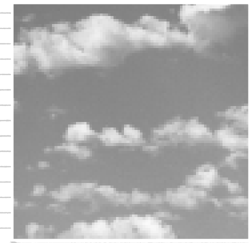
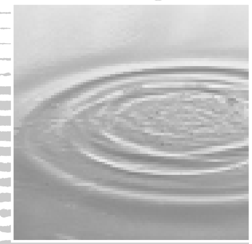
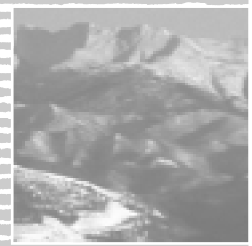

Yukon State of the Environment Report

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Yukon Department of Renewable Resources
Policy and Planning Branch
Box 2703
Whitehorse, Y.T. Y1A 2C6
Phone: (867) 667-5634
Fax : (867) 393-6213

Environment Canada
Canadian Wildlife Service
Mile 917.6B Alaska Highway
Whitehorse, Y.T. Y1A 5X7
Phone: (867) 667-3949
Fax: (867) 667-7962

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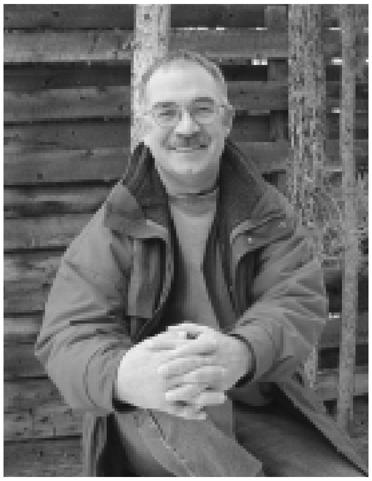

Dear reader,

I am pleased to provide the second State of the Environment Report prepared by the Government of Yukon with the assistance of Canada, the Council of Yukon First Nations, the City of Whitehorse and Raven Recycling. It presents a status report of where the state of the Yukon environment stood in 1999.

Scientists, government and non-government organizations, educators and industry can use this encyclopaedic reference to monitor changes occurring within the Yukon's environment. As well, the report's information can be used by decision-makers when preparing policies and legislation intended to maintain a healthy environment.

State of the Environment reports provide baseline information and an early warning of potential or emerging environmental problems so that appropriate action can help us avoid or mitigate the problems.

This major reference is not a policy document and does not make recommendations.

I would like to thank the many professionals, scientists and technicians who contributed to the science in this important work.

Equally important is the contribution and perspective of the First Nation Elders whose work forms part of this report. I would like to recognize the contribution of Stella Jim, Paddy Jim, Charlie Dick, Roddy Blackjack, Rowena Flynn, Johnnie Smith, Henry Broeren and Matt Thom, as well as the assistance of Council of Yukon First Nations for the excellent traditional knowledge work.

I hope this report will prove useful and interesting to you.

Dale Eftoda,
Minister of Renewable Resources

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Reviewers and Contributors

Yukon Council on the Economy and the Environment:
Past Chair Jennifer Mauro and *Chair* Rick Buchan, *Vice-Chair* Daryn Leas and *Members* Louise Bouvier, John Carroll, Ralph Nordling, Louise Ranger, Natalie Edelson, Kathy Watson, and Andy Williams.

Federal Government:
Renewable Resources – Roger Horner. *Environmental Protection* – Joan Eamer, Benoit Godin. *Water Resources* – Bill Slater, Gerry Whitley, David Sherstone. *Forest Management* – Howard Madill. *Contaminants & Waste* – Mark Palmer. *Mineral Resources* – Bob Holmes, Marian Dejean, David Jennings, Elsie Wain. *Fisheries & Oceans* –Al von Finster, John Burdek. *Canadian Wildlife Service* – Don Russell, Jim Hawkings.

Yukon Government:
Renewable Resources – Kathy Kosuta, Karen Clyde, Jean Carey, Rick Farnell, Todd Powell, Rick Ward, Katherina Egli, Rob Florkiewicz, Bruce Bennett, Don Toews, Susan Thompson, Doug Larsen, Mal Malloch, Chuck Hubert, Ben Moise, Edward Lee, Bob Collins, Lauren Crooks, Katie Hayhurst, Bengt Pettersson, Michael White, John Meikle, Jim McIntyre, David Murray, Jeff Monty, Joe Ballantyne, Brian Pelchat. *Health and Social Services* – Fred O'Brien. *Economic Development* – Shirley Abercrombie, Janet Moodie, Bob Collins, Dave Downing, Joe MacGillivray, Ella LeGresley, Don Dempster. *Community & Transportation* – Jeff Boehmer, Peter Percival, Wally Hidinger, George Stetkiewicz, Bruce Chambers. *Tourism* – Catherine Paish. *Heritage* – Ruth Gotthardt, Louise Profeit-Leblanc. *Executive Council Office* – Laura Prentice, Karen Sparrow, Ann MacDonald. *Bureau of Statistics* – Paul Harris. *Development Assessment Office* – Kelvin Leary. *Government Services* – Debra Thibodeau.

Other:
Yukon Energy – Duncan Sinclair , *City of Whitehorse* – Susie Ross, *Raven Recycling Depot* – Karl Stellbrink

Consultants:
Mining, Water, Solid Waste: Laberge Environmental Services, with sub-contractors Charlotte Mouchoet (for mining) and Sara Locke (for solid waste); *Wildlife:* Stu Withers, *Wilderness mapping and Forestry:* Applied Ecosystem Management; *Salmon:* DNA ; *Freshwater fish:* Rem Ricks; *Wetlands and Lands:* Karen McKenna; *Climate Change:* Mattanda with David Hiks.; Chief Editor: Liz McKee; Ass't Editor: Michael Brooks; Chief Researcher: Usha Srinivasan

Elders
Stella and Paddy Jim, Charlie Dick, Roddy Blackjack, Johnnie Smith, Matt Thom, Henry Broeren and Rowena Flynn. Traditional knowledge coordinator: Robert Lee Jackson of CYFN. Interpreter: Jim Smith.

Design and Production

Aasman Design Inc.:
desk top publishing and cover
Applied Ecosystem Management: maps

Project Coordination:
Department of Renewable Resources, Government of Yukon
Coordinator – Yvonne Harris
Director – Don Hutton,
Policy and Planning Branch
Deputy Minister – Bill Oppen

Government of Yukon: photo credits

Yukon State of the Environment Report 1999

The purpose of this report is to provide information that will help us make the right decisions to build a sustainable economy and conserve a healthy environment. This report does not make recommendations, set policy or present a report card on the environment. The first Yukon State of the Environment Report was published in 1996; this is the second major State of the Environment Report. Information in this report is compiled from many research reports and files of government and non-government agencies. Several First Nation Elders reviewed the information provided by scientists and added their traditional knowledge to the report.

Highlights

AIR AND CLIMATE CHANGE

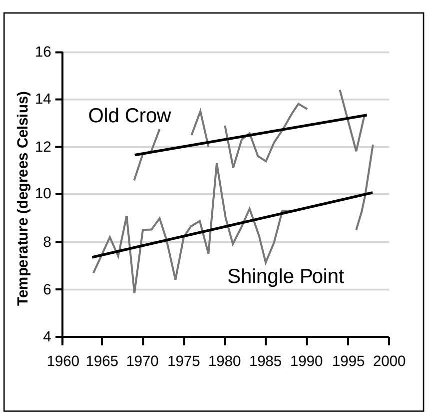
Climate Change

Carbon dioxide increased by 30 per cent since the 18th century. Temperature records show that the Earth has warmed an average of 0.5° C over the past 100 years. In the Yukon the summer temperatures in 1998 and 1999 were among the four highest years ever recorded.

Several studies have indicated the reduction of sea ice cover since the beginning of the 20th century. In the summer of 1998 the ice cap in the Beaufort Sea was 40 per cent below average.

At the 1997 Framework Convention on Climate Change in Kyoto, Canada made a commitment to reduce greenhouse gas emissions to six per cent below 1990 levels between 2008 and 2012. In September 1999 the Federal and Yukon governments announced the creation of the Northern Climate ExChange Centre based at the Northern Research Institute at Yukon College.

Government of Yukon enacted the *Ozone Depleting Substance Regulations* in 1988.

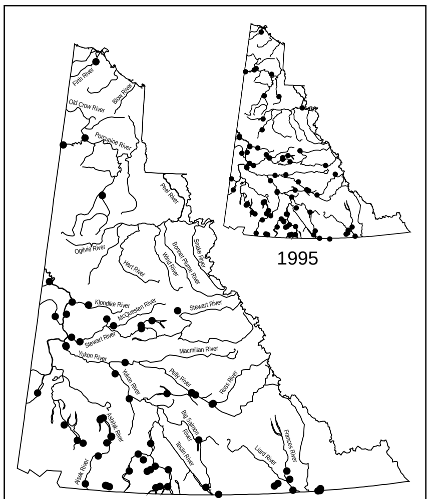


WATER

Water

Data on snow pack accumulations and river and stream discharges indicate that the Yukon has experienced drought conditions in the past two to three years. 1998 was recorded as the driest year in 51 years and the annual precipitation was 34 per cent below normal.

The number of hydrometric (water measuring) stations operated by DIAND decreased from 70 in 1995 to 48 stations in 1999. The information from these monitoring sites is used to estimate water availability for industry, hydroelectricity and to forecast flooding hazards.



1999 Hydrology Sites

The City of Whitehorse water consumption was 842 litres per person per day in 1998, compared to the 1996 national average of 326 litres per person per day. The Whitehorse figure may be misleading as a considerable amount of water is lost through leakage or in bleeder systems used to prevent pipes from freezing.

In 1999, the City of Whitehorse replaced free flow bleeders with 1,250 Thermostatically Controlled Bleeder devices in Whitehorse homes in order to reduce water loss.

Generally the drinking water guidelines are met for all Yukon communities. Where water quality did not meet the guidelines, it was due to higher than recommended levels of substances or condition of the water that affect taste and appearance (e.g. iron, manganese, sulfide and turbidity); the water did not pose a risk to human health.

Raw sewage mainly contains solid and organic waste and some disease causing bacteria. Although in 1999, Dawson City was still using a primary treatment system, the municipality is now required to upgrade its sewage treatment facility by the year 2002. The City of Whitehorse installed a new sewage treatment facility and the city has not discharged sewage directly into the Yukon River since September 1996, significantly reducing the bacterial contamination downstream of Whitehorse.

Two mines that have ceased operation in the past five years are Mt. Nansen Mine near Carmacks and the lead-zinc mine at Faro. Both require reclamation measures to ensure water quality is not affected by effluent from the tailings ponds.

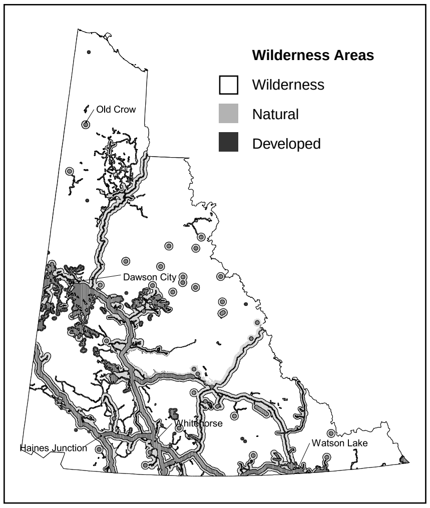
Viceroy Minerals Corporation won the 1999 Robert E. Leckie Award for its ongoing reclamation work at the Brewery Creek mine near Dawson City and Tic Exploration won the award for its reclamation practices on Gladstone Creek.

In 1996, two fuel spills totaling 192 tonnes at the Anvil Range mine near Faro accounted for 59 per cent of the total fuel spills recorded that year.

LAND

Wilderness

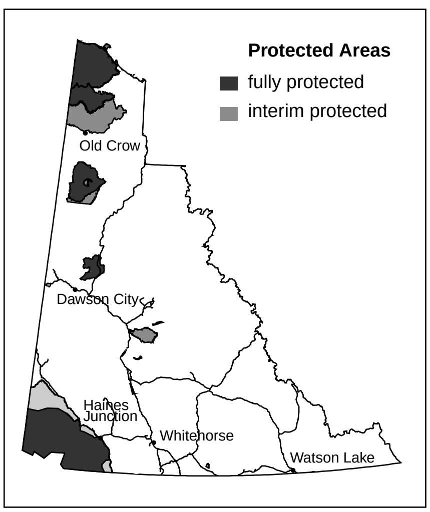
The 1999 wilderness-mapping project estimates that 77 per cent of the Yukon remains wilderness. Most areas of development are clustered along major roads.



Protected Areas

In 1998 the Government of Yukon approved the Yukon Protected Areas Strategy and in 1999 approved boundaries for the future Tombstone and Fishing Branch protected areas.

In the Yukon there are 44,433 km^2 of fully protected land as per Goal One of the Protected Area Strategy and 10,651 km^2 of land that is interim protected as per Goal Two of the Strategy.



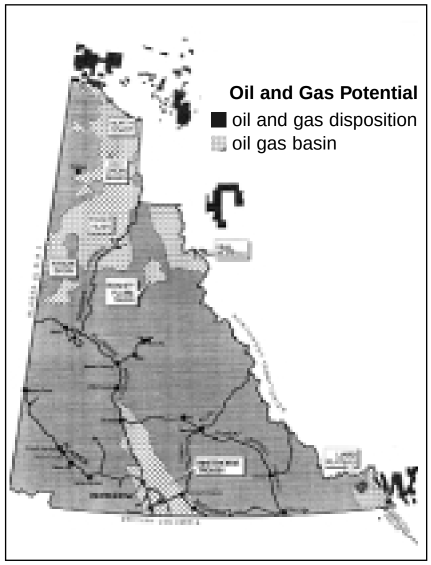
Mining

In 1998, 3.3 per cent of the area of the Yukon was held in mining claims; this represents a 0.8 per cent increase since 1994.

In 1998, enactment of the Yukon Quartz Mining Land Use Regulations was a significant step in ensuring that all mining related land uses are assessed for potential environmental effects.

Oil and Gas

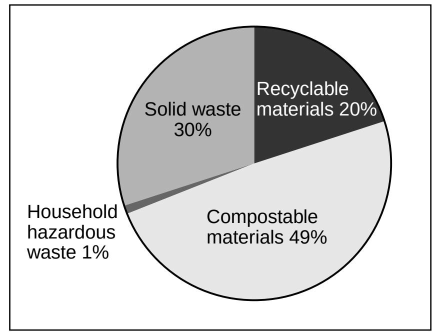
The Yukon government enacted the Yukon Oil and Gas Act in 1998 along with regulations to manage oil and gas in relation to the environment. There is currently interest in the Liard Plateau and Eagle Plains for crude oil extraction.



Waste

Yukoners dispose of an average of 700 kg of waste per person per year.

Reduce, reuse, recycle and reclaim are the four R's of waste reduction. It is an objective of the Yukon government to reduce the amount of waste directed to landfills by 50 per cent. The City of Whitehorse, through its waste reduction programs, is diverting 21 per cent of the waste stream, an improvement of five per cent since 1995. Of the total amount of waste generated in Whitehorse the following is the per cent composition of different types of waste: 30% solid waste, 20% recyclable, 49% compostable and 1% household hazardous waste. Based on these figures, 69 per cent of the waste could be composted or recycled.



Yukon Government legislation relating to waste enacted since 1995 includes:

Solid Waste Regulations
Beverage Container Regulation
Contaminated Sites Regulations

The War Eagle pit at the Whitehorse landfill and the Marwell tar pit in the Whitehorse industrial area are two special waste sites that require clean up of improperly disposed of hydrocarbons.

There are approximately 25 tonnes of special waste (solvents, petroleum products, waste oil, biomedical waste, cleaners, paints) collected annually in the Yukon. A special waste permit introduced in 1995 under the Special Waste Regulations together with the *Transportation of Dangerous Goods Act*, and the *Canadian Environmental Protection Act* complete all the necessary legislation and permits required to generate, handle or dispose of special waste. The Yukon government also enacted the *Contaminated Sites Regulations* in 1997 and is identifying sites in the territory that may be the source of contamination.

Through the DIAND Waste Management Program about half of the 801 identified contaminated sites in the Yukon have been remediated.

Agriculture

Agriculture sales have increased from \$2.3 million in 1991 to \$3.5 million in 1996.

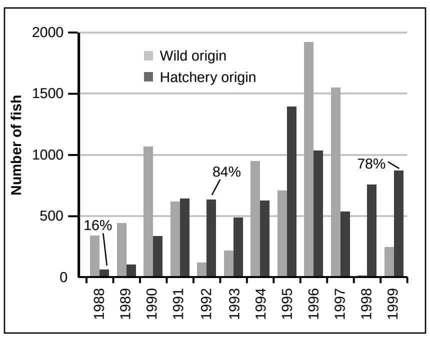
A 1997 study of agricultural land indicated that sixty per cent of the land disposed of for agriculture is not adequately used for agriculture.

Tourism

In 1994, over $50 million in revenue to Yukon businesses was related to tourism. The *Wilderness Tourism Licensing Act* came into effect in May 1999. This legislation sets out requirements that assist in protecting the environment.

Fish

The per cent of hatchery chinook passing the Whitehorse Rapids fish ladder has increased from 16 per cent in 1988 to 78 per cent in 1999.



The 1998 return of chum salmon on the Fishing Branch River and the 1999 return of sockeye salmon at Klukshu were among the lowest on record.

Between 1976 and 1999 the average per cent of Canadian catch of Alsek River sockeye was 11 per cent compared to 89 per cent for the U.S. commercial catch. Ninety per cent of the sockeye are hatched in Yukon waters.

In 1997, the Yukon Salmon Committee recommended to the Department of Fisheries and Oceans to retire many commercial fishing licenses to reduce the overall commercial catch; eight licenses have been retired since then.

The Pacific Fisheries Adjustment and Restructuring Program (PFAR) was implemented by the Department of Fisheries and Oceans in 1998 in response to dwindling salmon resources in British Columbia and the Yukon. The aim of the program is to restructure commercial fishing, protect and rebuild salmon habitat and get the public accustomed to reduced fishing opportunities.

In the early 1900s, 47 domestic and commercial fishing licences were issued in Dawson City. The number of sport fishing licences issued per year in the Yukon exceeded 16,000 in the 1990s.

Survey of lake trout in Teslin Lake indicates that the population of this species of fish is very low for a lake of this size. Survey of recreational anglers conducted in 1992 and 1997 indicated that the number of angled fish was far too high for a “High Quality Management Water”. Following public consultation, the Teslin Renewable Resources Council recommended that angling for lake trout be limited to one fish per angler per day. This change has been implemented and will be in effect for the 2000 fishing season.

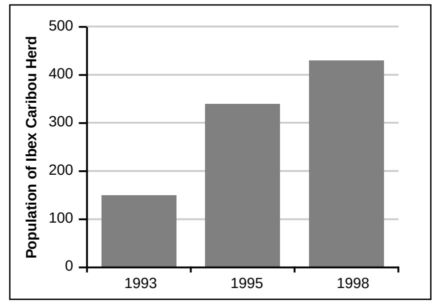
To decrease the pressure on native fish stocks through recreational fishing, pothole lakes are stocked with fish such as rainbow trout, konkanee and chinook. In 1997, Government of Yukon’s Fisheries Management Section started a formal hatchery program that involved fertilized eggs being obtained from wild broodstock and hatched in the Whitehorse Rapids Fish Hatchery Freshwater Facility for distribution throughout the territory.

Wildlife

The Yukon’s wildlife consists of 61 species of mammals, four species of amphibians, and 278 species of birds.

The Porcupine caribou herd decreased from 155,000 in 1995 to 129,000 animals in 1999. This fluctuation is considered to be within the normal range.

The Southern Lakes Caribou Recovery Project was initiated in 1993 to recover a declining caribou population in the Yukon and northwestern British Columbia. By 1997/98, the population of the Carcross and Ibex caribou herds had increased to triple the size of the 1993 population.



Moose are the most popular big game animal in the Yukon. Between 600 and 800 are harvested each year from the current population of 65,000 to 70,000 animals. The harvest provides 550,000 pounds of high quality meat to Yukoners each year.

The population of snowshoe hare is now at the peak of its ten-year cycle and is expected to crash in the next year or so.

Of the 278 species of birds that have been documented in the Yukon, 41 over-winter in the Yukon and the remainder are seasonal migrants.

By the fall of 2001, conventional leg-hold traps for lynx, coyote and wolf will be banned.

The only Yukon wildlife species considered to be endangered by the Committee on the Status of Endangered Species in Canada (COSEWIC) is the bowhead whale. The Department of Fisheries and Oceans works jointly with Alaska in monitoring the bowhead whale population, which is said to be increasing slowly.

Two wildlife species are identified as threatened by COSEWIC – the peregrine falcon and the wood bison.

The peregrine falcon has recently been down-listed from endangered to threatened. The re-introduction of the wood bison to the Yukon resulted in an increase in the herd from 36 animals in 1986 to 420 in March 1999. A limited harvest of wood bison began in 1997.

The following are species categorized as vulnerable world-wide: grizzly bear, polar bear, wolverine, short-eared owl, tundra peregrine falcon and Squanga whitefish. The great gray owl and trumpeter swan are no longer listed as vulnerable.

The elk, muskoxen, mule deer and the cougar are identified as Specially Protected Wildlife under the Yukon Wildlife Act due to their low number in the Yukon.

FOCUS ON ECOSYSTEMS

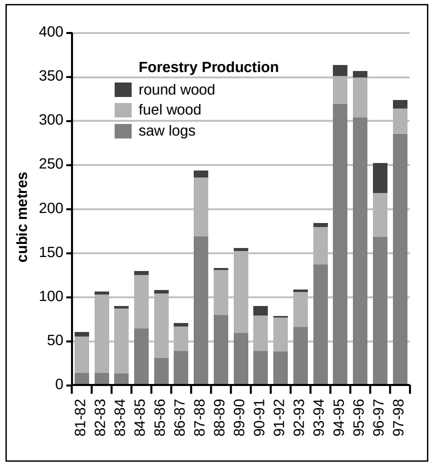
Wetlands

Wetlands include bogs, fens, swamps, marshes and shallow water. Wetlands are storehouses and purifiers of water, providing valuable key habitat for concentrations of waterfowl and other organisms. Approximately three per cent of the Yukon consists of wetlands. Ten of the 47 inventoried wetlands in the Yukon are now protected through legislation.

Forests

Approximately 275,000 km^2 or almost sixty per cent of the Yukon's land base is forested. Most of Yukon's forests are boreal coniferous forests. Yukon forests contain eight species of trees – balsam poplar, trembling aspen, paper birch, white spruce, black spruce, sub-alpine fir, lodgepole pine and tamarack. Among these, white and black spruce are the primary tree species over much of Yukon's forested land base.

Forest harvesting in the Yukon has remained between 250,000m^3 and 350,000m^3 since the peak reached in 1994/95.



In 1998, the South Yukon Forest Corporation in Watson built a modern mill with an annual capacity of 200,000 cubic metres.

The high summer temperatures and reduced precipitation resulted in increased forest fires between 1995 and 1998.

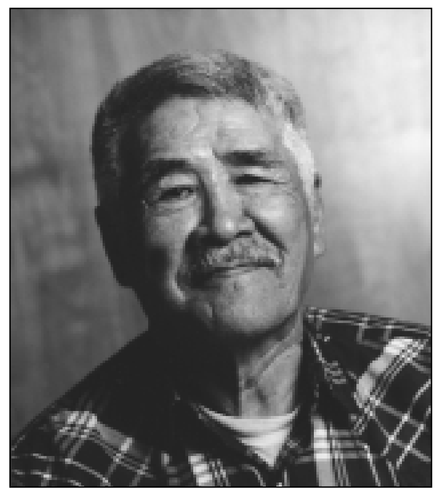
A major spruce beetle outbreak is continuing in the Kluane region of southwest Yukon and the Alsek-Tatshenshini River drainage of northern British Columbia. By the fall of 1998, the spruce beetle affected 200,000 hectares of forested land. Preliminary assessment in 1999 indicated a decrease in the beetle population.

The Elijah Smith Forest Renewal Program was developed in 1995. The fund to date has collected $ 2.5 million and has facilitated reforestation of 2000 hectares of harvested area. This program complements the natural regeneration of the forest after harvesting.

Subsistence Land Use and the Environment

Elders Stella Jim of Champagne and Aishihik First Nation and Charlie Dick of Ross River provide their accounts of the traditional way of life a half a century ago when the people who lived out on the land had little waste and minimal impact on the environment.

Stella Jim



Charlie Dick

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Introduction

The State of the Environment (SOE) Report fulfills the requirements of the Yukon *Environment Act*, Sections 47, 48 and 49. The purpose of this public report is to provide an early warning and analysis of potential problems for the environment, so that the public can monitor progress towards achieving the objectives set out in the Act, and to provide baseline information for environment planning, assessment and regulation.

The second Yukon SOE Report sets a new benchmark for our understanding of the environmental health of the territory. The 1995 SOE Report presented the first big picture of the Yukon environment, and established an all-important baseline of information on environmental factors.

With the publication of the second SOE Report, we are better prepared for measuring the progress that we have made and for addressing the challenges we face on environmental matters. The report provides information that can help us decide how to maintain a healthy environment and build a sustainable economy.

In Canada, state of the environment reporting began in 1986. Two years later, passage of the Canadian *Environmental Protection Act* made environmental reporting a legislated requirement. The Yukon *Environment Act* requirement for regular SOE reports is an indicator of the importance of this information.

The Yukon SOE reports are written to answer four questions.

- *What is happening in the environment?*
- *Why is it happening?*
- *Why is it significant?*
- *What are we doing about it?*

All Yukoners depend upon the complex, interconnected web of natural systems that makes up our environment. We continually place new demands upon these systems and need to ensure that we do not harm the environment in the process. Accurate information about the state of the territory's environment can help us track changes and trends, and make the best possible decisions about our environment.

Information has been gathered from many sources to prepare this report, including scientific knowledge and the traditional ecological knowledge held by Yukon First Nation Elders. When the perspectives of research scientists, Yukon First Nations and other resource users are shared and combined, we gain a fuller understanding of the intricacies of our environment.

Since the 1995 SOE Report was published, progress has been made in many areas and several key pieces of environmental legislation have been passed or drafted. Many challenges still await us in the next millennium, but the information provided by this SOE Report can help us choose our directions.

The Yukon Environment

We are fortunate to live in a land where environmental problems are relatively minor compared to those in most parts of the world. Overall, the air is clean, the water is pure and there is an abundance of wilderness and wildlife in the territory. Serious specific problems have been identified, but the Yukon, in general, has a healthy environment.

The quality and natural wealth of this environment have sustained Yukon First Nations for thousands of years and attracted many other people to build their lives here. More and more visitors are travelling here from other countries, intent on experiencing the pristine landscapes and plentiful wildlife that long ago disappeared from their homelands.

Many Yukoners depend upon the land's natural resources for their livelihoods and well-being, and all of our actions can have an impact upon the environment. The Yukon's small population of 31,000 is one reason that our environmental issues are not more serious. The communities in which we live take up only about two per cent of the Yukon's vast expanse.

We have also learned that the world's problems are our problems; contaminants blow in on the wind from all parts of the world, and scientists tell us that the effects of global warming could be more pronounced in the north than in southern regions. Because the environment is complex and interrelated, progress on environmental issues will never be a simple straightforward matter.

The differing fortunes of peregrine falcons and salmon stocks illustrate this point. Peregrine falcons almost became extinct in the 1970s because of the widespread use of DDT, but this species has now recovered, particularly in the north. But just as peregrines were being highlighted as an endangered species success story, the health of salmon populations began to cause grave concern. In 1998 and 1999, a record low number of salmon returned to spawn in the territory. It is suspected that another problem beyond our borders – dramatic changes in the North Pacific Ocean – could be at least partly to blame for this decline in salmon stocks.

In the last few years, major progress has been made on identifying and cleaning up contaminated sites in the Yukon. Many of the most serious problems were caused from the 1940s and 1960s, a time when there was less understanding about environmental impacts. Chemicals such as DDT and

Yukon Environment Act

Yukon State of the Environment Report

47. (1) The Government of the Yukon shall report publicly on the state of the environment pursuant to this Act.

(2) The purpose of a report under subsection (1) is

(a) to provide early warning and analysis of potential problems for the environment;

(b) to allow the public to monitor progress toward the achievement of the objectives of this Act; and

(c) to provide baseline information for environmental planning, assessment and regulation.

Requirements for the Yukon State of the Environment Report

48. (1) The Minister shall prepare and submit to the Legislative Assembly a Yukon State of the Environment Report within three years of the date this section comes into force and thereafter within three years of the date of the previous report.

(2) The Yukon State of the Environment Report shall

(a) present baseline information on the environment;

(b) incorporate the traditional knowledge of Yukon First Nation members as it relates to the environment;

(c) establish indicators of impairment of or improvement to the environment and identify and present analyses of trends or changes in the indicators; and

(d) identify emerging problems for the environment, especially those involving long-term and cumulative effects.

(3) The Minister shall coordinate preparation of a Yukon State of the Environment Report with the preparation of a revision of the Yukon Conservation Strategy and, to the extent practicable, with state of the environment reporting of the Government of Canada, circumpolar nations, and jurisdictions adjoining the Yukon, and an audit under section 39.

Review by Council

49. The Council shall review a Yukon State of the Environment Report and submit a report of its review to the Legislative Assembly.

Interim Report

50. (1) Commencing from the date of the first Yukon State of the Environment Report, for every period of twelve consecutive months in which a Yukon State of the Environment Report is not made, the Minister shall prepare an interim report and submit it to the Legislative Assembly.

(2) An interim report under subsection (1) shall comment on matters contained in the previous Yukon State of the Environment Report.

PCBs were in widespread use then, and hydrocarbon contamination was not a cause for concern.

We now know that the Yukon is not a limitless frontier, and that careless actions can haunt us for decades. Since the 1995 SOE Report, new regulations have been put into place on an array of matters, including spills, storage tanks, ozone depleting substances, beverage containers, contaminated sites and air emissions. The Yukon Protected Areas Strategy will help ensure that critical habitats are protected.

In the next millennium, there will be many changes in the way we manage the Yukon's environment, with a much higher level of local control or participation in resource management. A major step was taken in 1995 when the Yukon Umbrella Final Agreement was signed into law. Its passage led to the establishment of many local management boards. An agreement on devolution, now on the horizon, will transfer responsibility for resource management and other matters from federal to territorial control.

Yukoners depend upon the health of our natural systems and recognize that a healthy environment and a healthy economy go hand-in-hand. This second SOE Report adds to our understanding of the many different aspects of the Yukon environment, and how they relate to one another. It can give us a clearer idea of the challenges that face us in the next millennium, and it can help us to make better decisions about the environment and the way that we want to live.

Chapter 1

AIR AND CLIMATE CHANGE

1.1 Air Quality – local perspective

The 1997 interim State of the Environment Report addressed air quality in the Yukon. The 1997 report is available from the Yukon Department of Renewable Resources, Policy and Planning Branch.

1.2 Climate change and the Greenhouse Effect

There are many factors, of both natural and human origin, that determine the climate of the Earth. Climate is naturally variable, and can show large fluctuations over time, but recent evidence indicates that human activities are irrevocably changing the Earth's climate [1]. This phenomenon is known as climate change and has been defined by the United Nations Framework Convention on Climate Change as:

"a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."

In other words, the term climate change applies to those changes which are brought about by human activities, against a background of natural climate variability.

Climate change research and studies attempt to:

- understand natural variability in climate;
- identify activities which magnify these changes;
- identify the consequences of climate change; and

- recommend actions that adapt to or minimize the impact of these changes.

Climate change is caused by the accumulation of a number of gases in the atmosphere. These gases are relatively transparent to sunlight and absorb most of the infrared heat energy transmitted by the Earth towards space. This phenomenon has been called the ‘greenhouse effect’ and the absorbing gases that cause it are called greenhouse gases. Greenhouse gases include water vapour, carbon dioxide (CO2), methane, nitrous oxide, ozone and halocarbons. In recent years the possible impacts of the greenhouse effect on global and regional climate have been of increasing concern to scientists, the community and policy makers .

The greenhouse gas of greatest concern is CO_2. Since the industrial revolution and expansion of agriculture around 200 years ago, humans have been pumping additional CO_2 into the atmosphere. Today, the concentration of this gas is approximately 30 per cent greater than it was in the 18th century. Atmospheric concentrations of CO_2 are expected to double again to projected levels of 560 to 720 parts per million (ppm) by 2100, the highest recorded CO_2 levels during the past 35 million years. Levels of other greenhouse gases have also increased because of human activities.

Higher concentrations of greenhouse gases in the earth’s atmosphere will lead to warming of the lower atmosphere, resulting in changing weather and climate. An analysis of temperature records shows that the earth has warmed an average of 0.5°C over the past 100 years. The warming is real and significant, although its intensity has varied from decade to decade, from region to region, and from season to season. The potential effects of climate change are pervasive and will affect all species of plants and animals, including humans.

Although some preliminary data and models exist, there is a need for additional information in order to understand the impacts of climate change. The dominant view among experts is that if we continue releasing heat-trapping gases at the present rate, the average world temperatures are likely to be 0.8°C to 4.5°C higher over the next century. Global warming also presents a particular challenge to the management of natural resources and conservation of biodiversity in a world already largely modified by humanity.

This chapter summarizes the results of scientific research on climate change in the Yukon, and relates this information to a Canadian and global context. The potential impact of climate change on plants, animals and the human population are considered.

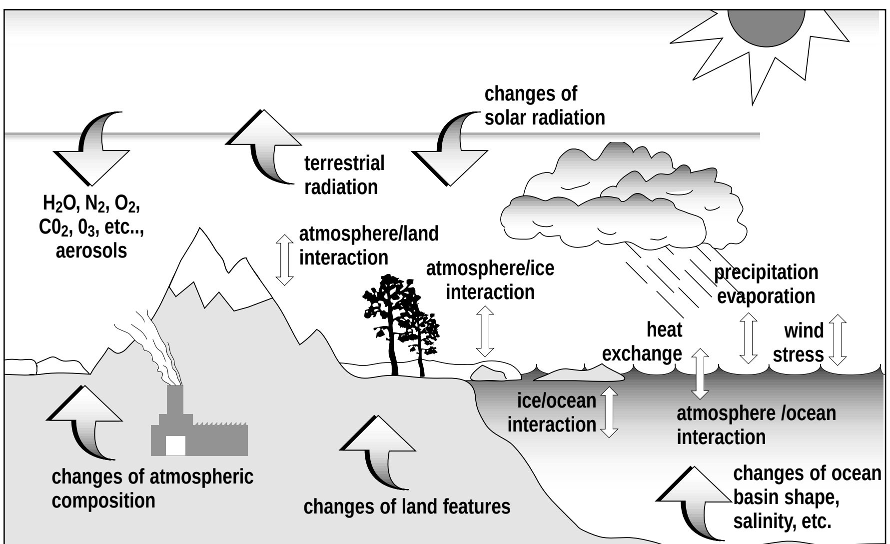


Figure 1.1 Components of a Climate Systems Model
Some are natural processes; others are influenced by human activities. It is the balance between them that will determine future climate change.

Weather versus Climate

Weather is defined as the state of the atmosphere with respect to temperature, pressure, humidity, clouds, wind and precipitation at a given place and time. Climate is usually defined as average weather. It is also defined by the variability of individual climate elements such as temperature or precipitation and by the frequency with which various kinds of weather conditions occur. Any factor which is characteristic of a particular location’s weather pattern is part of its climate. In other words, climate is what you expect, weather is what you get. Not all changes will be negative for everyone. Almost everywhere, however, the weather and climate will be different for the upcoming decades.

Climate Models

One of the most effective ways to estimate future climate is to use computer simulations of past and present climates. Climate models are complex computer programs based upon the physical laws and equations of motion that govern the Earth’s climate system. It takes the most powerful computers in the world to carry out the necessary computations. Climate models mimic the way in which the Earth’s climate behaves from day to day, and also over the seasons. This is done for all regions of the globe: the surface, throughout the atmosphere and for the depths of the oceans. Global climate models contain four main components: the atmosphere; the oceans; ice and snow covered regions; and land surfaces with vegetation cover (Figure 1.1). The models are designed to include all of these interacting parts.

The models confirm that increasing levels of greenhouse gases will produce a warming at the Earth's surface. They also show that the enhanced greenhouse effect is likely to lead to world-wide changes in weather and climate. The models show that land will warm more than the sea, that daily variations in temperature over land will likely decrease. The greatest warming is expected to occur in the sub-polar regions of the northern hemisphere during winter, due to melting sea-ice and snow. Average precipitation across the globe is likely to increase, particularly during winter in high latitudes.

Canadian scientists have developed one of the most advanced climate models. Their research suggests that average global surface temperatures could increase, on average, by almost a half degree each decade during the next century. Parts of the north, including the Yukon, will see the greatest changes in global climate and will experience these changes sooner than other regions of the planet (Figure 1.2).

Scientists also estimate that by the end of the 21st century, global warming will raise the average sea level (melting of glaciers) between 13 and 110 cm above the 1990 level. Records show that the global sea level has risen by between 10 and 25 cm during the past century, however, it is not possible to attribute this increase to the enhanced greenhouse effect.

Assessing Patterns and Effects of Climate Change in the Yukon

The issue of climate change and global warming is crucial to the future of the

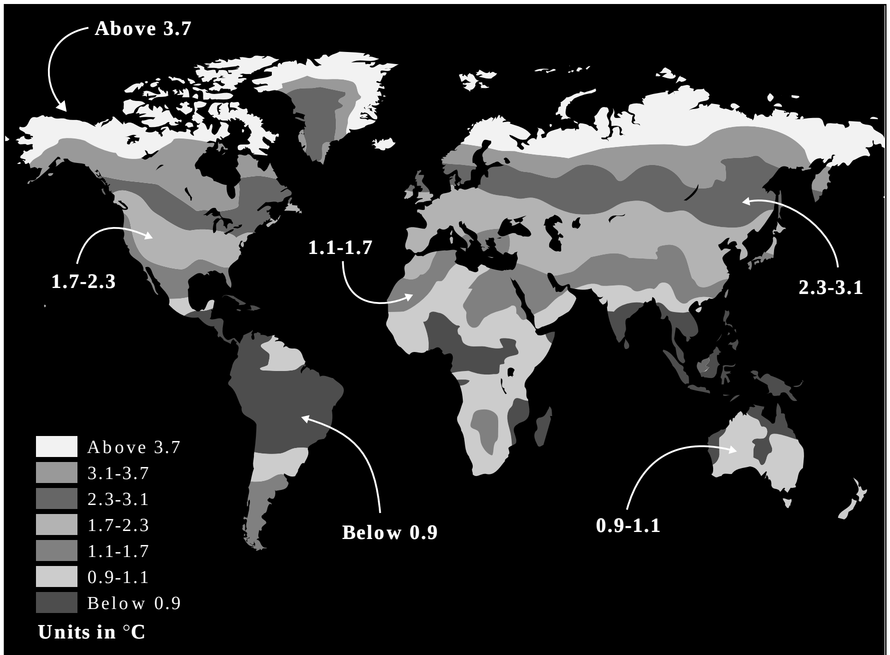


Figure 1.2 Projected Global Climate Change 1970-2050
This map shows the results of a global climate change model of projected temperature changes between 1970 and 2050. Light shading indicates the greatest increase of warming during this period.

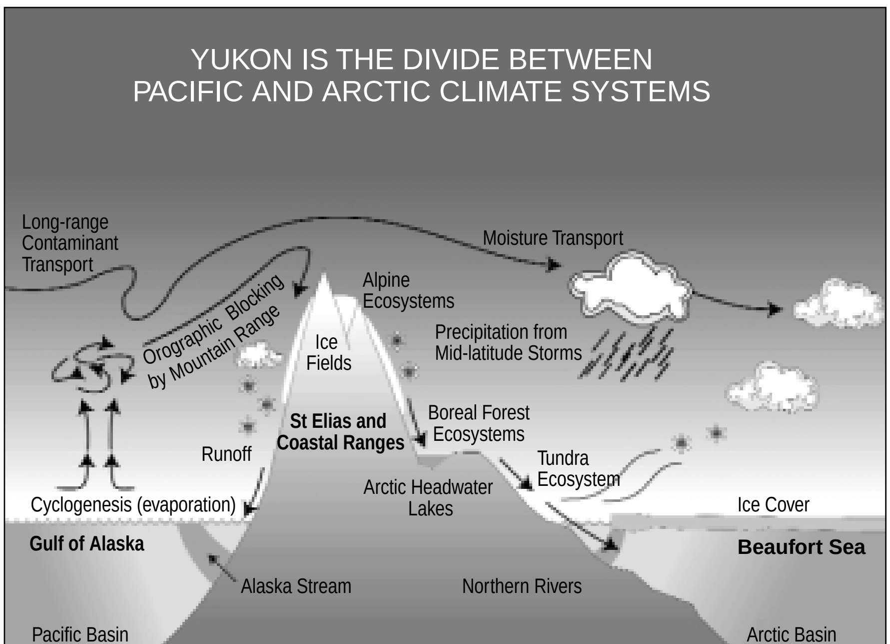
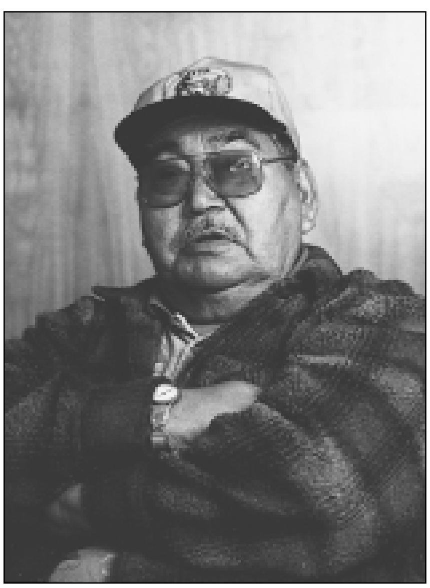


Figure 1.3 Yukon Climate System
The Yukon lies between the Pacific Ocean and Arctic Ocean basins and is a strategic region in understanding global climate change. The St. Elias Mountains form a steep barrier between these two oceans and moist air masses from the Pacific accumulate on the lower slopes and peaks of these mountains and surrounding ranges. This accumulation of snow results in a network of valley glaciers which feed the headwater lakes and rivers of the Yukon. Much of the rest of the Yukon lies in the arid rainshadow of the mountains, and these forest and tundra communities are also influenced by global changes.

Yukon (Figure 1.3). For example, the frozen north will be warmer due to winter temperatures rising as much as 10°C in northern latitudes. There will likely be more precipitation, especially in fall and winter. Snow seasons will be shorter, but the build-up of snow could bury food for northern wildlife and also result in heavy spring flooding along many northern rivers. The slow melting of the permafrost layer, which underlies much of the Arctic tundra, could turn the ground into a muddy quagmire. This could affect transportation, since in many areas surface travel is possible only when the ground is frozen solid. Buildings and other structures, such as pipelines built directly on permafrost, may become unstable. Forest fires and pest insects may become more common.

"I see what's wrong, we've been having no cold. We used to go beaver hunting and we used to see water running right through the bush, creeks flooded. This time you go in the springtime, you don't see water. We haven't got any cold weather to keep water in."–Johnnie Smith, Kwanlin Dun First Nation Elder



Johnnie Smith

The lifestyle and expectations of northern Canadians could be affected in many ways. In the Yukon, many scientific studies have addressed aspects of climate change in an attempt to define the scope of the problem, but there are still more questions than answers.

Traditional environmental knowledge is also an important source of information because formal record keeping in the Yukon is a product of the 20th century and scientific observation. First Nations bring historical and cultural knowledge to the understanding of changes in the Yukon climate, including

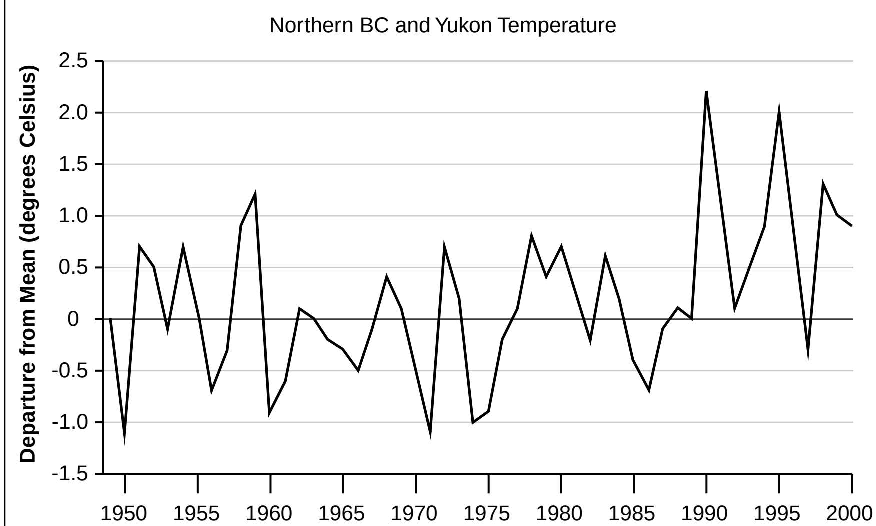


Figure 1.4 Annual Variation in Summer Temperature 1948 to 1999
This graph shows the difference (positive or negative) from 1948 to 1999 long-term average summer temperature in the Yukon and northern British Columbia. The three warmest years occurred in the 1990s.

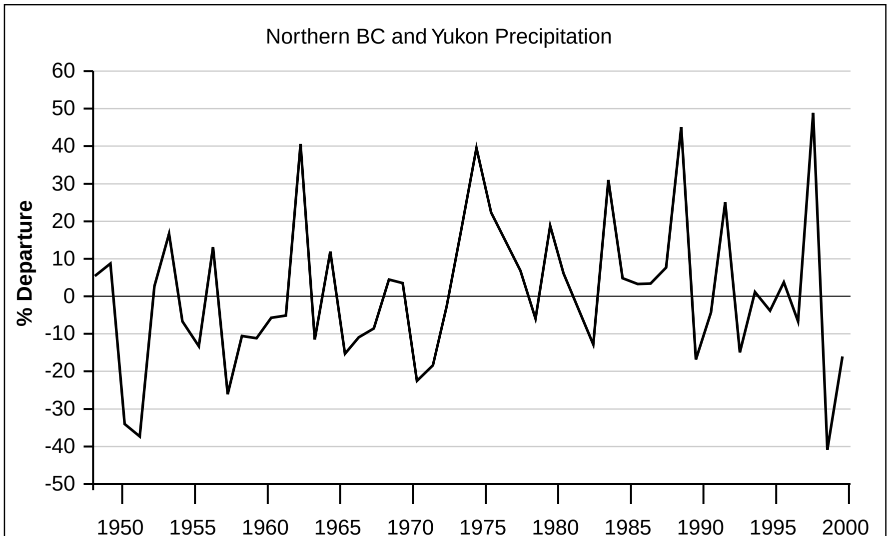


Figure 1.5 Annual Variation in Summer Precipitation 1948 to 1999
This graph shows precipitation as a percentage difference (positive or negative) from the long-term average summer precipitation in the Yukon and northern British Columbia. There is significant variation from year to year. However, the greatest extremes were in the last few years.

testimonies about glacier impounded lakes, changes in flora and fauna and "the year that summer didn't come" [2,3].

First Nations bring to light critical questions central to planning processes that involve their communities, about whether climate change may have an impact on programs directed at social, economic and resource management issues. People in communities provide information about past changes in the land as a basis for identifying links between previous climate trends and ecosystem impacts. They also monitor current trends in ecosystem health and related changes in land-use practices.

1.3 IS THE YUKON CLIMATE CHANGING?

Summer Temperature and Precipitation

According to Environment Canada, 1998 was the warmest year on record in Canada [4]. A comparison across the country of temperature and precipitation for 1998 with data from the past 52 years showed that the national average temperature for January to December 1998 was 2.5°C above normal. In 1998, some areas of the Arctic had annual temperatures more than 4°C above normal. In the Yukon, summer temperatures in 1998 and 1999 were among the four highest years ever recorded (Figure 1.4). These two summers were also among the driest recorded in the Yukon (Figure 1.5).

Regional trends in summer temperatures across the Yukon show considerable variation from one year to the next, but in general, there has been a trend towards higher temperatures over the past 30 years. In the northern Yukon, mean summer temperatures at Old Crow and Shingle Point have increased by almost 2°C since the 1960s (Figure 1.6). In other parts of the Yukon, there have also been changes in mean maximum and minimum summer (June–August) temperatures (Figure 1.7). These changes have been smaller in Whitehorse and Mayo compared to Burwash and Watson Lake, although all locations have seen an increase in recent years.

Growing Season Length

Changes in summer temperatures have also resulted in significant increases in the length of the growing season, measured as the number of days with average temperatures above 5°C between killing frosts. One of the longest records available is from Mayo.

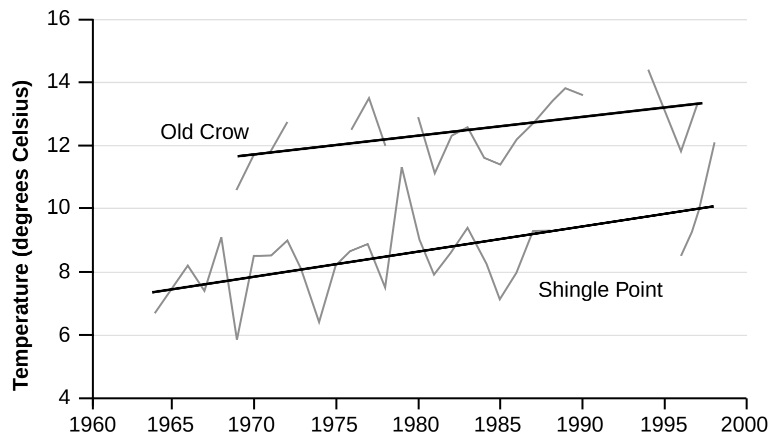


Figure 1.6 Trends in mean summer temperatures at Old Crow and Shingle Point from 1964 and 1998. *The data presented in these graphs are averages of mean monthly temperature data for June–August provided by Meteorological Service of Canada, Environment Canada. Missing data points are due to a lack of sufficient data to calculate seasonal averages for those years. Thick straight lines show the trends over the entire period and the thin lines indicate annual variability.*

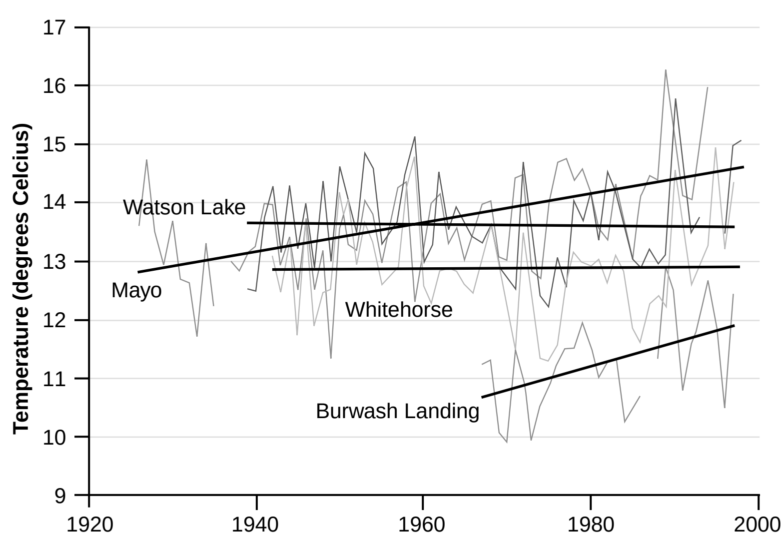


Figure 1.7 Mean summer temperatures at Mayo, Whitehorse, Burwash Landing and Watson Lake 1920 to 1998
There is considerably variability between years (light lines). Trend lines show only slight increases at Whitehorse and Watson Lake, but significant increases at Burwash Landing and Mayo.

It shows a significant temperature increase this century, particularly during the past two decades (Figure 1.8). A number of other Yukon regions show similar increases. This longer growing season may allow more agriculture to be developed, but there are potential negative impacts on other plants and animals, and permafrost.

Permafrost Depth and Temperature

Permafrost in central Yukon, measured at a depth of 12 m at several sites near Mayo, has cooled during the 1990s by about 0.2°C [5]. This is in response to several years of relatively little snow on the ground before Christmas. During the winter of 1998-1999 exceptionally deep frost penetration was recorded, partly because there was less than 10 cm of snow on the ground before December 15. Closer to the surface the ground has cooled further, however temperatures are more variable at these depths.

In southern Yukon, ground temperatures in permafrost have remained relatively constant at close to 0°C over the decade [6]. Disturbances to permafrost terrain from forest fires and other changes in surface conditions have produced the greatest measured impact on permafrost conditions. Within the Takhini Valley, changes in vegetation caused by forest fire have led to an increase in ground temperature of 3°C, while near Mayo ground surface temperatures have increased 4°C on disturbed sites near Stewart River [7]. Permafrost at both sites is not sustainable after such a change in surface temperature, and long term permafrost degradation has been documented. The melting of permafrost may destabilize soil and cause erosion in many areas. In wetlands, permafrost decay may generate and release methane gas, one of the primary 'greenhouse gases'.

Indicators of Past Climate and Climate Change in the Yukon

Direct instrumental climate records tend to be relatively short in the Yukon. Scientists rely on a number of indirect measures of climate change and climate variability over longer periods. The results of these studies emphasize the importance of different greenhouse gases, ocean circulation and other mechanisms in determining past as well as present global climate change. Past climate records are based on physical and biological evidence, such as the calibrated annual increments in ice cores and tree rings, as well as longer-term records from lake sediments, which may span millions of years. In recent years there have also been a number of very exciting discoveries of animal and human remains on melting snowpatches and glaciers.

Geological Record

The geologic record provides a unique long-term history of dramatic changes in the global climate and of the impact of these changes on vegetation and wildlife in the Yukon. Past environmental change may have caused species to migrate, to become extinct, or given rise to new species.

The marked changes in climate and vegetation from the Gulf of Alaska to the Yukon interior are caused by the topographic barrier of the St. Elias Mountains [8]. Tectonic evidence shows that uplift began in the late Miocene (approximately 8.5 million years ago), and is still continuing. Prior to this period, there were no significant continuous mountain ranges in the western Yukon. Evidence suggests that Arctic plants migrated from temperate mountains to northern regions about three million years ago. During this period of uplift, the vegetation changed dramatically from a temperate flora, to one dominated by herbs and shrubs, more typical of a continental, cool and dry climate. The uplift of the St. Elias Mountains may also have contributed directly to the development of high northern latitude continental glaciation, which had significant effects on the subsequent flora and fauna of the southwest Yukon. Numerous glacial periods are recorded during the last one million

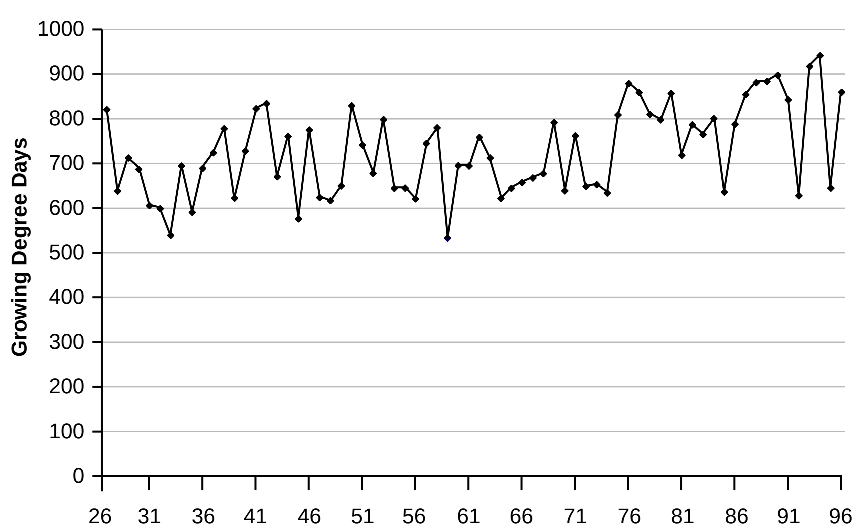


Figure 1.8 Growing degree days in Mayo 1926 to 1996
This graph shows that there has been a significant increase in the number of Growing Degree Days (days above 5°C between killing frosts) in Mayo, particularly in the last two decades.

years (Pleistocene), ending only about 12,000 years ago (Figure 1.9).

Since then, the Yukon has undergone significant warming with occasional glacial advances (the past 10,000 years are referred to as the Holocene). In the Yukon, most information about Holocene conditions comes from pollen obtained from sediment cores from smaller freshwater lakes [9]. One of the longest pollen records in the southwest Yukon is a 6.4 m sediment core from Antifreeze Pond near Snag which covers a period of 31,000 years before the present (YBP). The vegetation in this area was dominated by sedges, willow and birch during the last glacial period. As the glaciers melted, the pollen indicates a transition to spruce forest around 8,500 YBP. The area has had a closed white spruce forest for the past 8,000 YBP [10].

The rate at which changes in climate (and subsequently the flora and fauna) occurred has not been established, but evidence suggests that climate conditions may have changed very rapidly [11]. Measurements from Greenland ice cores suggest that rapid changes in climate at the end of the Pleistocene, on the scale of less than 20 years, suggests rapid shifts of patterns of Arctic atmospheric circulation. A group of scientists from Queen's University and Laval University analyzed lake sediments from a saline lake near Pelly Crossing and used fossil diatoms (small aquatic organisms) and pigments to study climate changes during the Holocene [12]. They found evidence of humid climatic conditions in the early Holocene, followed by a trend towards drier conditions during the past 2,000 years. The various indicators of past climate revealed an interesting history of frequent and rapid shifts during the past 10,000 years. This suggests that there were a number of times when the climate changed rapidly during the mid- and late Holocene. These rapid rates of change are consistent with some predictions of global change models.

Ice Core Records from Mount Logan

The long-term climate records based on the interpretation of geological and lake sediment records are fairly useful in assessing the general patterns of past climate change but provide less

Present	100 – 300 years ago	Little Ice Age
Holocene	8000 years ago	Closed spruce forest
	8500 years ago	Transition to spruce forest
	10 000 years ago	Significant warming with occasional glacial advances
Pleistocene		Numerous glaciations or "Ice Ages"
	1.7 million years ago	Vegetation dominated by sedges, willow and birch
Pliocene	3 million years ago	Arctic plants migrated from temperate mountains to northern regions
	5 million years ago	Flora dominated by herbs and shrubs
Miocene	8.5 million years ago	Uplift of the St Elias Mountains
	24 million years ago	Temperate flora

Figure 1.9 *This figure shows the geological record and timing of major climate and environmental events in the Yukon over the past 24 million years. Many of the characteristic Yukon plants and animals from these periods are on display in the Beringia Centre in Whitehorse.*

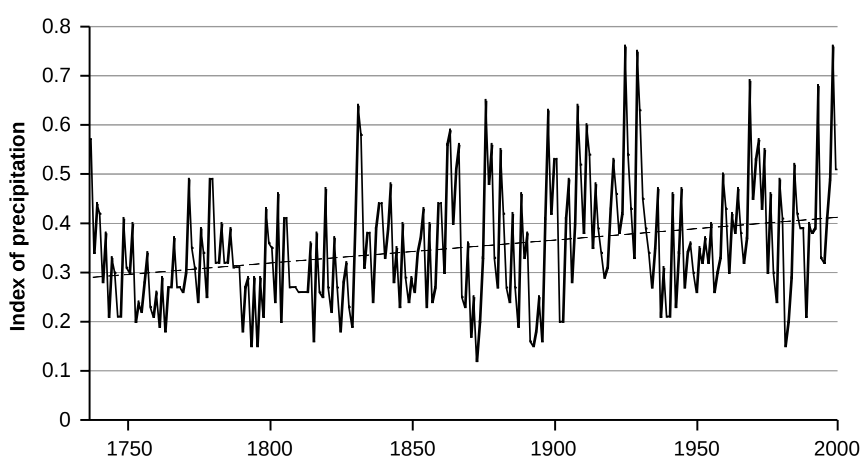


Figure 1.10 Annual precipitation. Mount Logan ice core (1732-1987)
There is a trend of increasing precipitation since 1732 as well as significant variations from year to year. The index is calibrated from the thickness of the annual ice layers in the core.

accurate information about annual variation in climate. One of the most complete and detailed records of changes in annual climate comes from the Mount Logan ice core time series (Figure 1.10). In 1980, glaciologist Gerry Holdsworth, now at the Arctic Institute of North America in Calgary, recovered a 103 m ice core from the summit plateau (5,300 m) of Mount Logan in Kluane National Park. The 300 year record yielded information about annual precipitation, temperature and atmospheric chemistry, from the analysis of annual layers of snow [13]. In the summer of 2000, an attempt will be made to recover another high resolution core from Mount Logan. This ice core sample is expected to yield climatic information from the past 10,000 years.

The Mount Logan ice core showed that snow accumulation peaks periodically, corresponding to the periods of the solar (sunspot) cycle and El Niño events. There is also a trend for an increase in the accumulation of precipitation (calculated as a percentage deviation from the long-term average) during the past 200 years. The data for temperature, based on oxygen isotope ratios in the time series, is not as strong, but also suggests a significant correlation with the 11-year solar cycle.

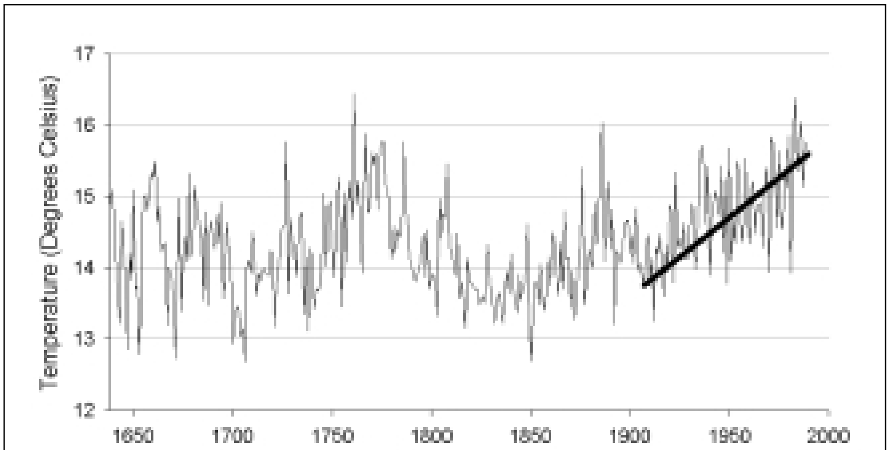


Figure 1.11 Estimated June and July temperatures from tree ring records, Tombstone, Yukon 1638 to 1988
There is a warming trend since 1988 [13].

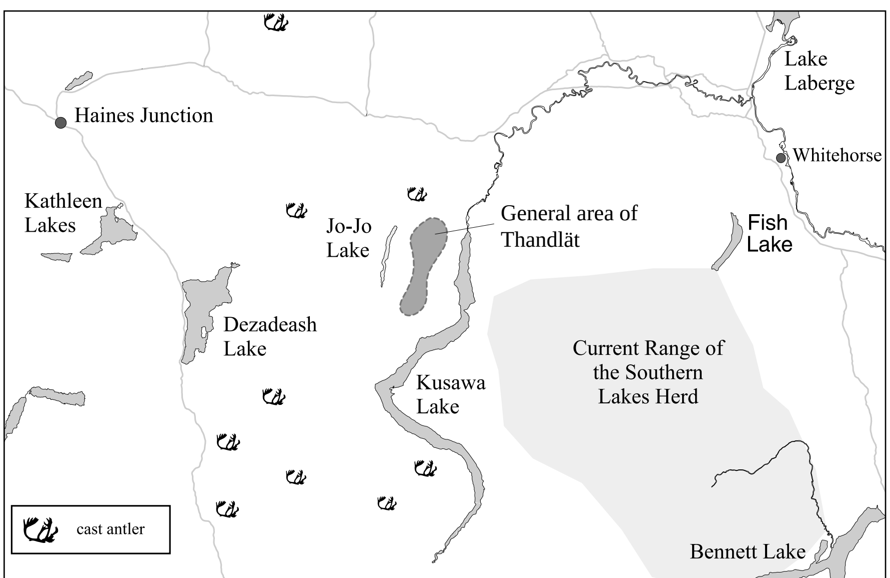


Figure 1.12 Area of Southwest Yukon where of prehistoric caribou sites are known [16].

Reconstruction of Summer Temperatures at Tombstone Mountains from Tree Rings

Trees produce an annual growth ring, the size of which depends on environmental conditions. Several researchers have examined tree ring growth in white spruce *(Picea glauca)* stands to reconstruct summer temperatures in northwestern Canada since 1638 A.D. The reconstruction suggests that June-July temperatures were cooler than present temperatures during most of the last 350 years with the exception of the late 18th century (Figure 1.11). Particularly cool periods occurred around 1702 [14]. Other temperature reconstructions over the past millennium indicate that the last 50 years stand out when compared to the past 1,000 years in the Northern Hemisphere. The past 10 years (1990s) have been the warmest decade of the millennium, and 1998, the warmest year [15].

Evidence of First Nations Hunting and Prehistoric Caribou from Melting Ice Patches, Southern Yukon

In 1997, large concentrations of caribou dung were discovered on melting permanent alpine snow patches in southern Yukon (Figure 1.12) [16]. At one site (Thandlät), the last reported herds of caribou were observed in 1932. Dung pellets indicate that caribou were present as early as 8,330 BP. Analysis of plant fragments from the caribou dung indicate that the diet of the Thandlät caribou consisted mainly of sedge and lichen. Evidence of prehistoric human hunting was also found at this site. A dart fragment was dated between

6,860 to 6,930 years old, representing one of the few organic examples of atlatl technology (short spear propelled by a throwing board) ever found in Canada [17]. These dates indicate that the formation of this alpine snow patch may coincide with a mid-Holocene cooling trend and that aboriginal Yukon hunters have been harvesting animals, presumably caribou, at this location for at least 6,000 years. These rapidly melting deposits provide rare insights into the history of caribou ecology and distribution through time, including factors such as changes in health and diet, and archeological information about the hunting methods and subsistence lifestyle of First Nations peoples from long ago.

Impacts of Climate Change on Yukon Plants, Animals and Ecosystems

What effects would climate change have on the Yukon's natural ecosystems? Even minor climate changes could have major consequences for plants and animals living on land and in water. The greatest effect will be on plants since they are directly affected by temperature and rainfall and cannot move if conditions become hostile or counterproductive. Species must either adapt to climate change, move, or disappear. If the changes are gradual, migrations of species may proceed with little disruption. Rapid change, allowing less time for adaptation or migration, could significantly decrease the populations of some species.

Species Migrations

One of the most profound effects of climate change may involve the northward movement of many southern species of plants and animals. Recent studies in the northern hemisphere have found that many species of animals and plants (especially mobile species such as birds and butterflies) have extended their range northward by 20 to 250 km over the past 20 to 30 years [18, 19]. Many models also suggest that forest communities will slowly shift northward and upslope on mountains. In general a 3° C increase in temperature will correspond to a 300 km shift in the northern range of a species distribution, or a 100 m shift upslope on mountains.

One of the most significant potential impacts of climate change is that species currently unable to survive the Yukon climate may be able to move north. In many cases these species may not cause problems, however some species may have a significant impact on plants and animals in the Yukon. For example, mule deer, white-tailed deer and elk sightings have increased in recent decades. Warmer winter temperatures allow species like mule deer to establish populations in southern Yukon. Similarly, ring-necked ducks were not observed on the Old Crow Flats until 1983, and although their populations fluctuate from year to year, this trend could indicate a northern extension of the breeding grounds for this species [20].

Non-native weedy plants may also increase in abundance as the climate becomes warmer. Recent reports of non-native introduced species include about 50 plants new to the Yukon and 40 plants with significant range extensions, including many potential weeds [21, 22]. Observations of these species may not be directly correlated with climate warming, but this growing list indicates the potential for new species to migrate to, and grow in the Yukon.

Increased Spread of Disease: Winter Tick and Moose

The spread of disease in populations is facilitated by combinations of certain conditions. In general, as the size of a host population increases, the load of parasites will also increase. Depending on the life cycle characteristics, habitat and climatic requirements for different parasites, the effects of climate change may increase susceptibility to disease.

One parasite that is a serious pest of moose in southern Canada in some years, is the winter tick (Dermacentor albipictus). Winter ticks on moose induce premature damage to, or loss of the winter hair (Figure 1.13). In spring 1999, thousands of moose in northern B.C. and Alberta died as a result of hair loss following winter tick infestation. While this parasite is not a serious pest in Yukon at present, research has demonstrated an association between the known distribution of winter ticks in Canada and bioclimatic zones where the mean annual number of growing degree days is about 1,000 [23, 24]. If summer temperatures and growing degree days in the Yukon continue to increase

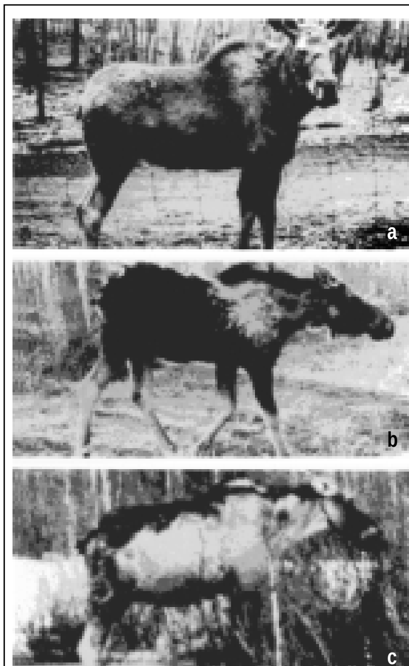


Figure 1.13 The sequence of premature loss of winter hair on moose infected with winter ticks (Dermancentor albipictus)
From top to bottom. (a) no hair loss, (b) 30-40% loss, (c) 'ghost moose" [26].

(Figures 1.6-1.8), conditions for survival of winter ticks may also improve.

In surveys conducted in 1987, a researcher at the University of Alberta found that only four percent of trappers in the Yukon had seen moose with alopecia (hair loss), compared to over 50 percent of the trappers in northern British Columbia and Alberta [25], (Figure 1.14). It appears that conditions in most of the Yukon are still unsuitable for winter tick to establish as a widespread pest (summers are too short, winters are too long), however, studies in central Alaska suggested that winter ticks could establish there in some years [26]. Environmental conditions, especially temperature, probably determine the numbers of larval ticks available for infesting moose in autumn. Monitoring temperature and degree days may be a practical means of determining when tick numbers could survive in the Yukon [27].

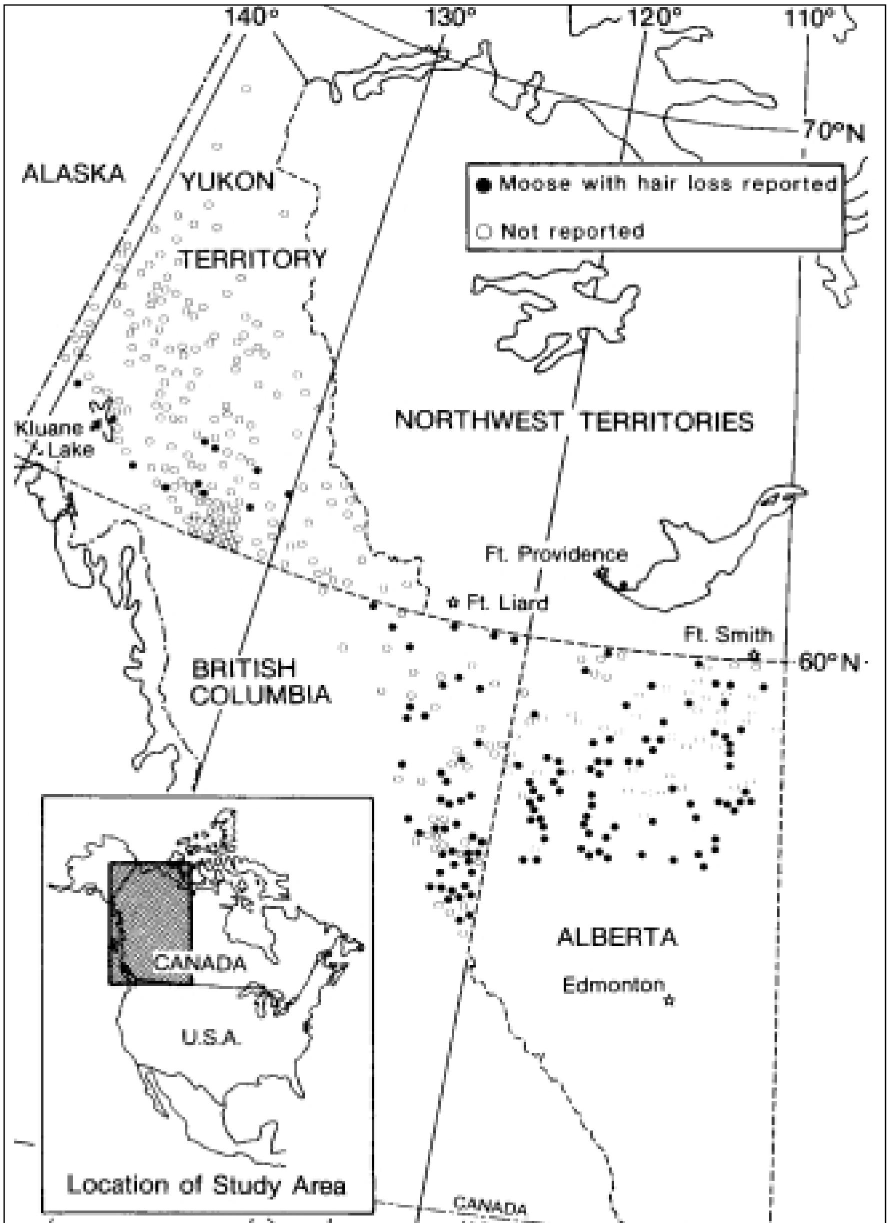


Figure 1.14 Tick Induced Hair Loss
The map shows locations of traplines where moose were observed in late winter and early spring 1987 with tick-induced hair loss [25]. Sightings are rare in the Yukon compared to Northern BC and Alberta. Warmer temperatures may result in greater incidences of hair loss in the Yukon.

Effects of Climate Change on Species
Polar Bears, Marine Species and Sea Ice

Animals dependent on sea ice cover in northern Yukon may be affected by changes in the extent, thickness and timing of ice cover. The distribution of polar bears on the northern coast of the Yukon is linked to the distribution of multi-year pack ice and the availability of seals, which are their main source of food. Although some polar bear maternal dens are located on the Yukon mainland, most dens (75 per cent) are located on drifting pack ice, in some cases up to 550 km offshore [28]. Both ringed seals and bearded seals are also born in snow caves under land-fast or transition zone sea ice.

The expected impacts of decreased sea ice cover include: reduced upwelling which brings nutrients to the surface, reduced nutrient inputs to coastal regions and reduced nutrient inputs from the loss of the undersurface of sea ice. This represents an important habitat for many species of algae and marine invertebrates. Fish that are dependent on ice cover and cold water would also be affected. The impacts of reduced sea ice cover would be expected to have major ecological consequences for both small and large marine organisms [(29, 30, 31)].

Several studies have found a general reduction of sea ice cover since the beginning of the 20th century. A recent analysis of sea ice cover in the western Arctic Ocean has found that since 1953, four of the 10 years of minimum ice extent have occurred since 1990, with increased regional variability in recent years [32]. The ice-free zone in the Beaufort Sea was especially wide during the summers of 1997 and 1998. In 1998, ice cover extent was

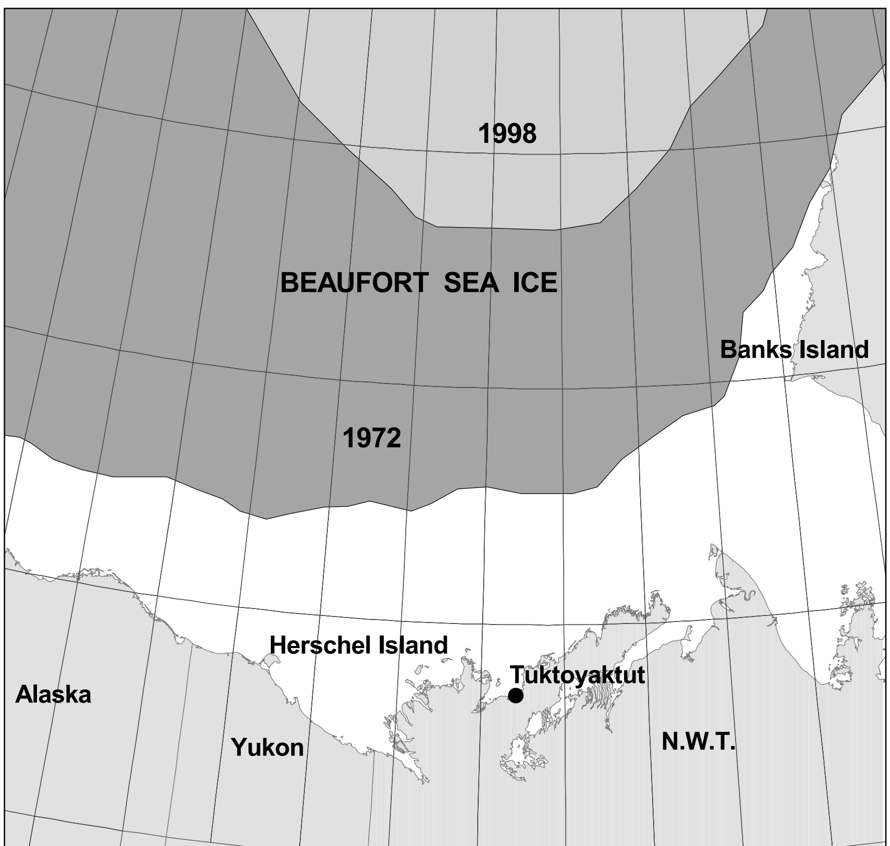
40 per cent below average values. Ships encountered no ice within 480 km of the coast, and found multi-year ice floes at 75°N in 1997 that were dramatically thinner than expected.

How unusual was the ice cover of 1997-1998? The zone between 145°and 170°W, a new record minimum was set in 1998, approximately 160 to 200 km north of the previous minimum. The sketch of the satellite image of the Arctic ice pack on September 25, 1998, shows the limited extent of ice off the Yukon coast (Figure 1.15), compared to 1972 conditions for the Yukon/Alaska coast on this date (Figure 1.15) [33].

Since there has also been a change in the circulation of the western Arctic pack ice in the 1990s, it is not known if the recent change in the Arctic is an especially large swing in a cyclic phenomenon, or part of a long-term trend. An analysis of Canadian historical data suggests that the thickness of coastal ice is probably more sensitive to snow cover than to atmospheric temperature. In the drifting ice fields of the Beaufort Sea, the thickness of level ice at a particular location depends on the date of formation of that ice. In addition, if the average tendency of drift through the winter is seaward, then ice at a particular location will be thinner, while if it parallels the shore, the ice will be thicker. Therefore, thickness will reflect prevailing atmospheric circulation rather than temperature.

Effects of Spring Weather on Plants and Animals

Snow cover influences the winter survival of plants and animals, and their growth and reproduction during the snow-free growing season by influencing temperature and moisture regimes. The effects of changes in snow cover and the timing of snowmelt in spring may include an overall reduction in the productivity of meadows and consequently a reduction in the availability of forage for small and large mammals. Alternatively, if snow melts earlier, high quality forage may not be readily available when animals are breeding or when young animals most require it. Studies have found that a shift in the timing of snow melt leads to rapid changes in the composition, growth rate and phenology (timing of growth) of alpine and Arctic plant communities.



Figures 1.15 Ice conditions between 1972 (the first year of ice records) and 1998
The average distance of the ice pack from the shore has in the past been approximately 100 km; the 1998 extent was at least three times as far.

Growth of alpine plants

Scientists from the University of Alberta measured the effects of a 2.5 week delay in snow melt during two summer seasons of plant growth in alpine meadows in the Ruby Range [34]. They found that in spite of a 20 per cent reduction in the number of snow-free days during the growing season, the timing and growth of polar willow *(Salix polaris)*, mountain sagewort *(Artemesia norvegica)* and sedge (*Carex*) species were only slightly delayed on plots where snow melt was delayed experimentally. There was no significant effect on the overall composition of the plant community. There was, however, a significant 25 per cent decrease in the total amount of vegetation or biomass at the end of the season on plots where snowmelt was delayed. While a reduction in plant growth could have serious consequences for survival and reproduction of large and small mammalian herbivores, such as Dall sheep, mountain goats, and marmots, that live in mountain regions, a longer growth season may result in more available forage.

Growth of Dall Sheep Horns

Since the 1970s, the horns of all Dall sheep shot by hunters in the Ruby Ranges have been measured by Yukon Department of Renewable Resources biologists. The horns of sheep can be

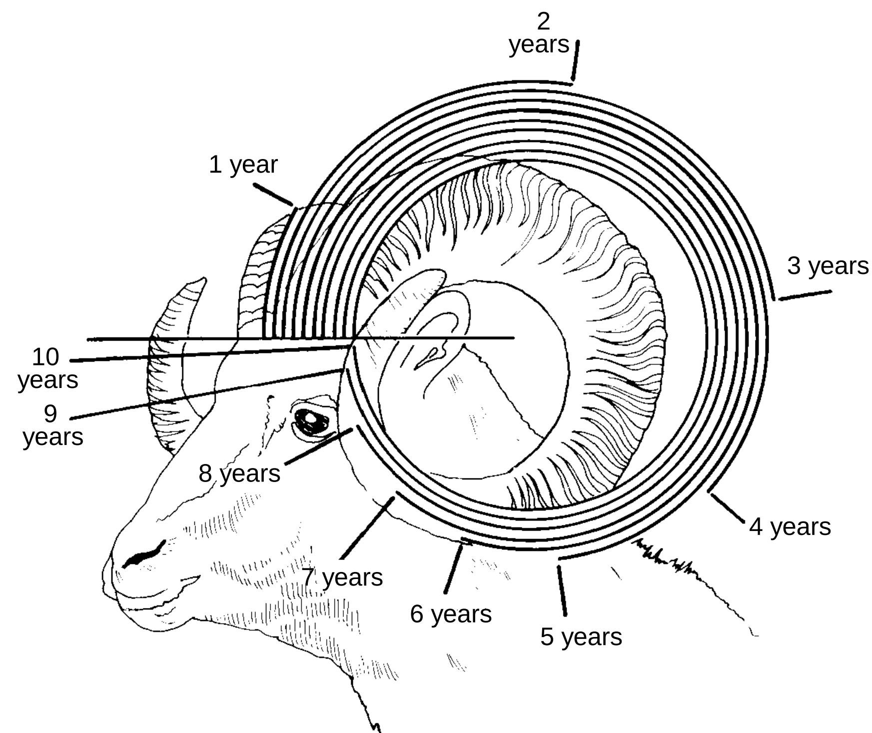


Figure 1.16 Measurement of annual growth of Dall sheep horns
There are distinctive growth increments during each year, much like tree rings. Climate and precipitation have been found to affect growth of sheep horns.

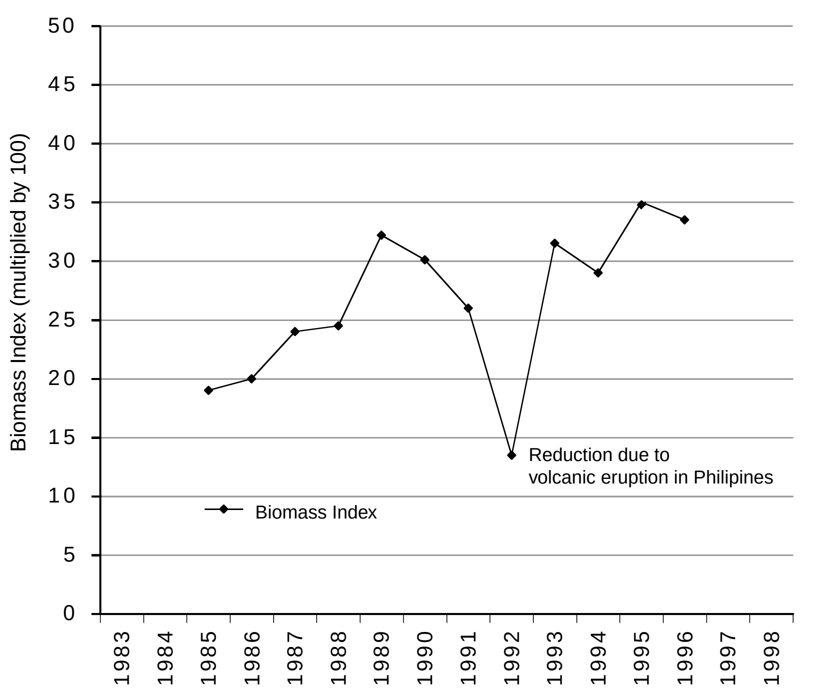


Figure 1.17 Available Forage: The Porcupine Caribou habitat
This graph shows an index of the amount of green biomass (forage) on Porcupine caribou calving grounds on June 21 measured by satellite. Managers are tracking calf survival and determined that the number of calves surviving increase in relation to available forage.

divided into annual growth increments, which are correlated to the availability of resources in a given season (Figure 1.16). In years when snow melt is delayed and plant growth is reduced early in the spring, the growth of sheep horns is greatly reduced. There is also a strong relation between mean temperature in May and the number of lambs born. This pattern was observed in 1982, 1992 and 1999. These years of poor growth and recruitment may have long-term implications for population dynamics and management of Dall sheep in the Yukon.

Population Dynamics of the Porcupine Caribou Herd

The 128,000 animals that make up the Porcupine caribou herd *(Rangifer tarandus granti)* range throughout the northern Yukon and neighbouring Alaska and Northwest Territories. Each year, conditions in the environment of the caribou are reflected in the survival, reproduction and body condition of the animals. Each year the birth and survival rates of calves depend on how much food is available for the cows to consume, and how much energy they must use to feed and to survive. Vegetation growth, snow depth, temperatures and winds affect the ability of caribou cows to build up enough body reserves to give birth and raise their young. Three predictions for the future of the northern Yukon are warmer summer temperatures, more snow, and faster snow melt.

As the dominant large herbivore in northern Yukon, migratory barren-ground caribou are likely to respond to global climatic changes that affect the growth or location of their food. Large scale habitat conditions for caribou during the growing season can be assessed from satellite data. Scientists from Alaska and the Yukon have found that there is a positive relation between early survival of caribou calves and the timing of green-up on the North Slope calving grounds [35]. In most years between 1985 and 1996, the caribou have had more food and have been able to eat it a few days earlier in June (Figure 1.17). With increasing food during calving, more calves have survived the month of June. Since small changes (~5 per cent) in the survival of caribou calves can determine whether a population grows or declines, the relation between calf survival and the quantity and quality of forage may predict the effects of a change in habitat conditions on caribou populations [36]. However, the overall effect of climate change will depend on the balance between negative and positive influences. For example, hotter summers lead to more insect harassment which affects the caribou's ability to gain weight in summer.

Snow Cover and Overwinter Survival and Reproduction of Arctic Ground Squirrels

Arctic ground squirrels are one of the more abundant and conspicuous small mammals in many parts the Yukon. They are an abundant source of food for all sorts of avian and mammalian predators. While their population numbers are linked in part to fluctuations in snowshoe hare and predator numbers, researchers at the University of Toronto have found a direct correlation between average snow cover in winter and subsequent reproduction of female ground squirrels in the Kluane area (Figure 1.18). In years when there is higher snow cover there is also an increase in the number of females in the population successfully raising young [37]. If winter snow cover increases, a larger number of Arctic ground squirrels may provide additional food for predators during the summer [38, 39, 40].

Fish in the Upper Yukon River Basin

The Upper Yukon River Basin is home to 20 native species of fish and three other species which have been introduced (see Section 4.1). Climate change induced alterations to fish habitat including water level, oxygen level, silt loads, temperature, acidity on spawning or overwintering areas, pose a threat to some of these populations [41]. Changes in the quality of habitat for fish may shift advantage from one species to another. For example, chinook salmon may not be able to migrate up a stream to spawn due to climate change induced low water (direct disadvantage) and increased beaver activity (indirect disadvantage). This would result in a lower number of juvenile chinook salmon the following summer in upstream habitats. Resident fish such as juvenile or adult Arctic grayling would not have to compete against dense populations of juvenile chinook salmon (indirect advantage) and would have increased volumes of habitat due to the beaver ponds (indirect advantage).

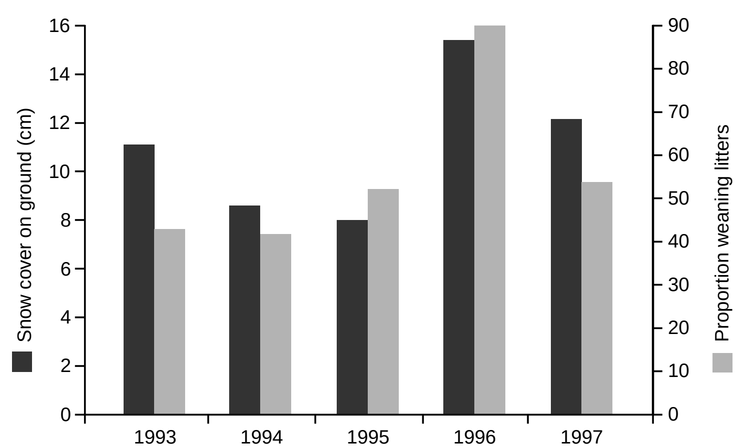


Figure 1.18 Snow cover and litters of squirrels

This graph shows the average amount of snow cover on ground from November to March, and proportion of adult female ground squirrels weaning a litter during the following spring at Kluane, Yukon. There is significantly higher reproduction in years with deeper snow.

In the short-term, as a result of glacial runoff there will continue to be greater volumes of water entering (and leaving) the upper lakes of the Yukon River Basin than can be accounted for by annual precipitation. As a result, the seasonal volumes and areas of lakes may be altered. The area of the biologically important shoreline zone may be significantly affected as it will be underwater longer. As most channels in the north are relatively wide and shallow, relatively minor increases in flow may result in increased areas of channels that are under water. Increased flows may also decrease stability of river beds or banks.

In the long term, however, the amount of water from the melting ice cap and associated glaciers will eventually decline. Surveys of glaciers indicate that many have already retreated. As a result the glaciers have reduced supplies of water, and therefore less energy, to move sediments. High or higher water levels in the lakes will shift toward the early summer, and mid– and late summer lake levels will be reduced in relation to the present levels, which may also affect fish populations.

Birds in Old Crow Wetlands

The extensive wetlands of Old Crow Flats and the Beaufort Coastal Plain are important to more than 100 species of migratory birds, including 21 species of waterfowl. The persistence of these wetlands is closely tied to permafrost processes. Lakes on the Old Crow Flats are constantly changing in gradual response to weather conditions and the growth and decay of ground ice. Lakes sometimes change dramatically over just a few years, by draining into a neighbouring lake or stream at a lower elevation. Extremely shallow lakes and those that have recently drained are very sensitive to further drying. Once drained, the basin is eventually revegetated, greatly reducing potential for nesting by many species of shorebirds and waterfowl. Baseline information on these wetlands is being compiled from satellite imagery and vegetation mapping in order to examine past changes and monitor trends in the wetlands [42].

1.4 POTENTIAL IMPACTS OF CLIMATE CHANGE ON THE ECONOMY

Agriculture: Global climate change may present some major opportunities for the Yukon's agricultural sector. There should be longer and warmer growing seasons based on observed increases in the number of growing degree days. This should allow higher yield crops to be grown and productive agriculture to expand further north. An overall increase of 2-3°C would provide the 1,000 growing degree days required for wheat to ripen. However, lack of suitable soils will potentially limit both the productivity and extent of agriculture in northern regions.

Forestry: A general trend towards warmer conditions combined with increasing levels of CO_2 would change forest distribution and growth in the Yukon. However, it could take decades, or even centuries before forests adjust to new climatic conditions. During this period of adjustment, the boreal forest in particular could be more vulnerable to insects and diseases, forest fires, and competition from unwanted species, and the forest industry would have to adapt to new climatic conditions. Species may shift northward by about 100 km for every 1°C of warming. However, in responding to changes in climate, many tree species migrate slowly, at rates of 700 m or less per year. In western Canada, the southern edge of the boreal forest could be eventually pushed northward as much as 1,100 km.

Insect pests migrate much faster with changing climate than forests. Many of these pests would be new to the forests and therefore, the trees would not have any natural defences against them.

Forest fire incidence will lead to loss of habitat for species that inhabit mature forests. This may be eased by changes in fire management policy in order to facilitate species migration and forest adaptation, but this would require significant investment. Since 1980, Canada has lost an average of 2.4 million hectares of forest to fires each year, a 140 per cent increase over the previous 30 years.

Fisheries: Many marine fish species are sensitive to variations in the ocean's surface temperature. Changes to water temperature and circulation can affect their migration routes and geographic distribution. The numbers of some fish species may also decrease if global warming disrupts the marine food chain by affecting the survival of phytoplankton at the bottom of the chain.

Climate warming has the potential to disrupt inland freshwater fisheries as well. Cold water species such as trout are very heat sensitive and would migrate from, or die out of waters that are too warm. Warm water could also affect the spawning grounds of many important species such as salmon. Eventually, new, more heat tolerant species might move into these warmer waters. However, these species may or may not be commercially usable.

Infrastructure: The threats posed by climate change to Canadian infrastructure are many and varied, with significant environmental, social, and economic implications.

For example, melting permafrost will likely affect infrastructure and transportation, including the integrity of foundations (pipelines, bridges and buildings), water control structures, ice-roads and the melting of the assumed impermeable permafrost beds of mine-tailing ponds and landfill sites. Changes to water flow in rivers and lakes could adversely affect the generation of hydro electric power at existing dam sites. Changes in sea level may cause coastal erosion. One important measure would be to base new construction on engineering standards revised to take account of changing climate.

Tourism: Warmer, longer summers may improve tourism opportunities, but less predictable weather patterns may create problems in planning and undertaking back-country trips. Damage to infrastructure and highways may make travel to some areas more difficult. In some areas, an increase in fire and insect damage to forests may result in reduced tourism opportunities.

Subsistence: Climate change could affect the traditional land-based economy of the Yukon by modifying ecological and environmental systems that provide the basis of sustenance or facilitate its harvesting (for example the freeze-thaw cycles of water bodies). The documented effects of climate change on Yukon plants and animals will eventually result in changes to the numbers and distribution of caribou, moose, sheep, fish and waterfowl, among others. It is difficult to predict what the impacts will be on subsistence harvest but it will be important to monitor potential impacts carefully. For example, deeper snow in forests during the winter, or reduced sea ice along the Beaufort Coast, may reduce hunting opportunities.

1.5 RESPONSES TO CLIMATE CHANGE

International

How can nations gradually but substantially reduce their emissions of greenhouse gases without stalling their economies, and at the same time, ensure that the burden of protecting the climate is shared most equitably among nations? The 167 nations that ratified the 1992 Framework Convention on Climate Change have been grappling with this question for the past decade. The December 1997 Kyoto Protocol, which was a follow-up to the original climate treaty, is the first international attempt to place legally binding limits on greenhouse gas emissions from developed countries. In addition to CO_2, the primary greenhouse gas, the protocol focuses on five other greenhouse gases: methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF_6). Specifically, the protocol aims to cut the combined emissions of greenhouse gases from developed countries by roughly five per cent from their 1990 levels by 2008 to 2012. It also specifies the amount each industrialized nation must contribute toward meeting that reduction goal. Nations with the highest CO_2 emissions, the United States, Japan and most European nations, are expected to reduce emissions by a range of six to eight per cent. By 2005, all industrialized nations that ratify the accord must show demonstrable progress toward fulfilling their respective commitments under the protocol.

National

As a signatory to climate change treaties and a northern nation facing multiple impacts of climate change, Canada has taken a number of actions to understand and react to this issue. Canada signed the Kyoto Protocol which sets out the commitment to reduce greenhouse gas emissions to six per cent below 1990 levels between 2008 and 2012. The national implementation strategy, expected this spring, includes agreement to develop a system to credit industries for taking early action to reduce emissions, to strengthen voluntary action measures, bring Canadian experts together to explore various ways of meeting our Kyoto commitments, and to develop a public education and outreach program.

There is also recognition that more extensive research and public involvement are urgently required. The $150 million Climate Change Action Fund (CCAF) was introduced in 1998 [43]. The fund supports projects that will reduce greenhouse gas emissions and increase our understanding of climate change. The CCAF's four components are: Technology Early Action Measures; Foundation Analysis; Science, Impacts and Adaptation; and Public Education and Outreach.

Yukon

The climate change issue is an important concern of governments and people in the Yukon. In September 1999, the federal and Yukon governments announced the creation of the Northern Climate ExChange (NCE) based at the Northern Research Institute at Yukon College. The NCE will conduct an analysis of what is known about impacts of climate change in northern Canada, using both conventional science and recorded traditional knowledge of aboriginal peoples.

One important question is how individuals and communities will respond to climate change in the future. Strategies to reduce greenhouse gas emissions and adapt to changes in climate must be considered. This will require open discussion of the issues in each community in order to identify, understand and plan for potential climate changes. There is also a need to extend the horizon for planning in order to ensure that the Yukon is not unprepared in the next century.

Very little is known about the probable impacts of climate change on individual Yukon communities. Variation in culture, economy, and location suggests that conditions in Yukon communities vary widely and geographically. Broad changes in conditions (such as vegetation characteristics, tree-line advance, permafrost melting, increased run-off, storm surges) may affect two communities in different ways. Information from each community about the physical geography of the regions in which they lie, their economy, the types of natural hazards they face and ways in which they have addressed such hazards in the past, will help to reduce uncertainty and provide a sense of the probable costs and benefits of climate change to the Yukon's population. For instance, in the southern Yukon, an increase in broad leafed trees may lead to early successional wildlife species such as deer, moose and bear providing an abundance of food, while in the northern Yukon, the availability of wildlife may be threatened by the loss of wetlands or the impact of increased snow cover on the ability of caribou to forage for food [(44)].

The only certainty is that the future will be uncertain. Science and traditional knowledge will only go so far in helping us to predict and adapt to climate change in the next century. The record of the Yukon's past climate and ecology is a reminder that dramatic changes have occurred in the past and are occurring now as the atmosphere of Earth is warmed by human activities. Although still mostly removed from the global masses of humanity and industry, the land, plants, animals and people of the Yukon will experience some of the largest impacts of climate change, according to global change models.

Although we are just beginning to understand climate change and its possible consequences, our current knowledge indicates that this issue cannot be ignored.

PROGRESS & CHALLENGES

Progress since 1995

- *1997 Kyoto Protocol to reduce greenhouse gas emissions in developed countries, signed by several countries including Canada.*
- *$150 million Climate Change Action Fund established by federal government in 1998.*
- *Formation of Northern Climate ExChange at Yukon College in February 2000*
- *Enactment of Yukon Ozone Depletion Substances Regulations,1996*
- *Increased public awareness of climate change issues.*
- *Air Emission Regulations, 1998*
- *Public Education Campaign on woodsmoke and vehicle idling, 1999-2000*

Challenges

- *Continuing increases in greenhouse gas emissions.*
- *Increasing evidence of climate change induced stresses on plants, animals and ecosystems in the Yukon.*

Chapter 2
WATER

The Yukon's abundant freshwater resources are stored in lakes, wetlands, streams, glaciers, snowpacks and groundwater systems. They eventually flow into the Bering Sea via the Yukon River, the Gulf of Alaska via the Alsek River, or the Beaufort Sea through the Liard, Peel, and North Slope drainages (Figure 2.1). The flows of streams, the levels of lakes and groundwater tables are regulated by climatic elements (precipitation, snow and glacier melt, and evaporation), as well as physical characteristics (topography, vegetation and permafrost) (Figure 2.2). Significant changes in climate, particularly air temperature and precipitation, alter streamflow patterns. A temperature increase, for example, might lead to increased glacial melt and higher stream flows in some areas. Many of the glacially-fed waterways of southwestern Yukon carry a heavy sediment load and are prone to flooding. Decreased precipitation can also have dramatic effects. Data on snowpack accumulations and river and stream discharges indicate that the Yukon has experienced drought conditions in the past two to three years [1]. Based on 51 years of weather information, 1998 was the driest year ever recorded in the territory. According to Environment Canada, annual precipitation was 34 per cent below normal in 1998 [2]. This results in lower lake levels. The water table also appears to be lowering in the Whitehorse area. Anecdotal evidence indicates that some residents in rural subdivisions who rely on groundwater for their water supply are finding that their wells are either drying up or providing insufficient volume.

Migrating salmon are affected by water flows. In low-water years, adult salmon cannot always reach their traditional spawning grounds. Chum salmon spawn in the groundwater-fed backwaters along several large Yukon rivers. If water levels are low in the spring, young salmon cannot escape from the backwaters into the rivers. During high-water years, salmon migrate further up the drainage basin. Extremely high water levels carry silt loads that damage spawning beds.

Long-term monthly average flows of the Yukon River at Whitehorse, Carmacks and Dawson are shown in Figure 2.3. For all three sites, the lowest flow occurs in late winter as the inputs decrease and freeze, and the ice thickness of the river's surface increases (up to two metres thick at some locations). The stream flow during this time is composed mainly of groundwater.

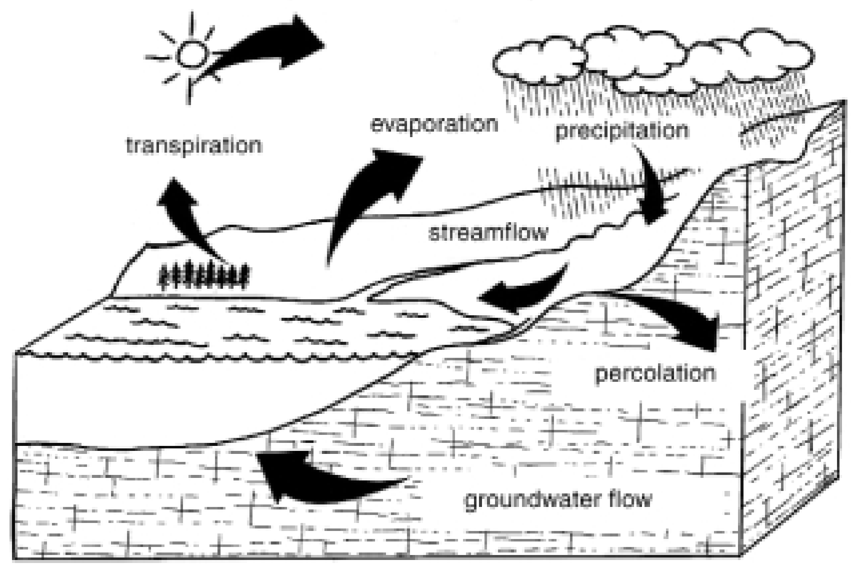


Figure 2.2 The Water Cycle
Water is stored in lakes, streams, snowpacks, glaciers and underground aquifers, It enters the atmosphere by evaporation from the surfaces of water and land, or from transpiration by plants. Most rain clouds in the Yukon come in from the Gulf of Alaska or from the Beaufort Sea. When moisture condenses in the atmosphere, it returns to the earth as rain or snow. On the earth's surface, water flows into streams or percolates through aquifers as groundwater.

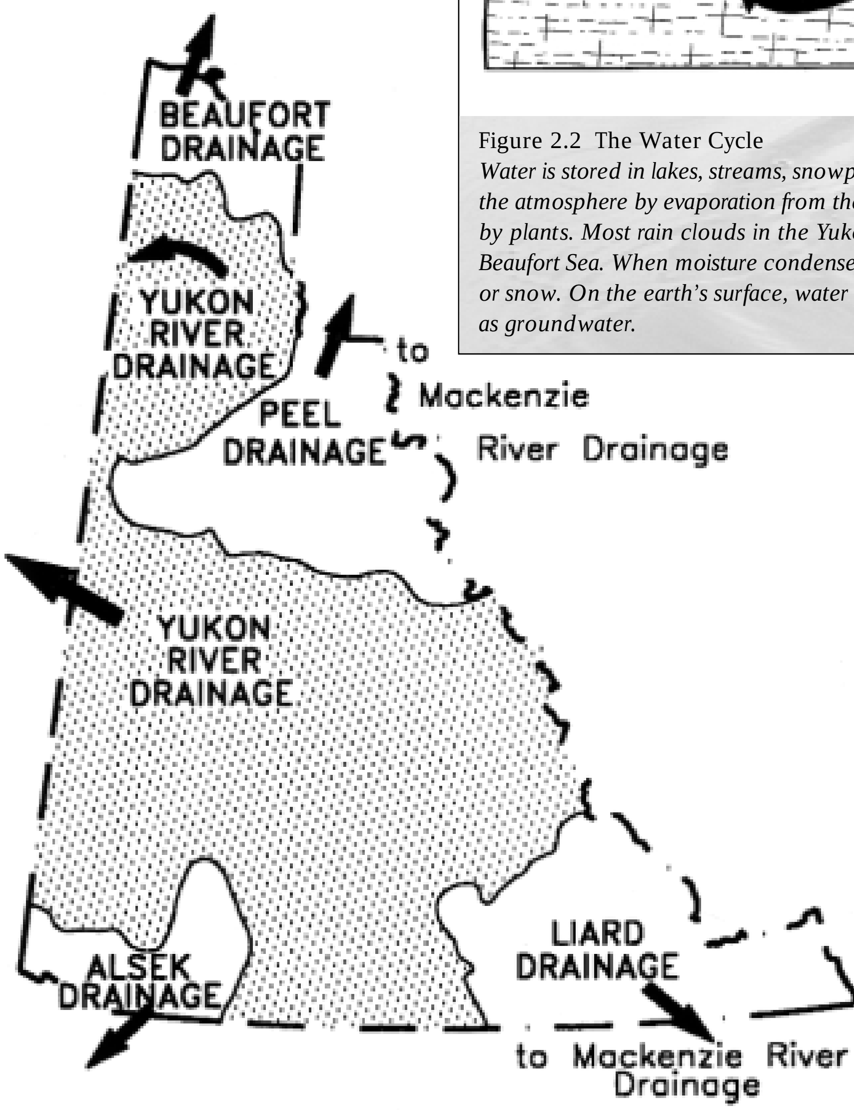


Figure 2.1 Drainage Basins of the Yukon

Spring melting brings a rapid increase in flow. Peak flow at Carmacks and Dawson occurs in early June, whereas glacial melt from the Yukon's headwaters keeps water levels high in Whitehorse throughout the summer, often peaking in late August or early September.

The abundance of fresh water is locally affected by human activity such as the withdrawal, diversion, or storage of water for industrial, hydroelectric generation or domestic use. Although demands on Yukon surface waters have not resulted in the major disruptions of natural flows experienced in many areas, hydroelectric development and mining have altered flow patterns in some locations. Hydroelectric generation depends on water availability. When water flows are low, we become more dependent on diesel fuel for the generation of electricity. When water levels are abnormally high, flooding can occur in storage reservoirs.

2.1 Water Allocation and Use

Measuring Stream Flow

The information provided by the hydrometric monitoring network is used to estimate water availability for industry and hydroelectric generation, to forecast flooding, to design culverts and bridges, and to determine water levels for river navigation. Streamflow information is also used to predict levels of contaminants in water bodies downstream from proposed industrial developments and to monitor long-term environmental change.

A territory-wide network of permanent hydrometric (water measuring) stations is maintained by Environment Canada. In 1995, there were 70 stations monitored year round; by 1999, the number of stations was reduced to 48. The Department of Indian Affairs and Northern Development (DIAND) also operates a network of hydrometric stations on small streams during open water months. There were 16 stations in 1998. Two more sites were added in 1999 for monitoring during 1999 open water season (Figure 2.4).

Groundwater

Not much is known about the quality or quantity of Yukon groundwater aquifers. A proposal by DIAND to set up a groundwater database in Ottawa to provide information on municipal wells in the Yukon and Northwest Territories has not yet been implemented [3]. A groundwater study is proposed for late 1999 early 2000 to monitor and evaluate groundwater conditions in the Whitehorse area [4]. Groundwater wells, often installed near tailings ponds of mines and domestic sewage lagoons to monitor effects on the quality of the immediate groundwater, provide localized information. A valuable groundwater resource is the Selkirk Street aquifer which provides almost 30 per cent of the water used in the City of Whitehorse (based on 1997 data). Although aquifers provide good quality drinking water, their most important features are the thermal properties provided by groundwater. A good portion of the water in the Selkirk Street aquifer is used in bleeder systems during the winter months and requires no further heating.

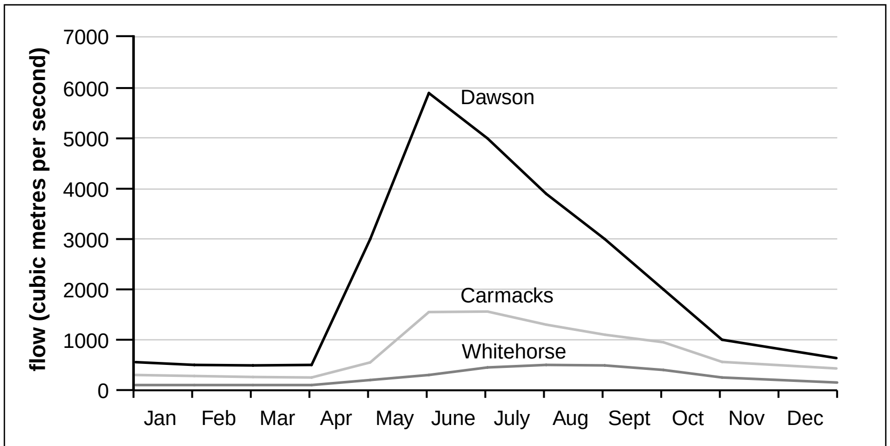


Figure 2.3 Long-term monthly average flows of the Yukon River at Whitehorse (1943-1998), Carmacks (1951-1995), and Dawson City (1945-1980)
The volume of water in the Yukon River increases moving downstream from Whitehorse to Dawson City: The peak flow at Dawson City in June results from the melting snow pack in the interior.

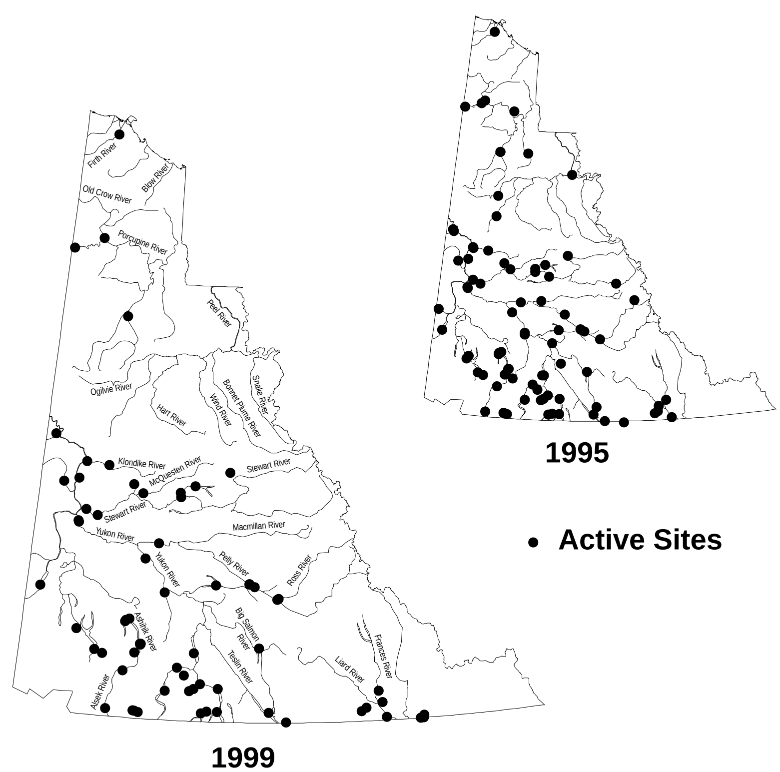


Figure 2.4 Water Hydrology Sites, 1995 and 1999
Due to budget constraints, the number of sites monitored for flow have decreased since 1995.

Drinking water supplied by groundwater in Carcross was the subject of concern in the mid-1980s. Wellwater testing indicated that arsenic, a naturally occurring poisonous element, was showing up in samples at levels approaching the unacceptable limit for drinking water (over 0.05 parts per million). Steps were taken to bypass the groundwater source and supplies are now obtained from an intake in Lake Bennett.

Is the Yukon's Water for Export?

In 1947, the Aluminium Company of America expressed interest in diverting the headwaters of the Yukon River through the Coast Mountains and into the Taiga River for power generation at Pacific tide-water in Alaska. An agreement between Canada and the United States resulted in the Yukon Power and Storage Investigation. The proposal was eventually rejected by the Government of Canada in 1952. Later in the 1950s, Northwest Power Industries announced plans for a $270 million power development on the Yukon-British Columbia border, known as the Yukon-Taku Project. Design work was to begin in 1957, but this plan was rescinded.

The economic potential from selling the Yukon's seemingly limitless fresh water was not forgotten. A proposal in 1964 by the North American Water and Power Alliance called for diverting flows from the Yukon River headwaters southward through the Rocky Mountain Trench into the United States and Mexico to provide water for irrigation and generating electricity. This proposal was eventually stalled due to social, environmental, economic and political opposition.

Large-scale diversion of the Yukon's surface water does not appear probable in the near future. Although there is a proposed nation-wide moratorium of bulk export of water, there is no federal legislation that deals specifically with water exports. Bulk water exports do not include bottled water. However, the federal government has considerable control over the Yukon's surface waters. The Fisheries Act *has broad powers to control alterations in waterways that support fisheries. Approval under the Navigable Waters Protection Act would also be required for alterations to larger water courses like the Yukon River. Also, international rivers such as the Yukon River are regulated under the International Rivers Improvement Act.*

Both British Columbia and Alberta have legislation that prohibits the removal of bulk water, including for export. The devolution of the management of water from the federal government to the Yukon government is to occur in the year 2001, and there may be an opportunity to create similar legislation to protect the territory's fresh water resource.

"We know that single and cumulative bulk removals of fresh water can have serious impacts on the environmental, social and economic health of communities and ecosystems that depend on these watersheds. I will be seeking agreement on a Canada-wide accord for the prohibition of bulk water removal from all of Canada's major watersheds when I meet with my provincial and territorial colleagues later this month. This is an environmental issue to be decided by Canadians. We will stop bulk removals at the source not at the border."

Environment Minister David Anderson News Release, November 22, 1999

Allocating Water

Two types of water demands are in-stream uses and water withdrawals. In-stream uses include fish and wildlife, navigation, and recreation. Water withdrawals are uses that remove water from streams or lakes for domestic, municipal, agricultural or industrial purposes. Withdrawals can alter stream flows and water levels, thereby affecting the supply of water for in-stream uses.

The allocation of water withdrawals (surface water and groundwater) to industrial users and municipalities is shown in Figure 2.5. Data are based on the amount of water individuals or companies are allowed to withdraw according to their water licences [5]. Some users cannot use water all year so a few assumptions have been made in compiling data for this graph. Water allocation for placer mining and agriculture was based on an average season of 110 days and a 12-hour working day. Hydroelectric use is not shown here because water is not withdrawn. Entire rivers are slowed down in storage reservoirs and then passed through turbines and spillways. In general, the same amount of water is returned and its quality is basically unchanged. In municipal and industrial uses however, the water is removed, used, and some or all of it is returned to the stream, usually in an altered state.

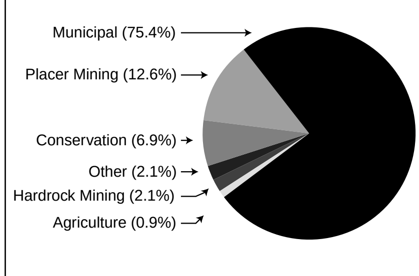


Figure 2.5 Water Allocation by Sector, 1998

Both sectors of mining, hardrock and placer, were down significantly in 1998. This is reflected in their water use.

Domestic Water Use

Total water use within the City of Whitehorse for 1998 was 5,674,557 cubic metres for a population of 23,406, representing 842 litres per person per day. This compares to the 1996 national average of 326 litres per person per day (Figure 2.6) [6]. The Whitehorse personal consumption figure is a bit misleading as a substantial amount of water is lost to leakage, and a considerable amount of water is used in bleeder systems to prevent pipes from freezing. During 1997, the city conducted 25 major repairs on leaky watermains, some of which had been leaking for an extended period of time. An additional five major repairs were completed in 1998. For the bleeder reduction program, a pilot project in the fall of 1995 and the winter of 1996 evaluated the use of Thermostatically Controlled Bleeder (TCB) devices as a cost-effective replacement to existing free-flow bleeders. The use of TCBs reduced the bleed-water use up to 98.5 per cent. In 1999, the City of Whitehorse began installation of 1,250 TCB units [7].

The city continues to provide water conservation education programs and encourages residents to conserve water on their own initiative. Commercial businesses pay for water use by volume (cubic metres used) whereas residential properties pay a flat rate.

A fact sheet produced by Environment Canada compared the effect of metering on residential water use in Canada for 1994. There was a significant reduction in water use, almost 40 per cent, when consumption was metered and price was determined by volume used, compared to unmetered use at a flat rate [8]. The City of Whitehorse conducted a cost analysis of installing and administering water meters for residential properties. They did not find it to be cost effective because, with the exception of chlorination, there is little expense in treating the drinking water. However, all new homes must be constructed so that meters can be installed.

To reduce water consumption, the city has a bylaw in place that requires all new construction and retrofitting to use low flush toilets. Homes in urban subdivisions developed since 1992, such as Arkell, Copperidge and most of Granger, have low flush toilets. This does not apply however, to homes in rural residential subdivisions within city limits such as Wolf Creek, Cowley Creek and Mary Lake, which have individual septic systems. Low flush toilets use 7.3 litres of water per flush compared to standard toilets which use from 16 to 27 litres of water per flush, depending on the brand of toilet.

Recreational Water Use

Before highways and airstrips were built, many waterways in the Yukon were transportation corridors. In recent decades, recreational uses of Yukon waterways have increased. One emerging problem is large motor craft use on lakes and rivers. Waves from motorized water craft can increase erosion along shorelines. As the number of river travelers increases, there is a potential for contaminants to enter the water. However, these emerging issues are being addressed by various programs and legislation such as the *Yukon No Trace Program* and the *Wilderness Tourism Licensing Act*. (See Chapter 3)

2.2 Water Quality

In 1999, the Canadian Environmental Quality Guidelines replaced the Canadian Water Quality Guidelines. Used to assess the quality of water, they include:

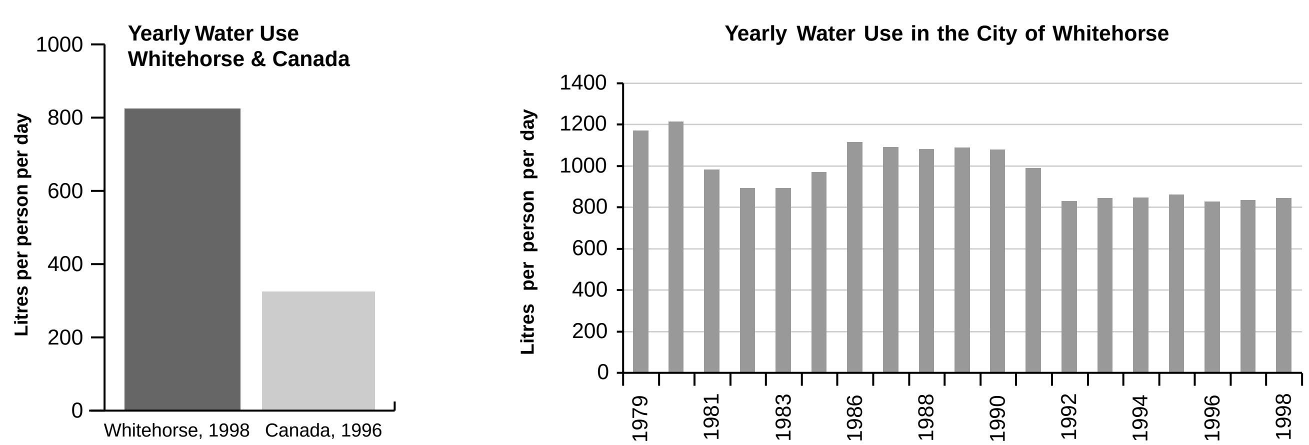


Figure 2.6 Water Use

Although the water use in Whitehorse is considerably higher than the national average, it has been decreasing in recent years.

- The guidelines for Canadian Drinking Water Quality (6th edition 1966) that provide drinking water guidelines based on the safety of water for human consumption, and on taste, odour and appearance;
- The Canadian Environmental Quality Guidelines (replaced the Guidelines for Canadian Drinking Water Quality in 1999) that are used to assess the quality of fresh water and to protect freshwater aquatic life - fish, invertebrates and plants (based on the suitability of water to maintain healthy aquatic ecosystems); and
- The Guidelines for Canadian Recreational Water Quality (1992) that provide recreational guidelines (based on the safety of water for recreational activities such as swimming).

Many people believe that any water fit for people to drink is good-quality water. Humans, however, are not the only users of water. Sensitivity to pollutants varies. Fish, aquatic insects, larvae, and algae are less tolerant of some substances than are humans. For example, zinc presents no health risk to people in the concentrations usually found in Yukon waters. Even when zinc is added to the water by natural or mining-related acid rock drainage, levels of zinc are generally well within the guidelines for drinking water. But zinc is toxic to fish and other aquatic organisms at low levels. The drinking water guideline for zinc is five milligrams per litre, whereas the recommended guideline for the protection of aquatic life is 0.03 milligrams per litre. Control of zinc levels is a major focus of water management for several mining projects in the Yukon.

"Our grandfathers kept everything clean, even the water. A boy tried to wash a horse blanket in the water at Klukshu. The Elder told the young man, 'Whoever threw that in there, take it out."
–Paddy Jim, Champagne and Aishihik First Nation Elder.

"Long time ago you can drink water from any place, even snow. For years snow is the best water you can get. Now you can't even take snow water, the air is too much polluted."
–Charlie Dick, Ross River Dena Council Elder.

Scientists tell us that snow is not polluted, but there is uncertainty among some people regarding the safety of this source of drinking water.

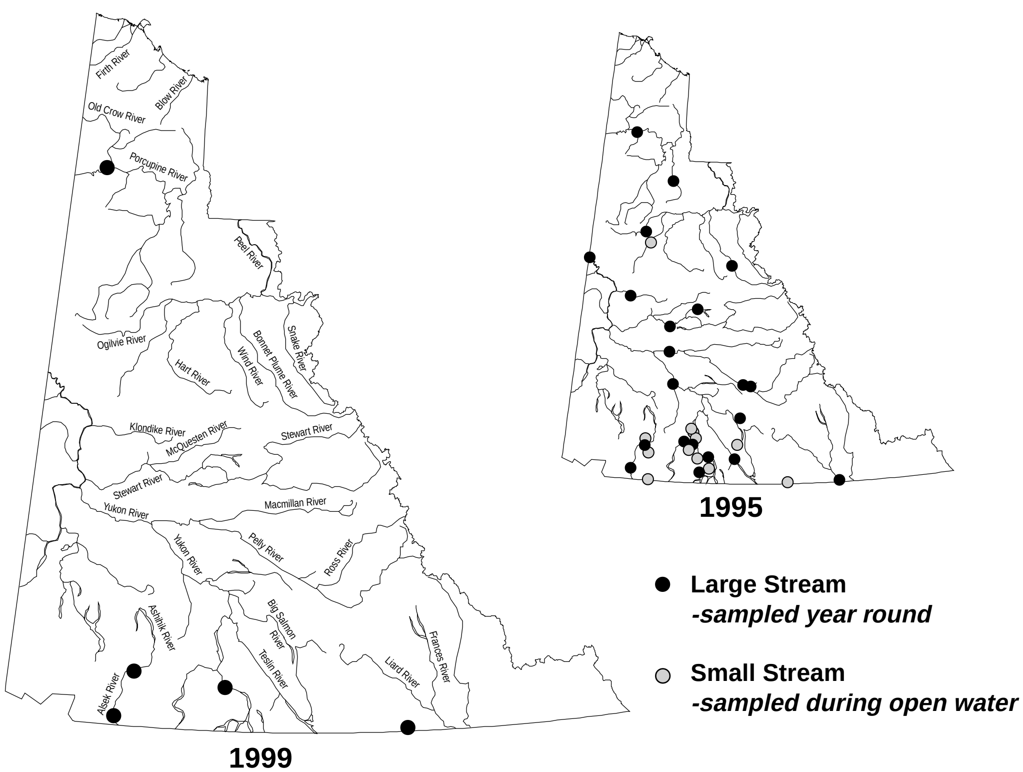


Figure 2.7 Water Quality Sites, 1995 and 1999
Locations of the active sample sites in 1995 compared to those that were active in 1999. Due to budget constraints, there has been a significant decrease in the number of sites monitored for water quality since 1995.

Water Quality Monitoring

Studies on local water bodies are called for in water licences, or as baseline monitoring before development (municipal, mining, heritage river status, hydro electric, etc.). Short-term studies have shown that the quality of most Yukon water is generally very good. Most metals and other natural constituents are within recommended guidelines for the protection of freshwater life and for drinking water, although there are some natural excesses. Surface waters are generally soft and slightly alkaline.

Long-term monitoring is done to detect trends in surface water quality. Water quality was sampled at 21 stations in the Yukon River Basin over a 13-month period in 1982 and 1983. At some locations drinking water guidelines were not met for turbidity, colour, iron and manganese. These guidelines relate to the taste, odour or colour of water rather than to a risk to human health. In some rivers the guidelines for the protection of aquatic life were not met for copper and lead during periods of high water. This was related to erosion of highly mineralized soils.

Long-term water quality was monitored by DIAND on 12 small streams and nine large streams in the Yukon during the 1990s. The 12 small streams were monitored weekly during open water for about five years. The large streams were monitored on a year-round, bi-weekly basis, some since as early as 1980. These monitoring programs were discontinued in 1996 due to funding constraints (Figure 2.7).

Environment Canada collects water samples bi-weekly at three sites (Liard, Porcupine and Dezadeash rivers). Samples are also collected four to six times a year from two locations along the Alsek River. Long-term monitoring was also conducted on five other sites, but these have been discontinued.

The data from the above two long-term water quality monitoring programs are available to the public; however, the data have yet to be critically analyzed by the responsible governments. A preliminary summary of data collected from the 12 small stream sites has been prepared by DIAND. As yet there is little information available on overall trends in Yukon water quality.

The Wolf Creek Research Basin project is a fully integrated, multidisciplinary research project. Studies on climate (three meteorological stations were established in 1993 within three different ecological zones in the drainage basin), climate change, vegetation, forestry, fisheries and wildlife are underway. A continuous water quality data logger was installed in the spring of 1999 to further characterize the watershed.

Drinking Water

All Yukon communities depend on groundwater for all or part of their domestic water supply. This water is supplied by municipal governments, the Yukon Department of Community and Transportation Services, and by DIAND. Water is transported to homes either by piped systems or by government or commercial truck delivery. Many rural Yukon homes have private wells.

The only municipalities partially dependent on a surface water supply for drinking water are Carcross and the City of Whitehorse. Figure 2.8 shows the water sources in all Yukon communities.

Raw (untreated) drinking water is monitored for total and faecal coliforms.

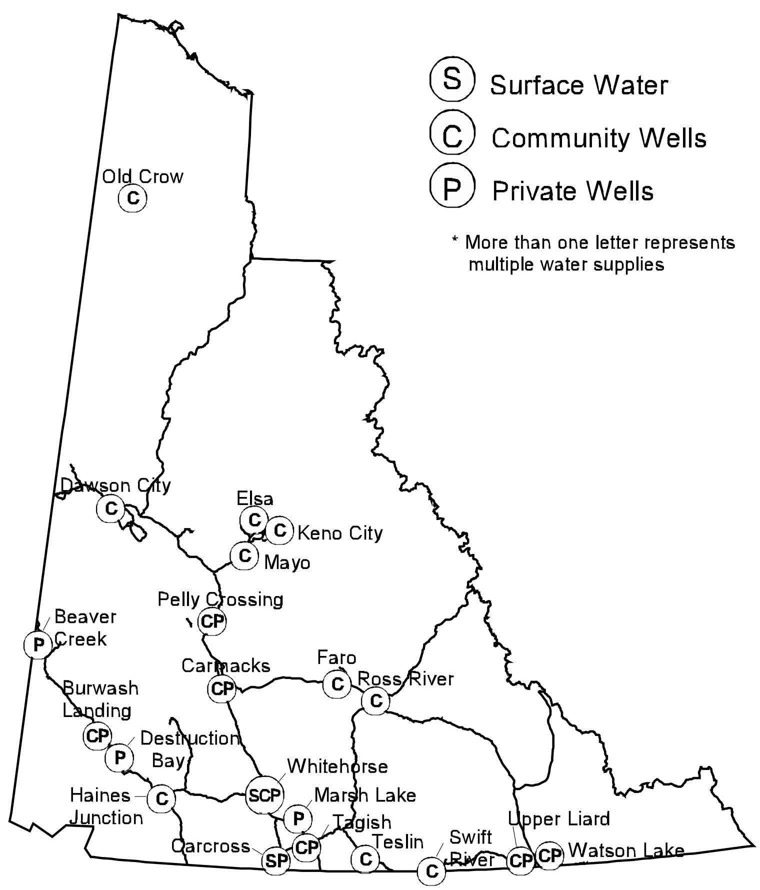


Figure 2.8 Water Sources for Yukon Communities

These bacteria are frequently found in raw surface water supplies since terrestrial and aquatic animals use these resources.

Faecal coliforms are a group of bacteria that live in the intestines of warm-blooded animals, including humans. If faecal coliforms are present in water, it could mean that harmful disease-causing bacteria, viruses and/or parasites could also be present. To ensure safety, no faecal coliforms are allowed in drinking water.

Chlorination effectively kills bacteria and is used to treat raw water supplies prior to delivery, either by piped systems or truck. Fluoride was also added to the Whitehorse drinking water supply as a dental health measure beginning in the 1960s. Following considerable debate on the advantages and disadvantages of fluoridation, the city discontinued its use in August, 1998.

Municipal water licence holders and Environmental Health Services, a Yukon government branch (devolved from the federal government on April 1, 1997) are responsible for monitoring the quality of the drinking water in Yukon communities. Generally, the drinking water guidelines are met in the water supplies. Where limits were exceeded, these were for aesthetic parameters of taste and appearance (such as iron, manganese, sulphide and turbidity); the water is not a risk to human health.

City of Whitehorse

The City of Whitehorse obtains its drinking water from Schwatka Lake and from local groundwater aquifers. The surface water (Schwatka Lake) is mixed with the groundwater to raise the water temperature in the winter months and to reduce the surface water silt load during the spring melt. The groundwater consists of the Selkirk aquifer and the deeper Whitehorse aquifer. Recent studies have shown that they may be hydraulically connected. Chlorine is added to treat the raw water at the Selkirk pumphouse before the water is distributed.

Schwatka Lake is used for transportation, recreation, hydro-generation and the drinking water supply for the city. Protection of the city's drinking water supply is a priority and the potential for contamination of Schwatka Lake has long been a public health concern.

Natural effects on the water sources include faecal contamination from wildlife, notably beaver and migrating waterfowl. Human effects include garbage and boat activities, but tend to focus on the float plane base located on the southwest shore of Schwatka Lake.

An historic review of environmental issues concerning Schwatka Lake from 1977 to 1993, compiled by Environment Canada, Environmental Protection Branch, showed that the majority of the issues were related to fuel and oil contamination associated with the float plane base. In 1995, a study on the uses of Schwatka Lake was conducted [1]. The results did not show that it was necessary to relocate the float plane base as the author of the study did not believe there was sufficient risk to the environment. Several recommendations were made however, and some of these have been adopted. The city has taken over responsibility of the float plane base. Development of a permanent docking structure and a proper fuel-handling facility commenced in the summer of 1999 and the temporary floating docks will be removed. Temporary washroom facilities are installed every summer (May through September). Bear-proof garbage containers are also in place. In 1998, the road was upgraded and several garbage containers and picnic tables were installed on the east shore of Schwatka Lake.

There is concern that with increased development upstream of the city, there is potential for more contamination to the city's drinking water supply. Although coliforms and giardia are present at the intake structure, levels are very low compared with raw water quality for other Canadian cities [2].

There are no immediate plans for further water treatment by filtration; however, a contact chamber may be installed at some point in the next sev-

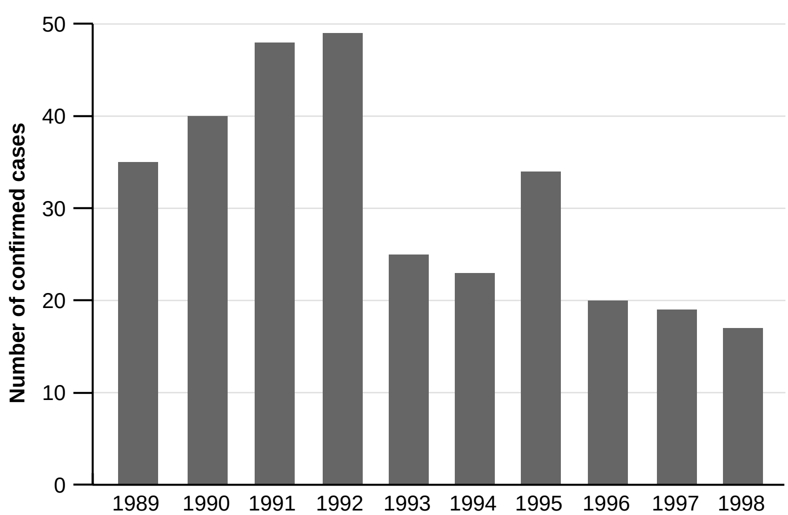


Figure 2.9 Number of Giardiasis Cases reported each year
Not all cases are reported and evidence suggests that the number of cases is probably higher than indicated.

eral years. Since the intake structure for the water supply is located approximately two to three metres below the water surface, depending on the lake level, potential contaminants would have to be well mixed in the water column to gain access to the intake. The position of the intake helps to decrease any impacts from floating contamination such as woody and plant debris, and from minor oil and gas spills.

What affects Water Quality?

Sewage

Although raw sewage is a complex chemical and biological mix, the primary constituents are suspended solids, nutrients such as nitrogen and phosphorus, disease-causing microorganisms (bacteria, viruses, and protozoans). Untreated sewage also contains several compounds which are toxic to fish such as surfactants (from cleaning solutions) and ammonia. Raw sewage from Yukon communities does not contain the contamination from metals and various chemicals that are associated with industrialized regions. However, the toxicity of Yukon sewage is increased if people pour substances such as solvent and full strength ammonia down their drains. Sewage can contain contaminants that pose risks to human health and the aquatic environment when released to the Yukon's surface waters.

Microorganisms in sewage cause a variety of diseases such as gastrointestinal illness, hepatitis A, and giardiasis (Figure 2.9) [3]. Bacterial contamination from sewage is a problem in cold surface waters. Higher coliform counts have been measured in winter when the constant sewage discharge combines with low river flows, cold water and ice cover to provide ideal conditions for the survival of these bacteria.

Oxygen is consumed when bacteria break down the organic material found in sewage. Reduction of oxygen levels has not generally been a problem in Yukon waters, but the potential exists because dissolved oxygen is easily depleted in ice-covered water.

Municipal sewage in the Yukon is treated before it is released into the environment (Table 2a). Most Yukon communities use lagoon systems, which settle out solids and begin the bacterial breakdown of organic matter. Some of the Yukon's sewage treatment systems are new and efficient and have little or no impact on receiving water.

Sewage from Haines Junction, Destruction Bay and Faro is stored in large lagoons and periodically discharged to the environment. The large lagoon systems at Mayo and Watson Lake have no discharge to surface waters.

During the 1990s, there was a significant increase in the resident population at Marsh Lake, which is located on the Yukon River system upstream of the City of Whitehorse. Due to the soil types in the area and the close proximity of homes to the lake, pump-out septic systems are generally required. A sewage lagoon was completed in the summer of 1998 in the Marsh Lake area. Sewage is hauled to, disposed of and treated at this site. This lagoon also does not discharge to surface waters.

Septic systems (consisting of a septic tank and soil absorption system) are used in parts of the Yukon where the ground conditions are suitable. Travel of the effluent through one to two feet of unsaturated silty, sandy, or clay loam soil can be expected to remove sewage micro-organisms and protect ground and surface water. Protection of the environment, animals and humans is further enhanced by required setback distances. Most septic tanks are developed for private or commercial use but, a community septic tank and soil absorption system was installed in

Community	Sewage Treatment Type				
	septic	*pump-out*	*screening*	*aeration*	*lagoons*
Beaver Creek	✗	✗			
Burwash Landing	✗	✗			
Carcross	✗	✗			
Carmacks		✗		✗	
Dawson City			✗		
Destruction Bay	✗				✗
Faro					✗
Haines Junction					✗
Keno City	✗				
Marsh Lake	✗	✗			✗
Mayo					✗
Old Crow		✗			✗
Pelly Crossing	✗	✗			
Ross River	✗	✗			
Tagish	✗	✗			
Teslin		✗			✗
Upper Liard	✗				
Watson Lake					✗
Whitehorse	✗				✗

Table 2a Yukon Municipal Sewage Treatment Systems

Destruction Bay in 1998.

Two communities use mechanical processes. Carmacks has a continuous discharge of treated sewage into the Yukon River. The extended aeration treatment plant, in operation since 1978, is now reaching its capacity to effectively treat sewage.

Dawson City also discharges sewage continuously into the Yukon River. A mechanical screening system removes solids from the sewage before it is discharged. The solids are removed and placed in the landfill. The screened water discharges directly into the Yukon River, under a water licence issued from DIAND. Tests conducted on the receiving water (Yukon River downstream of the sewage outfall) in the summer of 1998 showed elevated concentrations of faecal coliforms in some samples. In addition to the tests in mid-river, tests conducted off the shoreline indicated elevated coliform counts. These counts are believed to be associated with storm drain, ground and surface run-off. Some of the measures the town is taking to alleviate this situation include filling in some low-lying areas, improving ditching on several streets and conducting clean-ups along the riverbank.

Whitehorse Sewage Treatment System

Natural Wetlands as Sewage Treatment Systems

Natural wetlands have proven to be very effective sewage treatment systems and are especially efficient in removing, and reusing nutrients, such as nitrogen and phosphorous. They can also significantly reduce oxygen-demanding substances such as biochemical oxygen demand (BOD) and ammonia, suspended solids and other pollutants such as metals.

Solids are first removed from the wastewater by gravity and by filtration through sediments. Nutrients and metals are then available for uptake by aquatic plants.

The primary treatment process at work, however, is the consumption of organic wastes by the vast diversity of microbes found in wetlands, such as bacteria, algae, protozoans and aquatic invertebrates in the water and sediments. These microorganisms are free floating in the water column, submerged in the bottom sediments or attached to aquatic plants. Wetland plants serve an important role by providing structure to support algae and other aquatic microbes.

The size of a wetland required for sewage treatment depends on such factors as the depth of water in the wetland, the degree of treatment applied to the sewage before it enters the wetland, the volume of wastewater to be treated (hydraulic loading) and the time required to achieve the desired treatment (detention time).

Natural wetlands as sewage treatment systems are relatively easy to maintain, are very energy efficient when compared to mechanical systems and provide beneficial habitats for wildlife such as waterfowl.

In the Yukon, natural wetlands are used for sewage treatment in the community of Teslin.

The municipality's current licence to discharge sewage expires on January 29, 2000. The Yukon Territory Water Board has recommended that the Minister of Indian and Northern Affairs issue of a new licence expiring on December 1, 2005. Under its terms, the town is required to design, construct and operate a wastewater treatment facility by December 1, 2002, that meets all effluent quality standards specified in the licence.

The City of Whitehorse recently upgraded its sewage treatment system at a cost of $25 million (with 85 per cent of the funding coming from the Yukon government). As of September, 1996, direct discharge of treated effluent to the Yukon River was discontinued. The Whitehorse and Porter Creek sewage lagoons are no longer used for treatment. The wastewater is routed to the Livingstone Trail Environmental Control Facility. The facility comprises two primary lagoons with a total retention time of 12 days, four secondary lagoons with a total retention time of 80 days, and a long term impoundment lagoon that provides an additional 10 months of storage. An annual discharge is required in September and/or October. Originally the treated effluent was to be discharged directly to the Yukon River. During the fall of 1998, a study was completed on the use of a pothole lake, located southwest of the facility which is likely hydraulically connected to the Yukon River via a sand and gravel unit. Approximately two million cubic metres of treated effluent were discharged from the long-term storage impoundment to the pothole lake, initially raising the water level in the pothole lake approximately 20 metres. Discharge was stopped in October and water levels decreased throughout the fall and winter. This additional level of treatment provided positive results. The pothole lake was used again on a trial basis in the fall of 1999.

The Crestview sewage lagoon remains operational and does not discharge to the Yukon River. The sewage exfiltrates into the ground or evaporates into the air.

Before September 1996, the City of Whitehorse discharged treated effluent directly into the Yukon River causing concentrations of coliform bacteria to increase dramatically downstream from the Whitehorse and Porter Creek sewage outfalls, persisting as far as Lake Laberge. [4] Several studies conducted by DIAND Water Resources in the early 1990s, showed that coliform concentrations were lowest in early summer (June) and highest under ice cover (February and March). Following activation of the new system, similar studies conducted in October, 1996 [5] and in March 1997 [6], reported no faecal coliforms downstream in the Yukon River or in Lake Laberge (Figure 2.10).

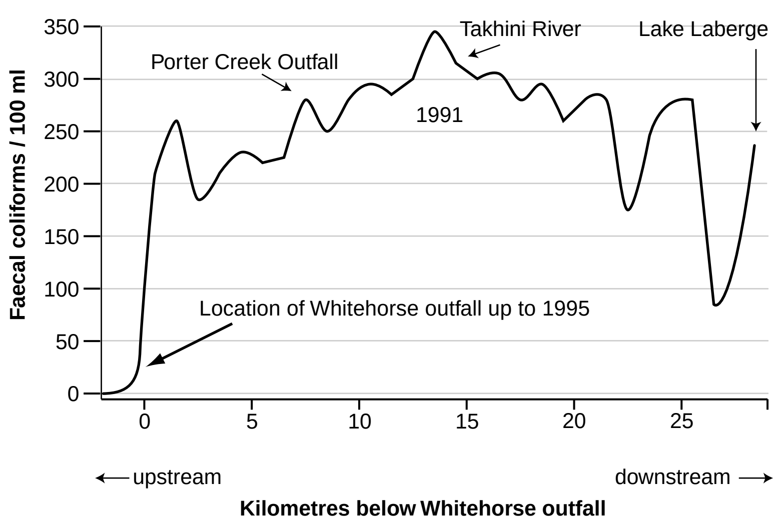


Figure 2.10 Faecal coliform bacteria in the Yukon River, winter, 1991
Faecal Coliform counts were 0 above the out fall in 1991 and as high as 350 faecal coliform/100 ml of water below the outfall. In 1996 and 97 no faecal coliform bacteria were found in similar test.

The Livingstone Trail Environmental Control Facility has improved the environmental quality of the Yukon River considerably in terms of bacteria counts.

Forestry

Forestry activities alter some streams in the Yukon (see also Section 5.2). Effects are related to stream crossings, erosion from logging and construction of access roads. Wood debris also clogs streams and alters aquatic habitat. Good logging practices and strips of intact vegetation along stream banks reduce these effects. Specific requirements to protect water quality are set as conditions of permits or agreements related to timber harvest, or as conditions of land use permits required for the creation of access to harvest areas.

Forest fires can also affect water. The effects depend on many variables such as the intensity of the fire, time of year, slope of the terrain, the characteristics of the soil, and the presence of permafrost. When a fire removes the vegetation cover, litter and the organic soil layer, runoff is increased and this leads to erosion. More snow can accumulate, resulting in increased melt water and possible erosion. The concentrations of nutrients, notably nitrogen and carbon, increase mainly from the organic detritus that is swept directly into the streams as part of the total sediment load.

Although few studies have been conducted, there is apparently insignificant long-term change in aquatic habitats after a wildfire. It is generally felt that fire suppression methods, application of fire retardant, and soil disturbances through the construction of bulldozed fire lines cause more damage than the actual fire [7,8].

Mining

Some changes to water quality can be expected when large quantities of water from a stream are diverted and used to process ore or placer dirt. The current federal environmental assessment and regulatory regimes do not allow changes to water quality to significantly affect either downstream aquatic ecosystems or the water supplies of licensed downstream water users.

Placer mining, however, has had significant effects on aquatic ecosystems in heavily-mined streams. New regulations are designed to reduce the extent of these effects and to rehabilitate streams following mining (see Section 3.4).

Placer mining operations release sediments to streams, both through increased erosion from the stripped ground and through discharges of mine effluent. Effluent from the sluicing process is run through one or more settling ponds to remove some of the settleable solids. These settling ponds, however, are often located in or near the natural streambed and can be a source of further sediment to the stream through wash-outs at high water. When mines are located in steep confined valleys, it is often difficult to construct adequate settling pond systems.

The exploration and development phases of hard-rock mining may also cause erosion and release sediments into lakes and streams. Exposure of acid-generating rock creates acid rock drainage which increases the release of metals into water; this process might not begin to affect water quality until years after mining activity has ceased.

Operating hard-rock mines use water and chemicals to extract and concentrate metals. Metals and reagents used in ore processing, such as cyanide, often appear in mill effluents, as does ammonia, which is used in explosives and is a by-product of cyanide degradation in gold milling. Effluent and site seepage are collected and treated as necessary to meet standards before release to streams. It can be difficult to recover all groundwater seepage and sometimes groundwater at a minesite must be pumped and treated so that it will not contaminate streams.

Mines can also affect water quality because of chemical or physical instability of waste rock dumps, pits, adits, or tailings impoundments. Acid rock drainage can develop or persist at a site after closure and the drainage might require control methods such as relocation of acid-generating rock, covers over tailings ponds, or long-term water treatment.

The lead-zinc mine near Faro shut down in January 1998, and is currently in receivership. The mine's activities potentially affect two watersheds; Rose Creek from the Faro deposit, and Vangorda Creek from the Vangorda and Grum deposits. Tailings ponds are located in the Rose Creek Valley behind a series of dams, with the creek diverted along the valley wall. Sections of pit walls, some of the waste rock dumps and all of the tailings are acid-generating. The main environmental issues related to decommissioning the mine are the stability of the dams and diversions, and acid rock drainage. Acid rock drainage from the site is dealt with during temporary closure and when

Acid Rock Drainage

Acid rock drainage occurs when sulphide-bearing rocks, particularly in the form of pyrite, are exposed to water and air, producing sulphuric acid. Sulphide minerals are ubiquitous in the geological environment. They are usually found in rock that lies beneath a mantle of soil and often beneath the water table. Consequently, there usually is little contact with oxygen and water and acid generation proceeds at a very slow rate if at all. Whether through mechanic disturbances resulting from mining activities or when there are natural outcroppings of sulphide bearing rocks, if conditions are right, acid rock drainage will occur.

There are several areas in the Yukon where acid rock drainage develops naturally, for example in Macmillan Pass, Clear Lake in the Pelly River Basin and Engineer Creek along the Dempster Highway. Acid waters that are produced may be consumed by alkaline minerals, such as calcium-based carbonate rock, and become neutralized. If there is little in the way of calcium-based rocks or if over time the calcium has become consumed, acidity will continue. Acidic waters can dissolve metals from the rocks over which they flow or can release metals that were previously adsorbed onto sediments. The main metals of concern in the Yukon are zinc and copper. Although these metals are essential in trace amounts for maintaining health, in higher concentrations they can be toxic. The line between health and toxic levels can overlap as in the case of zinc where levels required by algae are toxic to fish. As the acidic waters are mixed and diluted with groundwater or surface water, the pH increases toward neutral or alkaline conditions. The solubility of metals decreases and can precipitate out, often forming a distinctive orange coating on the stream bottom. Tailings from the mining of high sulphur ores are often acid-generating. The rock around the ore deposit is often also high in sulphur and sections of the pits or underground mine walls, and waste rock dumps often produce acid rock drainage. These acidic waters require treatment prior to their release to the environment.

the mine is operating by collecting and treating contaminated water prior to discharge to the environment. The Faro pit is managed with a seasonal dewatering and water treatment program which prevents a discharge of non-compliant water. Surface run-off through the Faro tailings impoundments is managed with a seasonal treatment program. Run-off water has been accumulating in the Vangorda and Grum pits since the mine shut down and active environmental management of these pits and their associated dumps will be required. When the mine is eventually decommissioned, perpetual water treatment and maintenance will be required.

Silver and lead deposits have been mined in the Elsa-Keno area since the 1920s. The mill last operated in 1989. The main environmental issues relate to acid rock drainage from adits and metals leaching from the tailings ponds. Drainage from some adits is high in metals, primarily zinc. Concerns are related to the long-term control of this drainage to protect habitat in the McQuesten River watershed.

The Brewery Creek Gold Mine near Dawson City has been operating since 1996. This open-pit heap-leach gold mine processes ore by percolating a cyanide solution through piles of ore. The gold is leached from the ore by the cyanide solution and then recovered from the solution. In this type of mine it is important to monitor the potential for breaks or leakages in the heap leach system, which could release cyanide to the environment. There is also concern regarding the detoxification methods for the heap when the site is decommissioned. Heap piles could contain residual cyanide.

The main environmental issues at the Ketza River Gold Mine near Ross River are the long-term stability of the tailings dams, the potential for arsenic release from the tailings ponds following decommissioning, and the water quality when the mines are operating.

Similar issues at the Mount Nansen Gold Mine near Carmacks relate to the water quality in the tailings pond and the stability of the tailings dam. The mine went into voluntary receivership on March 23, 1999, but the receivers abandoned the site on July 28 1999. The Mount Nansen Mine technically belongs to the creditors, and DIAND Water Resources has taken over operation of the tailings seepage pump and water treatment plant. Contaminated water seepage at the toe of the Dome Creek Valley dam has been impounded and must be pumped back into the tailings pond. DIAND applied to the Yukon Territory Water Board for a licence to legally discharge treated pond water to Dome Creek. Concentrations of cyanide, copper, zinc, arsenic and ammonia need to be brought down to acceptable levels before discharge can occur. The tailings pond levels will need to be lowered to allow enough free board to contain the spring freshet in 2000.

There are also concerns about the long-term stability and safety of the dam as it was constructed of sand and silt on permafrost. Stability evaluations are underway. The degrading water quality of local springs indicates that the groundwater at the site may be contaminated. The future of the Mount Nansen Gold Mine is uncertain.

The Sä Dena Hes lead-zinc mine near Watson Lake operated for a few years in the early 1990s and is temporarily shut down. Environmental concerns regarding road access to the mine and drainage from the tailings pond were addressed through the environmental assessment and licensing process. This site has little acid rock drainage associated with it. The long term abandonment plan is currently undergoing regulatory review.

The abandoned Clinton Creek asbestos mine is located in the Fortymile River drainage basin near Dawson City. The mine operated between 1967 and 1978. The main environmental concern relates to the physical stability of the site and its potential threat to public safety. Waste rock and tailings dumps have continued to slump and move, blocking the flow of two local waterways and creating impoundments. The continued instability, combined with erosion, could create failures, releasing large volumes of water and asbestos fibre to the environment.

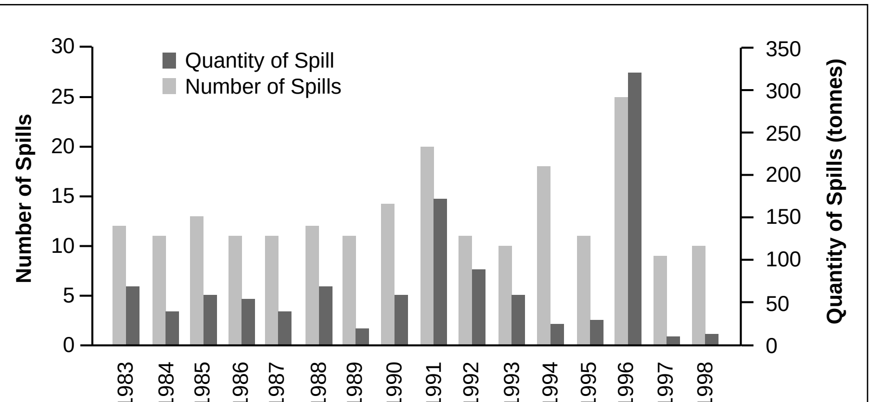


Figure 2.11 Petroleum Spills, 1983-1998
The high volume of spills in 1996 were a result of two spills at the Anvil Range mine near Faro.

Spills

When accidental fuel and chemical spills occur on soils, surface water and groundwater can be contaminated if the spills are not cleaned up. Petroleum is the most frequently spilled product in the Yukon. Diesel fuel is the most common, followed by asphalt emulsions and gasoline. The number and quantity of reported petroleum spills from 1983-98 is displayed in Figure 2.11. Only spills of more than 150 litres are included in the graph [9]. The worst year for spills was 1996, when 324 tonnes were reported spilled. Over half of this amount (192 tonnes) resulted from two spills at the Anvil Range Mine near Faro. Although the spills were captured within the secondary containment, the integrity of the containment, and the volume of the recovered spills are not known.

> Charlie Dick, Ross River Dena Council Elder recounted the spill at the Ketza River mine. *"Three years ago, they said that gas was leaking, the whole tank of gas had gone to the creek and nobody was doing nothing about it. And just a little while ago, they got some kind of tank broke again...and they haven't put in a dam or nothing. They say, 'it's really poison', even a policeman came and saw me about it. That water's going to the Pelly River, it goes into the Ross River."*

In 1998, a large non-fuel spill occurred near Rancheria north of Watson Lake. A B-train trailer truck hauling ammonium nitrate (fertilizer) hit a moose, turned over in a ditch and dumped its load of approximately 30 tonnes. Due to its proximity to the Rancheria River and the fact that ammonia is toxic to fish, the spill was immediately contained. The river was not contaminated, and the cleaned up spill and contaminated soils were spread on farm fields as fertilizer [10,11]

Contamination can continue creating problems for decades. For example, contamination from a railway tie plant, which operated in Carcross from the 1950s to 1975, was detected in the mid-1990s. Ties were dipped into a preservative mixture of diesel and pentachlorophenol (PCP). Soil samples taken in 1996 showed concentrations of PCP. Due to the tie plant's proximity to the Nares River, water and fish samples were also collected. The by-products, dioxins and furans, were found in the fish tissue samples. The site was cleaned up in 1997 to prevent any further contamination.

Emergency Spill Response

Environment Canada coordinates emergency spill response and spill prevention in the Yukon. A 24-hour reporting centre receives reports of environmental emergencies, coordinates other government agencies, and develops contingency plans with industry and government to encourage emergency preparedness. Anyone who causes a spill is required to take all reasonable measures to confine the spill and remove the substance. This includes restoring or rehabilitating the natural environment [12]. A spill must be reported depending on the substances and volumes as outlined in Section 7 of the *Hazardous Goods Transportation Act*, and the conditions outlined in licences issued under the *Yukon Waters Act.*

In the Canadian portion of the Beaufort Sea, exploration for offshore oil peaked in the 1980s. Drilling and exploration of offshore oil increases the potential for an oil spill. In the event of an oil spill, the polluter is immediately responsible for cleanup, although government agencies take charge of cleanup operations if the polluter does not have the capability. The Coast Guard maintains an inventory of spill response equipment in the Western Arctic.

Land-based oil and gas exploration increased in the northern Yukon in 1999, with several Yukon government-sponsored initiatives proposed (see Section 3.3).

Contaminants from Atmospheric Transport

Testing and studies over the past decade have shown the presence of contaminants, such as organochlorines, in traditional/country foods in Canada's north. Pesticides such as toxaphene, chlordane and dichlorodiphenyltrichonoethane (DDT), and the industrial chemical polychlorinated biphenyl (PCB) [13] have been transported here from other regions, entering the Yukon's aquatic environment through rain, dust and snow (see Chapter 1). One local source of PCB contamination was found in Lake Laberge, where sediment analysis suggested that PCBs leaked or were spilled into water in the 1950s, a time of high PCB use in the Whitehorse area [14]. DDT was used for mosquito control from the 1940s to the 1960s.

Organochlorines are mainly found in fatty tissues of animals high in the food chain and have been found at elevated levels in marine animal fat and burbot liver. The levels are very low in land animals and in most fish.

In 1991, the Yukon Medical Officer of Health issued consumption advisories for liver from burbot and for flesh from trout caught in Lake Laberge, and for liver from burbot caught in Atlin Lake. These advisories are still in effect.

The Cumulative Effects of Pollution

The effects of pollution on surface waters can be cumulative. Contaminant 'loading' is the amount of a contaminant discharged to the receiving water, and it can be cumulative. For example, if several placer mines are discharging sediment into the same stream, sediment-loading accumulates. If not settled out, the sediment load persists down the water course.

Regulation

The use of fresh water and the disposal of wastewater are regulated under the *Yukon Waters Act* and the *Fisheries Act*, which are both federal legislation.

A licence under the *Yukon Waters Act* is needed for water use or waste disposal to any waters, including groundwater. Water licences are issued by the Yukon Territory Water Board, but some licences also require the signature of the Minister of Indian Affairs and Northern Development. The maximum limits of water that can be used without a licence are set out in the Act's regulations.

The *Fisheries Act* states that no harmful or deleterious substances may be dumped into fish-bearing waters, or waters leading to fish-bearing waters. The Act also contains provisions to protect fish habitat. The Yukon Placer Authorization (YPA), which sets effluent limits for suspended solids in Yukon placer effluent, and the Metal Mine Liquid Effluent Regulations (MMLERs), which set effluent limits for some common constituents of base metal mine effluents, arise from the *Fisheries Act*. Water licences issued under the *Yukon Waters Act* incorporate effluent standards that must be as stringent as the effluent limits of the YPA and the MMLERs. The habitat protection and pollution prevention provisions of the *Fisheries Act* are enforced by the Department of Fisheries and Oceans, Environment Canada, and DIAND's Placer and Inspection Units.

The federal Mining Land Use Regulations (MLUR) came into effect on December 16, 1998. They ensure that the environmental effects of exploration activities are minimized. Exploration companies must comply with the operating conditions, however, there are differences in the details required depending on the level of exploration.

The current process for environmental assessment in the Yukon is the *Canadian Environmental Assessment Act* (CEAA). A new process for assessing proposed development activities in the Yukon is a requirement of Chapter 12 of the Yukon Land Claim Umbrella Final Agreement. This proposed new legislation, *Development Assessment Process* (DAP), is being developed by the Council of Yukon First Nations and the governments of Canada and the Yukon, and will apply to all lands in the Yukon. It will apply to development activities that might have an adverse impact on the Yukon's environment (land as well as water), people or communities, including activities that may cause an impact from beyond our borders. DAP is detailed in a federal *Yukon Development Assessment Act* and regulations. The Act will be designed to meet the requirements of the *Canadian Environment Assessment Act* and functionally replace CEAA for most projects in the Yukon. Some acts such as the *Yukon Waters Act*, will likely have to be amended to conform with DAP. Permits, authorizations and licenses will continue to be issued by the relevant regulatory agencies such as the Yukon Territory Water Board.

PROGRESS & CHALLENGES

Progress since 1995

- *The City of Whitehorse installed a new sewage treatment facility in 1996, significantly improving the quality of the Yukon River in terms of bacteria contamination.*
- *Thermostatically controlled bleeder devices are reducing the total water use within the City of Whitehorse.*
- *The new and improved Canadian Environmental Quality Guidelines were issued in 1999 to assess the quality of water.*
- *Spills Regulations (Yukon) 1997.*
- *The Yukon Water Board requested Dawson City install an improved waste water treatment facility.*

Challenges

- *There still is no groundwater-monitoring program in effect.*
- *The number of sites that are monitored by government agencies for water quality and quantity have decreased significantly since 1995. For example, in 1995, 31 stations were monitored for water quality whereas in 1999, there were only six.*
- *Two mines have gone into receivership since 1995 and unless steps are taken the cost of cleaning up and remediating these sites, may fall to government.*
- *Dawson City is still discharging screened sewage directly to the Yukon River although improvements are expected by 2002.*
- *The Carmacks sewage treatment facility is operating beyond its design life. Effluent standards for discharge to the Yukon River are not always met.*

The Yukon is situated in the northwest corner of Canada separated from the Pacific Ocean by the high Coastal Mountains. It is part of the Canadian Cordillera, a complex of mountain and plateau country that includes both the Rocky Mountains and the Canadian Cordillera. The area of the Yukon is 483,450 km^2, of which 478,970 km^2 is land and 4,480 km^2 is water. The land area includes islands such as Herschel, located within 32 km of the Beaufort shoreline.

This chapter reviews land use jurisdiction and assesses the status of wilderness, wetlands, and protected areas. As well, it includes a section on solid and special wastes and contaminants. It also examines the use of land for oil and gas, mining, agriculture, transportation and tourism.

Jurisdiction

The Yukon government presently has jurisdiction for approximately three per cent of the land, primarily within, and adjacent to, communities (Commissioner's Lands); the remainder of the land is the responsibility of the Government of Canada and the First Nations with final and self government agreement. This is expected to change with the proposed devolution of land, water, mineral and forest management to the Yukon and completion of First Nation Final Agreements. Currently, seven First Nations have Final and Self Government Agreements (Teslin Tlingit, Tr'ondëk Hwëch'in, Vuntut Gwitchin, Nacho Nyak Dun, Champagne and Aishihik, Selkirk and Little Salmon/Carmacks). Once all land claims are settled, First Nations will manage up to 41,439.81 km^2, approximately eight per cent of the Yukon.

The Yukon government has the lead role in wildlife management, tourism, recreation, agriculture, rural residential and cottage development, waste management and transportation. All existing roads are the jurisdiction of the Yukon government. Both the federal and Yukon governments have park systems in the territory.

Yukon First Nations

Carcross/Tagish First Nation	*Ross River Dena Council*
Champagne & Aishihik First Nations	*Selkirk First Nation*
Kluane First Nation	*Ta'an Kwach'an Council*
Kwanlin Dun First Nation	*Teslin Tlingit Council*
Liard First Nation	*Tr'on dëk Hwëch'in First Nation*
Little Salmon/Carmacks First Nation	*Vuntut Gwitchin First Nation*
Nacho Nyak Dun First Nation	*White River First Nation*

With the devolution of land, water, mineral and forest management and resources to the Yukon government proposed for 2001, the administration and control of most land will devolve to the Yukon government. In preparation for the management of land and resources, the Yukon government proposes to develop mirror legislation to the federal statutes. The Yukon government will also be proposing amendments to the *Yukon Act* to update and modernize the Act in line with devolution.

Major Umbrella Final Agreement Land and Resource Management Committees and Boards

- *Yukon Fish and Wildlife Management Board*
- *Salmon Sub-Committee*
- *Local Renewable Resources Councils (Recommends on fish and wildlife habitat and other renewable resources)*
- *Yukon Heritage Resources Board*
- *Yukon Land Use Planning Council (Recommends policy and priority planning regions)*
- *Regional Land Use Planning Commissions*
- *Yukon Development Assessment Board (Review of development projects)*
- *Kluane National Park Management Board*

"Let's work side by side with traditional knowledge and the public for our future generation to be healthy and have what we've enjoyed in the past. I'd like to see our future was the same, to be enjoyed all our life, on this land that we live on. I'd like to see these two cultures side by side to respect each other's knowledge." –Roddy Blackjack, Little Salmon/Carmacks First Nation Elder

Under the Umbrella Final Agreement, a number of joint government and First Nation boards and committees will contribute to the management of renewable resources, land, water, and heritage resources (see side bar).

The Yukon North Slope is within the Inuvialuit Settlement Region. Environmental assessment and resource management in this region are carried out through joint Inuvialuit and government boards and committees. Management plans have been prepared to address specific wildlife and community issues as shown opposite.

Environmental assessment for projects on federal lands or involving federal money or permits is the responsibility of the federal government, as are land use activities such as mining and forestry. It is expected that by 2001, environmental assessment in the Yukon will take place under the Development Assessment Process (DAP). The parties are continuing to work towards completing the Development Assessment Process that fulfills the requirements of the UFA and is reflective of the needs of Yukoners. Consultation on the next public draft of the legislation is expected to occur in 2000.

3.1 Wilderness

Wilderness means an area in the Yukon where human activity has not significantly changed the environment or the ecosystem. It includes an area restored to natural condition *(Yukon Environment Act).*

Wilderness areas are being lost throughout the world as the human population continues to climb and the use of land and resources increases. Since 1900, the world's population has multiplied almost fivefold and in 1999 the population of the world reached six billion. Projections of the world population are 10 billion in the year 2060 [1]. The ecological footprint of this number of humans is immense. As countries complete the industrialization process, the world-wide demand for resources and land will multiply exponentially. These forecasts allude to a profound impact on the remaining areas of wilderness in the world.

While at the beginning of the 20th century, wilderness was often seen as a frontier to be pushed back, many individuals now view natural and pristine areas as essential to the maintenance of a sustainable ecosystem. For the First Nation people who still have ties to the land, the vast undeveloped regions of the Yukon are their homeland with familiar trails, campsites, fishing camps, caches and hunting areas [2]. Despite a growing individual awareness of the value of wilderness, an escalating world population and demand for resources are so great that, on a global scale, there is increasing stress on the remaining wilderness areas. In many countries of the world, wilderness areas have disappeared.

The *Environment Act* recognizes wilderness as a natural resource with ecological as well as economic value. The Act provides enabling legislation for the establishment of Wilderness Management Areas to protect the wilderness resource. Currently, the approach is to use the *Yukon Parks Act* and the Protected Areas Strategy to identify and protect natural areas, including wilderness lands.

"Our history, painting, literature... all have been deeply influenced and distinguished by the wilderness... As we surrender our wild heritage, we surrender much of what distinguishes us as Canadians." –Bruce Littlejohn 1989 [3].

Management Plans for the Yukon North Slope

Plan	Responsible Agencies
Yukon North Slope Wildlife Conservation and Management Plan	*North Slope Wildlife Management Advisory Council*
Co-Management Plan for Grizzly Bears	*Government of the Northwest Territories*
Management Plan for the Porcupine Caribou Herd from 1996/97 to 1999/2000	*Porcupine Caribou Management Board*
Ivvavik National Park Management Plan	*Parks Canada, in cooperation with the Inuvialuit*
The Inuvik Inuvialuit Community Conservation Plan	*Inuvik Hunters and Trappers Association, Community Corporation and Elders Committee*
Aklavik Inuvialuit Community Conservation Plan	*Aklavik Hunters and Trappers Committee, Community Corporation and Elders Committee*
Herschel Island Park Management Plan	*Yukon Department of Renewable Resources in cooperation with the Inuvialuit Game Council, Inuvialuit Hunters and Trappers Committee and Wildlife Management Advisory Council (North Slope)*

Wilderness Mapping Project

In order to track changes in the amount of wilderness land in the Yukon, an estimate of developed, natural and wilderness lands has been calculated (Figure 3.1). The method and the limitations of the mapping project are detailed below.

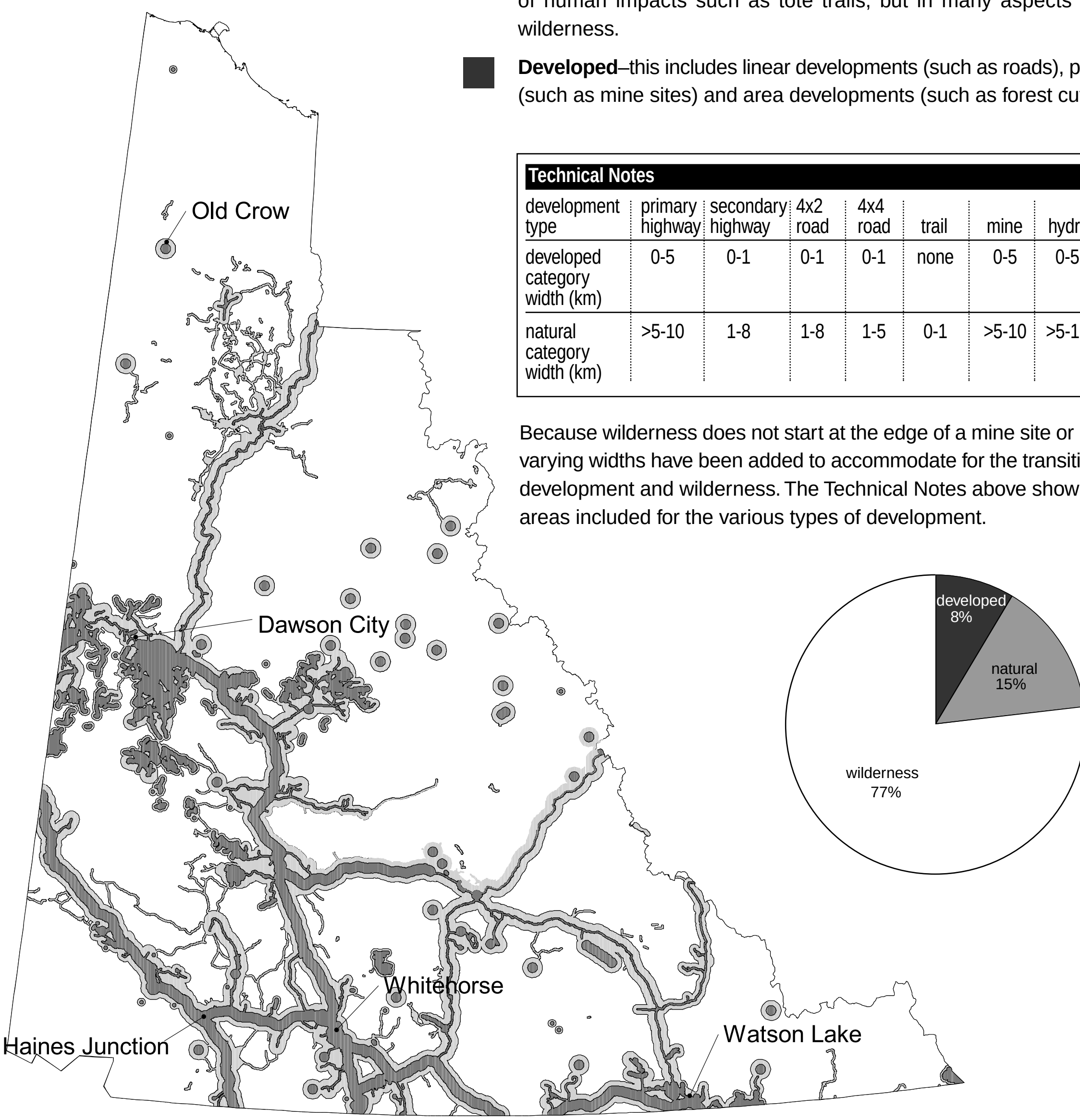
Technical Notes for the Preparation of the Wilderness Mapping Project

- A sub-committee of the 1995 Yukon State of the Environment Steering Committee developed the approach to mapping wilderness based on a methodology adapted from the British Columbia Ministry of Forests [4]. The approach used in 1995 has been repeated in 1999 with changes in terms of the data base used to build the wilderness map.
- In addition to the actual development (e.g. mine site, highway), areas of varying widths (depending on the type and intensity of development) were included in the Developed or Natural Categories. The width of the buffers surrounding the various types of developments as well as the minimum area of land included in the Developed and Natural Categories are shown in Figure 3.1.

Limitations of the wilderness mapping projects

- In both 1995 and 1999 it was impossible to accurately map all developments due to the cost and time involved and the lack of available data. Developments excluded from both 1995 and 1999 are: seismic lines, grazing lands, isolated dwellings, cabins, some placer operations, minor mineral exploration, and a number of power lines, smaller roads and trails or footpaths.

- As not all of the computerized data could be verified, there may be developments such as roads that are no longer in use and have reverted to wilderness. Alternatively, new roads that are not in the data base may have been missed. While this is a limitation of the wilderness map, overall, these mapping constraints likely balance out in terms of the total calculation of wilderness areas of the Yukon.



Wilderness–areas with little human activity other than subsistence use or activities with low-scale development

Natural–an intermediate category of 'moderate' wilderness. There may be evidence of human impacts such as tote trails, but in many aspects the land remains wilderness.

Developed–this includes linear developments (such as roads), point developments (such as mine sites) and area developments (such as forest cut blocks).

Technical Notes

development type	primary highway	secondary highway	4x2 road	4x4 road	trail	mine	hydro	placer	forestry
developed category width (km)	0-5	0-1	0-1	0-1	none	0-5	0-5	0-2	0-2
natural category width (km)	>5-10	1-8	1-8	1-5	0-1	>5-10	>5-10	>2-4	>2-4

Because wilderness does not start at the edge of a mine site or highway, areas of varying widths have been added to accommodate for the transition zone between development and wilderness. The Technical Notes above show the widths of the areas included for the various types of development.

Figure 3.1 Wilderness areas in the Yukon Territory

Different data sources for 1999 than 1995

- Due to availability of computerized mapping, a number of roads, power lines, tote trails and four wheel drive trails, excluded from the 1995 wilderness map, were included in the 1999 mapping project. As a result of the new data source, the 1999 wilderness map is a new baseline for the amount of wilderness land in the Yukon. Comparisons between the 1995 and the 1999 maps and per cent of wilderness should not be made.

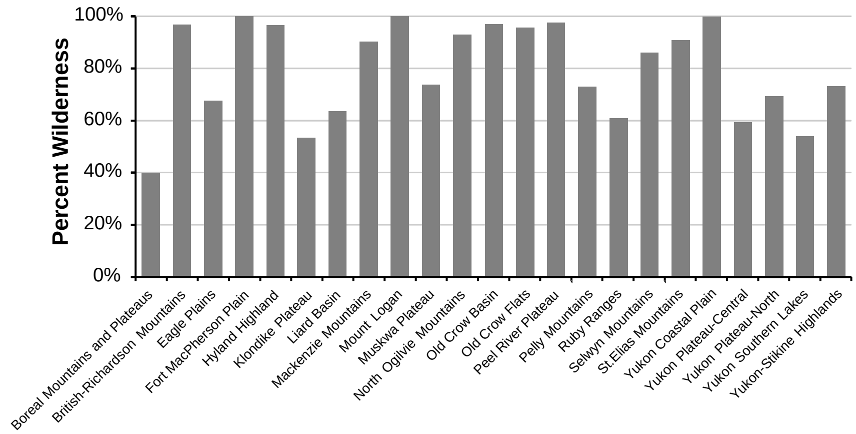


Figure 3.2 Percentage of Area of Wilderness by Ecoregion

Definitions of development used for mapping project

Roads: all weather highways, two-wheel and four-wheel drive roads or tote trails, (excluding foot trails). Winter roads shown on the 1:250,000 NTS maps are included in the calculations.

Resource extraction: mine sites (current or historical production greater than 500 tonnes) and significant mineral exploration and oil and gas sites.

Placer mining: placer sites and major placer mining streams. Isolated placer operations were not mapped.

Hydro development: hydro power generating sites and power lines shown on the 1:250,000 NTS maps.

Major Forestry Operations: sites where multiple permits for logging exceeded 15,000 cu metres.

Settlements: included with the road mapping.

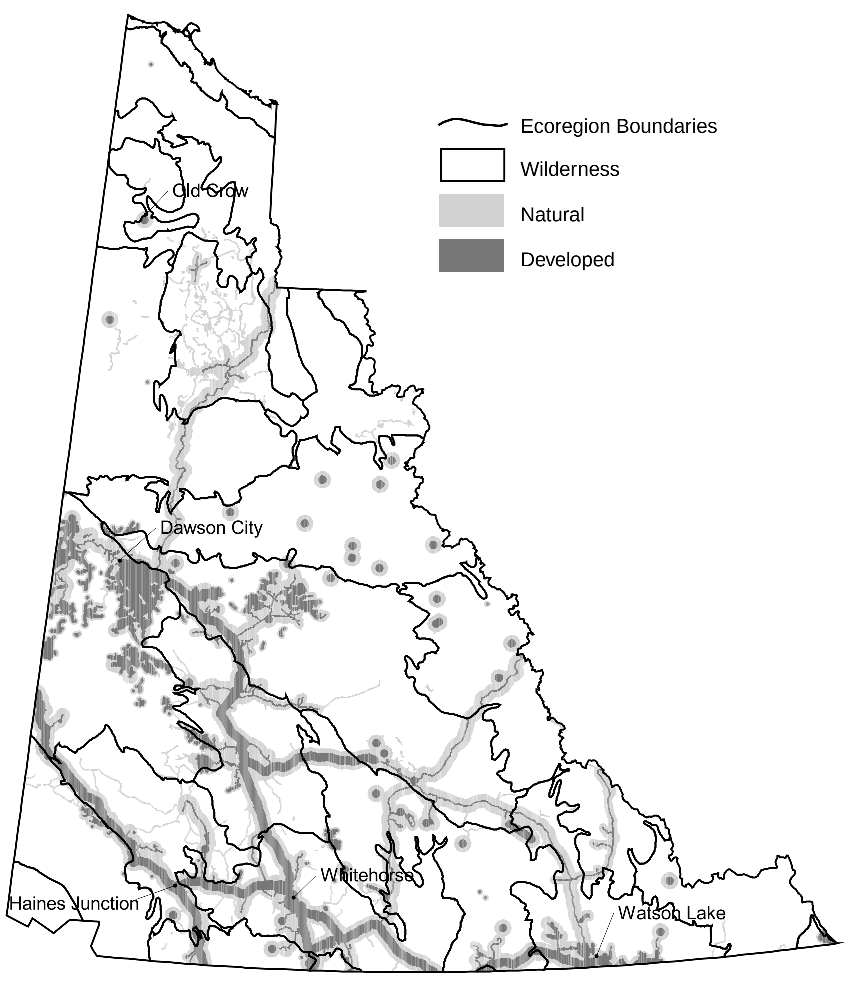


Figure 3.3 Wilderness areas of the Yukon by Ecoregion
Names of the ecoregions are shown in Figure 3.4

ECOZONE	ECOREGION	CODE
Pacific Maritime	Mount Logan	184
Southern Arctic	Yukon Coastal Plain	32
Taiga Plain	Peel River Plateau	51
	Fort Macpherson Plain	53
	Muskwa Plateau	66
Taiga Cordillera	British Richardson Mountains	165
	Old Crow Basin	166
	Old Crow Flats	167
	North Ogilvie Mountains	168
	Eagle Plains	169
	Mackenzie Mountains	170
	Selwyn Mountains	171
Boreal Cordillera	Klondike Plateau	172
	Saint Elias Mountains	173
	Ruby Ranges	174
	Yukon Plateau-Central	175
	Yukon Plateau-North	176
	Yukon Southern Lakes	177
	Pelly Mountains	178
	Yukon-Stikine Highlands	179
	Boreal Mountains And Plateaus	180
	Liard Basin	181
	Hyland Highland	182

** Yukon ecoregions and code numbers are part of a national framework for the classification of ecoregions.*

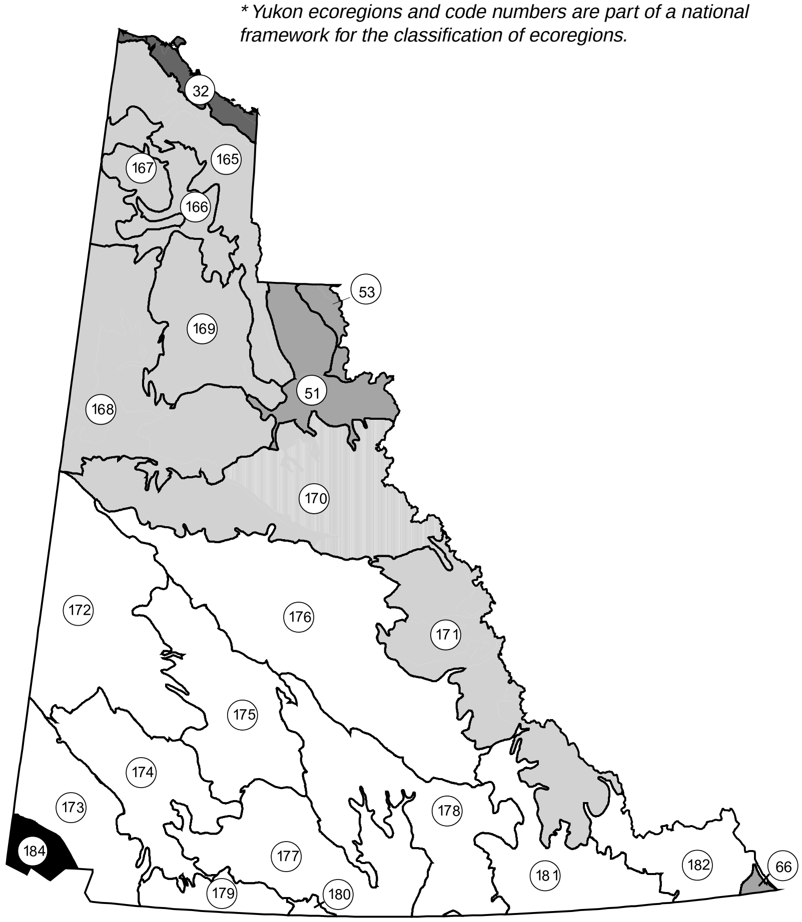


Figure 3.4 Ecoregions of the Yukon

Wilderness Lands in the Yukon

The Yukon has vast areas of undeveloped land. Approximately 77 per cent of the territory is within the 'wilderness' category (Figure 3.1).

Figures 3.2 and 3.3 illustrate the amount of wilderness, natural and developed land in each ecoregion. Ecoregions with the most wilderness are: the Yukon Plateau North, MacKenzie Mountains, North Ogilvie Mountains and Selwyn Mountains. Three ecoregions, the Klondike Plateau, Yukon Plateau North and Yukon Southern Lakes contain the most development. The Klondike Plateau has substantial areas of placer mining, while the Yukon Southern Lakes ecoregion is dominated by development in and around the City of Whitehorse.

3.2 Protected Areas

"Our shared relationship with the northern land, water, air and life forms defines our character, sustains our spirits and unites us as people of the Yukon.

We have a duty to protect the ecosystems and natural processes that support this relationship.

We will meet this responsibility for the benefit of ourselves and our children, and also for the benefit of other life forms and the earth as a whole – for bio-diversity and the intrinsic value of wilderness.

We will use the Yukon Protected Areas Strategy to guide us as we set up a network of protected areas based on ecosystem management, conservation biology, sustainable economies and values and knowledge of Yukon people."–Vision Statement of the Yukon Protected Areas Strategy [1].

The Yukon Protected Areas Strategy, approved in 1998, guides the establishment of a system of protected areas by:

- protecting core areas within each ecoregion to represent the ecological diversity of the Yukon; and
- protecting special areas which contain important wildlife and habitat values, uncommon landforms and natural features, special cultural, heritage and spiritual values, special outdoor recreation values or wilderness areas with intact ecosystems.

The representative core protected areas are very important. They must be able to support sustainable populations of plants and animals for the foreseeable future and longer, survive climate fluctuations, disease and provide a future gene pool. The four criteria used to select the representative core protected areas are:

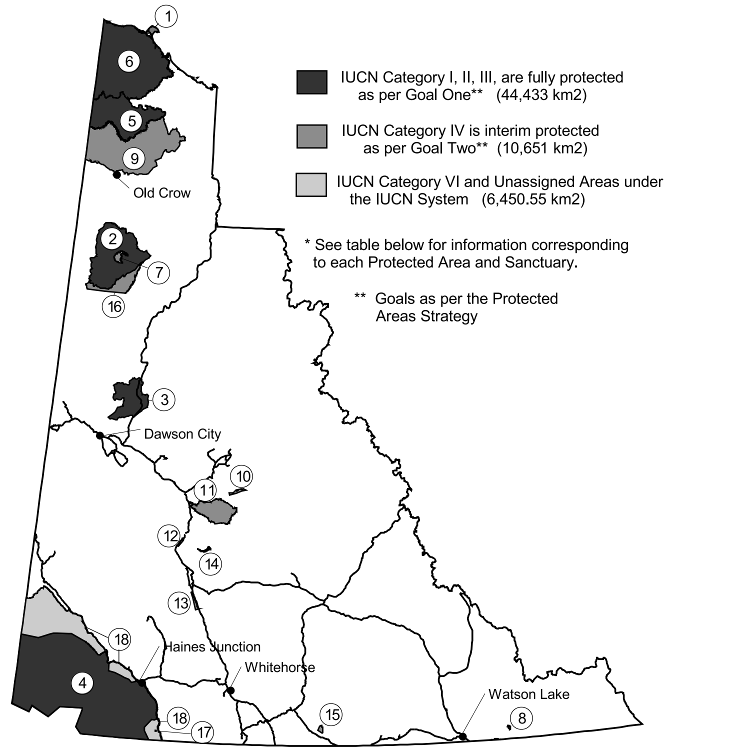
- representation of the ecosystem diversity of the ecoregion (Figure 3.5);
- naturalness with few human caused disturbances;
- ecological viability on a long term basis; and
- research and education values.

In 1999 the Yukon government set up a Protected Areas Secretariat (PAS) to coordinate the planning and establishment of protected areas [2].

Parks and other types of protected areas in the Yukon may be established by federal agencies (Parks Canada or

What is a Protected Area?

An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other means (World Conservation Union) [3].



WORLD CONSERVATION UNION[1] (IUCN) CLASSIFICATIONS

Categories I , II, III, are fully protected as per Goal One[2] (44,433 km²)
Category IV is protected as per Goal Two[3] (10,651 km²)

IUCN Category I and II: Strict Nature Preserve, Wilderness Areas, National Parks (44,252 km²)		
1	Herschel Island Territorial Park	116
2	Fishing Branch Wilderness Preserve	5,400
3	Tombstone Territorial Park	2,164
4	Kluane National Park	22,015
5	Vuntut National Park	4,387
6	Ivvavik National Park	10,170
IUCN Category III: Natural Monument (181 km²)		
7	Fishing Branch Ecological Reserve	165
8	Coal River Springs Ecological Reserve	16
IUCN Category IV: Habitat /Species Management Areas (10,651 km²)		
9	Old Crow Flats Special Management Area	7,785
10	Horseshoe Slough Habitat Protection Area	79
11	Ddhaw Ghro Habitat Protection Area[3]	1,595
12	Llutsaw Wetlands Habitat Protection Area	31
13	Nordenskiold Wetlands Habitat Protection Area	76
14	Ta'Tla Mun Special Management Area	32
15	Nisutlin River Delta National Wildlife Area	53
16	Fishing Branch Habitat Protection Area	1,000
ICUN Category VI (0.55 km²)		
17	Sha'washe Special Management Area	0.55
Unassigned under the IUCN System (6,450 km²)		
18	Kluane Wildlife Sanctuary	6450

[1] Changed in 1990 from the International Union for the Conservation of Nature. The acronym did not change.
[2] Goals as per the Protected Area Strategy
[3] With the exception of Fishing Branch Habitat Protected Area, these areas are currently withdrawn from mineral activity (status as of 1999). Status is subject to management planning

Figure 3.5 Yukon Protected Areas and Sanctuaries
The classification of protected areas in the Yukon is based on categories established by the World Conservation Union, an international organization. The classifications are generally accepted world-wide.

the Canadian Wildlife Service), or through four Yukon government agencies (Parks and Outdoor Recreation, Wildlife, Heritage, and Environmental Protection branches).

The guiding principles for establishing the protected areas network begin with ecological integrity. Through a process of public participation, partnerships, accountability, quality of information and coordination, the network will respect all values, recognizing economic interests and contributing to sustainable development.

Process to Establish Protected Areas

1. *The Protected Areas Secretariat identifies the first ecoregions and areas of interest.*
2. *Local planning team is established in the First Nation Traditional Territory to work with community stakeholders, and the Yukon public.*
3. *Local planning team identifies the study area.*
4. *Government reviews and approves the study area.*
5. *Local planning team completes the proposal for the protected area.*
6. *Review by the Development Assessment Process.*
7. *Final government (cabinet) review and approval*
8. *Designation of the protected area.*
9. *Preparation of a management plan and submission to government for approval.*
10. *Periodic review and update of the management plan every five years.*

Protected areas in the Yukon range from relatively small ecological areas to extensive wilderness preserves. Some reserves in the Yukon have strict provisions for preservation of the complete ecosystem; others include only provisions to limit wildlife harvesting.

Yukon protected areas and sanctuaries are shown in Figure 3.5 and the ecoregions of the Yukon are shown in Figure 3.4.

Some ecoregions are well represented in the protected areas network (Figure 3.6). The priority regions for the establishment of protected areas are the British–Richardson Mountains, Eagle Plains, Peel River Plateau and Fort MacPherson in the north and the Southern Lakes and Pelly Mountains.

A network of protected areas will maintain bio-diversity, protect wildlife and watersheds, preserve unique, natural, scenic, historic and cultural areas, preserve the genetic diversity of species, and preserve wilderness.

Cooperation between different sectors of government and industry is important to the establishment of protected areas which meet the objectives of the strategy. One issue which has been raised relates to mining. Though in many cases mining claims have lapsed in proposed park areas, some staking on or adjacent to proposed protected areas has occurred.

Chapter 10 of the Tr'ondëk Hwëch'in Final Agreement outlines the process for establishing the Tombstone Territorial Park, and a study area was established in April of 1997. A steering committee was struck in 1999 to recommend a final park boundary. There were 380 valid mineral claims

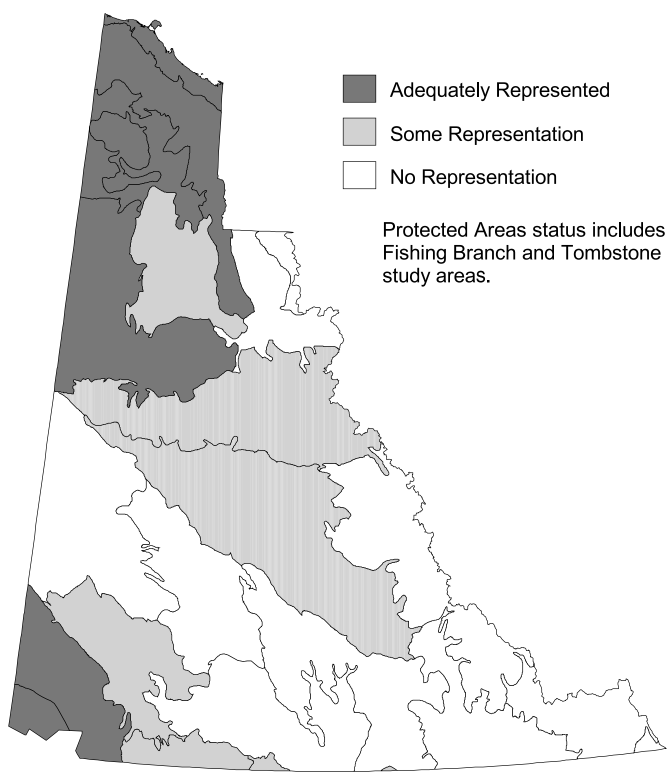


Figure 3.6 Representation of Ecoregions in the Protected Area Network

within the study area in February 1998, and some of the claim holders have let their holdings lapse. In the fall of 1999, there were 75 valid quartz claims within the draft park boundary. In December 1999, the Yukon and Tr'ondëk Hwëch'in governments approved the park boundary and permanent mineral staking withdrawal will be requested.

In the summer of 1999, a lapsed mineral interest was re-staked (6 claims) within an area of interest for "Goal one" protection under the Yukon Protected Areas Strategy. The location of the claims within the headwaters of the Fishing Branch River, has raised concerns regarding the potential risk to water quality. In December 1999 the Yukon government approved the entire Fishing Branch watershed as a Wilderness Preserve. The existing mineral rights will be respected.

Protected areas: A Canadian and Broader Perspective

The Government of Canada issued a Statement of Commitment to complete Canada's Network of Protected Areas by the year 2000. This commitment to complete a system of representative parks in each jurisdiction requires the cooperation of federal, provincial, and territorial governments [4].

The Yukon still needs adequate representation in 16 of its 23 ecological regions according to the Yukon Parks System Plan and the Yukon Protected Areas Strategy. The National Parks System Plan guides Parks Canada in establishing parks. Under this system, one of the five natural regions in the Yukon is not currently represented by a national park. Parks Canada has identified the Wolf Lake candidate area in the Northern Interior Mountains and Plateau Natural Region for further assessment in 1999.

First Nations are playing a key role in establishing parks and protected areas in the Yukon. The designation of Special Management Areas (SMAs) under the Yukon land claim protect areas of cultural and environmental significance. The extent of the influence of the land claim agreements is clear as only one protected area, Coal River Springs, has been designated outside the land claim process.

Non-government agencies, such as the World Wildlife Fund and the Canadian Parks and Wilderness Society, research and lobby for areas in need of preservation around the world. Major non-governmental initiatives for the Yukon include the World Wildlife Fund's Endangered Spaces Campaign, the Yellowstone to Yukon Project, Yukon Wildlands Project and the Caribou Commons Project.

Joint initiatives and meetings between private industry, government and environmental groups are the start of a cooperative approach for the establishment of protected areas.

PROGRESS & CHALLENGES

Progress since 1995

- *Yukon Protected Areas Strategy adopted December 1998.*
- *Protected Areas Secretariat established March 1999.*
- *There is adequate parks and protected area representation within seven of the 23 ecoregions of the Yukon. These protected areas meet Goal One of the Protected Area Strategy as there is a representative core area protected within each ecoregion.*
- *Four ecoregions have some representation in the Yukon protected areas network.*
- *Seven new protected areas established since 1995 (Tombstone Territorial Park, Fishing Branch Wilderness Preserve, and the Ta'tla Mun Special Management Area) and four Habitat Protection Areas (Nordenskiold Wetlands, Ddhaw Ghro, Lhutsaw Wetlands and Fishing Branch Habitat Protected Area).*
- *9.3 per cent of the Yukon was protected in 1999 according to Categories I to III of the World Conservation Union; an additional 2.2 per cent is interim protected.*

Challenges

- *Following consultation with First Nation governments and the public, oil and gas land sales were held in 1999 in the Eagle Plains Basin. An area was exempted from oil and gas land sales for future protected areas work. Additional oil and gas land sales in the area are contemplated for 2000. Areas to be exempted for protected areas planning remain under discussion. There is the potential that lands required for protected areas planning may be affected by the 2000 sale.*
- *Obtaining interim protection of areas of interests is recognized as a challenge.*
- *16 out of the 23 ecoregions are not adequately represented by protected areas.*

3.3 Oil and Gas Industry

The Yukon is entering a new era in the management of its oil and gas resources (Figure 3.7). Until recently, the Government of Canada owned and managed oil and gas in the Yukon. In the fall of 1998, the Yukon government assumed provincial-like responsibility for oil and gas resources and is establishing a competitive oil and gas regime.

Yukon First Nations are also assuming responsibilities for oil and gas through land claim agreements. The Yukon government has formed a partnership with First Nations and together the parties are pursuing the development of a common oil and gas regime. Under this common framework of legislation, regulations and policies there will be one set of rules for exploration and development. The core component of the common regime–the *Yukon Oil and Gas Act*–was enacted in 1998. A number of the key regulations have been developed and others are being developed. The existing regulations apply to the exploration stage and are regarded as very strict. They contain provisions that are not covered in other jurisdictions. For example, financial deposits are required to guarantee that abandonment and clean-up of wells will be conducted properly.

As conventional supplies of oil and gas dwindle in Western Canada and companies seek alternative sources, exploration in the north becomes more favourable. Yukon is situated at the periphery of oil and gas producing regions with Alberta and British Columbia to the south, the Northwest Territories to the east, and Alaska to the west. Activity and infrastructure in Alberta and British Columbia extend into the southeast Yukon and opportunities exist for it to move northward.

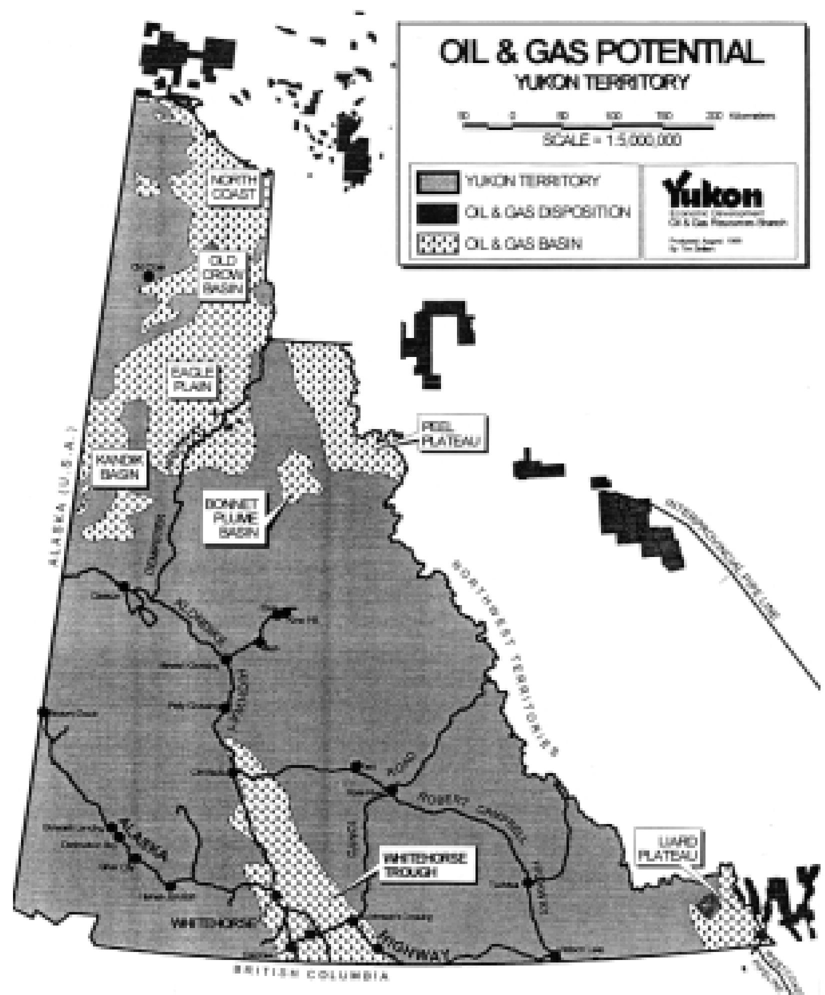


Figure 3.7 Oil and Gas Potential in the Yukon
Yukon contains eight sedimentary basins with potential to host oil and gas deposits. Each basin has its own unique geological history and character. Seventy-one wells have been drilled in the Yukon and most of these are located in the Liard Plateau, Peel Plateau, and Eagle Plain basins. The remaining five basins–Bonnet Plume, Kandik, Old Crow, Whitehorse Trough, and Coastal Plain–are virtually unexplored. There is also considerable oil and gas potential in the Beaufort Sea off the Yukon's north coast.

Current exploration interest is largely focused on the Liard Plateau in the southeast corner of the Yukon where one producing field is located. The best prospects are expected to be large deep gas pools similar to the producing field at Kotaneelee. There is also interest in Eagle Plains in north central Yukon and a company is currently planning to produce crude oil from proven oil and gas reserves here for sale in the local Yukon market.

In the past, seismic cutlines were six to eight metres wide which caused forest fragmentation and created access into otherwise remote areas. Through the assessment process, industry and the regulators are seeking to reduce access into the exploration areas. Technology has also evolved to significantly reduce access to and within exploration areas. Now cutlines are a maximum width of 1.5 meters, and trees are limbed and not entirely cut down. A team walks along the line and cuts an opening where a helicopter lowers the drill to conduct the seismic work. The drill is removed and lowered to another specified location further down the line. This method of exploring for oil and gas is far more environmentally friendly than previous methods.

The oil and gas industry is still in the exploration stages in the Yukon. With more producing wells coming on stream, there is the potential for emissions of carbon dioxide and sulphur dioxide to increase, contributing to global warming and acid rain. Industry and governments are currently addressing this problem [1].

3.4 Mining

Mining has been an important part of the Yukon economy since the late 1800s. For many Yukoners, mining is also a lifestyle. Prospecting and placer mining in particular offer opportunities to work 'in the bush' for at least part of the year. Mining is also one of the Yukon's major land uses, as buildings, access road, exploration and mineral extraction are all part of the industry.

Some mining activities such as prospecting and exploration have relatively little impact on the environment, whereas advanced exploration and mining extraction have significantly transformed the landscape in some areas. Major effects can be seen in the placer areas of the Klondike where large volumes of earth have been moved. Other effects include road development and the abandonment of equipment, infrastructure and camp refuse at mining and exploration sites.

Over the past 10 to 20 years, many controversial issues in the Yukon have revolved around mining and environmental regulation. Mining related environmental concerns have been particularly evident over the past few years because both the Faro and Mount Nansen mines went into receivership, creating uncertainty over the clean up of these sites and the responsibility. Many Yukoners have been concerned about the regulatory regime's capacity to protect the environment from certain mining-related impacts. They also want the mining industry to be held accountable for its effects on the environment. On the other hand, the mining industry has raised concerns about the increased levels and complexities of regulations and the accompanying additional expenses and delays.

The enactment of the *Yukon Quartz Mining Land Use Regulations* (MLUR) in December 1998, was a significant step forward, ensuring that all mining related land uses are assessed for potential environmental effects. Yukon-made legislation is the result of 10 years of consultation between government and stakeholders. It is designed to minimize the environmental effects of disturbance caused by exploration activities. All mineral exploration activities must now comply with operating conditions, which represent the minimal performance levels and conditions for: re-establishing vegetative mat, erosion control, trenching, archeological sites and burial grounds, camp cleanliness, stream crossings, line cutting, and many more.

	Total Surface (square kilometers)	Percentage of Yukon Land Base
Total area of the Yukon	483,450	100
Iron and mica claims	340	0.07
Quartz mineral claims (including leases which allow for prospecting only)	14,052	2.9
Placer claims (standard, discovery and co-discovery)	1,598	0.33

Figure 3.8 Amount of Yukon Land Under Mining Claims [1]
(Status as of November, 1998)

Mining projects are now classified into four categories, from small camps of prospectors to major operations involving drilling equipment, road development and large camps. Depending on the size and possible impact of the activity program, such as trenching, drilling, numbers of persons in the camp, amount of fuel used and stored, use of explosives and several other criteria, an operating plan may need to be submitted to the Mining Land Use Office. In some cases, additional mitigation may be necessary if the operating conditions are judged insufficient to deal with potential impacts. *A Handbook to Reclamation Techniques in the Yukon* has been developed to assist the mineral industry and will be updated as industry gains more experience at implementing the regulations. Also available from the DIAND Environment Directorate is a *Permit Guide for Projects in the Yukon Territory*, which outlines the permits required for various activities; roads, forestry and mining.

How Mining Affects the Land

In 1998, 15,990 square kilometers of land (3.3 per cent of the area of the Yukon) were held by mining claims in good standing (see Figure 3.8). This included placer, quartz, iron and mica claims, though not all staked claims are being actively explored. This represents an increase in mining claimed land of 0.8 per cent from the last SOE report (1994 data). Of these claims, less than one per cent will have the potential to support a large mine. Although less than 0.01 per cent of the Yukon is occupied by active mines, the impact of mining operations can extend far beyond the actual footprint of the mine. Major operations can potentially harm land, water, and wildlife.

Roads to exploration sites and camps have contributed to the fragmentation of large portions of the Yukon. Mining districts with a long history of activity, such as the Klondike, Faro and Carmacks areas, have a higher concentration of roads. Roads crisscross these areas from lowland floodplains to high alpine tundra and open up a range of ecosystems to hunters, visitors and other prospectors long after the initial developer has left the area.

Exploration

In some areas in the past, exploration activity left its mark. Cat trails, all-terrain roads, trenches and stripped areas have frequently been abandoned without reclamation work. In some disturbed areas vegetation will naturally re-establish itself after five to 10 years, such as cuts and tailing piles in some placer mines in the Klondike and Mayo regions. At other sites, such as high alpine trenches excavated in rock and coarse overburden piles, hardly any vegetation growth has reappeared even after 40 years. When the ground is bare for a long period of time, processes such as erosion, slumping and permafrost degradation can occur.

The new Federal Mining Land Use Regulations (MLUR) require environmental considerations. Many exploration companies have changed their operations independently of government regulations because of increased environmental awareness and improved technology. The combination of larger helicopters and lighter drilling equipment has allowed some drilling programs to leave a smaller footprint on the land. For example, when diamond drills are flown to a site, access roads are not needed. There is also a requirement for annual reports of activity to be filed during the life of the program.

Excavators are now often used instead of bulldozers to dig out trenches as their smaller size makes them cheaper to move and to run. They also dig smaller trenches and can set aside the organic rich topsoil, which can be replaced on the surface of the refilled trench. These excavators can be flown to exploration sites in pieces, which again removes the need for access roads.

An increasing number of exploration companies are conscious of Yukon wildlife issues. Some companies will avoid sheep areas during the sensitive lambing season or caribou areas during the fall rut. Many camps now prohibit fishing and hunting.

In spite of these efforts and changes in regulations, there is still a concern that exploration activities impact the pristine nature of wild lands.

Mine Sites

Placer and hard rock mines can affect the land by:

- disturbing vegetation and wildlife habitat and limiting other land activities such as traditional use, hunting, trapping and recreation;
- eroding of soils and slumping or creating other slope instability problems;
- disturbing streambanks and streambeds, which affects fish and wildlife habitats;
- introducing non-degradable materials, such as equipment, buildings, mills, refuse, fuel and drilling fluids which are at times abandoned on site; and
- contaminating soils and receiving waters with improperly treated effluent or spills.

Although earlier mines had limited environmental review, companies who now wish to construct a mine must go through a rigorous assessment procedure under the *Canadian Environmental Assessment Act* (CEAA). First, baseline studies are undertaken to collect information on the natural characteristics of the general area. These include water quality, fisheries, wildlife, vegetation and traditional land uses. Baseline studies are important because they help determine the effects an operating mine may have on the environment. New operations incorporate decommissioning planning and environmental monitoring into their proposals. Financing for abandonment is now addressed during the early stages of mine development. This Act and its enforcement are a federal responsibility as of the writing of this report, however, devolution of mining is to occur in 2001, at which time enforcement will be a Yukon responsibility.

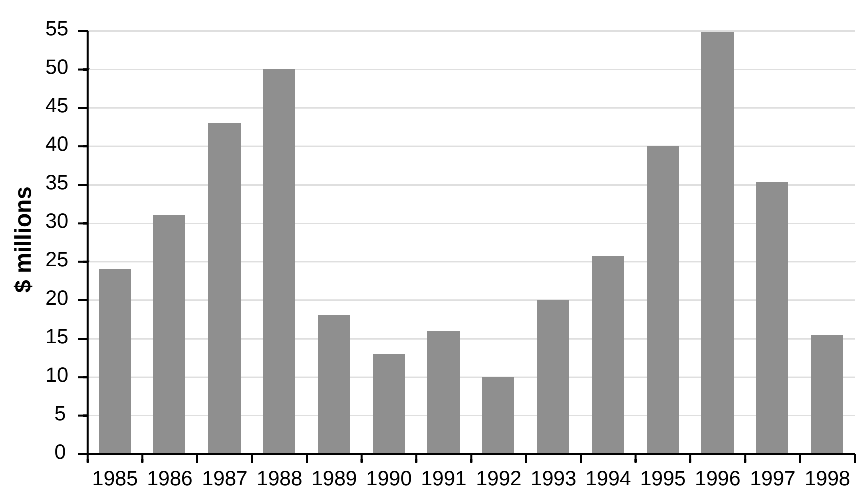


Figure 3.9 Yukon Mineral Exploration Expenditures

An environmental review committee, with representation from First Nations and federal and territorial government agencies, then examines the information. Public meetings are often held in communities closest to the project. The mine will only proceed to the licensing stage after the environmental review committee has reviewed the baseline studies and mine plans, and the federal government is satisfied that environmental effects will be ameliorated. An important part of the environmental assessment is the abandonment and reclamation plan submitted by the mining company. This plan sets out how the land will be restored after the mine shuts down. It is this stage of mining that has caused the most concern in the Yukon in recent years.

The Yukon Mining Industry

Prospecting and exploring for hard rock or quartz minerals has had a long history in the Yukon. Each season, the territory is explored for a variety of minerals like gold, silver, copper, tungsten, nickel, coal, lead and zinc. The degree of activity depends on world market prices, demand for minerals and the investment climate. Exploration activities are influenced by local discoveries or the availability of new geological maps. Figure 3.9 shows the fluctuations in mineral exploration spending over recent years. In 1998, low prices on the global market for gold and base metals are reflected by low exploration activity.

Yukon placer gold deposits contribute up to five per cent of Canadian gold production. The number of active placer mines increased greatly in the late 1970s due to a sharp rise in the price of gold and has remained at about 200 since 1980 (Figure 3.10).

The principal minerals produced in the Yukon are gold, lead, zinc and silver. The value of these four minerals from 1985 to 1997 is shown on Figure 3.11.

Mineral exploration and production have been the most significant non-government economic forces in the Yukon for more than 100 years. For a small economy, the Yukon has made a relatively significant contribution to global lead and zinc production. For example in 1996, production from Yukon mines accounted for 2.1 per cent of total world zinc production and 3.2 per cent of total lead production. When fully operational, the lead-zinc mine at Faro had historically accounted for about 12 to 15 per cent of the Yukon Gross Domestic Product (GDP).

Mineral Potential

The complex geology of the Yukon can be roughly split into two rock groups: those north of the Tintina Trench and those south of it. This dividing line cuts northwest to southeast across the territory from Alaska to northern British Columbia, with each side characterized by different types of rocks containing different types of mineral deposits [1].

The Tintina Trench is the huge valley formed by the erosion of the Tintina Fault Zone and is one of the territory's most distinctive and significant physical features.

Forces of erosion and deposition have concentrated secondary deposits of gold in river valleys. In most of the Yukon the glacial or ice-melt processes have dispersed the secondary gold deposits or covered them with thick layers of sediments. However, in the Klondike Plateau ecoregion there was little or no glaciation and the gold deposits are relatively undisturbed and easily accessible. Despite many years of exploration activity, the Yukon is still relatively poorly understood from a geological perspective. It is considered to have great mineral potential.

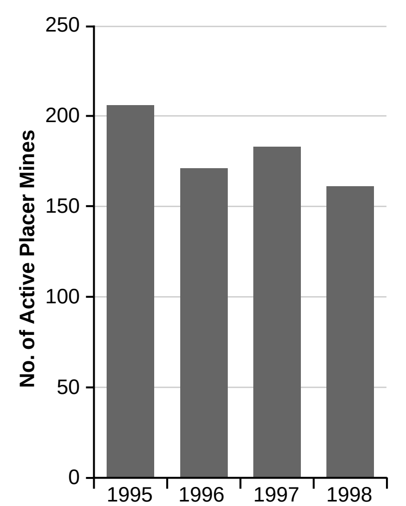


Figure 3.10 Active Placer Mines in the Yukon, 1995 to 1998

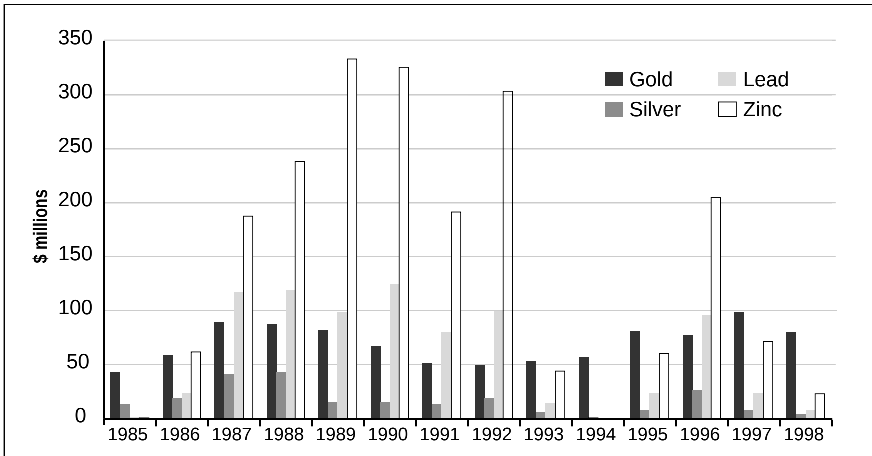


Figure 3.11 Yukon mineral production values

Figure 3.12 shows the location of some of the active mines, development projects and exploration projects in the Yukon in 1998. Production occurred at Brewery Creek and Mount Nansen in 1998. During 1999, only Brewery Creek Mine operated.

Placer Mining

Placer deposits occur throughout the Yukon, though historically, most of the mining has taken place in the Klondike gold fields near Dawson City. This area is particularly favourable for placer deposits because it lies in the unglaciated part of the Yukon. Approximately 80 per cent of the Yukon's placer gold is currently mined from the Klondike and other unglaciated parts of the territory.

Placer deposits consist of loose material (gravel, sand and clay) formed by the weathering of mineralized bedrock. As the bedrock breaks down, heavy minerals like gold, silver, platinum, tin, copper, tungsten and some gemstones are released. These minerals concentrate in layers because their relative weight (specific gravity) allows gravity and the natural flow of water to sink them to the bottom of creeks or a 'hardpan' layer where they accumulate through time.

Water is usually used as the transporting or washing agent to remove gold from sand and gravel. The water is often pumped from a stream into an elaborate system of pumps and settling ponds and is later returned once the fine sediments have settled. Water quality standards for Yukon placer mining streams are set by the Yukon Placer Authorization which establishes the allowable sediment that may be discharged into streams, based on fish habitat.

Low gold prices continued to daunt the Yukon's placer industry in 1998 and 1999, resulting in a decrease in both production and employment; however, placer mining is still an important sector in the Yukon's economy. In 1998, 90,288 ounces of placer gold, valued at $31 million (Cdn), were produced from 161 placer mines employing approximately 600 people. This represents an approximate 22 per cent drop in production from 1997.

Early Placer Miners

The first placer miners in the Yukon were First Nation people who recovered native copper nuggets from the White River area in the southwestern part of the Yukon Territory. After 1850, prospectors and explorers began to report fine gold on river bars and coarse gold in the Fortymile and Sixtymile rivers. On August 17, 1896, the discovery of nugget gold by George Carmack and Skookum Jim on Bonanza Creek set off the Klondike gold rush.

Emeralds

In 1999, Expatriate Resources announced that emeralds had been discovered on one of its exploration properties near Finlayson Lake. The company has commissioned a team of gem experts to evaluate the find. Gem quality emeralds are extremely rare and much work is needed to recover and appraise the rough gems. The wintering range of the Finlayson Woodland Caribou herd is located in this area.

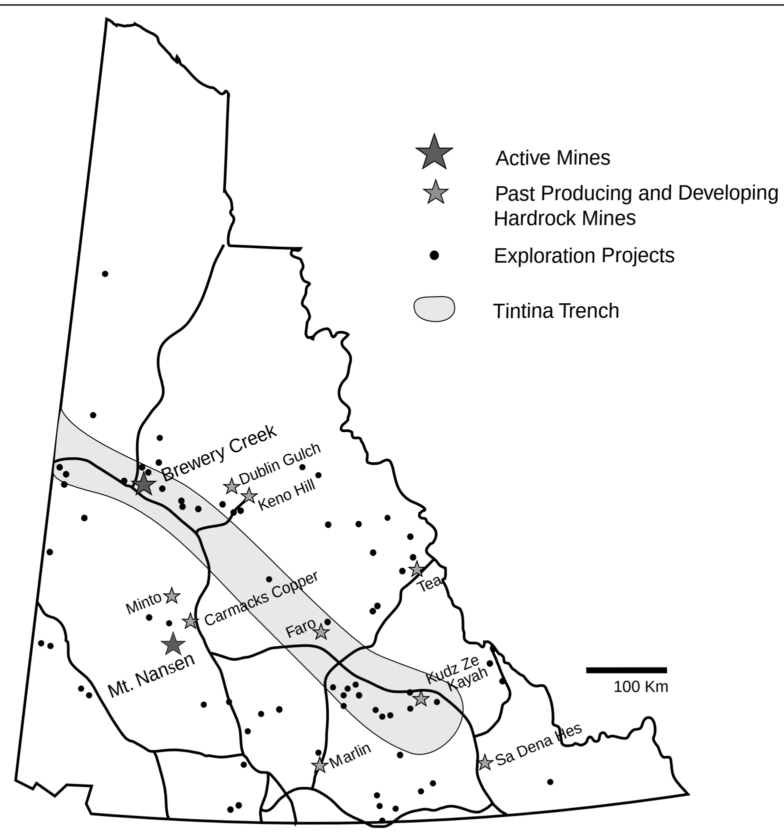


Figure 3.12 1998 Yukon Mining, Development and Exploration
By 1999, Brewery Creek was the only active mine operating in the Yukon.

Reclamation and Abandonment

When the ore body is exhausted, and a mining company wishes to abandon its site, the ultimate goal is to reclaim the area and return it to a natural state. All buildings, infrastructure and equipment must be removed; recontouring of land, capping or flooding of tailings, and revegetation is carried out, depending on the site requirements and configurations. The preferred solution is a 'walk away' scenario, where the land is revegetated and no further maintenance is required.

This will not always be possible, and some mines in the Yukon will require perpetual treatment of waste waters prior to their release to the receiving environment. The fragility of the northern environment makes mining and reclamation an even more challenging aspect of mine planning in the Yukon. Proven southern procedures may not necessarily be a panacea in the north.

One concern over the past few years is the lack of a process that ensures mining reclamation will take place. If a mine is in production for a number of years, a reclamation fund is to be created to clean up and rehabilitate the site following a mine closure or temporary shutdown. Under the old *Northern Inland Waters Act*, a company was to set aside a percentage of their total capital cost per year for reclamation purposes.

In recent years there have been changes to regulations that deal with the environmental impact of mining in the Yukon. Now companies must provide plans and financial guarantees that ensure reclamation work and mine abandonment will take place in a satisfactory manner. If abandonment is taken into consideration right from the start, reclamation objectives can be incorporated into their daily operations. Overburden, waste rock, tailings and structures are dealt with in such a way that their final disposition is feasible and affordable.

Ketza River Project 1998

Reclaimed mining areas may be developed for other land uses. For example, the City of Whitehorse used an abandoned open pit from the old Whitehorse Copper Mine as a solid waste disposal site for a number of years. Other feasible post-mining land use options include improved wildlife habitats, recreational opportunities, or other new industrial uses.

While under the *Yukon Waters Act*, the Water Board may require a reclamation fund to be established, the provisions under the Act and Regulations are discretionary, not mandatory requirements. In some cases, the funds accumulated are inadequate to cover the reclamation costs at the time of mine closer, as was the case with the Faro and Mt. Nansen mines.

Hard Rock Mining Properties – Active Mines

Brewery Creek

Viceroy Resources Corporation's Brewery Creek year-round heap leach gold operation (the first and only heap leach operation in the Yukon) is the only operating mine in the Yukon (1999). The first bar of gold was poured on November 15, 1996 and the mine reached full production in May 1997. Seasonal open-pit mining produces 11,000 tonnes of ore per day between April and October annually. Eight oxide deposits were originally delineated at Brewery Creek with Upper Fosters and Canadian deposits now mined out. Five new zones have been explored, drilled and trenched, expanding the reserves.

The reclamation of waste rock, mined-out pits and used ore is an ongoing process at the Brewery Creek mine. It is easier for reclamation to progress because ore deposits are mined from a series of relatively small pits, instead of from one large area. As each pit is mined out, it is reclaimed with waste rock from the next reserve. Backfilling is the preferred method as it causes less site disturbance and the pit walls end up re-contoured, allowing the area to blend into the original landscape.

In May 1996, an aggressive revegetation program was initiated in the Canadian mine area and the clearing below the leach pad and ponds, using an agronomic mix called Klondike Valley seed mix, covering an estimated area of 11 hectares [2]. In 1997 reclamation work was performed on approximately 20 hectares of disturbed land, including seeding and fertilizing various locations throughout the site, and recontouring and re-vegetating the Canadian waste dump and the West Canadian pit. Efforts were made to increase the use of native seed species (Brewery Creek seed mix) rather than the agronomic counterparts [3]. In 1998 approximately six hectares of disturbed land in the mine, leach pad, and access road were revegetated. Efforts to procure a native seed mix were continued. Research

We need to get involved with the mining companies to explain how we used the land before. After they finished (with the mine), see that they put everything back in place. Not to leave cyanide behind; that they clean up before they go away again.
–Roddy Blackjack,
Little Salmon Carmacks First Nation Elder.

Faro Mine Development

1953	Vangorda lead-zinc deposit discovered and staked by prospector Al Kulan
1953-1955	Prospector Airways optioned the property and conducted drilling programs
1955-1962	Kerr-Addison Mines acquired property but due to depressed metal prices, little work was done
1962	Exploration resumed
1965	Faro lead-zinc deposit discovered, a joint venture between Cyprus Mines and Dynasty formed to develop Faro deposit
1969-1984	Cyprus Anvil Mining Corporation operated the mine
1973	Grum lead-zinc deposit discovered
1975	In March a tailings pond spill occurred when 245,000 cubic meters of tailings slurry contaminated Rose Creek
1984	All production ceased completely by the end of 1984
1985	Curragh Inc acquired the property in 1985 and resumed operations in 1986
1989	The Faro operations supplied three per cent of the western world's zinc and five per cent of its lead concentrates, making Curragh Inc the 6th largest zinc producer in the world
1991	Stripping of Grum deposit began
1992	Ore reserves in Faro Pit exhausted, test work done on Grum deposit
1993	Mining operations ceased due to low metal prices and Curragh Inc was forced into receivership by its creditors
1994	Anvil Range Mining Corporation acquired the Faro property from the receiver and resumed production in 1995
1996	Anvil Range Mining Corporation filed a decommissioning plan
	By the end of 1996 the Vangorda pit was mined out but the mill continued to process low-grade stockpiles at 50 per cent capacity until March 1997
1997	The mine reopened at full production in November 1997 and operated until January 1998
1998	On April 21, 1998, an interim receiver was appointed to review the company's assets.
2000	The Faro property may be managed by DIAND, the Yukon government and Cominco until a new owner aquires the property

work was continued on the three trial plots that were established in July 1996 on the Canadian Knoll, and in the spring of 1998, 101 willow trees were planted on plots at the base of a south exposed face of Canadian waste rock storage area [4]. The reason for using native seed and pioneering woody species (willows) is to encourage the invasion of indigenous permanent species to establish a self-sustaining vegetation cover.

Viceroy Resources has a very good environmental record, and in 1992 they received an Environmental Excellence in Reclamation Award for the Castle Mountain Mine in California, where environmental regulations are very strict. Viceroy implements the same environmental policy on their Brewery Creek property and has committed no violations.

Hard Rock Mining Properties – Inactive Mines

Mount Skukum

The Mount Skukum Mine in the Wheaton River valley is the only mine in the Yukon that has been decommissioned by the mine operator to a state, which is acceptable to federal government authorities. There are still buildings including the mill on the site, but these are located on an active surface land lease, which has its own abandonment plan.

Mount Nansen

The first recorded lode gold discovery on the current Mount Nansen property was made in 1943 and the first underground work was conducted in 1947. The area underwent development, trenching and periods of inactivity until 1967/68 when a flotation mill was constructed. The mine operated until April 1969, and reopened for 10 months in 1975/76. In 1984 BYG Natural Resources Inc acquired the properties and carried out exploration programs. The company poured the first bar of gold on November 23, 1996 and operated sporadically until February 1999. The mine went into voluntary receivership on March 23, 1999 but the receivers abandoned the site on July 28, 1999.

DIAND Water Resources has taken over operation of the water treatment facilities [5] (see water chapter). The future of the Mount Nansen Gold Mine is uncertain at this time. If appropriate treatment does not take place and if the integrity of the impoundment structures are compromised, there will likely be significant damage to water, fish and wildlife. Concerns have been raised by the Little Salmon Carmacks First Nation, regarding impacts to the wildlife from ingestion of contaminated waters. Studies proposed for 2001 will examine the level of contaminants in local vegetation.

Faro

The lead-zinc mine near Faro consists of three open pits. Of the three open pits developed on the minesites, two (Faro and Vangorda) are depleted of economic ore reserves while the third (Grum) contains up to five years of mineable ore reserves.

While the Faro mine has provided employment and income to the Yukon over a period of thirty years, there may be differing perceptions from people who live a traditional life style.

Local First Nation Elder, Charlie Dick, speaks about the Faro mine:

"The place where I used to hunt years ago, I call it my farm back then, that's where we used to gather as Native people. We went there to dry out meat; we hunted our gophers there; we got our ground hogs there. But now when I go to this place, there's a big mountain that has been removed by the mining company and the place where I used to hunt is no longer there. That makes my heart hurt and makes me feel sad just to think about it."

The Faro property has been operated by three main companies since 1969 and currently is in receivership for the second time. In 1996, Anvil Range Mining Corporation filed the Integrated Comprehensive Abandonment Plan with the Yukon Territory Water Board which outlines proposed decommissioning activities. The plan is still under review.

The chronology of events at the largest mine in the Yukon is shown on page 48.

Reclamation work has consisted of small re-vegetation plots in the Vangorda Plateau in 1996. Approximately 10 hectares were seeded with a mixture of fescues, rye, wheat and clover, and were fertilized during the first season. Most plots continue to support healthy growth of grasses. DIAND funded physical reclamation work in 1994 and 1998 which involved re-sloping and providing a till cover on sections of the Vangorda waste dump. Some revegetation work has been completed on these slopes [6]. In September 1999, DIAND funded a project to salvage scrap steel from the Faro minesite. It is expected that over a thousand tonnes of metal will be removed before the winter of 1999 [7]. Long term reclamation requirements for the minesites are included in the two water licences and may undergo further investigation.

Although some reclamation work is progressing, this represents a small portion of what will be required. The estimated figure for clean–up is around $100 million. The water licence for the Vangorda Plateau minesite requires perpetual collection and treatment of minesite effluent (see water chapter).

Keno-Elsa

The United Keno Hill Mines property, in the Elsa and Keno areas, consists of several underground and open-pit silver-lead-zinc mines. The Elsa operation has been in production since the initial discovery of silver in 1906. The mill last operated in 1989 and exploration and development has occurred sporadically since then, mainly at the Bellekeno and Silver King Mines. The property is currently under care and maintenance.

Minto

Minto Explorations Ltd is proposing to develop the Minto property that would entail an open pit and underground operation, waste rock piles, a thickened tailings storage facility, ore crushing facility and conventional copper flotation mill. Permitting is in place with the granting of a type A water licence in May 1998 and a Quartz Mining Licence in October 1999, but start up of operations is not expected until some time in 2000 due to current low copper prices.

Ketza River

The mine at Ketza River, east of Ross River, is currently under care and maintenance. During the second week in October 1999, a sulphur dioxide leak from a storage tank was detected. Although the tank was thought to be empty, there was some residual gas remaining. Pressure had built up over time and the gas had leaked out through a rusty valve. The gas is toxic and combines with water to create sulphuric acid. Government officials removed the threat by releasing the pressure in the tank and replaced the valve. The mine owner, YGC Resources Ltd. is responsible for cleaning up and remediating the site [8, 9].

Several projects are in the development stage: Dublin Gulch/New Millennium Mining Limited near Mayo, Kudz Ze Kayah/Cominco near Finlayson Lake, and Carmacks Copper/ Western Copper Holdings Ltd near Carmacks. These projects have either been through the environmental screening or are in the final stages of environmental assessments.

Hard Rock Mining Properties – Exploration

Before the federal mining land use regulations were implemented in 1998, several companies voluntarily cleaned up their sites.

- In Macmillan Pass, Pan Pacific cleaned up their property in the Jason Knoll area and 15 years ago initiated a trench, drill pads and roads reclamation program which included the collection and testing of local grasses to revegetate disturbances.
- Noranda has cleaned up its old exploration sites on claims throughout the Yukon.
- In the Bonnet Plume area, Pamicon and Westmin have flown out fuel barrels left from oil and gas exploration in the 1970s.
- Several other companies, such as Kennecot, on their Scheelite Dome property, Eagle Plains Resources on their Rusty Spring property, Cominco LTD on their JC property and several more, spent considerable time and money reclaiming or cleaning sites.

While several mining companies have taken steps to clean up their remote sites, the effect of exploration in remote wilderness areas continues to raise concerns from environmentalists. This is especially clear when mineral exploration takes place in heritage river corridors, such as the Bonnet Plume, or within proposed park boundaries, such as around Tombstone Mountain. (see Chapter 3 Protected Areas)

Coal Exploration Property

Division Mountain

Cash Resources Ltd reclaimed its Division Mountain property on an on-going basis during its exploration programs. Care was taken not to disturb areas underlain by permafrost during road construction, overburden from drill sites was stock piled and then replaced, and trenches were backfilled and re-vegetated with native grass seed and local trees. Tree stumps and branches were placed back on the refilled trenches to restrict access, winter and summer, to recreational vehicles and to lessen disturbance to wildlife.

Research Initiatives

Mining projects in the Yukon are subject to environmental assessment under the *Canadian Environmental Assessment Act* (CEAA) and, soon, under the Development Assessment Process (DAP). Scientific uncertainty is a factor during assessment of mining projects due to new technology, different combinations of technology and northern environmental conditions, or simply different impacts from toxic-element releases to the environment.

Mining Related Legislation

Existing Legislation:

1 Yukon Placer Mining Act (federal) allows the staking of placer claims and leases.

2 Yukon Quartz Mining Act (federal) allows for the staking of mineral claims. Development and production at minesites requires a Quartz Mining Licence issued under Part II of the Act.

3 Canadian Environmental Assessment Act (federal) requires the environmental impact assessment and review of development projects requiring federal approval, federal funding or federal disposition of land.

4 Territorial Lands Act (federal) regulates land use activities. This act does not apply to mineral claims but will apply to the building or maintenance of access roads to mineral properties.

5 Yukon Waters Act (federal) regulates water usage and controls the deposition of waste into Yukon waters, bridge and stream crossings. Because what happens to the land affects what is deposited in water, provisions in water licences often contain requirements related to land, such as measures to stabilize waste dumps. The Yukon Territory Water Board is responsible for the issuing water licences.

6 Fisheries Act (federal) provides for protection of fish habitat, alteration, destruction or disruption of fish and fish habitat including the regulation of stream crossings.

7 Yukon Quartz/Placer Mining Land Use Regulations (federal) regulate the exploration and placer mining activities including camp cleanliness, reclamation of trenches or mining cuts, roads and drillpads.

Proposed Legislation:

- *Development Assessment Process Act will apply to all development activities that may have an adverse impact on the Yukon's environment, people or communities.*

This creates uncertainty and delays in project development and may translate into higher development costs and increased potential liabilities to government.

It would be beneficial to create a favourable environment to facilitate finding solutions before environmental problems in the Yukon arise. This approach was used for the Mine Environment Neutral Drainage (MEND) program. The MEND program was a cooperative effort between Canadian mining companies and provincial and federal departments. It was designed to develop and apply new technologies to prevent and control acid mine drainage. It is estimated that the liability due to acidic drainage has decreased by at least $400 million due to a research investment of $17.5 million over the eight year life of the program. The MEND program was completed in December 1997; however, in light of its success, a post-MEND initiative funded by NRCan and the Mining Association of Canada emphasizing technology transfer has commenced.

The Mining Environment Research Group (MERG) is a cooperative working group of government agencies, mining companies, Yukon First Nations and non-government organizations for the promotion of research into mining and environmental issues in the Yukon. Participants bring their resources and knowledge to work cooperatively on mining environmental issues and projects in an advisory capacity.

PROGRESS &CHALLENGES

Progress since 1995

- Viceroy Minerals Corporation won the 1999 Robert E. Leckie Award for its ongoing reclamation work at the Brewery Creek gold mine near Dawson City. In the placer mining category, Tic Exploration captured the award for its reclamation practices on Gladstone Creek.
- Pamicon Developments Ltd undertook the clean up of the Fairchild property at Bonnet Plume on its own initiative. At the Copper Point camp, all garbage was picked up by hand and the disturbed area was re-seeded.
- The Mine Environment Neutral Drainage (MEND) Program was designed to apply new technologies to prevent and control mine contamination through mine drainage.

Challenges

- Reclamation of abandoned hardrock mines.
- Achieving oil and gas development with minimal environmental impacts, particularly in the area of carbon dioxide and sulphur dioxide emissions.
- The clean up of contaminants in old exploration sites and mines across the Yukon.

3.5 Solid Waste

Not so long ago, one main word was used to describe the items that people no longer wanted. Everything from old tires to empty paint cans was called garbage and chucked into the local dump. Today we are much more sophisticated about the subject of garbage, both in how we define it and how we handle it.

Solid and special waste are two classifications that we have for garbage today. There are strict definitions for each of these terms, and we have come a long way in setting regulations for managing different types of waste. Unfortunately, we now generate so much waste, and so many different types of it, that action to reduce and manage it is essential.

Yukoners throw out on average almost two kilograms of trash per day. This adds up to about 700 kilograms of waste/person/year. But efforts are being made at every level to reduce this amount [1].

There are federal and territorial objectives to reduce the 1988 volume of waste by 50 per cent by year 2000. In 1995, the City of Whitehorse was diverting 16 per cent of its waste stream. It has increased that amount to 21 per cent, and started new programs in 1999 to divert even more waste from the landfill.

Since the publication of the 1995 State of the Environment Report, several major initiatives have been introduced to deal with waste in the territory.

These include:

City of Whitehorse:

- 1998 Solid Waste Action Plan

Yukon government *Environment Act* Regulations:

- Beverage Container Regulation – amended in 1996 and 1998
- Contaminated Sites Regulations – January 1997
- Storage Tanks Regulations – January 1997
- Spills Regulations – January 1997
- Solid Waste Regulations – 2000

All of these initiatives will help both to reduce waste and manage it more responsibly. While more progress is still needed, a brief look at the past shows how much we have improved already in some areas.

History of Yukon Wastes

Before the Klondike Gold Rush, the territory did not have a garbage problem. First Nations had no dangerous wastes to worry about, and all of their garbage would have been organic. The World War Two era is often seen as the time when garbage, pollution and special wastes became an issue in the Yukon.

When the Alaska Highway, the Canol Road and Pipeline, the airports of the

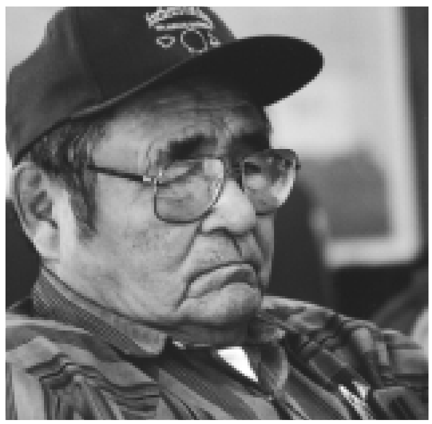
Northwest staging route, and an oil refinery were built during the 1940s, a war-time mentality prevailed. Speed was of the essence with all of these huge projects, and environmental considerations were often not taken into account. Little was known, for example, about the long-term effects of hydrocarbon wastes. An oil refinery was built in what is now known as the Marwell industrial area in Whitehorse. Though it only operated for a year, the refinery and the system of storage tanks and pipelines that went along with it left a trail of contamination behind them. Some sites, such as the Marwell tar pit, still have not been cleaned up.

In the 1950s the Cold War brought another US military project to the north, the Distant Early Warning (DEW) Line. This system was built to detect Russian long-range bombers. It was also the era when PCBs and other hazardous substances were in widespread use. PCB-laced paint was used at the three DEW Line stations built on the Yukon's North Coast, which are all slated for clean-up.

For more than two decades, DDT was used to control mosquitoes in the Yukon. Starting in the 1940s, DDT was sprayed from airplanes over lakes and rivers, roadways, pipelines and communities. Cans of DDT were abandoned at Rainy Hollow, a former pumping station in British Columbia, just across the Yukon border. Brooks Brook on Teslin Lake, a former military site, was also heavily contaminated with DDT. These two sites were cleaned up by the federal government at great expense.

Thousands of American soldiers and civilians came to the Yukon to work on these megaprojects, and their arrival created a garbage problem in the Yukon. The approach used for disposing trash in Whitehorse was typical for that era. The American army opened a dump by a cliff off Range Road, near the confluence of McIntyre Creek and the Yukon River. Debris was regularly pushed over the edge into the Yukon River [2].

"Before 1939, they were dumping all the garbage in the channels of the Yukon River right where Sophie Slim used to live (near Kishwoot Island) in downtown Whitehorse."
– Paddy Jim, Champagne and Aishihik First Nation Elder



Paddy Jim

The Range Road dump was closed in 1975, and tests have shown that leachate from this dump now has only a minor impact on groundwater at the dump site and no measurable impact on the quality of Yukon River water. But First Nations and other residents downstream of the dump are still concerned about lingering contamination. Tests of sediment cores taken from Lake Laberge, downstream of the dump, indicate that a spill of polychlorinated biphenyl (PCB) occurred sometime in the 1950s. This may or may not be associated with the Range Road dump.

In 1976 the City of Whitehorse tried a new disposal method. It began burning its garbage and putting the residue in the War Eagle Pit, an abandoned quarry pit located near the current Whitehorse landfill. Waste oil was disposed of in one part of the pit, a practice that continued until 1995. After 10 years, concerns about groundwater contamination led to the opening of the Son of War Eagle Pit, the territory's first sanitary landfill. Landfilling, or covering garbage with dirt, is an expensive way to dispose of trash, and the city is still working on ways to reduce the amount of waste that goes into the pit.

What is so special about Special Waste?

The main problem with solid waste is that it takes up space, and even in a land as vast as the Yukon, finding locations for new dumps can be a problem. Special waste, on the other hand, requires special handling. It cannot just be thrown into the dump.

Special wastes include dangerous goods that are no longer used for their original purposes, and can take any form from a solid to a gas. Waste oil and biomedical waste are two examples of special wastes. Common special wastes in homes and businesses include waste oil, solvents, petroleum products, unused household cleaners, paints and pesticides. This unwanted material presents a serious real or potential hazard to health, safety, and the environment. Permits are required for handling various quantities of special waste.

No exact figures are available on the amount of special waste generated

Special waste can be:

- *flammable*
- *corrosive*
- *toxic*
- *infectious*
- *explosive*
- *radioactive*
- *persistent*

every year in the Yukon, but the annual special waste collection alone removes 25 tonnes. This amount does not include the special wastes treated or disposed of in the Yukon, or the special wastes shipped independently of the Yukon government collection system. If national estimates of special waste generated per capita are applied to the Yukon, we probably produce about 100 tonnes of special waste per year in the territory.

When these wastes are not handled in a responsible way, the environment and human health can suffer. Because of a lack of money and poor understanding of the consequences, many kinds of special wastes have been treated like everyday garbage in the past. This has caused:

- groundwater contamination by leachate (the liquid that seeps through the waste);
- surface water contamination through run-off from precipitation and snowmelt, and contact with contaminated groundwater;
- local air pollution because of open burning and evaporation;
- soil contamination;

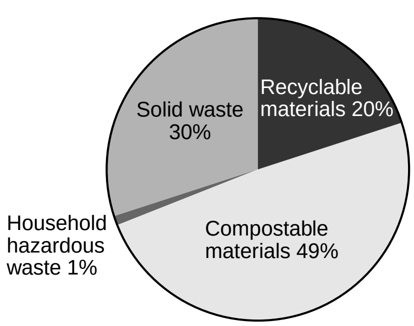


Figure 3.13 Current composition of Whitehorse waste
This figure shows the composition of the waste stream in Whitehorse, not the composition of the landfill. As shown, 69 per cent of Whitehorse waste could be recycled or composted.

- direct poisoning or injury to people and wildlife exposed to the waste;
- food web poisoning; and
- fires and explosions.

Cleaning up a site after it has been contaminated is both expensive and dangerous. Managing special and hazardous wastes has become a priority for all of us because of these potential problems. Now a special waste permit under the *Special Waste Regulations* is required to generate, collect, or dispose of special wastes.

Special waste is a harmful substance that requires special management and cannot be discarded without risk to public health and the environment. The federal *Canadian Environmental Protection Act* (CEPA) defines many substances that require special handling.

Under the Yukon government's *Dangerous Goods Transportation Act*, dangerous goods are defined as materials that have an inherent hazard. Oven cleaner and varsol are two examples of dangerous goods. When the time comes to dispose of these products, they are then classified as special wastes.

Types of waste

In our throw-away society, we produce many different types of solid waste. Figure 3.13 shows the basic components of solid waste in Whitehorse garbage and Figure 3.15 shows landfill volumes. Waste could be reduced significantly with greater composting and recycling.

How are we managing solid waste?

Solid waste is the everyday garbage that goes to the local dump. It can come from residential, commercial, industrial, or other human related activities or sources; and include everything from ashes, domestic garbage, compost, vehicle hulks, and tin cans to plastic containers and old tires. It also includes waste generated by the demolition or construction of buildings or other structures.

Solid waste does not normally include waste from industrial activities like mining or hazardous materials that are harmful to the environment and require special handling. These are called special wastes.

Waste disposal practices now

Most solid waste in the Yukon is disposed of in 26 waste sites located in or near communities (Figure 3.14). The Yukon Department of Community and Transportation Services manages 19 of these sites, while the rest are the responsibility of incorporated municipalities. Rural communities are served either by a municipal dump or by a Yukon government site.

All solid waste disposal sites managed by the territorial government are operated according to the *Solid Waste Management Procedures and Guidelines*, updated in March 1996. In addition to the 26 managed sites, the many abandoned and unregulated garbage dumps in the Yukon are regularly being assessed and cleaned up.

At most Yukon garbage dumps, waste is thrown into an excavated trench or natural depression where it is periodically compacted and burned. When the trench is filled to its capacity it is covered with soil. Most of these areas hold less than 30 cubic metres of garbage and last about five years.

Solid Waste Disposal regulations adopted in 2000, will affect how garbage is handled and waste sites are developed in the future.

We now know that there are costs associated with the dumping of solid waste. The City of Whitehorse Solid Waste Action Plan outlines the many direct and indirect costs associated with waste disposal [3].

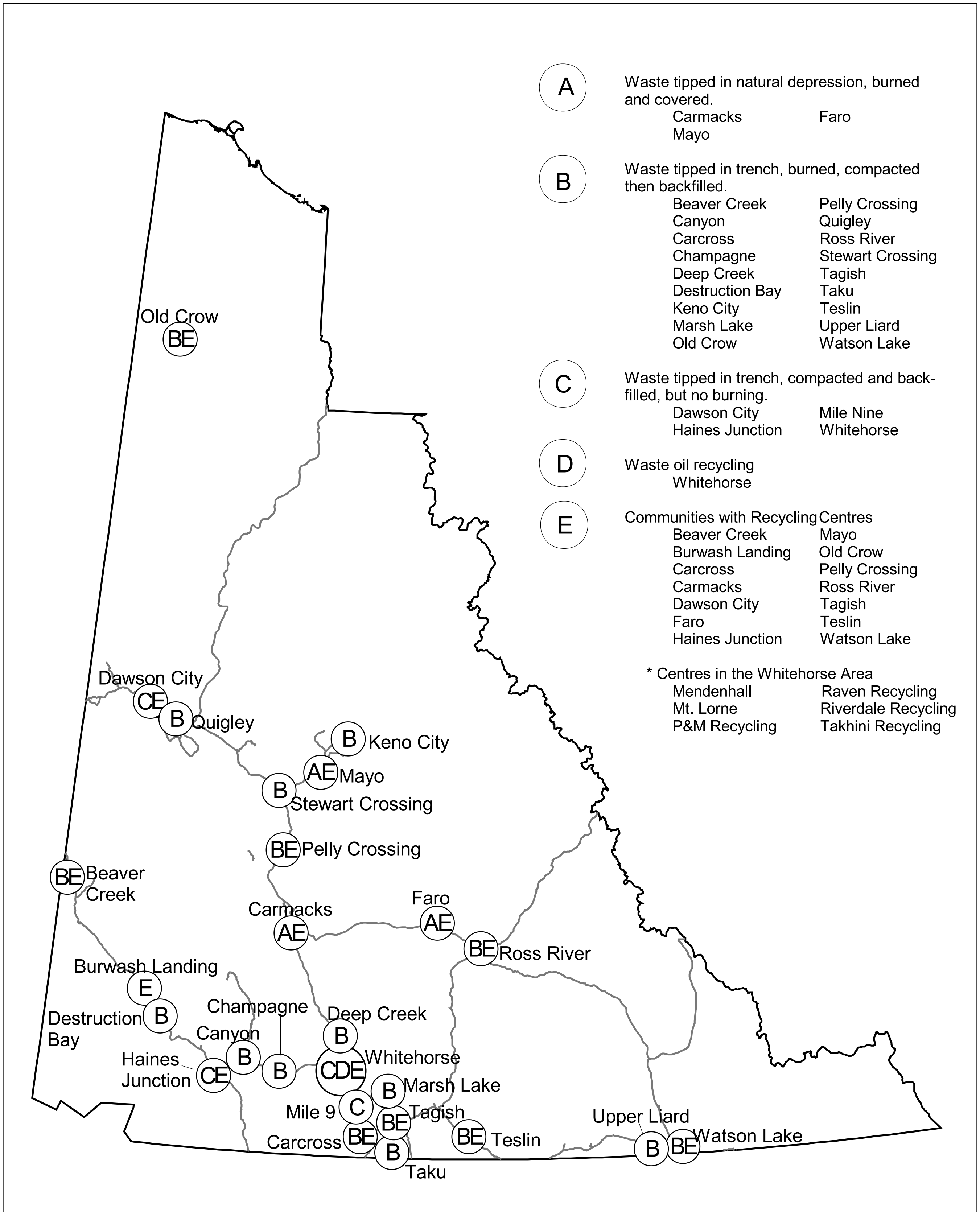


Figure 3.14 Solid Waste disposal sites

Direct Costs:

- Picking up Whitehorse residential garbage – $61.33 per tonne
- Disposing of Whitehorse residential garbage – $60 per tonne
- Operating rural waste sites – up to $5,000 per year with current practices (amount could increase under the new solid waste regulations)
- Operating the Whitehorse Landfill – $528,242 (Average cost 1996 to 1998)
- Developing a new 'cell' at the Whitehorse Landfill – $320,000

Indirect Costs:

- Air pollution from burning waste in landfills
- Harm to wildlife attracted to dumps, especially bears
- Littering caused by paper and plastic wastes blowing away from landfills
- Leaching from landfills may contaminate groundwater
- Water runoff from landfills may pollute surface waters

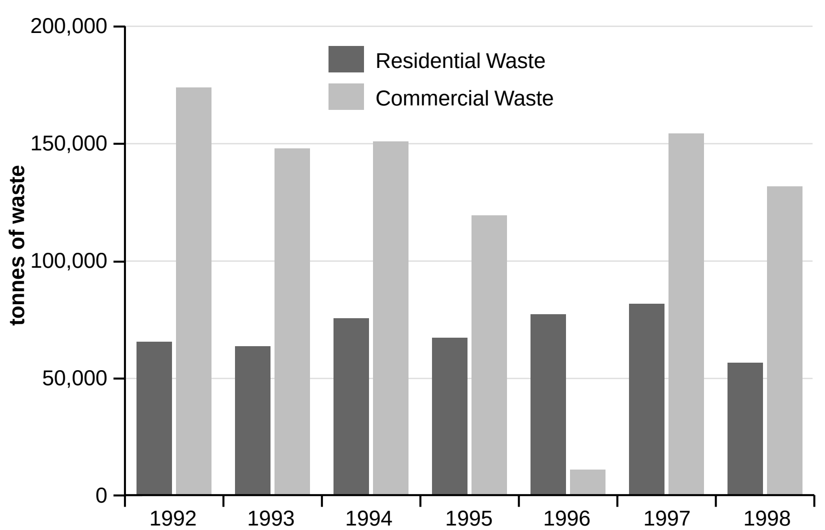


Figure 3.15 Data summary of Whitehorse landfill volume estimates

Tipping fees come to town

After studying various approaches used to reduce the amount of solid waste dumped in landfills, the City of Whitehorse has decided to make garbage disposal more of a user-pay system. But instead of asking users to pay the full costs of operating the landfill, the city has opted for a 50/50 split on these costs. Half of the money for running the program will come from taxes, while the other half will come from tipping fees charged at the landfill.

With tipping fees, people pay according to the amount of garbage that they dump at the landfill. Tipping fees provide a small financial incentive for households and businesses to reduce their waste as it is no longer cheaper to have everything hauled to the dump. Lower taxes for both businesses and residences will help to offset the new fees.

In Whitehorse, the fee is $1 per visit for up to eight bags of garbage, and $4 per pickup truck load. Bigger loads will be weighed and assessed a charge of $15 per tonne. The tipping fees double if construction and demolition wastes are mixed in with household garbage.

Users from outside the City limits are charged the full disposal cost of $60 per tonne since they do not contribute to the landfill costs through taxes. There is no tipping fee for compostable or locally recyclable materials. Households with city garbage collection will have a monthly fee of $2 added to their bills to cover their share of landfill costs.

Tipping fees are standard in most of the country and have been shown to reduce the amount of waste delivered to dumps by anywhere from 15 to 45 per cent. In southern Ontario, tipping fees range from $100 to $150 per tonne.

It is estimated that the user-pay system, implemented in November 1999, will further reduce residential waste by 15 per cent and commercial waste by 30 per cent, extending the life of the landfill by six years and saving the city $1,466,750 over the next 30 years.

All large waste loads will be weighed and assessed the appropriate tipping fee. Small, non-commercial loads will be directed through the transfer station to areas where people can properly sort and drop off household garbage, tires, wood waste, compost, and reusable and recyclable materials. The transfer station is slated to begin operations in July 2000.

Proposed Solid Waste Regulations

The Yukon government began developing Solid Waste Regulations in 1998. The draft regulations called for a ban on open burning at dumps and a requirement for permits to build and operate waste disposal sites. However, during the public review, municipalities were concerned about the high increases in operating costs and the proposed ban on open burning was dropped prior to the regulations being approved. The new regulations will establish modern standards for building and operating dumps and landfills in the Yukon. Permits will be required for public waste disposal.

One of the most controversial issues addressed in the draft regulations is the burning of garbage at dumps. Burning is the least expensive way to get rid of solid waste and also helps control odours that can attract wildlife to dumps. But open burning can produce air pollution, and it can also be dangerous during the fire season. In the summer of 1999, a forest fire started at the Burwash dump and caused considerable damage in that community.

The Yukon and the Northwest Territories are the only jurisdictions in Canada where open burning is still allowed.

Are we reducing our wastes?

Reduce, reuse, recycle, and reclaim are the four 'Rs' of waste reduction. Education programs can help people learn how to reduce the amount of waste they send to the landfill. We can reduce the amount of waste we generate in the first place by shopping for more durable goods or rejecting excessive packaging.

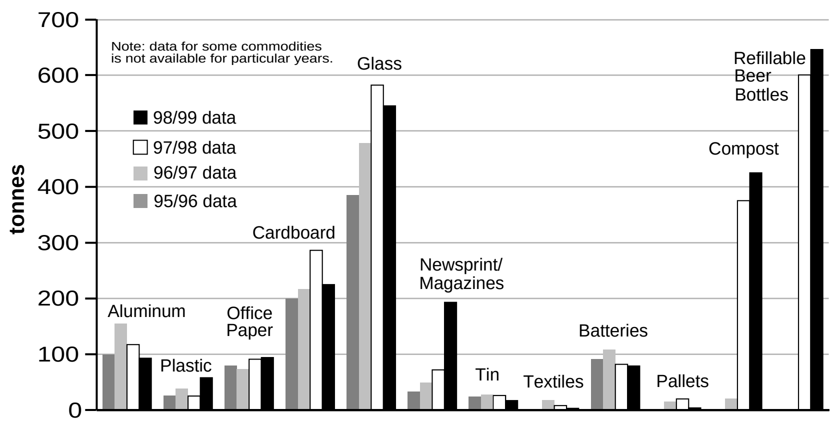


Figure 3.16 Recyclable materials processed by Raven Recycling

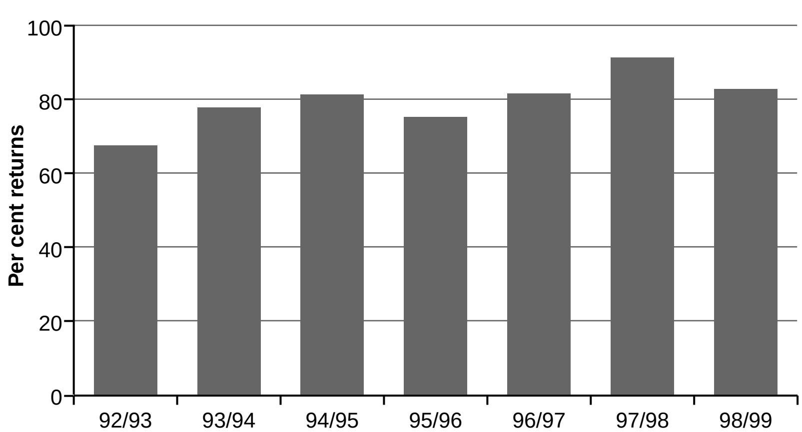


Figure 3.17 Return Rates: Beverage Container Program 1992-98

In 1994, three quarters of residential solid waste in Whitehorse was recyclable or reusable. That figure is not thought to have changed in 1999. Some of those materials were thrown out because there was no system for handling them, but now all Yukon communities have access to a non-profit community-recycling depot.

The City of Whitehorse initiatives on tipping fees and curbside pick-up of compostables through the Waste Watch program could help reduce the amount of waste dumped in the landfill by about half. The city estimates that about 21 per cent of the waste was diverted in 1999.

Community Recycling

All Yukon rural recycling depots ship to one of two Whitehorse recyclers; either P&M Recycling, a commercial operation, or Raven Recycling, a non-profit society. Raven Recycling began operating in 1989, and handles most of the territory's recycled goods. The volume of material that it collects has increased every year.

The original list of items accepted for recycling included aluminum, office paper, newspaper, brown paper bags, tin (steel) cans, corrugated cardboard, plastic (PET) drink containers, used oil and household batteries (Figure 3.16). Now Raven also accepts textiles, tetrapaks, auto batteries, magazines, refillable beer bottles, and compost. Most materials are shipped to Alberta or British Columbia for processing [4].

Local scrap dealers contribute to recycling by reclaiming iron, copper, aluminum and batteries. In August 1999, a local salvage company and the City of Whitehorse joined forces and collected a large quantity of scrap vehicles and compacted metal waste from the salvage yard and the landfill. Together they shipped more than 3,000 tonnes south for recycling.

The Yukon's beverage container recycling program

Since the Yukon government first initiated a deposit-refund system on beverage containers in 1992, the Beverage Container Regulations have been expanded twice. In 1996 glass and plastic containers were added to the list; in 1998 tin and tetrapak containers were included.

The deposit collected by retailers goes into a Recycling Fund, and is used to help run registered recycling centres. In 1997-98, 91.2 per cent of containers covered by the regulations were recouped based on sales of 16.4 million containers. Return rates in the Beverage Container Program peaked in 1997/98 (Figure 3.17).

Recycling Club

The Yukon government started the Recycling Club in 1996 to promote the Yukon's container recycling program. In 1998 more than 1,600 Yukon youth joined the Club and earned more than 29 million Recycling Club points by turning in pop cans and other beverage containers. The points were traded in for prizes ranging from books to bicycles.

This popular program, which is unique in North America, is credited with helping to increase container return rates from 80 per cent to 91 per cent in 1997/98.

Composting

Many Yukoners collect organic household waste in their backyards, using the rich compost to supplement their soils. Up to 50 per cent of household waste can be composted, so composting can also reduce the waste stream significantly. The City of Whitehorse runs two composting programs: Waste Watch and, through contracts, the Composting Program at the landfill.

In the *Waste Watch* program, compost is collected every other week at the curbside. In addition to vegetable and table scraps, yard waste and other organic items, the Waste Watch program also accepts non-recyclable paper such as box board and paper napkins. These materials can be composted because of the high temperatures achieved in its large compost piles. The average temperature is 55°C.

The *Waste Watch* program is the city's main strategy for reducing residential garbage. It is estimated that Waste Watch can reduce the portion of residential garbage that the city hauls to the landfill by 40 per cent. This reduction would extend the life of the landfill by four years, saving $637,809 over the next 30 years.

The Recycle Organics Together Society (ROTS) began a community composting project in 1990, and in its first few years produced about 200 cubic metres of compost annually (Figure 3.18). This immensely successful program now produces about 1,557 tonnes of compost every year. The programme is currently operated by Raven Recycling under contract and is located at the landfill site. Raven Recycling sells this valuable fertilizer to the public. This program has proven itself to be the most successful waste stream reduction activity so far.

The value of compost was demonstrated in a pilot project, sponsored by the Yukon Chamber of Mines, at the abandoned Whitehorse Copper Mine site. Different types of organic waste were rototilled into a series of test plots on the mine tailings. The site was irrigated for several seasons, but since 1997 the vegetation has continued to grow on its own. This experiment showed a direct link between the amount of compost used and the amount of revegetation that took place on different plots.

What are we doing about special wastes?

The management of special waste has changed dramatically since 1995 when the *Special Waste Regulations* were enacted. The regulations state that special wastes must be disposed of in an approved manner. The change in disposal of waste oil is one example of the effect of the new regulations.

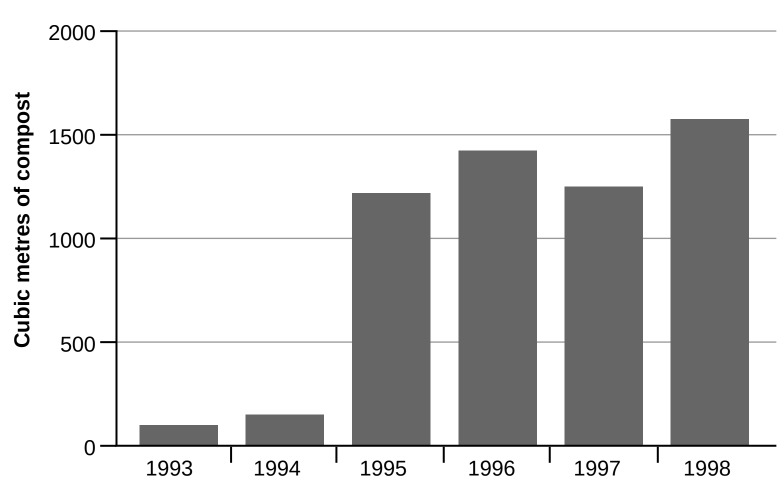


Figure 3.18 Organic material composted each year
Of the 1500 cubic metres of organic material composted in 1998, an estimated 245 cubic metres was collected from the 235 households on the Waste Watch programs.

Waste oil is the largest component of special waste in the territory, and disposal of this product was not regulated before this time. For many years waste oil was spread on the roads in the territory to suppress dust, a practice that is no longer permitted. Waste oil collected by the City of Whitehorse was poured into one area of the landfill, where it is causing an on-going environmental problem.

A Pond of Oil

For about 20 years, waste oil was dumped on top of piles of waste rock next to the War Eagle Pit. By the time this practice ended in 1995, a shallow pond of oil had formed on the surface, and hydrocarbons now seep out of the toe of the waste rock pile. The city is now studying the site to determine the best way to treat and clean up this contaminated area.

In Whitehorse, most waste oil is now burned in waste oil burners that are used to heat some businesses. Contaminated waste oil that is not acceptable for burning is shipped out of the territory.

Now the *Special Waste Regulations*, together with the *Dangerous Goods Transportation Act*, and the *Canadian Environmental Protection Act* complete a cradle-to-grave management system for dangerous goods handled in the Yukon. The most common special wastes in the Yukon are used motor oil, solvents, paint, cleaners, anti-freeze, dry cleaning chemicals, photo-processing fluids, batteries and biomedical wastes.

Under the regulations anyone who generates, stores, handles, mixes, disposes, collects or releases special wastes is considered a waste manager, and is responsible for knowing and complying with the regulations. Permits are required for generating, handling or disposing of special waste or for operating a special waste management facility (ie collecting waste from other sources). At the time of publication, 139 special waste permits had been issued in the territory.

The Yukon government ships special waste out of the territory once a year. Every year a tender is put out for operation of the Special Waste Collection Program. The successful contractor collects, transports, and looks after appropriate disposal for all the waste collected in this program.

One other initiative in special waste management is the Household Hazardous Waste Collection days. Special waste accumulated in the home can be dropped off during advertised collection days in Whitehorse and some communities, diverting these products from garbage dumps.

Shredding Rubber

Used tires are not an easy item to dispose of properly, and Yukoners wear out between 11,000 and 15,000 tires every year. Most of the tires end up at the Whitehorse dump, and by 1999, it is estimated that the tire pile there contained about 300,000 tires.

Tire piles are a major hazard. Fires have started in huge tire piles in several North American cities, and in 1997, a brush fire close to the Whitehorse landfill threatened to ignite the tire pile there before fire retardant was spread on the flames to stop the fire from spreading.

The City of Whitehorse has made several attempts to dispose of the tires. In October 1999, the city shredded a substantial number of the tires, and will use the resulting material to cover parts of the city landfill. This pilot project could be expanded in the future. In November 1999, the city began charging a $4 fee for dropping off tires at the landfill, and those revenues will be used to truck tires to disposal centres in the south. The option of a tire stewardship program, in which a point-of-sale tax is added to the price of the tire, has also been discussed.

What are we doing about contaminated sites?

Contamination is not an easy term to define. Some people might say that an area with piles of rusting drums, old equipment and crumbling buildings is a contaminated site. But according to territorial laws, only sites with chemical pollution are considered to be contaminated. The federal government manages contaminated sites on federal land, referring to them as waste management sites.

The Yukon Environment Act Contaminated Sites Regulations

The Contaminated Sites Regulations under the Yukon's *Environment Act* were proclaimed on January 1, 1997. The regulations are intended to protect human health and the environment from harmful contaminants in soil and water. The regulations apply to sites on Commissioner's Land, municipal land and private land. They do not apply to sites on federal land. The federal government has its own program for contaminated sites.

Contaminant?

In Carcross, the recent removal of the remains of an old sternwheeler tugboat from the Nares River showed how people can have very different ideas about this issue. To the local First Nation, the old boat was a contaminant, but other people were more concerned about losing an important part of the Yukon's heritage than about possible pollution from the boat.

Soil and water standards are used to determine whether or not a site is contaminated. A contaminated site contains chemical substances above the levels set out in the standards. After reviewing the available information, the Yukon Minister of Renewable Resources makes the final decision on whether or not a site is designated as contaminated.

If a designated contaminated site is determined to be a threat to public health or the environment, the person or corporation responsible for creating it may be ordered to clean it up. People who own or occupy a designated contaminated site also must apply to the Minister before making any significant change in the use of the site.

Five sites have been designated as contaminated under the Yukon legislation, and about 70 other sites are known to be contaminated, but have not yet been reviewed by the Renewable Resources Minister.

A railroad tie treatment plant operating from 1950s to mid 70s on the Nares River at Carcross used a mixture of pentachlorophenol, a wood preservative, and diesel oil to treat the wood. A 1997 assessment found that the soil and groundwater at the site were contaminated, as well as the water in the river. The contaminated soil was removed from the site and from the near-shore river bed.

The contaminated soil is being treated by a process called land-farming. The soil was spread on non-porous ground at an old pumping station outside of Carcross. There it will be tilled regularly to expose it to the air so that native microbes can break down the hydrocarbons in the soil.

Contaminated soil was land-farmed at another site, the fire-training area near the Whitehorse airport. The soil is now considered to be safe and the area will be reseeded. Contamination at the North of 60° Petro site in the Marwell industrial area is being contained. The Whispering Willows RV Park in Stewart Crossing has been completely cleaned up and has been issued a Certificate of Compliance.

The Marwell tar pit in Whitehorse was designated as contaminated in May 1998, but no decision has been made yet on cleaning up this site. The Yukon government has asked the federal government to pay the clean-up costs, but no decision on responsibility has yet been made [5].

Storage Tank Regulations

These regulations, passed in 1997, establish requirements for storing petroleum products and other hazardous substances on Yukon land. The requirements are for new or altered storage tanks, both above and below ground. They specify that tanks must be removed when they are of no further use or have been out of service for a year.

The regulations are aimed primarily at new tanks and do not set standards for old storage tanks. A survey conducted in 1993 estimated that hundreds of the old tanks scattered around the Yukon could be leaking.

Marwell Tar Pit

It cost about $27 million to build the Canol Refinery, which was used to process oil pumped from the oilfields of Norman Wells during World War II. The facility was closed down and later dismantled after only a year of operations. It is thought that the tar pit was established when the storage tanks from the refinery were removed.

A disposal site was needed for the sludge of heavy oil, called tank bottoms, left in the tanks, so they were dumped into one of the huge earthen berms that had been built around each of the tanks. For years other parties, including the Department of National Defence, continued to dump their waste oil into this well-known site.

In 1958 a man died from exposure after being trapped in the pit. There have been many calls for a clean-up of this heavily contaminated site, which has an estimated 27,000 cubic metres of contaminated soil. Several treatment methods have been investigated; including thermal desorption (high temperature burning) and biological treatment.

In 1994, the clean-up costs were estimated to be $4 million. To date, no decision has been made on who should pay for cleaning up the site; although the Yukon government has repeatedly asked the federal government to take action on this.

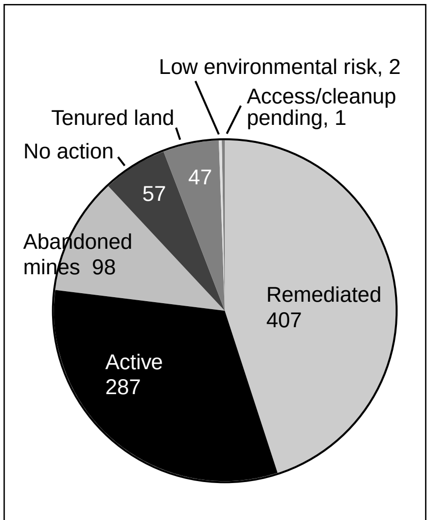


Figure 3.19 Status of Federal Waste Management Sites 1999

The Federal Waste Management System–Action on Waste

The federal Waste Management Program evolved out of the Arctic Environmental Strategy (AES) which ended in 1997. The current program –sometimes referred to as Action on Waste–inventories, assesses and cleans up abandoned waste sites all over the Yukon on a priority basis.

The federal government uses the term *waste management site* for contaminated sites, and 801 sites have been identified in the Yukon to date (Figure 3.19). Another 98 abandoned mine sites are being reviewed. These sites can range from old car bodies to abandoned fuel drums to highly contaminated industrial sites.

Sites are given a priority ranking after the seriousness of their environmental impacts have been evaluated. Top priority sites need quick action to stop pollution. Those with a lower priority do not pose an immediate threat to the environment or human health, but still need clean up for other reasons.

About half of the sites have been cleaned up to date including Rainy Hollow at a cost of about $2.5 million dollars and Brooks Brook on Teslin Lake at a cost of about $1 million dollars. Two other sites that have been managed under this program are the Old Venus Mine tailings pond on Bennett Lake, and the Watson Lake barrel dump.

The definitions for these rankings are:

Active – Inventoried site whose actual condition may need to be reviewed, but not considered to be a priority with the existing information.

Active Low Environmental Risk – Site considered to be a minor problem. Risks to human health and safety and the environment considered to be minimal.

Assessment/Cleanup Pending – Site known to require assessment or remediation.

Tenured Land – Identified site on land held under private ownership, or other type of tenure (such as a lease, permit, First Nation settlement land or mining claim).

Remediated – Site has been cleaned up to applicable standards.

No Action – Site is not within the jurisdiction of DIAND, or simply needs no action.

Abandoned Mines – Former mineral exploration or development-related sites that fall under the jurisdiction of DIAND.

Typically, the federal government hires a consultant and contractors to do the assessment and clean up at a site. First Nations also enter into contribution agreements with DIAND to assess and clean up sites on their traditional or settlement lands.

Above left, slinging abandoned drums of fuel from a waste site. Right, cleaning up an abandoned waste site.

PROGRESS & CHALLENGES

Since the 1995 State of the Environment report was published, many significant steps have been taken to control and regulate solid waste and contaminants in the Yukon. Some of the achievements in different areas are listed below:

Progress since 1995

City of Whitehorse 1998 Solid Waste Action Plan

- Tipping fees
- Waste Watch

DIAND Waste Management Program

- About half of the 800+ waste management sites have been cleaned up

Yukon Environment Act Regulations:

- Beverage Container Regulation – amended in 1996 and 1998
- Contaminated Sites Regulations – January 1997
- Storage Tanks Regulations – January 1997
- Spills Regulations –1997
- Solid Waste Regulations – 2000

On-site clean-up:

- Carcross waterfront
- Whitehorse fire-training area
- Whitehorse tank farm

Challenges:

While many sites could be listed as problem areas in need of attention, some of the more significant sites currently being assessed for clean-up are:

- Marwell tar pit;
- War Eagle oil pond at Whitehorse landfill; and
- DEW Line sites

Attitudes – If all Yukoners live by the four Rs of waste reduction, and reduce, reuse, reclaim and recycle as a way of life, we will significantly reduce the amount of waste that we generate.

3.6 Agriculture

Agriculture has been part of the Yukon economy since the beginning of non-native settlement in the mid-19th century. Cultivated crops were grown adjacent to fur trading posts, and the territory met most of its own requirements for vegetables and forage crops during the Gold Rush when most of the Yukon's 40,000 residents lived in Dawson City. During the 1920s, prior to improvements in the transportation network, extensive local gardens and farms in communities such as Mayo, Dawson, Carcross and at the mouth of the Pelly River provided vegetables, grain and hay for local markets. A very limited amount of agricultural production continued through to the 1960s and 1970s.

Since the Yukon agricultural land allocation program was adopted in 1981, farming has increased (Figure 3.20). Locally grown farm products are again available in the Yukon. In 1991 the sale of livestock and animal products accounted for half of annual farm production. Between 1986 and 1996, the land in crops, number of farms, as well as on-farm investment and infrastructure have increased. Steady growth in the numbers of domestic stock, broiler chickens, laying hens, turkeys, grain crops, green feed, forage crops and greenhouse vegetable production have contributed to the overall growth in the industry.

The significant increase in sales of farm products reflects the allocation of agricultural land through the Yukon government agricultural land programs (Figure 3.21). Beginning in 1981, individuals with a minimum of one year residency in the Yukon could apply for up to eight 65 hectare parcels for a total of 520 hectares (1,300 acres). As a result, land dispositions were high at the beginning of the program. In 1983 alone, there were 28 agricultural land dispositions for a total of 2,800 hectares. Between the years 1983 and 1991, a total of 6000 hectares of land were disposed of for agriculture.

While the availability of farmland in the 1980s boosted the production of farm products, some dispositions

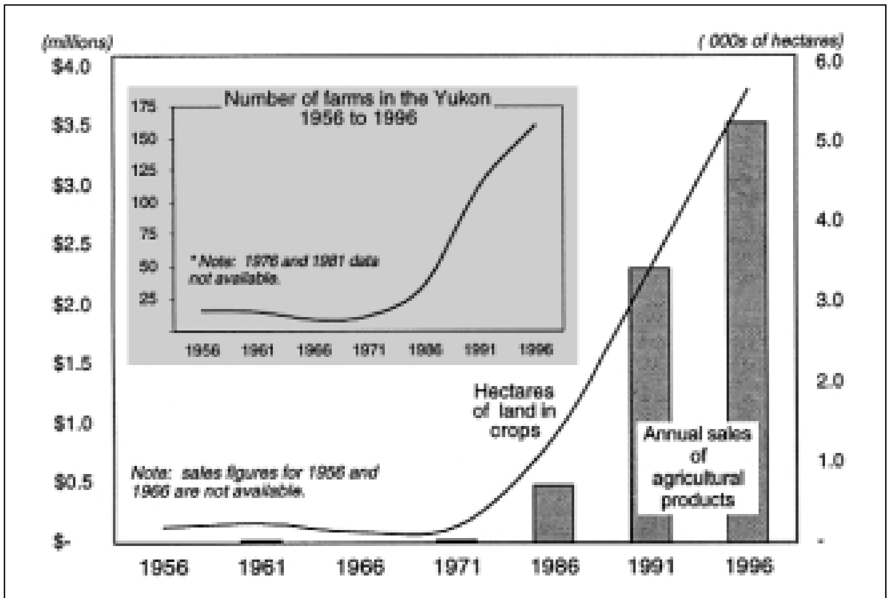


Figure 3.20 Growth of Agriculture in the Yukon from 1956-1996

From 1956 to 1996, the number of farms increased from 16 to 160; the total land in crops increased from 204 to 5,678 hectares, and the sale of agricultural products rose from $15,610 in 1961 to $3,536,098 in 1996. There were no data for 1976 and 1981.

Regulating Agriculture

Agricultural Development Act 1981 initiated the agricultural land allocation program in the Yukon.

Agriculture for the 90s, a Yukon government policy, came into effect in February 1990. A review of the policy is expected to be completed in early 2000. The 1990 policy includes:

- *provisions for allocating land for agriculture while ensuring sustainable agricultural development in accordance with sound conservation practices; and*
- *consideration of social and economic benefits while protecting wild habitats, and maintaining a balance with competing land uses [1].*

The Yukon Grazing Policy (1987) lays out ground rules for allocating land for grazing with the following provisions:

- *grazing lands are allocated on the basis of the grazing capacity of the land;*
- *grazing animals must be adequately contained; and*
- *grazing management plans include provision for public access to grazing lands.*

Yukon Game Farming Regulations were enacted in April 1995 under the Fish and Wildlife Act.

- *They apply to three species: Rocky Mountain elk, musk oxen and wood bison;*
- *provide for escapement, capture and testing; and*
- *restrict game farming to the greater Whitehorse area (other areas may be considered, subject to consultation with local and regional authorities).*

occurred with limited consideration of other resource values such as trapping or wildlife habitat.

The Yukon government's primary objective for the agricultural program is import replacement. This has been achieved to a degree with respect to local forage production which currently comprises close to 50 per cent of Yukon consumption. Import replacement in food products is more difficult due to the low cost of imports from the south. The operation of the abattoir near Dawson City is expected to assist

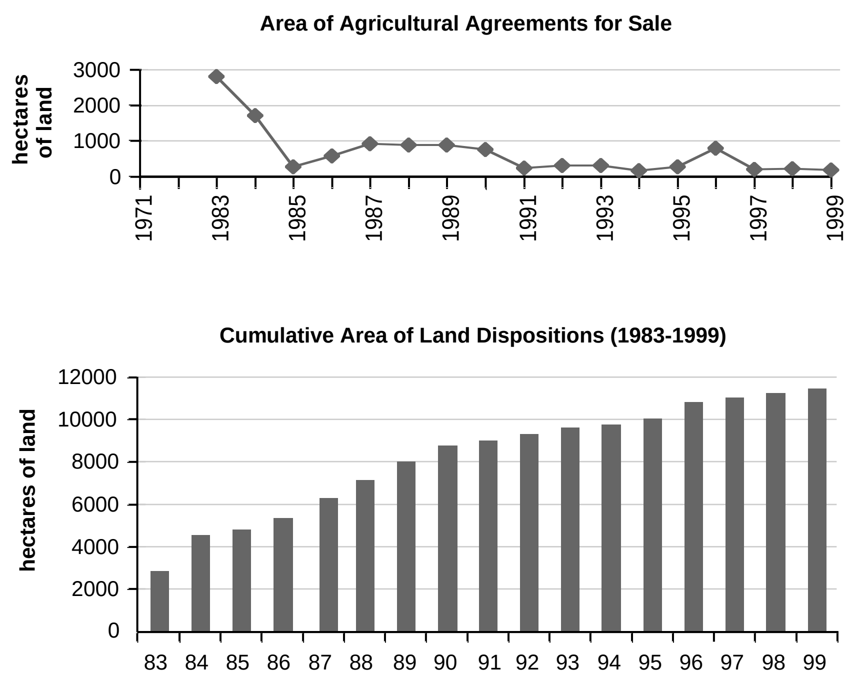


Figure 3.21 Agricultural Land Disposal–1981 to 1999
Most agricultural development in the past 20 years has occurred in the greater Whitehorse area on agriculture capability class five soils. In 1993, Whitehorse accounted for 71 per cent of the agriculture development in the Yukon. Agriculture in this area is primarily a lifestyle choice with many part time farmers dependent on employment within the city. Interest in agricultural lands close to major settlements and employment opportunities is expected to continue.

	estimated imports	1998-99 projected	1998-99 actual	% imports	projected to 2003-04	% imports
chicken	500,000	5,000	4,346	0.8	13,500	2.7
turkey		100	135		900	
beef	5,000	30	21	0.4	130	2.6
hogs	3,000	60	23	0.0	300	2.5

Figure 3.22 Processing at Partridge Creek Farm Abattoir
Source: projected data of number of animals from Partridge Creek Farm abattoir plan.

with the objective of import replacement [2] (Figure 3.22)

The agriculture policy also states that future development should include finding the right crops and products for the export market. Game farming has already reached the export market. Yukon elk breeding stock and antler velvet are considered among the best in Canada. The one woodland bison operation in the Yukon produces top quality breeding stock. Reindeer from the Yukon (classed as domestic stock) have been supplied to British Columbia, Alberta and Saskatchewan where reindeer farming has just recently been permitted [2].

Constraints to Agricultural Development

Although a variety of crops can be grown, there are constraints to agriculture in the Yukon. Climate is the most significant. The number of frost free days ranges from approximately 21 in Haines Junction to 75 around Dawson City. Killing frosts may occur in any month of the year over most of the territory.

While there is some Class 3 and 4 agricultural land in the Yukon, most agricultural development in the territory is on Class 5 land, only suitable for forage crops and cool climate vegetables. The best areas in Canada, such as the Fraser River Valley and parts of southern Ontario, are Classes 1 and 2 (suitable for a wide range of crops, including fruits and vegetables). Due to the mountainous terrain, the majority of the agricultural land in the Yukon is located in major river valleys (Figure 3.23).

In 1997, the Yukon Agriculture Branch carried out an agriculture land utilization survey in the range of the Southern Lakes caribou herd (see Wildlife section). The results indicate underutilization of the land disposed of for agriculture with only 40 per cent of land adequately used [3]. According to an official of the Agriculture Branch, there are a number of reasons for the low utilization of agricultural land.

- Agricultural land has been acquired by some people who want a rural residential parcel and may not have an interest in farm development.
- Farming and farm development require considerable capital, time and a great deal of hard work
- The agricultural policy does not require this land to stay in production nor does it set any expected level of production. As a result, without a strong incentive to remain in production, many would-be-farmers drift out of farming or use the land at a low farming intensity.
- Other than the recent (1999) construction of the abattoir, there has been limited infrastructure to support agriculture in the Yukon (e.g. vegetable storage, cost effective irrigation programs) [4].

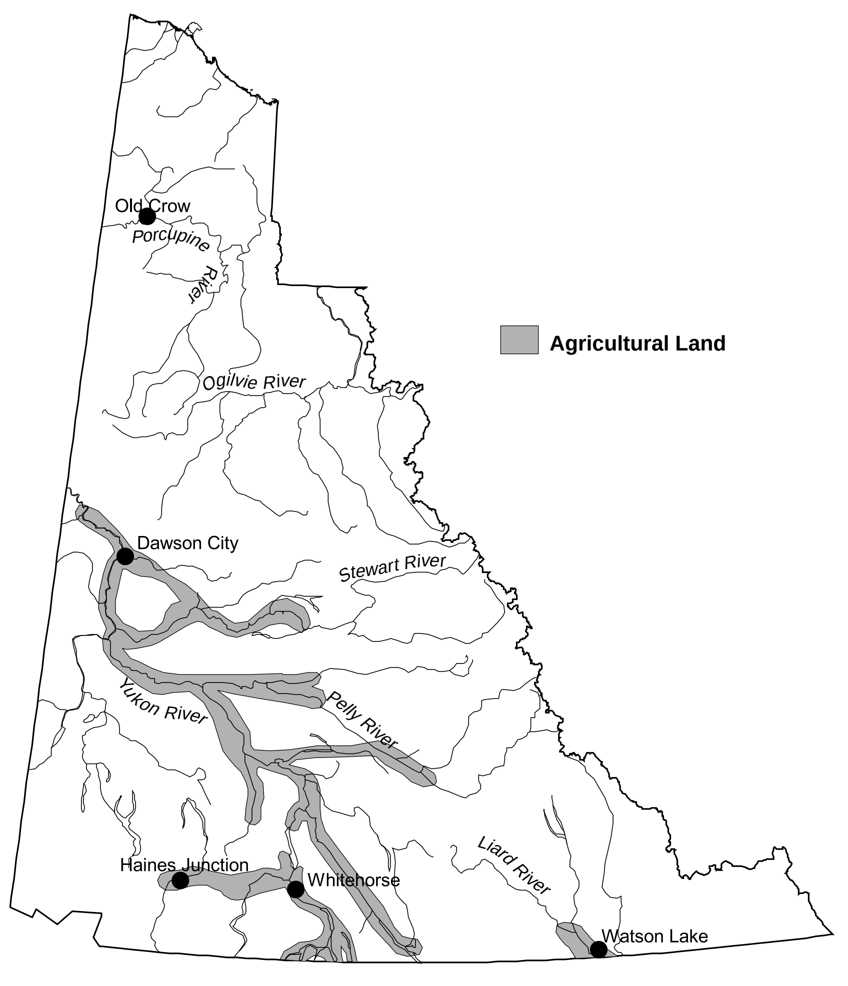


Figure 3.23 Areas in Yukon where Climate is Judged Suitable for Agriculture
The most suitable regions are near Dawson City, Stewart River, south of Stewart Crossing to Pelly River and Carmacks where the climate is class 3 and 4. While the best soils in these areas are capable of production of barley, oats, forages and a wide range of vegetables, most agricultural development in the Yukon is on Class Five land, only suitable for forage crops and cool climate, frost tolerant vegetables [2].

Relationship of Agriculture to the Environment

In the Yukon, the major impact of agriculture is the conversion of land from natural to developed areas and the related loss of wildlife habitat, subsistence and trapping areas, and public recreation lands. Competing uses for land are particularly critical in the greater Whitehorse area. Most land with agricultural potential close to Whitehorse is either subject to land claim negotiations or has already been allocated. Interest in agricultural parcels is reaching further into the hinterland where there may be less conflict with recreational use, but more potential for negative effects on wildlife and subsistence activities.

While competing interests between agriculture and other land and resource interests remain largely unresolved, the actual land area utilized for agriculture is small. An estimated 102 sq km, (1.5 per cent of the Yukon's 6,680 sq km of arable land) has been developed for farming. In terms of the total land area of the Yukon this accounts for only 0.02 per cent. However, areas developed for farming are usually valley bottom lands, which are limited in the Yukon and are often key wildlife habitat or of high recreation value.

As reported in the 1995 State of the Environment Report, the Takhini River Valley experienced a change from wildlands and habitat to farmland and rural residential over the past 20 years. While this farming area contributes to the supply of local food produce, the conversion of natural areas to farmland has been difficult for the First Nation families who traditionally used this area.

The 1991 agricultural policy, required the consideration of other resource interests. Despite the more thorough review in the 1990s, the end result was limited accommodation for the traditional land users.

Stella Jim explains how development affected her way of life. "Takhini valley, there is all fences now, and Champagne. It was all wide open. Ever since that place has started farming, fences all over the place. Old people can't hunt around where people used to hunt. Now it's just a fence all over the place. You can't go and step out there any place you want. All the way down, nothing but farm all over, from Stoney Creek to Whitehorse [5]."

Several local area land use plans have considered other resource values (Klondike Valley, Lorne Mountain and Golden Horn). However, in 1999 there were no regional land use plans in place to assess agricultural land use in a broader perspective in relation to the overall land and resource values in a region.

While land use allocation is seen as an important issue in terms of land use, there are other environmental concerns that have been raised. Disease transmission and genetic contamination are concerns with game farming. Currently there are six game farming operations in the greater Whitehorse area. These include wood bison, elk and a commercial game farm with a variety of animals. About 585 hectares is used by game farm operators at present. There is no evidence of genetic contamination or disease transmission to date [4].

Fish habitat can potentially be affected by agricultural activities but no records of significant fish habitat degradation from agriculture have been noted.

Soil erosion and pollution from agricultural activities can cause soil degradation if clearing and cultivation is not carried out in a sound manner. The Yukon Agriculture Branch monitors agricultural practices to prevent soil degradation.

PROGRESS & CHALLENGES

Progress since 1995

- Agricultural sales have increased from $2.3 million in 1991 to $3.5 million in 1996, indicating that the use of land for agriculture has fairly significant economic benefits to the Yukon [2].
- Ibex Valley, Mount Lorne and Golden Horn local land use plans that identified agricultural lands in an integrated approach have been prepared.
- The agricultural policy has been reviewed.
- The Yukon Land Use Planning Program, that is expected to address the disposition of agricultural land use in an integrated approach, has been established.

Challenges

- Continuation of the spot land allocation process for most agricultural dispositions.
- Lack of an adequate supply of rural residential lands, resulting in pressure on the agricultural land program.
- Under-utilization of land disposed of for agriculture.
- Increasing pressure for the subdivision of agriculture land.

3.7 Transportation

The story of the Yukon is linked to the territory's transportation network. Before the Gold Rush, people traveled by foot, dog team, boat, on trails and by river, leaving little evidence of their passage. During the Gold Rush, local roads were developed in the Klondike region and travel through the Yukon was enhanced by the railway from Skagway to Whitehorse, better overland trails between communities and a river boat system. Signs of past users still exist along the old trails and rivers in the dry Yukon interior. Regenerating forests in the major river valleys are evidence of the extensive woodcutting required to fuel the paddlewheelers. The City of Whitehorse, at the end of the rail line, became the major centre of the territory.

The modern road transportation network in the Yukon really began in 1942 with the construction of the Alaska Highway. Prior to that time, there was a winter road from Whitehorse to Dawson City, a road from Mendenhall to Silver City on Kluane Lake, and roads connecting the gold fields in the Klondike and the mining operations at Whitehorse and Keno.

Incentives such as the Yukon Regional Resource Road Program (RRRP) and Resource Transportation Access Program (RTAP) available from 1986 to 1992, and the federal government's Northern Road Policy in effect for 20 years before that increased the number of roads and trails into the hinterland [1].

Highways link most regions of the territory and join the Yukon to Alaska, British Columbia and the Northwest Territories. Old Crow is the only Yukon community not accessed by a year round road.

New roads and trails which exceed the thresholds of 1.5 meters wide and two hectares in area require a land use permit and are subject to environmental impact assessment. Applications for 51 new logging, mining and access roads on federal lands were approved between 1995 and 1999. Another 24 applications to upgrade and use existing winter roads were also approved [2].

The use of existing mining access and forest roads for recreation is probably increasing, associated with the greater numbers of people taking advantage of outdoor recreational opportunities in the Yukon backcountry in both summer and winter.

There is also an increase in air travel between Yukon communities. Flightseeing has increased dramatically in the 1990s especially in the Kluane area. Fly-in wilderness operations are expected to increase as the Yukon becomes recognized as a destination tourist area [3].

The Relationship of Transportation to the Environment

The development of a transportation network results in changes to the land, its resources and the people living on the land.

"Any road in the Yukon follows Indian trails, all the way through. Moose, they have trails, like we have trails, and they follow the trails".

–Paddy Jim, Champagne/Aishihik First Nation Elder 1999

Mineral exploration road west of Nahanni Range Road in the Logan Mountains

Roads:

The arrival of roads affected the people, the pattern of settlement and the wildlife in the Yukon. The Alaska Highway brought people, quantities of inexpensive southern goods, agricultural products, vehicles and dramatically increased the speed of travel.

First Nation people were seriously affected by the road development. Families were relocated to highway communities, a change that significantly altered a way of life that was closely tied to hunting, fishing and gathering. River life and river communities were gradually abandoned.

Food supply needs of military and civilian personnel during the construction of the Alaska Highway and the Canol Road resulted in over harvest that led to depleted wildlife populations in several areas. The Kluane Wildlife Sanctuary was created in 1943 and a 'no hunting' corridor was established along the Dempster Highway following its construction in the 1970s. A 0.5 km no hunting corridor now exists along the Dempster and a 0.8 km corridor along the Takhini Hot Springs and Annie Lake roads.

In addition to their effect on wildlife, other potential environmental impacts of roads include:

- incremental reduction of wilderness areas;
- disruption of natural surface and sub-surface drainage patterns possibly leading to sloughing;
- invasion of non-native vegetation species (e.g. foxtail barley) [4]; and
- increased refuse in remote areas accessed by road.

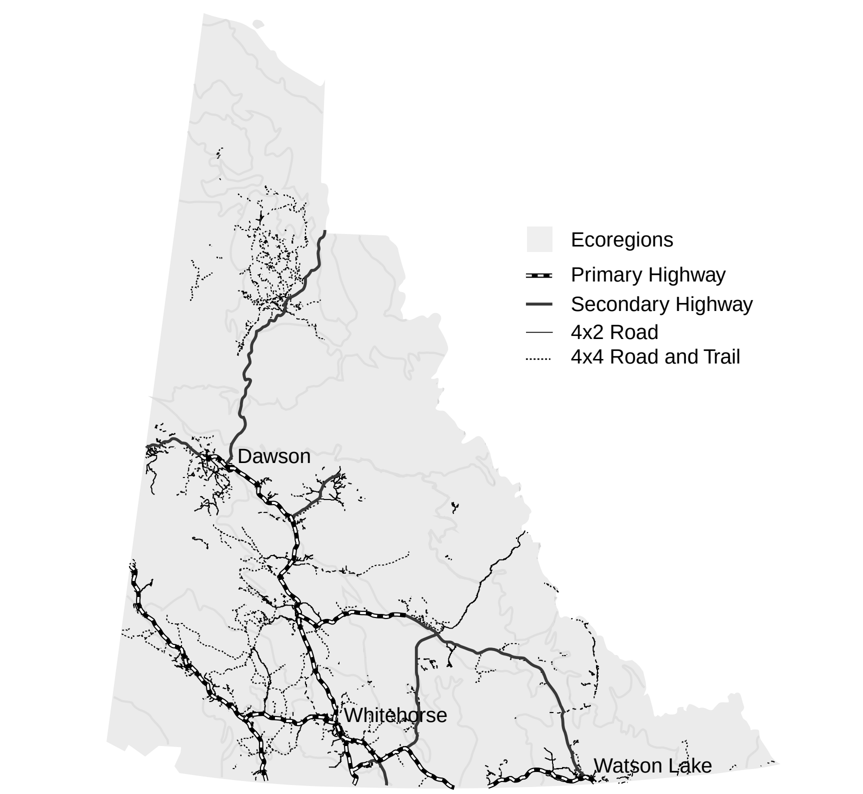


Figure 3.24 Yukon Roads by Ecoregion

These potential problems can be avoided or mitigated through the review process and in the proper design and construction of the road.

Air Transportation:

Impacts of air transportation relate to the potential for noise to disrupt wildlife and the intrusion into wilderness areas when remote air strips are developed.

Trails/rivers:

The increased use of trails and rivers by recreational users is discussed in section 3.8.

Legislation

- Transportation on Yukon roads is subject to the *Yukon Highways Act*, *Motor Transport Act*, *Motor Vehicles Act* and the *Dangerous Goods Transportation Act.*
- Road construction and upgrading are subject to the Canadian *Environmental Assessment Act* (CEAA) (1992). In the future, the Development Assessment Process will apply.
- Any roads which cross or otherwise impact a watercourse require licensing under the *Yukon Waters Act*. Permits may also be required under the *Fisheries Act.*
- Roads on mining claims are subject to the new Quartz Mining Land Use Regulations (June 1999), and the Placer Mining Land Use Regulations (effective December 1999).
- Small scale activities on Yukon lands that might damage the environment require approvals and permits pursuant to the *Yukon Environment Act.*

Where land claims and protected areas are dissected by, or abut Yukon roads, how the roads and road rights of way should be managed, who the road belongs to and who is responsible for it must be taken into consideration.

3.8 Tourism

Tourism is gaining importance across Canada with a 25.5 per cent growth in tourism expenditures from 1986 to 1996. In 1998 tourism spending in Canada amounted to $47 billion, a seven per cent increase from 1997. Tourism is the fifth largest revenue generator as well as the fifth largest employer [1].

Adventure travel is the fastest growing sector of the tourism industry in North America [2]. Studies indicate that adventure travel and ecotourism are driving the Canadian tourism industry [3].

The economic impact of tourism in the Yukon has been difficult to assess in the past due to its role in many sectors of the economy. In 1994, over $50 million in revenue to Yukon businesses was related to tourism. In 1996, $124 million was directly related to non-resident tourism. Over 2,000 jobs are directly related to tourism (11 per cent of the jobs in the territory) [4] and visitors to the Yukon are increasing (Figure 3.25).

Growth in the Yukon tourism industry is expected in the over 45 year old age groups, a sector of the Canadian population that will increase significantly as baby boomers age. About 43 per cent of the people interested in adventure tourism are over 45 [5].

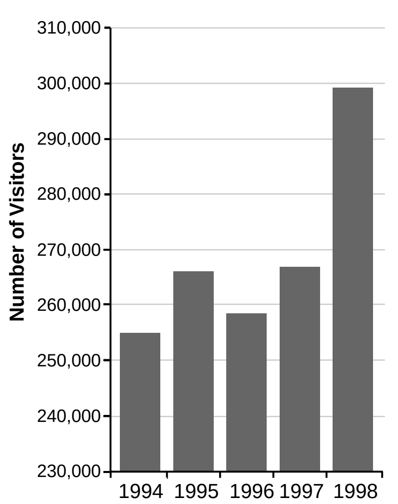


Figure 3.25 Visitors to the Yukon 1994 to 1998

What brings tourists to the Yukon? The Yukon landscape, scenery and wilderness are important in attracting both overseas and North American visitors to the territory. Forty-three per cent of visitors cited scenery as the most positive thing about their visit [6]. Ninety per cent rated scenery as good to excellent and 94 per cent of visitors rated their wilderness/outdoor experience as good or very good value for the money [7].

Sixty-nine per cent of air travelers to the Yukon in the summer of 1998 took part in some form of outdoor or wilderness activity and 59 per cent did some hiking; 36 per cent reported that wilderness was their most positive experience [8].

From the statistics it is obvious that the Yukon wilderness is a major attraction for visitors. Visitors to the Yukon want to view the scenery, wildlife and experience the Yukon outdoors. Viewscapes are important. Some popular activities include canoeing, fishing, hiking, wildlife viewing, backpacking, and white-water rafting.

Wilderness Tourism Statistics

- 41,400 visitors (June-September 1994) participated in outdoor / wilderness adventures [6].
- 550 parties per year enter the backcountry of Kluane National Park (level of use has remained constant over the last eight years) [9].
- Approximately 2,125 people traveled the Upper Yukon, Teslin and Big Salmon rivers between June 13 and September 15, 1997; 39 per cent were from Germany, 23 per cent from Canada (including eight per cent Yukoners), 38 per cent from other European countries and others [10].
- Recreational river travel on the Yukon River at Fort Selkirk has increased steadily over the last five years.
- Whitewater river rafting on the Firth, Alsek and Tatshenshini rivers is popular.
- Winter tourism is growing. In 1999, 13 companies offered dogmushing trips, others offer snowmobiling and winter camping [11].

Relationship of Tourism to the Environment

"Wilderness, scenery, pristine environment" are key motivators for people considering or choosing a trip to the Yukon, an expectation when they arrive; a key source of enjoyment when they are here, and an important factor in trip satisfaction.

In discussing the impacts of tourism on the land of the Yukon, the 90 per cent of visitors to the Yukon who come by road cannot be ignored [12]. Even though their numbers are large, the direct impact of these highway travelers on the wilderness, as defined in the section on wilderness, is slight as most do not leave the road corridors. The numbers of road visitors are still slowly increasing. These visitors require good roads, services and facilities including places to safely dispose of their waste and garbage. In addition to traditional road-side services, recent research indicates an increasing interest in road accessible, soft wilderness adventure for this market. Scenery and enjoying what they see to be Yukon wilderness is very important to them.

The number of people attracted to the Yukon's backcountry is increasing. Higher numbers of wilderness travelers (Yukoners and visitors) and wilderness outfitters are putting more stress on the wilderness. The most frequently mentioned serious problem encountered on the Yukon River was litter and garbage, mentioned by 13 per cent of river travelers [10]. Clean-up along heavily used rivers such as the Yukon River is undertaken periodically.

> *"There's one spot on the Canol Road where our family gathered and built shelters. Now the people that travel along that road are going down to the lake and the houses that we built there have been destroyed by bullets and the wood used for fires. The poles that we gathered for setting up our tents and the poles that we used to dry out our meat are all burnt up by the people that come through that way."*
>
> *–Charlie Dick, Ross River First Nation Elder*

Ross River Elder Charlie Dick still lives a traditional way of life. As more and more visitors use Quiet and Lapie Lakes to access recreational and wilderness areas like the Big Salmon River, these types of conflicts may increase.

The winter use of rivers and trails by recreational users on snowmachines and dogmushing appears to be increasing. Impacts of the increase in use of winter trails is not well understood. Extensive trail networks, increased noise and traffic may impact wildlife.

With more people, there is more potential for people/bear interactions as has been experienced in the last few years in Kluane, on the Snake River, and in northern British Columbia at the Liard Hot Springs. Bears are attracted by garbage, become dangerous and occasionally have to be destroyed. Harvesting of fish and wildlife without proper permits may further deplete fish populations that are already under stress.

Related Legislation and Educational Programs

To protect the natural resources important for tourism, government and the tourism industry have been cooperating in a number of areas. The *Wilderness Tourism Licencing Act* came into effect in May 1999. To obtain a licence, wilderness operators are required to pay a $100 annual fee, get public liability insurance, meet worker compensation standards and have standard first aid training for all guides. To maintain a licence requires compliance with low impact camping, waste disposal standards and trip reporting. The *Environment Act* prohibits littering on all public lands.

Other initiatives include placing environmental messages in the media and advertising the "No Trace Checklist". The leave no trace philosophy is becoming the wilderness tourism industry standard. The No Trace Yukon program was initiated in 1998 and the first No Trace Yukon instructor's course was delivered in 1999 through joint sponsorship of Renewable Resources, Yukon College and the National Outdoor Leadership School. Production of additional awareness materials and program development to promote and support minimum impact backcountry recreation is ongoing.

The "Into the Yukon Wilderness" brochure is available in English, French, German and most recently Japanese [13]. This guide is distributed widely in visitor reception centres, Renewable Resources offices and in response to visitor inquiries. Yukon Tourism and the industry regularly take them into the marketplace. The Yukon Vacation Guide and other tourism promotion information contain instructions on the safe and wise use of the Yukon's wilderness.

Highway travelers also require services including effluent dumping and waste disposal. The *Environment Act* prohibits the discharge of holding tanks except at designated sites and littering on all public lands. The government is working to provide suitable effluent dumping sites where communities have problems handling the eduction sewage volumes.

PROGRESS & CHALLENGES

Progress since 1995

- The *Wilderness Tourism Licensing Act* came into effect in May 1999 with requirements for wilderness guides and operators and responsibilities for clients in leave no trace camping and waste disposal.
- "Into the Yukon Wilderness", a Yukon government brochure is available for all Yukon visitors.
- Continued efforts of industry (Wilderness Tourism Association) to help members and others in the industry to recognize the value of wilderness and treat it with the respect it deserves.
- Implementation of the "No Trace Yukon" Program.

Challenges

- Increased human/bear encounters.
- Greater use (by visitors and residents) of Yukon rivers in the absence of management for most of the high use river corridors.

Yukon people of all cultures place a high value on the creatures that make up the biodiversity of the territory and provide spiritual nourishment as well as traditional foods. That is why fish and wildlife resources are an important part of recent land claim agreements, which are changing the way these resources are managed.

This chapter describes the status and trends of a variety of fish and wildlife populations. It also provides details about how Yukon people are using these resources, and the new management systems that are emerging as land claims are implemented.

4.1 Fish and Fish Habitat

Salmon

Pacific salmon spend the early part of their life cycle in fresh water, migrate to the ocean to complete their growth and mature, and then return to fresh water to spawn and die. Most of the salmon's growth is in the ocean where they feed on plankton, crustaceans, jellyfish, squid and smaller fish. Salmon may travel up to thousands of kilometres at sea before returning to freshwater to spawn at the same location where they were hatched.

The length of time salmon spend in fresh water varies from species to species and even between different populations of the same species. Chum salmon in the upper Yukon, for example, spawn in the fall. The eggs hatch in the winter and early spring and the fry begin their migration to the Bering Sea soon after spring break-up. Young chinook salmon in the upper Yukon, on the other hand, do not start their seaward migration until they have spent one or even two years in fresh water. Most lake-spawning sockeye in the Yukon also spend a year in fresh water before migrating to the ocean, but many sockeye populations that spawn in side channels in major rivers migrate to the sea in their first year. At the other extreme are kokanee, a form of sockeye that spend their entire lives in fresh water.

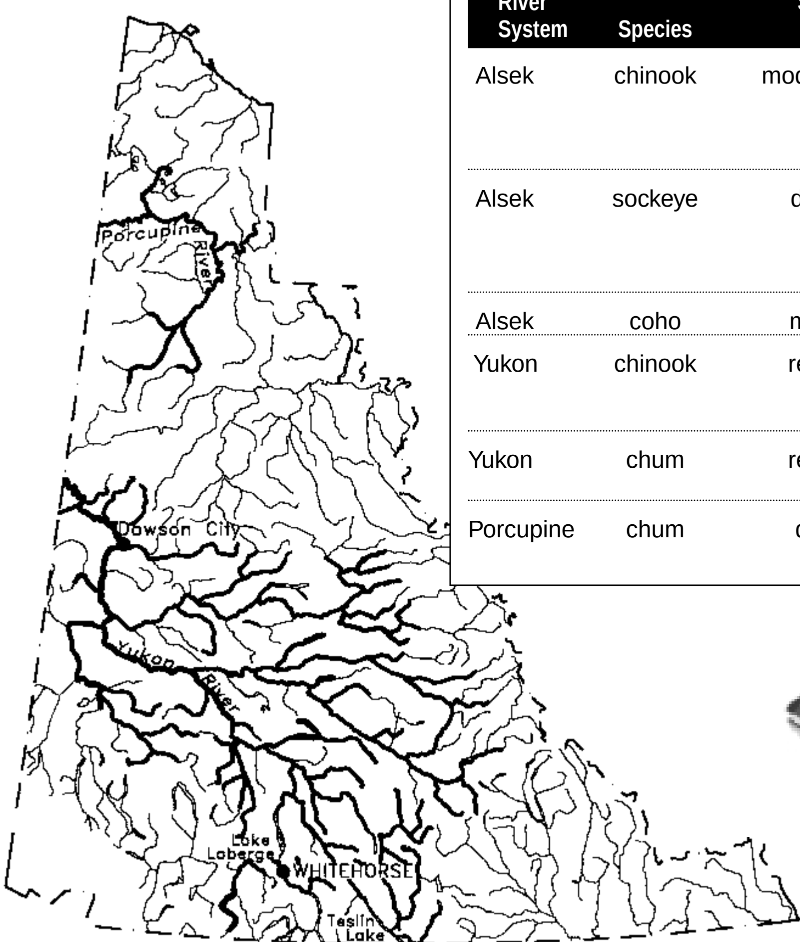
In the Yukon River, chinook salmon swim as far upstream as Whitehorse, Teslin and beyond, having begun this remarkable freshwater journey in the Bering Sea (Figure 4.1). Yukon River chum salmon that spawn in the upper Yukon and tributaries, such as the Teslin River, undergo some of the most extensive freshwater migrations of this species in the world. In the Porcupine sub-basin, which extends north of the Arctic Circle, chinook, chum and coho salmon migrate upstream past the village of Old Crow to spawn in the Fishing Branch River. In the Alsek drainage, chinook, sockeye and coho salmon spawn in a number of headwater tributaries of the Tatshenshini River. Some of these spawning locations are above treeline.

Salmon have a long tradition of use by Yukon First Nations. The importance of salmon is reflected in lifestyles and ceremonies. The 'first fish' ceremony, for example, is celebrated by the Tutchone people of the southwest Yukon with the arrival of the yearly salmon run [1].

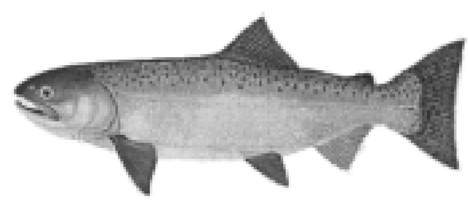
First Nations have used certain stocks of salmon for many hundreds of years. Increased exploitation of the fish in the twentieth century, however, has dramatically affected some stocks. Commercial fisheries for salmon in Yukon drainages started in the early 1900s. Commercial fisheries have been established on both the Alsek and Yukon River stocks in Alaska but only on the Yukon River stocks in Canada. Sport fishing and subsistence fishing, by both First Nation and non-First Nation people, are conducted on both river systems (Figure 4.2).

Salmon: an International Resource

The Yukon and Alsek Rivers flow through both Canada and the United States. Yukon salmon are harvested mostly by Alaskans rather than by Yukon people (Figure 4.3 and 4.4).



River System	Species	Status of stocks	Trends
Alsek	chinook	moderate level	Increasing except 98 & 99 run well below average– possibly due to poor marine survival
Alsek	sockeye	decrease	Increasing to 1995. Past four years well below average. 1999 worst year recorded
Alsek	coho	moderate	Stable–increasing
Yukon	chinook	rebuilding	Increasing to 1997. 1998 lowest on record and 1999 well below average
Yukon	chum	rebuilding	Rebuilding to 1997and decrease 1998-99
Porcupine	chum	declined	significant decline from 1970s–remains low



Known chinook spawning streams

Figure 4.1 Chinook migration and spawning areas in the Yukon River basin

Salmon are also captured in the open ocean by fishing fleets from countries other than the United States and Canada. With so many interests wanting a share of the resource, management of the salmon is a complex and difficult task.

Many Yukon and Alsek River salmon spend the early parts of their lives in Canadian waters, but they swim through American waters when they return to spawn and a large number of fish are harvested in American fisheries. The Pacific Salmon Treaty signed by Canada and the United States in 1985 was intended to establish salmon conservation requirements and create a fair distribution of the benefits from this international resource [2]. However, the short-term joint fishing plans that were initially agreed to, when the treaty was proclaimed, often were not renewed due to failures to achieve new harvest sharing agreements. In June 1999, however, new fishing arrangements under the treaty were signed following seven years of failed negotiations. The revised treaty commits both countries to rebuilding salmon stocks [3].

Salmon stocks returning to the Alsek River drainage are jointly managed by Fisheries and Oceans Canada (DFO) and the Alaska Department of Fish and Game through the joint Transboundary Technical Committee of the Pacific Salmon Commission.

The Yukon River salmon stocks are treated as a separate issue within the Pacific Salmon Treaty. In December 1994, Canada and the United States signed a three-year interim agreement on Yukon River salmon stocks. The agreement was an important milestone in negotiating a separate Yukon Salmon Treaty. This agreement has now expired and due to failed negotiations in 1998 a new agreement is not in place. Negotiations to form a new treaty are due to resume in late 1999.

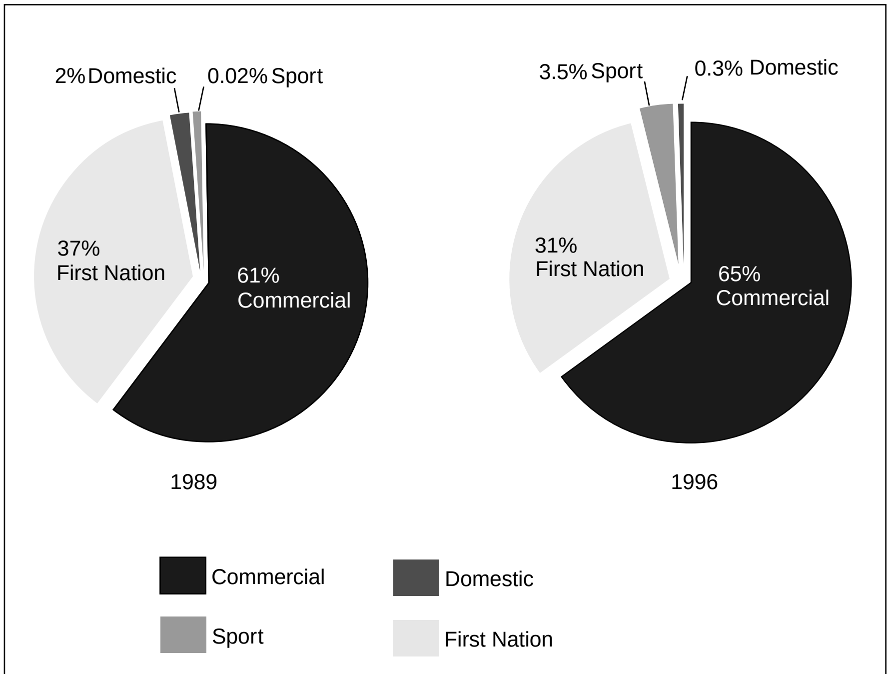


Figure 4.2 Estimated Yukon Salmon harvest 1989 and 1996 [3]

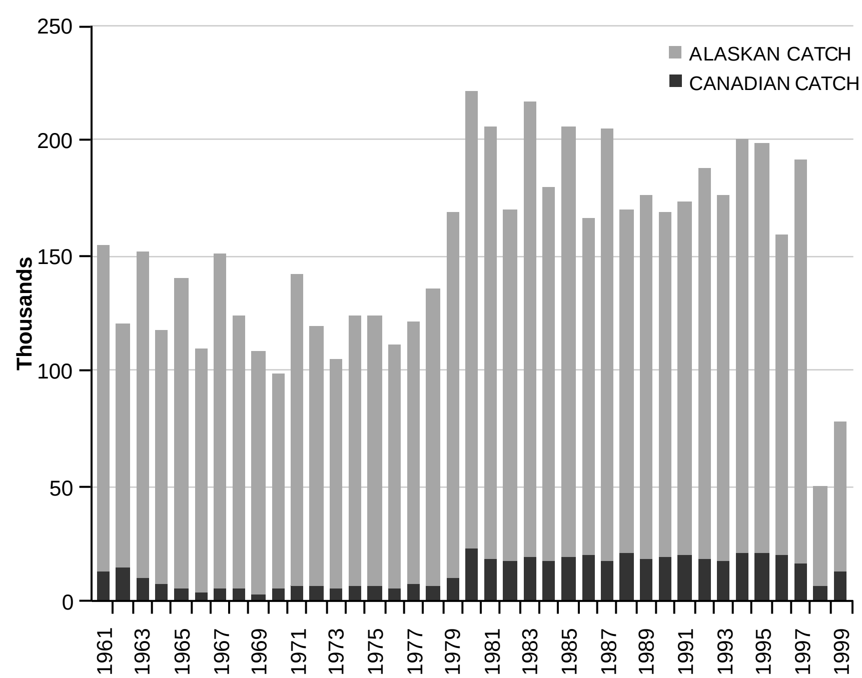


Figure 4.3 Chinook Salmon catches in the Yukon River [3,4]

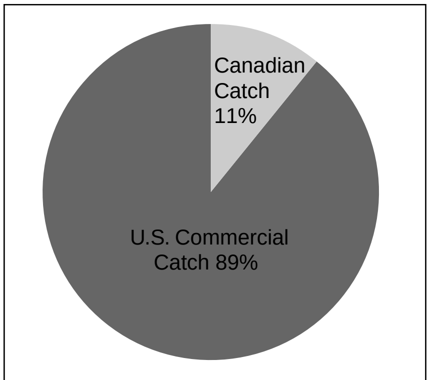


Figure 4.4 Alsek River Sockeye Catches, American vs Canadian Average 1976 to 1999
Fisheries & Oceans Canada estimates that roughly 90% of all sockeye salmon stocks in the Alsek River are hatched in Canadian waters. Canadian Catch includes aboriginal and sport fishery (3,5).

Management Responsibilities

The ultimate responsibility for management of Yukon salmon rests with DFO; however, much of that responsibility is now being shared with the Yukon Salmon Committee (YSC).

The Yukon Salmon Sub-Committee was established in 1995 under Chapter 16 of the Yukon Land Claim Umbrella Final Agreement (UFA) as "the main instrument of salmon management in the Yukon". The committee makes recommendations on all matters relating to Yukon salmon and represents Yukon stakeholders in Pacific Salmon Treaty negotiations between Canada and the United States. Recommendations made by the YSC are taken to Fisheries and Oceans Canada for review and, if accepted, are implemented. The 10-member committee represents a cross-section of Yukoners (both First Nation and non-First Nation), with a key interest in Yukon salmon stocks. The committee has conducted work in each of the fisheries it manages.

1. Sport Fishery – Introduction of the Salmon Conservation Catch Card

As of April 1, 1999 all sport anglers fishing for salmon in the Yukon must have a Salmon Conservation Catch Card as well as a Yukon Sport Fishing licence. Following the fishing season salmon sport fishers must return their cards with information on all salmon captured. Data collected from the cards will help to improve salmon sport fishing harvest statistics. These statistics combined with the commercial, aboriginal and domestic fisheries data will aid in the management and conservation of the resource (3,6).

2. Aboriginal Fishery

An intensive six-year aboriginal fishery harvest study in the Yukon River drainage was initiated in 1995. This study will be used to document and determine the annual fish requirements by First Nation families and individuals. When it is completed the study will be used by DFO and Yukon First Nations in 'Basic Needs Level' negotiations [3].

"I went to Dawson City...I always go down there to get my salmon. They're so small, just tiny little ones, and they're all small like that now. I think I've never seen that in my life, because I've seen all sorts of salmon, a great big one, caught one ninety-five pounds once. And this is pitiful. I look at that fish. They're nice fish but they're that long; they're supposed to be four years old."

Rowena Flynn, Tr'ondëk Hwëch'in First Nation Elder

Rowena Flynn

3. Commercial Fishery

In 1997 the YSC recommended that DFO retire a number of commercial fishing licences. The recommendation was made in order to allow for more First Nation participation in the fishery and to reduce the overall commercial catch. Since July 1997 eight licences have been retired [6].

Salmon Management Strategy

Salmon stocks are managed for optimal sustainable yield. A challenge to fishery managers is to maximize utilization of the salmon while ensuring its conservation. Allowing more salmon to reach the spawning grounds will not necessarily result in a higher yield or production of fish from that spawning event. Competition for suitable spawning habitat and/or rearing resources (space/food) may limit the production success (recruitment) within that year class of fish. Therefore fishery managers designate extra fish (fish in excess of the optimal number for

Lake Stocking – Kokanee

In 1991 the Yukon Department of Renewable Resources, Fisheries Management Section initiated a program to collect kokanee salmon eggs from stocks thriving in the Kathleen River system in Kluane National Park. Fry from this program were transplanted to several pothole lakes throughout the Yukon. These fry have since matured and have provided seed-stock for a continuing stocking program. This program will help ensure that the gene pool from this unique stock is available from more then just the one original source. The kokanee also provides a unique angling opportunity for sportfishers greatest spawning and production success) for harvest. For instance, the optimal escapement determined for sockeye salmon on the Klukshu River is 7,500 to 15,000 fish [5]. Escapement levels higher or lower than this may result in poor recruitment and thus low adult salmon returns four to five years later.

Although this strategy can maximize yield in the various fisheries it does ignore other ecosystem components to a certain extent. Salmon are an important food resource to a variety of animals such as bears, mink and eagles. The more salmon harvested in the various fisheries the less there are available for other animals. Over 75 per cent of the salmon returning to the Yukon River are harvested in Alaskan and Yukon fisheries [4]. The effect of this harvest on animals that use salmon for food has not been well documented.

Salmon are an important food resource for the Alaskan brown bears on Kodiak Island in Alaska. Fishery managers in Alaska allocate a portion of the salmon returns to the bears and incorporate it into their management strategy [3].

Educational and Research Programs

Salmon in the Classroom

The 'Salmon in the Classroom' Program is available to all Yukon schools. Teachers and students operate classroom incubators to monitor salmon development from egg to fry. In 1998, 22 schools in nine Yukon communities participated in the program and 2,300 chum and chinook salmon fry were released back into natal streams.

Streamkeepers Society

The Yukon Streamkeepers Society was formed in 1995. It fosters stream stewardship throughout the Yukon. The society conducts field trips, research and workshops that introduce interested individuals to the Streamkeepers Handbook.

Fishery Initiatives - Programs & Studies

In addition to research conducted on Yukon salmon stocks by Fisheries and Oceans Canada and the Alaska Department of Fish and Game, other research is conducted by First Nations, community groups, consultants and individuals throughout the Yukon. Funding for these salmon studies is provided through programs developed as a result of the Pacific Salmon Treaty negotiations.

Pacific Fisheries Adjustment and Restructuring Program (PFAR)

This program was implemented by Fisheries and Oceans Canada in 1998 in response to dwindling salmon resources in British Columbia and the Yukon. With a $400 million budget the main initiatives of this program are:

- restructuring of the commercial fishing industry including fishing fleet reduction;

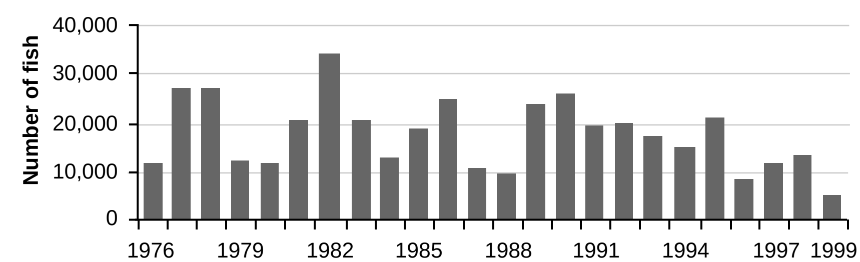


Figure 4.5 Klukshu weir sockeye returns
The Klukshu River, a tributary of the Tatshenshini and Alsek Rivers, is a significant producer of sockeye salmon. Sockeye salmon returns in 1999 were the lowest on record. Returns over the last four years are well below the average of 18,000 fish. Source:TTC 1998; DFO 1999 (3,5)

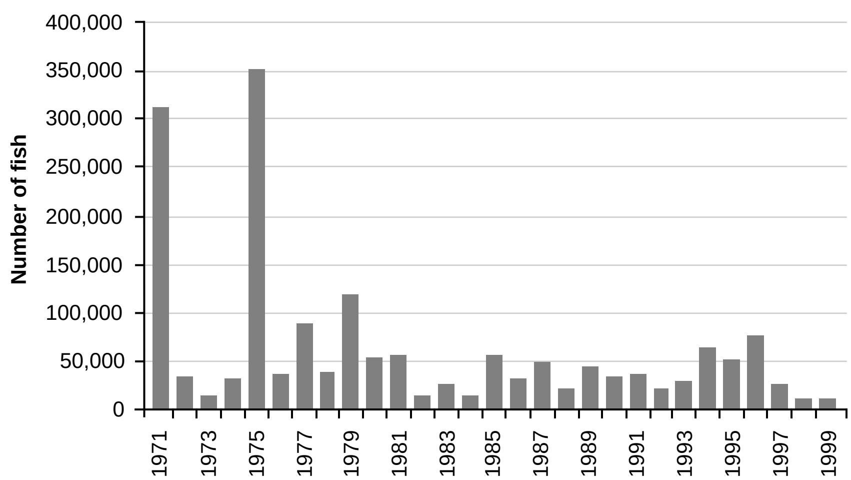


Figure 4.6 Fishing Branch River chum salmon escapement
During the 1970s the number of chum salmon returning to the Fishing Branch River used to exceed 300,000 in certain years. In recent years this escapement has consistently fallen to below 50,000. The DFO is attempting to manage the stocks to get escapement levels well over 50,000 fish. The 1998 return was one of the lowest on record and may reflect poor ocean survival of the salmon (3,4).

- aiding communities and people to adjust to reduced fishing opportunities; and
- protecting and rebuilding salmon habitat [7].

The Habitat Restoration and Salmon Enhancement Program (HRSEP) is part of PFAR. This program funds stewardship initiatives, stock rebuilding activities and projects to restore salmon habitat, in British Columbia and the Yukon [7].

Yukon River Restoration and Enhancement (R&E) Fund - This fund had been operating since 1994. Failure of Yukon River negotiations resulted in suspension of the program in 1998. Until 1998 a wide variety of enhancement, assessment and habitat protection programs and studies were conducted under this program. Yukon River salmon negotiations are scheduled to resume in November 1999 [3].

Ocean survival

In 1998 and 1999 some of the salmon runs on both the Alsek and Yukon Rivers (see Figure 4.5 and Figure 4.6) were among the lowest runs recorded. This situation was consistent with many salmon runs throughout British Columbia and Alaska; therefore, it has been assumed that ocean survival of these returning year classes has been relatively low resulting in low returns of adult salmon to the rivers.

Fishery managers have known that ocean survival fluctuates from one year to the next but have little information on it. It was assumed that the major influences on the populations were escapement, harvest and freshwater survival. It has recently come to light, however, that ocean survival rates may vary significantly over long periods of time. It is currently being accepted that dramatic changes occur in the North Pacific, changes that impact fish populations. These are being referred to as 'ocean regimes'. Regimes can be relatively stable for decades with respect to climate, weather patterns, temperature and marine organism survival rates but then shift abruptly. These 'regime shifts' change the ocean ecosystem and for species such as salmon these changes appear to dramatically affect the population size.

The trends coincide directly with population size of salmon and other fish species such as sardines and pilchards in the North Pacific (Figure 4.7). Salmon scientists at the Pacific Biological Station in Nanaimo, British Columbia believe that a 'regime shift' may have occurred in 1998, but they do not know yet if this will affect salmon populations [9].

Pacific Ocean research over recent years has revealed that the ocean undergoes large scale changes, changes which can have a dramatic effect on fish populations [8].

Period	Ocean temperature trend	North Pacific Salmon population size trend
1925-1947	warming	high
1947-1976	cooling	low
1976-1997	warming	high

Table 4a Ocean Regime Periods
Warming and cooling trends throughout the 1900s and relation to ocean temperature and Pacific salmon population size trend [8].

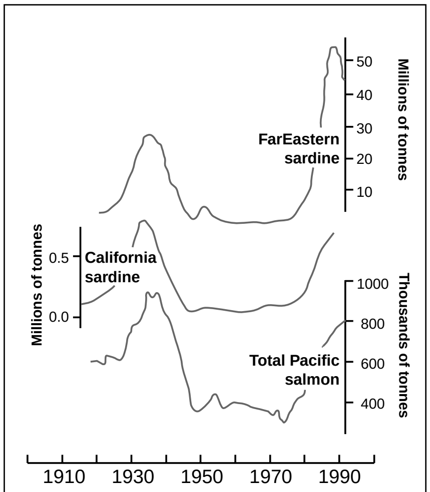


Figure 4.7 Harvest trends between Pacific Salmon sardine stocks and Pacific Salmon from the early 1900s to 1990
Note periods of high production relative to periods of low production [8].

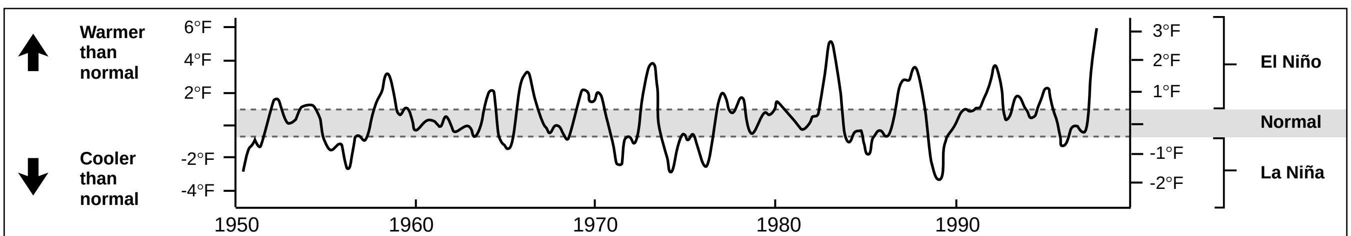


Figure 4.8 Sea surface temperature change over the past 50 years
Measurements taken near the equator, west of Peru [11].

The challenge to fishery managers is to incorporate the short and long-term ocean survival and production trends into salmon conservation strategies. Adding to the complexity of predicting ocean survival of salmon is the global warming trend. It is thought that this may increase the intensity and frequency in the ocean regime shifts. It is therefore important that programs designed to 'track' ocean survival are given higher priority.

It is not clear how these shifts affect fish populations, but there is evidence that during low fish production trends, cool nutrient-rich water from the ocean depths is not being drawn up (i.e. upwelling) to the surface as readily. Nutrients from the ocean depths are the fertilizers which drive primary production, forming the base of the food chain. Thus low productivity periods result in a reduction in foods available to salmon and other fish. The upwelling of nutrients from the ocean depths is linked to wind patterns (upwelling is more intense during periods of strong winds) (8,9,10).

It is not certain what causes regime shifts but it may be linked to the energy shifts between the rotation of the earth and the atmosphere. In turn these energy shifts are reflected in the location and intensity of the Aleutian low pressure system. At times, this system can cover a vast area of the North Pacific (as it did during its strong phase in 1998 when it covered an area from the Kamchatka peninsula to the British Columbia coast). During its weak phase it covers a much smaller area and tends to have less influence on weather patterns, in particular wind [9].

Within these major ocean regimes, which can last decades, are more short-term effects caused by major oceanic systems known as El Niño and La Niña. During El Niño events, surface waters, along the coast of British Columbia and Alaska tend to be warmer, creating a barrier that prevents nutrient rich bottom waters from reaching the surface. This in turn reduces primary productivity at the surface, possibly impacting salmon survival. This impact may not be apparent for a few years until the impacted age class of salmon become adults and are harvested or counted during their migration to spawning grounds in freshwater systems [8].

La Niña creates cooler coastal ocean conditions in the North Pacific which result in higher primary productivity and likely higher survival rates for salmon. During La Niña events, winds tend to be much stronger resulting in stronger upwelling events (the process by which nutrient rich bottom waters are brought to the surface) in the ocean.

During the past 50 years El Niño conditions have occurred 31 per cent of the time and La Niña conditions 23 percent of the time (Figure 4.8 and Table 4a).

Freshwater Fish

The Business of Fishing

Approximately 28 businesses offer fishing expeditions in the Yukon, ranging from short excursions near Whitehorse and some smaller communities, to week-long stays at remote fly-in fishing camps and lodges. Stores selling fishing supplies and a range of other businesses benefit from fishing activities.

There are approximately 27 species of freshwater fish (excluding salmon) in the Yukon, eight of which are strongly favoured by recreational anglers and other users of the resource. The freshwater fish targeted by anglers include Arctic grayling, lake trout, northern pike, rainbow trout, kokanee and, more recently, burbot or 'ling cod'. The First Nation subsistence fishery targets primarily lake whitefish, lake trout and ling cod.

During the fur trading and gold rush periods, fish were used for subsistence and, to some extent, commercially. During the Klondike Gold Rush, demands increased for fish as dog food and for a rapidly increasing human population. The Klondike River was

Fish have been an important resource for Yukon First Nations for thousands of years. Roddy Blackjack, Little Salmon/Carmacks First Nation Elder explains:

"I told them that Indian people eat fish any time of the day. That's what I tell them...non-natives take a little piece of fish every Friday but Indian people don't do that. They dry their fish and make stock for the winter. Because they can eat fish any time they want, that's why fish is so important for the First Nation and still continuing to go on the same way."

Roddy Blackjack

Freshwater Fish Species in the Yukon

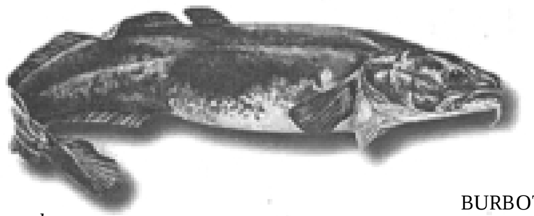
Older fisheries data indicated the presence of 40 species of freshwater fish in the Yukon. A more recent survey indicated that the actual number is 27. Species are shown below.

Arctic cisco

Arctic grayling

Arctic lamprey

Bering cisco



BURBOT

Boreal/rainbow smelt complex

Broad whitefish

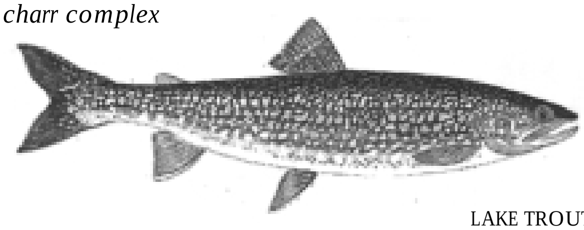
Bull trout

Burbot

Dolly varden/Arctic charr complex

Flathead chub

Inconnu



LAKE TROUT

Lake chub

Lake trout

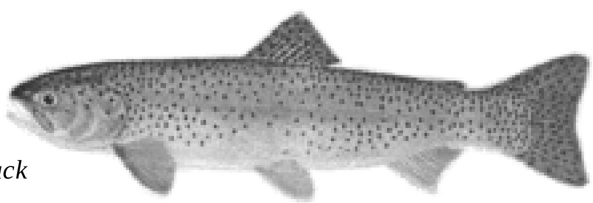
Lake whitefish

Least cisco

Longnose dace

Longnose sucker

Ninespine stickleback



RAINBOW TROUT

Northern pike

Pygmy whitefish

Rainbow trout

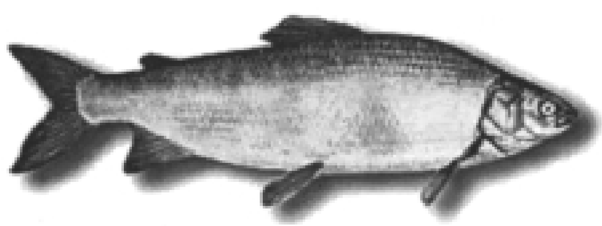
Round whitefish

Slimy sculpin

Spoonhead sculpin

Squanga whitefish

Trout perch



LAKE WHITEFISH

White sucker

heavily fished for Arctic grayling between 1898 and 1910. Between 1905 and 1913, a total of 47 commercial and 47 domestic fishing licences were issued by the Inspector of Fisheries in Dawson. Around 1913, the fur farming industry was established and large amounts of fish were used for animal food for the next several decades. The effects of these heavy rates of exploitation have not been documented, but managers suspect that some stocks were severely depleted and have never recovered.

Currently, Yukon freshwater fish are harvested by recreational angling and the commercial, domestic and aboriginal food fisheries (Figure 4.9). There has been a general increase in the overall number of recreational anglers from the early 1950s, when there were under 5,000 licences per year [12]. Levels in the 1990s have ranged from 16,000 to 18,000 (Figures 4.10, 4.11). The number of recreational anglers has recently declined. However, with more sophisticated equipment and better access to large lakes, the annual catch for many anglers is increasing.

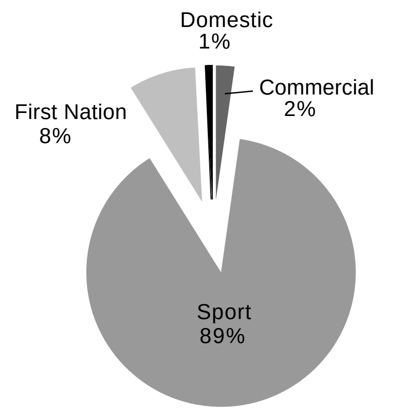


Fig. 4.9 Estimated Yukon Fish Harvest –1995
Freshwater Fisheries – 123,369 kg. The harvest of freshwater fish in the Yukon is categorized by First Nation, Domestic, Commercial and Sport.

Cold Waters–Slow Growth

Many Yukon freshwater fish spend their entire lives in frigid, relatively unproductive lakes. While these cold, clear waters are part of the appeal of the Yukon fishery to the angler, they produce fish that are very slow to grow, and reach maturity at an advanced age. A comparison of lake trout from Bennett Lake, Yukon, and lake trout from Ontario indicates a notably slower growth rate for the Yukon lake trout. This makes northern fish more vulnerable to overharvest.

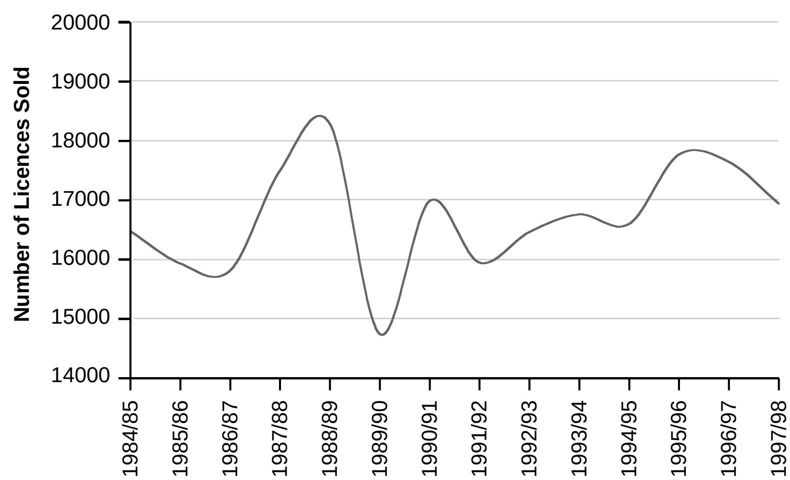
Assessing and Managing Yukon Freshwater Fish Stocks

In 1989, responsibility for management of freshwater fish was transferred from the federal Department of Fisheries and Oceans to the Yukon government. The government's primary management objective for freshwater fish is to ensure the sustainable use and development of the fish resources for present and future generations. To achieve this, the Yukon Department of Renewable Resources has implemented fish stock assessment and management policies and programs.

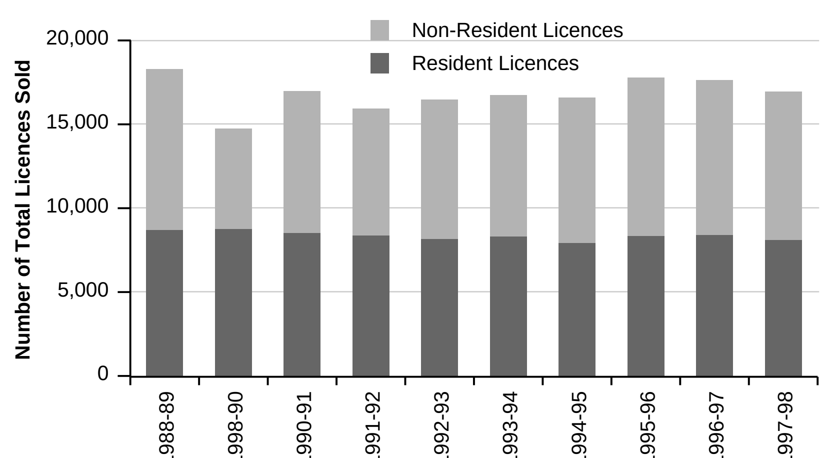
While limited information is available about the numbers of freshwater fish in most areas of the Yukon, that situation is improving every year. Rather than relying on data from a single survey, fisheries scientists are conducting repeated surveys on the same lakes. These more complete data sets can provide information regarding changes in fish populations and their relative abundance. Surveys and assessments that provide trend data are costly and time-consuming, but they will eventually provide a clear and accurate picture of the abundance of freshwater fish species in the larger Yukon lakes.

Index gillnet surveys are conducted by Yukon fisheries biologists to gather information about fish stocks in lakes, primarily lake trout. Nets of standard mesh sizes and lengths are set for specific periods of time. Fish captured during surveys are counted, weighed and measured, their stomach contents are analyzed and their sex and age are determined. This information is used to make inferences about the status of fish populations. The number of fish captured through netting over a certain period of time is used to calculate a catch per unit effort (CPUE).

Small mesh netting CPUEs have been conducted on selected Yukon lakes (Figure 4.12). This work will likely continue on for some time. When all of the lakes selected have been sampled, the process will begin again. During the summer of 1999, several larger lakes that previously underwent major netting programs, were re-sampled to see if lake trout stocks in specific lakes have



4.10 Yukon Angling Licence Sales–1984-1998
Licence sales include resident and non-resident – all categories. Over the past decade, approximately 170,000 Yukon fishing licences have been issued to recreational anglers, with an average of 16,704 licences issued annually during that period.



4.11 Resident Licences Sold Vs. Non-Resident Licences Sold – Yukon Territory Angling Licences–1989-1998
With the exception of the 1989-90 licence year, the sale of resident and non-resident licences has followed a similar pattern over the last 10 years. Before 1988/89, there was no distinction between resident and non-resident angling licences.

remained constant, or have increased or decreased. This data, however, will not be available until the year 2000.

High Quality Waters

Certain lakes and rivers in the Yukon have been designated as High Quality Waters for the purpose of developing management strategies. A lake or river that has received heavy recreational fishing may be classified as a High Quality Water. These waters may still be productive, or may have stocks that have gone into serious decline. Water bodies (lakes and rivers) that are managed as High Quality Waters have been so designated in order to prevent healthy stocks from declining. This preventative approach is preferable to trying to bring a stock back to a healthy abundance.

The relative abundance of the various species of fish caught in the gillnet surveys is used to evaluate fish stocks in lakes of similar size, productivity and fishing pressure. Fisheries biologists have concluded that lake trout populations are relatively stable in lakes where they make up at least 30 per cent of the weight of the total fish catch. The ratio of lake trout to total catch is used as a management tool in developing commercial and recreational fishery quotas and regulations. The target is 30 per cent lake trout for most Yukon lakes.

Decrease in the Commercial Fish Harvest

The number of lakes open to commercial harvest was almost immediately reduced from 20 to six in 1990, a direct result of the Yukon assuming responsibility for the management of freshwater fish from the federal government. As of 1999, there are only four Yukon lakes that may be commercially fished for lake trout (Table 4b). Strict quotas are set for lake trout, and a specific quota is set for each fisher. When this quota is reached, fishing must stop.

Location	Number of commercial licences	Lake Trout total allowable quota (kg) prior to 1990	Lake Trout total allowable quota (kg) after 1990
Atlin Lake	4	900	525
Bennett Lake	1	2,000	550
Kluane Lake	7	8,500	3,050
Teslin Lake	1	1,100	325

Table 4b Commercial Licences and Lake Trout Quotas
There are currently only four lakes in the Yukon that allow for commercial fishing. Given current conditions, it is unlikely that any new commercial licences will be issued on these lakes.

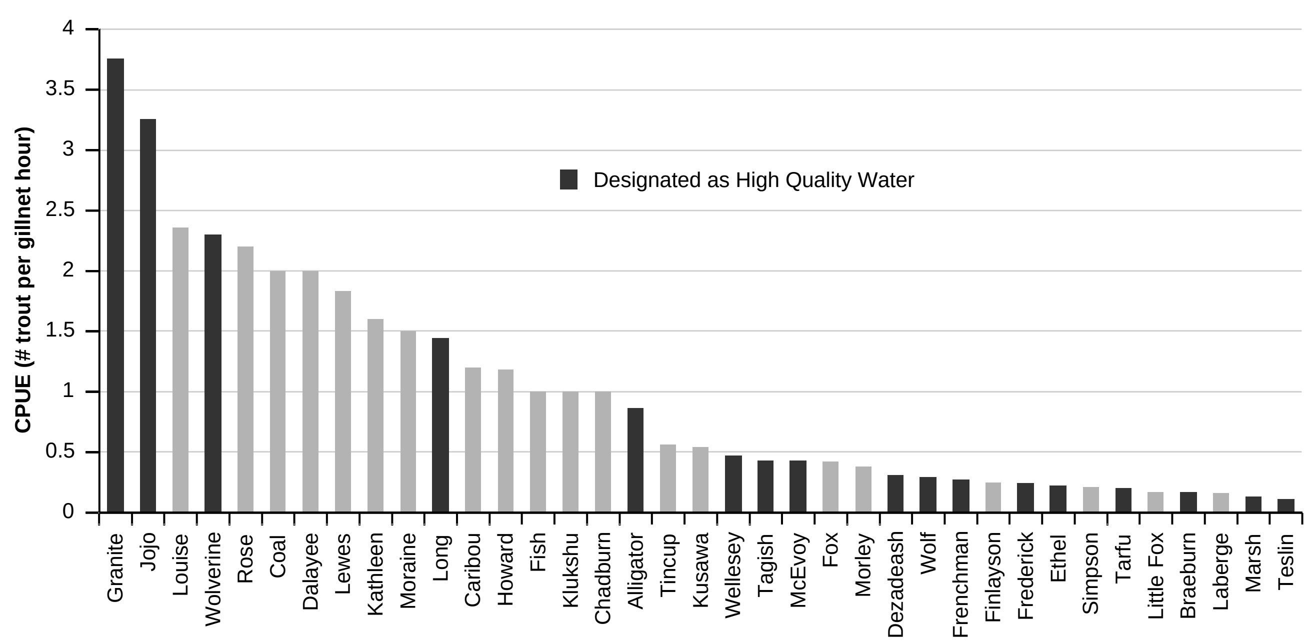


Fig. 4.12 Catch Per Unit Effort Data (Lake Trout) From Various Yukon Lakes – 1991 - 1998
Small mesh netting (catch per unit effort) in several Yukon lakes indicates the relative abundance of lake trout from those lakes. Dark bars indicate lakes managed as high quality waters. The index netting depicted in this chart was conducted over an eight-year period (1991 – 1998). While some lakes are being re-sampled, the data represented in this chart are based on one time sampling events.

Catch and Release

It is here to stay, according to the Yukon Fish and Wildlife Management Board [13]. The Board was established under the Umbrella Final Agreement and is an advisory body to the Yukon government. The arguments for retaining catch and live release are based on conservation and on meeting the demands of the recreational fishers, through the use of live release as a component of selective harvest. Those opposing catch and release, often quote the mortality associated with the practice. First Nations, and others, believe that catching a fish and then releasing it is disrespectful because it involves "playing with animals" [14]. With aggressive educational programs to improve fishing gear methods and handling of fish and limiting excessive catch and release of fish, managers believe that mortality rates due to catch and release angling will not be significant, and that differing values can be reconciled and accommodated.

> *"And fish, fish you let go. That slime on the fish is there for a purpose; I was told a long time ago when I was young that it's protection. You don't bother fish. If you don't eat it, don't bother with it, so it will be there when you need it."*
>
> Matt Thom, Teslin /Tlingit First Nation Elder

Matt Thom

Stocking of Pothole Lakes

Rainbow trout, kokanee and chinook salmon, Arctic charr and bull trout have been stocked into numerous Yukon pothole lakes (lakes with no inlet or outlet, and no existing game fish), in an attempt to offset recreational fishing pressure on native fish stocks, and still provide an opportunity for anglers to fish for species that would not normally be available (Figure 4.13).

In 1997, to augment earlier efforts to produce indigenous fish for recreational angling, the Yukon Department of Renewable Resources Fisheries Management Section started a formal hatchery program that includes an expansion to the existing chinook salmon hatchery. This program involved the raising of kokanee salmon, Arctic charr and bull trout, for release into pothole lakes throughout the territory. Fertilized eggs are obtained from wild broodstock, taken to the Whitehorse Rapids Fish Hatchery Freshwater Facility, and incubated. The resulting hatched fish, called fry, are grown to approximately two to five grams, and released into designated pothole lakes for recreational angling.

Some chinook salmon fry are obtained for stocking from Yukon River broodstock, and rainbow trout are, on occasion, imported from a certified disease-free fish culture facility in British Columbia.

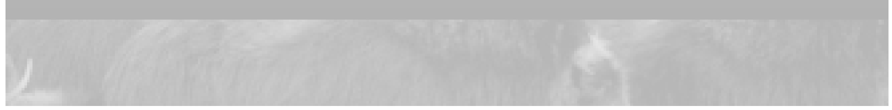
Lake Laberge Case Studies

A suspected decrease in lake trout populations in Lake Laberge was confirmed through gillnet surveys in

Aquaculture in the Yukon

Aquaculture, or fish farming, has become a major industry in many parts of Canada. It can encompass anything from the production of fertilized eggs from a wild broodstock to the production of processed fish from a captive broodstock. The Yukon currently has approximately 14 active licenced fish farm operations. Aquaculture has been the focus of substantial developmental effort and controversy during the past few years, especially in British Columbia, where it is viewed as a major new area of economic development, in this time of declining and failing wild fisheries. Of major concern is the potential for escape, the transmission of diseases to wild stocks, and the concern that escaped fish, especially those that are not native to the area, may establish themselves as a new species and compete, or even reproduce with existing species. There is also a concern regarding the degradation of water quality through fish farming. The potential for these scenarios, which could result in serious and long lasting problems, and might interfere significantly with the existing ecosystem of a specific area over the long term, require public debate and policy development.

These concerns are primarily directed at the saltwater net pen operations that are prevalent on the east and west coasts of Canada. Escapement of fish from large net pens located in the coastal waters of Atlantic and Pacific Canada have occurred, usually as a result of storms or predators. As the Yukon does not have suitable coastal waters for net pen aquaculture, and most fish farms involve the stocking of isolated pothole lakes, a large scale escapement of fish from a Yukon fish farming operation, if adequate precautions are taken, is not anticipated.



1991. Low numbers of lake trout and high numbers of longnose suckers and burbot were captured.

Lake Laberge lake trout are known for their excellent quality as recounted by two Yukon Elders. In 1999, Johnnie Smith, Kwanlin Dun First Nation Elder commented that the trout in Lake Laberge were the best.

> *"But I'm not kidding you when I say that I eat the best trout down at Lake Laberge. It used to be nice, firm meat. Cold, deep water, maybe 900 feet deep in some places, that lake".*
>
> Henrey Broeren further noted that he feels the Whitehorse Dam has changed water levels affecting the quality and numbers of lake trout in these waters
>
> *"There was lots of whitefish, lots of trout. There were some suckers, but now they make it just full of suckers and pike".*
>
> Henry Broeren, Ta'an Kwach'an First Nation Elder.

When compared with the stable fish populations in Kluane Lake, the relatively large numbers of suckers and burbot in Lake Laberge are very noticeable. Based on studies between 1990 and 1993, lake trout in Kluane made up thirty per cent of total fish population compared to seven per cent in Lake Laberge. This was not always the case.

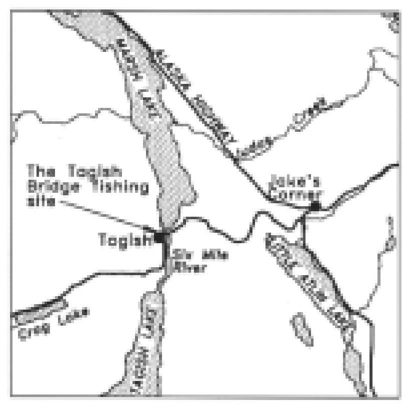
In an attempt to rebuild the lake trout stocks, Lake Laberge was closed to commercial fishing, the domestic fishery was restricted, the aboriginal fishery was voluntarily reduced and recreational angling effort was diminished. Fish stocks in Lake Laberge are being monitored to determine if the lake trout populations are responding to these fish harvest restrictions. These changes in the harvest of lake trout were also related to the discovery in 1991 of relatively high levels of toxaphene and other organochlorine contaminants in Laberge lake trout.

Little Atlin Lake Case Study

Little Atlin Lake is a popular fishing spot located 80 km south of Whitehorse on a good, all-weather road. The lake has an extensive shallow zone (also called a littoral zone) that provides good habitat for the production of plants, invertebrates and juvenile fish, and a deep centre zone that is composed of cold, well oxygenated water that is suitable for relatively large lake trout. Overall, the lake provides a relatively high nutrient base for all inhabitants. Being one of the first large lakes to thaw in the spring, it provides good fishing opportunities for the abundant northern pike and whitefish. It is also large enough and, in places, deep enough, to produce good-sized lake trout, but small enough to be inviting to boats of a moderate size.

In past times, fishing pressure from domestic netting, and more recently recreational angling, has been heavy over the years. A 1982-83 summer/winter netting survey produced only six lake trout from Little Atlin Lake, compared to 32 lake trout in Quiet Lake, which is of similar size and depth. A more recent survey of Little Atlin Lake

Fishing off the Tagish Bridge



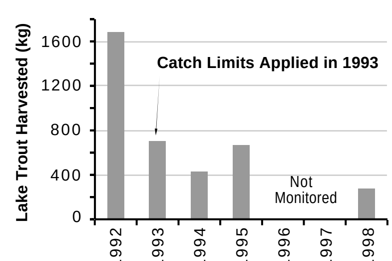


Figure 4.14 Tagish Bridge Angling Harvest

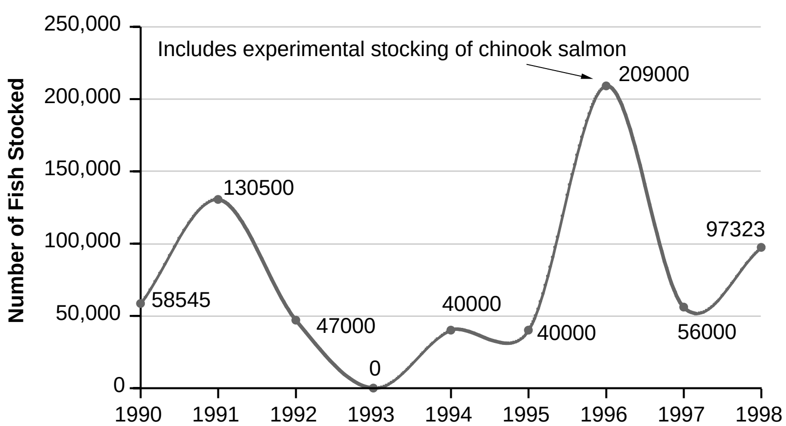


Fig. 4.13 History of Pothole Lake Fish Stocking

in the spring of 1992 produced no lake trout at all.

Through education and regulation, the current management strategy for this lake is to divert fishing pressure from lake trout to more abundant but somewhat less popular species, such as northern pike, whitefish and burbot.

Six Mile River – The Marsh/Tagish Connection

Concerns expressed by Yukon residents, including First Nation members, directed attention to recreational fishing activities at the Tagish Bridge. Fish regularly migrate back and forth between the cold, deep waters of Tagish Lake and the shallow, productive waters of Marsh Lake. During this migration, the lake trout swim through the Six Mile River and are easily intercepted at the Tagish Bridge by anglers.

Angler surveys supported local opinion that harvests of lake trout from the Tagish Bridge played a major role in reducing numbers of lake trout in Marsh Lake. Restricted catch and size limits applied in 1993 decreased the lake trout catch at this vulnerable site by 60 per cent in 1993 and 1994. The harvest increased again in 1995, due to increased fishing effort (Figure 4.14), but still remained within the prescribed limit set by the Yukon Department of Renewable Resources, Fisheries Management Section. The 1998 data indicate that, in the long run, the new fishing restrictions are working.

Lake Trout hit hard in Teslin Lake

One of the first steps in the management of fish in a lake is to estimate the abundance of a particular species. One method of doing this involves setting a specific number of gill nets incorporating a variety of mesh sizes. The number of fish captured in a specified time, at several predetermined locations in the lake, will provide for a reasonable estimate of the relative abundance of any given species. This process is referred to as index netting.

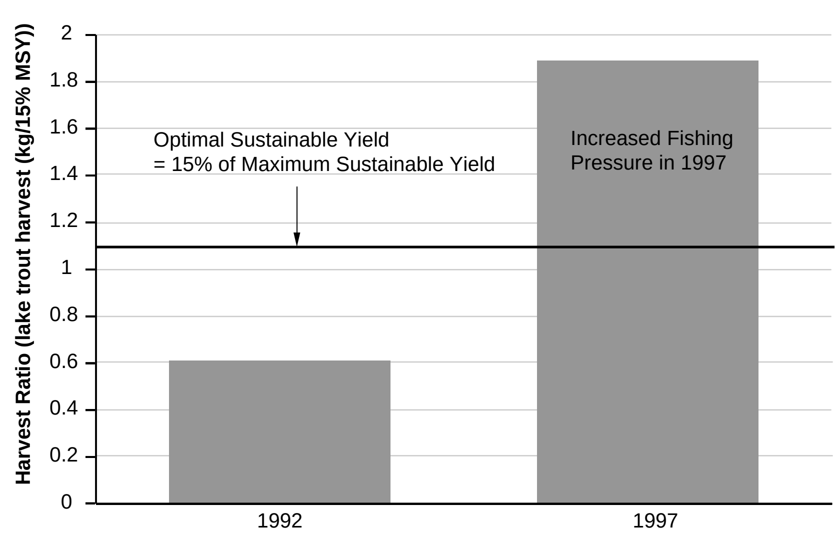
In 1992, the Yukon Department of Renewable Resources Fisheries Management Section conducted a standard index gillnetting project covering all of Teslin Lake. In 1997, they conducted a small mesh experimental gillnetting project on Teslin Lake. This method tends to target lake trout, and causes less harm to the fish than the standard index netting procedure. The small mesh procedure was developed by the Ontario Ministry of Natural Resources and has been a reliable method of predicting the abundance of lake trout in Ontario lakes.

The results of both netting surveys indicated that the lake trout population in Teslin Lake was less than it should be for a lake that size. This conclusion was reached through a process that estimates the potential production of a lake, and defines a value called the maximum sustainable yield.

The Ontario Ministry of Natural Resources has determined that for lakes that are managed as High Quality Management Lakes, such as Teslin Lake, the annual harvest of lake trout, on a weight basis, should not exceed 15 per cent of the maximum sustainable yield. This target of 15 per cent is sometimes referred to as the optimum sustainable yield (Figure 4.15).

A survey of recreational anglers, called a creel census, was conducted in 1992 and in 1997, on Teslin Lake. The total biomass, or weight, of angled lake trout that was accounted for during this census was shown to be well in excess of the optimum sustainable yield target for a High Quality Management Water.

A public meeting was held in the Village of Teslin on May 28, 1998, to present the data obtained, and to decide upon a recommendation for the future of the lake trout stock in Teslin Lake. The Teslin Renewable Resource Council (TRRC) recommended that the angling limit for lake trout on Teslin Lake be reduced to one fish per angler per day. This decision was based on stock assessment and harvest data that indicated depressed stocks and continuing high lake trout harvest.



4.15 Estimated Sport Fishing Harvest of Lake Trout in Teslin Lake

A recreational angling survey in 1997 indicated an increase in fishing pressure on lake trout in Teslin Lake of approximately 300% over that in 1992, well above the recommended optimum sustainable yield. Possible explanations for this situation include overfishing by recreational anglers, and domestic, commercial and First Nations fishers.

The Village of Teslin, the TRRC and the Teslin/Tlingit Council are all supportive of this proposal. This change, will be in effect for the 1999-2000 fishing season. Fisheries managers are currently considering a variety of management options for lake trout in Teslin Lake.

Whitehorse Rapids Fish Hatchery adds new fish species

The Whitehorse Rapids Fish Hatchery began operation in 1984. It was built to provide juvenile chinook salmon to compensate for the salmon fry that were killed each year as they passed through the turbines at the Whitehorse Rapids Generating Facility, during their downstream migration to the ocean. The hatchery was designed to produce up to approximately 350,000 chinook salmon fry every year for release in various streams associated with the upper Yukon River system. Since its beginning, there have been in excess of 3.6 million chinook salmon fry released in the Yukon River system upstream of Whitehorse.

In the fall of 1996, an addition was added to the existing chinook hatchery. This new fresh water facility was constructed to allow for the production of additional species of fish for the Yukon Department of Renewable Resources pothole lake stocking program. On site (remote) egg takes are conducted each year at specified lakes, and eggs are transported to the hatchery, fertilized, incubated and hatched. The resulting fry are raised for release into pothole lakes for recreational angling. Currently there are three species of fish being raised in the new facility: Arctic charr, kokanee salmon and bull trout.

Fishing around in the Klondike Valley tailings ponds

During the spring and summer of 1998, a fisheries assessment was conducted involving a large number of tailing ponds in the Klondike Valley, southeast of Dawson City, Yukon.

These tailings ponds were left behind from the gold dredges that operated in the area up until the 1950s. Because fish had previously been reported in some of the ponds in the area, the federal Department of Fisheries and Oceans, which is responsible for fish habitat in the Yukon, required that a full fisheries assessment be done on all of the ponds prior to further development of residential or industrial uses.

Approximately 100 ponds were evaluated for water quality in the spring, and for the suitability for and/or presence of fish species during the summer. Only a few ponds were found to contain any fish and most of them were slimy sculpins. One burbot was captured [15].

Arctic Charr

With the exception of one pond, evidence of active fisheries was not demonstrated. It was determined that the ponds with sculpins in them were also found to be susceptible to flooding in the spring, which provided the potential for an influx of new fish each spring.

Five to six ponds were selected to remain intact, and not be filled in. Criteria for selection included the presence of fish as demonstrated during the investigation, the potential for the introduction of fish, and the capacity to provide an aesthetic embellishment to the overall project.

The planning aspect of the project is still a work in progress, and the final design has not yet been completed.

Fish Habitat

Equally important as actual fish abundance is habitat – anywhere fish live and grow during any part of their lives. This includes most lakes, rivers or streams. The Yukon has an abundance of streams and rivers with few natural or human-made barriers. Fish make use of many streams right to their mountain headwaters.

A wide range of human activities may affect fish habitat.

- Change to the quantity and quality of water.
  - where water is withdrawn from a small stream for irrigation or hydro-power generation.
  - where water is discharged from a storm sewer into a river.
- Disruption to the land surface through agricultural, residential or forestry developments.
  - may result in erosion of fine sediments and deposition of the sediments in fish habitat.
- In-stream works, such as those associated with road construction (stream straightening).

- this may result in the affected streams becoming unstable.
- use of culverts at road crossings may require long-term monitoring to ensure that fish passage is maintained.

Fish habitat is protected through the federal *Fisheries Act*. Decisions about fish habitat are guided by the federal 'no net loss' fish habitat policy. If habitat is physically altered, it must be restored or equivalent habitat created as compensation. Habitat loss through alteration of water quality is not permitted. To conform to this policy, mines, for example, must be decommissioned in such a way that protects fish habitat in the long term from the effects of acid rock drainage or other influences on water quality.

When the glaciers melted, broad valleys and depressions were left in the landscape. Large, deep, cold lakes in mountain valleys and smaller, shallower and more productive lakes and wetlands on plateaus and in broad valleys, provide a diversity of fish habitat. In the unglaciated areas of the Yukon, valleys are narrow and lakes are rare. There are few waterfalls or other natural obstructions to the upstream migration of fish.

Fish tend to use streams on a seasonal basis, over-wintering in larger rivers, lakes, or in streams fed by groundwater

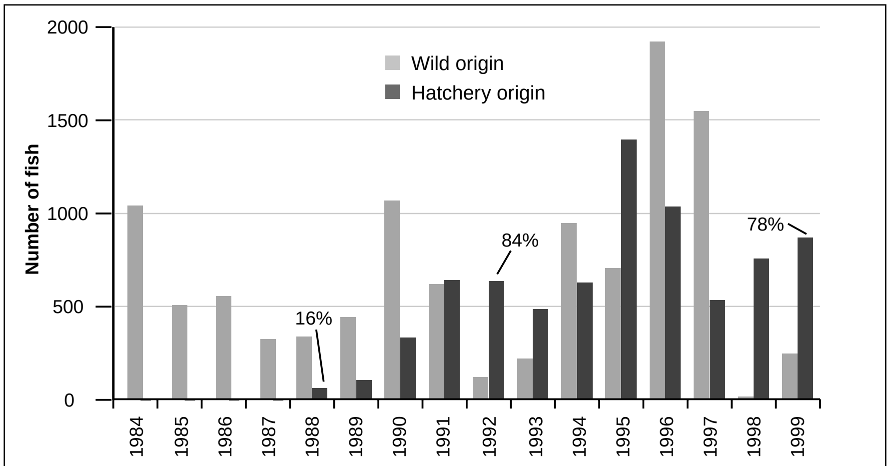


Figure 4.16 Whitehorse Rapids Chinook Returns
The per cent of hatchery origin fish has increased from 16 per cent in 1988 to 78 per cent in 1999. In 1992 the per cent of hatchery origin fish peaked at 84 per cent of total fish returns [3].

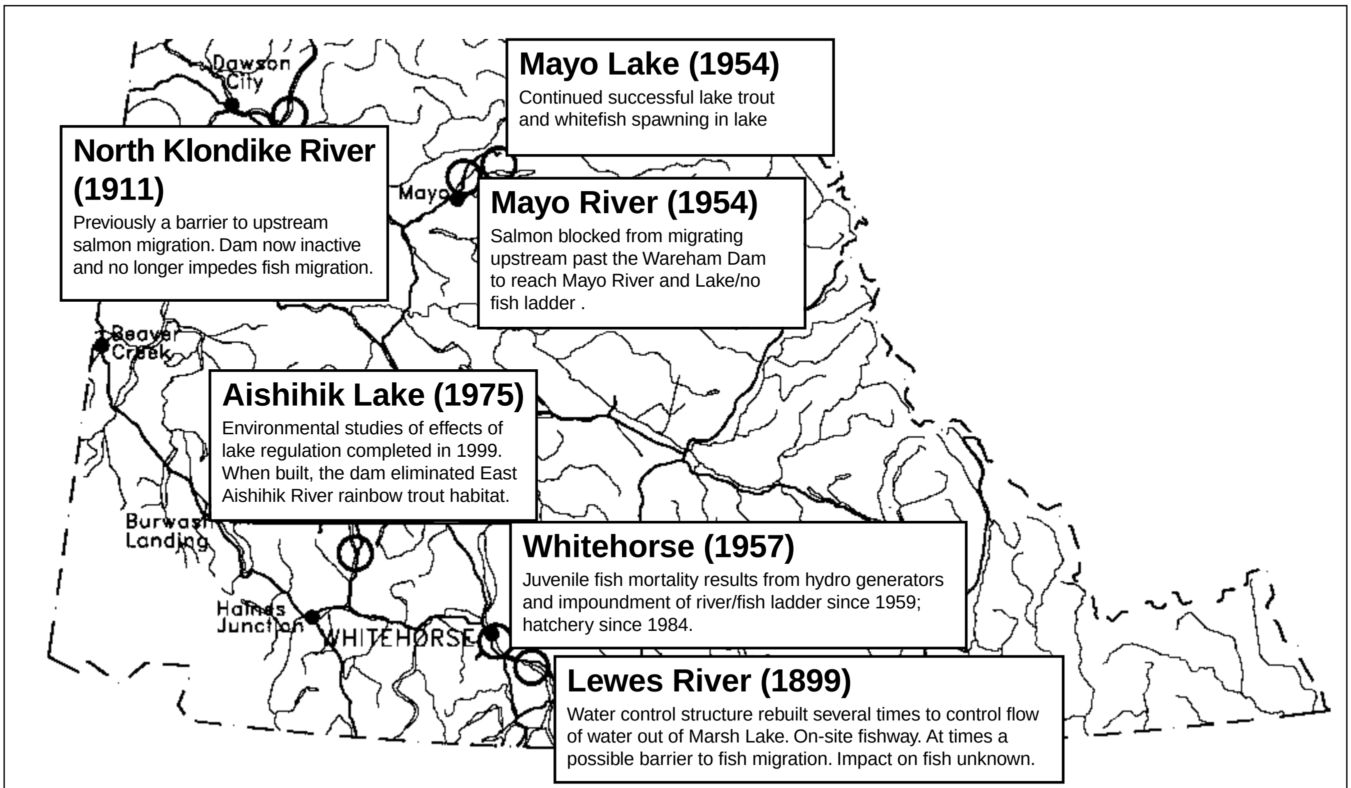


Figure 4.17 Major Yukon Dams: Effects on Fish Habitat and Migration

discharge. Fish habitat consists of both the physical components of the lake or stream and the characteristics of the water. Each species of fish at each life stage has certain requirements, such as clear water, good spawning gravel or overhanging banks for shelter. Degradation of these key habitat features at any life stage can decrease fish survival, growth rate and reproductive capacity.

The North Klondike and Klondike River dams built in 1911 but now removed, are believed to have had a negative impact on returning salmon in these rivers, either by blocking access to upstream spawning areas, reducing flows needed for successful egg incubation, or by the outright killing of juvenile salmon by the dam turbines during their outmigration. The dam on the Mayo River totally blocked upstream fish migration when it was built in 1954. The salmon spawning habitat in the region of these dams has also been damaged by placer mining.

The Yukon Energy Corporation fishway at the Whitehorse Rapids Dam allows fish to migrate past the dam into the headwaters of the Yukon River. The Whitehorse Rapids Fish Hatchery was constructed in 1983–84 to compensate for potential loss of chinook fry due to turbine mortality. Some of the fry released from the hatchery have a small coded wire tag implanted in their nose cartilage, and each one tagged in this manner has their adipose fin clipped (the small fatty fin located on the back of the salmon, closest to the tail). The clipped fin identifies these fish as hatchery fish when they return to the fishway so that the survival rate of the hatchery fish can be estimated (Figure 4.16 and 4.17).

In the Yukon, activities such as mining and road construction often occur on small streams that are not used by adult fish for spawning but are important for juvenile salmon and freshwater fish. These streams have little capacity to dilute effluents and the streambed and floodplains are easily damaged.

Arctic Grayling

Mining

Placer mining affects fish habitat by disrupting streams and releasing sediment into waters. High loads of sediment in streams have several types of effects; the water becomes murky and light needed for plant growth does not penetrate to the stream bottom; sediment settles and changes the nature of the streambed; and, increased sediment affects the health, behaviour or reproductive capabilities of fish and aquatic invertebrates. Yukon creeks that have been placer-mined for many years no longer provide habitat for salmon and many are also unsuitable for other species of fish. A major study of the effects of Yukon placer mining on fish, completed in 1992, concluded that existing regulations were not stringent enough to protect fish habitat from the effects of sediment released in placer effluent. New standards under the federal *Fisheries Act* (the Yukon Placer Authorization) have been phased in. The authorization sets limits for the amount of sediment that can be discharged in placer effluent to any stream. It also designates Yukon streams as one of four types, depending on fish use. Each stream type is assigned a sediment discharge standard and has set requirements for stream rehabilitation following mining. In some locations fish habitat values have been deferred to allow mining to proceed.

The main effects of hardrock mining are related to long-term discharges of low levels of metals, releases or spills of chemicals used in ore processing and disruption of streams through dams, diversions and mine development. Alterations to fish habitat are documented for the Faro and Elsa areas, where mining has occurred for many years (but not currently). In both areas, water downstream of the mines contains metals, mainly zinc, at levels above recommended guidelines for the protection of aquatic life.

Sewage Treatment in the Yukon

Inadequately treated sewage affects the water quality by reducing oxygen levels, increasing nutrients and introducing toxic substances. Most of the smaller Yukon communities have zero, or limited, seasonal discharges from sewage lagoons and do not affect fish habitat. Until recently, Whitehorse sewage was released year-round directly to the Yukon River from two lagoons. With the completion of the Livingstone Trail Environmental Control Facility in September 1996, no sewage effluent is discharged directly to the Yukon River (See Water Chapter).

Road Construction

In 1996 the City of Whitehorse proposed an upgrading of Robert Service Way (formerly called the South Access) that is adjacent to a portion of the Yukon River. The upgrade design required that the river be infilled up to 20 metres in some sections. Environmental baseline studies in the proposed area of impact revealed a relatively large population of spawning chinook salmon. As a result the city was required to redesign sections of the proposed construction and develop a fisheries compensation plan to protect the salmon habitat and replace habitat that would be lost as a result of the construction.

The redesign plans ultimately lead to the construction of a binwall to prevent encroachment of the road onto the salmon spawning grounds, the construction of a chinook salmon spawning channel and the construction of two additional channels to allow for rearing and overwintering of juvenile salmon and other species of fish. This work was done in 1997. Post-construction monitoring will determine the success of the fisheries compensation plan.

Activities associated with road construction, logging and residential growth can also affect fish habitat, mainly through increased erosion and disruptions to stream banks. Barriers that may block fish movement are created when roads are built across or beside streams. Culverts may be too small or have grades that are too steep, resulting in physical disruption of the waterway and flows that are too swift for fish to swim through.

Yukon Salmon Committee (YSC)

The Yukon Salmon Committee considers protection of salmon habitat to be of prime importance and an area of major concern. In 1998 the YSC commissioned a study which included a review of salmon habitat issues. One of the prime issues to come out of the study is the "unsatisfactory environmental clean-up records of various mining operations in the Yukon". Operations of concern that have, or have the potential to release toxic substances into salmon habitat include:

- water treatment, reclamation funding and licensing compliance concerns at United Keno Hill Mines;
- inadequate security and incomplete abandonment clean-up at Ketza River Gold Mine;
- the outstanding security deposit required for the licence at the Mt. Nansen Mine, as well as high levels of cyanide in the tailings pond and the discharge of metals toxic to salmon;
- incomplete environmental clean-up and proposed future development of the ore deposit near a salmon spawning system in the Blind Creek basin at Anvil Range; and
- the abandoned and eroding tailings dam at Clinton Creek Mine, as well as the stability of water control and diversion structures.

The Yukon Salmon Committee is currently lobbying various government agencies including the Yukon Territory Water Board in order to change the licensing system such that protection of habitat and conservation of fish is ensured [6].

4.2 Yukon Wildlife and Wildlife Habitat

The Yukon's wildlife consists of 61 species of mammals (including marine mammals), four species of amphibians, and 278 species of birds. Even though the Yukon's wildlife is diverse and remains relatively abundant, it has become clear that some populations are vulnerable to human activities. Although global factors affecting wildlife, such as the long range transport of contaminants and the warming of the earth's surface, are

Lake Trout

largely beyond local control, land and resource management by Yukoners can have significant and long-lasting effects on wildlife. Habitat disruptions may be the most notable cause of decline in some wildlife populations. The incremental encroachments on habitat that accompany a growing human population often have significant but hard-to-measure impacts. Maintaining the biological diversity of northern ecoregions in the face of such developments may be the greatest challenge facing today's resource managers.

Wildlife Habitat

Key wildlife habitats are areas used seasonally by wildlife for such critical life functions as breeding, nesting, feeding, migration or winter survival. Many species traditionally use key habitats around the same time each year. A population of thinhorn sheep, for example, will use the same wintering, lambing, and rutting ranges year after year. However, other wildlife species such as bears have more varied habitat ranges that are more difficult to define. Although several wildlife species may occupy key areas at the same time, each species has its own unique habitat requirements.

When wildlife populations congregate at these critical areas in large numbers, they are particularly vulnerable to disturbance. Populations decrease if these key habitats are destroyed or disrupted. If wildlife is to survive, key habitats must be protected [1].

Habitat Surveys and Mapping

The Yukon government maintains an inventory of the location, distribution, and abundance of key habitats for legally harvested and protected wildlife species. The Key Area Inventory is made up of GIS-based maps with an accompanying data base for each key area. A computerized system that provides flexible and easy access to the inventory maps and information is being developed.

To date, the Key Area Inventory contains mainly records based on systematic population surveys by wildlife biologists. As First Nation Final Agreements are reached and Renewable Resource Councils are established, regional biologists are located in Yukon communities and more local information about important wildlife areas is becoming available. The biggest challenge for the Key Area Inventory program is to find ways of systematically recording this local wildlife knowledge.

The ability to manage and conserve important wildlife habitat also depends on an understanding of the characteristics that make the habitat useful (the factors that make certain habitats 'key'). The mapping and description of vegetation are usually fundamental to understanding wildlife/ habitat relationships. In 1999, vegetation inventories were carried out on the Fannin sheep range near Faro (Figure 4.19) and the grizzly bear habitat along the Fishing Branch River. Other recent habitat surveys have been conducted along the Bonnet Plume heritage river, in the Tombstone Territorial Park, at Eagle Plains, in the La Biche and Beaver River valleys, in the Wolf Lake area, along the Snake River, and in the Dezadeash River area [1]. Mapping of the key caribou winter ranges in the Southern Lakes region was also underway in 1999. The objective of this project is to identify and conserve critical foraging areas (areas rich in lichens) in the winter range of the Carcross caribou herd.

This habitat information is used in wildlife management, in land use planning, in reviewing applications for land and resource use, and in identifying areas to be protected.

Habitat Protection

The protection of wildlife habitat from human development is an ongoing and frequently controversial process. The Yukon is viewed by some as having an infinite supply of resources available for development; others recognize the

Dall Sheep at Sheep Mountain in Kluane National Park intrinsic value of the remaining wilderness and express concern for its vulnerability. The disruption or loss of wildlife habitat is often at the centre of this concern [2].

A number of mechanisms have been established for the protection of wildlife habitat. These include national and territorial parks, ecological preserves, habitat protection areas, special management areas set up through land claim agreements, and through provisions in the *Yukon Wildlife Act*. (see Chapter 3 for a detailed discussion on protected lands in the Yukon)

Wildlife Population Trends

We are constantly learning more information about the Yukon's wildlife populations. This information comes from a number of sources including scientific surveys, game and fur harvest records, and local knowledge about wildlife. Accurate information on wildlife populations and their trends is essential for making sound wildlife management decisions. The population trends of a few of the Yukon's larger (and more economically important) species are described here.

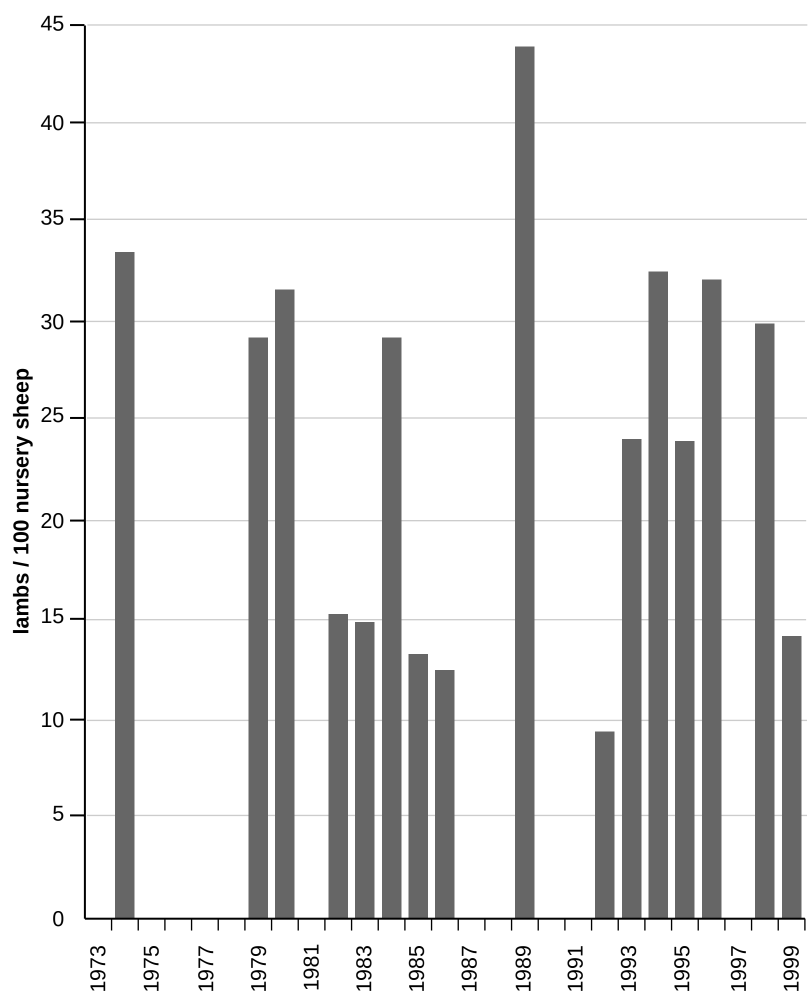


Figure 4.18 Lambs /100 nursery sheep in Talbot Arm area
No data for 1975-78, 1981, 1987-88, 1990-91, 1997.

Thinhorn Sheep

The estimated population of 22,000 thinhorn sheep in the Yukon is considered to be stable. These include about 19,000 white Dall sheep found throughout most of the Yukon, and about 3,000 dark Stone and Fannin sheep found mostly in the south-central Yukon [1]. The short-term fluctuations in sheep numbers are believed to be the result of natural weather related events. For example, very good conditions in the Talbot Arm area near Kluane Lake in 1989 resulted in a high number of surviving lambs (Figure 4.18). Consequently, in 1999 there were many more 10 year old rams shot by hunters in that area than in other years. Such events, both positive and negative, appear to balance out over the long term.

Thinhorn sheep population surveys are carried out in the Yukon on an irregular basis, but sheep harvest is closely monitored.

Mountain Goats

Mountain goats are found only in the southern third of the Yukon, where they occur at the northern limit of their range. The estimated population of 1,700 animals is considered to be stable [1]. Because of their relatively low numbers in the Yukon, only a small annual harvest of mountain goats is permitted.

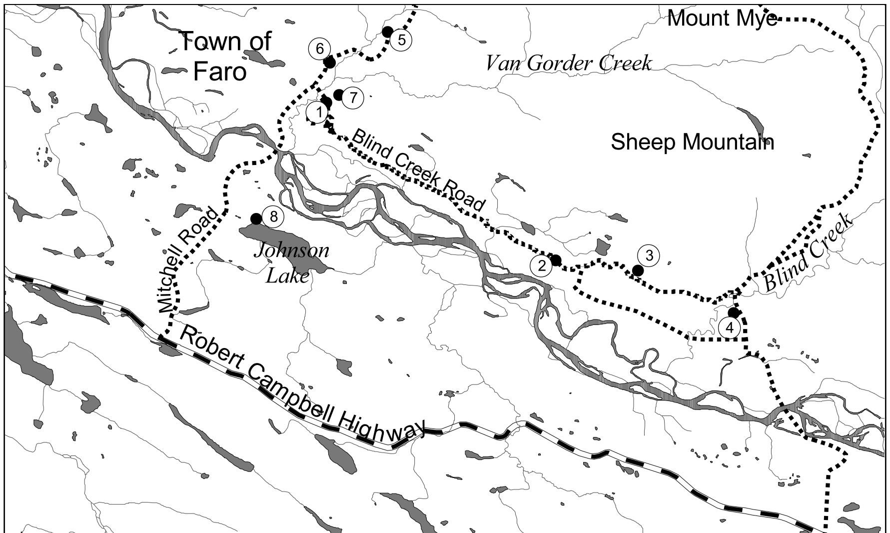
The populations of mountain goats are surveyed at an irregular basis. There have been no recent surveys of the small population of goats that were reintroduced to White Mountain in the mid-1980s (the 1992 estimate was 33 animals).

Woodland Caribou

Woodland caribou are distributed throughout much of the Yukon in 23 separate herds, ranging in size from 100 to 10,000 (Figure 4.21 and

Table 4c). The herds are differentiated from each other by their use of a traditional range. Radio collar surveys are used to delineate herd ranges. The total number of woodland caribou in the Yukon is currently estimated to be between 30,000 and 35,000 animals [1]. Yukon woodland caribou occur at densities well below their habitat carrying capacity and are held at those levels by predation and human harvest.

Woodland caribou management guidelines were developed by the Yukon Department of Renewable Resources in 1996. Management focuses on harvest control and the protection of key habitat through the mitigation of land use and control of access. Conserving key habitat (rutting areas, migration corridors and winter ranges) is crucial to maintaining a herd's health and abundance. Woodland caribou are managed on a herd basis. If a herd numbers less than 200, there is a complete hunting closure.



① Visitor Information Centre
② Sheep viewing Platform
③ Mount Mye Viewing Cabin
④ Sheep Mineral Lick
⑤ Fingers Site
⑥ Faro Arboretum
⑦ Van Gorder Falls
⑧ Johnson Lake Campground

Figure 4.19 Fannin sheep viewing sites near Faro

Faro's Fannin Sheep

About 80 to 100 Fannin sheep (an intermediate colour phase of Stone sheep) are found in the Mount Mye and Sheep Mountain area just north and east of Faro. The population of this small band of sheep has remained stable since monitoring started in the early 1980s. These are the only road-accessible Fannin sheep in the world.

The Town of Faro, the Yukon Department of Renewable Resources, the Ross River Dena Council and managers of the Faro Mine have been working to protect the sheep and their habitat and to increase public awareness of this unique local resource. These sheep are protected from all hunting.

The most sensitive habitats of these animals are their winter range and lambing cliffs on Sheep Mountain north of the Blind Creek road. This is where the nursery band (ewes, lambs and younger rams) spends the entire winter. Each year the sheep visit mineral licks on the escarpment overlooking the Pelly River. These mineral licks provide the sheep with essential supplies of calcium, sodium, magnesium, copper and phosphorous.

Measures to protect these Fannin sheep and their habitat include the rerouting of the Blind Creek Road away from the mineral licks, and closing of the old road during the winter months.

Steps were also taken to protect the migration route between Sheep Mountain and the summer range on Mount Mye during the development of the lead-zinc ore body on the Vangorda plateau. The current shut-down of the Faro Mine and the accompanying decrease in the town's population is expected to lessen human impact on the area's sheep.

An extensive public education program by the Town of Faro and the Yukon Wildlife Viewing Program includes an interpretive cabin and several viewing platforms (Figure 4.19). The development of these viewing sites is expected to generate a greater public awareness of the need to preserve this unique population of sheep.

Southern Lakes Caribou Recovery Project

The Southern Lakes Caribou Recovery Project stemmed from the realization that the thousands of caribou that once inhabited the southern Yukon and northwestern British Columbia had declined to a few hundred, and that the fractured remnants of the great herds might be headed for extinction. The Southern Lakes Caribou Recovery Project includes the Carcross, Ibex and Atlin caribou herds (Figure 4.20).

The five-year work plan, initiated in 1993, was designed to halt the decline of the caribou herd. It was made possible through the cooperation of six First Nations, local residents and the Yukon Department of Renewable Resources. It required a strong, positive commitment from all parties and a great deal of volunteer work.

The objectives of the work plan included the reduction of caribou harvest and the discouragement of human developments that were detrimental to caribou habitat. Documenting local knowledge of caribou in the area was also an important component of the project. Interviews with First Nation elders and other long-term residents provided valuable information on the historic range of the now-fragmented herd.

Another major part of the Caribou Recovery Project was the effort to increase public awareness of what the herd once was, why it was declining, and what steps can be taken to restore it. Public education initiatives included community workshops, school field trips, talks at local schools and Yukon College, feature newspaper articles, mailbox notices and public service announcements. Public participation is further encouraged through a 24-hour wildlife telephone hotline set up to receive reports of caribou and other wildlife in the southern lakes area.

Five Ibex caribou, 25 Carcross caribou and 12 Atlin caribou were fitted with radio collars for tracking the herds' seasonal movements. Field work also included aerial winter range surveys, rut counts, lichen surveys, and the analysis of caribou droppings as indicators of the range quality.

A 1997 census of the Carcross caribou herd estimates the population to be 450 animals. Although there is no reliable prerecovery estimate for this herd, public commentary suggest the size of the herd has recently been increasing. The Ibex caribou herd, surveyed in 1998, has grown to about 430 animals from a prerecovery estimate of 150 [1] (Figure 4.22 p.92). When the recovery plan began, a population target for the combined Ibex and Carcross herds was 2,000 animals.

The success of the first five years has led to further caribou recovery work in the Southern Lakes area. In the fall of 1999, some caribou will be recollared and may be outfitted with GPS collars. The latter will provide precise locations of the collared animals in their winter range. Further monitoring will be carried out to clarify the boundary between the Carcross herd and the Pelly herd, which is located to the north of the Carcross herd range. Each winter, two Yukon First Nation game guardians provide public education and carry out patrols throughout the winter ranges of the Carcross and Ibex herds.

Challenges for managing Southern Lakes Caribou over the next five years are securing winter habitats, reduction of mortality from highway traffic, developing a transboundary agreement with the British Columbia government, and learning to live with caribou in our backyards.

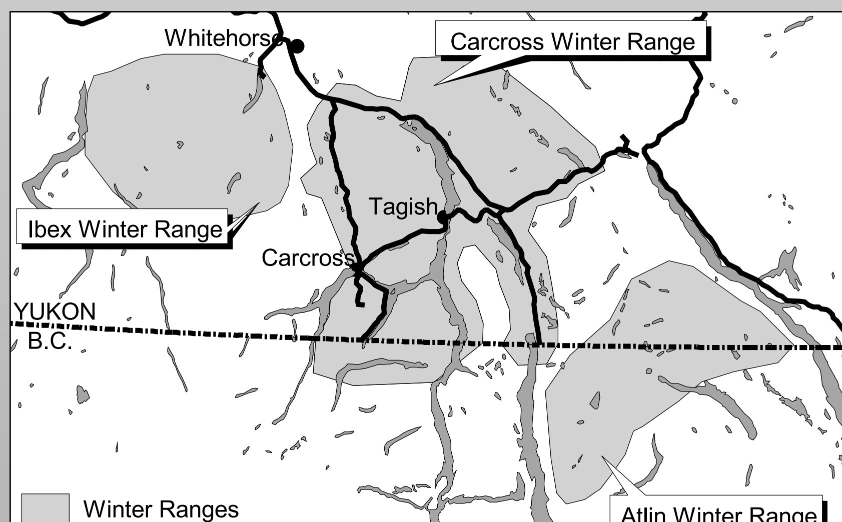


Figure 4.20 Winter range of Southern Lakes caribou herds

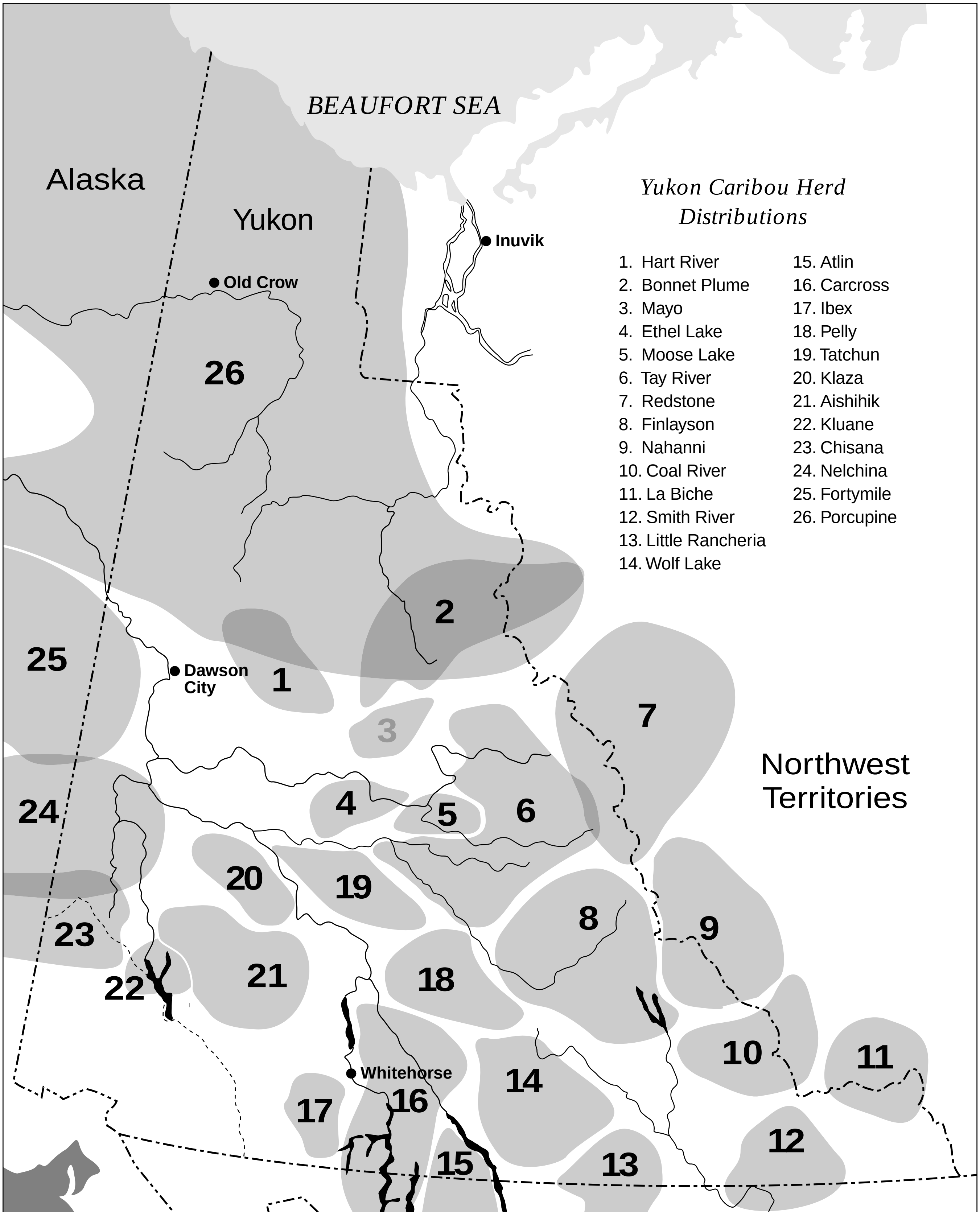


Figure 4.21 Yukon caribou herd distributions

Caribou Habitat Conflicts in the Little Rancheria Herd Winter Range

Situated near Watson Lake, the core winter range of the Little Rancheria caribou herd lies in the heart of the Liard Basin. This caribou herd migrates between northern British Columbia, where they spend their summers, and southern Yukon, where the herd winters within the Rancheria area of the Liard Basin. Forest stands that contain high levels of terrestrial lichen, the caribou's major winter food source, are limited in extent and are primarily the result of specific soil conditions.

The Liard Basin contains large areas of productive forest land within both the Yukon and northern British Columbia. In the past five years, significant volumes of timber have been harvested from upland forest sites in the Liard Basin of both the Yukon and British Columbia. The timing and location of forest harvesting activity in the Rancheria Valley may conflict with the caribou herd's winter use of the area. Management of the caribou herd in an area of forest harvesting represents a challenge that resource managers are addressing.

Barrenground Caribou

Three large barrenground caribou populations, the Porcupine, Nelchina and Fortymile herds, range across the Yukon-Alaska border (Figure 4.21). They are, therefore, managed by transboundary agreements.

Herd	Population	Survey	Status	Comments
WOODLAND HERDS				
1. Hart River	1,200	Sept./78	unknown	presently lightly hunted due to inaccessability
2. Bonnet Plume	5,000	Sept./82	unknown	remote range
3. Mayo	unknown		unknown	anecdotal information only
4. Ethel Lake	300	Oct./95	stable	small herd, vulnerable to disturbance
5. Moose Lake	200	Mar./91	stable	ranges in small area, limited access
6. Tay River	4,000	Mar./91	stable	naturally regulating herd with limited access
7. Redstone	5-10,000	unknown	unknown	ranges largely in NWT, most harvest occurs in Mac Pass
8. Finlayson	4,000	Mar./99	decreasing	permit hunting only
9. Nahanni	2,000	Oct./95	unknown	radio collar study by Parks Canada since 1994
10.Coal River	800	Oct./98	unknown	Newly identified herd
11. La Biche	400	Sept./93	unknown	presently a remote and undisturbed population
12. Smith River	200		unknown	small remote unhunted population shared with B.C.
13. Little Rancheria	1,200	Mar./99	increasing	potential forestry conflicts
14. Wolf Lake	1,400	Sept./98	stable	lightly harvested, used as a control for the Aishihik program
15. Atlin	500-1,000	Sept./95	unknown	managed primarily by B.C. with permit hunt and antler restrictions
16. Carcross	450	Oct./95	increasing	hunting suspended until herd size increases
17. Ibex	450	Nov./98	stable	herd stabilized as result of restoration program
18. Pelly	1,000		unknown	presently not studied
19. Tatchun	350	Oct./98	stable	ongoing radio program to understand range use
20. Klaza	450	Oct./95	stable	permit hunt in place, potential conflict with mineral exploration
21. Aishihik	1,200	Mar./97	increasing	intensive wolf control carried out until 1998
22. Kluane	200	Mar./98	stable	summer range mostly in Kluane Wildlife Sanctuary
23. Chisana	500	Sept./99	decreasing	ranges mostly in Alaska
BARRENGROUND HERDS				
24. Nelchina	30,000	June/99	decreasing	has wintered near Beaver Creek in recent years
25. Fortymile	31,000	June/99	increasing	recovery plan in effect
26. Porcupine	130,000	June/98	decreasing	decreasing since its peak of 178,000 animals in 1989

Table 4c Status and trends in population of Yukon caribou herds

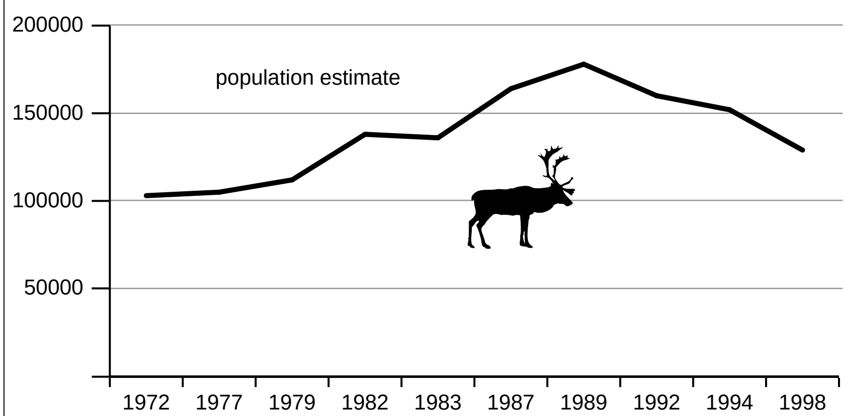
The Porcupine Caribou Herd is shared between the Yukon, Alaska and the Northwest Territories. It makes extensive migrations between its calving grounds on the Yukon-Alaska north slope, and its wintering areas in the Richardson and Ogilvie Mountains in the Yukon and the Brooks Range in Alaska.

Survey results from 1998 show that the size of the Porcupine herd has decreased from about 155,000 to 129,000 animals over the last four years (Figure 4.23) [4]. This indicates an annual decline rate of about four per cent. While the causes of the decline are not entirely understood, poor weather conditions during 1990-92 are likely responsible [4]. Canadian and United States management agencies will be monitoring the herd closely over the next few years.

Several First Nation communities in Alaska, the Yukon and the Northwest Territories rely on the Porcupine caribou herd for food and for the survival of their culture. There is also a non-native annual harvest of these caribou, mostly along the Dempster Highway. Hunting regulations for 1999-2000 include a no-hunting corridor of 0.5 km on both sides of the highway for both First Nation and non-native hunters.

Collars which have been placed on several of the caribou allow biologists to track the movements of the herd by satellite. Current information on the herd's location can be checked on the internet (www.taiga.net/satellite).

The Nelchina Caribou Herd winters along the Alaska-Yukon border. Part of the herd has wintered in the Beaver Creek area since 1991. A winter hunt of the herd has been open in the Yukon since 1993. Last surveyed in 1999, the Nelchina herd has a population of about 30,000 animals and is now decreasing [1].



Although the herd has declined to 129,000 in 1999, managers believe the population is within an acceptable range [3].

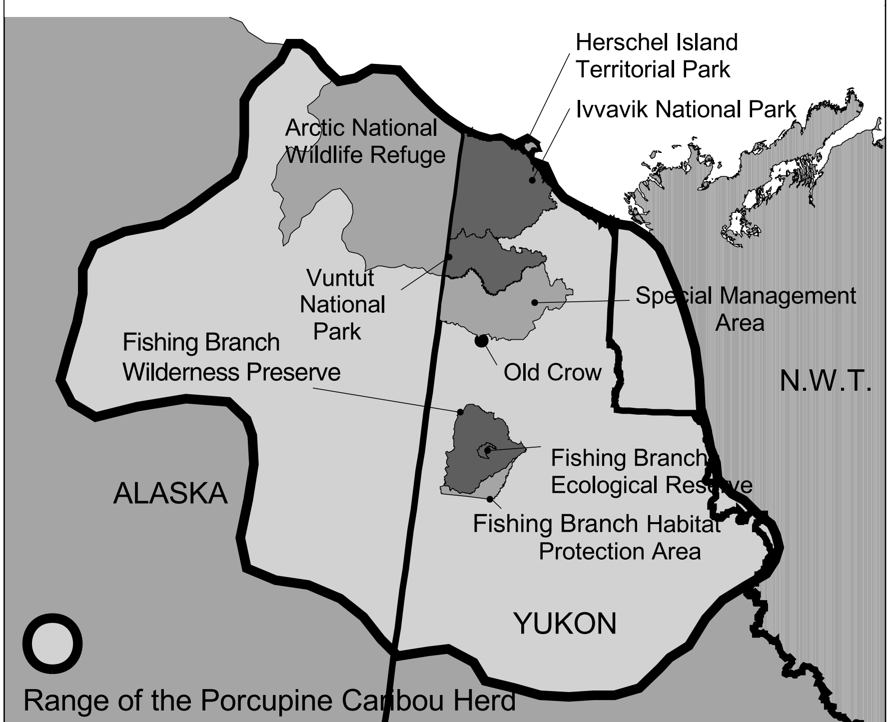


Figure 4.23 Range and population of Porcupine caribou herd

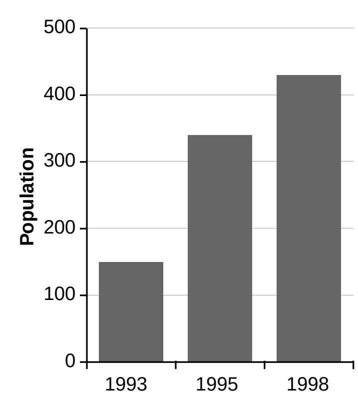


Figure 4.22 Population of Ibex caribou herd

The Fortymile Caribou Herd now occupies only a small portion of its former range that included a vast area from Fairbanks to Whitehorse. Following the overharvest of this herd in the early 1900s, the Fortymile herd declined from as many as 500,000 animals to a low of about 5,000 in 1975. The current calving and summer range is in Alaska, and the winter range extends into the Yukon's Sixtymile River area.

The management plan designed for the Fortymile herd's recovery includes maintaining the quality of the herd's range, reducing the harvest quota, non-lethal methods of reducing the wolf population, and increased monitoring of the herd's calf recruitment. This plan is now beginning to show results. Calf survival rates have improved significantly after one year of wolf sterilization and removal from the herd's calving ground, and the herd's size has now increased to about 31,000 animals [1]. The long-term goal of restoring the herd to its former range in the Yukon and Alaska is expected to take many years [4].

Moose

Moose are distributed throughout most of the Yukon (Figure 4.24). Their numbers are believed to be stable or slowly increasing on a territory-wide basis, with a current population of 65,000 to 70,000 animals [1]. Traditional knowledge indicates that, in the past, moose abundance has varied considerably throughout the Yukon.

Although moose numbers throughout most of the Yukon have remained stable or increased since systematic surveys began in the early 1980s, moose densities declined in several parts of the southwest Yukon during the 1980s and early 1990s (Figure 4.25). These areas have relatively easy access and came under high harvest pressure during these years. Moose

Cow moose

numbers throughout much of the southwest have now recovered to near 1980 levels as a result of intensive management programs. Management plans have been or are now being developed to ensure that moose numbers in these areas remain healthy in the future.

Moose are the most popular big game species in the Yukon, prized for their meat and for their trophy potential. Between 600 and 800 are harvested annually. This does not include the harvest by First Nations. Assuming the harvest by First Nations equals the harvest by licensed Yukoners, the total annual harvest is about 1,200 animals. This harvest provides about 550,000 pounds of high quality meat to Yukoners each year. Managers estimate that the Yukon moose population can sustain a harvest of 2,000 to 2,500 moose per year.

With the settlement of First Nations land claims in the Yukon, a new cooperative game management regime is being established. This should result in improved moose management and harvest monitoring.

Health of the Porcupine Caribou Herd

In 1992, the Canadian Wildlife Service released a report which stated that there could be health risks from cadmium contamination for people eating Porcupine caribou under certain conditions. After a thorough examination of the data and a public education program, the Porcupine Caribou Management Board concluded that there was no realistic health risk to anyone eating caribou kidneys or livers. Several Old Crow residents were tested for evidence of cadmium toxicity and found to have none. Tests from caribou samples for 1991-97 show that cadmium levels are not increasing in Porcupine caribou.

Porcupine caribou are also being tested for mercury contamination. In 1995 it was reported that although mercury levels in caribou for 1991-94 were slightly elevated, the mercury was not in the toxic methyl mercury form, and is therefore not considered to be a health hazard.

The health advisory issued by Yukon Health and Social Services in 1997 recommends limiting consumption of Porcupine Caribou kidneys to 25 / person / year and Porcupine caribou livers to 12 / person / year.

Porcupine caribou samples are collected regularly as part of the annual Body Condition Monitoring Program [4].

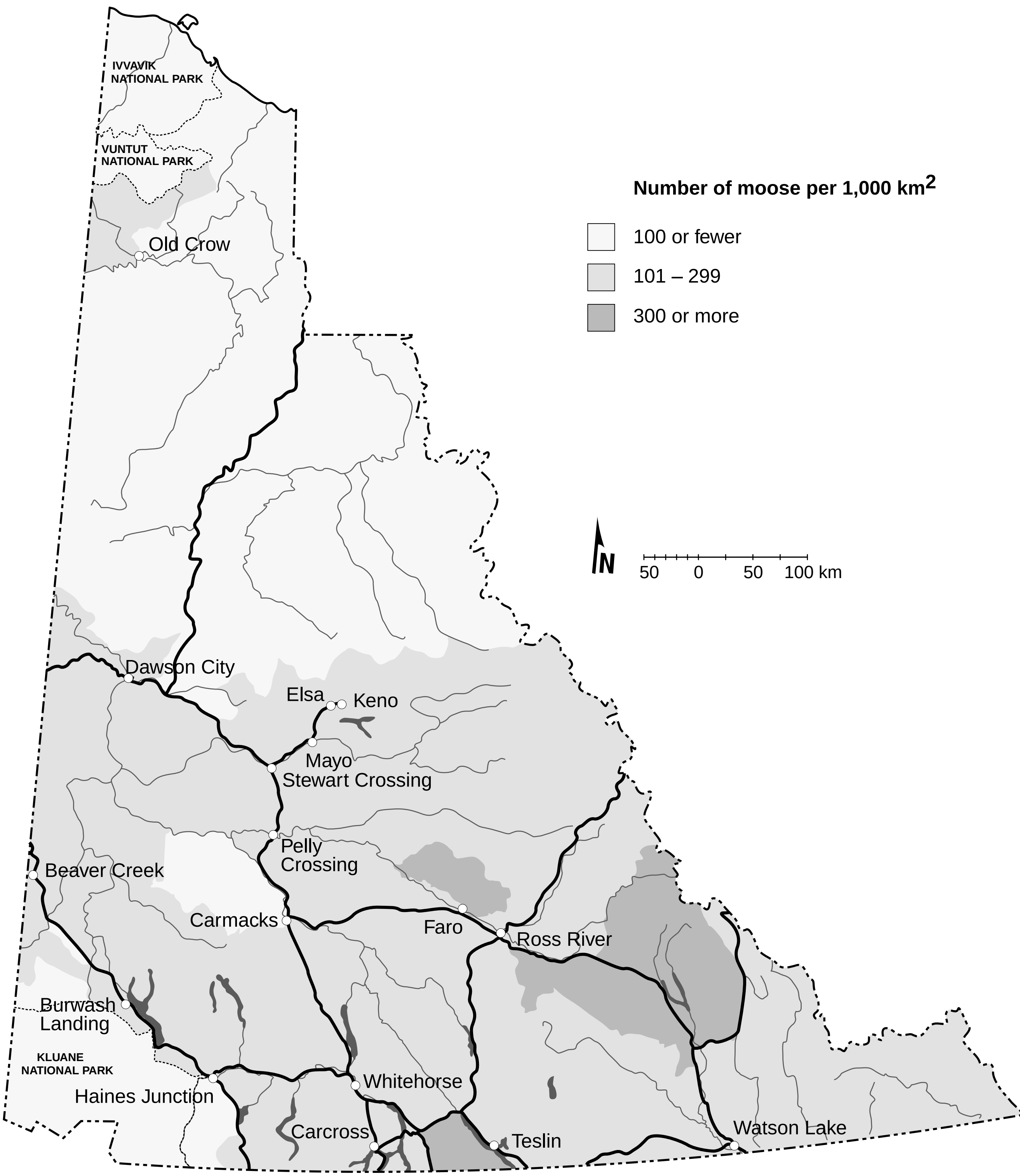


Figure 4.24 Yukon moose densities – 1994 and 1999

The change in moose abundance for areas around Beaver Creek, Faro and the Tungsten Road reflect improved estimating techniques. The increased population estimate for the Aishihik area is the result of the moose and caribou recovery program.

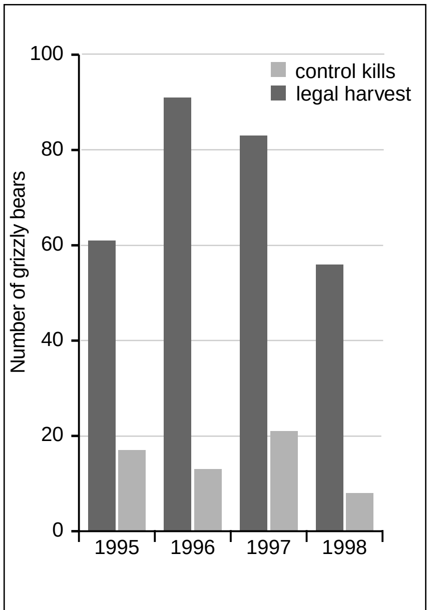


Figure 4.26 Legal harvest and control kills of grizzly bears

Black Bears

The Yukon's black bear population appears to be stable. Although systematic surveys are not carried out, the population is estimated to be about 10,000 animals [1]. The legal harvest of black bears is monitored annually.

Grizzly Bears

Grizzly bears are considered to be vulnerable because of their slow reproductive rate and their requirement for large territories. The grizzly bear population is therefore a good indicator of the health of the Yukon's wilderness habitat. There are an estimated 6,000 to 7,000 grizzly bears distributed widely throughout the Yukon [1].

Although the legal harvest is carefully regulated and monitored, a significant impact on the Yukon's grizzly bear population may be control kills (Figure 4.26). The number of control kills should be reduced in the future through improved garbage control at remote wilderness camps and by the fencing of municipal land-fills.

Furbearers

The Yukon furbearer population is considered stable or slightly increasing (Table 4d). The number of licensed trappers has decreased in recent years, primarily because of declining fur prices. A summary of the 1997-98 Yukon annual fur harvest is shown in Table 4e. Annual fur harvest records are used as an index to help determine the populations of furbearing animals.

The snowshoe hare population is now at the peak of its 10-year cycle and is expected to crash in the next year or so.

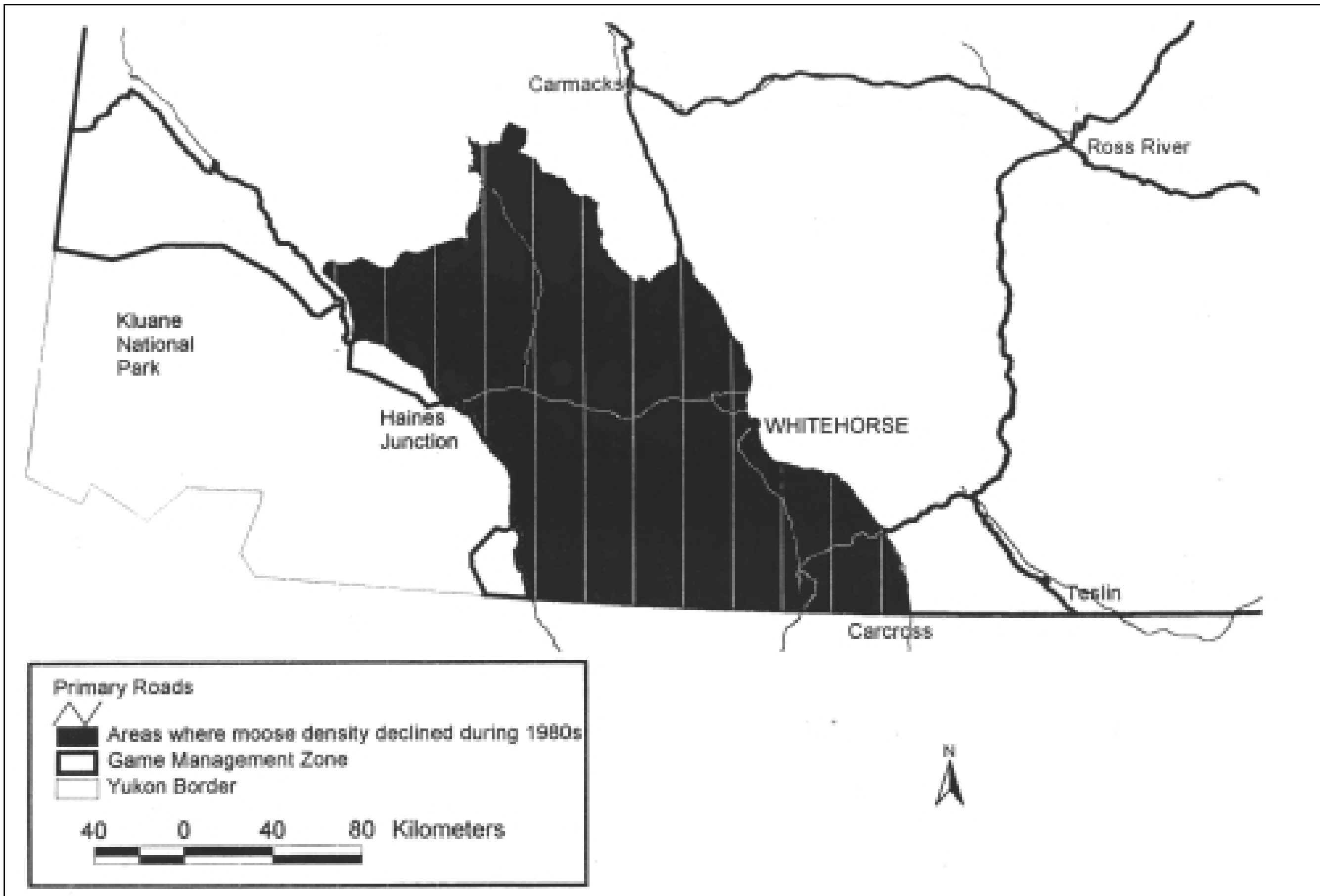


Figure 4.25 Southwest Yukon moose densities

The lynx population is also peaking in response to the high number of hares, which are the main food source for lynx (Figure 4.27).

Birds

We are constantly learning more about the population trends and ranges of Yukon birds. This fact is reflected in the ever-lengthening check-list of Yukon bird species.

Of the 278 species of birds with 186 confirmed breeders [3] that have been documented in the Yukon, 41 occur annually in winter; and the remainder are seasonal migrants [2].

Species	Trend	Comments on trapping
beaver	stable	not heavily harvested
coyote	stable	not heavily harvested
red fox	stable	not heavily harvested
lynx	at top of 10-year cycle	key species for trappers-interest fluctuates with market value
marten	increasing	key trapping species
mink	stable	not heavily harvested
muskrat	stable	not heavily harvested (except for Old Crow Flats)

Table 4d Population trends of selected furbearer species

Species	Total Harvest	Average Pelt Price	Total Harvest Value
Beaver	312	30.00	9,360
Coyote	30	30.00	900
Fisher	3	45.00	135
Fox, Coloured	36	22.00	792
Fox, Arctic	–	29.00	–
Lynx	442	92.00	40,664
Marten	5,049	43.00	217,107
Mink	94	18.00	1,692
Muskrat	130	3.50	455
Otter	11	78.00	858
Squirrel	2,803	1.20	3,364
Weasel	40	3.30	132
Wolf	111	120.00	13,320
Wolverine	118	199.00	23,482
TOTAL	9,179	—	$312,261.00

Table 4e Yukon annual fur harvest 1997-98

Waterfowl

Thirty-four species of swans, geese, and ducks inhabit the Yukon annually. Information on trends in waterfowl populations comes from two primary sources:

1. Annual aerial surveys every June since 1955 of the Old Crow Flats–part of the continental aerial survey program of the U.S. Fish and Wildlife Service and the Canadian Wildlife Service.
2. Annual ground-based surveys since 1991 of some 150 wetlands along the road system in the southern Yukon.

Results from both areas are fed into the Status of Migratory Game Birds in Canada report produced by the Canadian Wildlife Service. The results of these surveys indicate that our waterfowl populations are generally stable, or in some cases increasing. Waterfowl populations fluctuate naturally according to habitat conditions and other factors on widely separated breeding, wintering, and migration areas. Therefore, when trying to interpret trends, we need to look carefully at not only our own breeding ground data, but that from adjacent surveyed areas such as Alaska, the Northwest Territories, British Columbia and Alberta. For example, Scaup and Scoters appear to be declining in the Boreal forest areas east and southeast of the Yukon, while populations are stable in Alaska.

Trumpeter swans are counted in a separate dedicated Yukon-wide survey at five year intervals as part of a North American-wide effort. The 1995 survey indicated a population of approximately 1,260 in the Yukon. The next survey will take place in August 2000 [4].

Songbirds

There is still much to be learned about the breeding status of Yukon songbirds. Breeding bird surveys have been conducted across the Yukon each spring since 1993. This work is carried out by volunteers. Data from these surveys will be used to help determine the population trends and summer ranges of Yukon songbirds, especially seasonal migrants. There is still not enough data from these surveys to detect population trends.

The biggest environmental threat to our songbirds is the loss of habitat, including their breeding ranges in the Yukon, their southern wintering ranges, and their migration corridors.

Amphibians

The colonization of the Yukon by amphibians has been limited by extreme cold winters, cool short summers, scarcity of hibernation sites, and insufficient snow cover. They survive the long northern winter by hibernating underground, under ponds or under leaf litter beneath a blanket of insulating snow.

The northern wood frog is the only amphibian that is widely distributed throughout the Yukon. It inhabits forests, meadows, muskeg and tundra north to at least the Old Crow Flats. Its abundance is believed to be due to its rapid rate of development during the short northern summers, and its ability to hibernate at below freezing temperatures.

Other amphibians found in the extreme southern Yukon include the spotted frog, the boreal toad, and the northern chorus frog (found only in the Labiche River Valley) [1]. These species are found in the Yukon at the northern limit of their ranges.

Since amphibians are particularly sensitive to pollution and other environmental changes, there has been increased concern over the well-being of these northern species. Many species are declining in numbers on a worldwide basis and some have already become extinct. By tracking the health of amphibian populations, larger environmental problems may be detected. The populations and ranges of Yukon amphibians are monitored by the Declining Amphibian and Reptile Conservation Network (DAPCAN).

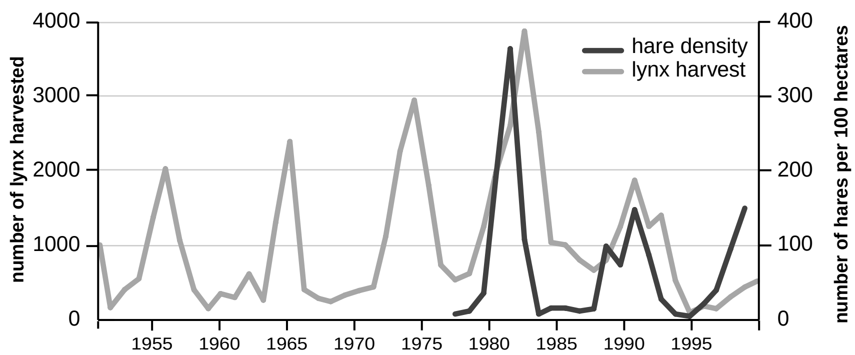


Figure 4.27 Current status of hare / lynx cycle 1995 to 1998

Birds of the Southeast

Recent studies of birds in the southeast Yukon suggest that this region has some of the richest bird life in the northern boreal forest. The mature stands of white spruce mixed with deciduous trees provide critical nesting habitat for songbird populations dependent on old-growth forests.

During surveys in the La Biche River Valley in the extreme southeast corner of the Yukon (1995-99), 114 bird species were observed. Several of these species, such as the Philadelphia Vireo and the Canada Warbler, are found no where else in the Yukon [4].

The southeast Yukon is also rich in natural resources such as timber, oil and gas. The increased demand for these resources in recent years has led to concern that songbird nesting habitat in the area may be disrupted even before it has been inventoried and assessed.

Wildlife Values

In the Yukon, as elsewhere in the world, wildlife is no longer seen solely as a resource for human consumption. The heightened appreciation for wildlife with value in its own right has led to increased efforts by governments to manage wildlife for non-consumptive purposes.

Hunting

Although the lifestyles of most Yukoners are not as closely dependent on the land as in past decades, game hunting remains important to many as a way to acquire high quality food and as a reason for spending time in the wilderness. Information on game harvest comes from mandatory hunter reports, biological submission reports and outfitter declarations (Figure 4.28). The 1994 to 1998 harvest figures do not reflect First Nation subsistence harvest.

Trapping

Although the number of licensed trappers has decreased in recent years, fur harvest is still a viable component of the Yukon's economy. Effective in 2000, only trappers who have successfully completed a trappers education workshop will be issued trapping licences.

To help meet the requirements of the 1997 Agreement on International Trapping Standards, the Yukon government will ban the use of conventional leg-hold traps for lynx, coyote and wolf by the fall of 2001 [1]. Trappers will still be permitted to use padded leg-hold traps for these species. A ban on leg-hold traps for fisher, marten, squirrel, weasel and wolverine is already in effect.

In the south central Yukon, trappers are currently taking advantage of the high numbers of lynx (Table 4e).

Wildlife Viewing

The increase in non-consumptive use of the Yukon's wildlife is reflected in the rising attendance figures at nature interpretive centres, the popularity of interpretive field trips organized by volunteer groups such the Yukon Bird Club and the Yukon Conservation Society, and the growth of ecotourism in the territory.

The Yukon Department of Renewable Resources Wildlife Viewing Program has assisted in establishing 35 wildlife viewing sites in accessible areas throughout the territory. Partners in some of the projects have been the Girl Guides of Canada and Ducks Unlimited. More than 50 additional sites are outlined in the Yukon's Wildlife Viewing Guide as excellent viewing opportunities [1]. The number of visitors recorded at the Dempster Highway Interpretive Centre is shown in Figure 4.29. This centre also serves the new Tombstone Territorial Park. The *Explore the Wild* program provides free walks and talks to residents and visitors throughout the Yukon.

Each year in April many Yukon residents visit Swan Haven at M'Clintock Bay for the Celebration of Swans festival (Figure 4.30) [1]. April 1999 was the first annual Yukon Biodiversity Awareness Month, providing opportunities to increase awareness and appreciation of the

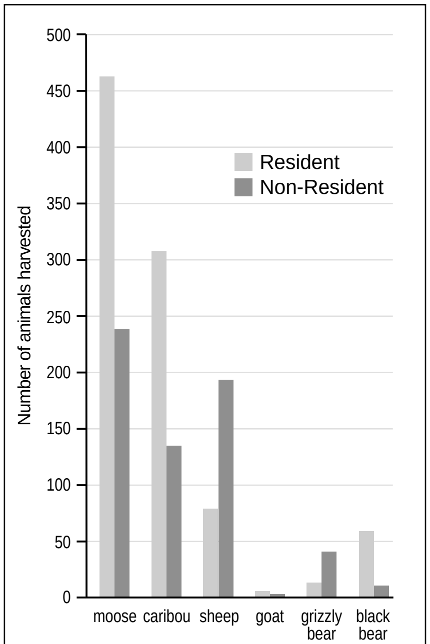


Figure 4.28 Yukon big game harvest 1994-1998

The Importance of Wildlife Viewing to Yukoners

In the 1999 report The Importance of Nature to Canadians, *Yukon residents far exceeded all provinces (no information is available from the other territories) in the percentage of residents who participated in wildlife viewing in 1996 (27.9 per cent for the Yukon, Canadian average 18.6 per cent, next closest is B.C. with 20.8 per cent).*[4] *Wildlife Viewing is defined as watching, photographing, studying or feeding wildlife on trips taken for the purpose of enjoying wildlife and natural areas. Wildlife encounters on trips taken for purposes such as vacation or business are excluded from this definition.*

life that surrounds us and the return of spring.

Wildlife viewing continues to grow in importance both to Yukon residents and to visitors (see Tourism, Chapter 3).

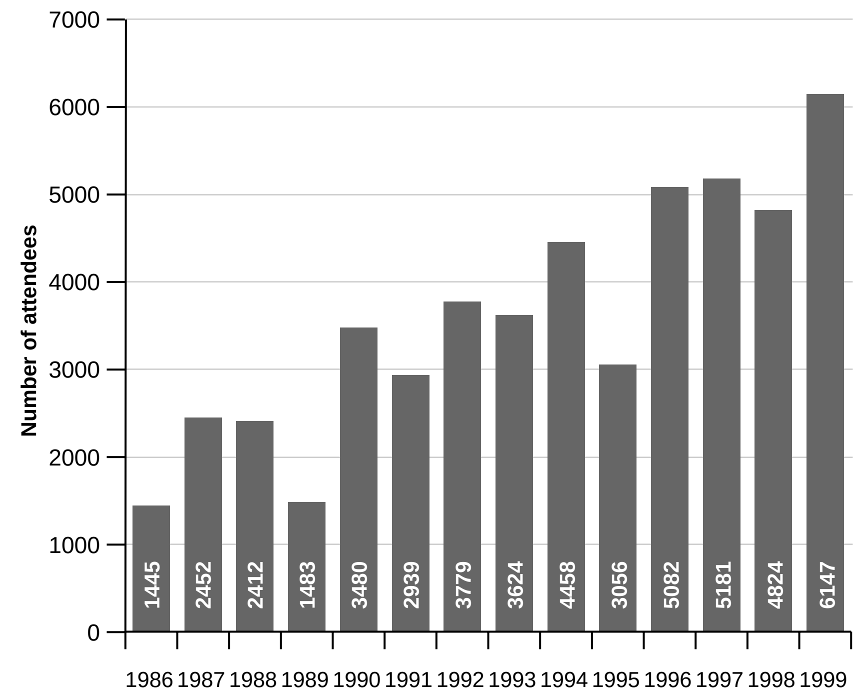


Figure 4.29 Dempster Highway Interpretive Centre

Cooperative Wildlife and Habitat Management

Cooperative wildlife management is the collaboration of governments, First Nations and other interested parties in managing wildlife for all users, both consumptive and non-consumptive. As Final Agreements come into effect, First Nations assume proactive roles in developing wildlife conservation plans. A number of Yukon First Nations are already working with governments in cooperative wildlife management.

The Yukon's wildlife is managed through a number of pieces of legislation and agreements including the Yukon Wildlife Act, the Migratory Birds Convention Act, the National Parks Act, the Umbrella Final Agreement and the Inuvialuit Final Agreement.

Yukon Fish & Wildlife Management Board

The Yukon Fish and Wildlife Management Board was established in 1995 when four First Nation Final Agreements and the Umbrella Final Agreement came into effect.

The 12 board members are appointed by the Yukon Minister of Renewable Resources. Six members are recommended by Yukon First Nations and six by the Yukon government. The board focuses its efforts on policies, legislation, and protective measures to guide the management of fish and wildlife, and its habitat. The board influences management decisions in relation to wildlife issues through public education and by recommendations to Yukon, federal and First Nation governments. These recommendations are based on a combination of the best technical, traditional and local information available.

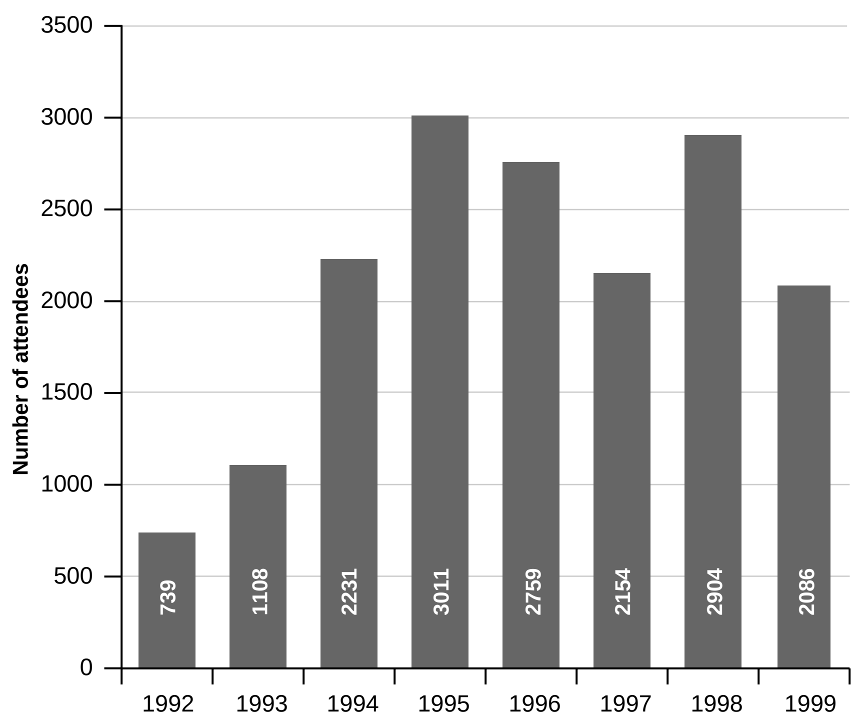


Figure 4.30 Swan Haven Interpretive Centre

Renewable Resource Councils

As laid out in the Umbrella Final Agreement, a Renewable Resource Council is established in each Yukon First Nation territory when it signs its Final Agreement. The Renewable Resource Councils provide advice on the direction of renewable resource management specific to their traditional territories. They play a leading role in the wildlife management decisions made for these traditional lands. There are now seven Renewable Resource Councils active in the Yukon. They include the Alsek, Little Salmon-Carmacks, Selkirk, Dawson District, North Yukon, Teslin and Mayo Renewable Resource Councils. Renewable Resource Council chairs meet annually with the Yukon Fish and Wildlife Management Board to discuss wildlife matters of common concern.

Porcupine Caribou Management Board

Two boards manage the Porcupine caribou herd. The Management Board was formed by an Agreement signed in 1985 by the three First Nation organizations and governments of Canada, Yukon and Northwest Territories. The mandate of the board is to cooperatively manage the Porcupine caribou herd and its habitat in Canada to ensure continuance of the herd for subsistence use by First Nation users while recognizing that other users may also share the harvest. The board plans and coordinates management actions among governments and First Nations within Canada.

In 1987, Canada and the United States signed an international agreement for the conservation of the Porcupine caribou herd. This agreement established the International Porcupine Caribou Board in 1989. This board provides advice and recommendations that will improve cooperation and coordination between Canada and the United States in managing the herd. The board consists of four members from Canada and four members from the United States.

In 1993, a Plan for the International Conservation of the Porcupine caribou herd was accepted as a framework for coordinating international aspects of managing the herd. There are five management agencies which work on the herd: Canadian Wildlife Service, U.S. Fish and Wildlife Service, Government of Yukon, Government of Northwest Territories, and the Alaska Department of Fish and Game.

The board also published a report on the Sensitive Habitats of the Porcupine caribou herd in 1993. Research and logistics are coordinated by the Porcupine Caribou Technical Committee which consists of biologists from the five agencies.

Non Game and Specially Protected Wildlife

Many of the earth's wildlife species are at risk, including some that live in the Yukon. Yukon wildlife species at risk have been identified and managed through three mechanisms: the Committee on the Status of Endangered Species in Canada (COSEWIC), the Convention on International Trade in Endangered Species (CITES) and the *Yukon Wildlife Act.*

COSEWIC evaluates the status of wildlife species in Canada, and places species at risk into four categories.

- Extirpated A species no longer existing in the wild in Canada, but occurring elsewhere.
- Endangered A species facing imminent extirpation or extinction.
- Threatened A species likely to become endangered if limiting factors are not reversed.
- Vulnerable A species of special concern because of characteristics that make it particularly sensitive to human activities or natural causes.

Endangered Species

The only Yukon wildlife species considered by COSEWIC to be endangered is the bowhead whale.

Bowhead Whale

This large mammal (by far the largest in the Yukon) winters in the Bering Sea and feeds in the summer in the Beaufort Sea along the Yukon's north coast. Beaufort Sea bowhead whales were exploited for their blubber and baleen from 1848 to 1914. It is not known how low their numbers dropped. Protected from commercial harvest since 1935, this population is now estimated to be about one quarter of its original size.

A low-level harvest of bowhead whales by the Inuvialuit continues along the coasts of Alaska, Yukon and Northwest Territories. It should be remembered that these whales became endangered from an intense commercial harvest and not from low level traditional hunting.

The federal Department of Fisheries and Oceans works jointly with Alaska to monitor the Beaufort Sea bowhead population. The current management regime appears to be working as bowhead whale numbers in the Beaufort Sea are slowly increasing.

Threatened Species

Two wildlife species in the Yukon are considered by COSEWIC to be threatened. They are the anatum peregrine falcon and the wood bison.

Anatum Peregrine Falcon

The anatum subspecies of the peregrine falcon spends the summers in the interior regions of North America. In the Yukon, it nests along major rivers. The harmful effects of pesticides, such as DDT, caused a drastic decline in peregrine falcon populations in the 1960s. They became extinct in most of North America by the mid-1970s. Only a few remained in the Yukon.

DDT was banned throughout North America by 1970, and the reintroduction of captive peregrine falcons to their former Yukon range began in 1978. Peregrine populations recovered rapidly in the Yukon, and by 1995, an estimated 120 breeding pairs were spending the summer here [1]. Nearly all of its former nesting sites have been reoccupied. It has recently been downlisted by COSEWIC from endangered to threatened.

Although the peregrine falcon recovery program in the Yukon appears to be a success, they are still at risk. In the winter, they migrate to Central and South America where dangerous pesticides are still in use. As part of a national peregrine falcon recovery plan, they are surveyed intensively every five years, with the next survey scheduled for the year 2000.

Wood Bison

Wood bison, the largest land mammal in North America, formerly occupied an extensive range in what is now northwestern Canada, including the southern Yukon. They disappeared from the Yukon early this century. The exact cause of their disappearance is not known, but habitat deterioration, through the succession of grassland to forests, followed by the arrival of firearms, is the most likely explanation.

The re-introduction of wood bison to its former Yukon range is part of a national wood bison recovery program started in 1975. The goal of this program is to establish independent, disease-free herds of wood bison in acceptable habitats within its former range.

The Yukon herd was started in 1986, when 36 wood bison from Elk Island National Park were released into the Nisling River enclosure. Additonal wood bison were acquired in subsequent years totaling 142, with an even sex ratio of 71 male and 71 female. Releases to the wild began in 1988, when 21 bison were set free from the enclosure, followed by annual releases until 1992, when all remaining animals were set free and the enclosure was dismantled. The wild herd is growing at a rate of 15 to 20 per cent per year and was estimated at 420 head in March 1999. It is expected to pass the population target of 500 animals (stipulated in the management plan) after the spring of 2000's calf production [1]. A carefully controlled annual harvest of this herd has been permitted since the winter of 1997-98 (Figure 4.31). Concern persists among the area's First Nations that wood bison may be interfering with other wildlife.

The primary risk to wood bison is now disease. Other bison populations in North America have been inflicted with brucellosis, anthrax and tuberculosis.

Vulnerable Species

Yukon wildlife species now considered by COSEWIC as vulnerable include the grizzly bear, polar bear, wolverine, short-eared owl, tundra peregrine falcon, and Squanga whitefish. The great gray owl and the trumpeter swan were both delisted in 1996.

Grizzly Bear

The Yukon grizzly bear population is believed to be stable. An annual hunt is permitted. Tracking of the legal harvest is currently the only monitoring of the Yukon population outside of Kluane National Park, where some inventory surveys have been carried out.

Polar Bear

A stable population of about 2,500

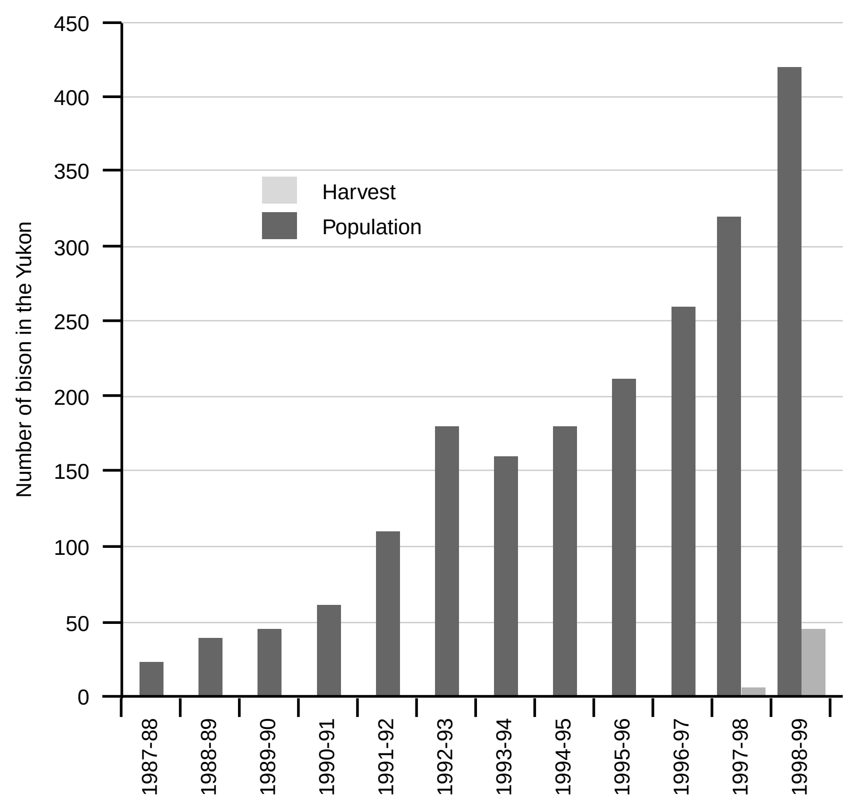


Figure 4.31 Yukon wild wood bison herd population and harvest
Harvest of the herd began in 1997/98 with permits issued through a lottery system

polar bears inhabit the Beaufort Sea region. In the winter, a small number of them are found along the Yukon's north coast. Polar bears are managed under international agreements. A limited annual harvest by the Inuvialuit of the western Arctic is permitted.

Wolverine

Wolverine are thought to be secure in the Yukon and are harvested annually by licensed trappers and by a few hunters. No systematic population monitoring is carried out other than tracking the annual harvest.

Short-eared Owl

The Yukon breeding population of the short-eared owl is believed to be stable. Last examined by COSEWIC in 1994, this migratory bird is considered to be vulnerable because of its population decline in southern Canada.

Tundra Peregrine Falcon

After disappearing as a breeder in the Yukon's north slope in the early 1980s, tundra peregrine falcon numbers are still much lower than historic counts. It was downlisted by COSEWIC from threatened to vulnerable in 1992. This subspecies is of increasing concern in the Yukon because its numbers have not recovered as quickly as the anatum subspecies.

Squanga Whitefish

Squanga whitefish are found only in one ecozone and two drainages in and around Squanga Lake in the southern Yukon. While its population is assumed to be stable, it is subject to a small harvest. At this time there are no significant threats to this population of whitefish.

Other Species of International Concern (CITES)

The following wildlife species have been identified by CITES as being at risk elsewhere but not in the Yukon:

Black Bear

The concern over black bears is based on a high rate of poaching for illegal trade in other jurisdictions. This rarely occurs in the Yukon, and the black bear population here is assumed to be stable.

Lynx

The lynx population in the Yukon is monitored through fur harvest records. The population here is stable but cyclic. Lynx are highly dependent on the cycle of the snowshoe hare, their main prey species. Lynx are at the peak of their cycle in 1999 (Figure 4.27). At the low point in the cycle, lynx are vulnerable to overharvest. A refugium in suitable reproduction habitat is necessary during these population lows.

River Otter

The river otter occurs in the Yukon in relatively low numbers because this is the northern limit of their range. The river otter population is monitored through the limited number that are harvested each year by licensed trappers (Table 4e).

Wolf

A stable population of wolves is widely distributed throughout the Yukon. Their population is monitored through fur harvest records. Several wolves are being tracked by radio collar in the area between Haines Junction and the Nisling River in conjunction with the ungulate management program in the area.

Gyrfalcon

The Yukon's population of gyrfalcons is stable but cyclic. They are considered to be vulnerable because of the low numbers reaching breeding age during the low points of their population cycle.

Specially Protected Yukon Mammals (Yukon Wildlife Act)

Because of their low numbers in the Yukon, several mammal species are specially protected under the Yukon Wildlife Act and its regulations. These species are considered to be at risk in the Yukon but not elsewhere. They include elk, mule deer, muskoxen and cougar.

Elk

The elk that were first introduced to the Yukon in the late 1950s, and subsequently supplemented with later introductions, currently occupy two well-defined ranges in the southwestern Yukon. One population has a large distribution including the Nordenskiold River drainage, Hutshi Lakes, and areas adjacent to the Klondike Highway from Fox Lake in the south to Twin Lakes in the north, with most sightings being reported from the Braeburn area. This population is estimated at 50 to 60 head. The second population of similar size is very restricted in its distribution, essentially occupying the Takhini River burn west of Whitehorse from the Takhini River bridge on the Alaska Highway west to the Mendenhall Subdivision. While the Takhini herd has been growing slowly over the past decade, the Hutshi / Braeburn herd appears to be stagnant with high losses to predation, highway accidents, and poaching.

Muskoxen

After being overhunted during the height of the whaling industry in the Beaufort Sea, muskoxen had disappeared from the north slope of Alaska and the Yukon by the mid-1800s. They were re-introduced to northeastern Alaska in 1969, and the rapidly increasing population has since expanded its range onto the Yukon's north slope. By 1995, the Yukon population of muskoxen had grown to about 150 animals, but has since declined to about 120 [1]. This may reflect movement of muskoxen back and forth between Alaska and the Yukon.

A management plan for muskoxen is being developed through the North Slope Wildlife Management Advisory Council. Concern exists among subsistence hunters of the northern

Yukon and Mackenzie Delta that muskoxen may interfere with the Porcupine caribou herd.

Mule Deer

Mule deer are at the northern limit of their range in the Yukon. They have been observed as far north as Dawson City and Ross River. Their numbers have been estimated between 500 to 1,000 animals, and appear to be slowly increasing [1]. Their habitat in the Yukon is limited, and the population is subject to predation and winter weather extremes.

Cougar

Over 100 cougar sightings have been reported in the Yukon over the past few decades. The size of the Yukon population is unknown, but is probably very low. It is believed that cougars may be expanding their range into southern Yukon in response to an increasing mule deer population.

PROGRESS & CHALLENGES

Progress since 1995

- *Southern Lakes Caribou Recovery Project appears to be effective.*
- *Moose densities in southwest Yukon are recovering.*
- *Wood bison herd has reached population target.*
- *Anatum peregrine falcon no longer endangered.*
- *Trumpeter swan no longer vulnerable.*

Challenges

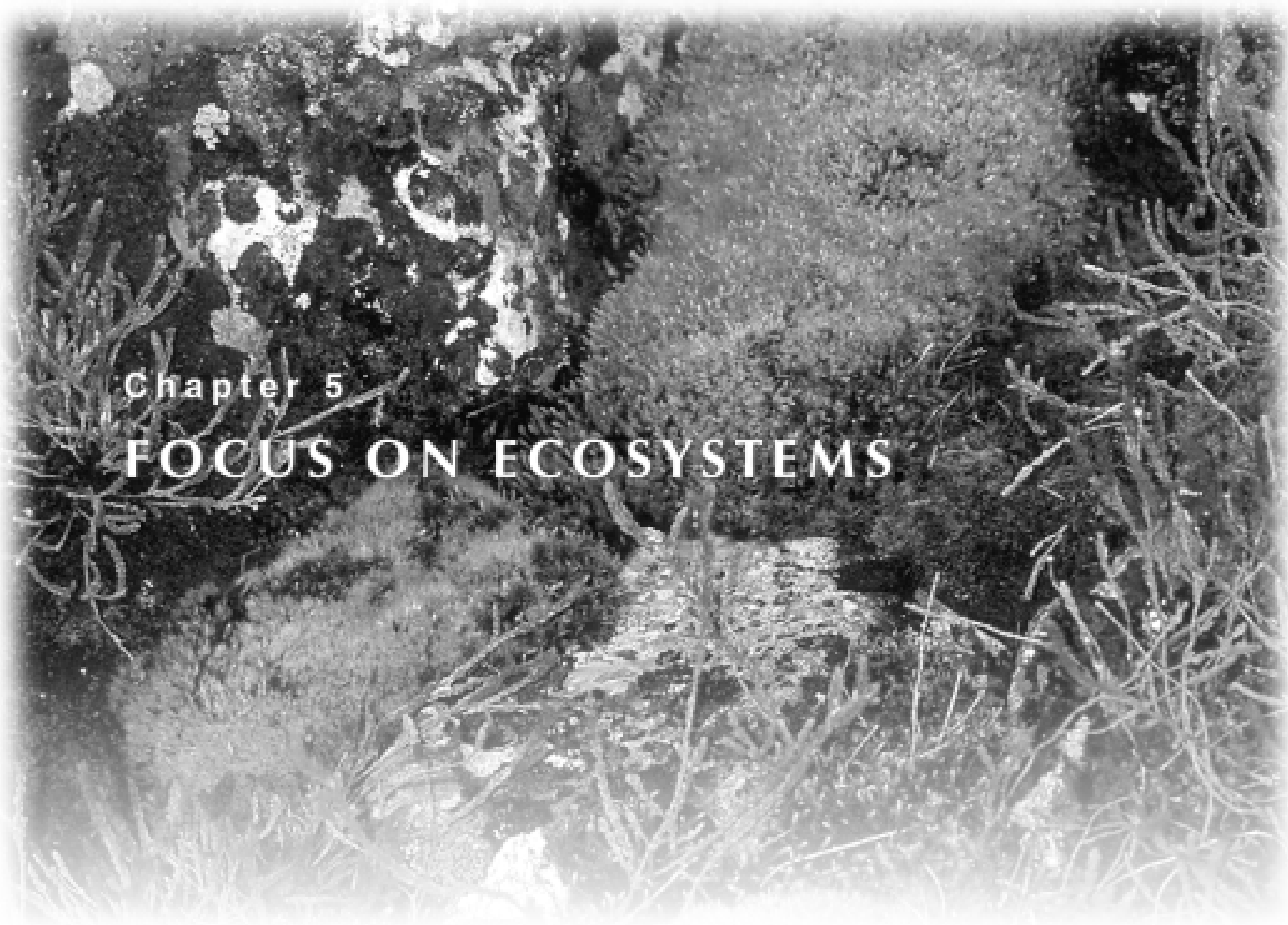
- *The need to establish Renewable Resource Councils in seven Traditional Territories with unresolved land claim agreements.*
- *The demand for natural resources in southeast Yukon may potentially affect unique songbird habitat.*
- *There is relatively little research and management directed at the smaller, non-economical wildlife species, such as rodents, bats, frogs.*
- *Recovery of the Fortymile caribou herd.*

Grizzly with cub, Fishing Branch River

Two caribou at the Dempster Highway

Small waterfall, Carcross/Skagway Road

Mountain view from Emerald Lake area



Chapter 5
FOCUS ON ECOSYSTEMS

5.1 Wetlands

Wetlands include bogs, fens, swamps, marshes and shallow water. Wetlands are storehouses and purifiers of water, providing valuable key habitat for concentrations of waterfowl and other organisms. Many wetlands also contain large supplies of peat.

> *"Wetlands...are lands in which the water table is at, near, or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric (saturated) soils, hydrophytic (water loving) vegetation, and various kinds of biological activity that are adapted to the wet environment."*
>
> *–Tarnocai, 1980* [2]

The distribution of wetlands is dependent on climate and landform. The Yukon has approximately three per cent wetlands by area (about one per cent of Canada's wetlands). While this is much less than in many parts of Canada, it is typical of the mountainous Cordilleran region of Western Canada [1].

Wetlands are found throughout the Yukon along river floodplains and deltas, headwaters of creeks and lower slopes in narrow mountain valleys and in the flatter, forested areas of central and southern Yukon. The Yukon's most extensive wetlands are north of the Arctic Circle on flat, poorly drained permafrost terrain with abundant peatlands and many shallow lakes.

Fens and bogs are organic wetland forms usually containing more than 40 cm of peat. Permanently frozen veneer, sloping and peat plateau bogs are common throughout most of the Yukon, especially on moist lower slopes, cooler northerly facing slopes and in depressions. High centre lowland polygons are extensive on the north slope and in the Old Crow Basin. Only in the dry rainshadow area around Whitehorse, Carcross and Carmacks are bogs limited in distribution.

Fens are higher in nutrients with more water circulating through them, and are often non frozen in southern parts of the territory. They are widespread in the Yukon along river floodplains, and headwaters of creeks. Minerotrophic fens are common in south central Yukon, around Whitehorse, where peat accumulation is limited by the dry rainshadow climate and calcareous soils. Low centre polygons of Yukon's north slope are classed as fens.

Permafrost is widespread in the northern Yukon and wetlands are strongly influenced by the delicate balance between freezing and melting cycles. When the ground surface is disturbed or when there are changes in the water table, areas with high soil ice content, such as ice wedges, will melt, causing the ground to collapse. Marshes, shallow ponds, or lakes will form in the depressions. In the Old Crow Flats, there is a complex cycle of shallow water thermokarst lakes forming and growing larger by thermokarst erosion of the banks, and then drying out and draining as outlets are eroded.

Swamps throughout most of the Yukon are found along creeks, rivers, and around lakes and other wetlands where mineral-rich water flows through the soil. In permafrost areas, swamps are characteristic of seepage slopes and slope drainage channels. Medium to tall willows and sometimes alders dominate the vegetation of swamps though some trees may grow.

Throughout the Yukon, shallow lakes and marsh wetlands are especially important for waterfowl and other migratory birds, moose, muskrats, and beaver. Marshes are periodically flooded mineral soil wetlands characterized by emergent sedges and reeds. They are found adjacent to many lakes, ponds and rivers throughout the Yukon. Shallow open waters less than two metres deep include ponds, sloughs and shallow lakes. They are often associated with thermokarst melting of permafrost. Submergent and emergent vegetation found in marshes and on the margins of the shallow water wetlands provide food and cover for widespread waterfowl species.

Wetlands are often highly productive forage sites as well as a source of water that attract wildlife. A high diversity of vegetation community types often surround wetlands reflecting zones of different water regimes. This diversity of habitats provides shelter, food and water in close proximity, for high densities of songbirds, waterfowl, raptors, moose, small mammals and other species.

Natural Cycles and Climate Change (see also chapter 1)

Wetlands are subject to natural fluctuations in water levels as a result of yearly and several year variations in rainfall and evapotranspiration. Several years of high precipitation can lead to high watertables and flooding over a region as occurred in 1991-1992 in the Whitehorse-Aishihik area. Subsequent years of lower precipitation have lead to low water tables and lake levels in the same area during 1998 and 1999. Reduction in the extent of wetlands may affect the number of local waterfowl within a given year.

Old Crow residents feel that many of the lakes of the Old Crow Flats are drying up as a result of the warmer temperatures and earlier springs in recent years.

Are these changes related to long term climate change, global warming induced by human activities or natural fluctuations in annual weather patterns that have occurred for millions of years? Summer temperatures and annual temperature means from northern British Columbia and the Yukon indicate a slight but significant warming trend since 1900 [3].

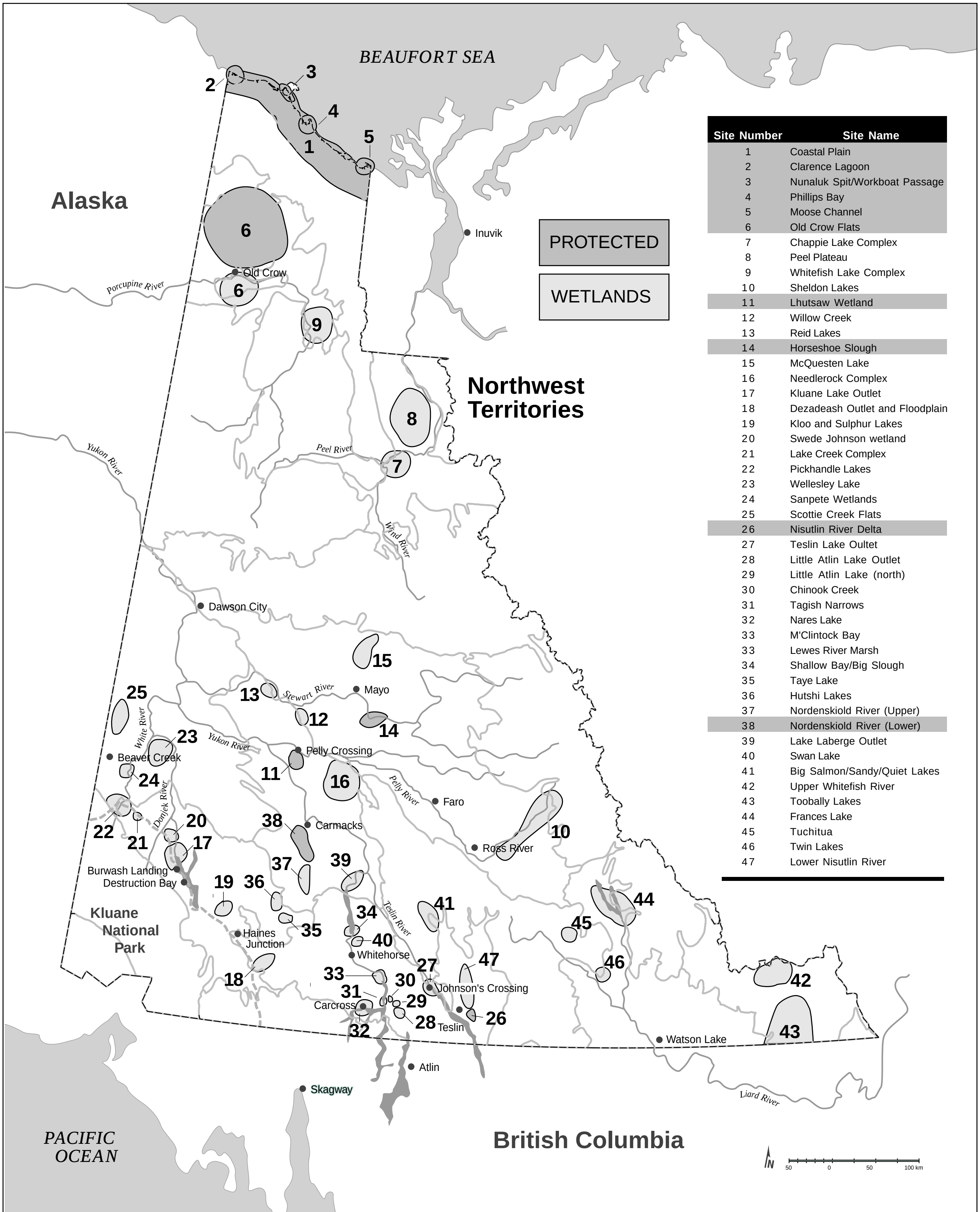
Inventory

Compared to other habitats, the important Yukon wetlands are relatively well known but a systematic inventory has not been done. Forty-seven wetland areas have been identified as significant, based on their value as migratory bird habitats (Figure 5.1). Some are important breeding or moulting areas, while others serve as vital stopping places during spring or fall migration.

Fourteen of the identified key sites have received some degree of initial research (including the Aishihik/Sekulmun wetlands, Kloo Lake wetlands, McQuesten Lake wetlands since the last reporting).

Some site specific and regional studies are being undertaken. A survey and mapping of wetlands in the City of Whitehorse was completed in 1987. According to this study, 2.5 per cent of the city (1,084 ha) is wetland, though the actual per cent is probably higher as most shallow water areas were mapped as lakes and are not included in these totals. The need for further assessment and monitoring of the wetlands was identified in order to expand our understanding of the ecological relationships and the biological diversity of the ecosystems [4]. A preliminary inventory of wetlands using aerial photos was undertaken in the Beaver River watershed [5]. A detailed study of the wetlands that drain into Aishihik Lake has been completed. The study determined the effects of regulating Aishihik lake levels on the hydrological regime of the wetlands and their waterfowl and muskrat populations [6].

The Yukon Wetland Technical Committee (YWTC) is developing terms of reference for a common classification system for the territory and identifying priority areas for inventory.



Site Number	Site Name
1	Coastal Plain
2	Clarence Lagoon
3	Nunaluk Spit/Workboat Passage
4	Phillips Bay
5	Moose Channel
6	Old Crow Flats
7	Chappie Lake Complex
8	Peel Plateau
9	Whitefish Lake Complex
10	Sheldon Lakes
11	Lhutsaw Wetland
12	Willow Creek
13	Reid Lakes
14	Horseshoe Slough
15	McQuesten Lake
16	Needlerock Complex
17	Kluane Lake Outlet
18	Dezadeash Outlet and Floodplain
19	Kloo and Sulphur Lakes
20	Swede Johnson wetland
21	Lake Creek Complex
22	Pickhandle Lakes
23	Wellesley Lake
24	Sanpete Wetlands
25	Scottie Creek Flats
26	Nisutlin River Delta
27	Teslin Lake Oultet
28	Little Atlin Lake Outlet
29	Little Atlin Lake (north)
30	Chinook Creek
31	Tagish Narrows
32	Nares Lake
33	M'Clintock Bay
33	Lewes River Marsh
34	Shallow Bay/Big Slough
35	Taye Lake
36	Hutshi Lakes
37	Nordenskiold River (Upper)
38	Nordenskiold River (Lower)
39	Lake Laberge Outlet
40	Swan Lake
41	Big Salmon/Sandy/Quiet Lakes
42	Upper Whitefish River
43	Toobally Lakes
44	Frances Lake
45	Tuchitua
46	Twin Lakes
47	Lower Nisutlin River

Figure 5.1 Important Wetlands in the Yukon [7]
This map does not show all wetlands (eg. Aishihik/Sekulman is not mapped yet). More areas will be added as research continues.

Loss of wetland habitat

In many parts of Canada there has been substantial loss of wetlands and wetland values as a result of human activity. The main causes of this loss have been the draining of wetlands for agriculture or for urban expansion, and flooding by hydroelectric development.

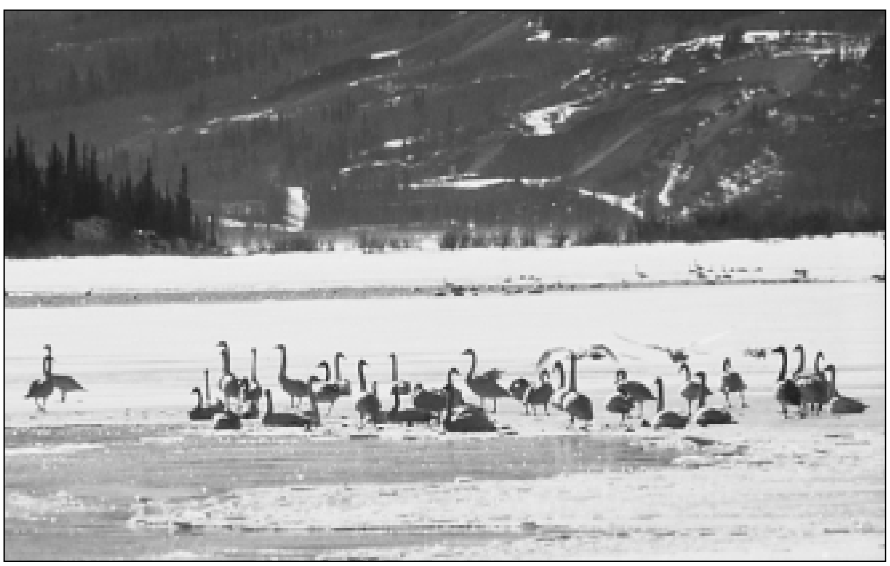
In the Yukon, there has been little loss of important wetlands. Some grazing by horses has occurred in at least five of the 47 wetlands identified as important waterfowl areas, at least four have adjacent residential developments, and at least two have adjacent agriculture. Roads skirt or cross some wetlands and may affect their function. None of these activities has had significant detrimental effects on the major wetlands.

Water regulations for hydro purposes affect the hydrologic regime of wetlands at Marsh Lake, Aishihik and Mayo Lake. Higher water levels in late summer and fall have changed the natural hydrology of the Marsh Lake wetlands. Wetland studies around Aishihik Lake indicated that low spring water levels affect local waterfowl populations breeding in the area.

Though probably insignificant on a territory wide basis, some effects of agriculture on smaller wetlands can be noted. One agricultural operation uses a drained peat wetland to grow sod for the Whitehorse market. Some farming occurs on organic soils in the Watson Lake and Dawson areas. Several wetlands in the Whitehorse area have been mined for peat and topsoil. As the existing sources of peat and topsoil are used up, demand for alternate sources will emerge.

Wetland	Protected as
Coastal Plain	a. Ivvavik National Park b. Special Conservation Area
Old Crow Flats	a. Vuntut National Park b. Special Management Area
Nisutlin River Delta	National Wildlife Area
Horseshoe Slough	Habitat Protection Area
Nordenskiold Wetlands	Habitat Protection Area
Lhutsaw Wetlands	Habitat Protection Area

Table 5a Yukon Wetlands with protected status (updated from 1995)
Note: Horseshoe Slough, Nordenskiold and Lhutsaw Wetlands are temporarily withdrawn and are therefore not protected over the longterm, however the provisions of the land claim agreements require habitat protection.



McClintock Bay is an important spring staging area for Trumpeter Swans and Tundra Swans and numerous species of ducks.

Protection of Wetlands

Ten of the 47 inventoried wetlands in the Yukon are now protected through legislation (Table 5a). This includes the Yukon's two largest wetland complexes, the Coastal Plain and the Old Crow Flats. Clarence Lagoon, Nunaluk Spit/Workboat Passage, Phillips Bay and Moose Channel were formerly included in the coastal plain but have been identified because of their importance as coastal ecosystems different from the inland wetlands typical of the coastal plain. Some open water parts of Workboat Passage/Nunaluk Spit and Phillips Bay are not protected.

Four other wetlands have been identified as special management areas under First Nation land claims including the Nisutlin River Delta, Horseshoe Slough, Nordenskiold River and Lhutsaw Lakes. Nordenskiold and Lhutsaw Wetlands gained protected status in 1997 although there is only interim withdrawal of staking. Several others are proposed for protection in as yet unsettled land claims. Some additional wetland areas are under review by the Yukon Protected Areas Secretariat to see how they fit within Yukon Park System ecoregion representation.

Two wetlands are protected under the *National Parks Act.*

Federal legislation related to land and water use provides some mechanisms to minimize the effects of development on other Yukon wetlands. The *Migratory Birds Convention Act* protects migratory birds through the prevention of habitat destruction and by hunting regulation. Certain projects are currently subject to environmental assessment under the *Canadian Environmental Assessment Act* (CEAA). A new *Development Assessment Act* is being developed under Chapter 12 of the Yukon Land Claim Umbrella Final Agreement.

Activities, except mining activities, on federal lands, are subject to the *Territorial Land Use Regulations*. Terms to mitigate environmental impact are incorporated into land use permits. Mining is subject to the new *Mining Land Use Regulations* (MLUR) which require specific operating conditions designed to reduce negative impacts on the environment. Projects which involve the use of water require licensing under the *Yukon Waters Act*. Terms can be set in the licence to protect wetlands under the objective of providing for the conservation, development and use of waters that will provide the optimum benefit for all Canadians and Yukoners.

Other initiatives which affect wetlands in the Yukon include the Yukon Waterfowl Management Plan (1991). Coordinated by the Yukon Waterfowl Technical Committee, a cooperative effort among Canadian Wildlife Service, Yukon Renewable Resources and Ducks Unlimited, the goals of the plan are to maintain waterfowl populations, habitats and encourage use at levels consistent with population and habitat goals.

PROGRESS & CHALLENGES

Status in 1999

- *Ten important wetlands in the Yukon are protected.*
- *About 15,812 km^2 of wetland and surrounding areas are now protected.*

Progress since 1995

- *Two more wetlands are now protected (Nordenskiold and Lhutsaw).*
- *There is a move toward wetland inventory.*
- *There is more public awareness of wetland values and issues.*
- *The Protected Areas strategy received a strong public endorsement for the blanket protection of all Yukon wetlands.*

Challenges

- The two additional wetlands protected since 1995 are temporarily withdrawn and long term protection may not be assured.
- There is no complete inventory of key wetlands.

5.2 Forests

Introduction

Approximately 275,000 km^2, or almost 60 per cent of the Yukon's land base, is considered forested. This area represents about seven per cent of Canada's total forested area. The Yukon's boreal forests are part of a great northern circumpolar band of mostly coniferous forests extending across the sub-arctic latitudes of Russia, Scandinavia, and North America. Yukon forests reflect three key environmental conditions: cool soil temperatures, low annual precipitation and a short growing season. The Yukon is a signatory to the National Forest Strategy and the Canada Forest Accord [1].

The Ecology and Distribution of Yukon Forests

Forest Diversity: Trees, Forest Communities and Landscapes

Many people view the boreal forest as a relatively simple system that contains low levels of ecological diversity. This may be true if one only considers the limited number of tree species that occur in the Yukon. However, it should be recognized that diversity occurs across a range of scales, from the individual to the community to the landscape (Figure 5.2). Much of the diversity of the boreal forest is observed at

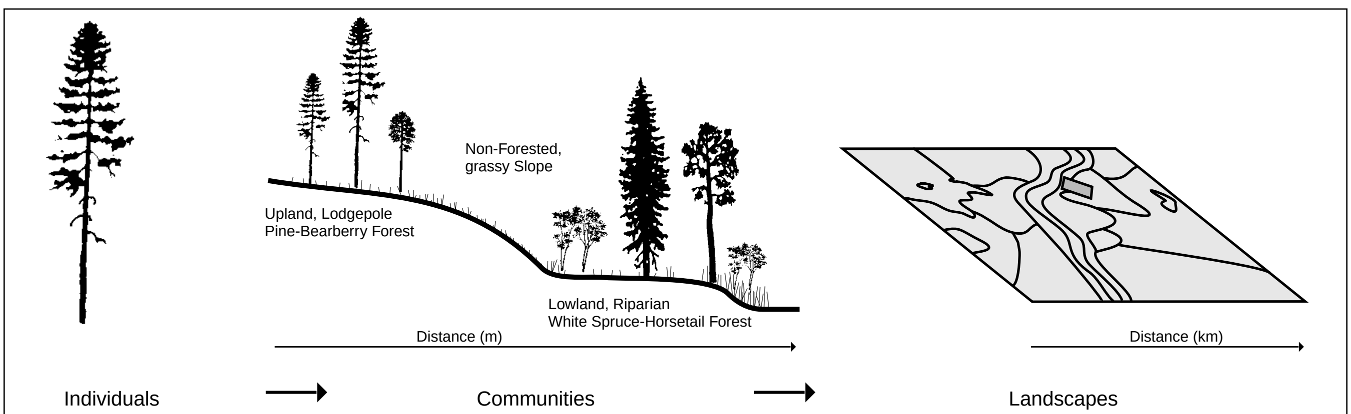


Figure 5.2 Boreal Forest Diversity occurs across a range of spatial scales, from the individual to the community to the landscape. Much of the diversity of the boreal forest is observed at the landscape-scale.

the landscape scale. The boreal forest is a result of a complex inter-relation between environmental conditions, plant and animal species, disturbance and time; interactions between all of these elements create and maintain a complex landscape mosaic across the Yukon.

Forest Tree Species

Yukon forests contain eight species of trees (Figure 5.3). A similar tree species composition is found across most of the boreal forest in Canada. White and black spruce are the primary tree species over much of Yukon's forested land base. Lodgepole pine is currently limited in distribution to the southern regions of Yukon; some researchers believe that pine is still recovering from the last major glaciation and has not yet advanced northward to its fullest extent [2].

Forest Communities and Environmental Gradients

The local distribution of tree and plant species can be explained by an understanding of *environmental gradients* (Figure 5.4). Environmental gradients describe the change in abiotic factors from one place to another- the change in moisture conditions from a dry ridge crest to a low-lying hollow or the change in soil temperature from a north-facing slope to a south-facing slope. Tree and plant species are adapted to grow under a certain range of environmental conditions. Some species prefer cool moist conditions while others grow best on warm, dry sites. When specific tree and plant species are found growing together under characteristic environmental conditions, this is known as a *plant* or *forest community*. Forest communities are the fundamental unit in the description and ecological classification of forests. Characteristic forest communities are distributed locally according to important environmental gradients, such as lowland white spruce to upland lodgepole pine, with different forest community variants found in different regions of the Yukon.

> *"Ecosystems are defined as much by their processes as by their structures."* [3]

Forest Processes

In the past, forest ecosystems were described and classified primarily by their major plant species compositions. It is now recognized that ecosystem processes are as much a part of the definition of forest ecosystems as their canopy-understory associations. Forest ecosystem processes refer to the rate,

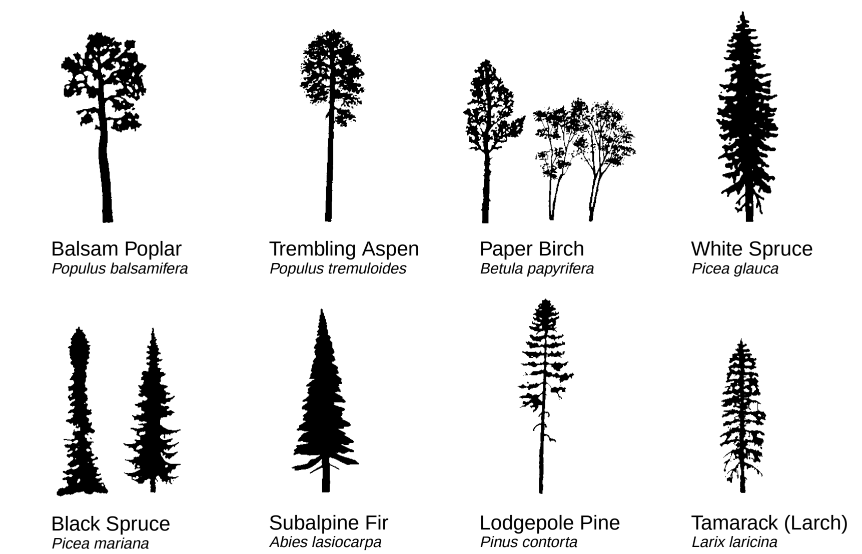


Figure 5.3 Tree species of the Yukon

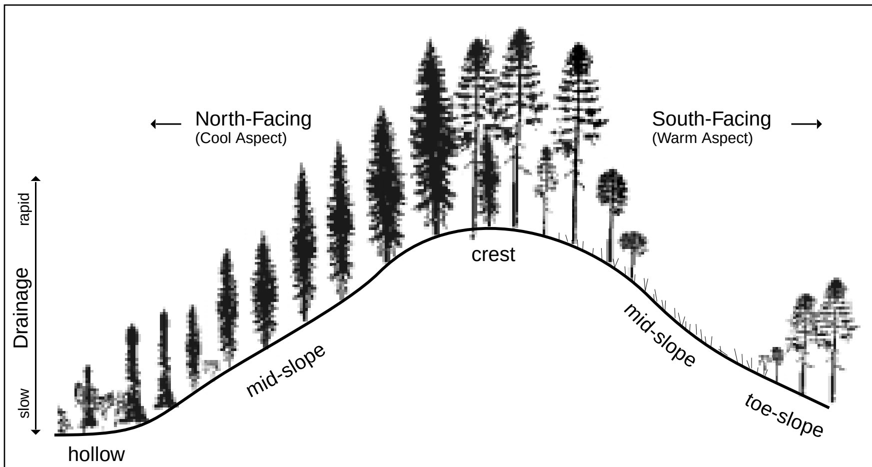


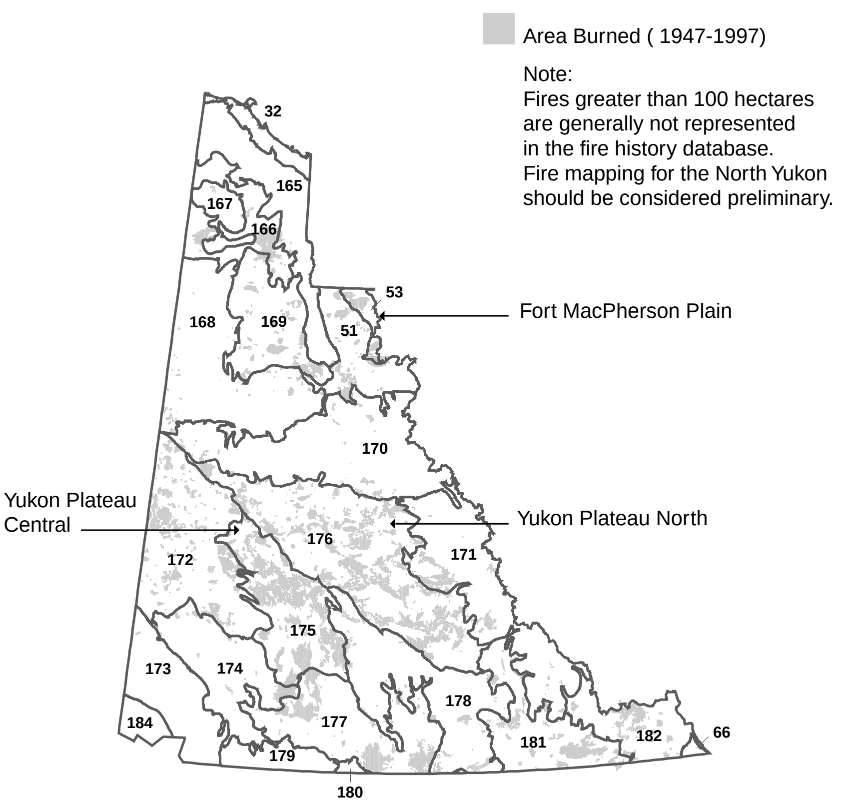
Figure 5.4 Environmental gradients

This environmental gradient diagram shows the typical change in soil drainage conditions between upland and lowland sites, and the difference in soil temperature between cool and warm slope aspects. Different types of forest communities are generally found growing under characteristic environmental conditions. Forest communities are the fundamental unit in the description and ecological classification of forests.

Location	Ecozone	Ecoregion	Community	Mean Temp (°C)	Mean Precip (mm)
60°45'N, 137°30'W	Boreal Cordillera	Ruby Ranges	Haines Junction, YT	-3.2	292.5
60°05'N, 128°44'W	Boreal Cordillera	Liard Basin	Watson Lake, YT	-3.3	425.2
54°45'N, 101°55'W	Boreal Shield	Churchill River Upland	Flin Flon, MB	-1.0	475.8
48°10'N, 77°0'W	Boreal Shield	Lake Timiskaming Lowland	Val D'Or, PQ	1.0	919.7

Table 5b Temperature and precipitation data for selected communities across Canada
Climatic variation between the major terrestrial ecozones and ecoregions of Canada has a large effect on forest conditions found in each region.

extent and distribution of nutrient cycling, natural disturbances and stand dynamics. In Yukon boreal forests, wildfire, insects and diseases, blowdown and flooding are all important natural disturbance agents that play critical roles in the functioning of ecosystem processes. Different forest communities in different landscape positions within the various ecoregions of the Yukon have characteristic rates, patterns and intensities of these disturbances. At the landscape scale, fire is generally considered to be the dominant disturbance agent in the Yukon's boreal forests. Large gains in understanding have been made in the fields of *landscape* and *natural disturbance ecology* within the Yukon over the past five years (Figure 5.5).



ECOREGION	CODE
Yukon Coastal Plain	32
Peel River Plateau	51
Fort Macpherson Plain	53
Muskwa Plateau	66
British Richardson Mountains	165
Old Crow Basin	166
Old Crow Flats	167
North Ogilvie Mountains	168
Eagle Plains	169
Mackenzie Mountains	170
Selwyn Mountains	171
Klondike Plateau	172
Saint Elias Mountains	173
Ruby Ranges	174
Yukon Plateau-Central	175
Yukon Plateau-North	176
Yukon Southern Lakes	177
Pelly Mountains	178
Yukon-Stikine Highlands	179
Boreal Mountains and Plateaus	180
Liard Basin	181
Hyland Highland	182
Mount Logan	184

Figure 5.5 Fire activity within each of the Yukon's 23 ecoregions from 1947-1997
Great variation in fire activity exists between Yukon's ecoregions due to differences in forest cover, lightning activity and climate. Area burned is shown as a percentage of each ecoregion within the Yukon. The Yukon Plateau-Central and Yukon Plateau-North ecoregions experience the highest levels of fire activity in Yukon. Most of the Fort MacPherson Plain ecoregion is contained in the Northwest Territories; a few large fires in the Yukon portion of the ecoregion create an artificially-high per cent area burned statistic for the 50 year period of record.

Ecoregion Variation: Forest Differences Across Yukon

All of the Yukon's forests are considered boreal, but the territory is a vast landscape with large regional differences in climate, geology, landform and vegetation. The National Ecological Framework [4] provides a broad ecological classification system for describing the similarities and differences that occur between the diverse regions of the Yukon (Figure 5.5). The National Ecological Framework exists for all of Canada, allowing a comparison to be made between Yukon boreal forests and eastern Canadian boreal forests or adjacent boreal regions in British Columbia (Table 5b). Forests in southwest Yukon are some of the driest boreal forests in Canada, if not the world. The most diverse and productive forests in the territory are located in southeast Yukon.

Forest Management

Forest management is a combination of planned forest-related activities, ranging from forest protection, health and conservation to forest harvesting and renewal, which are applied and monitored over specified time frames and geographic areas. Forest management within the Yukon has changed dramatically since the 1995 Yukon State of the Environment Report. The large increase in harvest volumes during the 1994/95 operating season necessitated a critical examination of Yukon forest management policy and capacity. The federal government is currently in the process of devolving, or handing over, forest management responsibilities to the Yukon and First Nation governments. The settlement of First Nation land claims is key to this process; seven of 14 First Nation Final Agreements have been signed.

Forest Management Policy

In planning for forestry devolution, the Yukon has prepared itself to assume forest management responsibilities. The management arrangements that have been established are unique within Canada. First Nation Final Agreements establish the basic principles of sustainable forestry and integrated resource management. The Umbrella Final Agreement gives Yukon communities a direct voice in resource management through the creation of local Renewable Resource Councils and Regional Land Use Planning Commissions. These agreements, along with the Yukon First Nation self government agreements, lay the foundation for strong working relationships among the Yukon and First Nation governments, and local communities in the cooperative management of Yukon forests.

The Yukon Forest Commission was established in 1996. During 1997 and 1998, the Yukon government undertook a territory-wide public consultation process that led to the development of the Yukon Forest Strategy [5]. As a planning framework, the strategy provides a public vision for the management of Yukon forests. It outlines the broad goals, objectives and principles required for the development and delivery of made-in-Yukon forest legislation.

Forest Management Planning and Practices

At the cornerstone of the Yukon Forest Strategy are the principles of *ecosystem-based management* [6]. Many definitions have been proposed for ecosystem-based management but all share a common principle; societal and economic desires must be achieved within the ecological constraints of the managed system. Ecological systems have thresholds that cannot be crossed without affecting plant and animal populations over the longterm. Approximately one quarter of the Yukon's forested land base is considered productive, or being biologically capable of producing economical timber harvests within reasonable time frames.

The Yukon is divided into 13 Forest Management Units (Figure 5.6). These management units are based on the major watersheds of the territory. Forest management planning and reporting activities are based on these watershed-delineated areas.

Integral to sustainable forest management is the development of an objective *timber supply analysis.* A timber supply analysis is an assessment of future timber supplies over long planning horizons that take into account tree growth rates, natural disturbance patterns, and a variety of management assumptions. Such an exercise is critical to determine the capacity of a system to produce a sustained level of forest products over long time periods. The first preliminary timber supply analysis for southern Yukon was completed in 1998 [7]. Based on this exercise, historical harvest levels decreased in some areas but increased in others. The ultimate decision regarding sustainable harvest levels must include the input of local communities through established planning frameworks.

Several key forest management developments have occurred in the Yukon during the past five years that reflect a shift towards ecosystem-based management.

Yukon Forest Strategy Goals

- *build cooperative forest management approaches*
- *protect the health of Yukon forests*
- *plan for an integrated and balanced approach to forest use*
- *build a resilient and diverse forest economy*

- Development of Harvest Planning Areas (HPAs). Recently, forest harvesting was administered on an individual harvest-block basis; forest operators applied for merchantable timber and each permit was treated as a separate unit. HPAs have been adopted by DIAND Forest Resources as the principal forest harvesting land management unit. In this model, a number of individual operators work within a planned harvest area where stream buffers, sensitive soils, cultural values and other similar features have already been identified and netted out of the operable land base. In the absence of regional land use plans and the general lack of long-term forest tenure for most areas of the Yukon, HPAs are an important step towards the delivery of landscape-level forest management goals. To date, almost all HPAs occur in southeast Yukon.
- Completion of a Preliminary Timber Supply Analysis for Southern Yukon. A preliminary timber supply analysis was completed for southern Yukon in 1998 [7]. Understanding the capacity of Yukon forests to produce a sustained yield of forest products is a key component of ecosystem-based forest management. 1998 was the first time such an objective timber supply assessment was performed in the Yukon.
- Establishment of the Elijah Smith Forest Renewal Program (ESFRP). In August of 1995, DIAND Forest Resources developed the ESFRP to ensure that harvested areas are reforested. To date, this has generated approximately $2.5 million to be used on forest renewal projects. ESFRP funding is provided through a $5 surcharge to forest operators for each cubic metre of wood harvested. Another $1.9 million is expected to be collected before the end of the 1999-2000 fiscal year. The re-planting that is possible through this forest renewable fund supplements the natural regeneration of the forest. Focused forest renewal efforts in Yukon only began in 1993.
- Completion of the Yukon Silvicultural Information System. The location and status of all harvest blocks in the Yukon has now been entered into a geographic information system, to assist in a more accurate assessment of cutting levels and forest regeneration.
- Incorporation of Natural Disturbance Dynamics into Timber Harvest Operational Guidelines. The boreal forest is considered to be a system that evolved with, and is dependent on, disturbance. Natural disturbances such as fire, forest insects and diseases can be highly variable. For example, fires may be large or small, they may contain patches of unburned vegetation, or they may consume entire trees or just surface vegetation. Similarly, some forest insects may affect only individual trees, while others, like the spruce beetle, have the potential to affect hundreds of thousands of hectares. While great variation can and does exist, some natural disturbance patterns can be observed and quantified for specific vegetation community/landform associations. The current Operational Guidelines [8] recognize distinct *natural disturbance zones* which are used to guide harvesting methods, patch sizes and reforestation options. Such information will assist in maintaining important ecosystem structures and functions, allowing a harvested area to better emulate a naturally-disturbed area.
- Development of an Ecosystem Classification System for Southeast Yukon. Recognizing and describing the variety of forest communities that occur in a region is integral to the success of ecosystem-based management. The development of a mappable, ecologically-based land stratification system is key to understanding the distribution of the different forest communities. A detailed forest ecosystem description and classification guide for southeast Yukon was completed in 1996 [9]. While this system is useful for site specific interpretations and management recommendations, it has the shortcoming of being non-mappable. Also, southeast Yukon is currently the only region where such a classification has been completed. Several other products exist for other regions of the territory [10,11,12,13] but no detailed, comprehensive land classification system has been developed for the Yukon.

Figure 5.6 Forest Management Units of the Yukon
Thirteen Forest Management Units are contained within the territory, each based on a major Yukon watershed.

- Forest Health Assessments and Monitoring. Permanent forest health monitoring plots have been established in various locations across the Yukon to record forest health, insect and disease conditions. Detailed assessments have occurred in priority areas such as the spruce bark beetle infestation in the Kluane Region of southwest Yukon and spruce budworm/heart rot disease conditions in the La Biche Region of the extreme southeast Yukon.

Forest Management – Measuring Success

We may never fully understand all of the complex inter-relations of the boreal forest. However, some forest management issues occur within the Yukon that require immediate decisions. To deal with potential uncertainties, a key component of ecosystem-based management is the concept of *adaptive management.* Adaptive management means simply to learn from our actions. When a forest management treatment is recommended, a specific outcome or result must be anticipated. The effects of the treatment must then be monitored to examine whether the management action resulted in the desired outcome. If differences are found between the observed and expected, management recommendations must incorporate these findings and adapt to the new information. Only by this method will it be possible to improve our forest management practices. In slow growing forest regions like the Yukon, the results of management actions may not become apparent for long periods of time. Such implications require a high level of caution with forest management planning and decisions.

The ultimate test of Yukon forest management decisions will be the long-term health of forest ecosystems and the continuation of a sustainable forest industry. Nationally, the Canadian Council of Forest Ministers has agreed upon a framework of six criteria with 83 indicators to measure the success or failure of sustainable forest management initiatives [14]. Internationally, Canada is part of the Montréal Process [15], a working group of 12 countries that is developing and promoting a framework of sustainable forest management criteria and indicators for temperate and boreal forests outside Europe. Similar to the national effort, the Montréal Process has seven major criteria with a total of 67 indicators. Yukon has a national and international commitment to participate in these sustainable forest management efforts. The ability of the Yukon to achieve and measure these key forest indicators will be a significant challenge in the coming years.

Fire Management

Forest fire management has been an important activity of DIAND Forest Resources in the Yukon since the 1950s. Since this time, the territory has been zoned into either *Fire Action* or *Fire Observation Zones* (Figure 5.7). The Fire Action Zone is defined primarily by important transportation corridors, town sites and private infrastructure; all fire starts within this zone

”There must be an ecological classification of the forest” – Hamish Kimmins, 1998. Keynote Address to Sustainable Forest Management Conference.

“There can be no vision for the future of our forests, and no ecologically-based land allocation strategy, until the ecological variability (the ecological diversity) of our forests has been recognized and described...the process of ecosystem inventory and classification must be completed for the whole country”.

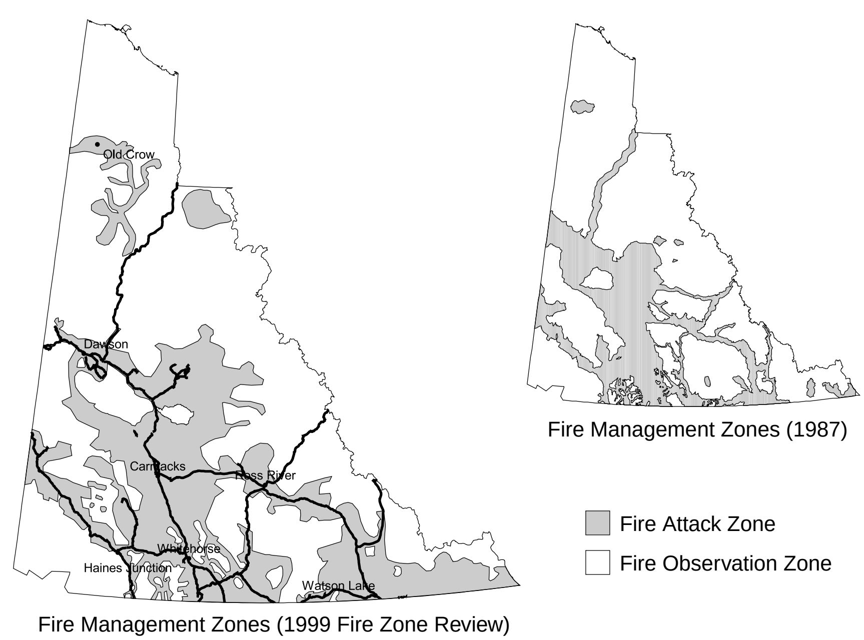


Figure 5.7 Fire Action and Fire Observation Zones of the Yukon
A 1998/99 review of the 1987 Fire Action Zone resulted in some original areas being removed while other areas were added. Such a shift reflects the changing values of Yukon’s forests.

are fought aggressively upon detection. The Fire Observation Zone includes areas farther away from infrastructure or roads. Fires occurring in the observation zone are only actioned if they pose a threat to public safety or infrastructure. A fire zone management review took place in the early summer of 1999 to update the original Fire Action and Fire Observation Zones (Figure 5.7). In some situations, this public process resulted in a shift in the Fire Action Zone away from historical transportation corridors to areas with high timber harvesting values, cultural values or important ungulate habitat. Such a shift reflects the changing values of Yukon forests.

Community fire protection has become a major issue in the Yukon in the past five years [16,17]. Fire hazard and forest fuel mapping are being completed around most Yukon communities. A Fire Smart Program has also been established to provide communities with fuel management expertise and funding. Such a trend indicates a more proactive approach to fire management within the Yukon and a changing emphasis from suppression to management.

Human Use of Yukon Forests

Forest Harvesting

Historically, forest harvesting has been an important part of the Yukon economy for both personal and commercial uses. Fuel wood and building materials have been harvested around major mining centers and river corridors for approximately 100 years. Within this 100-year history, peak harvesting periods have been closely related to the level of economic activity in the territory at that time. Significant levels of timber harvest occurred during the Gold Rush; it is estimated that 253,000 m^3 of wood was cut for river steamers, mining and domestic purposes in 1900 alone [18]. Most forest harvesting prior to the 1970s was done with hand tools, chainsaws or light equipment.

Since the 1970s, forest harvesting in the Yukon has changed dramatically. Forestry has grown from small-scale, labour intensive logging operations to the point where it is now predominately a mechanized, industrial-scale activity [19, 20]. Since the 1970s, most forest harvesting has occurred in southeast Yukon and has focused almost exclusively on high value, alluvial white spruce timber along major river valleys such as the Liard, Rancheria, Coal and Hyland (Figure 5.8). Only in the past few years have significant timber volumes been obtained from upland spruce and pine stands.

Since the 1994/95 peak in harvest levels, demand for Yukon timber has remained high. Timber shortages in British Columbia and Alberta have created heightened interest in the fiber values of southeast Yukon forests. Also, a new, modern sawmill with a 200,000 m^3 annual capacity was built by South Yukon Forest Corporation in Watson Lake in 1998. The South Yukon Forest Corporation has indicated an interest in a long-term timber lease in the Watson Lake region. Kaska Forest Resources is currently the only forest company with a long-term timber harvest agreement in the Yukon.

The preliminary 1998 Timber Supply Analysis for Yukon [7] determined a sustainable harvest level of approximately 400,000 m^3 for the six southern Forest Management Units. Since the 1994/95 operating season, harvest levels in Yukon have ranged from 250,000 m^3 to 350,000 m^3, with the majority of the volumes being harvested in the Watson Lake and La Biche Regions of southeast Yukon (Figure 5.9). Such sustained levels of mechanized forest harvesting have not occurred in Yukon before.

Forest Harvesting Impacts

Without integrated forest harvest planning, there is the potential for impacts to other forest values. The impacts of forest harvesting are dependent on numerous factors including the methods, season and area of harvest, the amount of standing and downed material left on the site, and the reforestation methods. Given all of

Archival photo of 1900 wood camp along the Yukon River
Significant volumes of fuel wood were harvested along major river corridors in Yukon during the steam boat era between the late 1800s and the 1950s.

these factors, it is difficult to generalize the impacts that forest harvesting has on the environment:

- Forest Landscapes. The effect of intensive forest harvesting on the boreal forest landscape is to generally increase the number of small patches and linear disturbances (i.e. roads), leading to various levels of *landscape fragmentation* [21]. The development of HPAs in southeast Yukon has concentrated forest harvesting activities into smaller areas, minimizing the amount of landscape-level fragmentation but, increasing it locally.

Archival photo of 1940s forest harvesting operation near Mayo
Prior to the 1970s, most forest harvesting was done with hand tools, chainsaws, or light equipment.

Mechanical Tree Harvester working in the Liard Basin of southeast Yukon
Since the 1970s, most forest harvesting in the Yukon has relied on the use of heavy equipment..

- Forest Ecosystems. To maximize profitability, forest harvesting tends to focus on specific types of forest ecosystems in mature age-classes. From the 1970s to the early 1990s, most forest harvesting was concentrated in the productive, mature alluvial white spruce forest ecosystems of major river corridors in southeast Yukon. These forest ecosystem types are very limited in extent; between 1970 and 1994 it is estimated that at least 30 per cent of the total alluvial white spruce ecosystems in the region were harvested. Since the early 1990s, most forest harvesting has been concentrated in mature, upland pine and spruce ecosystems around Watson Lake. Upland sites with adequate volumes of mature forest that are accessible from the existing road network are becoming difficult to find in the Watson Lake area.
- Water. Forest harvesting may impact watercourses through the development of stream crossings or from minor fuel spills. Increased snow accumulation in harvest blocks with rapid spring melting can affect local hydrologic regimes. Water impacts of forest harvesting have not been well documented in the Yukon but are generally considered to be relatively minor. To minimize impacts on water, forest harvest operating ground rules require minimum riparian buffers and set established guidelines for stream crossings.
- Soil. Increased soil erosion due to the removal of forest cover, a common problem in British Columbia due to steep, mountainous terrain and high levels of precipitation, is

generally not a large concern in the Yukon, as boreal landscapes are not as steep and the levels of precipitation are much less. Before 1995, much of the forest harvesting in the Yukon occurred in lowland riparian spruce forests. The removal of large patches of forest cover from these areas and the associated heavy equipment impacts resulted in elevated water tables at some locations. Reforesting these areas has been problematic. Winter harvesting on upland sites decreases the impacts to soil and groundcover.

- Wildlife. The size of the forest harvest patch, the amount of forest cover removed and the operating period are the key determinants to wildlife impacts. Forest harvesting generally results in an immediate decrease in the amount and quality of habitat for some wildlife species, most notably forest birds and raptors, small mammals and foraging ungulates such as woodland caribou. However, as the harvest areas begin to re-forest with early successional species, such as willow and trembling aspen, new habitats become available. The transition from young to middle-aged to mature forest is usually accompanied by distinct assemblages of wildlife species. Many of the undesirable wildlife impacts associated with forest harvesting are the result of increased access into previously inaccessible areas. Increased human activity in the forest and the associated rise in hunting pressures are especially acute for ungulates such as woodland caribou and moose. Forestry and woodland caribou conflicts are becoming apparent in both the Watson Lake and Southern Lakes regions of the territory.

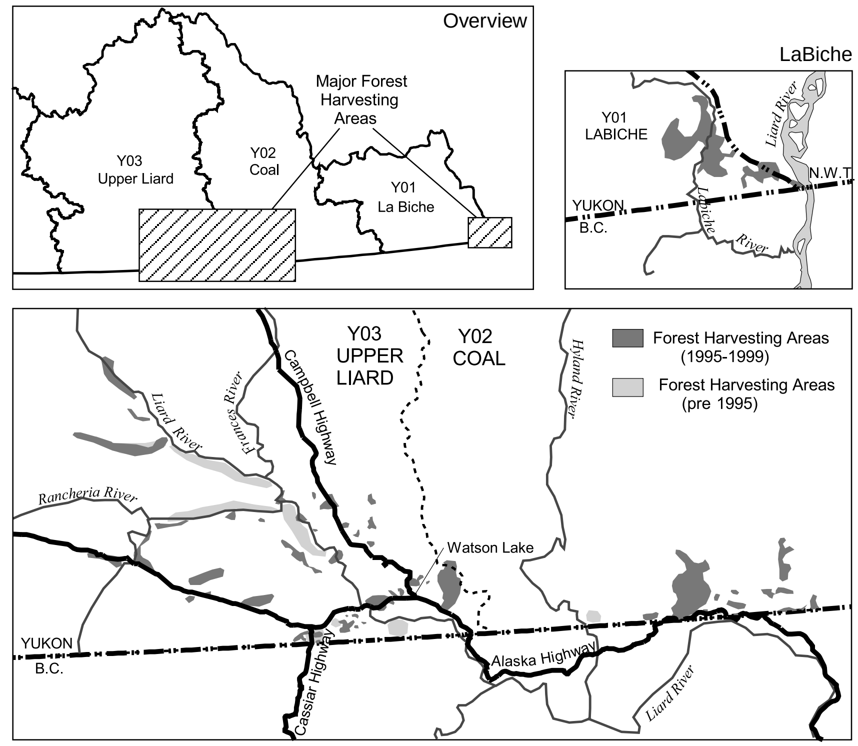
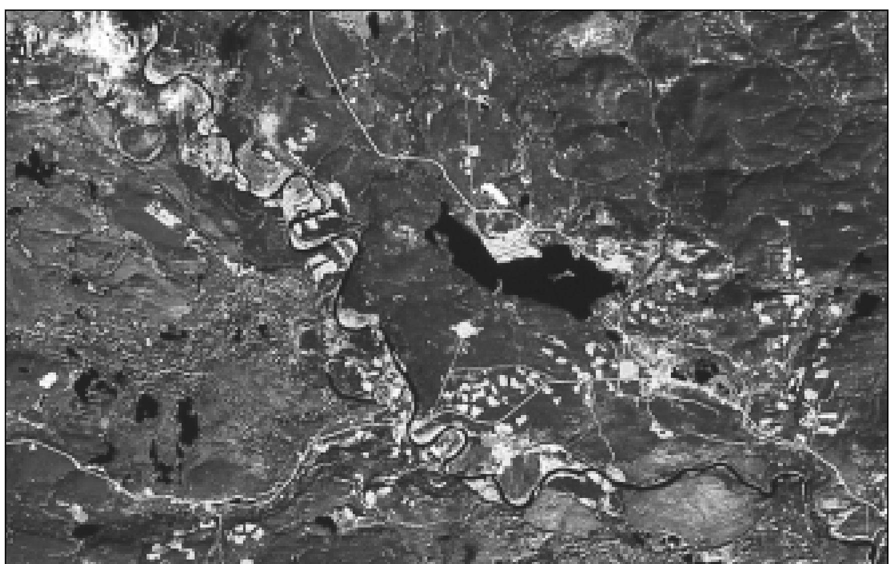


Figure 5.8 Major forest harvesting areas in southeast Yukon
Prior to the mid–1990s, most forest harvesting occurred in riparian areas along major river valleys such as the Liard, Rancheria, Coal and Hyland. Since this time, significant forest harvesting activity has been concentrated in upland spruce and pine stands. In the past 20 years, the highest levels of forest harvesting activity have occurred in the Watson Lake District - Forest Management Units Y01 (La Biche), Y02 (Coal) and Y03 (Upper Liard).



Satellite image of Watson Lake area, southeast Yukon
Forest harvesting and road infrastructure generally lead to increased levels of landscape fragmentation. Forest harvest blocks appear as regular-shaped, bright patches on the satellite image. Most upland forestry developments visible in this scene have been harvested since the 1993/1994 operating season. (LANDSAT TM sensor, August, 1998)

Non-Timber Forest Uses

In addition to timber values, Yukon forests are valued for many other uses. The harvesting of morel mushrooms in recent burns has created an important summer industry in the territory since 1995 [22]. While this summer activity can provide seasonal employment, littering, water pollution, high-impact camping and increased fire risks have been associated with this activity. Other important non-timber forest uses rely on the maintenance and sustainability of intact, productive forest ecosystems. Subsistence hunting and gathering, spiritual and aesthetic values are difficult to evaluate in terms of economics but are of the utmost importance to residents of the Yukon. Forest ecosystems are also valued for outdoor-based recreational pursuits, nature appreciation and wildlife viewing. Much progress has been made in the past five years towards the development of modern timber harvest guidelines to minimize the impacts of forest harvesting and prevent long-term degradation of the Yukon's forests.

Key Forest Statistics

The following section presents a summary of key forest statistics for the Yukon.

Forest Harvesting

Forest harvesting activity has remained relatively high since the large increase during the 1994/95 operating season (Figure 5.9). Annual harvest volumes have ranged between 250,000 and 350,000 m^3 for the period 1995-1998, with the majority of forest production focused on saw logs. While harvesting activity has not risen above the peak 1994/95 volumes in the Watson Lake region, harvesting activity has increased from pre-1995 levels in nearly all other forest management units.

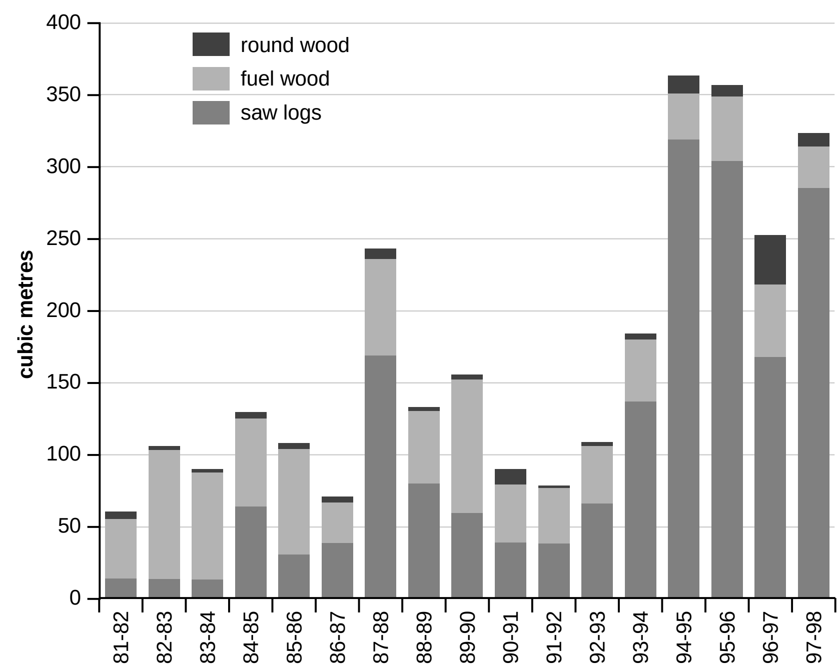


Figure 5.9 Primary Forest Production in the Yukon
Forest harvesting has remained between 250,000 m3 to 350,000 m3 since 1994/95.

Forest Renewal

Since the establishment of the Elijah Smith Forest Renewal Program (ESFRP) in 1995, large gains have been made towards reforestation. The ESFRP has collected over $2 million since 1995. This has been used to reforest approximately 2,000 ha of harvested area with over three million tree seedlings (Figures 5.10). While this is an excellent step towards sustainable forest management, the current rate of forest harvesting is keeping pace with the rate of planting; the result is only a minor gain in total reforested area (Figure 5.11)

Forest Economy

Forest harvesting is an important source of employment, fuel-wood and building material in the Yukon. Although not a large portion of the measured Yukon economy (Figure 5.12), the value of Yukon forest international exports has been growing in recent years. Due to the recent construction of two new milling facilities, exports from the Yukon forest industry to other countries grew from an estimated $150,000 in 1994 to over $6.4 million in the first ten months of 1999 alone.

Forest Fire Activity

Related primarily to climatic conditions, the summer fire seasons from 1995 to 1998 saw a large variation in the total annual area burned (Table 5c). High profile fires occurred during this period near most Yukon communities. In late summer of 1999, several dwellings were destroyed in the community of Burwash Landing as a result of a human-caused fire.

Forest Health

Several major forest health issues have been affecting various regions of the Yukon over the past five years. A major spruce beetle *(Dendroctonus rufipennis)* outbreak is continuing in the Kluane region of southwest Yukon and in the Alsek-Tatshenshini River drainages of northern British Columbia (Figure 5.13). This outbreak was first detected in 1994 but has probably persisted since about 1991. As of fall, 1998, this spruce beetle infestation had affected approximately 200 000 ha of forested land. In some forest areas, almost 100 per cent mortality of the mature forest canopy has occurred. Preliminary assessment of the beetle in the summer of 1999, indicated that the rate of beetle population increase had slowed. A forest insect infestation of this size and intensity has not been observed in the Yukon before.

Subalpine fir stands in high elevation areas across southern Yukon have experienced high levels of western balsam bark beetle *(Dryocetes confusus)* activity over the past years. The areas most affected occur in the southeast from Watson Lake to the Labiche River and in the Southern Lakes area, above Tagish Lake and the community of Carcross.

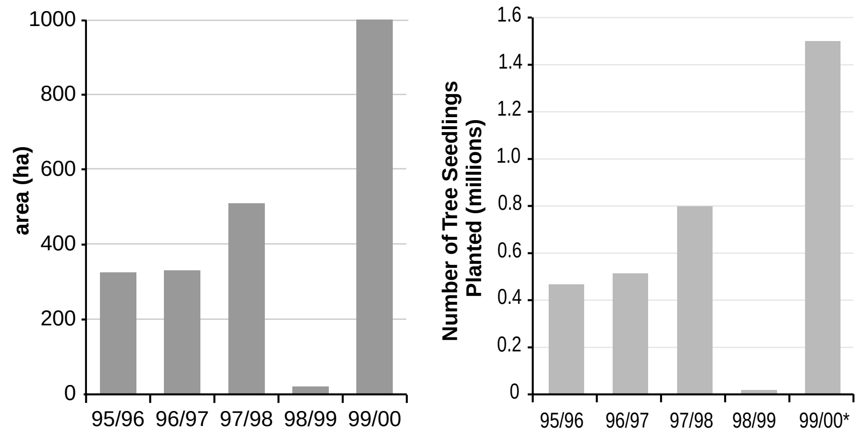


Figure 5.10 Area planted in the Yukon (1995-1999)
Number of tree seedlings planted in the Yukon (1995- 1999)
**Note: 1999 tree planting statistics unavailable at time of publication. One thousand ha of harvested area and the planting of 1,500,000 tree seedlings was planned for tree planting activities during the summer of 1999.*
***The large decrease in area and in number of seedlings planted during the 1998 season was a direct result of high fire suppression expenditures.*

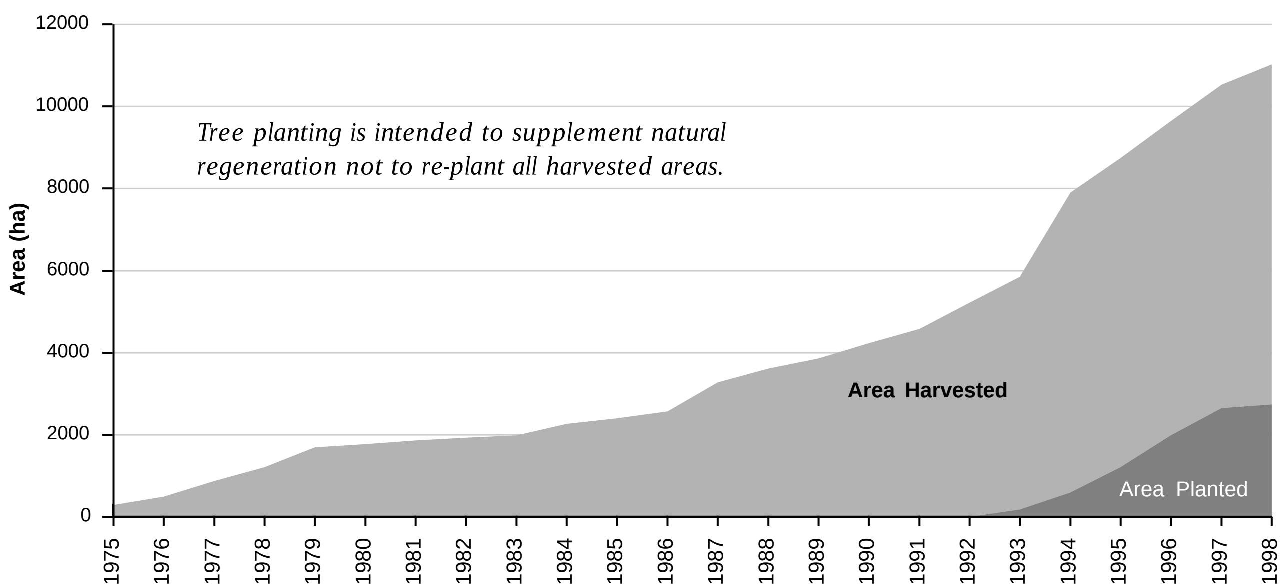


Figure 5.11 Balance of forest land harvested and planted in the Yukon (1975-1998)
This figure shows the cumulative area harvested and planted (each year's total is added to the previous year's total). A large backlog of harvested area exists in the Yukon, some dating back to the 1970s. Large increases in tree planting along with regeneration, is assisting in ensuring sustainable forests.

**Note: 1999 harvest and planting data unavailable at time of publication. The planting of 1,500,000 tree seedlings was planned for the 1999 planting season.*
***Area of land harvested is estimated from the volume harvested, using a conversion factor of 200 m³ per hectare. This conversion factor is considered to be a good average for southeast Yukon but may be high for other areas.*
****The total amount of land impacted by forest harvesting would be higher as this estimate does not include roads, landings and salvage logging.*

Several defoliating insects have affected deciduous forests along the North Klondike Highway over the past years. An area of several thousand hectares of young trembling aspen forest was moderately and severely defoliated by the large aspen tortrix, *Chroristoneura conflictana*, beginning just north of Braeburn along the Klondike Highway. Up to 100 per cent of trembling aspen leaves were mined by the aspen serpentine leafminer, *Phyllocnistis populiella*, over a very large area stretching from Carmacks in the south to Dawson City in the north. Leafminers have been present consistently in this general area from 1994 to 1999 with the most severe damage occurring in stands between Stewart Crossing and Mayo. Despite the severity of repeated infestation, the trees appear to have sustained little damage, though the compromising of their photosynthetic capacities may have resulted in a reduction of growth increment.

Drought stress is thought to be responsible for the decline of forest health in various areas across the territory with many red and dying trees being observed in the Whitehorse area.

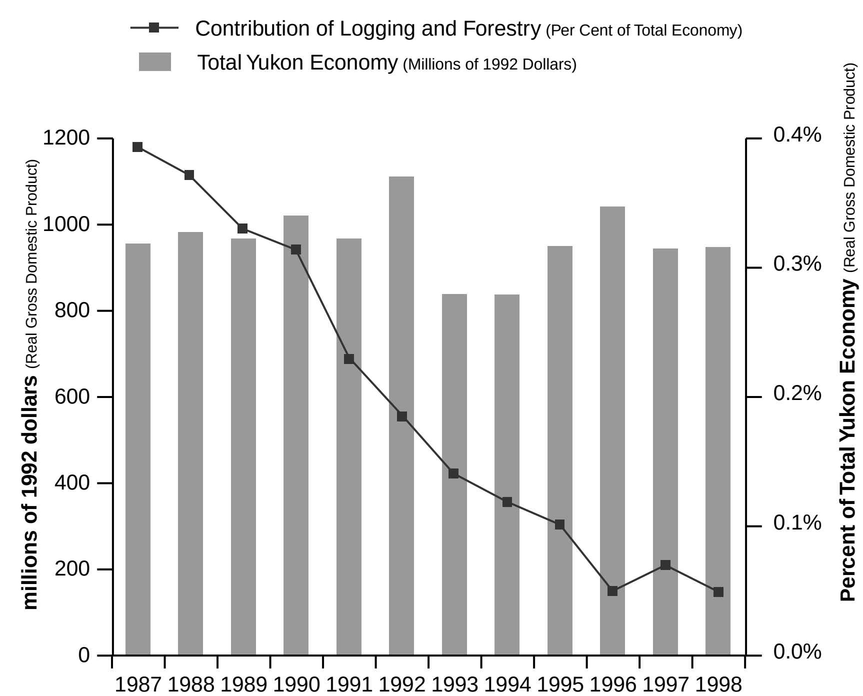


Figure 5.12 Forestry and Logging as a Percentage of the Yukon Economy
Contribution of forestry and logging as a percentage of the Yukon economy ranged from 0.4% in 1987 to 0.05% in 1998.

YEAR	AREA BURNED (HA)	FIRE STARTS	HUMAN CAUSED	LIGHTNING CAUSED
1995	271,645	148	71	77
1996	106,175	147	71	78
1997	10,170	112	70	42
1998	387,800	197	110	87

Table 5c Forest fire statistics for the Yukon (1995-1998)
*Approximately 776 000 ha of forest land was burned in the Yukon during this four year period. *Note: 1999 fire statistics unavailable at time of publication.*

Yukon Forests and Climate Change

We don't know how rising temperatures will affect the Yukon forests, but several trends are beginning to emerge. Forest insect species generally associated with more southerly conditions have been documented recently in the Yukon as they possibly expand their range northward. These include the western balsam bark beetle (Dryocetes confusus) which affects high elevation subalpine fir, the lodgepole terminal weevil (Pissodes terminalis), which is now well established in many lodgepole pine stands from Whitehorse to Watson Lake, and the eastern spruce budworm (Choristoneura fumiferana). A small spruce budworm outbreak was detected between km 30 and km 50 of the Dempster Highway, the most northerly infestation of that insect ever recorded. The duration and intensity of insect and disease activity may also increase, with the unprecedented success of spruce beetle activity in the Kluane Region being an obvious example.

It has also been hypothesized that tree line may advance northward, perhaps even reaching the Arctic coast [2]. Under drier, warmer conditions, wildfire intensity and activity may also increase which could facilitate the rapid conversion of some forested areas to shrub or grasslands [23]. The highest recorded levels of wildfire activity across western North America, despite enormous fire suppression efforts and expenditures, have all occurred during the 1990s [24].

PROGRESS & CHALLENGES

Progress since 1995

- *The Elijah Smith Forest Renewal Program resulted in the collection of over $2 million for forest renewal projects such as tree planting and site preparation.*

- *The use of resource reports and timber supply information has assisted in a planned approach to forest harvesting in the Yukon.*
- *The creation of modern Timber Harvest and Operational Planning Guidelines which incorporate natural disturbance-based principles and establish a number of guidelines to minimize harvesting impacts on soil, water and wildlife.*
- *The establishment of long-term forest health monitoring plots will allow forest health issues to be monitored over meaningful time frames.*

Challenges

- *The slow pace of regional land use planning throughout the Yukon has hampered regional forest management planning activities.*
- *The potential impacts of forest harvesting on other user groups, especially subsistence users.*

5.3 The Traditional Way of Life

Prior to the fur trading period in the Yukon (approximately mid 19th century), the indigenous people of the Yukon participated in a hunting and gathering society. The people belonged to small, highly mobile family groups that followed a seasonal round, camping at fishing sites during the salmon run, moving into the mountains to hunt, finding shelter and food besides ice-fishing lakes during the winter [1]. Throughout most of the year, family groups traveled across large areas. A single hunter would often utilize resources over an area up to one thousand square miles [2].

This way of life had a relatively low impact on the land. There was evidence of fires set by the First Nation people to enhance habitat, but little long-term change to the land. Foot trails connected the harvesting areas and trading routes linked the interior to the coast [3]. As the groups traveled by foot or boat from place to place, their goods were few and portable. A set of poles and ring of stones may have been all that remained when the group moved to the next camp. The footprint on the land from this hunting gathering society was light.

Not many people would want to return to a society that had to survive off the land. However, there remain at least a few Elders, some who still live out on the land, who think back to the time of their childhood with the happiest of memories. While the hunting and gathering society is vanishing, there are lessons to be learned from the Elders who recall those earlier times and remember stories told by their parents and grandparents.

As part of the research for this report, a group of Elders met to provide advice on the scientific information being gathered for the State of the Environment report. This group of Elders also provided traditional knowledge for the 1995 report and were able to give their understanding of what has changed in the environment over the past five years. Their comments on water quality, land, wildlife, fish and various land uses are integrated throughout the report. The Elders also told stories of

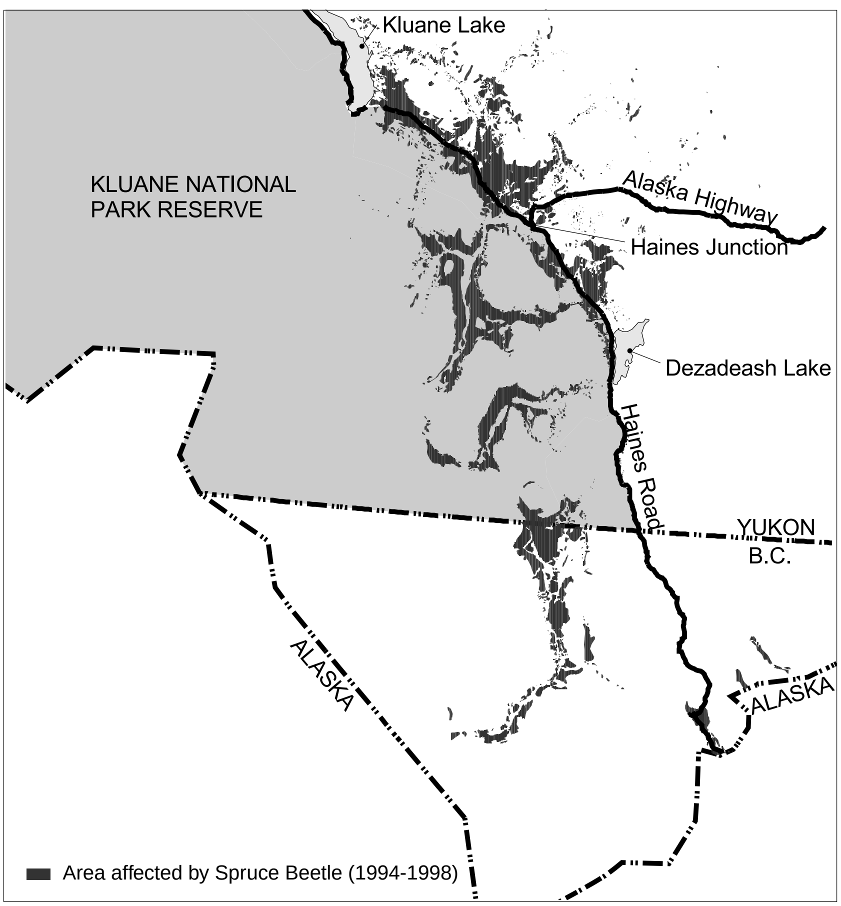


Figure 5.13 Area affected by Spruce Beetle
As of fall, 1998, this outbreak of spruce beetle (Dendroctonus rufipennis) *had affected approximately 200 000 ha of mature forest in the Alsek and Tatshenshini River watersheds of the Kluane region of southwest Yukon and northern British Columbia.*

Shya (meat cache) at the Black Fox Caribou Fence, Northern Yukon. Photo by Raymond LeBlanc, 1992.

Canoes arrive at Ft. Selkirk. Schwatka, 1883.

Arrow or Dart Shaft, dated approximately 7,000 years ago, from Thandläat site near Kusawa Lake. Photo by Government of Yukon.

how they used to live 40 or 50 years ago in a traditional way of life [4]. Below are two accounts from the 1920s and 1930s of their hunting and gathering activities and their travels.

Stella Jim (Champagne and Aishihik Elder)

I like to travel a long time ago when my mother and dad were going on the trapline. We have to go with the dog pack from here (Whitehorse) to Fifty-two Mile (near Takhini Crossing 30 km west of Whitehorse). We go by dog pack and leave everything for the team of horses. Five dogs pack everything for us, our clothing, grub, our bedding, our tent, whatever.

Springtime come and then we go hunting again for rats, beaver, then move to Champagne, to Harold Chamber's camp. That's the other side of the lake. Go hunting there: beaver hunt all spring; walk with dog pack back (to Fifty-two mile). From there on until June start walking to Klukshu.

We would go down to the creek at Klukshu and start fishing right away. Get fish in no time; lots of people from everywhere camping, just white tents all over the place. In June and July, the fish would be dry by that time, getting ready to go back; start packing up your fish, about fifty in a bundle. Pack up and then go back again. I don't know how those old people did it. Some go with a horse pack, some go by boat, pack train, some with dog pack. On the trail, we would camp with each other. They had a campground long ways down where they're going to meet, where they're going to have lunch, everybody would sit around. Nice place, pick berries on the way down. Where you camp, already fish net set out for salmon, whitefish or trout. I wish I could see all those things again. Never see it again though. Never see it happen again.

We did all this when we were small; we

Stella Jim

walked for miles every day. When we get there, we still worked: gathered up some wood, fetched water, help the old people, packing water for them or getting wood. We worked all day but it wasn't like work. It was just as if we were playing.

In the morning we would make a fire; that's about the best time, sixty below in the morning in the tent. You want to be the first one to get up and make the fire inside the tent. My sister and I used to see who could get up first. You don't go back to bed after you get up once. That is a law to us: not to go back to bed. First thing is we'd run over to Grandma and Grandpa to make fire for them, but Grandpa was always up, sitting down beside the fire. That was a good life those days.

Grandpa, he don't want to stay in a cabin; he want to stay in a tent. He's a really old man when he come to Whitehorse from Fifty-two Mile. All winter, he'd stay down Fifty-two Mile. Then we'd come back down to the bottom of Two-Mile Hill. There's spring water there. Grandpa always stay there and make camp (where the government compound is now). He made a fish camp and then a main camp. Spring

The Elders described the society without waste:

Gopher snares were made of eagle feathers.

Sinew from moose was used for fish nets and babiche.

We could make a knife that was razor sharp from a caribou horn.

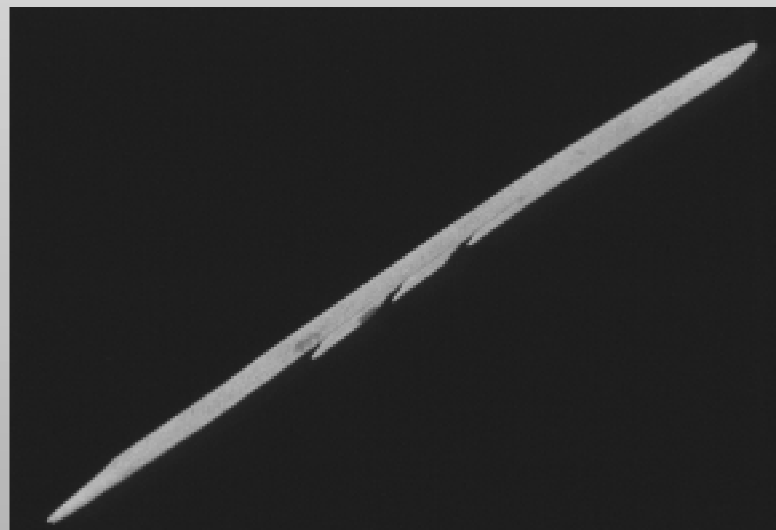
Fences were built with brush to make a corral where you would lead moose into snares.

Shelters were made with poles that were covered with moose hide. We would stick moss between the poles and leave a whole for the smoke.

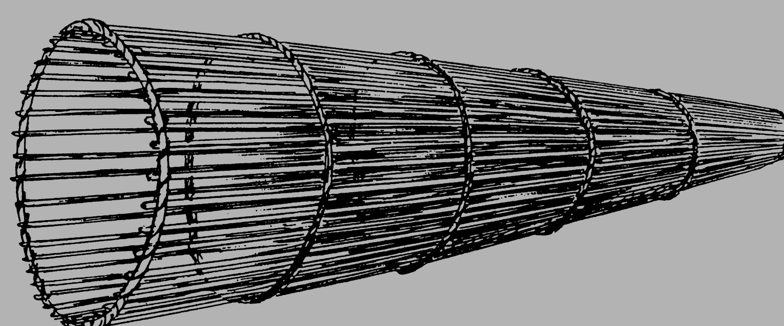
There were dome houses with a caribou skin on the top.

My mother (Annie Ned) used to make a toboggan from the shank of a moose.

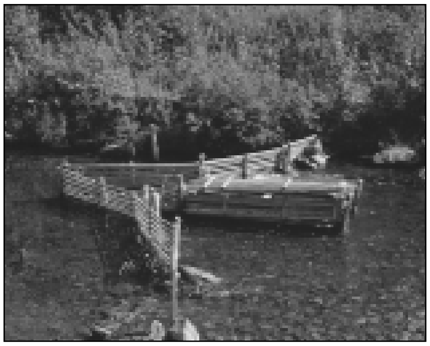
Sleighs were made with the caribou skin on the bottom. Going down hill, we would turn the hair around to provide a break.



Antler Point



River Fish Trap



Fish Trap at Klukshu

water is why he'd stay there, right at the mouth of that creek there and he'd set a fish net. Get fresh fish there. Any place old people stay, there's got to be fish.

There was an old camp at Dalton Post where they used to set fish trap. Jack Dalton and my grandmother used to live together. There were foot trails all over, from Carcross to Klukshu, to Fifty-two Mile and over to Hutshi. We traveled to Carmacks in the summertime with dog pack. Sometimes we go with a team of horses. Sometimes in the wintertime we go with toboggans.

Used to get lots of caribou. Used to remember when they come here to Whitehorse. The last time I see them come down that hill (into Whitehorse) was in 1942.

Charlie Dick (Ross River Elder)

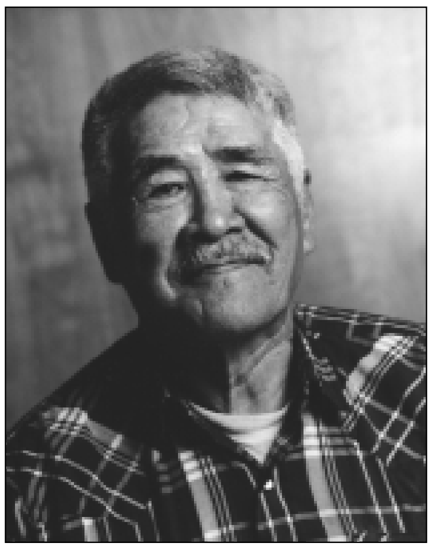
Springtime, people gather and all come together, sometimes for two weeks. People come from Carmacks, Fort Norman and Watson Lake. When the games are over, they talk and plan for the winter, telling each other where there is an abundance of game.

In summer, we prepare fish for the winter. Bundles are two to three feet high. Families tie ribbons on the bundles so not to mix them up, and put them in a high cache. In the fall, five families all go up to the mountains, where the men hunt moose, caribou and ground hogs. Women and children prepare gopher snares and pick berries.

When the men get two to three bull moose, families pack up and move to where the moose was killed. Women prepare a meal, cut and dry the moose and work on the skins. When the meat is dried, it is packed back to a fishing site and stored in the cache with the bundles of fish. We travel to many different places and when you run out of food, you come back to the cache.

Grandpa used to dry meat and fish, never seen money in his life, never go in a cafe. Grandpa said, "when I pass on, I want you to take care of the land."

Charlie Dick is a Kaska Elder living on the land.



Charlie Dick

Glossary

Words in Italics are defined or explained elsewhere in the glossary.

Abiotic factor: may be defined as factors that are non-biological that influence an outcome such as pH, temperature, humidity etc.

Alluvial: Describing something related to sediment deposited by moving water, such as alluvial deposits.

Anthrax: A highly contagious and often lethal bacterial disease that is caused by *Bacillus anthracis*. It afflicts cattle and sheep and can be transmitted to humans via infected raw meat, blood, or other fluids. Anthrax causes high fever, convulsions, and lung lesions.

Aquifer: A layer of rock or soil that holds or transmits *groundwater*.

Bioclimatic Zone: A major ecological region corresponding to a particular climate zone, with characteristic plants and animals (i.e. tundra or boreal forest).

Biodiversity (biological diversity): The term describing the variety of life on Earth. It refers to all animals, plants, and micro-organisms in terrestrial, freshwater, and marine ecosystems. It includes three levels: species, ecosystem and *genetic diversity*.

Boreal Forest: A forest made up mostly of conifers, such as spruce, forest and pine, and reaching across North America from Newfoundland to Alaska.

Calcareous: Containing calcium or calcium carbonate (lime), as an alkaline soil.

Degree Days: The difference, in Celsius degrees, between the air temperature for a given day (usually the mean daily temperature) and an established reference temperature. Growing degree-days are used as an index of growth potential in agriculture and are commonly calculated as the number of Celsius degrees by which the mean daily air temperature exceeds 5 °C. Calculation of Growing-Degree Days: Measure the mean temperature for a day. Every degree above degrees C is equal to one growing-degree day. For example, if the mean temperature on a given day is 15 °C, this would convert to 10 growing-degree days. If the Yukon experienced 100 consecutive days with a mean temperature of 15 °C, this would convert to a total of 100 x10 =1000 growing-degree days for that period.

Dioxins and Furans: Dioxin is the popular name for a class of *organochlorine compounds* known as polychlorinated dibenzo-p-dioxins. Furans (polychlorinated dibenzo-furans) are also organochloride compounds. Only a few of these compounds are highly toxic. Dioxins and furans are formed either as by-products during some types of chemical production that involve chlorine and high temperatures or during combustion where a source of chlorine is present. Dioxins can occur in airborne particulate (anything that can be filtered from the air) incinerators that burn trash containing chlorinated compounds, when organic matter is burnt, and in exhaust from diesel engines.

Ecoregion: For land areas, ecosystem units defined in the ecological land classification system in Canada; for marine areas, *ecosystem* units defined in the marine ecological classification system for Canada. For both systems, ecozones are the largest units. These are subdivided into progressively smaller units based on ecological characteristics such as climate, soil or water properties, and wildlife. Each ecozone is subdivided into ecoregions.

Ecosystems: A dynamic complex of organisms, including humans and their physical environment, interacting as a functional unit. Ecosystems are spatially explicit and vary in size and composition. The term may be applied to a unit as large as the entire ecosphere or to smaller divisions like the Arctic or even small lakes. In its broadest sense, an ecosytem includes environmental, social, and economic elements. The root words of ecosystem are *eco*, a derivative of the Greek term for house or home, and *system*, which addresses the relationship and connections between the biological and physical parts.

El Niño: El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe. This event occurs approximately every four years, but can occur more frequently. (http://www.pmel.noaa.gov/toga-tao/el-nino/nino-home.html).

Endangered: In this report, this term refers to an official designation assigned by the Committee on the Status of Endangered Speicies in Canada (COSEWIC). The designation is assigned to any indigenous species, subspecies, or geographically separate population that is at risk of imminent extinction or extirpation throughout all or a significant portion of its Canadian range. See also *extinct*, *extirpated*, *threatened* and *vulnerable*.

Eutrophication: The gradual increase in nutrients in a body of water. Natural eutrophication is a gradual process, but human activities may greatly accelerate the process.

Evapotranspiration: Loss of water by evaporation from the soil and transpiration from plants.

Extinct: In this report, this term refers to an official designation assigned by the Committee on the Status of Endangered Speicies in Canada (COSEWIC). The designation is assigned to any indigenous species, subspecies, or geographically separate population formerly indigenous (native) to Canada that no longer exists anywhere. See also *endangered, extirpated, threatened* and *vulnerable*.

Extirpated: In this report, this term refers to an official designation assigned by the Committee on the Status of Endangered Species in Canada (COSEWIC). The designation is assigned to any indigenous species, subspecies, or geographically separate population no longer existing in the wild in Canada but occurring elsewhere. See also *endangered, extinct, threatened* and *vulnerable*.

Genetic diversity: The infinite variation of possible genetic combinations among individuals within breeding populations, between breeding populations and within species. Genetic diversity is what enables a species to adapt to ecological change.

Ground water: Water occurring below the ground surface, which may supply water to wells and springs. Groundwater occupies pores, cavities, cracks, and other spaces in bedrock and unconsolidated surface materials, and is free to move by gravity. See *aquifer*.

Habitat: The place or type of site where plant, animal, or micro-organism populations normally occur. The concept of habitat includes the characteristics of that place (such as climate, the availability of water, nutrients and shelter) which make it especially well suited to meet the life cycle needs of the particular organism or population.

Hydrocarbons: An organic molecule which consists only of carbon and hydrogen atoms, and no other elements.

Ice cores: Similar to lake sediment cores, but recovered using an ice drill from high altitude glaciers. A variety of chemical analysis methods allow scientists to determine past climate conditions.

Lake sediment cores: Mud and organic material recovered from the bottom of lakes using long tubes. These cores provide information about past climates from the chemical, plant and animal remains in the sediments. Since these sediments are deposited over time, and are relatively undisturbed, it is possible to construct a chronology of past climate and environments.

Lichen: A mutualistic association of a fungus and photosynthetic organism, either a unicellular alga or a cyanobacterium.

Long range atmospheric transport: The process whereby contaminants (especially *organochlorine compounds* and metals) through effluents or from evaporation from soils or water bodies, move through the Earth's atmosphere and return to the Earth at a different location attached to dust particles, rain or snow. The contaminants then move through *ecosystems* and often accumulate through the food chain. Also refers to movements of contaminants through the oceans.

Organochlorine compounds: Chlorine-containing organic compounds, which may contain oxygen and other elements, such as phosphorous. The term includes many pesticides and industrial chemicals. Examples are *dioxins* and *furans*, PCB's, DDT, and *toxaphene*. Many of these kinds of compounds tend to be persistent, meaning that they do not break down easily in *ecosystems*.

Permafrost: A permanently frozen layer of soil underlying the Arctic tundra and northern boreal forest bioclimatic zones (http://www.geodata.soton.ac.uk/ipa/).

Plankton: Small (often microscopic) plants and animals floating, drifting or weakly swimming in bodies of fresh or salt water, and serving as food for fish and other larger organisms.

Plume: The movement of water along flow lines from a point source of ground water pollution toward its eventual emergence at the surface.

Protected Area: An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other means (IUCN).

Reclamation: The combined process of land treatment that minimizes water degradation, air pollution, damage to aquatic or wildlife habitat, flooding, erosion, and other adverse effects from surface mining operations, including adverse surface effects incidental to underground mines, so that mined or developed lands are reclaimed to a usable condition which is readily adaptable for alternate land uses and creates no danger to public health or safety. The process may extend to affected lands surrounding mined lands, and may require backfilling, grading, resoiling, revegetation, soil compaction, stabilization, or other measures.

Riparian: On, or pertaining to, the banks of a stream. (As in riparian vegetation or riparian woodland).

Pertaining to the banks and other adjacent terrestrial (as opposed to aquatic) environs of freshwater bodies, watercourses, and surface-emergent aquifers (e.g. springs, seeps, oases), whose imported waters provide soil moisture significantly in excess of that otherwise available through local precipitation – soil moisture to potentially support a mesic vegetation distinguishable from that of the adjacent more xeric upland.

Salmon "Fry": Life stage of salmon (and also of trout) between full absorption of the yolk-sac and a somewhat arbitrarily defined fingerling (young fish, usually in its first or second year and generally between two and 25 centimeters long) stage, which generally is reached by the end of the first summer.

Sedge: Plants that look a bit like grasses, but they belong to a different plant family, the Cyperaceae. Most grasses have stems that are round in cross section, while the stems of sedges are triangular in cross-section, thus you can remember the difference with the rhyme "sedges have edges."

Seismology: The study of earthquakes, and of the structure of the Earth by both natural and artificially generated seismic waves.

Sunspot cycle: Every 11 years the sun undergoes a period of activity called the "solar maximum", followed by a period of quiet called the "solar minimum". During the solar maximum there are many sunspots and solar flares, which can affect communications and weather on Earth (http://www.sunspotcycle. com/).

Tailings: Material rejected from a mill after most of the recoverable valuable minerals have been extracted. Tailings are generally finely ground rock particles that are transported as a water slurry to a storage area, known as a tailings pond, at the mine site. Usually the tailings composition is similar to the parent ore body and may therefore contain metals, sulphides or salts.

Threatened: In this report, this term refers to an official designation assigned by the Committee on the Status of Endangered Species in Canada (COSEWIC). The term describes any indigenous species, subspecies or geographically separate population that is likely to become *endangered* in Canada if the factors affecting its vulnerability are not reversed. See also *endangered, extinct*, *extirpated* and *vulnerable*.

Topography: Configuration of a surface, including its relief and the position of natural and human-made features.

Toxaphene: $C_6H_{10}Cl_8$; toxic *organochlorine compound* used as an insecticide on cotton fields. Also used to kill unwanted fish in lakes prior to lake stocking. No longer used in Canada, but still used in other parts of the world. Generally the main organochlorine compound found in Yukon fish tissues from *long range atmospheric transport*.

Vulnerable: In this report, this term refers to an official designation assigned by the Committee on the Status of Endangered Species in Canada (COSEWIC). The term describes any indigenous species, subspecies or geographically separate population that is particularly at risk because of low or declining numbers, small range, or some other reason but is not a threatened species. See also *endangered, extinct, extirpated* and *threatened*.

Watershed: an area of land that drains naturally into a stream or other waterway.

Wetlands: lands in which the water table is at, near or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric (saturated) soils, hydrophytic (water loving) vegetation, and various kinds of biological activity that are adapted to the wet environment. Includes fen, bog, swamp, marsh and shallow open water.

Wilderness: Means an area where human activity has not significantly changed the environment or the ecosystem. It includes an area restored to natural condition. The *Yukon Environment Act* recognizes wilderness as a natural resource with ecological as well as economic value.

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Elders words quoted in the text, unless otherwise noted, are from transcripts of Elders' Traditional Knowledge Workshop held October 13-14, 1999 with the assistance of the Council of Yukon First Nations.

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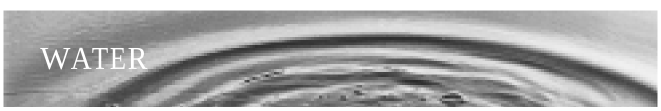

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