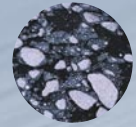


7. *The Mackenzie Great Bear Sub-basin*



Introduction

Geography

The Mackenzie-Great Bear sub-basin is the largest of the six sub-basins, covering 475,000 square kilometres, or 26% of the entire Mackenzie River Basin (Figure 7–1).¹⁹⁸ It contains the Mackenzie River, which, at 1,800 kilometres in length, is Canada’s longest river. This sub-basin includes the largest lake entirely within Canada, Great Bear Lake, which covers 31,328 square kilometres. It also includes Canada’s largest delta and second largest wetland, the Mackenzie Delta, covering 13,500 square kilometres.^{2, 176}

The Mackenzie River transports 60% of Canada’s freshwater that drains to the north.¹¹⁴ In part because of its high water velocities, the Mackenzie River transports more sediment to the Arctic Ocean than any other circumpolar river. These sediments may contain substances that can be harmful to

small organisms that live near the bottom of the river.¹⁹⁹

Another name for the Mackenzie River is “Deh Cho”. “Deh Cho” means the “Great River” in the Dene language. Alexander Mackenzie, the explorer for whom the river was named, did not share the same appreciation of “Deh Cho”. He described it as “the river of disappointment”. He was searching for the Pacific Ocean, not the Arctic Ocean, at the time.

Human Populations

People first settled the Mackenzie River valley over 5,000 years ago.¹⁹⁸ It has always been important to the Dene and Inuvialuit First Nations of the present-day Deh Cho, Tlicho, Sahtu, Gwich’in and Inuvialuit Land Claim areas.

The Mackenzie-Great Bear sub-basin has an approximate population of 7,800 people, and includes thirteen communities (Figure 7–1). Inuvik, with a population of 2,900 is the largest community in the sub-basin. Nearly 70% of the residents in the sub-basin are Aboriginal.

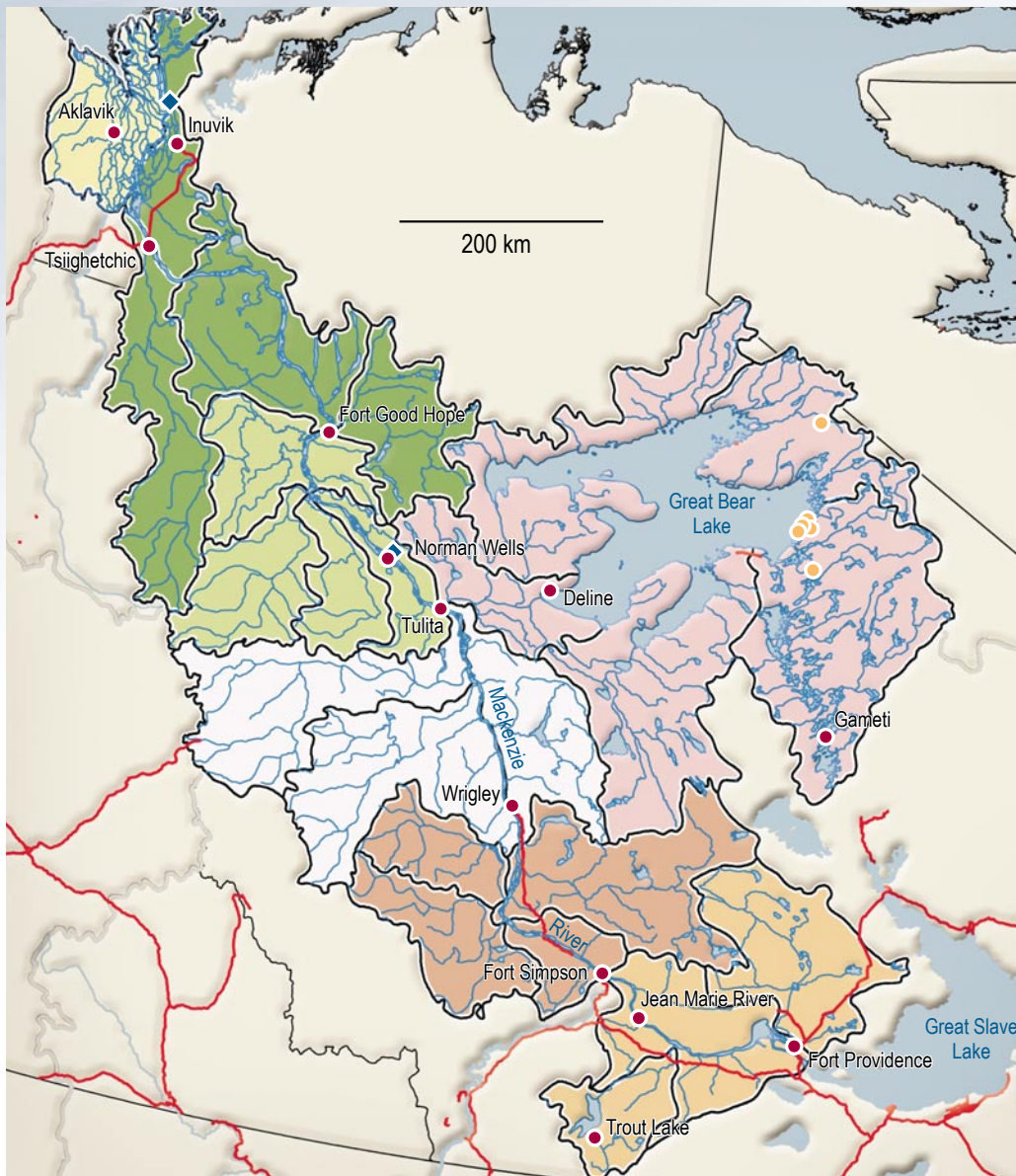


Figure 7-1.
Map of the Mackenzie - Great Bear
sub-basin.

Legend

- Mackenzie River Basin
- Community
- Roadways
- ◆ Oil or Gas Field
- Past Producing Mine

Sub-Basins

- Northwest Arctic Ocean
- Lower Mackenzie
- Lower Central Mackenzie
- Great Bear
- Central Mackenzie
- Upper Central Mackenzie
- Upper Mackenzie

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

Industry

The western and northern portions of the Mackenzie-Great Bear sub-basin are underlain by a vast reserve of oil and gas that was first commercially exploited at Norman Wells (or “Le Gohlini”, Dene for “place where the oil is”), where a crude oil refinery operated between 1943 and 1997. The Norman Wells oil field currently produces between 11 and 12 million barrels of oil per year which is shipped by pipeline to northern Alberta.^{200, 201}

Vast reserves of petroleum were discovered in the Mackenzie Delta-Beaufort Sea area in the 1970s. The Mackenzie-Great Bear sub-basin holds 15% of Canada’s natural gas reserves.²⁰² Currently, only the Ikhil gas field in the Mackenzie Delta produces natural gas, all of which is used locally. However, if the proposed Mackenzie Valley Pipeline is built, the development of natural gas reserves will increase substantially since the pipeline will link them to southern markets. A consortium, consisting of oil companies and a First Nation corporation, is currently advocating development of the Mackenzie Valley Pipeline.²⁰³

Barges operate each summer between Hay River on Great Slave Lake and Inuvik in the Mackenzie Delta. They serve communities and exploration camps along the Mackenzie River.

In 1930, Gilbert LaBine staked silver-cobalt claims at Echo Bay on the east side of Great Bear Lake. This led to the establishment of a mine at Port Radium. It operated intermittently until 1982. Uranium became the mine’s most important product during World War II. The United States government used the uranium to

test and build atomic bombs. Eventually, six uranium, silver and base metal mines operated along the eastern shores of Great Bear Lake (Figure 7–1).^{204, 205} Little was known, at the time, of the lethal and chronic effects of even minor exposure to uranium. There is now concern that such exposure may have harmed the health of people who lived and worked near the mines and along the transport route.

Improve Water Quality

Water Quality Guidelines

The Canadian Council of Ministers of the Environment has established Environmental Quality Guidelines for protecting freshwater aquatic life and a number of different uses of water such as recreation/aesthetics. These guidelines are threshold concentrations of various chemical, physical and microbiological substances in water that are deemed to be safe for most forms of freshwater aquatic life or for various types of recreation, like swimming and other water sports.¹⁴⁶ When concentrations exceed the guidelines, freshwater life may be placed at risk and recreational uses of water may be compromised.

What is happening?

Information on water quality has been summarized for three sites that have been monitored since the 1960s (Mackenzie River at Norman Wells, Mackenzie River above Tsiigehtchic and the Great Bear River) and one site that has been monitored since the 1980s (Mackenzie River at Strong Point).

Turbidity, an indicator of the “cloudiness” or suspended sediment and dissolved solid load of water, naturally exceeded the guideline level designed to protect recreation/aesthetics from 0% (Great Bear River) to 88% (Mackenzie River above Tsiigehtchic) of the time (Figure 7–2). The frequency with which turbidity exceeded the guideline did not change over

time, except at Norman Wells, where exceedances have occurred more frequently since the 1980s than they did in the 1960s and 70s.

Aluminum, copper and iron are metals that occur in water, usually in association with small particles of silt or clay or small organic particles. Concentrations of aluminum, copper and iron exceeded Canadian

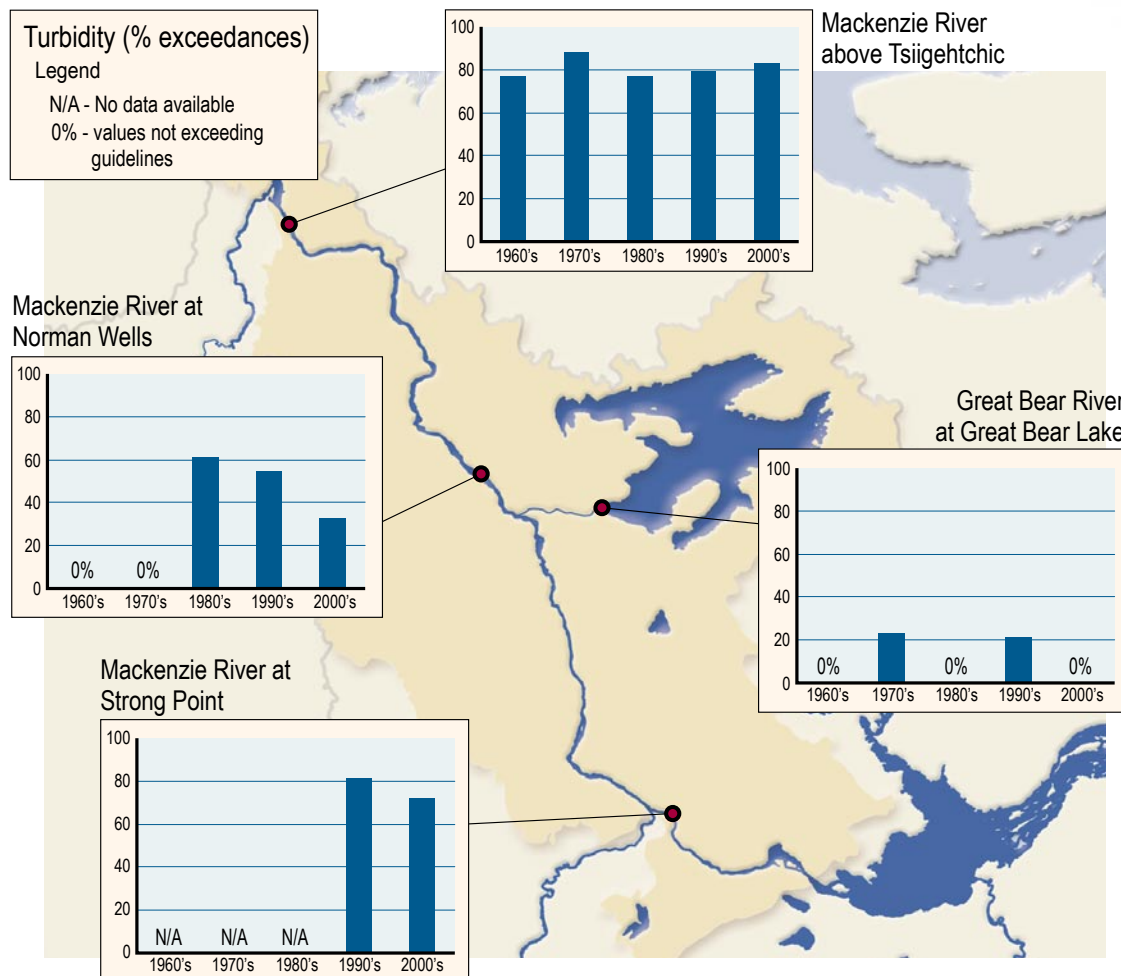


Figure 7–2.

Turbidity – percentage of samples that exceeded Canadian Council of Ministers of the Environment – Environmental Quality Guidelines for Recreation/ Aesthetics at four long-term sampling stations in the Mackenzie – Great Bear sub-basin.

Data Source: Environment Canada

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

Environmental Quality Guidelines for protecting aquatic life more often on the Mackenzie River than on the Great Bear River (Figure 7–3). The frequency with which these metals exceeded freshwater life guidelines did not change over time, with the exception of the Mackenzie River above Tsiigehtchic, where copper exceeded the guideline more often since 1980 than it did in the 1960s and 70s (Figure 7–3).

Why is it happening?

Much of the sediment carried in the Mackenzie River originates in the mountains of the Liard sub-basin or is carried downstream by mountain rivers draining the Mackenzie Mountains that lie west of the

Toxic compounds called polycyclic aromatic hydrocarbons (PAHs) are occasionally found in water samples taken from the Mackenzie River, sometimes at concentrations that are higher than water quality guidelines. PAHs may form when organic materials, especially fossil fuels, are burnt. They also occur in petroleum deposits. PAHs in the Mackenzie River are likely associated with the river's rich petroleum deposits and are natural in origin.

Mackenzie River. Erosion of soils and soft sedimentary rocks along the main channel of the Mackenzie River is another important source of sediment.²⁰⁶ The result is a river with a suspended sediment and dissolved solids load greater than any other river in the circumpolar world. This explains why turbidity values measured in the Mackenzie River routinely exceed Canadian Environmental Quality Guidelines for recreation/aesthetics. Turbidity is highest during peak discharge that occurs most often during the snowmelt period each spring.

Underlying geology of the Mackenzie-Great Bear sub-basin and the naturally-high sediment load carried by the Mackenzie River are the reasons why a high percentage of samples exceeded guidelines for aluminum, copper and iron.²⁰⁵ As rivers cut through the metal-rich Mackenzie and Franklin mountains and Precambrian Shield, they naturally erode surface materials to which metals are bound. Therefore, even though concentrations of these metals in the rivers often exceeded guidelines, this was the result of “natural” processes. The absence of consistent time trends over the past forty years indicates that concentrations of these metals in the Mackenzie-Great Bear sub-basin are naturally high and not the result of human activities that are polluting the rivers.

What does it mean?

The high sediment load of the Mackenzie River provides a rich supply of nutrients that are the basis for food chains in the river and in the highly productive Mackenzie Delta.

Metals such as aluminum, copper and iron exist in different chemical forms in water, depending on the water's acidity, hardness and numerous other

characteristics. Some chemical forms of metals are toxic to certain types of aquatic life. Concentrations of several metals have probably been high for thousands of years in the Mackenzie River and some of its tributaries. Therefore, aquatic plants and animals that live there have likely evolved mechanisms enabling them to tolerate the high metal levels. Furthermore, the potential for uptake of metals by biota is limited because most of the metals are strongly bound to suspended and bottom sediments in the rivers.

The Environmental Quality Guidelines of the

Canadian Council of Ministers of the Environment were developed as national reference guidelines for water quality standards. When using the guidelines, the natural environmental conditions and unique aspects of specific water bodies or individual watersheds must be considered. Therefore, the frequency with which water samples from the Mackenzie-Great Bear sub-basin exceeded these national guidelines does not necessarily indicate that the plants and animals that are native to these rivers are at risk.

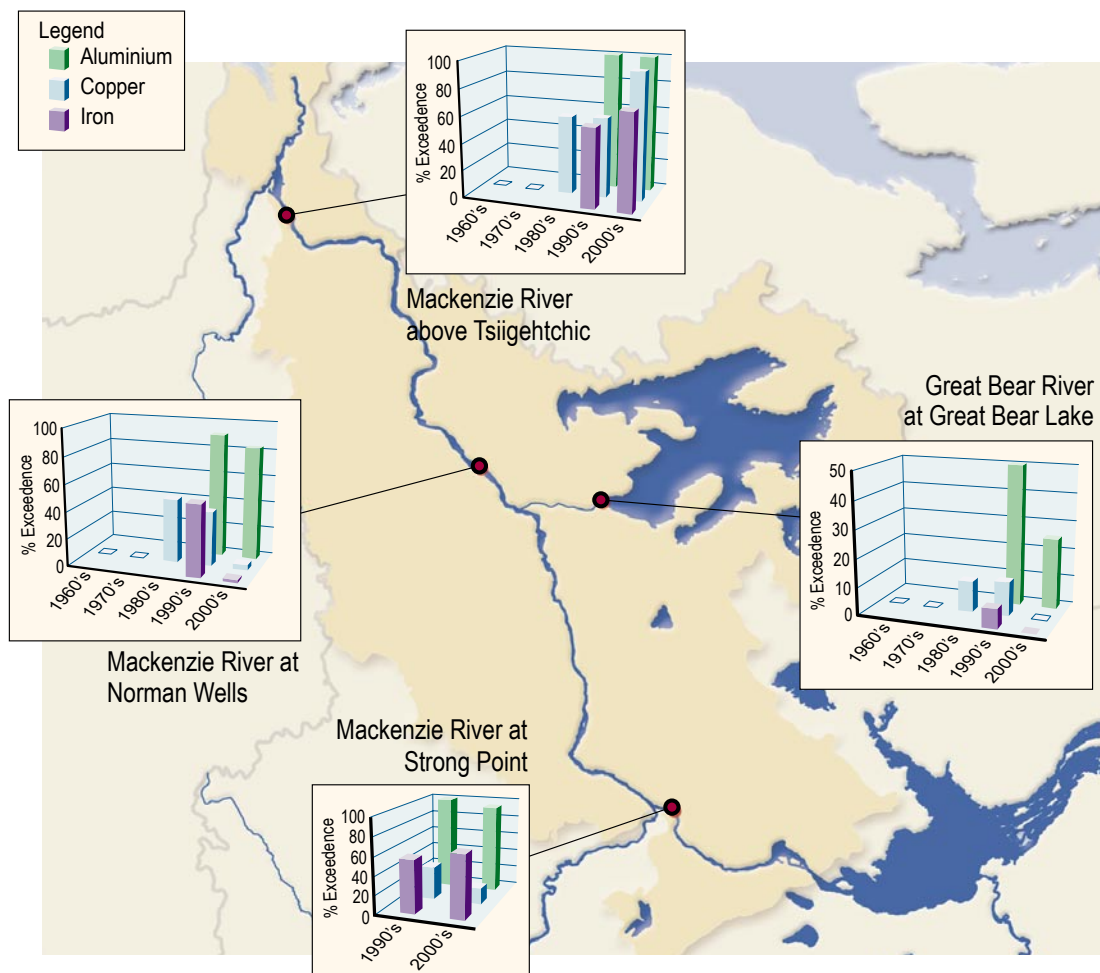


Figure 7-3.

The metals, aluminum, copper and iron – percentage of samples that exceeded Canadian Environmental Quality Guidelines for the Protection of Aquatic Life at four long-term sampling stations in the Mackenzie – Great Bear sub-basin.

Data Source: Environment Canada.

What is being done about it?

Federal, territorial, land claim and municipal governments, as well as universities, research institutes and environmental non-government organizations are carrying out short-term water quality studies and long-term water quality monitoring. Where and when northern developments are imminent, environmental impact assessments are carried out as part of a regulatory process that is now defined by the *Mackenzie Valley Resource Management Act*, or the *Inuvialuit Final Agreement* and the *NWT Water Act*.

The Canadian Council of Ministers of the Environment has developed generic Canadian Water Quality Indices (CWQI) for reporting on the state of water quality in Canadian waters.¹⁴⁶ The CWQI is intended for use as a convenient way of summarizing complex water quality data and communicating it in plain language to a general audience. The indices have been tested in the Mackenzie River. Results indicate that they must be fine-tuned before they will be capable of conveying information concerning complex water quality issues in a way that is easy to understand.

✔ Overall Assessment – Favourable

There is no evidence that water quality has deteriorated in the Mackenzie and Great Bear rivers over the past four decades. Turbidity and metal concentrations are naturally elevated in the Mackenzie River and have likely been so for thousands of years. The plants and animals that live in that river have evolved mechanisms over the centuries that enable them to tolerate the high turbidity and metal concentrations.

Sources of Sewage

Point sources refer to direct sources of pollution or effluent such as industrial discharge pipes and community sewage outlets.

What is happening?

Eight communities and one major industry are licensed to discharge wastewater to surface waters within the Mackenzie-Great Bear sub-basin (Figure 7–4). Four communities use primary treatment only, while the other four use a combination of primary and secondary treatment. Primary treatment removes most of the solids from wastewater while secondary treatment removes an even greater amount of the solids and also serves to substantially detoxify the wastewater. The total wastewater effluent from eight communities in 2000 was 844,000 cubic meters.

The crude oil processing plant at Norman Wells is the only industrial discharge in the sub-basin, the effluent discharge rate being one million cubic meters per year into the Mackenzie River. In addition, the plant discharges approximately 1.7 million cubic meters of wastewater into the ground.

Why is it happening?

Most people have moved off the land into communities along the Mackenzie River during the last half century. This has created the need for proper sewage treatment. Over time, communities in the sub-basin have adopted measures to improve the treatment of wastewater prior to its eventual release into the environment. Such measures include the use of primary and secondary sewage treatment systems.

What does it mean?

The Mackenzie River receives little wastewater effluent from point sources. In fact, the total volume of wastewater that enters the Mackenzie River from licensed community and industrial discharges in the Mackenzie-Great Bear sub-basin accounts for only

about three-millionths of one percent of the river's total flow above Tsiigehtchic (Arctic Red River).¹⁷⁴

Wastewater from community and industrial sources contains many noxious substances that are hazardous to aquatic life and human health. Communities or corporations wanting to discharge wastewater into surface waters must be authorized to do so.

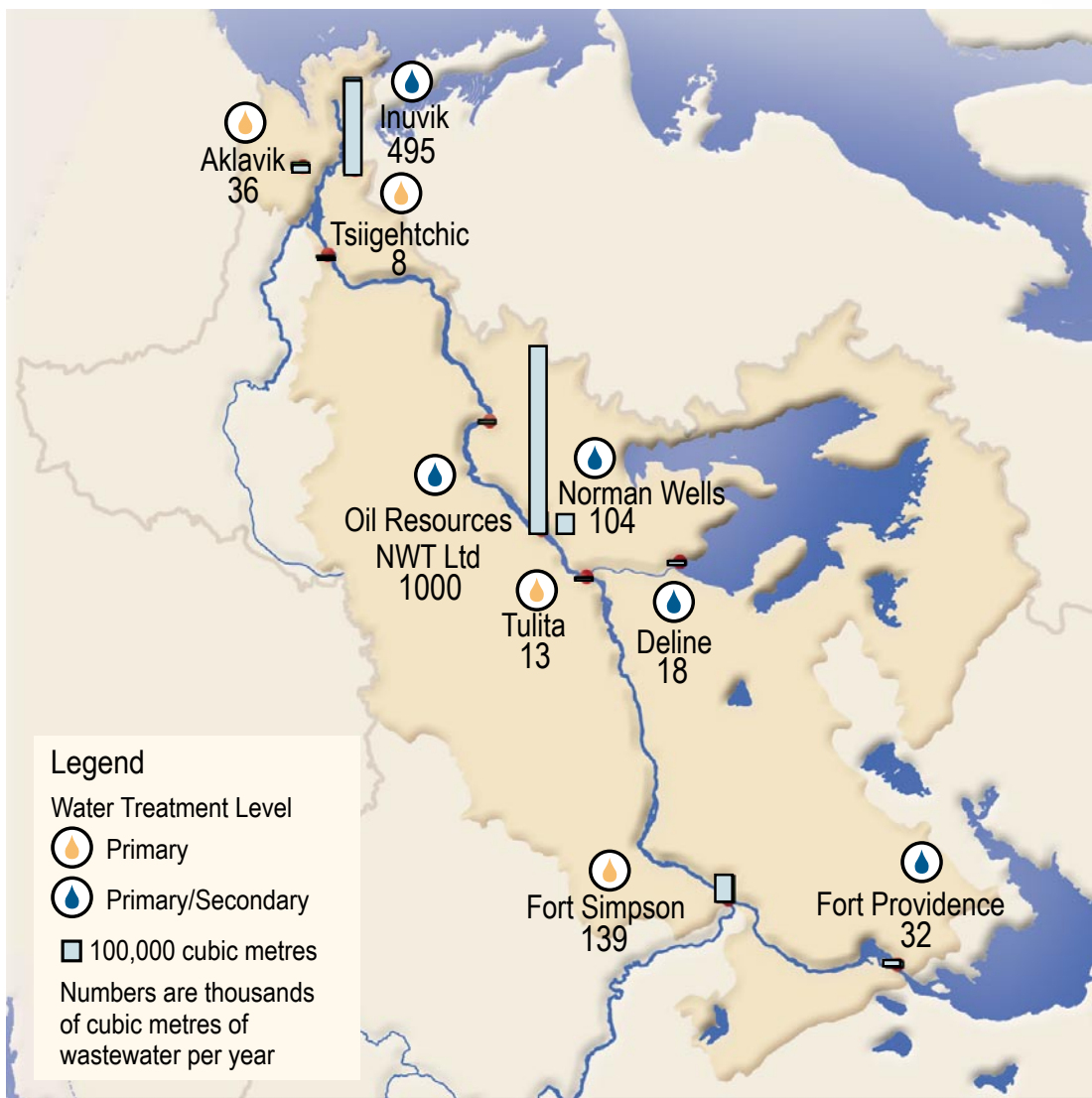


Figure 7-4.

Eight communities and one major industry discharge treated wastewater into surface waters of the Mackenzie River system. The total amount is negligible when compared to the amount of water in the rivers.

Data Sources: Government of the Northwest Territories; Department of Indian Affairs and Northern Development.

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

What is being done about it?

The NWT Water Board, the Mackenzie Valley Land and Water Board and two First Nations land and water boards regulate water licenses. The licences stipulate how much wastewater can be discharged, when it can be discharged, how “clean” it must be before it can be discharged and how often it must be tested to ensure compliance.

✔ Overall Assessment – Favourable

There are relatively few point sources of pollution on the Mackenzie River compared to other major rivers in Canada. Moreover, existing regulations, wastewater treatment systems and monitoring efforts are adequate to ensure that point sources do not harm water quality in this sub-basin.

Ensure Sufficient Water Quantity

Traditional Knowledge of Water Quantity

Some Aboriginal residents of the Mackenzie Delta have noticed low water levels and commented on how their lifestyles have been affected. In 1999, low water levels in the delta interfered with people travelling back to their communities after whaling and fishing along the coast.²⁰⁷ Fishing itself has been affected since “many places where formerly nets were set are now too shallow; this is especially the case in some of the lakes and streams.”²⁹ It was not indicated whether

the low water levels lasted only for a few years or whether they occurred over a longer period of time. It was also not mentioned whether the low water levels were widespread throughout the delta or localized to a small part of the delta.

▼ Overall Assessment – Mixed Signals

Aboriginal residents of the Mackenzie Delta have raised concerns about low water levels and the associated effects on their lifestyles. Additional information would be useful in determining whether these changes are due to natural annual fluctuations or if they indicate long-term trends over time.

River Flow Trends

The annual average flow near the mouth of the Mackenzie River is about 9,000 cubic meters per second. Outflows from Great Slave Lake provide close to 60% of this flow, and an additional 20% is provided

Most of the water that flows to the mouth of the Mackenzie River comes from Great Slave Lake and the Liard River. The large volumes of water stored in Great Slave Lake and Great Bear Lake have a stabilizing effect on flows in the Mackenzie River. The influence of the Liard River is greatest during the spring when it receives a substantial amount of snowmelt runoff.

Environment Canada, Water Survey of Canada.

by the Liard River. During the winter, when flow in other tributaries is reduced, the Great Bear River provides 12% of the flow at the mouth of the Mackenzie River. It provides only 4% during the spring and summer when the influence of the Liard River and other tributaries increases.

What is happening?

Figure 7–5 illustrates that there have been no consistent trends in average annual flow rates in rivers in the Mackenzie-Great Bear sub-basin and that

flow varies greatly from year to year. This is in agreement with studies that show that there were no significant trends in mean annual flows in rivers of the Mackenzie-Great Bear sub-basin in the late 20th century.^{208, 209, 210}

Why is it happening?

The large amount of water stored in Great Slave Lake helps maintain flows on the Mackenzie River in dry years when other sources provide less water. Thus, the flow of water down the Mackenzie River is

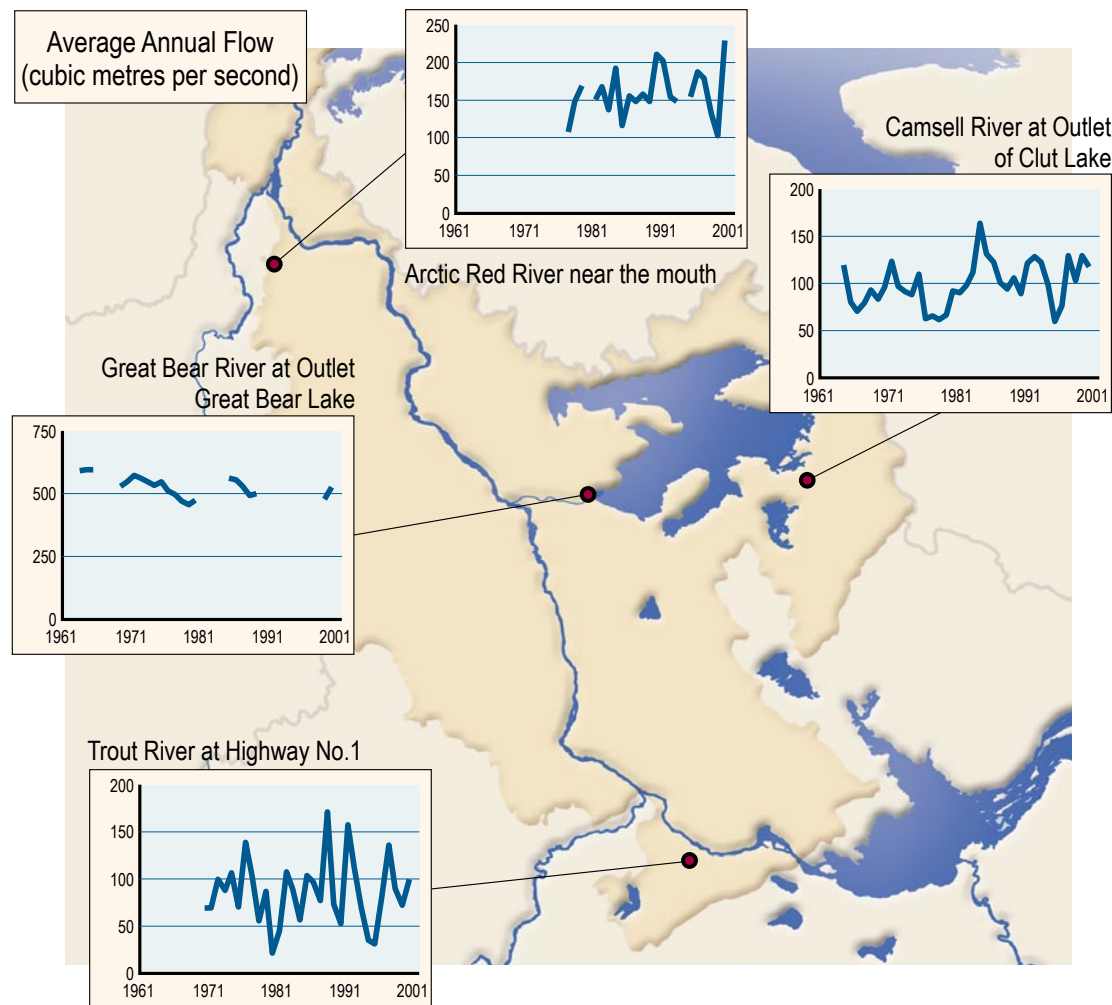


Figure 7–5.

There is strong year-to-year variation in average annual discharge in four tributaries of the Mackenzie River. However, increasing or decreasing trends have not been observed over the past three to four decades.

Data Source: Environment Canada, Water Survey of Canada.

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

somewhat dependent on the water level in Great Slave Lake. Water levels in Great Bear Lake fluctuate little because the lake occupies a large portion of its own basin and the amount of stream flow into the lake is small relative to its volume. Because the lake level is stable, the flow of water in the Great Bear River remains relatively constant throughout the year.

The Mackenzie Valley is getting warmer.¹⁹ Climate change predictions suggest that a warmer climate in the Mackenzie River Basin would be accompanied by lower stream flow in the Mackenzie River.^{211, 212} However, recent results from the *Mackenzie Global Energy and Water Cycle Experiment (GEWEX) Study* emphasize that the many factors and feedback cycles which influence river flow are not fully understood.¹⁷ A better understanding of the influence of regional climatic conditions on river flow trends is needed.

What does it mean?

For the most part, the flow of water in the Mackenzie River and its tributaries remains natural. There are small withdrawals relative to its volume with undetermined, but presumably small, effects of regulation on the Peace River. The poor predictions of the impacts of climate change on river flow suggest that there is still much to be learned about the water cycle of the sub-basin, and much to be done on incorporating this knowledge into predictive models.

What is being done about it?

Environment Canada and Indian and Northern Affairs Canada continue to monitor climate and river flow throughout the region. The Mackenzie GEWEX Study and the Canadian Climate Impacts and Scenarios project are examples of research that is

being done to understand the interactions between water and climate. Such an understanding is essential for predicting how future changes in climate will affect the region's aquatic ecosystems.

✔ Overall Assessment – Favourable

Flow in the Mackenzie River and its tributaries naturally fluctuates from season to season and from year to year. However, monitoring programs have not found any measurable changes in river flow over time. These monitoring programs will be important in detecting any future changes to river flow due to climate change. A better understanding of how regional climatic conditions influence flow in rivers of the Mackenzie-Great Bear sub-basin is needed.

Sustain In-Stream Water Uses

Ferry and Ice Bridge Seasons

Ferries and ice bridges are important parts of the transportation system in the NWT. All-season roads cross the Mackenzie River at three locations. Ice bridges serve as crossings during the winter while ferries operate during the ice-free season.

What is happening?

Between 1990 and 2002, the number of days each year that ferries operated increased at two crossings in the southern part of the sub-basin but showed no consistent trend at Tsiigehtchic (Arctic Red River) in the north (Figure 7–6). Conversely, the ice bridge at the Fort Providence crossing was open for fewer days from 1997 to 2002 than from 1990 to 1997 (Figure

7–6). The season lengths for the other ice bridges changed substantially from one year to the next but did not show a trend over time.

Why is it happening?

Climate and technology determine the lengths of seasons for ferries and ice bridges. These operations will remain open as long as it is safe to do so. Recent warm winters, especially since 1998, likely contributed to the trend towards longer ferry seasons and shorter ice bridge seasons at Fort Providence but appeared to

have little effect at the other crossings. Modern technology and improvements in operating methods have enabled ferries and ice roads to lengthen their operating seasons, offsetting some of the consequences associated with warmer winters.

What does it mean?

Despite the recent warming trend in the Mackenzie River Basin, the transportation system at the Mackenzie River crossings has continued to operate efficiently with few interruptions in service.

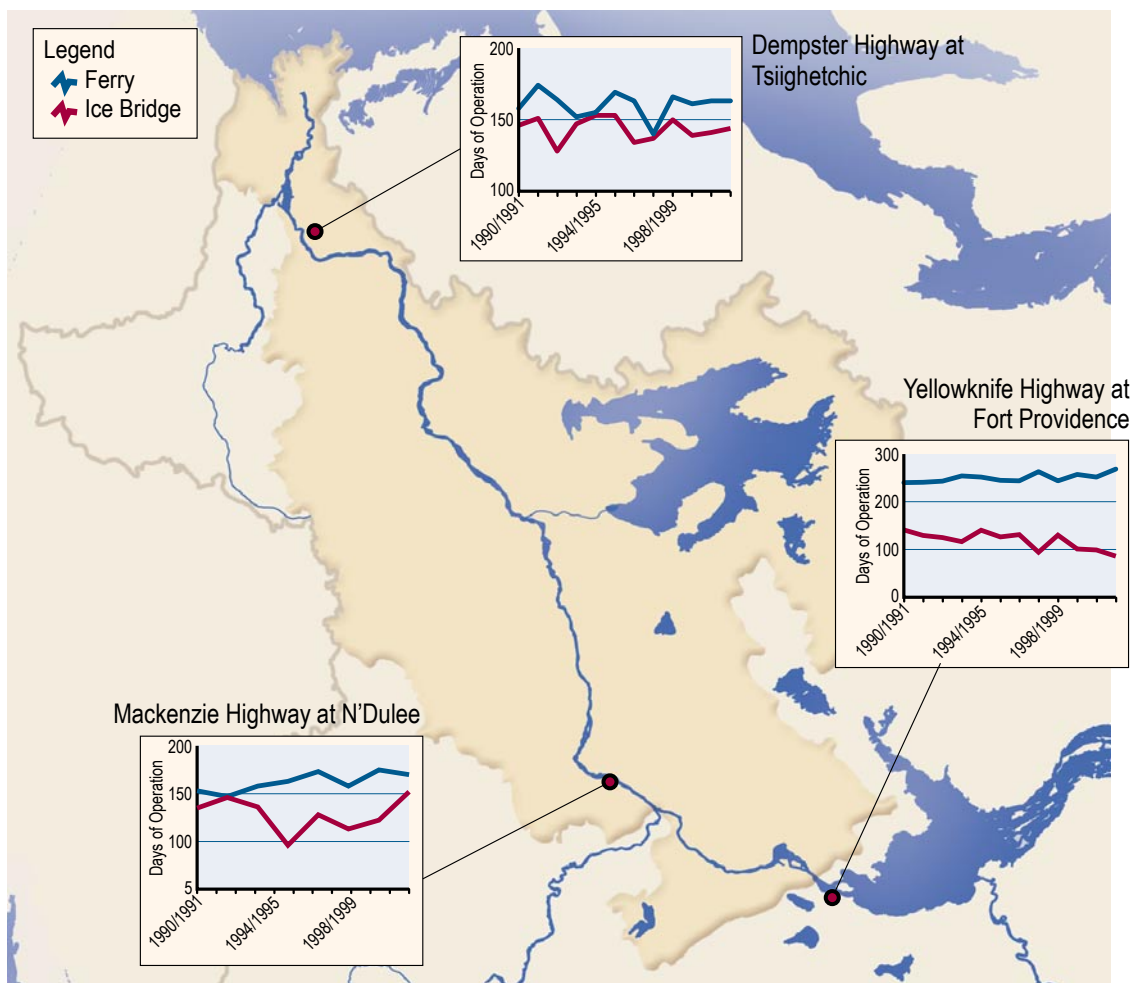


Figure 7–6.

Changes in climatic conditions have not strongly affected the length of ferry and ice bridge seasons at major river crossings on the Mackenzie River.

Data Source: Department of Transportation, Government of the Northwest Territories.

Many scientists have predicted that the climate of the Mackenzie River Basin will become warmer. It is possible that ferry seasons may become longer, while ice bridge seasons may become shorter. In addition, climate change is expected to increase seasonal variability in weather patterns. This will increase the difficulties associated with planning and operating the transportation system at river crossings. Finally, although climate change may lengthen the overall ferry season, insufficient water flow and ice jams may increase the frequency of disruptions in ferry service.

What is being done about it?

The Government of the Northwest Territories Transportation Department is committed to ensuring that the three major river crossings remain open for as much of the year as possible, even during fall freeze-up and spring melt, the most difficult times of year to keep ferries or ice bridges operating. The increasing population and booming economy of Yellowknife may soon make it cost-effective to build a bridge across the Mackenzie River at Fort Providence, rendering the ferry and ice bridge obsolete at this particular location.

✔ Overall Assessment – Favourable

Ferries and ice bridges are important parts of the ground transportation network in the Mackenzie-Great Bear sub-basin. Ferry and ice bridge services continue to operate efficiently despite a recent warming trend in the Mackenzie River Basin. Climate is one of the important determinants of how long these operations remain open each year. Climate change may make the season lengths of these operations less predictable in the future.

Water Allocations

What is happening?

In the Mackenzie-Great Bear sub-basin, ten communities are licensed to withdraw water for domestic use. Three other communities, Jean Marie River, Trout Lake and Wrigley, are unlicensed communities. In 2000, the licensed communities withdrew 874,425 cubic meters of water. The crude oil processing centre at Norman Wells withdraws approximately 2.8 million cubic meters of water per year (Figure 7–7). Most of this water is returned to the surface water sources from which it is drawn after primary or secondary treatment. There is currently no water withdrawal information from the natural gas facilities at Ikhil Gas Field near Inuvik.

Why is it happening?

In the Mackenzie-Great Bear sub-basin, water is needed only for domestic purposes and to meet the needs of the oil and gas industry at Norman Wells and in the Mackenzie Delta. Because the population in the Mackenzie-Great Bear sub-basin is extremely small, the demand for water for domestic purposes is also small.

What does it mean?

Maximum water withdrawals from the ten communities and one oil processing facility represent only a negligible percentage of the total annual flow of the Mackenzie River. The Mackenzie River can easily accommodate additional local water withdrawals. This is not surprising, given that it is one of the greatest freshwater resources of Canada.



Figure 7-7.

Ten licenced communities and one licenced industry withdraw a negligible amount of water from the Mackenzie River each year.

Data Sources: Government of the Northwest Territories; Department of Indian Affairs and Northern Development.

What is being done about it?

The NWT Water Board, the Mackenzie Valley Land and Water Board and two First Nations land and water boards issue water licences. Licenses stipulate the amount of water that can be withdrawn and impose certain conditions on the licensee, including those related to the eventual discharge of treated wastewater back to surface waters.

Overall Assessment – Favourable

The population of the Mackenzie-Great Bear sub-basin is very small and there is only one major industry. The demand for water relative to its supply is negligible. Clean water is very plentiful in this sub-basin.

Fish Stocks and Harvest

What is happening?

Fish stocks in the Mackenzie Great Bear sub-basin have been assessed relatively infrequently. There was, however, a recent assessment of the Mackenzie River inconnu, as well as recent stock studies for twelve lakes in the Deh Cho region and twelve lakes in the Sahtu region. Harvesting of different fish species by recreational, subsistence and commercial fishers is more commonly monitored. Below are summaries of various harvest-monitoring programs as well as the inconnu stock assessment and Great Bear Lake trophy lake trout harvest.

Inconnu

Inconnu, a type of whitefish, are abundant in large, silty northern rivers and associated lakes. They migrate from the Beaufort Sea up to 1,000 kilometres upstream to spawning areas in the Mackenzie River and its tributaries. First Nations people have harvested

inconnu for centuries in the Mackenzie Delta and Mackenzie River. The outlook for Mackenzie River inconnu is excellent at present levels of harvest and if spawning, feeding and over-wintering habitats in the Mackenzie Delta are protected from degradation.²¹³

Lake trout fishery on Great Bear Lake

Commercial lodges and outfitters, subsistence fishers, itinerant anglers, and a gill net fishery share Great Bear Lake trophy lake trout stocks.²¹⁴ Management is directed towards conserving the trophy lake trout fishery. There are five lake trout management areas on Great Bear Lake: (1) Dease Arm, (2) North McTavish Arm, (3) South McTavish Arm, (4) McVicar Arm and (5) Smith Arm. Currently, there is no management plan for the Keith Arm. The harvest of lake trout from Great Bear Lake declined steadily from the early 1970s to 1990 as a result of conservation measures (Figure 7–8).

Aboriginal food fish harvests

Subsistence fisheries occur in the Inuvialuit, Gwich'in, Sahtu and Deh Cho areas. Broad whitefish and lake whitefish are the two most important species harvested in these areas. Inconnu and lake cisco are also important in some communities.²¹⁵ Recent harvests of broad whitefish in the Mackenzie Delta are only 5–10% of the estimated numbers harvested during the 1950s.

Why is it happening?

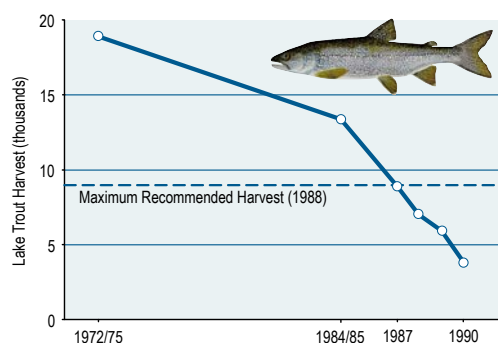
Lake trout fishery on Great Bear Lake

Great Bear Lake is world-renowned for its trophy lake trout. The decrease in harvest of lake trout over

Figure 7–8.

Harvest of lake trout in Great Bear Lake declined from 1972 to 1990, in response to various measures and policies that are intended to conserve this world-class sport fishery.

Data Source: Department of Fisheries and Oceans, Hay River.



time reflects a shift towards more conservation-oriented fishing. Lodges now prohibit their guests from taking fish home at the end of their fishing trips. The killing of trophy fish is also discouraged. Fish are now harvested only for shore lunches or when they have been injured by fish hooks. Live release fishing and the use of barbless hooks are now the norm in Great Bear Lake.

The importance of the Mackenzie Delta

The Mackenzie Delta has the richest fishery in the Mackenzie-Great Bear sub-basin. It is also an area which includes Inuvik, the largest community in the Mackenzie-Great Bear sub-basin with the largest number of recreational and subsistence fishers. The importance of subsistence fishing has declined in recent years, in part because of a corresponding decline in the number of people who keep dog teams. Traditionally, fish were fed to dogs.

What does it mean?

Subsistence, commercial and sport fishing in the Mackenzie-Great Bear sub-basin are important activities, both culturally and economically.

Lake and broad whitefish and inconnu

Lake and broad whitefish and inconnu are the most popular species of fish in subsistence fisheries. It is unclear whether these stocks have increased or are likely to increase in response to the decline in subsistence fishing in the Mackenzie-Great Bear sub-basin that has occurred since people reduced their reliance on dog teams. Stock status reports for these species will help to address that issue.

Subsistence fish harvests were monitored for several years, beginning in the early 1990s, in each of the Inuvialuit, Sahtu, Gwich'in and Deh Cho territories. This activity provided much-needed information on the number of fish caught, species composition and number of people participating in subsistence fishing. Subsistence fishers catch several thousand broad and lake whitefish each year. Inconnu (coney) is also important in some communities.

Department of Fisheries and Oceans, Inuvik and Hay River.

Lake trout fishery on Great Bear Lake

The current harvest of lake trout in Great Bear Lake is well below the maximum sustainable yield.²¹⁴ Earlier studies showed that the lake trout population of Great Bear Lake declined slightly until 1984.²¹⁶ Because of those findings and in order to maintain trophy lake trout stocks, quotas were assigned in 1987 specifying the maximum number of lake trout that could be harvested in each of the lake's five management areas. The maximum harvest in the five management areas combined is 9,000 fish. Since 1987 the actual harvest in each management area has been much lower than the maximum sustainable harvest. There have been no studies done on lake trout populations in Great Bear Lake since 1984. Therefore, it is not known with certainty whether this population is stable.

What is being done about it?

Fish are managed through co-operative arrangements amongst land claim Renewable Resources Boards, the federal Department of Fisheries and Oceans, the Northwest Territories Department of Resources, Wildlife and Economic Development as well as Renewable Resource Committees in each of the communities. The Renewable Resources Boards, Renewable Resource Committees and Department of Resources, Wildlife and Economic Development make recommendations to the federal Department of Fisheries and Oceans on issues such as allowable

harvests, licensing of sport and commercial fishers and studies of fish stocks.

A management plan has been instituted for inconnu stocks in the lower Mackenzie River and Mackenzie Delta. A stock status report and management plan for lake and broad whitefish in the Mackenzie Delta and lower Mackenzie River will be completed in 2004.

There is a five-year study underway that is assessing the lake trout population in the Keith Arm of Great Bear Lake. Managers will have more information to make decisions related to the future development of a fishery in the Keith Arm once the study is completed. In addition, there is a multi-agency plan to develop a watershed management plan for Great Bear Lake.

Overall Assessment – Favourable

Subsistence, sport and commercial fishing are important activities in the Mackenzie-Great Bear sub-basin, both culturally and economically. Fish are especially abundant in the Mackenzie Delta. Great Bear Lake is the site of a world-class trophy lake trout fishery. Assessments of key fish stocks have been or are currently being done and are the basis for management strategies that have been implemented or will be implemented in the near future. The aim of management is to ensure the sustainable harvest of fish stocks. The involvement of key stakeholders in fish management bodes well for the conservation of fish stocks.

Ensure Healthy, Abundant, and Diverse Aquatic Species and Habitat

Traditional Knowledge of Aquatic Species and Habitat

During the 1950s, the residents of Inuvik and Aklavik caught 112,000 to 315,000 broad whitefish per year.²⁹ Broad whitefish is still an important food source, but its overall importance in the local economy has decreased because fewer people keep dog teams and run trap lines than in the past.²⁹

By the mid-1990s, the Gwich'in had noticed an increase in fishing for Dolly Varden, and they expressed concern about its effects on the population of that species: "Elders said people bother dhik'ii [Dolly Varden] too much today. They said people should leave dhik'ii alone for several years, and let them come back and grow in number."⁵⁸ People also explained that setting nets can interfere with efforts to catch burbot by jigging.²⁹

By the mid-1990s some residents of the Mackenzie Delta believed that fish had become less abundant than in the past, while others had not noticed any change in fish abundance.^{29, 58} Some of the year-to-year variation in fish populations was thought to

result from differing migration routes. For example, people explained that in the past only herring migrated upstream to spawn near Fort Good Hope but that in recent times coney [inconnu] and whitefish also travelled that far up the Mackenzie River. There also appeared to be changes in the timing of migration: "Dhik'ii [Dolly Varden] used to reach Rat River at the end of August; however, for the last several years people have noticed dhik'ii starting their upstream migration a week or two earlier than usual."⁵⁸ It is also believed that fish numbers vary with changes in water level. For example when the water is high there are fewer broad whitefish.⁵⁸ Although some people did not notice any changes in fish quality²⁷, others did, particularly in the frequency of abnormalities.^{29, 58} Changes to population size and health were attributed to changes in the environment, such as forest fires and pollution, and to human activities such as commercial fishing and fish tagging.⁵⁹

"Elders often talk to the young people about the changes they have seen during their lifetime. Stories shared often speak of birds, animals and fish that were more abundant and healthier in the past. Many Elders believe that development and industry in the south are partially responsible for polluting the north and affecting the wildlife that migrate to the Gwich'in Settlement Area each year."⁵⁹

People living in the Gwich'in Settlement Area said

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

that there were fewer beaver in the area around Travaillant Lake⁵⁸ and that there were more river otter in the delta⁵⁹ than in the past. Some people reported that muskrat numbers decreased considerably after seismic work was done in the Mackenzie Delta during the 1960s and 1970s. Populations have increased since then, perhaps because fewer people hunt and trap muskrat. Nevertheless, many people believed that the muskrat population had not recovered to its pre-1970s level. In addition to changes in population size, people noticed white spots on muskrat livers in the early 1980s. This is indicative of a lack of food and poor health.⁵⁸

Gwich'in Elders said that scoter duck populations were low in 1995 and that tundra swans were uncommon in the 1950s, but that population numbers for both these species recently increased.⁵⁸ In recent years, there were more ducks, geese, and swans in the Fort McPherson area than in the past.²⁷ People explained that waterfowl populations vary from year to year, in part because the birds choose different migration routes.⁵⁸

▼ Overall Assessment – Mixed Signals

Traditional knowledge has raised concerns about the populations or health of some wildlife species such as Dolly Varden, beaver and muskrat. Other species such as swans and otters may have increased in numbers. Much of the traditional knowledge of aquatic species and habitat is based on information collected before 1997. It would be useful to update this information in order to determine whether the health,

abundance and diversity of aquatic species and habitats have changed since then.

Waterfowl Populations

The Mackenzie River is a major “highway” during the spring, when birds fly north to their nesting grounds, and again in the autumn, when they return south. The numerous wetlands of the Mackenzie-Great Bear sub-basin support regionally and internationally important populations of waterfowl. The Mackenzie Delta is the most important wetland area in the Mackenzie-Great Bear sub-basin. More than a quarter of a million ducks and several thousand geese and swans spend their summers there.

What is happening?

Every spring, the United States Fish and Wildlife Service counts the numbers of breeding ducks from aircraft on six survey strata within the western portion of the Northwest Territories. Data from these surveys are useful for evaluating the status of waterfowl in an area encompassing the Mackenzie Valley, Mackenzie Delta and Great Slave Lake area.

Over the past forty-three years, populations of four types of ducks (northern pintail, scaup, long-tailed ducks, and scoters) have declined substantially in this region. Ten species groups show no obvious trends (mergansers, mallards, gadwalls, American wigeons, green-winged teal, northern shovelers, canvasbacks, redheads, ring-necked ducks, and goldeneyes). Three species show upward trends (blue-winged teal,

buffleheads, and ruddy ducks). Population trends of representative species are shown in Figure 7–9.

Why is it happening?

The size of duck populations is influenced by changes in habitat, predation rates, weather and numerous other factors. In the Northwest Territories, populations of some duck species, such as mallard and wigeon, can change dramatically from year to year. Such changes may occur because drought in the prairie region to the south forces birds to over-fly their normal prairie breeding areas and spend the summer in the north where habitat is more stable. However, long-term drought in the prairie area can reduce the continental population size of these species, so that eventually there will be fewer in the Northwest Territories as well.

For other species, such as scaup and scoters, the northern boreal forest is the most important part of their breeding range. They spend winters on the Atlantic or Pacific coasts or on the Gulf of Mexico. Because they are migratory, it is possible that their population sizes are influenced primarily by conditions they encounter while in areas outside of the Northwest Territories.

Reasons for the declines in populations of four species and increases in population of three species in the Northwest Territories are not known.

What does it mean?

Waterfowl are a moderately important type of traditional food in the Inuvialuit Settlement Region, which includes a portion of the Mackenzie Delta.⁶⁸

Mallards and scoters are the types of ducks that are most commonly eaten. Changes in sizes of their populations may affect the numbers of ducks that are harvested by subsistence hunters in the Northwest Territories.

Also, when long-term changes in populations are detected, the 'bag limit' or allowable kill by sport hunters in southern Canada and the United States may be changed. Such changes are intended to either reduce hunting pressure on species whose populations are declining or to provide further opportunity for harvesting species whose populations are increasing.

What is being done about it?

The Canadian Wildlife Service and the United States Fish and Wildlife Service continue to co-operate in studies and monitoring of waterfowl populations in North America. These agencies, together with

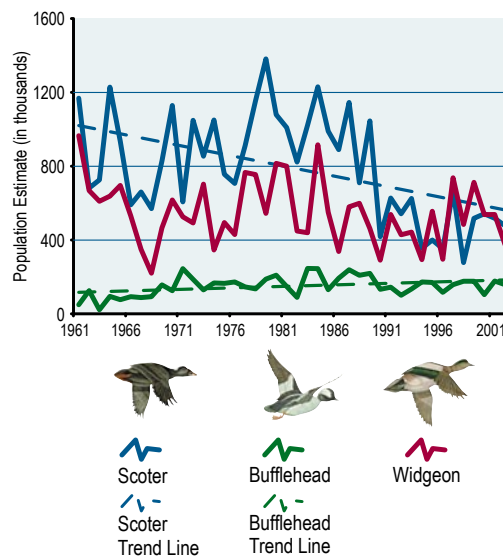


Figure 7–9. Waterfowl populations change dramatically from year to year in the western Northwest Territories. Scoter populations have declined, buffleheads have increased and American widgeon have shown no long-term trend.

Data Sources: US Fish and Wildlife Service; Canadian Wildlife Service.

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

provincial, territorial and state wildlife departments co-operate in setting bag limits on individual populations. Furthermore, government agencies and Ducks Unlimited work together through the North American Waterfowl Management Plan (NAWMP) to develop programs intended to promote the conservation of waterfowl and their habitat. The Sea Duck Joint Venture is one of NAWMP's programs. It is attempting to identify the cause of the decline in species of sea ducks such as scoters. Ducks Unlimited and its partners have developed the Western Boreal Forest Initiative to address water bird conservation concerns in the vast boreal forest region of western Canada. As part of this initiative, studies are being conducted on ducks and their habitat in the Mackenzie Delta and the Sahtu region of the Mackenzie Valley. The Canadian Wildlife Service manages the Kendall Island Migratory Bird Sanctuary located in the outer Mackenzie Delta. Kendall Island is an important breeding area for waterfowl.

▼ Overall Assessment – Mixed Signals

There are intensive efforts by American and Canadian government agencies to monitor changes in population sizes of species of waterfowl in the Northwest Territories. Government agencies in Canada and the United States, together with Ducks Unlimited, implement programs intended to conserve waterfowl populations. Populations of some species in the Northwest Territories have declined while others have increased. The causes of these changes are not known.

Ensure Human Health and Safety

Flood Hazard Management

Floods are a natural occurrence on the Mackenzie River and its tributaries, and can be caused by ice jams or intense rainstorms.

What is happening?

Ice jams (Figure 7–10) are common along the Mackenzie River during spring break-up and can cause flooding by creating ice dams which prevent water from flowing further. Such events can raise water as high as ten meters above normal river levels,²¹⁷ significantly erode the riverbanks, and place communities at risk. Fort Simpson, at the confluence of the Mackenzie and Liard rivers, is prone to flooding caused by major ice jams that typically form about thirty to forty kilometres downstream of the community.

Intense rainstorms in the Mackenzie Mountains can cause very quick and destructive floods.²¹⁸ Flooding in the Taiga Plains Ecozone is less common, but wet conditions can transform normally small streams into torrents and cause a great deal of damage, as happened in July 1988.¹⁵⁷ Summer floods are a greater risk on the tributaries of the Mackenzie River than on the main stem itself.

Why is it happening?

Ice jams occur on the Mackenzie River because the river often contains intact ice when spring snowmelt causes the water level to rise quickly. The Mackenzie-Liard confluence experiences ice jams because the stabilizing outflows from Great Slave Lake usually keep the ice intact until the arrival of the Liard River spring flow.^{219, 220} High flows from the Liard River also trigger break-up on the Mackenzie River downstream of Fort Simpson.

Mackenzie River tributaries in flood can have flows that are much greater than during dry conditions. This occurs because wet conditions saturate the land, thereby greatly increasing surface runoff into streams and rivers. The sheer size of the Mackenzie River provides a dampening effect on most summer floods, which usually are limited to small areas where precipitation is heaviest.



1982 flood at Aklavik caused by ice jamming.

Source: Kriwoken 1983.

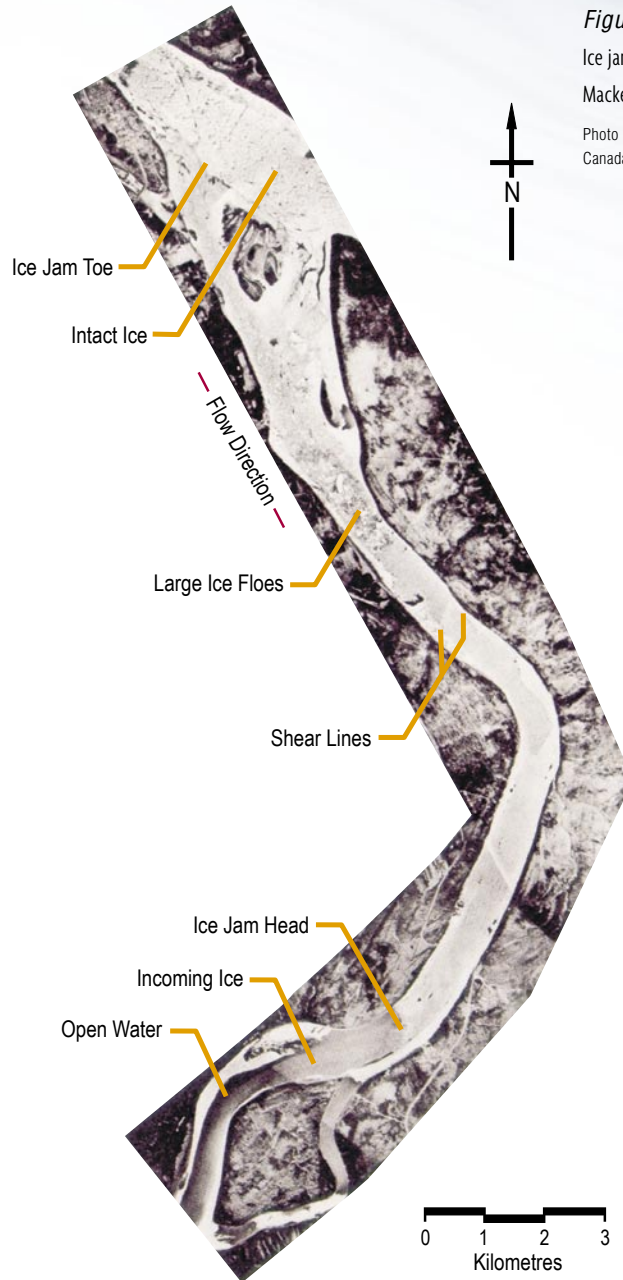


Figure 7-10.

Ice jam at the confluence of the Mackenzie and Liard rivers.

Photo Credit: T. Prowse, Environment Canada.

7. The Mackenzie Great Bear Sub-basin – Mackenzie River Basin

What does it mean?

An intense rainstorm in the southern and western NWT caused a flood in the Mackenzie-Great Bear sub-basin in July 1988. On July 3 the Mackenzie River at Norman Wells peaked at a record-breaking 33,700 cubic meters per second. Industry, communities, and government agencies were caught off guard by the speed and magnitude of this event. Nothing like this had been experienced since before much of the infrastructure in the region had been built. The July 1988 flood destroyed or damaged a significant portion of the transportation infrastructure in the upper Mackenzie River and became the benchmark for designing roads and bridges in the region.

Even with information gathered during the 1988 flood, the historical record is still relatively limited. Flood magnitude predictions remain poor, with most estimates only accurate to within 30%. To some extent, the magnitudes of large floods have been estimated from historical anecdotal descriptions, traditional knowledge, and studies based on damage to trees caused by high water.^{169, 217, 221} There are also very few estimates of the frequency of floods along the Mackenzie River, especially those due to ice jams.

What is being done about it?

Government agencies perform flood frequency studies periodically in order to integrate newer data into the predictions of flood magnitude and timing. The Flood Damage Reduction Program of the 1980's identified Fort Simpson, Tulita, Fort Good Hope and Aklavik as flood prone communities. Flood-prone areas in each community were mapped under this program. Development in locations that are

vulnerable to flooding is discouraged by zoning by-laws and planning guidelines and through financial assistance programs available to developers.

Research on ice jam processes has historically been performed near Fort Simpson,²²⁰ but there is little recent work. The last assessment of ice jam floods along the Mackenzie River was performed in 1973.²¹⁹ Little is known of the potential impacts of climatic change on ice jams.

Overall Assessment – Favourable

Although people were unprepared for the 1988 flood, knowledge and infrastructure have improved greatly since then. Nevertheless, further work is required to accurately predict or evaluate trends in the timing and magnitude of flooding in the Mackenzie-Great Bear sub-basin.

Fish Consumption Advisories

Health Canada conducts health risk assessments to evaluate the risk posed by contaminants in food. If required, the territorial health department, working together with communities, issues fish consumption advisories in the form of a Recommended Maximum Weekly Intake (RMWI). An RMWI is the maximum amount of fish that should be eaten per week. These recommended limits are specific to a particular location, species of fish, type of fish tissue and cohort of the human population (adults, women of childbearing age and children).

What is happening?

There are twelve lakes within the Mackenzie-Great Bear sub-basin with fish consumption advisories

based on the concentration of mercury in fish fillets. Figure 7–11 shows the number of fish consumption advisories for eight species of fish and three segments of the human population. Children are more sensitive to contaminants than adults so there are more fish consumption advisories for children. All twelve lakes had RMWI advisories for children, eleven had advisories for women of childbearing age, and nine had advisories for other adults. The RMWI values for a particular fish species in a particular lake are smaller for children than for adults, with the recommended consumption limits for children as low as thirty-five grams of fish per week.

Why is it happening?

Fish consumption advisories are designed to protect people from consuming harmful levels of contaminants by limiting their consumption of highly contaminated fish. Some contaminants increase to higher levels along food chains so predatory fish such as walleye, lake trout, and northern pike tend to have the highest levels of contaminants (see **Chapter 1 - Contaminants** for more information on contaminants in fish).

What does it mean?

Fish and other country foods are inexpensive, readily available, and healthy. These benefits far outweigh the risks associated with trace metal, organic or radionuclide contamination, provided that the fish are not too contaminated. It is a good idea to eat a diversity of foods, and limit consumption of predatory species from a long food chain. By following fish consumption advisories, people can keep their exposure to contaminants to acceptable levels.

What is being done about it?

Health Canada conducts health risk assessments to evaluate the risk posed by contaminants in food. When warranted, the territorial health department, working together with communities, may issue fish consumption advisories. The NWT Environmental Contaminants Committee was established under the Northern Contaminants Program to provide northerners with information on contaminants so that they can make informed decisions about their use of traditional foods.

Overall Assessment – Mixed Signals

The existence of fish consumption advisories for lakes in the Mackenzie-Great Bear sub-basin is a cause for concern. Mercury is naturally elevated in some areas of this sub-basin, so the presence of this contaminant may not be due to human activities. Additional monitoring at more lakes is required to determine whether further advisories are required. Fish consumption advisories can help northerners make healthy and informed choices about their use of fish.

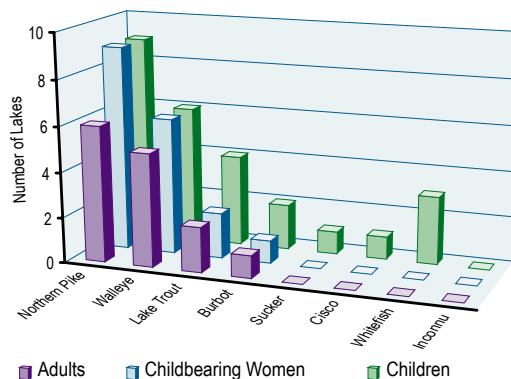


Figure 7–11. Consumption advisories have been issued for fish from twelve water bodies in the Mackenzie – Great bear sub-basin. All advisories are related to excessive mercury.

Data Source: Health Canada; Stanton Regional Health Board.

Mackenzie Delta

The Mackenzie Delta is the largest delta in Canada, and the 12th largest in the world. It covers an area of approximately 13,500 square kilometres.²²² The area boasts a variety of stunning landscapes including mountains and plains. The majority of the delta is situated within discontinuous permafrost, with the northeastern corner encroaching into continuous permafrost. Away from the influence of the Mackenzie River, the permafrost layer is greater than one hundred meters thick.

Sedimentary rocks, built up by deposition from the Mackenzie, Peel and Rat rivers, cover the Precambrian Shield in a wedge-shaped fan. There has been almost continuous washing of sediment into the delta for much of the last sixty-five million years, resulting in a sedimentary rock layer up to fifteen kilometres in thickness. The last major geologic event to impact the delta was the Wisconsin Ice Age, during which the Laurentide Ice Sheet extended from the Keewatin to the Tuktoyaktuk Peninsula between 18,000 and 20,000 years ago. These continental glaciers retreated 12,000 to 13,000 years ago.²²³

The climate of the Mackenzie Delta is characterized by long cold winters and short cool summers. The mean annual precipitation in the delta is 257 millimetres, which is low compared to the average across the whole Mackenzie River Basin (410 millimetres). Snow and ice cover the lakes and the channels of the Mackenzie Delta for up to eight months of the year.²²⁴

There are roughly 25,000 lakes in the Mackenzie Delta. Their shapes and sizes are constantly changing in response to sediment deposition, changes in permafrost and cycles of flood and drought. Lakes affect permafrost distribution, support fish and wildlife, and store water, sediment and pollutants. Delta lakes are shallow and their depths are controlled mainly by discharge of the Mackenzie and Peel rivers, growth of river ice, ice break-up and jamming, changes in sea level, permafrost conditions and precipitation and evaporation.²²³ Floods are required to replenish the water supplies of delta lakes. The frequency of flooding is likely to decrease in the future because of climate change. As a result, many of the lakes in the inner delta will disappear and others will become shallower.³²

The Mackenzie River creates a warming effect on the surrounding landscape. As a result, the tree line extends considerably farther north in the western arctic than in the east.²²² The Mackenzie Delta is predominantly forested with stands of stunted black spruce, white spruce and tamarack. Low, shrubby vegetation such as willow and ground birch occupies the transitional zone between the tree line and the tundra. In the central part of the delta, vegetation distribution is controlled by water levels. From the air, the forested areas appear as narrow ribbons along the channels with the remainder of the area being covered in willows, sedge flats and alders.²²³

Wildlife within the Mackenzie Delta consists of

Mackenzie Delta - continued

muskrat, beaver, moose, mink, lynx, red fox, wolf, wolverine, snowshoe hare and black bear. Beluga whales migrate from Alaska to the outer delta to calve in the summer. Common fish species include broad whitefish, lake whitefish, inconnu, northern pike, arctic grayling, cisco, Dolly Varden, and arctic char. During the warmer months, the delta is used by numerous species of birds, including tundra swans, several species of ducks and geese, bald and golden eagles, peregrine falcons, loons, ptarmigan and several smaller species of birds.^{222, 223}

As the Laurentide Ice Sheet receded 13,000 years ago, people living in Alaska and Yukon began to migrate into the Mackenzie Delta. There were an estimated 4,000 people living in the delta in 1848. However, small pox and other diseases decimated Aboriginal populations. Fort McPherson was established as a Hudson Bay Company trading post and the traders began to focus more on the delta and its valuable fur trade. Today there are five settled communities within or very close to the Mackenzie Delta: Inuvik, Aklavik, Tuktoyaktuk, Tsiigehtchic and Fort McPherson. The current population of the Mackenzie Delta is approximately 5,500 people.²²³ Many people maintain hunting or fishing camps for weekend getaways, and the traditional way of life still plays an important role in their lives. Although store-bought food is readily available, many people continue to eat more nutritious and less costly country foods and to hunt and fish for a good part of their diet.

Oil and gas deposits in the area are contained within the relatively young shale and sandstone sedimentary rocks. Recent exploration has demonstrated a vast potential for oil and gas development, with reserves being estimated at seven billion barrels of oil and two trillion cubic meters of natural gas. Most of the oil wells in the delta were drilled during the 1970s. The pace of development tapered off after that. However, as the demand for natural gas in North America increases, the development of the delta's petroleum reserves will become more feasible. A consortium of oil companies and a First Nation corporation, is working to guide future work on economic and timely development of a Mackenzie Valley Pipeline. The construction of the pipeline will lead to the development of the delta's oil and gas reserves.



The Mackenzie Delta near the mouth of the Mackenzie River.

Courtesy of: A. Czarnecki