6. Great Slave Sub-basin

Introduction

Geography

The Great Slave sub-basin includes the Slave River drainage from the Peace-Athabasca Delta and all other tributary inflows into Great Slave Lake. It covers more than 379,000 square kilometres. Approximately 75% of the sub-basin is in the southeastern NWT and 20% is in northern Alberta. The remainder extends into northeastern British Columbia and northwestern Saskatchewan.

Great Slave Lake is the largest lake in the Great Slave sub-basin and is entirely within the NWT. It is the fifth largest lake in North America with a surface area of 28,568 square kilometres and a volume of about 2,088 cubic kilometres of water.[173] Great Slave Lake is also the deepest in North America with an average depth of about seventy-three meters and a maximum depth of 614 meters.

The Great Slave sub-basin consists of fourteen major drainage systems. The largest river, the Slave, contributes about 77% of the inflow to Great Slave Lake. Other major inflows to Great Slave Lake are shown in Figure 6–1. The drainage areas of the Taltson, Lockhart, and Hay rivers contribute about 11% of the flow into Great Slave Lake, while the other ten drainage areas provide the remaining 12%.[174]

The Great Slave sub-basin straddles two distinct physiographic regions: the erosion-resistant Precambrian Shield to the east; and the Interior Plains to the west (Figure 6–1). The Shield features open, stunted taiga forest and hundreds of lakes, while the Plains are characterized by a more dense boreal forest in a landscape that was sculpted and smoothed by continental glaciers.[175] As a result of geological and vegetative differences between these areas, annual runoff is greater in the Shield than in the Interior Plains. Moreover, the presence of hundreds of small and large lakes in the Precambrian Shield produces more stable flow regimes in its rivers than in rivers of the Interior Plains.

Human Populations

The Dene have lived in the Great Slave sub-basin for thousands of years, and are the sub-basin's principal Aboriginal group. First

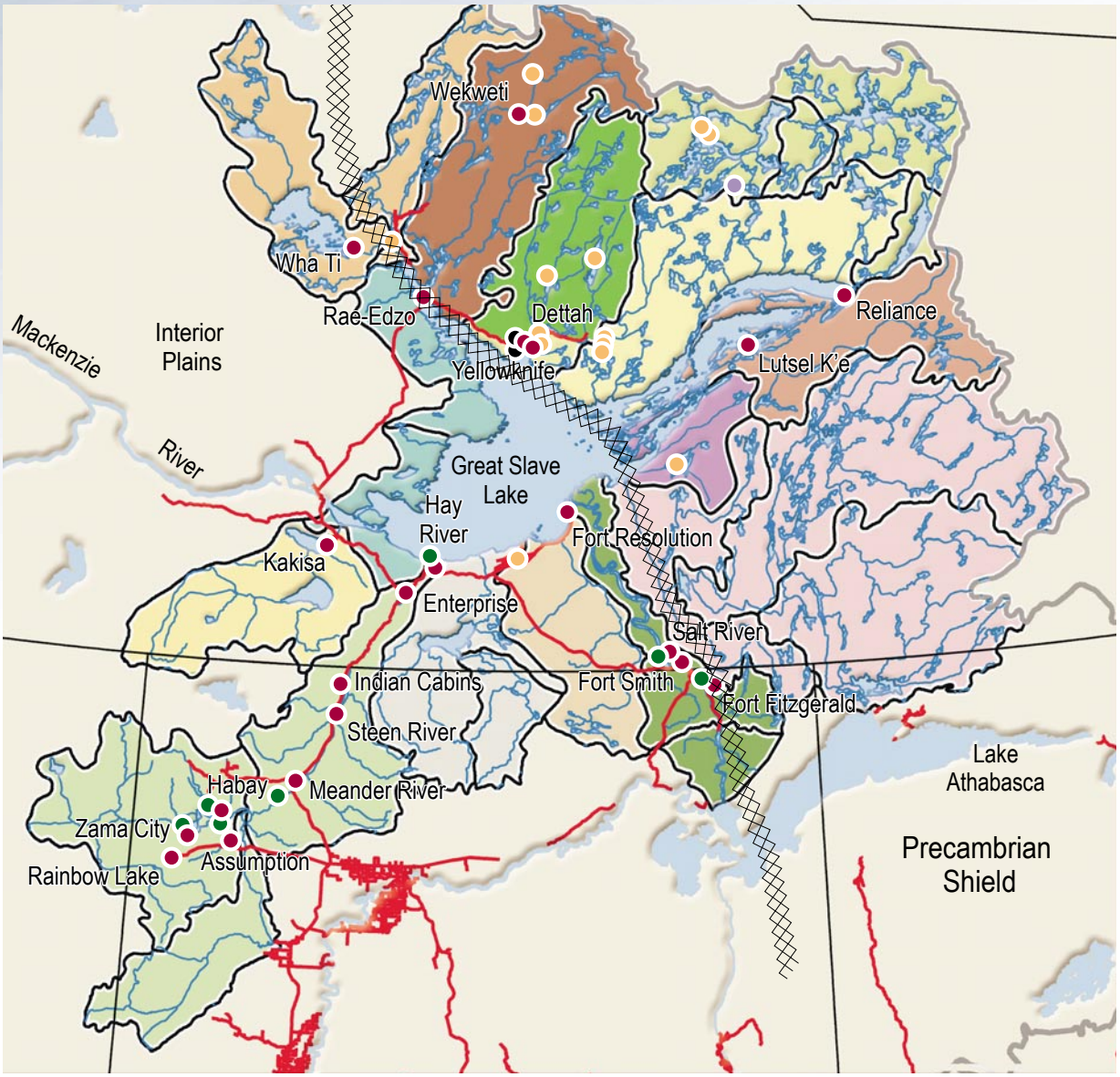


Figure 6-1.
Map of the Great Slave sub-basin.

Nations people comprised about 38% of the population of the Great Slave sub-basin in the 1996 census.

Approximately 28,000 people live in the Great Slave sub-basin. Eighty-seven percent of the population resides in the Northwest Territories; the remaining 13% lives in Alberta. There are twenty-two communities in the sub-basin (Figure 6–1). The largest community is Yellowknife with a population of 18,500.

Industry

Discovery of gold during the 1930s on the northern shore of Great Slave Lake brought the first major industry to the Great Slave sub-basin. Over the years other mines were developed within the basin (Figure 6–1). The former lead-zinc mine at Pine Point, on the south shore of Great Slave Lake, brought the railroad north of 60° latitude in 1964.[176]

There is high potential for mineral development in the Great Slave sub-basin, but by global standards the area remains relatively undeveloped. There were two operating gold mines in Yellowknife in 2003 and there are about twenty past-producing mines within the sub-basin (Figure 6–1). A proposed diamond mine at Snap Lake, located about 250 kilometres northeast of Yellowknife, is currently in the environmental assessment phase. A 600-kilometre winter road crosses the northeastern part of the sub-basin and provides access to several mineral exploration camps as well as two diamond mines and one gold mine, which are located outside the Mackenzie River Basin.

There are six hydroelectric generating facilities in the Great Slave sub-basin located on the Snare, Yellowknife and Taltson river systems (Figure 1–5). These facilities provide power to most of the communities and mines within the sub-basin.

The petroleum industry has expanded northwards from the oil and gas fields of Alberta. The Alberta communities of Zama and Rainbow Lake are hubs for crude oil and natural gas production. A major pipeline from the Norman Wells oil field in the NWT passes through Zama. Recent oil and gas development has been occurring in the Cameron Hills, which straddle the Alberta-Northwest Territories boundary.

Improve Water Quality

Traditional Knowledge of Water Quality

Based on data collected prior to 1995, 75% of respondents from Fort Smith and Fort Fitzgerald noted more algal growth, 44% noted higher turbidity, 17% indicated the water was dirtier, and 33% reported there was more green slime on the river banks and in fish nets.[28] Increased algal growth was also reported by over half of the respondents from Fort Resolution. The Slave River was considered dirty because of turbidity.

People from Fort Smith and Fort Fitzgerald considered pulp and paper mills, oil exploration, and oil sand plants at locations upstream from the Great Slave sub-basin to be the industries with the worst

impacts on water quality.[28]

Elders from the Lutselk'e Dene First Nation expressed concern that the flooding that occurs at hydroelectric dams spoils the water and harms fish populations.[12] They also expressed concern that mining harms water quality.

Overall Assessment – Unfavourable

Many people have observed that water quality has deteriorated in the upstream portion of the Slave River system and near the dam on the Taltson River. One of the most common observations has been that there is more algal growth than there used to be.

Water Quality Guidelines

The Canadian Council of Ministers of the Environment (CCME) publishes Environmental Quality Guidelines for protecting freshwater aquatic life. The guidelines are maximum or minimum concentrations of various chemical, physical and microbiological substances in water that are deemed to be safe for most forms of freshwater aquatic life.[146] When concentrations exceed the guidelines, freshwater life may be placed at risk.

What is happening?

Generally, water quality in the major rivers of the Great Slave sub-basin is good. This region is sparsely populated and has little industry compared to southern Canada. In rivers of the Interior Plains, metals like copper and iron exceed guidelines for protecting freshwater life most of the time (Figure 6–2). The same is true of turbidity, an indicator of the suspended sediment load or "cloudiness" of a water body. In contrast, metals and turbidity seldom exceed water quality guidelines in rivers of the Precambrian Shield (Figure 6–2).

> "Elders from Fort Resolution recalled "hearing their grandfathers speak of the future when the water would not be clean and that it would affect the fish and the animals... Water was good all over before, and there was no concern about its quality or its presence on the land."
>
> Bill *et al.* 1996. Northern River Basins Study.

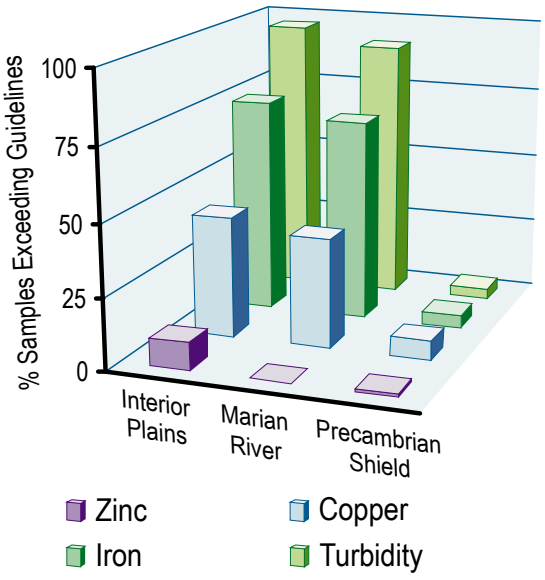


Figure 6–2.
Turbidity and metals – copper, iron and zinc – percentage of samples that exceeded Canadian Environmental Quality Guidelines for the Protection of Aquatic Life in rivers of the Interior Plains and Precambrian Shield in the Great Slave sub-basin. The Marian River flows through both the Shield and the Interior Plains.

Data Sources: Environment Canada; Department of Indian Affairs and Northern Development; Alberta Environment.

Why is it happening?

The role of landscape and underlying geology

The landscape and underlying geology of a region are important factors that affect river sediment loads and the associated water quality characteristics. The Precambrian Shield is composed mainly of crystalline bedrock, which has less soluble material than the glacial till and sedimentary rocks of the Interior Plains.[176] Sedimentary rocks and glacial till of the Interior Plains are more easily eroded and washed into rivers than the hard bedrock of the Precambrian Shield.

Sediment load affects metal levels

Metals can be dissolved in the water column or be attached to particles of sediment.[139, 177] Usually high metal concentrations in rivers are associated with large sediment loads. Therefore, water quality guidelines for copper, iron, and other metals are routinely exceeded in rivers with high sediment loads, such as the rivers of the Interior Plains (Figure 6–2).

Water Quality changes with the seasons

Water quality in lakes and rivers changes with the seasons. During high water periods, such as the spring freshet and following summer rainstorms, sediment loads are usually at their highest due to erosion. At these times of year, turbidity is high and metals occur mainly in their particulate forms.[178] Conversely, during late summer and fall, flow rates decrease while the lowest flows occur in winter. A river has less capacity to dilute metals, salts and other solids under low flow conditions and concentrations of some substances may therefore exceed guidelines. Under winter ice cover, water quality can be influenced by groundwater. The chemical composition of groundwater normally reflects the mineral composition of the rock or soils through which it moves.

What does it mean?

Metals such as copper, iron and zinc exist in various chemical forms in water, depending on numerous characteristics of the water, including acidity and hardness. A metal, depending on its form, can be toxic to certain types of aquatic life. Because concentrations of some metals have probably been high for thousands of years in rivers of the Interior Plains, aquatic plants and animals that live in those rivers have likely adapted to these conditions.

High sediment loads in rivers of the Interior Plains provide a rich supply of nutrients that are the basis for food chains in river, lake and delta ecosystems of the Great Slave sub-basin.

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 Great Slave sub-basin exceeded these national guidelines

does not necessarily indicate that the plants and animals that are native to these rivers are at risk.

What is being done about it?

Through the efforts and commitment of federal, provincial, territorial and municipal governments, water quality monitoring continues at long-term monitoring sites. Federal, territorial and regional legislation serves to protect water quality by regulating the use of water and the discharge of wastewater to natural water bodies in the NWT. Water licences are required for community and industrial use of water and for the discharge of wastewater. The licences set limits on the amount of water that can be used and the quantity and quality of wastewater that can be discharged. They also stipulate conditions for water quality testing and monitoring to ensure that licence holders are complying with regulations. When developments are proposed, environmental and health impact assessments must be done as part of a regulatory process. These assessments are done to ensure that the development is planned in such a way as to prevent or minimize damage to the environment. Through the *Mackenzie River Basin Transboundary Waters Master Agreement*, governments will negotiate bilateral water management agreements aimed at protecting water quality and ensuring that sufficient water flows to each jurisdiction to meet its needs.

Overall Assessment – Favourable

Although turbidity and concentrations of certain metals in rivers of the Interior Plains of the Great Slave sub-basin routinely exceed Canadian Environmental Quality Guidelines for protecting freshwater aquatic life, the causes are likely natural in origin. Aquatic plants and animals that are native to these rivers have likely adapted to these conditions.

Arsenic in Yellowknife

What is happening?

Yellowknife is the site of two gold mines, the Con Mine, near the shores of Yellowknife Bay, and the Giant Mine, adjacent to Back Bay.

There is arsenic in the gold-bearing ore that occurs within the bedrock of the Yellowknife area. Arsenic dust is a by-product of the process that separates the gold from the ore. Arsenic levels in sediments collected from Yellowknife Bay have increased since gold mining began in the area in 1938. Figure 6–3 shows the levels of arsenic in a dated sediment core sample taken from Yellowknife Bay. Arsenic levels were quite low in deep sections of the core that were deposited

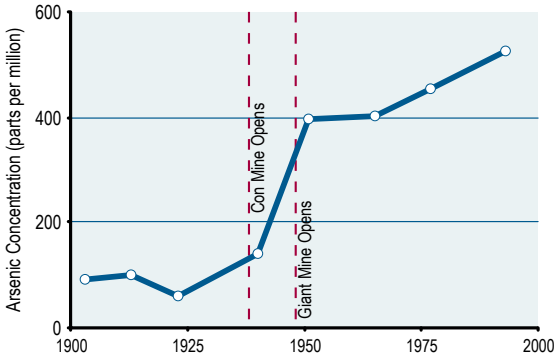


Figure 6–3.
The amount of arsenic in sediments of Yellowknife Bay has increased substantially over the past sixty years, based on an analysis of arsenic levels in a dated sediment core.

Data Source: C. Ollson, Thesis, Royal Military College.

Arsenic trioxide dust was a by-product of the gold recovery process at Giant Mine. From 1951 until 1999, approximately 237,000 tonnes of this dust was conveyed into fifteen underground storage chambers at the mine. The Department of Indian Affairs and Northern Development is evaluating long-term management alternatives for the underground dust and will prepare a Project Description for submission to the Mackenzie Valley Land and Water Board.

before gold mining began. Sections closer to the core's surface, containing more-recently deposited sediment, contained higher arsenic levels.

Why is it happening?

The amount of arsenic in the local environment surrounding Yellowknife is the legacy of sixty years of gold mining and a product of the area's geology.[179, 180]

The process by which gold is recovered from the ore results in some arsenic being emitted to the air. Emissions of arsenic to the air were greater in the early days of mining at Yellowknife than they have been in recent times. Furthermore, tailings management in the early days resulted in large amounts of arsenic-containing tailings being deposited in Baker Creek near the Giant Mine and in the Meg-Keg-Peg lakes system near Con Mine. Water

The Giant Mine near Yellowknife, NWT.
Courtesy of: Giant Mine Archives

A Legacy of Old Mines

The Great Slave sub-basin is rich in minerals and has a long history of mining. There are nineteen old mines in the sub-basin, sixteen of which are considered abandoned. Many were not properly cleaned up when they closed. Consequently, some sites in the immediate vicinities of the mines became polluted.

The Discovery Mine is one such site. Gold was mined at Discovery, on Giauque Lake, from about 1944 to 1969. In those days, mercury was used to separate gold from the ore.

When the mine closed, approximately 1.1 million tonnes of tailings were spread over thirty-two hectares of land and 3.7 hectares of shoreline. Metals such as mercury entered Giauque Lake through leaching and erosion. Sediments and fish became so highly contaminated with mercury that, in 1978, people were told to stop eating fish from Giauque Lake.

Reclamation began in 1998. It involved an intensive clean-up of the site and the contouring and capping of the tailings. The latter activities were completed in 2000. Approximately $9 million has been spent so far.

It will take time for the Giauque Lake ecosystem to recover. Early indications are positive and suggest that the tailings cover has been effective in reducing infiltration through the tailings. The situation will continue to be monitored for years to come.

Clean-up has commenced at several other abandoned mines in the basin. In addition, governments have taken steps to make sure that mines do not leave a legacy of pollution to the future. Governments now demand that mining companies provide substantial security deposits before they start mining. These deposits cover the costs of clean-up and closure. Future mining operations in the North will have to provide for full financial security before receiving regulatory approvals for development.

in these systems flows into Back Bay and Yellowknife Bay, respectively. Thus, arsenic, released by emissions and in drainage from tailings, was deposited in the local aquatic environment. Consequently, even after dilution in Back Bay (Latham Island) and Yellowknife Bay (Dettah Dock), arsenic levels remain slightly higher than in the Yellowknife River, upstream of the discharge points (Figure 6–4).

What does it mean?

Water at the Baker Creek outlet to Back Bay and the Peg Lake outlet to Yellowknife Bay is unsafe to drink and does not meet the Canadian Environmental Quality Guidelines for protecting aquatic life. However, the waters in Back Bay and Yellowknife Bay are well within the Canadian Environmental Quality Guidelines for drinking and aquatic life (Figure 6–4). Mine effluent is treated and released in accordance with water licence limits for each site. The water license limits were based on the old Metal Mining Liquid Effluent Regulations of 0.5 parts per million arsenic for industrial wastewater.

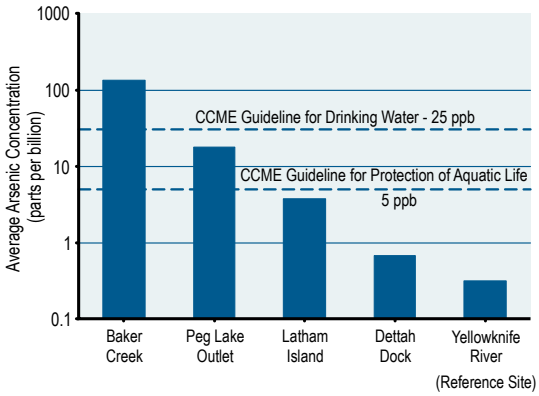


Figure 6–4. Water in Baker Creek and Peg Lake, which receive effluent from the Giant and Con mines, respectively, contains more arsenic than water from the Yellowknife River, which is unaffected by gold mining. Even Yellowknife Bay (Latham Island and Dettah Dock), into which effluent-containing creeks eventually flow, has slightly higher levels of arsenic than the Yellowknife River. NOTE: Arsenic levels are shown on logarithmic scale.

Data Source: Department of Indian Affairs and Northern Development.

What is being done about it?

Giant Mine stopped processing ore in 1999. Ore from the Giant Mine is now processed at Con Mine, a change that has brought about a substantial reduction in the amount of treated wastewater being released to Baker Creek. Con Mine is also treating arsenic-contaminated tailings that have accumulated on its property over the years. The wastewater produced by this process is treated to reduce the arsenic prior to release into the Meg-Keg-Peg lakes system.

The mines are obligated to monitor effluent and local water quality at regular intervals to ensure that wastewater released from both sites is in compliance with their licences. The Department of Indian Affairs and Northern Development also regularly monitors mine effluent and local waters.

Environmental studies have been done at Giant Mine and are continuing as part of the ecological and human health risk assessments for the mine and local communities. These studies will lead to an improved understanding of whether a history of gold mining at the Giant Mine poses a risk to the environment in the Yellowknife area.

The Department of Indian Affairs and Northern Development spent more than $4 million at the Giant Mine during 2001 and 2002. These expenditures paid

for some clean up of the mine site and for environmental studies to support the development of a long-term plan to manage arsenic trioxide at the site.

Overall Assessment – Mixed Signals

The amount of arsenic in the local environment surrounding Yellowknife is the legacy of sixty years of gold mining and a product of the area's geology. Since gold mining began, arsenic levels have increased in some of the region's aquatic ecosystems. Except for a couple of small lakes and creeks on the mine properties, arsenic levels are within guidelines. Several government- and industry-led initiatives are addressing the issue of arsenic management and containment in the Yellowknife area.

Ensure Sufficient Water Quantity

Traditional Knowledge of Water Quantity

Some individuals from Lutselk'e, Fort Resolution, Fort Smith, and Fort Fitzgerald have noticed decreases in water levels at certain locations.[12, 28] Some relatively large lakes and rivers have lower water levels while a few smaller bodies of water have disappeared entirely. This has meant that people have had to carry water with them into the bush and that traditional boating routes are no longer navigable. The low water levels are attributed in part to the Bennett and Taltson dams, which have also interfered with water fluctuations and flooding. About half of the respondents in the Fort Smith and Fort Fitzgerald region indicated that the flood times have changed. Compared to the Peace sub-basin, a lower percentage of respondents in the Great Slave sub-basin reported changes in water quantity that could be related to hydro operations.

Overall Assessment – Unfavourable

Some Aboriginal inhabitants of the Great Slave sub-basin have reported decreases in water levels and changes to water fluctuations and flooding at certain locations in the sub-basin. In some cases, these changes have interfered with peoples' traditional lifestyles.

Rapids in the Slave River, NWT.

Flow in the Slave River

What is happening?

Flow regulation by the Bennett Dam on the headwaters of the Peace River has affected flows on the Slave River, over 1,100 kilometres downstream from the dam. Although the total annual flow on the Slave River was only affected during the filling period of Williston Lake Reservoir (1968–1971), there continue to be effects on seasonal variability. The average flows from May until October have been reduced by about 20%, while the average minimum flow in winter is double that of pre-dam conditions (Figure 6–5). High flows are more variable, with an absence of sustained peak flows that formerly occurred in late spring to early summer.

Water levels at Great Slave Lake have been recorded at Yellowknife Bay since 1941. The annual maximum water level fluctuates over a range of seventy centimetres. Since the Bennett Dam was completed in 1968, the average annual maximum water level on Great Slave Lake at Yellowknife Bay has declined by seven centimetres, which appears to be within the range of natural variation.

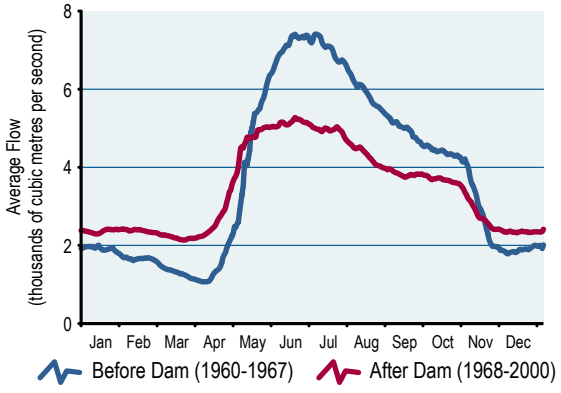


Figure 6–5.
Spring flows became lower and winter flows became higher on the Slave River at Fitzgerald after the Bennett Dam was built.
Data Source: Environment Canada, Water Survey of Canada.

Why is it happening?

Operation of the Bennett Dam has changed the timing and magnitude of flows on the Peace River, just downstream from the dam at Hudson's Hope (see **Chapter 3 – Flow in the Peace River**). The flow at Hudson's Hope accounts for one-third of the Slave River flow at Fitzgerald, averaged over the whole year;[174] therefore, changes in the flow regime of the Peace River below the Bennett Dam have affected the flow regime on the Slave River as well.

The Slave River provides about 77% of the total inflow to Great Slave Lake. Thus, flows down the Slave River are important in affecting water levels in Great Slave Lake. Scientists have attempted to estimate the relative importance of climatic variability and flow regulation by the Bennett Dam in affecting water levels on the lake. Their preliminary estimates suggest that both climatic variability and flow regulation have affected water levels.[125] More research is needed to establish the relative importance of these factors and other possible contributing factors on water levels in Great Slave Lake.

What does it mean?

The high flows and sediment load of the Slave River are important in the formation of the Slave River Delta. Using a sediment rating approach, scientists have estimated that the sediment load on the Slave River at Fitzgerald has tripled during winter since the Bennett Dam began operating, but has decreased by almost half during the open-water season (Figure 6–6).[181] With the possible exception of periods of very high flows, it is believed that the sediment

rating approach is a reasonable tool for predicting what sediment loads would have been like in the Slave River during the pre-dam years.[181]

The *Northern River Basins Study* reported that periodic flushing of the Slave River Delta during high flow has been reduced from pre-dam levels, redistribution of flow among the major delta channels has occurred, propagation of the outer delta has slowed, and colonization by the plant species preferred by moose and muskrat has been reduced.[18] It is uncertain whether these changes are related to flow regulation by the Bennett Dam or to other factors. The uncertainty is due to the relatively limited effort made in studying the Slave River Delta. It can also be attributed to its great distance from the dam (1,500 km) and the additive effects of flow and sediment fed into the Slave River by the unregulated Athabasca River via the Peace-Athabasca Delta and Lake Athabasca.[18] Exposure of the delta shoreline to waves on Great Slave Lake may also affect habitat in the outer portion of the delta.[18]

Changes to flow, sediment load, and the corresponding changes to the physical structure of the river can have an impact on aquatic communities. For example, changes in peak flow may affect fish habitat and interfere with migration and spawning.[18]

What is being done about it?

Water level and stream flow stations in the Great Slave sub-basin are operated by the Water Survey of Canada in partnership with the Alberta government and with the Department of Indian Affairs and Northern Development. Monitoring and research programs provide information relevant to environmental assessments and management decisions. Through the *Mackenzie River Basin Transboundary Waters Master Agreement*, the governments of British Columbia, Alberta, Saskatchewan, Yukon and the Northwest Territories will negotiate bilateral water management agreements, the intent of which will be to ensure that a sufficient amount of water flows to each jurisdiction to meet its needs.

Overall Assessment – Mixed Signals

A number of factors, including operation of the Bennett Dam and climate variability have likely altered the Slave River's flow regime and sediment load, factors that can influence aquatic habitat and communities. Recent changes in climate and flow regulation at the dam appear to have affected water levels in Great Slave Lake. While some recent changes have been observed in the ecology of the Slave River Delta, it is uncertain whether they are the result of flow regulation by the Bennett Dam, of climate change or just natural variation that is common in delta ecosystems.

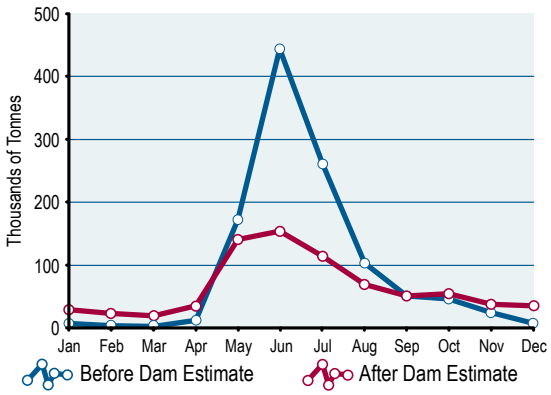


Figure 6–6.
The amount of sediment carried down the Slave River was estimated to have decreased since the Bennett Dam was built.

Data Source: English *et al.* 1996.

Timing of Spring Freshet and Annual Peaks

What is happening?

From 1964 to 2000, peak spring freshet flows have occurred two days earlier per decade on the Hay River (Figure 6–7). Since 1953, the annual peak flow of the Slave River has occurred on average six days earlier per decade (Figure 6–7).

Why is it happening?

Earlier freshets on the Hay River and earlier peak flows on the Slave River may be influenced by the climate warming trend in the Mackenzie River Basin.[182] However, because the Bennett Dam on the Peace River influences flow in the Slave River, climate change may not be solely responsible for the earlier peak flows on the Slave River. Operation of the Bennett Dam has reduced peak flows on the Peace River. The time required for water to flow from the Bennett Dam to the Slave River and the smaller peak flows on the Peace River may be factors that contribute to the earlier peak flows on the Slave River. Further investigation would help to clarify this issue.

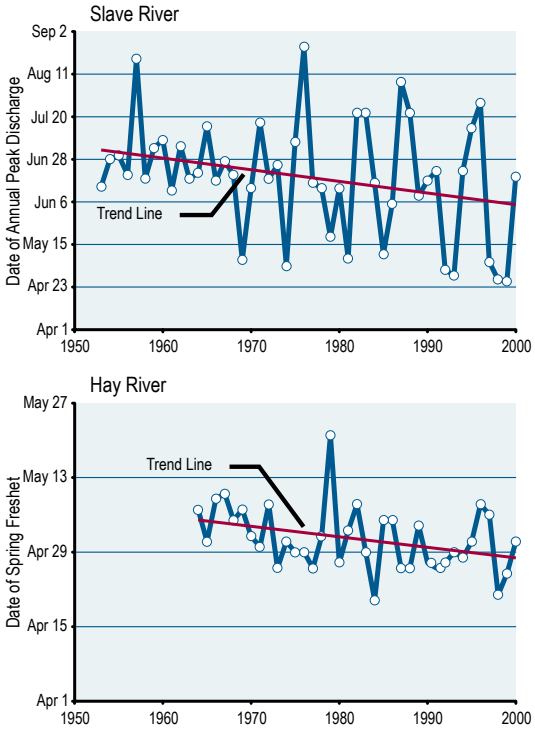


Figure 6–7.
Peak spring discharge on the Slave River and spring freshets on the Hay River have been occurring earlier in recent years than they did in the past, possibly because of earlier and warmer spring weather.
Data Source: Environment Canada, Water Survey of Canada.

What does it mean?

Earlier freshets on the Hay River may have implications for ice jam flooding near the community of Hay River at the river mouth. Spring freshet occurs earlier in the southern headwaters than in the lower reaches to the north, and ice break-up on the river often occurs while the lake ice at the river mouth is still intact. This situation can cause ice-jams in the Hay River Delta and may cause flooding in the community.

The spring freshet and ice jam flooding are two of the major hydrological events that occur in northern aquatic ecosystems each year.[18] The key activities of aquatic species, such as migration and spawning, are often timed to coincide with or to avoid peak discharge rates. Earlier spring freshets could force some aquatic species to migrate, spawn and initiate other key activities earlier in the year than they normally do.

What is being done about it?

Modelling of ice break-up during spring freshet and the formation of ice jams, particularly for north-flowing river reaches on the Peace, Athabasca and Hay rivers, has been an integral part of studies undertaken

at the University of Alberta. Information on what is being done about climate change can be found in **Chapter 1 – Actions on Climate Change**.

Overall Assessment – Mixed Signals

Spring freshet and annual peak flow on certain rivers in the Great Slave sub-basin are occurring a few days earlier than in the past. Climate warming is a possible explanation for this trend. There is a need for more information on the impact of climate change, both on the aquatic ecosystem and human communities.

Sustain In-Stream Water Uses

Commercial, Subsistence and Sport Fishing

What is happening?

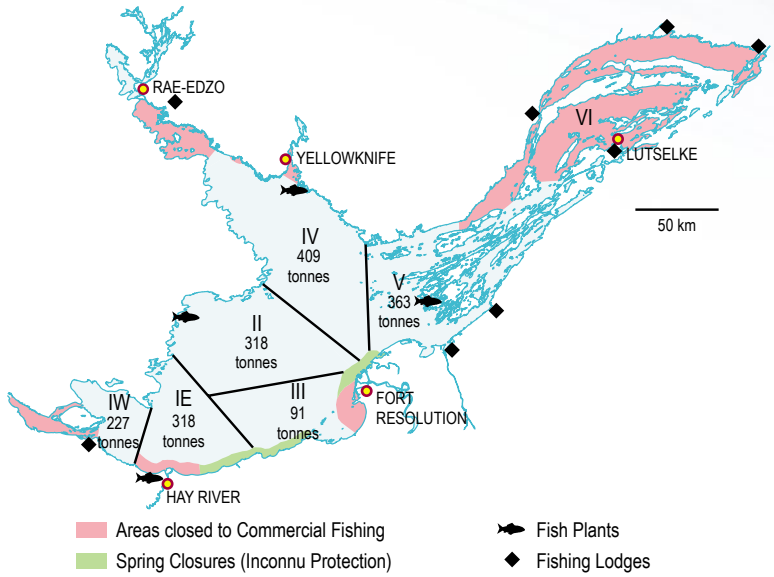
Management of fish in Great Slave Lake is directed towards balancing subsistence, sport and commercial fishing so that all fish stocks are sustained. There are six fish management areas in Great Slave Lake. Each area has its own management plan.

Commercial Fisheries

Commercial fishing occurs in the western and central portions of Great Slave Lake; however, Area VI in the East Arm and certain inshore areas are closed to commercial fishing (Figure 6–8). The East Arm is managed for a trophy lake trout fishery and the other areas are important for the Aboriginal subsistence fishery. The commercial gillnet fishery in the West Basin has been managed primarily for lake whitefish after the collapse of lake trout stocks in the mid-1960s.[183] The commercial fish harvest has declined over time (Figure 6–9), and there are fewer licensed boat operators on the lake, but the number of commercial fishing licences has increased.

Figure 6–8. Map of administrative fishing areas in Great Slave Lake.

Source: Department of Fisheries and Oceans



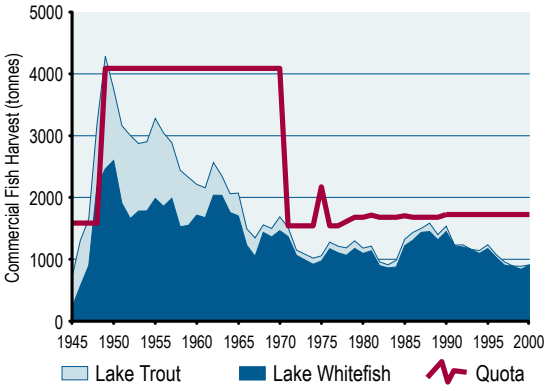


Figure 6–9. Commercial fishing harvest and quota from Great Slave Lake, 1945–2000.

Data Source: Department of Fisheries and Oceans.

Note: Prior to 1992 the quota referred to whitefish and trout; since then it refers only to whitefish, except in Area V where the quota refers to the two species. The lake trout harvest since 1992 refers only to fish caught in Area V.

Subsistence Fisheries

All communities on Great Slave Lake and its major tributaries have subsistence fisheries that are dependent on Great Slave Lake stocks. These fisheries are poorly monitored and current harvest statistics are only available for Fort Resolution and Fort Smith. In those communities, whitefish make up 68% of the overall subsistence catch.

Sport Fisheries

There is a trophy lake trout fishery in the East Arm of Great Slave Lake, especially in Area VI, which is closed to commercial fishing. The sport fisheries on Great Slave Lake involve fishing lodges, outfitters, and unguided anglers. There are seven sport fishing lodges and eight outfitters licensed to operate on Great Slave Lake. Guest capacity at lodges on Great Slave Lake is virtually the same as it was in 1980. Although lodges and outfitters are reporting good catches, there are increasing recreational pressures in the East Arm. Surveys conducted by the Lutselk'e Dene Band indicate that anglers are travelling to new areas and moving further into the East Arm. Lake trout harvest by unguided recreational anglers in the East Arm nearly doubled from 1986 to 1994.[184]

Sports fishing in the east arm of Great Slave Lake.
Courtesy of: G. Low.

Why is it happening?

Commercial Fisheries

The reduction in commercial harvest since 1990 is due to a reduction in effort, which is the result of an ageing workforce, a greater variety of employment opportunities, and lifestyle changes. The recent increase in the number of commercial fishing licences has occurred because operators often pay their employees with a share of the catch. In such situations, the employees need commercial fishing licences to sell the fish.[185] Thus, the increase in commercial licences is not indicative of an increase in fishing effort or increasing pressure on the fish stocks. Commercial fishing effort is actually declining, as evidenced by the decline in the number of commercial boats on the lake.

Sport Fisheries

The population of Yellowknife has grown considerably in recent years. In addition, improvements to the highway system have made Great Slave Lake more accessible to people from the south. Those factors, coupled with the scenic beauty of this nearly pristine lake and the general public's expanding appetite for wilderness recreation, have increased the pressure on the trophy lake trout fishery in the East Arm.

What does it mean?

The extensive and diverse use of fisheries resources in Great Slave Lake has the potential to seriously stress

populations of key fish species. To ensure that fish populations are harvested in a sustainable manner it is important to regulate the fisheries, monitor the fish harvest, evaluate fish stocks, and implement management plans. In particular, additional information is needed on the Aboriginal food fishery and on sport fishing in the East Arm in order to complete the understanding of the use of fisheries resources.[186]

What is being done about it?

The federal Department of Fisheries and Oceans (DFO) is responsible for the assessment of fish stocks and the management of fisheries on Great Slave Lake. This involves studying and monitoring fish stocks, and regulating and licensing fisheries in accordance with fishing plans for the lake and its tributaries. The Great Slave Lake Advisory Committee, with voting members from various resource user groups and government agencies, makes recommendations to DFO on the allocation and management of the fisheries resources. DFO restricts the extent of commercial fishing on Great Slave Lake by establishing quotas, by setting minimum mesh sizes for gill nets and limiting the number of commercial operator certificates available.

In light of incomplete information on lake trout stocks, management has taken a conservative and precautionary approach. Daily catch and possession limits have been lowered to one and two fish, respectively; the use of barbless hooks will be mandatory starting in 2004; and sport fishing lodges are committed to live release practices.

Aboriginal organizations are fully involved in fish management through co-management initiatives that ensure a good integration of traditional knowledge with scientific protocol.

Overall Assessment – Favourable

The fisheries of Great Slave Lake provide jobs, food, and recreation to people in the basin. Comprehensive, updated information on the Aboriginal food fishery and sport fishing in the East Arm is needed to assess the effects of these activities on the fisheries of Great Slave Lake. In light of incomplete information on fish stocks and harvest, management has adopted a precautionary approach that appears to be working thus far.

Hydroelectric Facilities

What is happening?

Hydroelectric facilities have been developed on three river systems in the Great Slave sub-basin: Snare River, Yellowknife River and Taltson River (Figure 1–5). The Snare River system produces electricity at four plants and supplies electricity to Rae-Edzo, N'Dilo, Dettah, and Yellowknife, and to the Giant and Con gold mines. The Snare Rapids site, located 140 kilometres northwest of Yellowknife, was commissioned in 1948 and created Big Spruce Lake Reservoir. Downstream sites were developed as electricity demand increased: at Snare Falls in 1961, Snare Cascades in 1996, and Snare Forks in 1975.[8]

The Yellowknife River was developed for hydro-electricity in 1949. The power plant is located at Bluefish Lake, twenty-five kilometres northeast of

Yellowknife. Duncan Lake, about sixty kilometres upstream, is regulated to provide additional water storage. The Bluefish plant is connected to the Yellowknife grid.

The Taltson River was developed in 1965 at the Twin Gorges site, sixty-five kilometres east of Fort Smith, to supply power to the Pine Point lead-zinc mine and later to Fort Smith, Fort Resolution and Hay River. Nonacho Lake, about 200 kilometres northeast of Twin Gorges, is also regulated to provide additional water storage capacity.

There is insufficient information to properly assess the effects of these hydro developments on their localized aquatic ecosystems within the Great Slave sub-basin.

The Taltson Dam on the Taltson River.
Courtesy of: Dan Grabke

Why is it happening?

Hydroelectricity has been developed to meet the electrical demands of many Great Slave sub-basin communities and mines. Hydro is a relatively clean, economical alternative to diesel-electric generating plants, the other major power source in the NWT.

What does it mean?

Operation of hydropower facilities can affect water levels in lakes and rivers, and can change the timing and volume of river flows. These changes can affect ice formation and ice stability in certain reaches, which may affect traditional travel routes and stream crossings. Changes in water levels and flow rates may also affect aquatic habitat, fish and wildlife. Proper regulation and monitoring will help reduce problems.

What is being done about it?

All hydroelectric facilities are regulated by water licenses, which require regular renewal. Environmental assessments will be performed if new developments are proposed. Currently, the Northwest Territories Power Corporation is working with Aboriginal government partners to assess the feasibility of a small number of new or expanded hydropower facilities in the Great Slave sub-basin to serve the growing demands for electricity in the north (see **Industrial Developments – Hydroelectricity** in Chapter 8).

▼ Overall Assessment – Mixed Signals

Hydro development in the Great Slave sub-basin has proceeded slowly in recent years, with only one new facility built since 1975. Moreover, the scale of

hydro developments in the sub-basin has been quite small compared to mega-projects that have occurred elsewhere in Canada. Nevertheless, changes in aquatic ecosystems associated with changes in flow patterns are an inevitable consequence of hydro development. There is currently insufficient information to assess the magnitude of such changes in the Great Slave sub-basin. Through environmental assessments, licensing and public involvement in future developments, the negative effects of hydro development can be minimized.

Ensure Healthy, Abundant and Diverse Aquatic Species and Habitat

Traditional Knowledge of Aquatic Species and Habitat

Based on information collected prior to 1995, some people living along the Slave River and near the Slave River Delta had observed more willow growth and the loss of productive muskrat habitat.[28] They attributed this to a reduction in periodic flooding. As a result, muskrat populations had declined over the past ten to fifteen years. In contrast, there were more beavers in the 1990s than in the 1930s and 1940s, when a quota was instituted to prevent extinction. It was also reported that low water levels had resulted in a loss of waterfowl habitat and were partially responsible for the declining waterfowl populations observed along the Slave River and in the Slave River Delta.

Elders from the Lutselk'e Dene First Nation have also seen a decline in waterfowl populations, and suggest that there may be something happening to them on their southern wintering grounds.[23]

Some residents of Fort Smith and Fort Fitzgerald reported a decrease in fish abundance over the past fifty years and a general deterioration of fish health. Individuals from Fort Resolution reported that commercial fishing in Thubun Lake has depleted the fish stocks in that water body.[28] The fish nowadays are smaller, less firm, and more likely to exhibit deformities or signs of disease in comparison with those caught in the past. There have also been changes in the species composition at certain locations. For example, coneys used to spawn on the Taltson River, but since the dam was constructed whitefish spawn there instead.[28]

Overall Assessment – Unfavourable

Insights into the health and population trends of wildlife in localized areas of the sub-basin have been gained through traditional knowledge. While beaver populations have increased, populations of muskrat and certain species of fish and waterfowl have decreased in some areas. Localized observations of deteriorating fish health and fewer muskrat, fish and waterfowl are causes for concern. Much of the traditional knowledge of aquatic species and habitat is based on information collected prior to 1995. It would be useful to update this information.

Fish Population Status

What is happening?

Information summarizing the population status of valuable, large and abundant species of fish inhabiting Great Slave Lake is shown in Table 6–1.[187] During the 1960s and 1970s there were changes in species composition and the populations of some species declined.[188] Recently however, Aboriginal harvesters, fishing lodges, and other anglers have not reported any declines in fish stocks.

Why is it happening?

Exploitation of fish stocks in Great Slave Lake by commercial, subsistence and sport fishers has affected fish populations in some cases. Commercial fishing in the West Basin decimated the lake trout population in that area of the lake. Lake trout populations are unable to withstand intense commercial gillnetting.[183] Whitefish are more resilient to commercial gillnetting and can be effectively managed using modern management techniques. Commercial fishing has not affected their populations.

What does it mean?

Fish in Great Slave Lake are widely exploited by several user groups. This has the potential to deplete fish stocks. It is important to regulate the fisheries, monitor harvests, evaluate fish stocks, and implement management plans in order to protect fish stocks. More information about fish populations will be required to meet these objectives.

What is being done about it?

The federal Department of Fisheries and Oceans (DFO) conducts research, stock assessments, and monitoring studies on Great Slave Lake. There is a need for stock assessment studies to determine the current status of lake trout throughout Great Slave Lake but in particular the East and North Arms.[189] Stock assessments for other important species are also required.

Fish stocks in Great Slave Lake are managed by DFO in co-operation with major stakeholder groups, including Aboriginal subsistence fishers.[185] The East Arm is managed for a trophy lake trout fishery and certain inshore areas are managed for the Aboriginal subsistence fishery. These closures protect lake trout populations, inshore species, and fish migrating into rivers to spawn. In light of incomplete information, management has taken a conservative and precautionary approach to protect fish stocks from over-exploitation.

▼ Overall Assessment – Mixed Signals

Commercial gillnetting caused dramatic declines in the lake trout population in the West Basin thirty to fifty years ago. Intense fishing pressure reduced inconnu and walleye populations in some of the major tributaries to Great Slave Lake. On the other hand, conservative management of the trophy lake trout sport fishery in the East Arm of the lake seems to have resulted in stable populations in that area. Whitefish stocks appear to be stable and the commercial harvest of this species seems to be sustainable. The stock status of most species is

Table 6–1.

Status of major fish species in Great Slave Lake.

Status of Major Fish Species in Great Slave Lake.

Species	Population Status
Lake Whitefish 	The lake whitefish population appears to be stable in the western basin of Great Slave Lake, where this species is commercially fished. Fishing at or below the current quota appears to be sustainable.
Lake Trout 	Lake trout accounted for 64% of the catch in 1945, when commercial fishing began, but accounted for only 4% of the catch in the western basin in 1985. Although populations in the west basin have declined dramatically, populations in the East Arm are doing well. However, increasing pressures from recreational fishing in the East Arm may be of concern.
Northern Pike 	Stocks appear to be stable in all areas of the lake, although this assessment is based on inadequate information.
Walleye 	Information about walleye populations is inadequate. While there is concern for Hay River and Little Buffalo River populations harvested for subsistence and sport, no current problems with fish stocks have been reported. The Mosquito Creek population was overexploited from 1973 to 1988, but closing that sport fishery has resulted in a stable population.
Inconnu 	Spawning stocks on the Taltson, Little Buffalo and Hay rivers were extirpated by the 1960's. The Buffalo River stocks were overfished in the late 1970s and early 1980s. Protection has helped but inconnu still needs protection and updated assessment. Stocks on the Slave River and in Great Slave Lake appear to be stable.
Burbot 	There are currently no concerns regarding the burbot stocks.
Sucker 	There are currently no concerns regarding the sucker stocks.

relatively unknown. This is unfortunate given the magnitude and regional importance of the Great Slave Lake fisheries.

Aquatic and Riparian-Dependent Wildlife Species at Risk

What is happening?

The Government of the Northwest Territories compiles status reports for wildlife species in the NWT under a program entitled *NWT Species 2000 – general status ranks of wild species in the NWT*. The goal of this program is to ensure that no species become extinct in the NWT as a consequence of human activity.

Through this program, status ranks have been assigned to most species of birds, mammals, freshwater fish and amphibians; few species of plants and no insects have been ranked, however. The four status ranks are: at risk, may be at risk, sensitive and secure.

In ecozones within the portion of the Mackenzie River Basin that lies within the NWT, eight species of aquatic or riparian-dependent wildlife are listed as at risk or may be at risk. A further thirty-three are considered to be sensitive (Figure 6–10). The majority of species are, however, secure and not under imminent threat.

Why is it happening?

Loss of natural habitat, invasion by exotic species, excessive harvest, pollution and climate change are some of the threats faced by wildlife. The Northwest Territories has vast areas of undisturbed habitat but northern ecosystems are under increasing pressure from climate change, mining and oil and gas developments. Some species for which there is concern, such as the whooping crane and American white pelican, are migratory. Population-limiting pressures may be exerted on these species while they are in areas outside of the Mackenzie River Basin. Other species, such as the shortjaw cisco and inconnu of the upper Mackenzie River and Great Slave Lake may be threatened by excessive harvest.[190]

What does it mean?

The number of species at risk is an indicator of the capacity of an ecosystem to support a diversity of wildlife. Although it is natural for some species to become extinct, the current global extinction rate is higher than what is expected naturally, and concern about biodiversity has increased in recent decades. Conditions that lead to population declines or that

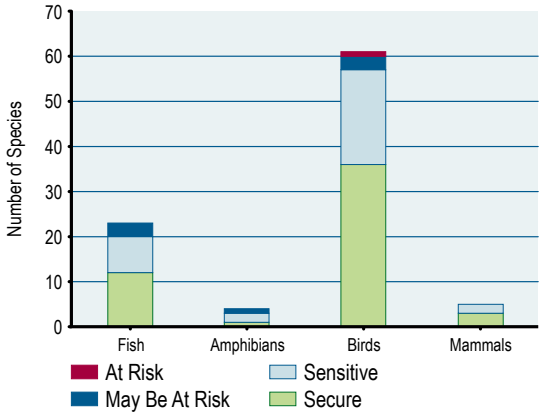


Figure 6–10. Number of aquatic and riparian-dependent wildlife species at risk in the Mackenzie River Basin portion of the NWT.

Data Source: Resources, Wildlife and Economic Development (GNWT).

cause species to become extinct are more likely to occur in ecosystems in which various human activities and industries have had a profound impact. The ecozones of the western Northwest Territories are still largely intact, having been changed little by the hands of human beings. As a result, relatively few species at risk occur there.

It is important to investigate the status of wildlife species so as to identify species in need of special protection before they become critically endangered. Protecting all species in an ecosystem is important because the loss of even a single species may have negative consequences that ripple through an ecosystem, resulting in threats to the survival of both game and non-game species.

What is being done about it?

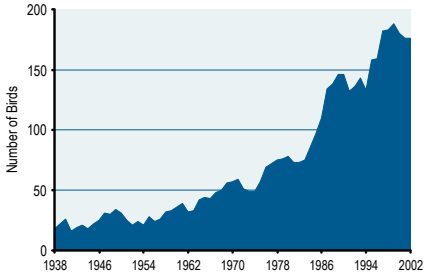
In the NWT, the Department of Resources, Wildlife, and Economic Development (RWED) investigates the vulnerability of different species and uses this information to help in setting conservation priorities.

The Whooping Crane

A Conservation Success Story in the Making

The whooping crane, an endangered species, has been an icon of conservation in North America. Its last-remaining nesting grounds were discovered in 1954 in Wood Buffalo National Park, which straddles the Alberta and Northwest Territories border. In 1966, the Canadian Wildlife Service and the U.S. Fish and Wildlife Service began a captive-breeding program to conserve whooping cranes. Recently, whoopers have been re-introduced to areas from which they had been extirpated. Research to understand their ecology has also played an important role in their conservation. Conservation efforts are paying off. The Wood Buffalo population has increased from sixteen birds in 1942 to 173 in 2002, and reintroduced populations total 111 in the USA. Threats still remain, however. Wetland breeding habitat could deteriorate because of climate change and associated drought. Furthermore, their main wintering area, situated on the Texas coast near a busy shipping lane, could be devastated by spills of toxic chemicals or fuel oil.

Photo credit: Brian Johns



A committee to assess the status of species at risk in the NWT is being planned under proposed NWT legislation that will protect species at risk. In 2003, the federal *Species at Risk Act* (SARA) was enacted to provide legal protection for species that are at risk of becoming extirpated or extinct. SARA is one component of a three-part strategy for protecting species at risk that also includes the Habitat Stewardship Program and the *Accord for the Protection of Species at Risk*, a Canada-wide agreement on federal-provincial-territorial cooperation. The Government of the Northwest Territories intends to introduce legislation to protect species at risk in the NWT.

Overall Assessment – Favourable

There are relatively few species at risk within the portion of the Mackenzie River Basin that lies within the Northwest Territories compared to other areas in Canada. The new federal *Species at Risk Act* and other recent initiatives will help to prevent the further endangerment of wildlife in this area.

Ensure Human Health and Safety

Fish Consumption Advisories

When toxic contaminants are detected in fish tissues, the responsible government agency may issue a fish consumption advisory recommending that people limit the amount of fish they eat. Such advisories can be expressed as the maximum amount of fish that can be eaten per week. A fish consumption advisory is specific to a particular location, species of fish, and type of fish tissue. There are often different advisories for children, women of childbearing age, and other adults because children and developing foetuses are more sensitive to toxic substances than adults.

What is happening?

Fish consumption advisories have been issued for five species of fish in three water bodies in the Great Slave sub-basin (Figure 6–11). Unacceptably high levels of toxaphene were found in burbot livers from the Slave River near Fort Smith. In 1992 it was recommended that consumption of burbot livers from this location be limited to no more than one liver per week. The need for this fish consumption advisory is currently being re-evaluated as more recent data for this location shows lower levels of contaminants. In 1994 elevated mercury concentrations prompted consumption advisories for lake trout, northern pike, longnose sucker, and whitefish from Giauque Lake and for lake trout and northern pike from Thistlethwaite Lake.

No fish consumption advisories have been issued for Great Slave Lake. There is an ongoing assessment of fish from the Hay River where, between 1988 and 1990, some walleye and northern pike had mercury concentrations equal to or greater than the suggested guidelines for subsistence use.[191] There are no fish consumption advisories in the Alberta portion of the Great Slave sub-basin at present.

Why is it happening?

Persistent organic contaminants like toxaphene originate in other parts of the world and are

transported through the atmosphere into the Mackenzie River Basin. During cold weather they condense out of the atmosphere, fall to earth and eventually enter food chains. Contaminants increase to higher concentrations with each step in the food chain and predatory species such as burbot therefore accumulate the highest concentrations.

Fish from Giauque Lake are unsafe to eat because mercury, which was used at the old Discovery Mine to separate gold from the gold-bearing ore, leached or eroded from the mine tailings into the adjacent lake and entered the food chain (see A **Legacy of Old Mines** in this chapter). Bioaccumulation of mercury through a long food chain may explain why lake trout and northern pike from Thistlethwaite Lake contain elevated levels of mercury. The mercury may originate from natural sources in the local watershed or it may be transported on air currents over great distances from industrial sources in foreign countries (see **Chapter 1 – Mercury** for more information about mercury in fish).

What does it mean?

Fish and other country foods are inexpensive, readily available, and healthy. These benefits far outweigh the risks posed by contaminants, provided that the contaminant levels are not too high. It is a good idea to eat a diversity of foods and limit consumption of predator species from a long food chain. People can reduce their exposure to contaminants to acceptable levels by following fish consumption advisories.

What is being done about it?

Due to new regulations imposed on industry and sewage treatment plants, some types of contaminants are declining in fish and the health of some aquatic ecosystems is improving.[192] Through the Northern Contaminants Program, the Department of Indian Affairs and Northern Development and its partners have carried out comprehensive studies to identify the potential impacts of contaminants on human health. 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. In Alberta, the Ministry of Sustainable Resource Development provides information on fish consumption advisories in the annual sportfishing guides.

Overall Assessment – Mixed Signals

Fish consumption advisories, although not widespread in the Great Slave sub-basin, are indicative of a problem with environmental quality. Additional assessment of fish from more lakes in this sub-basin is required to further examine the extent to which contaminants in the environment pose a risk to human health.

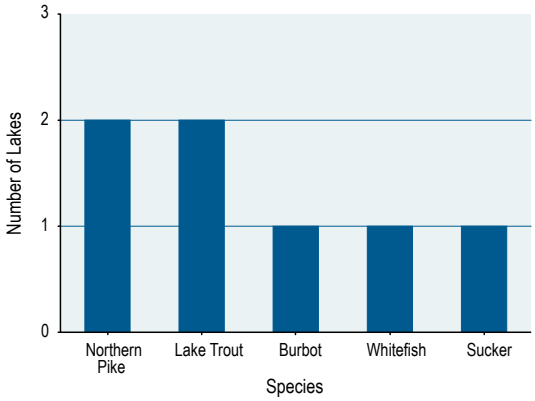


Figure 6–11.
There are few lakes and rivers in the Great Slave sub-basin with fish consumption advisories attributable to contaminants.

Data Source: Stanton Regional Health Board.

Slave River Delta

The Slave River Delta covers a broad area of about 640 square kilometres where the Slave River enters Great Slave Lake.[10, 193] It is a typical bow-shaped delta consisting of several active channels. The delta is growing outward into Great Slave Lake. The community of Fort Resolution is situated on the delta less than ten kilometres south of Old Steamboat Channel (Figure 6–12). Its residents rely on the delta as a source of country food and for supplementary income from the sale of pelts. These resources are themselves dependent on the natural hydrological regime of this dynamic ecosystem.[194]

Delta Dynamics

The most active portion of the Slave River Delta occupies an area of about seventy-five square kilometres between the branches of Old Steamboat Channel and Resdelta Channel (Figure 6–12). The Resdelta Channel discharged over 88% of the measured flow in 1980. This was not always the case. Photos taken in 1946 indicate that discharges from the Resdelta and Old Steamboat channels were comparable to each other and much smaller than the dominant Middle channels were at that time (Figure 6–13). Photos taken in 1966, when the water level on Great Slave Lake was forty centimetres higher than it was in 1946, clearly show the emerging dominance of Resdelta Channel and a reduction in the width of Old Steamboat Channel and Middle channels. This change occurred because of the formation of bars at entrances to Old Steamboat and Middle channels and an associated reduction in discharge. It began prior to regulation of the Peace River. The trend has continued since 1966, as shown by photos taken in 1970 and 1997 (Figure 6–13).

Like all delta ecosystems, the Slave River Delta's high biological productivity depends on periodic flooding and deposition of fresh nutrient-rich sediment that is transported down the Slave River.[176] Since the Bennett Dam was built, it was estimated that there has been a reduction of 31% in the amount of suspended sediment transported by the Slave River each year (Figure 6–6). This reduction is believed to be the result of much lower peak discharges that have occurred since the dam was built (Figure 6–5). The lower peak discharges have also contributed to reduced flood levels in the delta and may play a role in the drying of outer sandbars

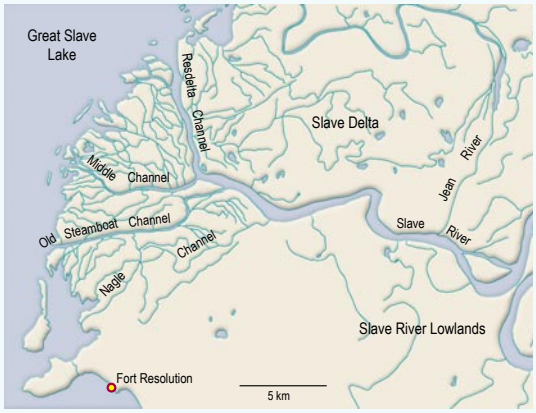


Figure 6-12.
Map of the Slave River Delta.
Source: Department of Indian Affairs and Northern Development.

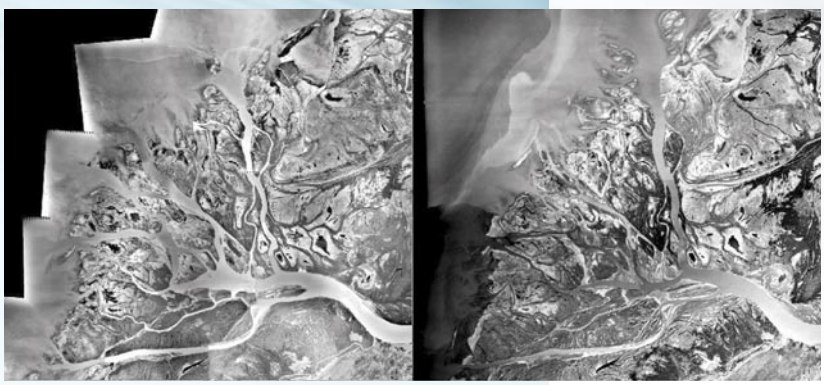
Slave River Delta - continued

and the lower abundance of aquatic plants that moose and muskrat prefer.[18, 181] Reductions in peak discharge and transport of sediment may be slowing the rate of growth of the outer delta.[18] Moreover, channels may shrink, the active delta may become smaller and aquatic and semi-aquatic habitat may be lost as a result of reductions in peak discharge and sediment transport.[195]

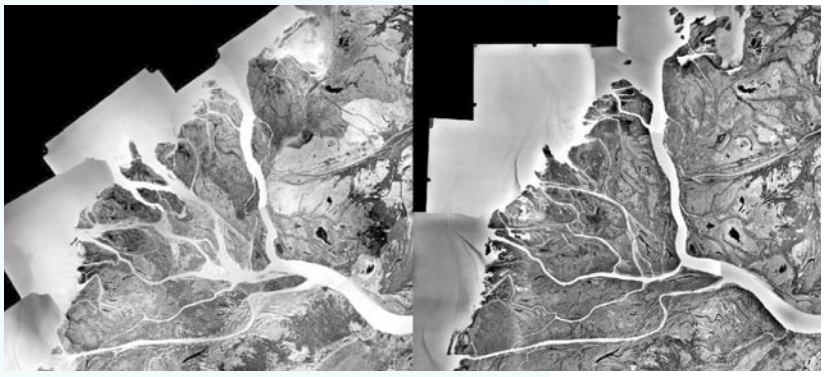
Delta Ecosystem

The delta supports diverse communities of macroinvertebrates and aquatic vegetation, which provide food and habitat for birds, fish and semi-aquatic mammals such as muskrat. Four continental flyways intersect the delta, making it of international significance to migratory birds. For this reason, it has been designated as one of Canada's Important Bird Areas.[196] The delta is an important area for migrating swans, shorebirds and arctic-nesting geese. It also provides habitat for nesting ducks. Twenty-four species of fish either migrate through or live in the delta. It is an important feeding, spawning and nursery area for many of these species.[195, 197]

It is not yet clear whether hydro and other developments that have occurred upstream have impacted the Slave River Delta ecosystem. Such an understanding will be an integral aspect of the development of future plans to protect the Slave River Delta.



Slave River Delta 1946 | Slave River Delta 1966



Slave River Delta 1970 | Slave River Delta 1997

Fig 6–13. Time series of photographs of the Slave River Delta (1946, 1966, 1970 and 1997) showing changes in channel morphology. By 1966, the Resdelta channel had grown relative to its size in 1946. It soon became the largest channel in the delta.

Photo Credit: National Air Photo Library.