentially during the exploration related to construction of new ice roads, which in turn could increase competition among user groups for wildlife and fish resources. Road access during winter exploration may be limited to ice roads, and may not impact sport fishing that occurs in the summer months. Potential direct effects of exploration are also discussed in the preceding habitat impact sections.

Properly mitigated exploration activities in the winter may cause few impacts to general hunting and fishing on the coastal plain. Regulatory oversight and coordination can avoid conflicts, and operators can adapt to hunting and fishing season uses, as was determined in NPR-A for the 1998 Northeast Integrated Activity Plan, (USDOI, BLM, and MMS, 1998). Timing and proper siting is critical to minimize negative impacts for these uses.

c. Historic and cultural resources impacts

The Alaska Office of History and Archaeology and ANWR managers have reported occurrences of historical and cultural resources throughout the coastal plain area. The potential impacts from oil and gas exploration activities to these resources may arise from a variety of sources, including accidental oil spills, erosion, and vandalism (Dekin, et al., 1993).

The Alaska Office of History and Archaeology is the designated State Historic Preservation Office (SHPO). They provide consultation to the federal agencies under the National Historic Preservation Act (NHPA). NHPA requires that federal agencies consider the effects of projects they carry out, approve, or fund on historic properties. Federal agencies work with SHPO to prevent and resolve adverse effects to historic, cultural and archeological resources (U.S. Advisory Council on Historic Preservation, 2012).

In the event that increased activity is planned for historically and culturally rich areas, enforcement of authorities for state and federal statutes and regulations are in place to mitigate effects to archaeological resources.

Oil spills can have an indirect effect on archaeological and cultural sites by contaminating organic material, which can eliminate the possibility of using carbon C-14 dating methods (USFWS, 1986). Subsequent to the Exxon Valdez oil spill, the detrimental effects of cleanup activity on these resources were mitigated by a work plan for cleanup which was constantly reviewed. Cleanup techniques were changed as needed to protect archaeological and cultural resources (Bittner, 1996).

2. Suggested Mitigations – Phases 1-3 – Human Uses and Environment Impacts

Winter seismic survey programs are recommended to be planned in cooperation with local residents to reduce short- and long-term impacts to subsistence hunting and land uses. However, impacts are expected to be minimal because little hunting and fishing take place in winter in large portions of the 1002 Area.

Exploration operations are recommended to be conducted to prevent unreasonable conflicts with subsistence activities. Operators are encouraged to communicate with subsistence communities to discuss impacts on subsistence and harvest activities. It is recommended that a communication plan be established to address specific needs of impacted communities and users. All prudent efforts should be made to maintain traditional and customary access to subsistence areas, using the means generally available to subsistence users. Conflict resolution will be a priority for exploration activities within known subsistence hunting areas, but few conflicts are expected because of primary use of winter exploration activities.

Exploration activities should also be conducted in a manner that avoids conflicts with general hunting and fishing, as approved within Alaska game management areas (GMU) of the coastal plain.

A survey of prehistoric, historic, and archaeological sites within the area affected should be conducted prior to exploration activities that involve surface impacts. The inventory must be submitted to federal agencies and to SHPO, as necessary. If a site, structure, or object of prehistoric, historic, or archaeological significance is discovered, the operator must report this find as appropriate. Compliance with NHPA is required for all exploration operations.

Well site safety and drilling requirements prevent dangers to personnel. While an exhaustive discussion of safety procedures associated with oil and gas operations is not included in this resource evaluation proposal, these measures are integral to operations. Alaska requires rigorous specifications for blowout preventers and that the equipment be tested every seven days for exploration wells (AOGCC 2012; under 20 AAC 25.035, 25.036, 25.527).

a. Well abandonment and closure mitigations

Closure of activity sites must comply with approved federal and state requirements. Drilling permits require well plugging and abandonment procedures. Wells are inspected to ensure compliance. Abandonment activities may impact wetlands and ground surfaces associated with dismantling drilling equipment. However, when ice-based roads and pads melt, vegetation can reestablish over time. Native re-vegetation is encouraged and site abandonment is monitored to achieve approved site closure conditions. All sites must be rehabilitated to the satisfaction of federal and state agencies and be secured by guarantees from the operator.

D. Conclusion

As introduced, proven methods have evolved that ensure exploration can be completed with minimal impact to the environment while maximizing the information available. This section details how multiple land uses, including exploration for oil and gas, can occur concurrently on the Arctic coastal plain with minimal impacts to habitats and the fish and wildlife that inhabit them. Exploration activities can also be located and timed to reduce any impacts to human uses on the coastal plain. There is substantiated information and research that supports the benefits of encouraging multiple land uses on the coastal plain of ANWR. Effective mitigations can further reduce these impacts, and produce positive outcomes that meet local community, resource development, and environmental protection goals and standards.

Obtaining definitive information about the presence and extent of ANWR's oil and gas resources is a critical step in Alaska's contribution to the national energy supply. This chapter has detailed the steps that will be taken to insure all risks are recognized and compliance is assured as a multi-year proposed exploration plan is conducted. It is the goal of ADNR to respect the land, the wildlife, and the people's traditional way of life when managing state lands. These same principles can be upheld while definitively assessing the magnitude of the oil and gas resources underlying the 1002 Area on federal land. For these reasons, the findings of this proposal must be considered during the administrative process consistent with the intent of ANILCA and the informed decision process of NEPA.

Chapter 7
Benefits to the Nation and to the State of Alaska

The low-impact exploration activities detailed in this proposal provide a path forward for policy makers to obtain a thorough understanding of the oil and gas resources that may be present in ANWR. As discussed in Chapter 3, earlier estimates of the 1002 Area's potential have placed it as one of the most prolific under-explored conventional hydrocarbon basins in the country. If Congress decides that the information obtained from exploratory activities merits following a path towards responsible development of the 1002 Area, a wide range of benefits could accrue to Alaska and the Nation as a whole. ANWR development could bolster every area of the United State's energy policy - from providing secure domestic supplies that support energy and national security to supporting the major economic boons of increased revenues to the national treasury and increased employment for American workers.

When the Alaska Statehood Act was being debated by Congress, there was significant concern about how the new state – one of the poorest in the country – could support itself without an established industrial base. As a result, the Alaska Statehood Act allowed the State of Alaska to select 104 million acres of land from the federal public domain to build an economic foundation for the new state. The Act also granted Alaska the right to all minerals underlying its landholdings and required the state to retain this mineral interest when conveying interests in the surface estate, so that revenues from mineral development would robustly support the State's economy.

Consistent with the Congressional action to secure economic independence for Alaska with the mineral revenue from these lands, the Alaska Constitution proclaims that "It is the policy of the State to encourage the settlement of its land and the development of its resources by making them available for maximum use consistent with the public interest." (Article VIII, Section 1).

Below we provide a brief analysis of the primary benefits that could accrue to Alaska and the U.S. due to exploration and development in the 1002 Area. The predictions and revenue forecasts in this proposal are approximations based on current reserve estimates, existing laws and policies, and tax structures in place today.

A. Domestic Energy Supply, Domestic Needs, and Energy Independence

The potential supply of oil and gas from the 1002 Area is significant on both local and national levels. Alaska's North Slope currently produces under 600,000 barrels of oil per day, a significant decline since the peak production of 2.2 million barrels of oil per day that was transported through the Trans-Alaska Pipeline System (TAPS) in 1988. At that time, Alaska provided about 25 percent of the nation's domestic crude oil production. In 2011, Alaska's share has decreased to about 10 percent of total U.S. production (EIA, 2012a).

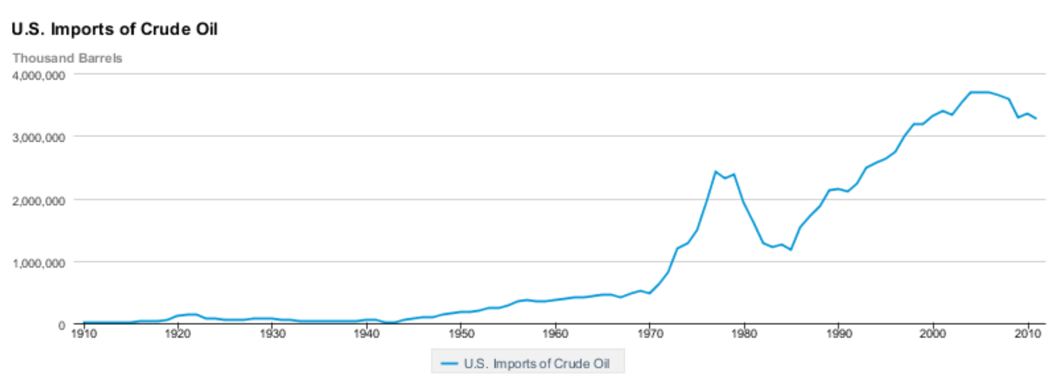
The United States consumed a total of 6.87 billion barrels, or 18.83 million barrels per day, of refined petroleum products and biofuels in 2011. This was a slight decline from the 7.0 billion barrels, or 19.18 million barrels per day, in 2010. For both years, this was about 22 percent of total world petroleum consumption (EIA, 2012a).

U.S. oil consumption has long depended on imported oil, as shown in figure 7-1. Oil produced in Alaska can offset these imports and improve the United States' energy security and trade deficit. Increased domestic supply due to unconventional resources have supported this strategic priority in recent years, and demonstrated the tremendous benefits that accrue to the U.S. when oil and gas are produced domestically rather than imported.

Future production from the 1002 Area would strengthen the domestic energy portfolio by tempering declines from existing North Slope fields and supplementing contributions from non-conventional oil plays in the contiguous states. The geologic features that underlay the 1002 Area indicate that production on a scale needed to bring about this benefit is a serious possibility. In fact, the 1002 Area is one of the largest unexplored prospect for significant conventional onshore oil reserves. However, the only data on ANWR's geology was collected in the early 1980s. The geology of the 1002 Area needs to be better understood so that possible development in ANWR can be taken into account in the U.S.energy security equation.

Figure 7-1

U.S. imports of crude oil from all countries



Source: EIA 2012a

The estimates of potential economically recoverable volumes, as well as the feasible production profiles, suggested by the 1980s data could have major impacts to Alaska's energy supply within ten years, assuming leasing in the 1002 Area is allowed to occur in the near term. Compared side-by-side to current production and production forecasts, these volumes would represent a significant turnaround for Alaska's role in domestic oil production.

It is difficult to exactly predict the future oil supply needs of the nation, as numerous variables affect consumption. Population changes, technological advances, alternative energy growth, unconventional oil and gas developments, price fluctuations, and global political relations will all contribute to future needs. However, oil and gas will continue to be a critical portion of the U.S. energy supply for the foreseeable future. In light of these variables, a diverse energy portfolio is a valuable national asset. Most critically, price stability is fostered by defining and producing large conventional reservoirs such as those that may underlie the 1002 Area.

Domestic oil and gas production provides economic security to our nation, and new production is the best path forward to displacing U.S. energy imports and obtaining energy independence. Gaining knowledge of the reserves available in the 1002 Area can play a significant role in furthering this goal. If it is decided that oil and gas development should be undertaken in the 1002 Area, Alaska's role in providing secure long term security and supplying the Nation's energy needs will be supported.

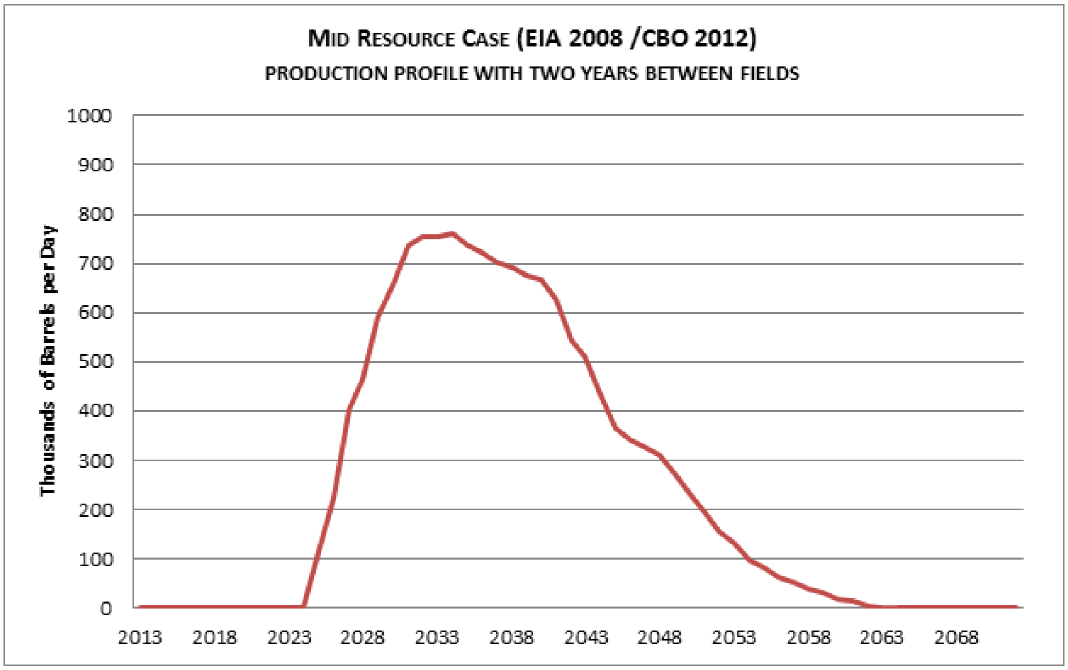
B. Revenues

Most of the subsurface lands within ANWR are owned by the federal government and would be administered in accordance with federal laws and policies. The Mineral Leasing Act of 1920 assigns the Bureau of Land Management (BLM) ultimate responsibility for oil and gas leasing on most federal onshore lands and lands where mineral rights have been retained by the federal government but the surface estate transferred to states or to private owners. ANILCA reserved decision making regarding the timing and terms of development in the 1002 Area to Congress. Potential revenues from oil development in the 1002 Area will be administered in the context of these legal regimes.

Earlier reports have investigated aspects of the potential revenues associated with potential oil and gas development in ANWR. In August 2012, the Congressional Budget Office (CBO) attempted to analyze potential revenues that would result from immediately opening most federal lands to oil and gas leasing, including the coastal plain of ANWR. While the CBO report was the basis for the estimates of production values in Chapter 3, the scope of its revenue analysis was limited to federal budgetary effects. The CBO did not consider the economic effects of increased employment, reduced oil transportation tariffs, and augmented state and local tax revenues. This proposal attempts to broadly address the additional revenues that exploration and development in ANWR would provide.

Figure 7-2

Mid Resource Case production forecast from the 1002 Area in thousands of barrels a day.



Source: USGS 1988; EIA 2008; and ADNR 2012

Revenue sharing between the federal government and the State of Alaska may be an issue to consider in future debate regarding ANWR. Currently, the Alaska Statehood Act and the Mineral Leasing Act split revenues from resource development on federal lands within Alaska, with the State receiving 90 percent of the royalty, rental, and bonus bids and the federal government receiving 10 percent. Arguably, Congress could decide to apply an alternative revenue split arrangement for ANWR oil and gas development, such as the 50 percent-50 percent split used in production from the National Petroleum Reserve-Alaska (NPR-A).

1. Assumptions in Calculating Revenues

- This chapter is premised on current economic conditions, conventional development scenarios, and current leasing and taxing regimes. It is assumed here that any natural gas produced from the 1002 Area would be utilized for on-site power or enhancing oil recovery similar to the Prudhoe Bay's field operations in the absence of current infrastructure to transport Alaska's North Slope gas to market. While Alaska's gas commercialization efforts have seen recent significant progress, the issue is not addressed in detail in this document.

Revenue predictions were created with the use of models developed by the ADNR-DO&G unless otherwise noted. These models were based on the CBO mid-case scenario described in detail in Chapter 3. The mid-case scenario is based on:

- Mean economically recoverable volumes and field distribution estimated by the most recent USGS resource assessment (USGS, 1998);
- Production profile and development timeline developed by the Energy Information Administration (EIA, 2008); and
- $100 per barrel ANS spot West Coast price, roughly reflecting current market conditions.

2. Bonus Bids and Lease Rental Payments.

A primary source of revenue from ANWR development would come from bonus bids and lease rental payments. Bonus bids are the payments made to the resource owner to originally secure a lease of subsurface rights for a particular tract. In the case of federal or state government competitive lease sales, the minimum bonus bid per acre is set prior to a lease tract auction and interested companies submit sealed bids at or above the minimum bid price. These bids are paid by the interested company regardless of the eventual success or failure to explore or develop their leased acreage.

By securing the lease, the company receives an exclusive right to explore, develop, and produce from the leased tracts. Rental payments are collected throughout the term of the lease to maintain ownership of the lease, though once production commences, royalty payments stand in lieu of rentals. Lease terms are typically ten years for federal leases managed by the Bureau of Land Management (BLM). Lease rental rates are set in advance, and are usually progressive, with the rates increasing as the lease term nears its end, in order to incentivize development of the resource. Rent is due whether the lease is actively being explored, developed, or assessed. Standard BLM leases have an annual rental rate of $1.50 per acre for the first five years and $2.00 per acre each subsequent year until the lease terminates. However, Congress could mandate higher or lower rental rates within the 1002 Area.

The size of bonus bids that particular tracts may generate are difficult to predict. Corporate strategy and gamesmanship influence companies bidding decisions in addition to technical economic and resource assessment figures. For onshore federal lands such as the 1002 Area, BLM holds competitive lease sales where all qualified bidders are given the opportunity to bid on acreage offered in a lease sale. A qualified bidder may decide, based on its financial strength and informational analysis, what bid price it thinks would result in a profitable investment. Comapnies may also price their bids based on what they anticipate their competition might to do. Alternatively, a company may choose to bid based on the low-case, conservative resource estimates and hope that no other bidders show interest in the tracts. Even when bidding parties are evaluating the same areas, with knowledge of the same variables, differences between their bids can be quite common.

There have been several large lease sales in Alaska in the past that can be used as very rough comparisons to a potential 1002 Area lease sale. In 1969, after exploration wells confirmed the Prudhoe Bay oil field, the state lease sale brought in $900 million in nominal dollars to Alaska, which is over $5.4 billion in today's dollars. More recently, the Alaska Outer Continental Shelf (OCS) Lease Sale 193 held in 2008 and offered 29.4 million acres. $3.4 billion was received by the federal government in bonus bids from this sale (MMS, 2008a).

The CBO recently estimated that leasing the entire 1.5 million acre 1002 Area would result in $5 billion in bonus bids (CBO, 2012). In its analysis, the CBO considered historical information about oil and gas leasing in the United States and information from individuals working in the oil and gas industry about the factors that affect the amounts that companies are willing to pay to acquire oil and gas leases. A key variable in determining potential bonus bids is the value of the resource that would result from estimated production volumes. This underscores the importance of additional exploration and analysis of ANWR's resources.

Ultimately, bonus bids are based on the expected profit a bidder will make from developing the leases they are seeking. Even when they possess the same resource and oil price expectations, bidders' expected profits will differ if their capital and operating cost assumptions are not the same. In addition, the fiscal take (both federal and state) directly affects profitability. It is unclear what cost assumptions the CBO report used, or how the CBO modeled Alaska's production tax.

ADNR-DO&G has developed a model that includes Alaska's production tax, which is a significant revenue source for the State but a substantive cost for potential bidders. Consideration of the state tax regime is an important part of financial forecasting and determining bid amounts (ADNR-DO&G, 2012).

Figure 7-3
High bonus bids

HIGH BONUS BIDS	90/10	50/50
State of Alaska	$7.47 Billion	$4.15 Billion
Federal	$0.83 Billion	$4.15 Billion

Figure 7-4
Low bonus bids

LOW BONUS BIDS	90/10	50/50
State of Alaska	$1.17 Billion	$0.65 Billion
Federal	$0.13 Billion	$0.65 Billion

Source: ADNR-DO&G 2012

Based on the CBO's 1002 Area production scenarios, bonus bids could be as high as $8.3 billion in the high resource case scenario or as low as $1.3 billion in the low case scenario. These lease bonus bids, and subsequent rentals, are subject to revenue sharing and would support both the federal and Alaska treasuries. As mentioned above, the two most probable percent splits are the 90/10 and the 50/50 between the State of Alaska and the federal government, respectively.

3. Royalties

Another major source of oil and gas revenue from ANWR would come from royalty payments. Royalties represent the share of production volumes due to the mineral interest owner and are calculated as a portion of the gross value received at the wellhead. In the areas relevant to this document, the mineral resource owner would be the Federal government for the 1002 Area, the Arctic Slope Regional Corporation (ASRC) for the Kaktovik Inupiat Corporation lands, or the State of Alaska for the state-owned submerged lands up to the 3 mile limit beyond ANWR.

Royalty rates may be set by statute or negotiated in a lease. For state and federal lands, royalty rates at or above 12.5 percent are typical, although royalty rates on currently producing state leases can be significantly higher. Federal leases may also have exceptions. Royalties can be paid either in value, in kind, or with a combination of both. In-value royalties are payments that represent the value of the owner's share, while in-kind payments mean that the owner is entitled to a percentage of the actual production.

While a 12.5 percent royalty rate is typical for state and federal leases, the federal government assigned prospective leases closer to infrastructure or in the eastern portion of the NPR-A a 16.667 percent royalty rate (a 1/6th rather than a 1/8th royalty) during the last NPR-A lease sale. In its 2005 economic analysis, the USGS assumed that leases for ANWR would also carry a 1/6th royalty, which is the basis for the revenue predictions below.

Considering the mid-case scenario (with mean economically recoverable volumes at $100 per barrel), and a royalty rate of 16.667 percent, total undiscounted royalty revenues from full development of the 1002 Area are estimated to be over $78 billion ($38 billion discounted at three percent). Depending on how future legislation addresses revenue sharing with the state, possible distributions of ANWR's royalty revenues are shown in Figures 7-5 to 7-7.

Figure 7-5

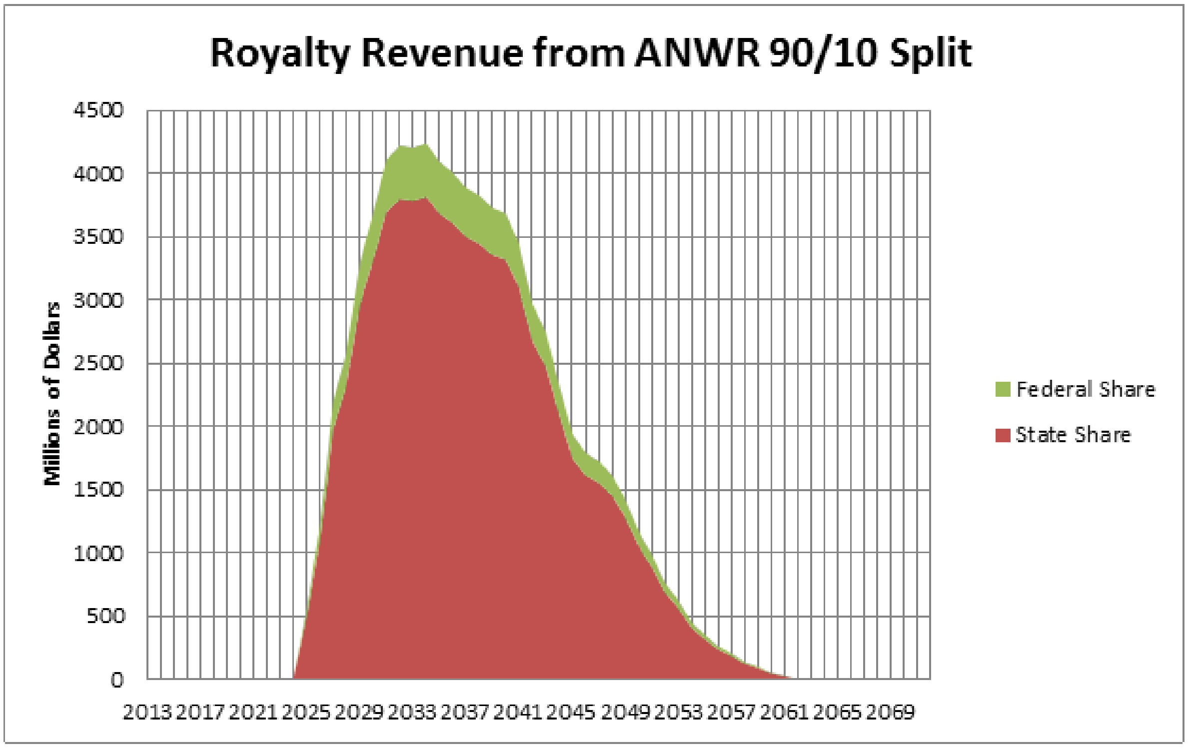
Royalty Revenue

ROYALTY REVENUE	90/10	50/50
State of Alaska	$70.8 Billion	$39.3 Billion
Federal	$7.9 Billion	$39.3 Billion

Source: ADNR-DO&G 2012

Figure 7-6

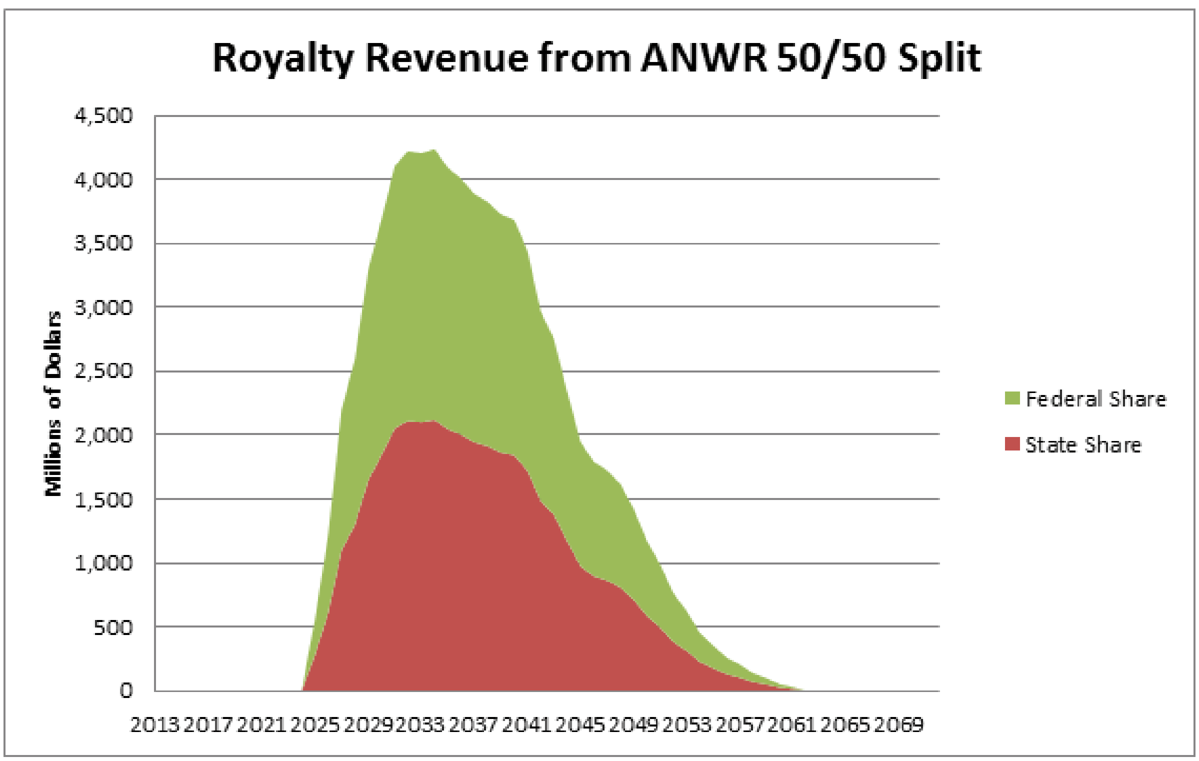
Stacked royalty revenue, 90 percent state - 10 percent federal split



Source: ADNR-DO&G 2012

Figure 7-7

Stacked royalty revenue, 50 percent state - 50 percent federal split



Source: ADNR-DO&G 2012

4. Taxes

The third primary revenue source associated with oil and gas development in ANWR comes from a variety of taxes related to production activities. Unlike royalty and lease rental payments, which are agreements between the resource owner and the developer, taxes involve an exercise of the government's sovereign power to tax and are set by legislative action. Both the State of Alaska and the federal government hold and exercise these powers by imposing various taxes on oil and gas producers, regardless of the owner of the resource in the ground.

a) State of Alaska Production Taxes

The State of Alaska levies a tax on the value of oil and gas derived from all production in the State, regardless of surface ownership or ownership of the resource. However, production taxes are not levied on royalty production benefiting the government, or when oil and gas are used to power operation or enhance oil recovery on site. This tax is distinct from bonus bids, lease rentals, and royalties paid to Alaska's treasury as a result of the State being the resource owner. (Most production in Alaska occurs on state-owned land).

The State of Alaska has modified its production tax in recent years. In 2006, the State repealed a tax based on gross value (akin to royalty value) and adopted a tax based on a measure of net profits, or the value of crude oil after deducting production costs (both operating and capital costs). This production tax, the Petroleum Profits Tax (PPT), was in effect for a year and a half. In late 2007 the State modified PPT by adopting legislation titled Alaska's Clear and Equitable Share (ACES). ACES increased the tax rate adopted with PPT while keeping PPT's general structure. Under PPT and ACES, the tax rate increased with net profit per barrel. These tax regimes included upfront credits (a 20 percent credit for capital expenses, a net operating loss credit of 25 percent). As stated above, a producer could deduct the full amount of the capital and operating expenditures in the year those expenditures were incurred to arrive at net profits.

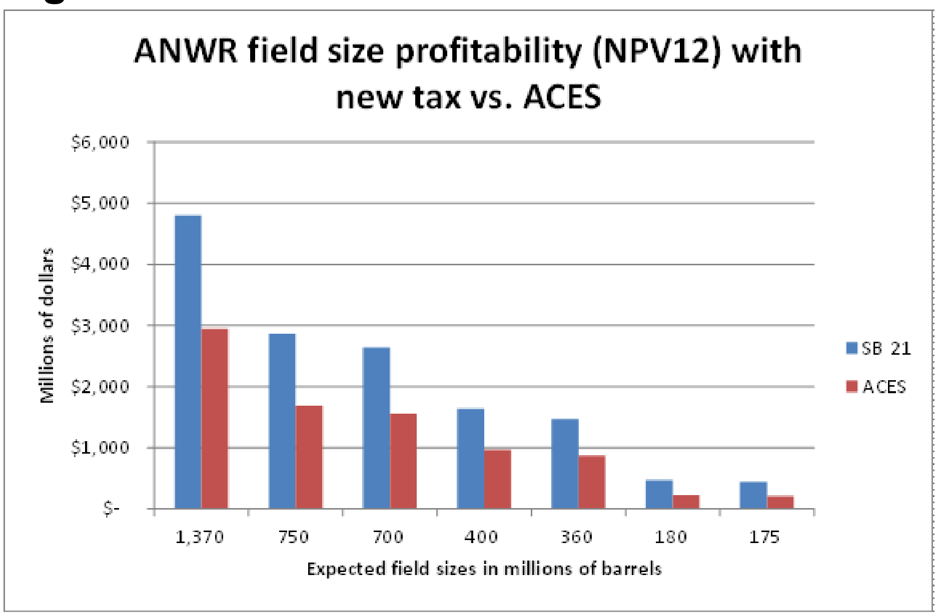
To spur investment and respond to criticism that the progressive element of the tax was too onerous, the State modified its production taxes in 2013. The State Legislature passed Senate Bill 21 (SB 21) in April 2013, which fixed the tax rate at 35 percent rather than allowing the rate to vary with different levels of profit per barrel. SB 21 also substituted a per barrel credit ($5 per barrel for new fields) for a 20 percent capital credit. The tax base was further reduced with 20 percent gross revenue exclusion for revenue from production from new fields (including ANWR fields).

Certain features of ACES/PPT were kept. There remains a minimum tax of four percent of the gross value of production, and upstream capital costs and operating costs are still deductible in the year incurred. For expenditures that have no taxable revenue to offset, there remains a net operating loss credit at the tax rate of 35 percent (increased from 25 percent under ACES).

At $100 per barrel oil price, the new production tax improves field profitability across different expected ANWR field sizes, as shown in Figure 7-8. Field profitability is measured using a discount rate of 12 percent for the net present value (NPV) calculation.

New Field Tax Liability = [((1 – Gross Revenue Exclusion)* Value – Costs)* Tax Rate] – Credits
The terms used in the equation are defined as follows:
Value = Volume of Taxable Oil and Gas Produced * Value of oil and gas at Point of Production
Gross Revenue Exclusion = 20%
Credits = $5 per barrel of oil produced; 35% * Costs not able to be deducted from value.

Figure 7-8

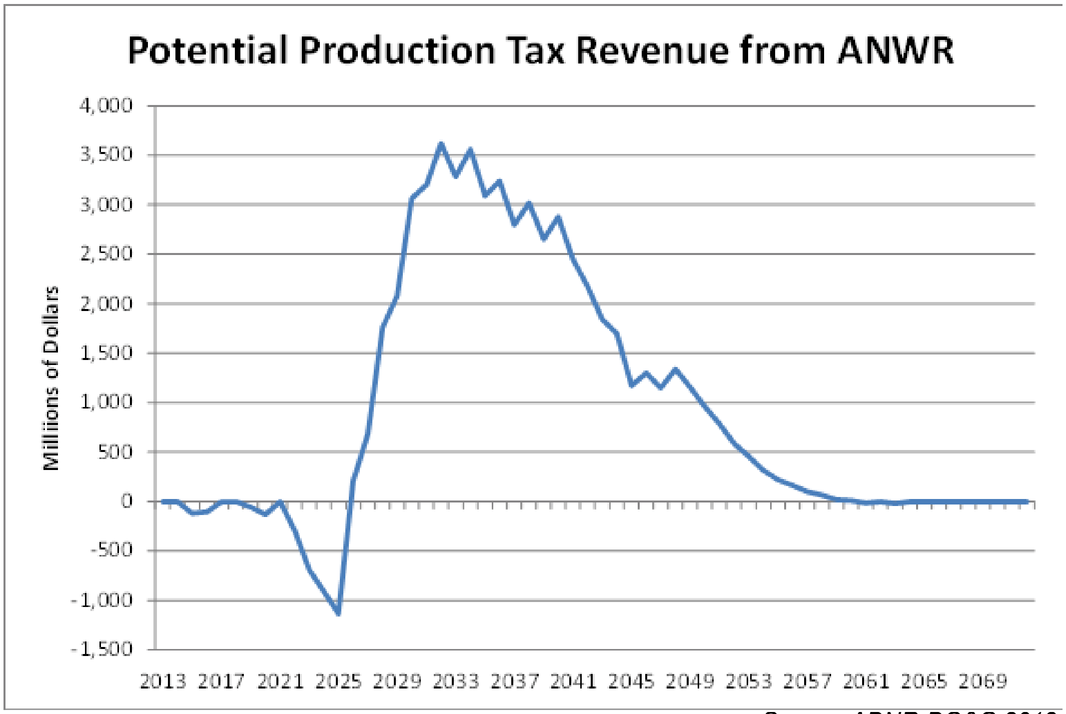


Source: ADNR-DO&G 2013

It is also useful to view the potential revenue stream that could be generated from state production taxes on ANWR development over the decades. As seen in the Figure 7-9, the State may initially lose revenue, as credits for the substantial exploration and development expenditures in ANWR are "cashed in". The net operating loss credit provides a generous incentive for companies to drill, and also makes the State a significant investor, along with the producers, in Alaska's oil future. However, as production increases in the 1002 Area, the cost of the credits quickly reverses and the State begins to receive a large amount of revenue from the production tax.

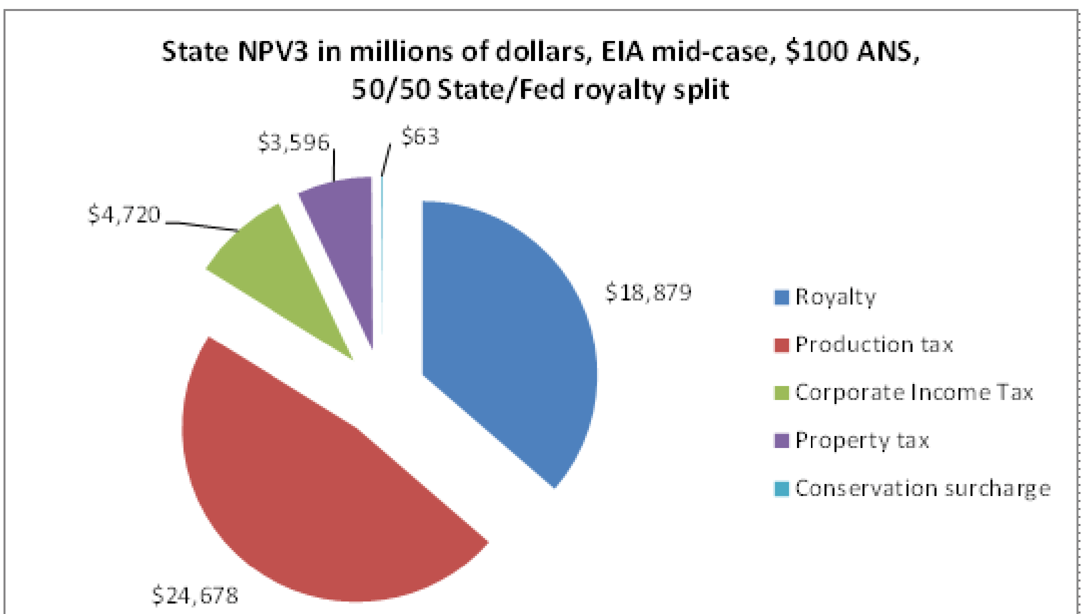
Using a discount rate for State cash flows of three percent, the production tax attributable to ANWR could yield almost as much to the state (around $25 billion) as all of the other elements of State annual revenue combined. This estimation assumes a fifty percent state share of royalties and does not include potential ANWR bonus bids. On an undiscounted basis, the State would receive around $54 billion.

Figure 7-9



Source: ADNR-DO&G 2013

Figure 7-10



Source: ADNR-DO&G 2012

b) Federal Income Taxes

Corporate income taxes due to the federal government on production profits would likely be the largest source of revenue to the federal treasury from ANWR. In 2008, the Congressional Research Service (CRS) calculated potential federal revenues from development in ANWR, using the 1998 USGS mean-case production volumes. This estimate was based on profits earned domestically over the life of the development, with a tax rate similar to the rates currently applied to the major companies that would likely be developing ANWR. At $100 per barrel, the CRS report estimated $152.9 billion in undiscounted revenues from federal corporate income tax (Lazzari, 2008). The ADNR-DO&G, based on EIA production scenarios, estimates undiscounted federal corporate income tax receipts of $81 billion ($39 billion at three percent discount rate).

c) State of Alaska Corporate Income Taxes

While there is no individual income tax in the State of Alaska, all corporations must pay a corporate income tax on taxable income generated in Alaska, based on federal taxable income with certain Alaska-specific adjustments.

An oil and gas corporation's Alaska income tax liability depends on the relative size of its Alaska and worldwide activities and the corporation's total worldwide net earnings. The corporation's Alaska taxable income is derived by apportioning its worldwide taxable income to Alaska based on the average of three factors as they pertain to the corporation's Alaska operations: (1) tariffs and sales, (2) oil and gas production, and (3) oil and gas property. Tax rates are graduated from 1 percent to 9.4 percent in increments of $10,000 of taxable income. The 9.4 percent maximum rate applies to taxable income of $90,000 and over.

Due to the apportionment equation needed to determine the Alaska taxable income, it is very difficult to estimate taxable income without facts such as a company's world-wide income, their world-wide property, sales and tariffs, and production. This makes a direct estimation of the state corporate income tax related to potential ANWR development infeasible. Instead, the income from a typical Alaska oil field can be estimated, and a percentage of this separate, Alaska-specific income can be used to estimate corporate income tax liability. The USGS has previously estimated this state corporate income tax proxy at 4 percent (Attanasi and Freeman, 2009). For the estimates below, the Division of Oil and Gas did the same.

Each of the three factors in an apportionment formula is a quotient:

- Alaska sales and tariff / world-wide sales and tariffs;
- Alaska property / world-wide property; and
- Alaska production / world-wide production.

Considering the mid-case production scenario described earlier in this document, at $100 per barrel, total net Alaska corporate income tax revenues are estimated to be $9.654 billion ($4.7 billion using a discount rate of three percent) over the life of production in the 1002 Area (ADNR-DO&G, 2012).

d) Property Taxes

The State of Alaska assesses a value on all oil and gas exploration, production, and transportation property located in Alaska. A local tax can also be levied on the state's assessed value for oil and gas property within a city or borough, and is credited against the state property tax. The city or borough tax rate does have a cap in order to protect the state's share of this revenue stream.

The state's mill rate is effectively 20 mills, or 2 percent of the assessed value, minus the local rate. In 2011, nearly $477 million was collected and distributed to the State of Alaska and local governments with taxing authorities. Property tax on production facilities, tangible above-ground well equipment, and pipelines associated with potential ANWR development may amount to around $7.5 billion undiscounted ($3.6 billion discounted at three precent) under the mid-case development scenario.

The ANWR 1002 Area is entirely within the North Slope Borough (NSB), a form of local government which has taxing authority. The North Slope Borough is the largest borough in Alaska, containing over 15 percent of Alaska's total land area. It consists primarily of the north and northeastern coast of Alaska, including the Brooks Range and most U.S. land north of the Arctic Circle.

A significant portion of NSB tax collections come from oil producers, and the Borough relies on these tax revenues to provide public services to all of its regional hub and rural communities. Recently, depletion of existing reservoirs has lowered the assessed value of the properties in the NSB tax base and resulted in a decline in tax revenue. This reduction has negatively affected the local government's ability to supply essential services to residents paying some of the highest costs of living in the country.

e) Other State of Alaska Taxes

The Oil and Hazardous Substance Release Prevention and Response Fund was created by the Alaska legislature in 1986 to provide a "readily available funding source to investigate, contain, and clean up oil and hazardous releases" (AS 46.08; ADEC, 2011). An amendment in 1994 divided the fund into two separate accounts:

(1) the Response Account was created with the purpose of financing the state's response to an oil or hazardous substance release declared a disaster by the Governor;

(2) the Prevention Account was created with the purpose of financing clean-up

of oil and hazardous substance releases not declared a disaster by the Governor. This account can also be used to fund oil and hazardous substance release prevention programs in Alaska.

Both accounts are funded by a surcharge on all oil production except federal and state royalty barrels.

The Response surcharge (AS 43.55.201) is $.01 per taxable barrel of oil and the Prevention surcharge (AS 43.55.300) is $.04 per taxable barrel of oil produced.

By law, the Response Account balance is to be maintained at $50 million, and the surcharge tax is only suspended when the balance equals the target maximum of $50 million (ADEC, 2011). As response and cleanup projects are done, they receive eligible payments that reduce the total fund's amount (AS 46.08.040). As needed, the surcharge is levied to bring the fund balance to the required maximum amount. It was reported that about $9.5 million dollars was collected in fiscal year 2013 from the necessary surcharge taxes as directed by statute (ADEC, 2013).

This category of tax revenue is a relatively small component of the total government take, and only serves to contribute to the funds to respond to substance releases or release prevention programs.

C. Employment

In addition to the role ANWR's oil and gas resources could play in meeting the Nation's energy supply needs and providing significant government revenue, the activity associated with development would provide enormous employment opportunities throughout Alaska. According to a 2011 report commissioned by the Alaska Oil and Gas Association (AOGA), employment and payroll in Alaska's oil and gas industry in 2010 was directly responsible for 4,848 jobs and $764 million in payroll (McDowell, 2011). Taking into account indirect employment, the report estimated 44,800 jobs in Alaska are due to the oil and gas industry, contributing $2.65 billion in payroll dollars to Alaska residents in 2010. For each job directly attributable to an oil company, nine jobs are generated in the Alaska economy, and for each dollar earned by employees of oil companies, three and a half payroll dollars are generated in Alaska (McDowell, 2011). If ANWR's production volumes were as large as the CBO has estimated relative to current production, a correspondingly impressive employment profile would likely result from development as well.

Oil industry jobs fall within the Construction and Extraction classification, the 5th largest sector of Alaska's workforce (ADOL, 2012). However, jobs relating to the development of ANWR would not be limited to direct exploration and extraction. The trade, transportation, and service industries are inextricably connected with the oil industry and would see large booms due to an infrastructure build out associated with development in ANWR. Recent large scale projects, such as

Shell's off shore exploration activity and ExxonMobil's Point Thomson development, have demonstrated the additional positive economic effects that development in new areas can bring.

Based on government-published data, the percentage of non-Alaskan Americans employed in the Alaska oil and gas industry has remained fairly steady over the past several years, averaging around one third of the workforce. Generally, as the number of oil and gas workers has increased, the number of non-Alaska resident employment in the industry has increased at the same rate (ADOL, 2012). In addition to the boom expected for local employment, ANWR development could provide good jobs for the national workforce.

According to the Alaska Department of Labor and Workforce Development, while the oil and gas industry is expected to grow, it is not due to expected increases in production, but rather to the enhanced recovery methods required for aging oil fields being more labor-intensive. These labor needs, as well as increasing oil prices that may make marginal fields commercially viable, may limit the decline of Alaska oil jobs, but will likely not keep pace with the growth of the economy in general.

Photo: Christina Holmgren-Larson ADNR-DO&G

Workers insulating pipeline, North Slope.

Many analyses have been conducted to estimate the number of jobs that development in ANWR could produce. Employment directly related to ANWR development is difficult to predict. Analyses based on data from the Bureau of Labor Statistics (BLS) estimate that hypothetical employment levels could range from about 20,000 to over 170,000 jobs, based upon the market conditions and demand for oil field services (Gelb, 2006, citing to BLS, 2002).

The oil and gas industry's many positive effects on Alaskan employment are substantial and drive the State's economy. The measurement of this phenomenon becomes an academic question based on the different measurements that can be used. However, in the Native village of Kaktovik the majority of workers are either employed in the public sector, (i.e., the North Slope Borough or School District) or the ANCSA villages and regional corporations. These jobs depend on revenue streams associated with oil and gas development, whether directly or indirectly. Kaktovik could gain a great deal from development of their lands adjacent to the 1002 Area.

If exploration and development of the 1002 Area occurs, jobs would be added to the national, state, and local economies. These jobs would not be limited to the petroleum industry, but would be spread throughout the trade, transportation, service, and construction industries. The number of jobs produced would depend on whether commercial quantities of oil and gas are discovered, and how projects to responsibly develop those resources are initiated. Additionally, ANWR does not have existing infrastructure. Development would require significant industry investment in environmental and wildlife studies, planning and design activities, materials acquisition, facility construction, seismic surveys, transportation, and logistics. All of this preliminary work would dramatically contribute to the well-being of the state and national economies.

D. Trans-Alaska Pipeline System Capacity and Integrity

Photo: ADNR-DO&G

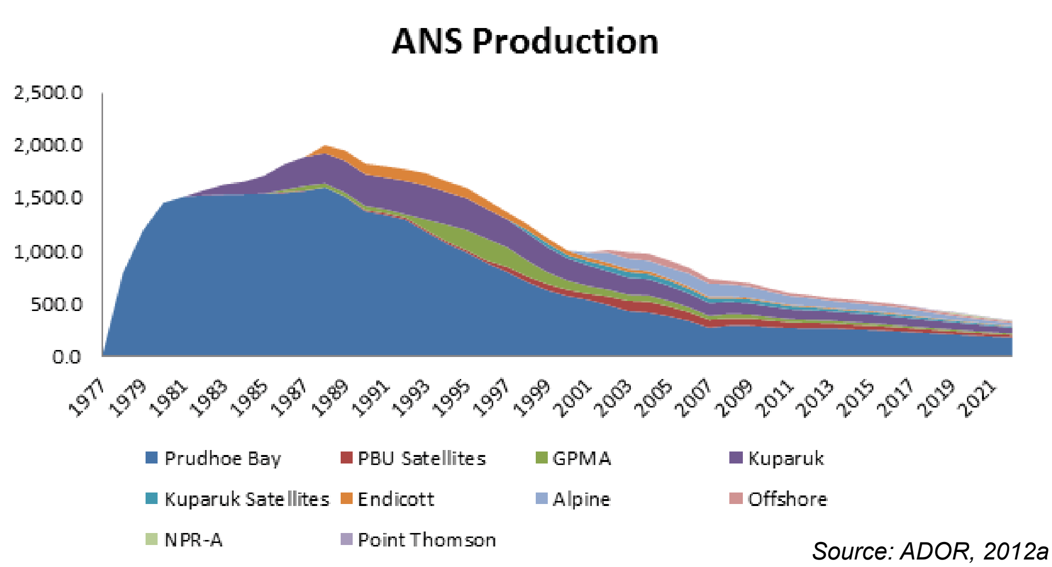
Caribou bull under pipeline, North Slope.

The Trans-Alaska Pipeline Systems (TAPS) is one of our nation's foremost domestic energy infrastructure assets. After oil was discovered in Prudhoe Bay in 1968, transporting it to market became a priority. This endeavor proved to be environmentally, legally, and politically challenging. However, the 1973 oil embargo and resulting price spikes in the United States prompted Congress to pass the Trans-Alaska Pipeline Authorization Act, which authorized streamlined construction of the pipeline. Four years later, oil began flowing through the pipeline in 1977. As of 2013, over 16 billion barrels of oil have travelled through TAPS's 800 mile length to the Valdez Marine Terminal, where it is loaded onto tankers and delivered to west coast refineries.

The Alyeska Pipeline Service Company (APSC) operates the pipeline on behalf of a consortium of industry owners. Over 99 percent of TAPS is owned by the major three North Slope producers: BP, ConocoPhillips, and ExxonMobil.

The value of TAPS as the lifeline of Alaska's economy cannot be understated. Maintaining the efficient use of this infrastructure is critically important due to the physical realities of shipping crude oil great distances in extreme conditions. As further discussed below, the pipeline was designed to operate under certain conditions and with certain levels of throughput. Changes to these conditions can have significant adverse impacts to the pipeline itself, as well as the economic health of the Alaskans that benefit from its operation. TAPS is the backbone of the Alaskan economy, and the investments and developments that will sustain it are an Alaskan priority.

Figure 7-11 *Production decline chart*



Source: ADOR, 2012a

1. Production Declines

Production declines since the late 1980s have caused great concern among the pipeline operators and the State of Alaska. Over two million barrels per day flowed through TAPS in 1988, but throughput has steadily decreased since this peak. TAPS throughput has not exceeded one million barrels per day since 2002, and has been decreasing at an average of five percent per year for the past decade. In 2012, the most recent complete year of data, TAPS throughput was under 550,000 barrels per day, the lowest annual amount since the pipeline began operation in the summer of 1977 (APSC, 2013).

Of the eleven pump stations originally built to support the flow of oil through the pipeline, only four are needed for operations today. While this is due in part to technological efficiency improvements, it dramatically illustrates how much spare capacity the pipeline currently has. These auxiliary pump stations are still being utilized for relief stations and response bases, providing equipment, housing and staging areas for oil spill response crews along the pipeline corridor.

2. Low Flow Physical Impacts

Low flows of crude oil through TAPS results in a chain of physical impacts that negatively affect the pipeline system. First, the speed at which crude oil is transported through the pipeline is reduced as the volume is reduced, increasing the amount of time it takes the product to reach the Valdez Marine Terminal. The increased transit time exposes the oil to Alaskan ambient temperatures for a longer period. This causes the oil to cool, along with the suspended water and solids contained in the crude product. Oil temperature also decreases from the loss of frictional heating are also a result of low flow and decreased velocities.

Lower temperature oil in the pipeline presents geotechnical concerns related to the engineering assumptions at the time of pipeline construction. In areas where the pipeline is buried (about half of its total length), low temperatures may allow the surrounding soils to freeze. This freezing can cause ice lenses and upheaval in areas, and ultimately may threaten the structural integrity of the pipeline.

The decrease in velocity from low flows also correlates to a decrease in turbulence in the pipeline. Reduced turbulence can allow suspended water and solids to settle out of the crude oil mixture. Separation of the transported crude product creates a multitude of operational problems, including corrosion, ice formation, and wax residue deposition.

APSC prepared a Low Flow Impact Study in 2011 outlining the engineering findings, mitigations, and recommendations necessitated by the low levels of oil throughput in TAPS. The study evaluated flow scenarios ranging from 300,000 to 600,000 barrels per day.

The results of the study paint an ominous picture. Some of the more immediate risks include:

- Water drop-out rates at flows below 500,000 barrels per day change the exposure of the interior of the pipeline to corrosion;
- At current flow rates, loss of heat even after hot residuum from the North Pole Refinery is re-injected will result in the pipeline operating below freezing, possibly creating an ice slurry in the line that pump stations are not currently designed to handle;
- Pump stations and pigs are not currently designed for ice and wax build-up conditions that may result from a prolonged shutdown at low temperatures (APSC, 2011).

At a certain point, TAPS service interruption would critically impact oil production from the North Slope, especially in the winter when temperatures can reach minus 70 degrees Fahrenheit. The immediate issue for North Slope oil fields from an operational standpoint would be shutting in wells and choking back production levels from producing wells. There is limited tank storage capacity for the numerous North Slope production sites, which is not able to handle extended duration pipeline shutdowns. While the economic impacts to the State from a TAPS shutdown would be substantial, a shutdown could also lead to irreversible well damage, reduction in future well flow rates, and lower ultimate oil recovery throughout the North Slope.

Operators on the North Slope will also struggle to produce enough natural gas to keep facilities and pipelines from freezing during shutdown. Emergency measures by Alaska Oil and Gas Conservation Commission during a brief winter 2011 shutdown allowed for oil to be pumped into specified development wells to help produce fuel gas.

3. Low flow economic impacts

The economic impacts of reduced flows are a critical near-term problem for the State. First and foremost, decreased production on the North Slope means decreased state revenue and economic opportunities for Alaskans. Additionally, the regulatory framework that administers the tariff (or shipping costs) system for TAPS is constructed in a way that limits competition and reduces incentives to increase flows by the producers.

Pipeline owners, or “carriers”, charge a tariff to “shippers” for the use of their pipeline to transport product. Tariffs are intended to compensate the carrier for the cost of operating the pipeline when the shipper paying a price per unit shipped. The tariff rate is regulated by the Federal Energy Regulatory Commission for the portions of tariff that are attributable to the exportable product, and by the Regulatory Commission of Alaska for the portions attributable to the product that remains and is refined in Alaska.

Generally, higher maintenance and operation costs will raise the tariff rate, while a higher volume throughput will lower it. The two primary variables in determining acceptable tariff rates are the cost of operating and maintaining the pipeline and the volume of product flowing through it. While operation and maintenance expenses are expected to rise slowly over time as the cost of goods and inflation increases, government and industry have more influence over pipeline throughput.

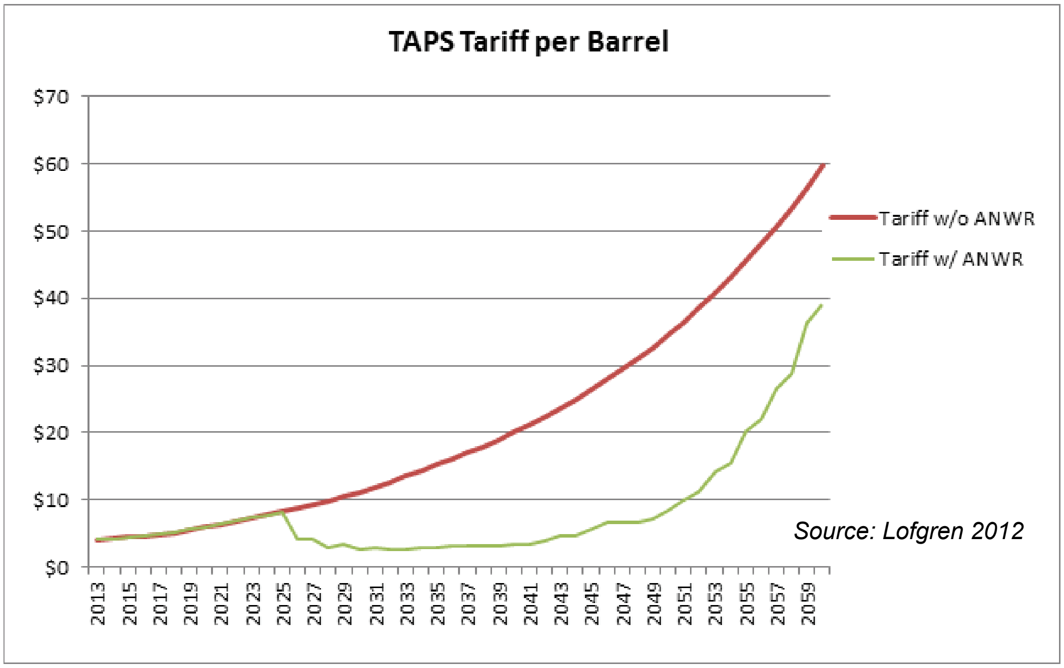
In the case of TAPS, the majority owner/carriers are also the majority shippers. As mentioned above, over 99 percent of TAPS is owned by BP, ConocoPhillips, and ExxonMobil, and these companies are also the major oil producers on Alaska’s North Slope. This means that when one of these oil companies ships oil through TAPS, it is essentially charging itself for the cost. If the tariff is high, it receives a high payment on the other end.

Although it may be economically negligible for the TAPS owners, unjustifiably high tariffs adversely affect the State and federal revenue streams because those shipping costs are deductible expenses in the calculation of production taxes, income taxes, and royalty payments. In addition, non-owner/carrier companies wanting to ship product through TAPS must pay these tariffs without the benefit of having them “reimbursed” down the line.

One of two scenarios is likely to materialize in coming years in regards to flow and tariffs for TAPS. Under the first scenario, continuing decline in TAPS throughput would result in increasingly higher per barrel tariffs, which in turn would significantly cut into North Slope production profitability. Even if the pipeline could technically continue to operate, it might be economically challenged if the price of oil fell. Oil producers would produce oil from areas where they could still profit from oil sold at the prevailing market price. This scenario places Alaska’s economy in severe risk in low oil price scenarios.

Figure 7-12

TAPS tariff forecasts with and without ANWR production.



The second scenario is one in which production and flow through the pipeline increases. This scenario would have the effect of lowering per-barrel operation and maintenance costs; reducing the amount of deductible transportation costs; increasing taxable revenue; increasing state and federal income tax, production tax and royalty share; and making North Slope development more attractive to smaller companies without an ownership share of TAPS.

Since tariffs are calculated based on production volumes and the cost of operating and maintaining the pipeline system, we can use production forecasts to predict the tariff over time. In future years, production from ANWR could have a substantial effect on the TAPS tariff. The red line on the chart above (Figure 7-12) estimates the TAPS tariff if production declines continue as forecasted in the Fall 2012 Revenue Source Book (ADOR, 2012a). The green line estimates the tariff if production from the 1002 Area was brought online in 2025, at the volumes predicted in the mid-case production scenario described earlier.

It should be noted that the steady increase in TAPS tariffs forecasted if throughput continues to decline does not include additional expenditures that could be required for low-flow mitigation infrastructure, upgrades, and repairs. The 2011 Low Flow Impact Study only made general findings regarding potential low flow issues at volumes below 350,000 barrels per day. The report did not estimate a particular plan of action or costs associated with mitigating low flows, but they would be expected to be substantial. Should costly mitigation measures be required to address such low levels of throughput, those costs could push the TAPS tariff higher than the rate estimated above.

4. How low can it go?

In 2011, in the course of determining the value of TAPS for the calculation of property taxes, the issue of 'how low could the flow go' received renewed attention. Alaska Superior Court Judge Sharon Gleason issued a decision in December 2011 regarding the assessed value of TAPS in 2007, 2008, and 2009 (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al. – Decision Following Trial de Novo – 2007, 2008, 2009 Assessed Valuation, December 30, 2011) . The minimum throughput was a critical piece of information for Judge Gleason's decision, as the value of TAPS and its accumulated depreciation is directly attributable to how long the pipeline may be utilized. Judge Gleason's decision on the appraised value of TAPS was based on her conclusion that the pipeline could accommodate flows as low as 100,000 barrels per day.

In 2012, the U.S. Energy Information Administration (EIA) released its Annual Outlook report, which examines factors that shape the U.S. energy system over the long term. This report addressed what it deemed, "considerable uncertainty," about the TAPS's long-term future, and described scenarios that would necessitate the shutdown of TAPS as well as the North Slope oil fields. The EIA considered some cases where a shutdown could occur as early as 2020. The Annual Outlook also asserts that the discovery and production of large new oil sources to add to the pipeline's throughput would more readily alleviate these concerns, rather than mitigation of low flow impacts by extensive infrastructure spending and process modifications. According to the EIA, "there is considerable uncertainty about the long-term viability of North Slope oil production and continued operation of TAPS through 2035. The two most important determinants of their future viability are the wellhead oil price that North Slope producers receive and the availability and cost of developing new North Slope oil resources." (EIA, 2012a)

The legacy fields of Prudhoe Bay and Kuparuk River have passed their peak production volumes, and will one day become uneconomical for continued production. Offshore resources in the Chukchi and Beaufort Seas are only now being field tested with preliminary exploration drilling programs. Economic finds in those areas are expected, but the engineering, permitting, and legal challenges for construction of hundreds of miles of feeder pipeline to TAPS present additional complications and uncertainty for these prospects' ability to mitigate low flows in the short term, which are already at critical levels. Also, there is no certainty that oil produced offshore will be routed to TAPS for transportation to market. While the 1002 Area also lacks developed infrastructure, it is onshore and does not face many of the challenges that these other potential reservoirs do. It is close proximity to developments on state land on ANWR's border that feed into TAPS. Responsible development of the resources is one of the State's best options for dramatically reversing the North Slope's production declines.

E. Alaska's Economy

The sections above describe the significant benefits that would result from responsible development of the petroleum resources in the 1002 Area. These benefits would accrue to the nation as a whole, but could be transformative for the State of Alaska and its residents.

The state's economy is dependent on natural resource development, with oil and gas revenues making up over 90 percent of the State's unrestricted revenue. Payroll dollars, government spending, and royalty and tax revenue all underlie a well-functioning Alaskan economy. Oil revenues support the provision of basic services to residents across Alaska, many of whom live in remote areas that have scarcities of basic goods and extremely high costs of living. Many of the stark concerns of low oil production would be even more pronounced in Alaska if recent declines had occurred without this decades record high oil prices.

While there are valid short-term concerns regarding low TAPS throughput and production declines, there are also significant economic opportunities in the State's future. The economic benefits described in this chapter are an example of one possible future for Alaska. There are many steps that would have to be taken for ANWR oil production to materialize, but it cannot be seriously contemplated until comprehensive modern exploration defines the resource potential of the 1002 Area.

Chapter 8
Future Outcomes and Conclusion

A. Summary

Previous chapters have described a potential exploration plan for the 1002 Area as well as the potentially impacted resources, suggested mitigation measures, and potential benefits to the nation and to the State of Alaska related to oil and gas exploration. It is important to note that since the passage of ANILCA in 1980, the power to allow oil and gas development in ANWR has always resided with the U.S. Congress.

The oil and gas resource potential of the 1002 Area is estimated to be on the scale of other mega field discoveries in northern Alaska and Canada. However, until and unless Congress acts, the full potential of this area will remain unknown. Given that the federal government is not taking the lead to improve the assessment of the resources and potential for investment, the State has chosen to make the case for the value, importance, and public benefit of assessing the resource and allowing private competitive evaluation of the public findings.

The State of Alaska strongly objects to the planning process undertaken by the USFWS. The draft CCP/EIS that has been prepared fails to analyze or consider any alternative that addresses management of future oil and gas activities. This is contrary to the directives in NEPA to *consider all reasonable alternatives,* particularly when an alternative may have foreseeable positive impacts on the human environment and the decision to exclude this alternative is based on incomplete or unavailable information.

An adequate resource assessment using modern technology is necessary in order for Congress to make an informed decision regarding management of ANWR, specifically the 1002 Area. This alternative has not been considered by the USFWS as part of the draft CCP/EIS. In order to make the decisions that will best serve the country, Congress needs to review the best scientific information about oil and gas potential and be fully informed of what the country would be giving up if the ANWR 1002 Area is designated as a wilderness area.

The vintage 2-D seismic data that underlies current estimates is generations behind the technologies and methods used today to locate and delineate potential reservoirs. Even with new interpretation of this seismic data, there is a wide variability in the amounts of oil that have been estimated.

A thorough 3-D seismic and exploration drilling program will provide the level of detail needed for government and industry to fully understand the area's potential to yield the substantial benefits predicted if full development is permitted to occur. The necessary next step in realizing these benefits is for Congress to act, and for the President to authorize a 3-D seismic and exploration drilling program in the 1002 Area of ANWR. The State supports this action and stands ready to provide the knowledge and expertise that resides in managing our oil and gas resources so that the exploration program can be conducted in an efficient and environmentally safe manner.

1. Domestic Energy Supply

Increasing the domestic supply of crude oil would increase the energy security of our nation by tempering declines from existing North Slope fields, supplementing contributions from non-conventional oil plays in the contiguous states, and reducing the reliance on international imports. Chapter 7 further describes the benefits of a steady supply of domestically sourced crude oil, as well as the indirect benefits to our economy from secure supplies.

Once explored, the 1002 Area's proximity to the major shipping infrastructure of TAPS could protect the United States from oil price volatility that may jeopardize non-conventional oil plays. TAPS has shown great resiliency to price fluctuations, functioning at a price range from $10 to $140 per barrel over the last 15 years. Unconventional oil plays have not shown that level of resiliency and could impact domestic energy supply were there to be a significant reduction in price per barrel.

Figure 8-1

Total potential revenues in billions of dollars from all sources.

	Federal Government 10% (Bonus and Royalty Only)	Federal Government 50% (Bonus and Royalty Only)
Bonus Bids	$0.83	$4.15
Royalties	$7.90	$39.30
Income Tax	$152.90	$152.90
	$161.63	**$196.35**

	State of Alaska 90% (Bonus and Royalty Only)	State of Alaska 50% (Bonus and Royalty Only)
Bonus Bids	$7.47	$4.15
Royalties	$70.80	$39.30
Production Tax	$128.87	$128.87
Income Tax	$6.50	$6.50
Property Tax	$7.55	$7.55
Conservation Surcharge	$0.132	$0.132
	$221.32	**$186.50**

Data: ADNR-DO&G 2012

2. Economic Benefits

Once the oil and gas potential of the 1002 Area is better defined by a modern seismic and exploration drilling program, future oil production would be driven by the type and extent of development that is economically feasible. Many variables are considered in determining the process for developing a major oil discovery.

Financial benefits in the form of bonus bids alone could add over $8 billion to federal and state treasuries. Assuming the mid-case production scenario described in Chapter 3, projected future economically recoverable reserves of over 5.2 BBO may exist with a production period of nearly 40 years. As described in Chapter 7, at these svolumes, the 1002 Area's development could provide hundreds of billions of dollars in revenue to both the federal government and state government through royalties and various taxes.

3. Trans-Alaska Pipeline System (TAPS)

The only year that has seen less TAPS throughput per day than 2012 was 1977, when the pipeline was brought online half-way through the year. Since the peak throughput in 1988, total throughput has continued to decline as the giant oil fields of Prudhoe Bay and Kuparuk mature.

Chapter 7 described in detail the potential consequences to the pipeline infrastructure and to the State's economy should flows continue on their current downward trajectory. To avoid the potential negative corrosion and operational impacts due to the effects of low throughput in TAPS, it is imperative that the amount of production and transportation through TAPS increase as soon as possible. The 1002 Area, with its promising resource potential and close proximity to TAPS, remains the key on-shore resource to help stem throughput decline in the TAPS in the long term.

4. Alaska Economic Security

Alaska is dependent on oil production revenues, which fund state and local government operations and programs, infrastructure projects, and schools. Oil revenues collected by the state government in the form of bonus bids, royalties, and production taxes make up over 90 percent of the state's budget. This economic boon supports employment opportunities including thousands of jobs that support oil field operations, construction projects, and ancillary businesses.

B. Seismic Exploration and Exploration Drilling

The results of a complete 3-D seismic and exploration well drilling program will provide the information necessary to determine the viability of development in the 1002 Area. Making long-term and substantial land management decisions should be informed by the most comprehensive resource study possible. As this proposal has described, technological advancements allow for collection of this information with minimal impact on the region's natural environment.

In Chapter 5, the ADNR-DO&G's geological, geophysical, and engineering experts outlined a potential exploration program that would provide government and industry the data needed to make accurate determinations of resource size and distribution in the 1002 Area. The exploration proposal consists of a multi-phased approach, beginning with a multi-year seismic acquisition program then transitioning into planning and permitting that informs and authorizes the multi-year exploration drilling phase. All phases of the exploration proposal that require entry into the 1002 Area would be conducted entirely during the winter, using temporary access roads and pads made out of ice. These methods are required for exploration activities on Alaska's North Slope, and allow the collection and analysis of comprehensive resource data with minimal lasting impacts on the environment.

This exploration program, however, is just one of several possible solutions to enable a systematic and thorough evaluation of the petroleum resources in the 1002 Area. Although the subsequent post-exploration phases are hypothetical and therefore cannot be discussed in detail, this proposal concludes below with an outline of issues and considerations for future decision-making.

C. Development Considerations

Upon discovery of technically and economically recoverable petroleum reserves, any subsequent oil and gas development, production and transportation activities would depend upon many factors and be affected by dozens of agencies, permits, policies, and standards. Remaining questions that would have to be answered and issues that would be analyzed in the years after a seismic and exploration drilling program would include the following:

1. Operating Plan

How will the fields be developed? Which agency will have jurisdiction?

BLM has oversight over oil production on on-shore federal lands, and would likely assume jurisdiction over oil production activity in ANWR. The regulations followed for other federal lands, NPR-A for example, would likely be the basis for how ANWR is leased and developed in the future. It should be noted, however, that by Congress authorizing "…activities leading to production…" as ANILCA requires, before any production development can take place, many of the specifics regarding how the field or fields are developed could be included in the enabling legislation. These mandates may not follow traditional jurisdictions or procedures.

2. Technology

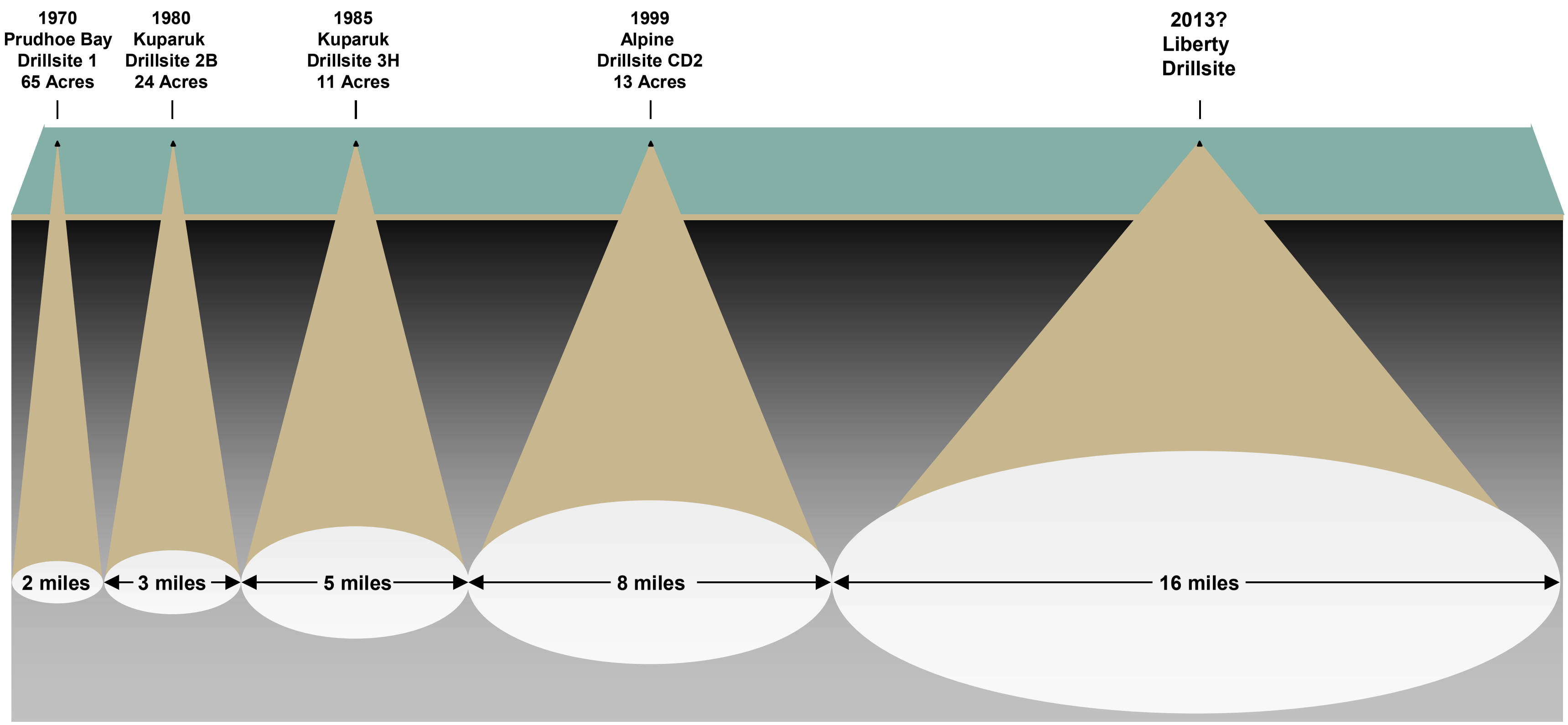
What technology will be used in the 1002 Area?

Many of the technological advances in drilling engineering, now used around the world, were conceived and developed by North Slope operators as they tried to reduce costs and environmental impacts in the Arctic.

Unlike the proposed winter-only seismic and drilling exploration program, it is likely that production drill pads and facilities would be constructed of gravel. Pad

Figure8-2

Alaskan North Slope Drillsite Reach Evolution: Pad size and corresponding subsurface drillable acreage.



Source: ADNR-DO&G 2012

access roads and pipeline access roads, however, may be either temporary (ice) or permanent (gravel).

Drilling technology has greatly advanced since the 1002(h) report recommended that the entire area be opened for development (Clough, et al, 1987). From a single pad, a well drilled with modern technology is now able to penetrate one or more small targets, identified by the 3-D seismic, at distances of more than four miles from the drill rig location. The size of pads required for wells has also diminished appreciably as technology has advanced. Application of the extended reach drilling method allows numerous exploration and development wells to be drilled within a radius of in excess of five miles from a single drill pad (ADNR-DO&G, 2012).

3. Field Distribution

Where are the viable fields located? How will phased development proceed to enable smaller fields to become economically viable in later years?

A comprehensive exploration plan, similar to the one proposed in Chapter 5, would provide geologists and geophysicists in both industry and government the information needed to identify the areas with the highest potential for economically recoverable reserves. As described in Chapter 3, the most recent comprehensive analysis of the vintage 2-D seismic data shows that a majority of the oil in place exists in the western portion, or undeformed zone, of the 1002 Area. If this can be proven and refined further, through modern 3-D seismic surveys and exploration wells, field locations could be determined to a higher degree of accuracy and a plan for systematically producing those fields could be developed.

4. Revenues

How will the proceeds from bonus payments and royalties be split between the federal and state government? How will the revenues from the 1002 Area be designated or spent?

The question of how to split the proceeds of production from the 1002 Area will likely be decided by Congress in the enabling legislation. Under current law, revenues from resource development on federal lands is split, with 90 percent going the state and 10 percent going to the federal government. However, Congress could decide to apply a different standard to ANWR oil and gas development. Many of the more recent bills introduced in Congress have prescribed a 50/50 split for ANWR oil revenues akin to the split arrangement for the National Petroleum Reserve - Alaska.

5. Transportation

What will be the method for transporting product to TAPS? What is the most efficient system of gathering pipelines, given what is discovered about the distribution of fields throughout the 1002 Area?

The 1002 Area, with its promising resource potential, is approximately 60 miles east of TAPS Pump Station 1 located in the Prudhoe Bay unit. In addition to TAPS, the Endicott and Badami pipelines extend 40 miles towards ANWR. Winter 2012-13 construction is planned for an extension of the Endicott/Badami pipeline system to the Point Thomson Unit, less than 10 miles from ANWR's northwestern boundary. Whether future pipelines in the 1002 Area will make use of these pipelines or whether oil will be collected and transported directly to TAPS will depend on the location of reserves found and how development proceeds over the years.

Whichever method is ultimately selected, the addition of oil from the 1002 Area is critically important to preserve the infrastructure and operation of TAPS in the long term.

6. Environmental Impacts and Mitigation Measures

What environmental impacts are anticipated during the production phase? What mitigation measures will be required to reduce environmental impact?

During the production phase of potential ANWR development, the environmental impacts and mitigation measures that will have to be considered will differ from the impacts considered during the exploration phase. In particular, because some facilities, pads, pipelines and access corridors would exist year-round when the wells are producing, additional mitigation measures would be required to prevent or reduce the direct impacts to habitats and species, and prevent the subsequent short- and long-term indirect impacts to populations and uses.

Additional species, such as migratory birds, would be encountered in the summer, requiring the designation of mitigation considerations to avoid areas and practices that would significantly and adversely affect them. Calving, nesting, and rearing areas and habitats would warrant additional mitigation measures. Migration corridors, insect relief areas, and food location would also necessitate consideration during the planning stages of production.

Despite these additional considerations, industry is well adapted to provide for needed mitigation measures to minimize environmental impact of production facilities. Both spatial and temporal restrictions to sensitive areas are currently employed by industry operating on Alaska's North Slope and have proven effective as approved by the agencies listed in Appendix D.

7. Permitting

What permits must be obtained for development?

In addition to the regulatory process outlined in Chapter 5 for a winter seismic and drilling exploration program, several layers of environmental review will be required to advance any proposed project to the development stage.

It would be anticipated that the lease sale, as well as any specific development plan, would mandate an environmental review process according to the requirements of the National Environmental Policy Act (NEPA). Through this process, ample opportunities for inter-agency coordination and public involvement exist. These opportunities serve to bring to light available information regarding the proposed project to help shape alternatives, project design, and mitigation measures.

Many agencies require one or more permits and/or authorizations, as well as mandated inter-agency consultations, tribal coordination, and public notice and involvement. A typical development project on the North Slope could be anticipated to acquire the list of permits and authorizations found in Appendix D.

D. Conclusion

Often overlooked in the debate surrounding the future of the 1002 Area is the fact that much of the information regarding the resource assets of the area was gathered in conjunction with the ANWR petroleum exploration programs of the mid-80s. Those programs provided the impetus, support and means to compile comprehensive studies of the environmental and wildlife values of the area.

Since that time, industry innovation and a more complete understanding of the sensitive environmental conditions in the Arctic have progressed in tandem, allowing new development techniques designed to minimize or eliminate impact on the environment. However, these new technologies have never been used to update the scientific knowledge of the subsurface resources of the 1002 Area. Updating this information is critical for informing future ANWR management decisions.

How much oil lies beneath the permafrost along the coastal plain of ANWR? Only Congress holds the authority to permit the actions that will provide this answer. The history of the great compromise that shaped ANILCA and dedicated over 100 million acres in Alaska to conservation purposes is unknown to most citizens engaging in the current debate of wilderness versus development of the 1002 Area. This has become one of the last unresolved issues in ANILCA's promise, and through this proposal, Congress has the opportunity to honor the legacy of that great compromise. To respect the Natural Resource Policy of Alaska's Constitution, and honor the decades of resolutions by the Alaska legislature, and meet the requirements of NEPA, these steps must be taken to fully define the oil and gas reserves of the 1002 Area.

The State's proposal is a way forward. At the end of the exploration program, Congress, the State, industry, and the public will all know what oil and gas resources are available under the 1002 Area. This will allow Congress to make an informed decision regarding an area that has been under debate since the 1980s.

Appendix A: References

ADEC (Alaska Department of Environmental Conservation).

2013 Oil and Hazardous Substance Release Prevention & Response Fund: Fiscal Years 2011-2012, Biennial Report to the Legislature, Page 20. Juneau, Alaska. http://dec.alaska.gov/spar/rfa/docs/budget/biennial/OHSRPRF%202011-2012%20Report%20.pdf

2011 Response Fund Administration: History of the Fund. Juneau, Alaska. http://www.dec.state.ak.us/spar/rfa/history.htm

2007 Oil Spill Response Mechanical Recovery Systems for Ice-infested Waters: Examination of Technologies for the Alaskan Beaufort Sea. Juneau, Alaska. http://www.dec.state.ak.us/spar/ipp/docs/2007%20Mechanical%20Recovery%20Ice.pdf

ADEC SPAR (Alaska Department of Environmental Conservation, Spill Prevention and Response).

2012 Incident Description and Update: Exploration Drilling Gas and Mud Fluids Release, 2/15 through 4/10/2012. http://dec.alaska.gov/spar/perp/response/sum_fy12/120215301/120215301_index.htm

2004 North Slope, Alaska: Risk Layers for Candidate Site for Geographic Response Strategies & Potential Places of Refuge, Map.

ADEC, et al. (Alaska Department of Environmental Conservation, U.S. Coast Guard, and U.S. Environmental Protection Agency).

2008 In Situ Burning Guidelines for Alaska. Revision 1. March. http://www.akrrt.org/ISB_GuidelinesRev1/Final/Final-2008.pdf

ADCRA (Alaska Division of Community and Regional Affairs).

2012 Kaktovik, Community Database Online. http://commerce.alaska.gov/dca/commdb/CF_BLOCK.cfm?Comm_Boro_Name=Kaktovik&Data_Type=generalOverview&submit2=Get+Data

ADF&G (Alaska Department of Fish and Game).

2012a. Publications: Management & Harvest Reports. http://www.adfg.alaska.gov/index.cfm?adfg=librarypublications.wildlifemanagement

2012b. Game Management Unit (GMU) Information, Unit 26. http://www.adfg.alaska.gov/index.cfm?adfg=huntingmaps.gmuinfo&gmu=26

2012c. Subsistence in Alaska: Amounts Reasonably Necessary for Subsistence. http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.reasonable

2012d. Subsistence in Alaska: Overview. http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.main

2012e. Unpublished Files. Muskoxen. By ADF&G.

2012f. Unpublished Files. Caribou and Sheep Harvest. By ADF&G.

2011a. Unpublished Files. Moose. By ADF&G.

2011b. Muskox Management Report of Survey and Inventory Activities, 1 July 2008-30 June 2010, *in* P. Harper, (Ed.). Prepared by E. A. Lenart, Pages 63-84. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/11_muskox.pdf

2010a. Moose Management Report of Survey and Inventory Activities, 1 July 2007 – 30 June 2009, Patricia Harper, (Ed.). Prepared by J.R. Caikoski, Pages 611-626, and by E.A. Lenart, Pages 666-677. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/10_moose.pdf

2010b. Furbearer Management Report of Survey and Inventory Activities, 1 July 2006 - 30 June 2009, *in* P. Harper (Ed.). Prepared by J.R. Caikoski, Pages 329-347. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/10_fur.pdf

2009a. Caribou Management Report of Survey and Inventory Activities, 1 July 2006 - 30 June 2008, *in* P. Harper, (Ed.). Porcupine Caribou Herd, Prepared by J.R. Caikoski, Pages 240-258; and Central Arctic Caribou Herd, Prepared by E. A. Lenart, Pages 299-325. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/09_caribou.pdf

2009b. Wolf Management Report of Survey and Inventory Activities, 1 July 2005-30 June 2008, Pages 248-264 *in* P. Harper, (Ed.). Prepared by J.R. Caikoski, Pages 248-257. Alaska Department of

Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/09_wolf.pdf
2009c. Brown Bear Management Report of Survey and Inventory Activities, 1 July 2006-30 June 2008, *in* P. Harper, (Ed.). Prepared by E.A. Lenart, Pages 300-312. Alaska Department of Fish and Game, Division of Wildlife Conservation, http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/09_brbear.pdf
2008a. Sheep Harvest, GMU 26C, 2007-2008: Unpublished Files, ADF&G.
2008b. Caribou Harvest, GMU 26C, 2007-2008: Unpublished Files, ADF&G.
2007a. Caribou Management Report of Survey and Inventory Activities, July 1 2002 – June 30 2004, *in* P. Harper, (Ed.). Porcupine Caribou Herd, Prepared by E.A. Lenart, Pages 232-243; and Central Arctic Caribou Herd, Prepared by E.A. Lenart, Pages 284-299. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/07_caribou.pdf
2007b. Economic Impacts and Contributions of Sportfishing in Alaska. http://www.sf.adfg.state.ak.us/Static/economics/PDFs/2007Summary.pdf Accessed March 4, 2010.
2007c. Furbearer Management Report of Survey and Inventory Activities, 1 July 2003-30 June 2006, *in* P. Harper, (Ed.). Prepared by M. M. Szepanski, Pages 313-320. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.wildlife.alaska.gov/pubs/techpubs/mgt_rpts/07_fur.pdf
2007d. Muskox Management Report of Survey and Inventory Activities, July 1 2004-30 June 2006, *in* P. Harper, (Ed.). Prepared by E. A. Lenart, Pages 49-61. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.wildlife.alaska.gov/pubs/techpubs/mgt_rpts/07_musk.pdf
2007e. Monitoring of Annual Caribou Harvests in Three Communities. Prepared by Sverre Pedersen, Alaska Department of Fish and Game, Division of Subsistence.
2007f. Personal communication from Mark Fink, Habitat Biologist, Alaska Department of Fish and Game, Division of Sport Fish, Anchorage to Allison Iverson, DO&G, June 6.
2006 Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. Alaska Department of Fish and Game, Juneau, Alaska. http://www.sf.adfg.state.ak.us/statewide/ngplan/NG_outline.cfm
2005 Caribou Management Reports of Survey and Inventory Activities, July 1 2002 – June 30 2004, *in* P. Harper, (Ed.). Porcupine Caribou Herd, Prepared by M. A. Keech, Pages 219-228; and Central Arctic Caribou Herd, Prepared by E. A. Lenart, Pages 269-283. Alaska Department of Fish and Game, Division of Wildlife Conservation. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/ca05_int_nth.pdf
1996 Alaska Wildlife Harvest Summary, 1994-1995. Alaska Department of Fish & Game, Division of Wildlife Conservation, Information Management Section, Wildlife Information Data Base Project, March 6.
1994 Wildlife Notebook Series. http://www.adfg.alaska.gov/index.cfm?adfg=educators.notebookseries
1991 Blasting Standards for the Protection of Fish, 11 AAC 95.248, Draft, Juneau, Alaska. http://www.adfg.alaska.gov/static/license/uselicense/pdfs/adfg_blasting_standards.pdf
1986a. Alaska Habitat Management Guide, Southcentral Region, Vol. I, Life Histories and Habitat Requirements of Fish and Wildlife.
1986b. Alaska Habitat Management Guide, Arctic Region, Vol. II: Distribution, Abundance, and Human Use of Fish and Wildlife. Division of Habitat, Juneau.

ADGC (Alaska Division of Governmental Coordination).
1985 Coastal Clean Water Plan.

ADNR (Alaska Department of Natural Resources), Division of Oil and Gas.
2012 ADNR-DO&G 2012: Unpublished data, Alaska Department of Natural Resources, Division of Oil and Gas, Anchorage, Alaska.
2012b. Alaska Department of Natural Resources, Division of Oil and Gas Homepage. http://dog.dnr.alaska.gov/
2011 North Slope Foothills Areawide Oil and Gas Lease Sales: Final Finding of the Director, May 26, 2011, http://dog.dnr.alaska.gov/Leasing/BestInterestFindings.htm#nslopefh
2009 Beaufort Sea Areawide Oil and Gas Lease Sale: Final Finding of the Director, November 9, 2009, http://dog.dnr.alaska.gov/Leasing/BestInterestFindings.htm#bsea
2008 North Slope Areawide Oil and Gas Lease Sale: Final Finding of the Director, July 15, 2008,

http://dog.dnr.alaska.gov/Leasing/BestInterestFindings.htm#nslope
2003 Oil and Gas in the ANWR? It's Time to Find Out!, February, 2003. http://dog.dnr.alaska.gov/Publications/Documents/OtherReports/Oil_Gas_in_ANWR_Review_2003-02.pdf
1991 Final Finding of the Director Regarding Oil and Gas Lease Sale 65, Beaufort Sea, February 26.
1990 Final Finding and Decision of the Director Regarding Oil and Gas Lease Sale 70A, Kuparuk Uplands, September 13.

ADNR-DO&G (Alaska Department of Natural Resources, Division of Oil and Gas)
2013 ADNR-DO&G 2013: Unpublished data, Alaska Department of Natural Resources, Division of Oil and Gas, Anchorage, Alaska.
2012 ADNR-DO&G 2012: Unpublished data, Alaska Department of Natural Resources, Division of Oil and Gas, Anchorage, Alaska.

ADNR MLW NRO (Alaska Department of Natural Resources, Division of Mining, Land, and Water, Northern Region Office)
2012 Personal Communication from Melissa Head, (MLW NRO) to Susan G. Browne (DO&G) regarding ice road and tundra travel data, North Slope, Alaska.

ADOL (Alaska Department of Labor and Workforce Development).
2012 Alaska Department of Labor and Workforce Development Home Page. http://labor.alaska.gov/

ADOR (Alaska Department of Revenue).
2012a. Revenue Sources Book, Fall 2012. Prepared by the Tax Division. http://www.tax.alaska.gov//programs/documentviewer/viewer.aspx?2682f
2012b. Department of Revenue, Tax Division Home Page. http://tax.alaska.gov/

AEIDC (Arctic Environmental Information and Data Center, University of Alaska).
1975 Alaska Regional Profiles, Arctic Region. (Ed.). Lidia Selkregg, Joint Federal-State Land Use Planning Commission for Alaska.

ANCSA (Alaska Native Claims Settlement Act, 43 USC Chapter 33.1601 et sec).

AOGA (Alaska Oil and Gas Association).
2011 Economic Impact Report: Executive Summary. Prepared by the McDowell Group. http://www.aoga.org/facts-and-figures/economic-impact-reports-2/2011-executive-summary/
2010 Pad Size and Corresponding Subsurface Drillable Acres. Technical Information. http://aoga.org/wp-content/uploads/2010/05/tech2.jpg

AOGCC (Alaska Oil and Gas Commission).
2012 Alaska Oil and Gas Conservation Commission, Mission. http://doa.alaska.gov/ogc/; and Welcome to AOGCC, Who We Are. http://doa.alaska.gov/ogc/WhoWeAre/welcome.html

API (American Petroleum Institute).
2012 New Technology Minimizes Impact of Arctic Operations. http://*new*.api.org/aboutoilgas/sectors/explore/newtechnology.cfm

APSC (Alyeska Pipeline Service Company).
2013 Fact Declining Throughput. http://www.alyeska-pipe.com/assets/uploads/pagestructure/NewsCenter_MediaResources_FactSheets_Entries/634957398640875372_LowFlow_final.pdf
2012 Pipeline Facts. http://www.alyeska-pipe.com/TAPS/PipelineFacts
2011 Low Flow Impact Study: Final Report, June 15, 2011. http://www.alyeska-pipe.com/assets/uploads/pagestructure/TAPS_Operations_LowFlow/editor_uploads/LoFIS_Summary_Report_P6%2027_FullReport.pdf

ARCUS (Arctic Research Consortium of the United States).
2012 North Slope Regions and Climate Scenarios. http://www.arcus.org/alaskafws/downloads/pdf/2-7_WildREACH_briefing_book.pdf. Accessed October, 2012.

ASRC (Arctic Slope Regional Corporation).
2013 Oil. http://www.asrc.com/lands/pages/oil.aspx

Amstrup, S.C.
1995 Movements, Distribution, and Population Dynamics of Polar Bears in the Beaufort Sea. Steven C. Amstrup, Ph.D. Dissertation, University of Alaska Fairbanks, May.
1993 Human Disturbances of Denning Polar Bears in Alaska. *In* Arctic 46(3):246-250.

Amstrup, S.C., and DeMaster, D.P.
1988 Polar Bear, *Ursus Maritimus*. In Selected Marine Mammals of Alaska: Species Accounts with Research Recommendations, Jack W. Lentfer, (Ed.), Marine Mammal Commission, Washington D.C.

Amstrup, S.C., Durner, G.M., McDonald, T.L., and Johnson, W.R.
2006 Estimating Potential Effects of Hypothetical Oil Spills on Polar Bears. U.S. Geological Survey final report to the U.S. Minerals Management Service. U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska, March.

Amstrup, S.C. and Garner, C.
1994 Polar Bear Maternity Denning in the Beaufort Sea. Steven C. Amstrup and Craig Gardner, Alaska Fish and Wildlife Research Center, USFWS, *In* Journal of Wildlife Management, Vol. 58(1), p. 1-10.

Amstrup, S.C., Garner, G.W., and Durner, G.M.
1995 Polar Bears in Alaska. Pages 351-353 *in* E. T. LaRoe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, (Ed.). Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U. S. Plants, Animals, and Ecosystems. U. S. National Biological Service, Washington, D. C. 530 p.

Arctic Council.
2009 Arctic Offshore Oil and Gas Guidelines. Protection of the Arctic Marine Environment Working Group, April 29. http://arcticgovernance.custompublish.com/oil-and-gas-guidelines-2009.4632216-137743.html

Arctic Power
2013 Alaskans Strongly Support ANWR Development, citing to Dittman Research Corporation poll, 2009. http://www.anwr.org/People/Alaskans-Strongly-Support-ANWR-Development.php

Attanasi, E.D.
2005a. Economics of 1998 U.S. Geological Survey's 1002 Area Regional Assessment: An Economic Update. U.S. Geological Survey Open File Report 2005-1359. http://pubs.usgs.gov/of/2005/1359/
2005b. Undiscovered Oil Resources in the Federal Portion of the 1002 Area of the Arctic National Wildlife Refuge: An Economic Update. U.S. Geological Survey Open File Report 2005-1217. http://pubs.usgs.gov/of/2005/1217/

Attanasi, E.D. and Freeman, P.A.
2009 Economics of Undiscovered Oil and Gas in the North Slope of Alaska: Economic Update and Synthesis, Open File Report 2009-1112. http://pubs.usgs.gov/of/2009/1112/

BLM (Bureau of Land Management, U.S. Department of the Interior)
2012a. National Petroleum Reserve-Alaska Final Integrated Activity Plan/Environmental Impact Statement, December 28. Prepared in cooperation with the North Slope Borough, the U.S. Bureau of Ocean Energy Management, and the U.S. Fish and Wildlife Service.
2012b. Oil and Gas Leasing in the National Petroleum Reserve-Alaska (NPR-A). http://www.blm.gov/ak/st/en/prog/energy/oil_gas/npra/npra_leasing/auth_to_lease.html
2008 Northeast National Petroleum Reserve - Alaska Final Supplemental Integrated Activity Plan/ Environmental Impact Statement, Vol. I: Abstract, Executive Summary, Chapters 1-3. May 2008. http://www.blm.gov/pgdata/etc/medialib/blm/ak/aktest/energy/npra_planning.Par.1035.File.dat/NE_May_2008_supp_npra_final_vol_1.pdf

2006a. National Petroleum Reserve-Alaska (NPR-A) 5-Year Winter Exploration Drilling Program, 2006-2011: ConocoPhillips Alaska, Inc. Prepared by USDOI BLM, Alaska Arctic Field Office, Fairbanks District Office, Anchorage Field Office, Alaska. http://www.blm.gov/pgdata/etc/medialib/blm/ak/aktest/energy/egy_maps.Par.25037.File.dat/cpai_ea_final.pdf

2006b. National Petroleum Reserve-Alaska (NPR-A) Northwest Planning Area Winter Exploration Drilling Program: FEX, L.P. Prepared by USDOI BLM, Alaska Arctic Field Office, Fairbanks District Office, Anchorage Field Office, Alaska. http://www.blm.gov/pgdata/etc/medialib/blm/ak/aktest/energy/egy_maps.Par.94059.File.dat/fex_npra_ea_final.pdf

2005 Northeast National Petroleum Reserve – Alaska: Final Amended Integrated Activity Plan/Environmental Impact Statement, Vol. 1, January.

BLM and MMS (Bureau of Land Management, U.S. Department of the Interior, and Minerals Management Service).

1998 Northeast National Petroleum Reserve – Alaska: Integrated Activity Plan/Environmental Impact Statement.

BP (British Petroleum).

2012 Oil and Gas Exploration. http://www.bp.com/sectiongenericarticle.do?categoryId=9021489&contentId=7039991

Bachrach, R.

1999 High Resolution Shallow Seismic Subsurface Characterization: Dissertation PhD, Geophysics, Stanford University Department of Geophysics. http://srb.stanford.edu/docs/theses/SRB_71_SEP98_Bachrach.pdf

Bader, H.R, and Guimond, J.

2006 Tundra Travel Modeling Project. Alaska Department of Natural Resources, Division of Mining, Land, and Water. http://dnr.alaska.gov/mlw/tundra/TundraModelReport.pdf

Baker, B.

1987 Memorandum from Acting Director, Habitat Division, ADF&G, to Jim Eason, Director, DO&G, regarding Oil and Gas Lease Sale 54, February 24.

Beak Consultants, Ltd.

1976 A Study of the Influence of Seismic Exploration on Muskoxen and Caribou on Banks Island, N.W.T., Canada. Prepared for Panarctic Oils Ltd.

Bergman, R. D., et al.

1977 Waterbirds and Their Wetland Resources in Relation to Oil Development at Storkersen Point, Alaska. USFWS Resource Publication 129.

Bird, K.J. and ANWR Assessment Team.

1999 The Oil and Gas Resource Potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska, U.S. Geological Survey Open File Report 98-34: Assessment Overview.

Bittner, J. E.

1996 Cultural Resources and the Exxon Valdez Oil Spill: An Overview. *In* American Fisheries Society Symposium 18:814-818.

1993 Cultural Resources and the Exxon Valdez Oil Spill. *In* Exxon Valdez, Oil Spill Symposium Abstract Book, Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska, February.

Braund, S.R.

2007 Subsistence and Traditional Knowledge Studies: Subsistence Use Area and Traditional Knowledge Study for Tyonek and Beluga, Alaska. PACRIM Coal, Chuitna Coal Project, West Cook Inlet, Alaska. Prepared for DRven Corporation, Anchorage, Alaska, February 28.

Braund, S.R., and Kruse, J. (Ed.).

2009 Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska, Minerals Management Service Study 2009-06.

Bright, L.K.
1992 Letter from Larry K. Bright, Acting Field Supervisor, USFWS, Northern Alaska Ecological Services, to James Hansen, DO&G, regarding additions to the Five-Year Schedule, August 21.

Brower, H. K., Jr., Olemaun, T.P., and Hepa, R.T.
2000 North Slope Borough Subsistence Harvest Documentation Project: Data Kaktovik, Alaska for the Period July 1, 1994 to June 30, 1995. Technical Report.

Brown, J. S., Sauer, J.T.C, Wade, M.J., and Neff, J.M.
1992 Chemical and Toxicological Characterization of Produced Water Freon Extracts. *In* Produced Water, International Produced Water Symposium, San Diego, CA, p. 113-131.

Bruns, T.R., et al.
1987 Regional Structure of Rocks Beneath the Coastal Plain. *In* Bird, K.J. and Magoon, L.B. (Ed.), Petroleum Geology of the Northern Part of the Arctic National Wildlife Refuge, Northeastern Alaska. *Prepared by* T. R. Bruns, M.A. Fisher, W.J. Leinbach, and J.J. Miller. U.S. Geological Survey Bulletin 1778: p. 249-254.

Bryner, W.M.
1995 Toward a Group Rights Theory for Remedying Harm to the Subsistence Culture of Alaskan Natives. Alaska Law Review, Vol. 12:2, p. 293-334.

Burgess, R.M.
2000 Arctic Fox. Pages 159-178 *In* Joe C. Truett and Stephen R. Johnson, (Ed.). The Natural History of an Arctic Oil Field: Development and the Biota. San Diego, CA: Academic Press.

Burgess, R.M., and Ritchie, R.J.
1988 Snow Goose Monitoring Program, 1987 Endicott Development Project. Draft Report by Envirosphere Company, for U.S. Army Corps of Engineers, Anchorage.

CBO (Congressional Budget Office).
2012 Potential Budgetary Effects of Immediately Opening Most Federal Lands to Oil and Gas Leasing, August 9, 2012. http://www.cbo.gov/sites/default/files/cbofiles/attachments/08-09-12_Oil-and-Gas_Leasing.pdf

CEQ (Council on Environmental Quality)
2013 NEPA's Forty Most Asked Questions: Range of Alternatives; and Alternatives Outside the Capacity of Applicant or Jurisdiction of Agency. http://ceq.hss.doe.gov/nepa/regs/40/40p3.htm

Caikoski, J.
2011 Pre-publication, Unpublished, Porcupine Caribou. By ADF&G.

Calef, G.W., DeBock, E.A., and Lortie, G.M.
1976 The Reaction of Barren-ground Caribou to Aircraft. *In* Arctic 29: p. 201-212.

Callahan, J.E., Brougham, G.W., and Bascle, R.J.
1987 Economically recoverable oil resources, Chapter 23, *in* Bird, K.J., and Magoon, L.B., eds., Petroleum geology of the northern part of the Arctic National Wildlife Refuge, northeastern Alaska: U.S. Geological Survey Bulletin 1778, p. 299-307.

Carpenter, T.
1997 Personal communication from Terri Carpenter, U.S. Army Corps of Engineers, to Brian Havelock, DO&G, May 16.

Chevron (Chevron U.S.A. Inc.)
1991 Plan of Operations Kustatan Number 1 Prospect, ADL 369156 LOCI 91-041. Alaska Department of Natural Resources, Division of Oil and Gas, Anchorage.

Clough, N.K., Patton, P.C., and Christiansen, A.C., (Ed.), USDOI.
1987 Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment, and Final

Legislative Environmental Impact Statement (LEIS), Washington, D.C.: U.S. Fish and Wildlife Service, U.S. Geological Survey, and Bureau of Land Management, Vol.1 (Report). http://library.fws.gov/Pubs7/ANWR_coastal_LEISa.pdf

ConocoPhillips (ConocoPhillips Alaska, Incorporated).
2010 Environmental Assessment National Petroleum Reserve - 3D Seismic Program DOI-BLM-LLAK010-2010-0002-EA. Arctic Field Office, Alaska, January 22, 2010. http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/arctic_fo_planning.Par.65721.File.dat/Final%20%20CPAI%202010%20Seismic%20EA%20and%20FONSI.pdf

Cowardin, L.M., Carter, V., Golet, F.C., and LaRoe, E.T.
1979 Classification of Wetlands and Deepwater Habitats of the United States. USDOI, USFWS, FWS/OBS-79/31.

Davis, W. P., Hoss, D.E., Scott, G.I., and Sheridan, P.F.
1984 Fisheries Resource Impacts from Spills of Oil or Hazardous Substances. Pages 157-172 *In* J. Cairns, Jr. and A. L. Buikema, Jr., (Ed.). Restoration of Habitats Impacted by Oil Spills. Boston, MA: Butterworth Publishers.

Dawe, R.A.
2001 Modern Petroleum Technology: Vol. 1, Upstream, (Ed.), John Wiley & Sons, Ltd. New York: New York, p. 117-121.

Dekin, A.A., et al.
1993 Exxon Valdez Oil Spill Archaeological Damage Assessment: Final Report, Contract 53-0109-00325. By A.A. Dekin, M. S. Cassell, J. I. Ebert, E. Camilli, J. M. Kerley, M. R. Yarborough, P. A. Stahl and B. L. Turcy, of the Research Foundation of the State University of New York, Binghamton. *For* the USDA Forest Service, Juneau, Alaska.

Durner G.M., S.C. Amstrup and K.J. Ambrosius.
2001 Remote Identification of Polar Bear Maternal Den Habitat in Northern Alaska, George M. Durner, Steven C. Amstrup, and Ken J. Ambrosius in Arctic Vol. 54, No. 2 (June 2001), p. 115-121.

Dyer, S.J.
1999 Movement and Distribution of Woodland Caribou (*Rangifer tarandus caribou*) in Response to Industrial Development in Northeastern Alberta, Thesis. Master of Science in Environmental Biology and Ecology, University of Alberta, Edmonton, Canada.

EDAW/AECOM (formerly Eckbo, Dean and Williams/Architecture, Engineering, Consulting, Operations, and Maintenance).
2007 Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting Activities in the Beaufort Sea. OCS Study MMS 2007-062, U.S. Dept. of the Interior, Minerals Management Service, Alaska Outer Continental Shelf Region/Environmental Studies. http://www.mms.gov/alaska/reports/2007rpts/2007_062/2007_062.pdf

EIA (Energy Information Administration).
2012a. Annual Energy Outlook 2012 with Projections to 2035. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf
2012b. U.S. Energy Information Administration. http://www.eia.gov/
2008 Analysis of Crude Oil Production in the Arctic National Wildlife Refuge, May. http://www.eia.gov/oiaf/servicerpt/anwr/pdf/sroiaf(2008)03.pdf

E&P/UNEP (Exploration and Production Forum, United Nations Environment Programme).
1997 Environmental Management in Oil and Gas Exploration and Production: An Overview of Issues and Management Approaches. London, UK: UNEP, Old Burlington Street, p. 25-28. http://www.eandpforum.co.uk

Eberhardt, W.L.
1977 The Biology of Arctic and Red Foxes on the North Slope, Master's Thesis. Master of Science, University of Alaska, Fairbanks, Alaska.

Ehrlich, P., Dobkin, D., and Wheye, D.
1988 The Birder's Handbook: A Field Guide to the Natural History of North American Birds. Simon and Schuster Inc., New York.

Fall, J.A.
1999 Subsistence, Restoration Notebook. Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska. http://www.evostc.state.ak.us/Universal/Documents/Publications/RestorationNotebook/RN_subsist.pdf

Fechhelm, R.G., and Griffiths, W.B.
1990 The Effect of Wind on the Recruitment of Canadian Arctic Cisco into the Central Alaskan Beaufort Seas. Canadian Journal of Fisheries and Aquatic Sciences, 47(11): 2164-2171.

GPPO (Gas Pipeline Project Office).
2012 Alaska Gas Pipeline Office. http://gasline.alaska.gov/

Galginaitis, M. S. and W. R. Koski.
2002 Kaktovikmiut Whaling: Historical Harvest and Local Knowledge of Whale Feeding Behavior. Pages 2:1 - 2:30 *in* W.J. Richardson and D.H. Thomson, (Ed.). Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea. Update of Scientific and Traditional Information, Volume 1. Minerals Management Service, Alaska Outer Continental Shelf, OCS Study MMS 2002-012. http://www.mms.gov/alaska/reports/2002rpts/2002_012.pdf

Gallant, A.L., Binnian, E.F., Omerinik, J.M., and Shasby, M.B.
1995 Ecoregions of Alaska. U.S. Geological Survey Professional Paper 1567:1-15.

Gelb, B.A., Corn, M.L., Twyman, T.R.
2006 Arctic Petroleum Technology Developments. January 23. Congressional Research Service Report, US Library of Congress, Order Code RL31022. Prepared by Bernard A. Gelb, M.Lynne Corn, and Terry R. Twyman.
2006 ANWR Development. Economic Impacts. Congressional Research Service, US Library of Congress, January 24.

Gertler, P.E.
1988 Letter from the Field Supervisor, USFWS, to Pam Rogers, DO&G, regarding proposed Oil and Gas Lease Sale 65, June.

Gibbs, W.W.
2001 The Arctic Oil and Wildlife Refuge. By W. Wayt Gibbs. *In* Scientific American 284(5). p. 62-69, May.

Grepinet, M., and Flak, L.
2012 Part 7 – Shallow Gas Blowouts. John Wright Co. Technical Literature. http://www.jwco.com/technical-litterature/p07.htm

Guyer, S. and Keating, B.
2005 The Impact of Ice Roads and Ice Pads on Tundra Ecosystems, National Petroleum Reserve-Alaska, U.S. Department of the Interior, Bureau of Land Management, BLM-Alaska Open File Report 98. http://www.blm.gov/pgdata/etc/medialib/blm/ak/aktest/ofr.Par.59140.File.dat/OFR%2098.pdf

Hanley, P.T., et al.
1983 A Handbook for Management of Oil and Gas Activities on Lands in Alaska. Petroleum Industry Practices Environmental Impacts and Stipulations. U.S. Fish and Wildlife Service, Office of Biological Services, U.S. Department of the Interior. By P.T. Hanley, J. E. Hemming, J. W. Morsell, T. A. Morehouse, L. E. Leask and G. Harrison.
1981 Natural Resource Protection and Petroleum Development in Alaska. U.S. Fish and Wildlife Service Office of Biological Services, Department of the Interior. By P.T. Hanley, J. E. Hemming, J. W. Morsell, T. A. Morehouse, L. E. Leask and G. Harrison.

Hinzman, L.D., et al.
1997 Numeric Simulation of Thermokarst Formation During Disturbance. Pages 191-211. By L.D. Hinzman, D. J. Goering, T. C. Kinney, and S. Li. *In* R.M.M. Crawford, (Ed.). Disturbance and Recovery in Arctic Lands. Dordrecht, The Netherlands. Kluwer Academic Publishers.

IAOGP (International Association of Oil & Gas Producers).
2010 Oil and Gas Producers Risk Assessment Data Directory, Report No. 434-2, March.

IUCN (International Union for Conservation of Nature and Natural Resources).
2006 Bears. Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20–24 June 2005, Seattle, Washington, USA. J. Aars, N.J. Lunn, and A.E. Derocher, (Ed.). IUCN, Gland, Switzerland and Cambridge, UK.
1993 Oil and Gas Exploration and Production in Arctic and Subarctic Onshore Regions. IUCN Gland, Switzerland and Cambridge UK, with E&P Forum, London, UK.

Institute of the North.
2004 ANILCA. A Training Curriculum. Anchorage, Alaska. www.institutenorth.org

Jacobson, M.J. and Wentworth, C.
1982 Kaktovik Subsistence. Land Use Values Through Time in the Arctic National Wildlife Refuge Area. U. S. Fish and Wildlife Service, Northern Alaska Ecological Services, Fairbanks, Alaska.

Johnson, J. and Klein, K.
2009 Anadromous Waters Catalog 2009. Alaska Department of Fish and Game. http://gis.sf.adfg.state.ak.us/FlexMaps/fishresourcemonitor.html?mode=awc

Johnson, S.R. and Herter, D.R.
1989 The Birds of the Beaufort Sea. BP Exploration, Bridgetown Printing, Publishers, June.

Joly, K., Nellemann, C., and Vistnes, I.
2006 A Reevaluation of Caribou Distribution Near an Oilfield Road on Alaska's North Slope. *In* Wildlife Society Bulletin Volume 34(3): p. 866-869. http://www.jstor.org/pss/3784720

Jorgenson, J.C., and Martin, P.
1997 Effects of Winter Seismic Exploration on Tundra Vegetation and Soils. Janet C. Jorgenson and Philip Martin, USF&WS, *In* NPR-A Symposium Proceedings: Science, Traditional knowledge, and the Resources of the Northeast Planning Area of the National Petroleum Reserve-Alaska, sponsored by the Bureau of Land Management and Minerals Management Service, OCS Study MMS 97-0013, April 16-18.

Jorgenson, M.T., and Cater, T.C.
1996 Minimizing Ecological Damage During Cleanup of Terrestrial and Wetland Oil Spills. *In* Storage Tanks: Advances in Environmental Control Technology Series. P.N. Cheremisinoff, (Ed.). Gulf Publishing Co.; Houston, TX; p. 257-293.

Jorgenson, M. T., Roth, J.E, Emers, M., Cater, T.C., Schlentner, S.F., and Mitchell, J.S.
2002 Assessment of Impacts Associated with a Rolligon Trail in Northeastern National Petroleum Reserve-Alaska, 2002. ABR, Inc., Fairbanks, Alaska.

Jorgenson, J.C., Ver Hoef, J.M, and Jorgenson, M.T.
2010 Long-term Recovery Patterns of Arctic Tundra After Winter Seismic Exploration: ANWR. *In* Ecological Applications 20(1): p. 205-221.

Kruse, J.A.
1991 Alaska Iñupiat Subsistence and Wage Employment Patterns: Understanding Individual Choice. *In* Human Organization 50(4): p. 317-326.

Kruse, J.A., et al.
1983 A Description of the Socioeconomics of the North Slope Borough, Minerals Management Service, Alaska OCS Socioeconomic Studies Program, Technical Report 85.

Lapham, W.W., Wilde, F.D., Koterba, M.T., and U.S. Geological Survey.
1997 Guidelines and Standard Procedures for Studies of Ground-water Quality: Selection and Installation of Wells and Supporting Documentation. USGS, Water Resources Investigations Report 96-4233.

Larned, W., Stehn, R., and Platte, R.
2003 Eider Breeding Population Survey Arctic Coastal Plain, Alaska 2002. U.S. Department of Interior, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Lazzari, S.
2008 Possible Federal Revenue for Oil Development of ANWR and Nearby Areas, Congressional Research Service. Prepared by Salvatore Lazzari, Specialist in Energy and Environmental Economics Resources, Science, and Industry. Prepared for Members and Committees of Congress, June 23, 2008.

Lenart, E.A.
2011a. Pre-publication, Unpublished. Caribou, by ADF&G.
2011b. Pre-publication, Unpublished. Muskoxen, by ADF&G.
2007 Units 26B and 26C Muskox. Pages 49-69 *in* P. Harper, (Ed.). Muskox Management Report of Survey and Inventory Activities, 1 July 2004-30 June 2006. Alaska Department of Fish and Game, Division of Wildlife Conservation. Project 16.0. Juneau, Alaska.
2004 Unit 26BC Moose Management Report. Pages 613-628 *in* C. Brown, (Ed.). Moose Management Report of Survey and Inventory Activities, 1 July 2001-30 June 2003. Project 1.0. Alaska Department of Fish and Game, Division of Wildlife Conservation. Juneau, Alaska.

LeResche, R.E., Bishop, R.H., and Coady, J.W.
1974 Distribution and Habitats of Moose in Alaska. Le Naturaliste Canadien, 101: 143-178.

Lilly, M.R., Paetzold, R.F, and Kane, D.L.
2008 Tundra Soil-water Content and Temperature Data in Support of Winter Tundra Travel. *In* Kane, D.L., and Hinkel, K.M. (Ed.), Ninth International Conference on Permafrost Proceedings (ICOP).

Linkins, A.E., et al.
1984 Oil Spills: Damage and Recovery in Tundra and Taiga. Arthur E. Linkins, Department of Biology, Virginia Polytechnic Institute and State University; L.A. Johnson, U.S. Army Cold Regions Research Engineering Laboratory; K.R. Everett, Institute of Polar Studies and Department of Agronomy, Ohio State University; and R.M. Atlas, Biology Department, University of Louisville. *In* Restoration of Habitats Impacted by Oil Spills, John Cairns, Jr. & Arthur L. Buikema, Jr., (Ed.). Boston, MA: Butterworth Publishers.

Lofgren, J.
2012 Personal Communication from Joyce Lofgren (ADOR) to Greg Bidwell (ADNR DO&G) regarding TAPS Tariffs, State of Alaska.

Lyons, S.M., and Trawicki, J.M.
1994 Water Resource Inventory and Assessment, Coastal Plain, Arctic National Wildlife Refuge 1987-1992 Final Report. Anchorage, Alaska: USDOI, U.S. Fish and Wildlife Service, Water Resource Branch.

MIT (Massachusetts Institute of Technology).
2007 Mission Environment 2007. http://web.mit.edu/12.000/www/m2007/teams/finalwebsite/environment/phyenv_hydrology.html

MMS (Minerals Management Service, U.S. Department of the Interior).
2008a. Alaska OCS Region: Final Bid Recap, Oil and Gas Lease Sale 193, 2008.
2008b. Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas Lease Sales 209, 212, 217, and 221 Draft Environmental Impact Statement. Alaska Outer Continental Shelf Region.
2007 Environmental Assessment: Shell Offshore Inc. Beaufort Sea Exploration plan. OCS EIS/EA MMS 2007-009, Alaska OCS Region.
1996 Beaufort Sea Planning Area, Oil and Gas Lease Sale 144, Final Environmental Impact Statement, OCS EIS/EA, MMS 96-0012, May.
1990 Subsistence Resource Harvest Patterns: Kaktovik, Final Special Report No. 9. Prepared by Impact Assessment Inc., for Minerals Management Service, OCS Region, July 24.

Mallek, E.J., **Platte, R., and Stehn, R.**
2003 Aerial Breeding Pair Surveys of the Arctic Coastal Plain of Alaska - 2002. Unpublished Report by U.S. Department of Interior, U.S. Fish and Wildlife Service, Waterfowl Management, Fairbanks, Alaska.

Mast, R.F., McMullin, R.H., Bird, K.J., and Brosg, W.P.
1980 Resource Appraisal of Undiscovered Oil and Gas Resources in the William O. Douglas Arctic Wildlife Range: U.S. Geological Survey Open File Report 80-916.

McDowell Group.
2011 The Role of the Oil and Gas Industry in Alaska's Economy. Prepared for Alaska Oil and Gas Association, October 2011.

McKendrick, J.D.
2000 Vegetative Responses to Disturbance. Pages 35-56 *In* Joe C. Truett and Stephen R. Johnson, (Ed.). The Natural History of an Arctic Oil Field: Development and the Biota. San Diego, CA: Academic Press.

McLellan, B. N. and Shackleton, D.M.
1988 Grizzly Bears and Resource-extraction Industries: Effects of Roads on Behaviour, Habitat Use and Demography. *In* Journal of Applied Ecology 25: p. 451-460.

McNay, M. E.
2002 A Case History of Wolf-human Encounters in Alaska and Canada. Alaska Department of Fish and Game. http://www.wildlife.alaska.gov/pubs/techpubs/research_pdfs/techb13_full.pdf

Meehan, R. and Jennings, T.W.
1988 Characterization and Value Ranking of Waterbird Habitat on the Colville River Delta, Alaska. Rosa Meehan and Thomas W. Jennings, U.S. Fish and Wildlife Service, Alaska Investigations. Prepared for U.S. EPA under Interagency Agreement #DW1493233-01-0, June.

Morris, W.A., et al.
2006 Seasonal Movements and Habitat Use of Broad Whitefish (Coregonus nasus) in the Teshekpuk Lake Region of the National Petroleum Reserve-Alaska, 2003-2005. ADNR Office of Habitat Management and Permitting, Technical Report # 06-04, pp. 18-19, 77, and 86.

Morris, W. and Winters, J.
2005 Fish Behavioral and Physical Responses to Vibroseis Noise Prudhoe Bay, Alaska 2003. Technical Report 05-02, Alaska Department of Natural Resources, Office of Habitat Management and Permitting. http://www.habitat.adfg.alaska.gov/tech_reports/05_02.pdf

NEPA (National Environmental Policy Act of 1970, as amended, 42 USC 4321-4347; & 42 USC 4371 et seq).
1986 40 CFR Part 1502.22, 51 FR 15625, Apr. 25, 1986, Regulations, Environmental Impact Statement: Incomplete or unavailable information. http://ceq.hss.doe.gov/NEPA/regs/ceq/1502.htm#1502.22
1978 40 CFR Part 1502.14, 43 FR 55994, Nov. 29, 1978, Regulations, Alternatives including proposed action. http://ceq.hss.doe.gov/NEPA/regs/ceq/1502.htm#1502.14

1978 40 CFR Part 1508.14, 43 FR 56003, Nov. 29, 1978, Regulations, Terminology and Index: Human environment. http://ceq.hss.doe.gov/nepa/regs/ceq/1508.htm#1508.14

NPC (National Petroleum Council).
2011 Sustainable Drilling of Onshore Oil and Gas Wells. Prepared by the Technology Subgroup of the Operations & Environmental Task Group, http://www.npc.org/Prudent_Development-Topic_Papers/2-23_Sustainable_Drilling_of_Onshore_Oil_and_Gas_Wells_Paper.pdf

NRC (National Research Council).
2003 Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. National Research Council. Washington, D.C.: National Academy Press.
1983 Drilling Discharges in the Marine Environment, National Academy Press.

NSB (North Slope Borough).
1979 Nuiqsut Heritage: A Cultural Plan. Prepared for the Village of Nuiqsut and the North Slope Borough Planning Commission and Commission on History and Culture, February.

NSBCMP (North Slope Borough Coastal Management Program).
1988 North Slope Borough Coastal Management Program. Maynard & Partch, Woodward-Clyde Consultants, April.
1984 North Slope Borough Coastal Management Program Background Report. Maynard & Partch, Woodward-Clyde Consultants.

National Driller.
2010 Drilling Fluids Overview: Excerpt from USGS Report 96-4233. National Driller. http://www.nationaldriller.com/Articles/Feature_Article/506bb4a729798010VgnVCM100000f932a8c0____

Noland, L.J. and Gallagher, T.
1989 Cross-Cultural Communication for Land Managers and Planners in Alaska. *In* Agroborealis, Vol. 21, No. 1.

Oilandgasiq.
2012 Seismic Surveys, http://www.oilandgasiq.com/glossary/seismic-surveys/

Olsgard, F. and Gray, J.S.
1995 A Comprehensive Analysis of the Effects of Offshore Oil and Gas Exploration and Production on the Benthic Communities of the Norwegian Continental Shelf. Marine Ecology Progress Series 122: p. 277-306.

Ott, Alvin G.
1997 Memorandum from Regional Supervisor, Habitat and Restoration Division, Alaska Department of Fish & Game, to James Hansen, Division of Oil & Gas, regarding Proposed Oil & Gas Lease Sale 87, North Slope Areawide, March 5, 1997.
1995 Memorandum from Regional Supervisor, Habitat and Restoration Division, Alaska Department of Fish & Game, to James Hansen, Division of Oil & Gas, regarding Proposed Oil & Gas Lease Sale 87, June 30, 1995.
1992 Memorandum from Regional Supervisor, Department of Fish and Game, to James Hansen, Division of Oil and Gas, regarding Sale 80, Shaviovik, April 27.
1991 Memorandum from Regional Supervisor, Department of Fish and Game, to James Hansen, Division of Oil and Gas, regarding Sale 64, Kavik, January 3.

PCMB (Porcupine Caribou Management Board).
2006 Updates, Population of the Porcupine Caribou Herd, February.

Pedersen, S., Coffing, M.W., and Thompson, J.
1985 Subsistence Land Use Baseline for Kaktovik, Alaska. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper No. 109.

Pedersen, S., Kruse, J., and Braund, S.R.
2009 Subsistence Harvest Patterns and Oil Development on Alaska's North Slope, Chapter 7. *In* Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Alaska, S.R. Braund and Dr. J.A. Kruse (Ed.). Minerals Management Service Study 2009-06.

Popper, A.N. and Hastings, M.C.
2009 The Effects of Anthropogenic Sources of Sound on Fishes. *In* Journal of Fish Biology 75: p. 455-489. www.interscience.wiley.com

Popper, A.N., Smith, M.E., Cott, P.A., Hanna, B.W., MacGillivray, A.O., Austin, M.E., and Mann, D.A.
2005 Effects of Exposure to Seismic Airgun Use on Hearing of Three Fish Species. *In* Journal of the Acoustical Society of America 117(6): p. 3958-3971.

RDC (Resources Development Council for Alaska, Inc.)
2009 Co-existing With Oil Development, Central Arctic Caribou Herd Thrives, Population at Record High. Alaska Resources Development for Alaska, Inc., Resources Review. http://www.anwr.org/images/pdf/Cariboufinal_6-09.pdf

Regehr, E.V., Armstrup, S.C., and Stirling, I.
2006 Polar Bear Population Status in the Southern Beaufort Sea. U.S. Department of the Interior, U.S. Geological Survey. Open File Report 2006-1337.

Reynolds, J.B.
1997 Ecology of Overwintering Fishes in Alaskan Freshwaters. Pages 281-302 *In* Alexaner M. Milner and Wark W. Oswood (Ed.). Freshwaters of Alaska: Ecological Syntheses. New York, New York: Springer-Verlag, Inc.

Reynolds, P.E., Wilson, K.J., and Klein, D.R.
2002 Terrestrial Section 7: Muskoxen - Part 1. *In* Wildlife Research Summaries, D.C. Douglas, P.E. Reynolds, and E.B. Rhode (Ed.). http://alaska.usgs.gov/BSR-2002/section7part1.html

Reynolds, P.E., Reynolds, H.V., and Follman, E.H.
1986 Responses of Grizzly Bears to Seismic Surveys in Northern Alaska. *In* International Conference on Bear Research and Management (6).

Roguski, E.A., Komarek, Jr., Edwin, and Kogl, Dennis R.
1971 Annual Progress Report for Monitoring and Evaluating of Arctic Waters with Emphasis on the North Slope Drainages. Alaska Department of Fish and Game, Division of Sport Fish.

Russell, J.
1977 Some Overt Responses of Muskox and Caribou to Seismic Activities, Northeastern Banks Island. Fish and Wildlife Service, Yellowknife, Northwest Territories, Canada.

SB 21 (Alaska Senate Bill 21, State of Alaska 28th Legislature)
2013 Alaska Senate Bill 21: 2013-2014, Oil and gas production tax bill, retroactive to January, 2013. Download. Alaska-2013-SB21-Enrolled.pdf; http://legiscan.com/AK/bill/SB21

Saad, L.
2011 U.S. Oil Drilling Gains Favor with Americans: Support for Offshore Drilling and Oil Exploration in Alaska Reach New Highs. *In* Gallup Politics. http://www.gallup.com/poll/146615/Oil-Drilling-Gains-Favor-Americans.aspx

Scanlon, B.
2008 Fishery Management Report for Sport Fisheries in the Northwest/North Slope Management Area, 2006. Alaska Department of Fish and Game, Fishery Management Report No. 08-35, Anchorage, Alaska. http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr08-35.pdf

Schmidt, D.R., Griffiths, W.B., and Martin, L.R.
1989 Overwintering Biology of Anadromous Fish in the Sagavanirktok River Delta, Alaska. Biological Papers of the University of Alaska.

Schmidt, J. A., Tammi. C.E., and Cameron, D.J.
1999 Evaluating the Effects of Muds on Wetlands from Horizontal Directional Drilling. ENSR, GRI; Permit Condition and Mitigation Measures Review and Alternatives Evaluation Topical Report GRI-99/0132, Acton, MA.

Schuenemeyer, J, and ANWR Assessment Team.
1999 The Oil and Gas Resource Potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska, U.S. Geological Survey Open File Report 98-34: Assessment Results. http://pubs.usgs.gov/of/1998/ofr-98-0034/

Shideler, R.T.
1986 Impacts of Human Developments and Land Use on Caribou: A Literature Review, Vol. II. Impacts of Oil and Gas Development on the Central Arctic Herd. Technical Report No. 86-3, Alaska Department of Fish and Game, Division of Habitat.

Smith, D., and Walker, T.
1995 Alaska's Mammals: a Guide to Selected Species. Alaska Northwest Books, Anchorage.

Smith, L., Byrne, L.C., Johnson, C.B., and Stickney, A.A.
1994 Wildlife Studies on the Colville River Delta, Alaska, 1993.
1993 Wildlife Studies on the Colville River Delta, Alaska, 1992.

Smith, W.T., and Cameron, R.D.
1991 Caribou Responses to Development Infrastructures and Mitigation Measures Implemented in the Central Arctic Region. *In* T. R. McCabe, D. B. Griffith, N. E. Walsh, and D. D. Young, (Ed.). Terrestrial Research 1002 Area - Arctic National Wildlife Refuge, Interim Report. 1988-90, USFWS, Anchorage, Alaska.
1985 Factors Affecting Pipeline Crossing Success of Caribou. Alaska Department of Fish and Game, Fairbanks, Alaska. Pages 40-46 *in* A.M. Martell and D.E. Russell. (Ed.) Caribou and Human Activity: Proceedings of the First North American Caribou Workshop. 28-29 September 1983. Whitehorse, Yukon, Canadian Wildlife Service Special Publication, Ottawa.

Sousa, P.
1995 USFWS letter to James Hansen, Division of Oil and Gas, regarding the Preliminary Finding for Oil and Gas Lease Sale 80, April 14.
1992 USFWS, letter to James Hansen, Division of Oil and Gas, regarding state Oil and Gas Lease Sale 80, April 29.

Spellerberg, I.F. and Morrison, T.
1998 The Ecological Effects of New Roads: A Literature Review. *In* Science for Conservation: Vol. 84, New Zealand Department of Conservation.

Sprague, J.B. and Logan, W.J.
1979 Separate and Joint Toxicity to Rainbow Trout of Substances Used in Drilling Fluids for Oil Exploration. *In* Environmental Pollution 19(4): p. 269-281. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B75CG-48XD90M-93&_user=5781704&_coverDate=08%2F31%2F1979&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1430189542&_rerunOrigin=google&_acct=C000016587&_version=1&_urlVersion=0&_userid=5781704&md5=6ff5c9ccf3b8324d25cf9ddd2f5b1f2e

Stirling, I.
1990 Polar Bears and Oil: Ecological Perspectives. Ian Stirling, Canadian Wildlife Service and Department of Zoology, University of Alberta, *in* Sea Mammals and Oil: Confronting the Risks, Joseph R. Geraci & David J. St. Aubin, (Ed.), Academic Press, 1990.

Trawicki, J.M, Lyons, S.M., and Elliott, G.V.
1991 Distribution and Quantification of Water Within Lakes of the 1002 Area, Arctic National Wildlife Refuge, Alaska. *In* Alaska Fisheries Technical Report No. 10, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Truett, J.C., and Johnson, S.R.
2000 The Natural History of an Arctic Oil Field: Development and the Biota. Pages *in* Joe C. Truett and Stephen R. Johnson, (Ed.). San Diego, CA: Academic Press.

URS Corp.
2005 North Slope Borough Comprehensive Plan: Kaktovik Village Profile. Prepared for the North Slope Borough, October 2005. http://www.north-slope.org/information/comp_plan/KaktovikVillageProfile06.pdf

USACE (U.S. Army Corp of Engineers).
2012 Point Thomson Project EIS: Final Environmental Impact Statement. JBER Anchorage, Alaska: Alaska District, Alaska Regulatory Division CEPOA-RD, P.O. Box 6898, 99506-0898, July, 2012.
2007 U.S. Army Corps of Engineers. 2007. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0), (Ed.). J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-07-24. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
1987 U.S. Corps of Engineers Wetlands Delineation Manual. Department of the Army, Waterways Experiment Station, Environmental Laboratory, Wetlands Research Program, Technical Report Y-87-1, January.
1984 Endicott Development Project, Final Environmental Impact Statement, August.

USDOI (U.S. Department of the Interior).
2012 National Petroleum Reserve-Alaska: Final Integrated Activity Plan/Environmental Impact Statement. Prepared by U.S. Department of the Interior, Bureau of Land Management, Anchorage, Alaska, in cooperation with the North Slope Borough, U.S. Bureau of Ocean Management, and U.S Fish and Wildlife Service, December 28.
1983 Final Environmental Impact Statement and Preliminary Final Regulations, Proposed Oil and Gas Exploration Within the Coastal Plain of the Arctic National Wildlife Refuge, Alaska, 1983. Prepared by U.S. Fish and Wildlife Service, Alaska Region, Anchorage, Alaska, p. I-1.

USFWS (U. S. Fish and Wildlife Service).
2013 Federal Subsistence Management Program. http://alaska.fws.gov/asm/index.cfml
2012 Caribou Maps, Arctic National Wildlife Refuge, Alaska Region. http://arctic.fws.gov/cariboumaps.htm
2010a. Southern Beaufort Sea Stock Assessment Report: Polar Bear (*Ursus maritimus*), Revised 01/01/2010, http://alaska.fws.gov/fisheries/mmm/stock/final_sbs_polar_bear_sar.pdf
2010b. Fishes of the Arctic National Wildlife Refuge: Freshwater and Anadromous Species. http://arctic.fws.gov/fishlist.htm
2008 Time Line: Establishment and Management of the Arctic Refuge. http://arctic.fws.gov/timeline.htm
2006 Conservation Agreement for the Yellow-billed Loon (*Gavia adamsii*), September 30.
2005 Summary of 2005 Survey Activities, Alaska Region. http://arctic.fws.gov/ct05summaries.htm
2004 Effects of Oil Spill on Wildlife and Habitat, Alaska Region. http://alaska.fws.gov/media/unalaska/Oil%20Spill%20Fact%20Sheet.pdf Accessed May 6, 2010.
2001 Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for the Spectacled Eider; Final Rule. http://www.gpo.gov/fdsys/pkg/FR-2001-02-06/html/01-1342.htm
1995 Habitat Conservation Strategy for Polar Bears in Alaska. Prepared by U.S. Fish and Wildlife Service, Alaska Region, August 14.
1988 Arctic National Wildlife Refuge: Comprehensive Conservation Plan, Environmental Impact Statement, Wilderness Review, Wild River Plans, Prepared by USFWS Alaska Region, Anchorage, AK, p. 475: Secretary's Recommendation.
1986 Final Report Baseline Study of the Fish, Wildlife, and their Habitats: Arctic National Wildlife

Refuge Coastal Plain Resource Assessment, Section 1002C, Alaska National Interest Lands Conservation Act, Vol. I and II, Region 7.
1983 Final Environmental Impact Statement and Preliminary Final Regulations: Proposed Oil and Gas Exploration Within the Coastal Plain of the Arctic National Wildlife Refuge, Alaska. Prepared in cooperation with US Geological Survey and Bureau of Land Management, U.S. Department of the Interior.

USGS (U.S. Geological Survey, U.S. Department of the Interior).
2006 Polar Bear Population Status in the Southern Beaufort Sea, Open File Report 2006-1337.
2002 Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries, Section 3: The Porcupine Herd – Part 1. By Griffith, B., Douglas, D.C., Walsh, N.E., Young, D.D., McCabe, T.R., Russell, D.E., White, R.G., Cameron, R.S., and Whitten, K.R. http://alaska.usgs.gov/BSR-2002/section3part1.html
2002 Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries, Section 4: The Central Arctic Caribou Herd – Part 1. By Cameron, R.D., Smith, W.T., White, R.G., and Griffith, B. http://alaska.usgs.gov/BSR-2002/section4part1.html
2002 Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries, Section 7: Muskoxen. By Reynolds, P.E, Wilson, K.W, and Klein, D.R. http://alaska.usgs.gov/BSR-2002/section7part1.html
1998 The Oil and Gas Resource Potential of the Arctic National Wildlife Refuge 1002 Area, Alaska: U.S. Geological Survey Open File Report 98-34.
1995 Alaska Ecoregions: Arctic Coastal Plain and Arctic Foothills. United States Geological Survey, EROS Data Center, Alaska Region, Alaska Land Characteristics Data Set, August 25.

U.S. Advisory Council on Historic Preservation.
2012 A Citizen’s Guide to Section 106 Review. Washington, D.C.: 1100 Pennsylvania Avenue, NW, Suite 803, http://www.achp.gov

Van Dyke, K.
1997 Fundamentals of Petroleum, Fourth Edition. Austin, Texas: University of Texas, Petroleum Extension Service.

Veil, J.A., Burke, C.J., and Moses, D.O.
1996 Synthetic-Based Muds Can Improve Drilling Efficiency Without Polluting. Oil and Gas Journal 94(10) p. 49-54.

Viavant, T.
2009 Aerial Monitoring of Dolly Varden Overwintering Abundance in the Anaktuvuk, Ivishak, Canning, and Hulahula Rivers, 2006-2008. Final Report for Study 06-108, USFWS Office of Subsistence Management, Fisheries Division, and Divisions of Sport Fish and Commercial Fisheries, ADF&G.
2007 Aerial Monitoring of Dolly Varden Overwintering Abundance in the Anaktuvuk, Ivishak, Canning, Hulahula, and Kongakut Rivers, 2007. Annual Report for Study 06-108, Division of Sport Fish ADF&G.

Viereck, L.A., Dyrness, C.T., Batten, A.R., and Wenzlick, K.J.
1992 The Alaskan Vegetation Classification. General Technical Report PNW-GTR-286. U.S. Dept. of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Walker, D.A., and Weber, P.J.
1980 Vegetation. *In* Geobotanical Atlas of the Prudhoe Bay Region, Alaska, D.A. Walker, K.R. Everett, P.J. Weber, and J. Brown, (Ed.), CRREL Report 80-14.

Whitten, K.R.
1995 Results of the 1995 Central Arctic Caribou Herd Photo-census. Memorandum from Kenneth R. Whitten, Acting Research Coordinator, ADF&G to Wayne Regelin, Director, Division of Wildlife Conservation, October 20.

Wojtanowicz, A.K.

2008 Environmental Control of Drilling Fluids and Produced Water. Pages 77-122, Stefan T. Orszulik, (Ed.). *In* Environmental Technology in the Oil Industry, 2nd Edition. Springer, Dordrecht.

Woodward, D.F., Snyder-Conn, E., Riley, R.G., and Garland, T.R.
1988 Drilling Fluids and the Arctic Tundra of Alaska: Assessing Contamination of Wetlands Habitat and the Toxicity to Aquatic Invertebrates and Fish. Archives of Environmental Contamination and Toxicology, 17:683-697.

Appendix B
ANWR: A Timeline of History

1958 The Alaska Statehood Act establishes a new owner state with 103 million acres, with perpetual state ownership of the subsurface energy resources and hard rock minerals. It mandates that 90 percent of revenues earned from resource development on Alaska federal lands be returned to the State. Alaska's statehood was effective on Jan. 3, 1959.

1960 U.S. Secretary of Interior signed a Public Land Order establishing the 8.9 million acre Arctic National Wildlife Range, PLO 2214.

1971 President Richard Nixon signed the Alaska Native Claims Settlement Act (ANCSA). The Act gave the Kaktovik Inupiat Corporation (KIC) surface rights to 92,160 acres of federal lands adjacent to the village, of which 69,120 were to be selected within the Arctic National Wildlife Range.

1980 President Jimmy Carter signed the Alaska National Interest Lands Conservation Act (ANILCA). The Act expanded the Arctic Range to approximately 18 million acres, renamed it the Arctic National Wildlife Refuge, designated eight million acres as wilderness, and designated three wild and scenic rivers.

Section 1002 of the Act also directed to inventory the fish and wildlife resources of the coastal plain and to explore and identify those areas with oil and gas potential in the 1.5 million acres of the Refuge coastal plain. ANILCA also allowed KIC to relinquish their selected lands outside the Arctic Refuge, and to select replacement lands within the Refuge.

Section 1317 directed a one-time wilderness review of ANWR.

Section 1326(b) stated that no further studies of Federal lands in the State of Alaska for the single purpose of considering establishment of a conservation system unit….or for related or similar purposes shall be conducted unless authorized by this Act [ANILCA] or further Act of Congress.

1983 The U.S. Fish and Wildlife Service (USFWS) published an Environmental Impact Statement (EIS) that identified the coastal plain as highly prospective for significant accumulations of oil and gas, and recommended exploration to estimate volume of potential resources. The USFWS recognized that the results of exploration will provide valuable information for evaluating potential oil and gas resources to meet the nation's need for domestic sources of energy.

Federal regulations were promulgated for oil and gas exploration in the Arctic National Wildlife Refuge, 50 CFR 37.

The Chandler Lake land exchange agreement conveyed subsurface ownership of KIC lands from the federal government to the Arctic Slope Regional Corporation. This exchange also allowed an exploratory oil well to be drilled on KIC lands.

1983-85 Exploration for oil and gas of the ANWR 1002 area was conducted on the coastal plain, using 2-D seismic, gravity, and shallow surveys, surface mapping, field observations, with analyses for geochemistry and hydrocarbon reservoir potential.

1987 The USDOI published a Legislative EIS with research findings, results of the 1983-1985 exploration, with recommendations for land management and continued exploration of the coastal plain under ANILCA, Section 1002(h). The report, the result of a decade of studies, recommended that oil and gas exploration continue where this could be done without significant adverse effects on fish and wildlife, their habitats, or the environment.

1988 The USFWS published the "Arctic National Wildlife Refuge: Comprehensive Conservation Plan, Environmental Impact Statement, Wilderness Review, Wild River Plans". Secretary of the Interior Donald Paul Hodel recommended to Congress that an orderly oil and gas leasing program for the entire 1.5 million-acre 1002 Area proceed.

1995 Congress passed a bill to develop the 1002 Area. President Clinton vetoed it.

1997 President Clinton signed the National Wildlife Refuge System Improvement Act, to provide specific guidance to the Refuge System, and established the mission "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

1998 USGS published a comprehensive assessment of undiscovered oil and gas resources in ANWR (OFG 98-34). The findings estimated the technically recoverable and oil-in-place resources, with about 74 percent ascribed to the ANWR 1002 Area.

2005 USGS published a report that assessed the undiscovered oil resources of the 1002 Area (Attanasi, 2005; Survey Open File Report 2005-1217).

USGS (Attanasi, 2005; Open File Report 2005-1359) also published an economic assessment that used full-cycle cost functions to predict economically recoverable oil and gas. The study found 73 to 83 percent of technically recoverable oil to be economically recoverable.

2011 Three federal acts including options to open the coastal plain to oil and gas leasing were before Congress: The Security Act of 2011, S. 352; the No Surface Occupancy Western Arctic Coastal Plain Domestic Energy Security Act, S. 351; and the American Energy Independence and Price Reduction Act, H.R. 49.

USFWS published a draft Comprehensive Conservation Plan (CCP), June 2011. An oil and gas exploration program was not considered in the Alternatives presented in the draft CCP.

2013 Alaska Department of Natural Resource, Division of Oil and Gas (ADNR-DO&G) provides a feasible, proposed oil and gas exploration proposal for the ANWR 1002 Area, including a resource study, and recommended protections and mitigations to prevent unnecessary adverse effects to the coastal plain environment.

Source: Institute of the North, 2004; USFWS, 2008

Appendix C

Permits and Authorizations for Proposed Exploration Program

Federal Authorizations and Approvals	
U.S. Fish and Wildlife Service (USFWS)	Concurrence on approval of proposed exploration program.
	Application for Rights-of-way
	Endangered Species Act (ESA) Consultation. Letter of ESA "No Effect" determination.
	Letter of Authorization (LOA) for Incidental Take of Polar Bears; Polar Bear/Personnel Encounter Plan.
	Essential Fish Habitat Assessment (No consultation with National Marine Fisheries Service may be required).
	ANILCA 810 subsistence evaluation and findings with BLM.
	Consultation with the State of Alaska primary regulatory agencies, as required. (ADEC, AOGCC, ADF&G)
National Marine Fisheries Service (NMFS)	Letter of Authorization (LOA) for Incidental Take of Small Numbers of Marine Mammals incidental to barging equipment and supplies to ports, docks and sea lift facilities.
Bureau of Land Management (BLM)	Application for Permit to Drill
	Concurrence on Rights-of-way.
	Consultation with State of Alaska Primary regulatory agencies, as required. (ADEC, AOGCC, ADF&G)
	Coordination of ANILCA 810 subsistence evaluation and findings with USFWS.
U.S. Army Corps of Engineers (USACE)	Application for Section 404 Permit, under Clean Water Act (CWA), as needed during exploration.
	Application for Section 10 Permit, under Rivers and Harbors Act (RHA) of 1899, as needed during exploration.
	Potential coordination with the Conservation Fund for approved compensatory wetlands mitigation, with communcation with the North Slope Borough, as needed.
U.S. Environmental Protection Agency	Hazardous substance storage or disposal under RCRA, as needed.

State Authorizations and Approvals	
Alaska Department of Environmental Conservation (ADEC)	Domestic Wastewater Discharge Permit, under APDES Primacy for the NPDES (general permit/ camp contractor; drilling in Phase 3)
	Wastewater and Water Treatment System approval; permit to operate systems (camp contractor; drilling in Phase 3).
	Solid Waste Storage and Disposal Permits, as needed. Temporary storage of drilling wastes, camp wastes.
	Spill Prevention, Control, and Countermeasures (SPCC) C-Plan - Primacy for C-Plan Program in Alaska (drilling/ testing contractor in Phase 3); Oil Discharge Prevention and Contingency Plan (ODPCP).
	Air Quality Minor Source General Permit
	Certificate of Financial Responsibility
Alaska Department of Natural Resources (ADNR)	Temporary Water Use Permits (TWUP), as needed during exploration program.
	Application for Rights-of-way, or coordination with current rights-of-way lessee(s) for temporary use across State lands for access to exploration sites.
	Cultural Resources Coordination/ Consultation with Alaska Office of History and Archaeology - State Historic Preservation Office (SHPO), Alaska Heritage Resources Survey compliance.
Alaska Oil and Gas Conservation Commission (AOGCC)	Aplication for a Permit to Drill; shallow hazard survey.
	Approval for annular disposal of drilling wastes, as needed. UIC Program Primacy
Alaska Department of Fish and Game (ADF&G)	Fish Habitat Permit (Division of Habitat)
	Coordination with subsistence fishing and hunting requirements; avoidance of conflicts with cultural and subsistence harvests.
	Anadromous and resident fish species protections; overwintering and spawning locations protections.
Local Authorizations and Approvals	
North Slope Borough (NSB)	Municipal Code, Title 19 compliance and permits under AS 29.40.020-.040
	Potential coordination with the USACE and the Conservation Fund for approved compensatory wetlands mitigation, as needed.
	Cultural Resources Coordination/ Consultation with NSB for compliance with Traditional Land Use Inventory (TLUI).
Village of Kaktovik	Coordination with federally recognized tribe for use of community services and transportation facilities, as needed.
Kaktovik Inupiat Corporation	Coordination for use of subsurface mineral estate, rights-of-ways, community services and transportation facilities, as needed.
Arctic Slope Regional Corporation (ASRC)	Coordination for use of subsurface mineral estate, and surface rights-of-way, as needed.
Alaska Eskimo Whaling Commission (AEWC)	Issuance of a Conflict Avoidance Agreement to minimize impacts to subsistence whaling for transport within marine waters.

Appendix D
Permits and Authorizations for North Slope Development

FEDERAL:

National Oceanic and Atmospheric Administration (NOAA)

- Provides consultation under the Endangered Species Act of 1973, Section 7(a)(2) regarding effects to threatened or endangered species.
- Provides consultation under the Magnuson-Stevens Fishery Management and Conservation Act for effects on Essential Fish Habitat.
- Provides consultation under the Fish and Wildlife Coordination Act regarding effects on fish and wildlife resources.
- Provides consultation under the Marine Mammal Protection Act regarding effects on marine mammals.
- Issues Incidental Harassment Authorization under the Marine Mammal Protection Act for incidental takes of protected marine mammals (bowhead whales and ringed seals).

U.S. Army Corps of Engineers (USACE)

- Issues a section 404 permit under the Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1344) for discharge of dredged and fill material into waters of the U.S, including wetlands.
- Issues a section 10 permit under the Rivers and Harbors Appropriations Act of 1899 (33 USC § 403) for structures or work in, of affecting, navigable waters of the U.S.
- Issues a section 103 Ocean Dumping permit under section 103 of the Marine Protection Research and Sanctuaries Act of 1972 (33 USC § 1413) for transport of dredged material for ocean disposal.

U.S. Bureau of Land Management (U.S. BLM)

- Reviews and approves Applications for Permit to Drill (including drilling plans and surface-use plans of operations) and subsequent well operations as prescribed, and other Federal laws, for development and production of Federal leases.
- Approves lease administration requirements including Unit Agreements and Plans of Development, Communitization Agreements and Participating Area Determinations, under the Mineral Leasing Act of 1920 (30 USC §§ 181 et seq.), Federal Oil and Gas Royalty Management Act of 1982 (43 USC §§1701 et seq.), Department of the Interior Appropriations Act, Fiscal Year 1981(Public Law 96-514), and other Federal laws, for exploration and development of oil and gas leases.
- Issues geophysical permits to conduct seismic activities as described in 43 CFR part 3150, under authority of the Mineral Leasing Act of 1920, Alaska National Interest Lands Conservation Act (16 USC §§ 3101 et seq.), Federal Land Policy and Management Act of 1976 (43 USC §§ 1701 et seq.), and Department of the Interior Appropriations Act, Fiscal Year 1981.
- Issues rights-of-way grants and temporary use permits for the construction, operation, and maintenance of pipeline, production, and related facilities.
- Delegates authority to ADEC for review and approval of Oil Discharge Prevention and Contingency Plans and Certification of Financial Responsibility for accidental oil discharge into navigable waters under section 1016 of the Oil Pollution Act of 1990 (OPA90; 33 USC § 2716), and Section 311(j)(5) of the Federal Water Pollution Control Act (33 USC § 1321(j)(5); 30 CFR part 254).

U.S. Environmental Protection Agency (USEPA)

- Issues an Underground Injection Control Class 1 Industrial Well permit under the Safe Drinking Water Act (42 USC §§ 300f et seq.; 40 CFR parts 144 and 146) for underground injection of Class I (industrial) waste materials.
- Requires a Spill Prevention Containment and Countermeasure (SPCC) Plan under section 311 of the Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1321;40 CFR part 112) for storage of over 660 gallons of fuel in a single container or over 1,320 gallons in aggregate in tanks above ground.
- Conducts a review and evaluation of the Draft and Final EIS for compliance with CEQ guidelines (40 CFR parts 1500-1508) and section309 of the Clean Air Act (42 USC § 7609).
- Authority delegated to ADEC to issue air quality permits for facilities operating within state jurisdiction, including a Title V operating permit and a Prevention of Significant Deterioration (PSD) permit under the Clean Air Act, as amended (42 USC §§ 7401 et seq.), to address air pollutant emissions.

U.S. Fish and Wildlife Service (USFWS)

- Provides consultation under the Endangered Species Act of 1973, section 7(a)(2) regarding effects to threatened or endangered species.
- Provides consultation under the Fish and Wildlife Coordination Act regarding effects to fish and wildlife resources.
- Issues a Letter of Authorization under the Marine Mammal Protection Act for incidental takes of marine mammals.

STATE:

Alaska Department of Environmental Conservation (ADEC)

- Under authority transferred from the USEPA, issues an Alaska Pollutant Discharge and Elimination System (APDES) permit under section 402, Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1342) for discharges into waters of the U.S.
- Issues a Certificate of Reasonable Assurance for discharge of dredged and fill material into U.S. waters under section 401, Federal Water Pollution Control Act of 1972, as amended in 1977 (Clean Water Act; 33 USC § 1341); AS 46.03.020; 18 AAC chapters 15, 70, and 72.
- Issues a Certificate of Reasonable Assurance/NPDES and Mixing Zone Approval for wastewater disposal into all state waters under section 402, Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1342); AS 46.03.020, .100, .110, .120, and .710; 18 AAC chapters, 10, 15, and 70, and ; § 72.500.
- Issues a Class I well wastewater disposal permit for underground injection of non-domestic wastewater under AS 46.03.020, .050, and .100.
- Reviews and approves all public water systems including plan review, monitoring program, and operator certification under AS 46.03.020, .050, .070, and .720, 18 AAC § 80.005.
- Approves domestic wastewater collection, treatment, and disposal plans for domestic wastewaters (18 AAC chapter 72).
- Approves financial responsibility for cleanup of oil spills (18 AAC chapter 75).
- Reviews and approves the Oil Discharge Prevention and Contingency Plan and the Certificate of Financial Responsibility for storage or transport of oil under AS 46.04.030 and 18 AAC chapter 75. The State review applies to oil exploration and production facilities, crude oil pipelines, oil terminals, tank vessels and barges, and certain non-tank vessels.

ADEC cont.
• Issues a Title V Operating Permit and a PSD permit under Clean Air Act Amendments (Title V) for air pollutant emissions from construction and operation activities (18 AAC chapter 50). • Issues a solid waste disposal permit for state lands under AS 46.03.010, 020, 100, and 110; AS 46.06.080; 18 AAC § 60.005; and 200. • Reviews and approves solid waste processing and temporary storage facilities plan for handling and temporary storage of solid waste on Federal and state lands under AS 46.03.005, 010, and 020; and 18 AAC § 60.430. • Approves the siting of hazardous waste management facilities.
Alaska Department of Fish and Game (ADFG)
• Issues Fish Habitat Permits under AS 16.05.871 for activities within streams used by fish that the agency determines could represent impediments to fish passage, or for travel in, excavation of, or culverting of anadromous fish streams.
Alaska Department of Natural Resources (ADNR)
• Issues a Material Sales Contract for mining and purchase of gravel from state lands under AS 38.05.850; and 11 AAC §§ 71.070 and .075. • Issues Rights-of-Way (ROW) and Land Use permits for use of state land, ice road construction on state land, and state freshwater bodies under AS 38.05.850. • Issues a Temporary Water Use and Water Rights permit under AS 46.15 for water use necessary for construction and operations. • Issues pipeline ROW leases for pipeline construction and operation across state lands under AS 38.35.020. • Issues a Cultural Resources Concurrence for developments that may affect historic or archaeological sites under the National Historic Preservation Act of 1966, as amended (16 USC §§ 470 et seq.), Alaska Historic Preservation Act (AS 41.35.010 through .240).
Alaska Oil and Gas Conservation Commission (AOGCC)
• Issues a Permit to Drill under 20 AAC § 25.05. • Issues approval for annular disposal of drilling waste (20 AAC § 25.080). • Authorizes Plugging, Abandonment, and Location Clearance (20 AAC § 25.105 through 25.172). • Authorizes Production Practices (20 AAC §§ 25.200 through 25.245). • Authorizes Class II Waste Disposal and Storage (20 § AAC 25.252).
• Approves Workover Operations (20 § AAC 25.280). • Reports (20 AAC §§ 25.300 through 25.320). • Authorizes Enhanced Recovery Operations under 20 AAC §§ 25.402-460.
LOCAL:
North Slope Borough (NSB)
• Issues Development Permits for oil and gas projects under NSB Code of Ordinance Title 19.

Source: BLM, 2012a, Appendix B