

U.S. Department of Interior
U.S. Geological Survey

Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries

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Biological Science Report
USGS/BRD/BSR-2002-0001

U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
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U.S. Geological Survey, Reston, Virginia: 2002

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Citation example:

Griffith, B., D. C. Douglas, N. E. Walsh, D. D. Young, T. R. McCabe, D. E. Russell, R. G. White, R. D. Cameron, and K. R. Whitten. 2002. The Porcupine caribou herd. Pages 8-37 *in* D. C. Douglas, P. E. Reynolds, and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U. S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Preface

In 1980, when the U.S. Congress enacted the Alaska National Interest Lands Conservation Act (ANILCA), it also mandated a study of the coastal plain of the Arctic National Wildlife Refuge. Section 1002 of ANILCA stated that a comprehensive inventory of fish and wildlife resources would be conducted on 1.5 million acres of the Arctic Refuge coastal plain (1002 Area). Potential petroleum reserves in the 1002 Area were also to be evaluated from surface geological studies and seismic exploration surveys. Results of these studies and recommendations for future management of the Arctic Refuge coastal plain were to be prepared in a report to Congress.

In 1987, the Department of Interior published the *Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment - Report and Recommendation to the Congress of the United States and Final Environmental Impact Statement*. This report to Congress identified the potential for oil and gas production (updated* most recently by the U.S. Geological Survey in 2001), described the biological resources, and evaluated the potential adverse effects to fish and wildlife resources. The 1987 report analyzed the potential environmental consequences of five management alternatives for the coastal plain, ranging from wilderness designation to opening the entire area to lease for oil and gas development. The report's summary recommended opening the 1002 Area to an orderly oil and gas leasing program, but cautioned that adverse effects to some wildlife populations were possible.

Congress did not act on this recommendation nor any other alternative for the 1002 Area, and scientists continued studies of key wildlife species and habitats on the coastal plain of the Arctic Refuge and surrounding areas. This report contains updated summaries of those scientific investigations of caribou, muskoxen, predators (grizzly bears, wolves, golden eagles), polar bears, snow geese, and their wildlife habitats.

Contributions to this report were made by scientists affiliated with the U.S. Geological Survey; U.S. Fish and Wildlife Service; Alaska Department of Fish and Game; University of Alaska-Fairbanks; Canadian Wildlife Service; Yukon Department of Renewable Resources; and the Northwest Territories Department of Resources, Wildlife, and Economic Development.

Sections of the report presenting new information on caribou and forage plants were peer-reviewed by three independent, non-affiliated scientists. The remaining sections summarize previously published peer-reviewed scientific papers and were reviewed by a single independent scientist. The U.S. Geological Survey and the U.S. Fish and Wildlife Service collaborated in the publication of this report.

* U.S. Geological Survey Fact Sheet FS-028-01
<http://geology.cr.usgs.gov/pub/fact-sheets/fs-0028-01/>

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Acknowledgements

Much of the research reported in this document was designed and conducted between 1988-1994 while Thomas R. McCabe served as the Senior Scientist and Coordinator. His participation was a significant contribution to the research program. The comments and suggestions of the independent peer-reviewers greatly improved the scientific quality of this report. Many others contributed in a wide variety of ways. The authors express their thanks to the following persons:

G. W. Anthony	T. Fathauer	R. A. Kelleyhouse	D. C. Miller	J. S. Sedinger
A. Badyaev	R. Fernau	J. G. King	J. Milne	M. B. Shasby
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S. G. Fancy	R. Kedrowski	P. Merchant	J. M. Scott	S. A. Wolfe
			J. Seagren	B. Woods

The authors also wish to acknowledge the following agencies and organizations that provided financial support:

- Federal Aid in Wildlife Restoration
- National Science Foundation, Grant OPP-9521459
- Natural Science and Engineering Research Council of Canada
- Northern Oil and Gas Action Program of Canada
- Ivvavik National Park
- Roger Tory Peterson Institute of Natural History

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Section 1: Introduction

Background

The Arctic National Wildlife Refuge in northeastern Alaska is one of 16 refuges in Alaska and 539 refuges nationwide within the National Wildlife Refuge System administered by the U.S. Fish and Wildlife Service. First established as the Arctic National Wildlife Range in 1960 by Public Land Order 2214, it initially had a three-fold purpose to preserve unique wildlife, wilderness, and recreation values on 8.9 million acres.

In 1980, the Arctic National Wildlife Range was expanded to the southwest and renamed the Arctic National Wildlife Refuge (also called the Arctic Refuge in this report) when the U.S. Congress passed the Alaska National Interest Lands Conservation Act (ANILCA), Public Law 96-487 (94 Stat. 2371). This legislation also designated almost all of the original Arctic National Wildlife Range as wilderness, and it directed the Secretary of the Interior to conduct studies evaluating both the biological resources and the potential petroleum

reserves of 1.5 million acres (titled the 1002 Area) on the coastal plain of the Arctic Refuge.

In April 1982, the Arctic Refuge staff completed a report summarizing the then current state of knowledge on the fish, wildlife, and their habitats present on the coastal plain of the Arctic Refuge (U.S. Fish and Wildlife Service 1982). From 1982 to 1985, field investigations of biological resources of the 1002 Area were carried out by a number of investigators, and annual reports summarized the results (Garner and Reynolds 1983, 1984, 1985, 1986, 1987). These reports and other resources were used to prepare a Department of the Interior report to Congress: *Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment - Report and Recommendation to the Congress of the United States and Final Environmental Impact Statement* (Clough et al. 1987).

Biological investigations continued from 1988 through 1994 in and near the 1002 Area coordinated by research scientists from the U.S. Fish and Wildlife Service who are now part of the U.S. Geological Survey (McCabe et al. 1992). Collaborators included specialists from the Arctic National Wildlife Refuge; Alaska Department of Fish and

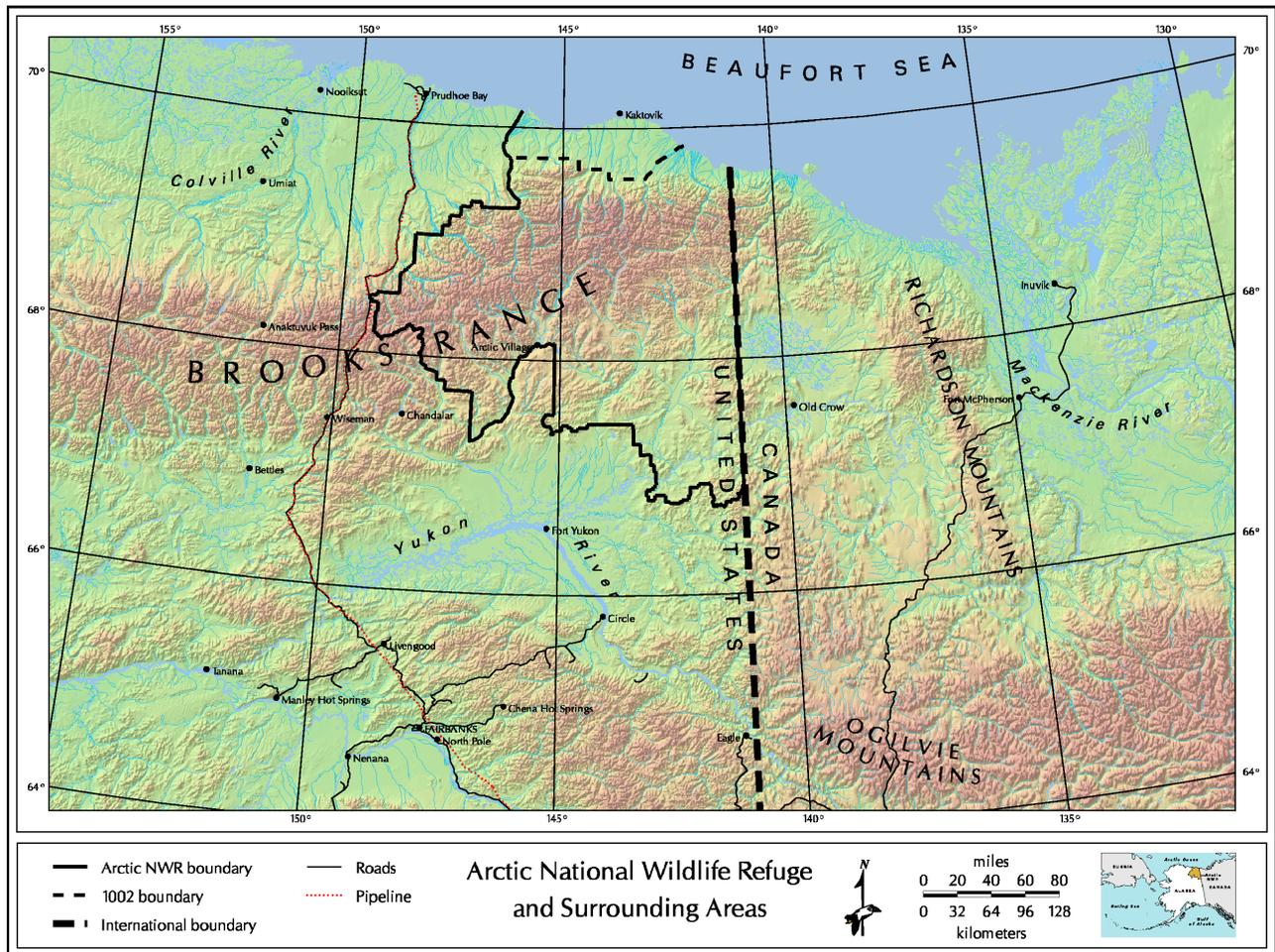


Figure 1.1. Geographic map of the Arctic National Wildlife Refuge, Alaska, USA, and surrounding areas.

Game; University of Alaska-Fairbanks; Canadian Wildlife Service; Yukon Department of Renewable Resources; and the Northwest Territories Department of Resources, Wildlife, and Economic Development. Additional information continued to be collected from 1995 until the present (2001) as part of monitoring caribou (*Rangifer tarandus*), polar bear (*Ursus maritimus*), and muskox (*Ovibos moschatus*) populations and their habitats.

This current report is a summary of these recent investigations, building upon the information of past studies. It includes updated information about population dynamics, distribution, energetics, and habitat use of the key wildlife species as well as discussions about potential effects and mitigation of petroleum development on wildlife and habitats in the 1002 Area.

Study Area

The studies summarized in this report focused on the 1002 Area of the Arctic National Wildlife Refuge but also extended into adjacent regions of the Arctic Refuge, eastward into Canada, and as far west as the Prudhoe Bay and Kuparuk petroleum development areas in north central Alaska (Fig. 1.1).

The Arctic National Wildlife Refuge is the largest and most northern national wildlife refuge in the United States, encompassing 19.6 million acres (30,000 square miles). A variety of arctic and subarctic habitats exist in the Arctic Refuge, including near shore marine habitats along the coast, arctic tundra on the coastal plain, alpine habitats in the foothills and mountains of the Brooks Range, and taiga and boreal forests south of the mountains (Fig. 1.1).

The coastal plain of the Arctic Refuge contains calving grounds of the international Porcupine caribou herd, year-round habitats for muskoxen, fall staging areas for lesser snow geese (*Chen caerulescens caerulescens*), denning habitat for pregnant polar bears, and summer nesting areas for numerous species of migratory birds.

The 1002 Area is a region on the coastal plain in the northern part of the Arctic Refuge (Fig. 1.2). It lies between the mountains of the Brooks Range (69° 35' N) and the Beaufort Sea (70° 10' N) and is bounded on the east by the Aichilik River (142° 10' W) and on the west by the Canning River (146° 15' W).

Numerous northward-flowing rivers and streams bisect the 1002 Area. Only a few large lakes are present and most freeze to the bottom by late winter. The climate is characterized by extremely low winter temperatures, persistent winds, and short cool summers. Temperatures at Kaktovik on the coast of the Beaufort Sea (Fig. 1.2), averaged -25°C (-13°F) in February and +6°C (+43°F) in June during 1986-1995.

Precipitation occurs frequently as drizzle in summer and light snow in winter. The ground surface is frozen

from September until June. A permanently frozen substrate called permafrost lies below the surface of the soil. Winter conditions with below freezing temperatures and snow exist for 8 to 9 months each year. Easterly winds predominate most of the year, although storms usually arrive on westerly winds. At Kaktovik, the sun is continuously above the horizon from May 15 to July 27 and below the horizon from November 24 to January 17.

The mountains of the Brooks Range converge with the Beaufort Sea in this northeastern corner of Alaska. The result is a unique juxtaposition of landscape features in the Arctic Refuge compared with surrounding areas (Fig. 1.1). The steeper elevation gradient between mountains and ocean on the coastal plain condenses a diversity of habitats and ecological niches into a narrow area.

Vegetation in the study area is predominantly tundra with a groundcover of low-growing plants (<1 foot high) that includes dwarf shrubs, sedges, small herbs, lichens, and mosses. Taller shrubs are restricted to drainages and south facing slopes. Almost the entire coastal plain is classified as wetland.

Five terrain types predominate across the study area. *Mountain terrain*, with its complex and often sparsely distributed vegetation communities, occurs along the southern periphery. Sedges, tussock-forming sedges, and low willow and birch shrubs dominate the *foothill terrain*. *Hilly coastal plains* of gently rolling topography have large areas of patterned ground formed by ice-wedge polygons and frost boils and support tussock tundra, low shrubs, and graminoid-dominated tundra. *River flood plains* support localized habitats of willow thickets as well as a rich diversity of other plant species and communities. *Flat thaw-lake plains* near the seacoast have wet and moist graminoid tundra and abundant shallow lakes formed by thawing of permafrost.

More extensive descriptions of the study area can be found in Clough et al. (1987) and U.S. Fish and Wildlife Service (1982, 1988).

References

- Clough, N. K., P. C. Patton, and A. C. Christensen, editors. 1987. Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment - report and recommendation to the Congress of the United States and final legislative environmental impact statement. U.S. Fish and Wildlife Service, U.S. Geological Survey, and Bureau of Land Management, Washington DC, USA.
- Garner, G. W., and P. E. Reynolds, editors. 1983. Arctic National Wildlife Refuge coastal plain resource assessment: 1982 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

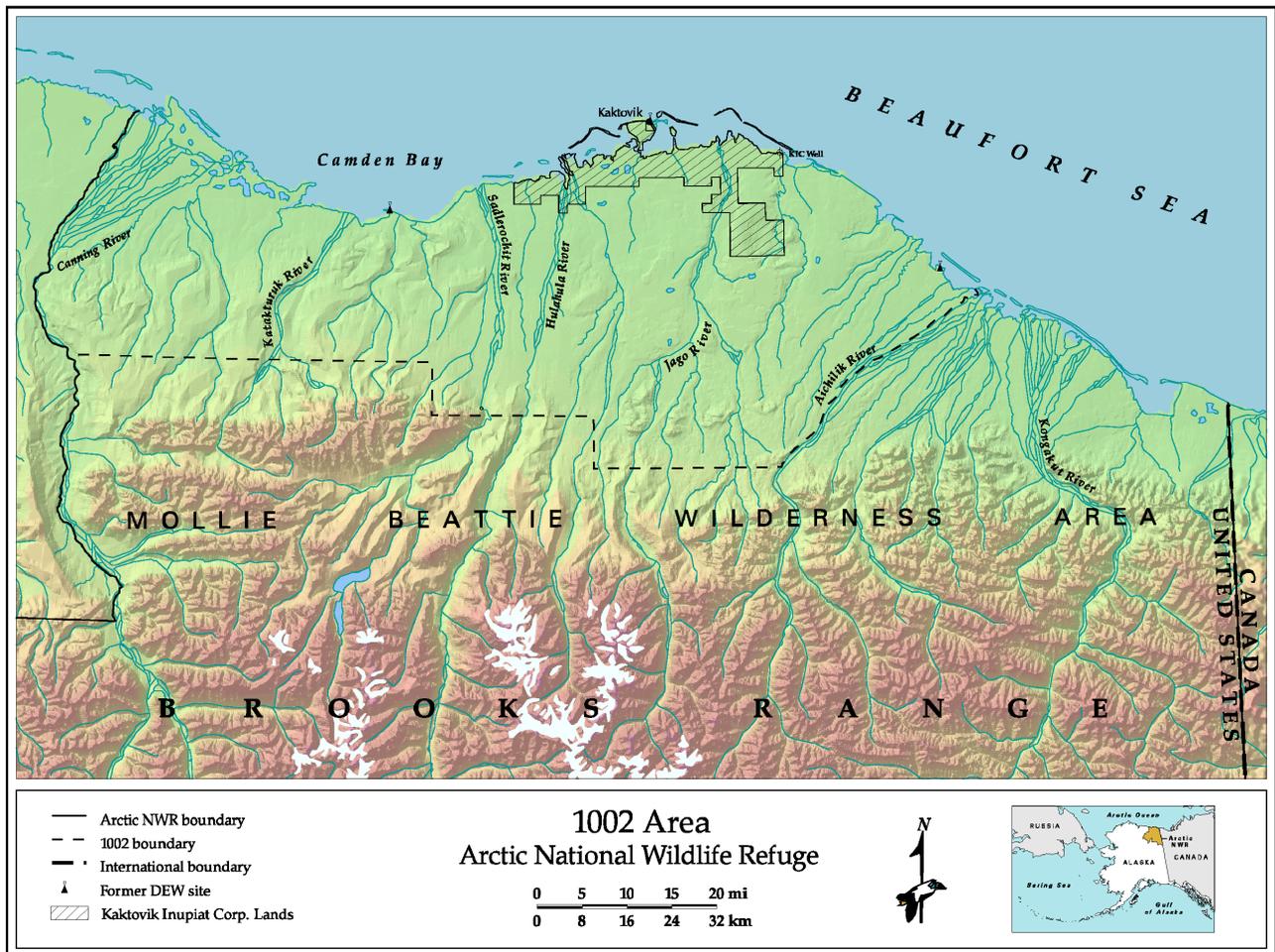


Figure 1.2. Geographic map of the 1002 Area of the coastal plain of the Arctic National Wildlife Refuge, Alaska.

_____, and _____, editors. 1984. Arctic National Wildlife Refuge coastal plain resource assessment: 1983 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

_____, and _____, editors. 1985. Arctic National Wildlife Refuge coastal plain resource assessment: 1984 update report, baseline study of the fish, wildlife, and their habitat. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

_____, and _____, editors. 1986. Arctic National Wildlife Refuge coastal plain resource assessment: final report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

_____, and _____, editors. 1987. Arctic National Wildlife Refuge coastal plain resource assessment: 1985 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

McCabe, T. R., B. Griffith, N. E. Walsh, D. D. Young, editors. 1992. Research on the potential effects of petroleum development on wildlife and their habitat, Arctic National Wildlife Refuge interim report, 1988-1990. Alaska Fish and Wildlife Research Center and Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

U.S. Fish and Wildlife Service. 1982. Arctic National Wildlife Refuge coastal plain resource assessment: initial report baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Region 7, Anchorage, Alaska, USA.

_____. 1988. Arctic National Wildlife Refuge final comprehensive conservation plan, environmental impact statement, wilderness review, and wild river plans. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.