2010 Northwest Territories Environmental Audit

Status of the Environment Report

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NWT ENVIRONMENTAL AUDIT 2010

STATUS OF THE ENVIRONMENT REPORT

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EXECUTIVE SUMMARY

The *Mackenzie Valley Resource Management Act* (*MVRMA*), an outcome of the land claim agreements established between the First Nations and the Government of Canada, and the Gwich'in, Sahtu and Tłįchǫ land claims agreements, require that an independent environmental audit be conducted at least once every five years. One component of the audit is an evaluation of information on the environment in order to determine trends in environmental quality, potential contributing factors to changes in the environment and the significance of those trends. The term "environment" is broadly defined as follows:

> *"The components of the Earth and includes:*
> *a) land, water and air, including all layers of the atmosphere;*
> *b) all organic and inorganic matter and living organisms; and,*
> *c) the interacting natural systems that include components referred to in paragraphs (a) and (b)."*

Given the above context, this Status of the Environment report covers seven major components of the NWT environment:

- atmospheric environment (including air quality, climate and climate change);
- freshwater aquatic environment;
- marine environment;
- terrestrial environment;
- permafrost, ground ice and snow;
- human health; and,
- socio-economic and community wellness.

As a starting point in conducting the Status of the Environment assessment, the valued components (VCs) identified in the Indian and Northern Affairs Canada (INAC) report, *A Preliminary State of Knowledge of Valued Components for the NWT Cumulative Impact Monitoring Program* (NWT CIMP) *and Audit* were selected. Key indicators of change for the selected VCs were then identified and carried forward through the study. For these key indicators of change, trends in environmental quality were assessed for the Mackenzie Valley, the Inuvialuit Settlement Region and the NWT as a whole.

To assess current conditions and trends, previously completed studies were relied upon extensively, particularly where these studies had assessed trends in environmental quality. Where required, these studies were supplemented with original data analysis; however, conducting original research was not within the scope of the Status of the Environment reporting.

For each of the key indicators, available data were analyzed and assessed to identify: trends; potential contributing factors to any changes in the environment; the significance of any trends identified; the likely impact of the trends; activities to mitigate the factors/emissions that are causing the observed trends, and, data gaps. Table ES.1 provides an overall summary of the results of the Status of the Environment assessment.

As was found with the 2005 SOE, overall, environmental quality in the NWT was found to be favourable for most components. In some cases it was difficult to determine the current condition of an environmental component or evaluate trends due to a lack of adequate baseline data for the NWT. However, where data were sufficient, several instances of unfavourable conditions and deteriorating trends were identified. The two most disturbing of these are: the recent large decreases recorded for the size of caribou herds that Aboriginal people living in the NWT rely on as a major source of subsistence; and, the need for action in the area of socio-economics and community wellness.

The most significant development in the status of terrestrial mammals in the NWT since the 2005 SOE is the massive decline in major barren-ground caribou herds. Many of the mainland herd in the NWT have declined, but is most noticeable in the Bathurst, Beverly and Bluenose herds. The change in population size has led to major restrictions on hunting. These restrictions have affected all segments of the NWT population, but in particular aboriginal groups that have reduced hunting, and outfitters who rely on sport hunting for business. As noted in 2005, with changes to the environment from climate change and the potential for increasing development near calving grounds, the need for accurate data on the status of the individual caribou herds and their habitat is increasingly important.

With respect to socio-economics and community wellness, while traditional economic indicators show that the NWT population and economy are growing, there is no commensurate progress in community wellness with numerous measures of social well-being being found to be less favourable than national averages. In the case of education, while data show that secondary school graduation rates have increased steadily since 2004–05, other key indicators of student achievement (e.g., Alberta Achievement Test results, secondary school diploma examination results, and functional grade levels) show limited or no progress since 2004–05. Overall, social problems appear even more pronounced in the NWT smaller communities and are more associated with the Aboriginal population. This situation requires action by government agencies that have health and social service mandates.

Looking forward, climate change is expected to have a profound effect on the Canadian North. Evidence of Arctic warming comes from the widespread melting of glaciers and sea ice, and a shortening of the snow season. The potential effects extend to all components of the environment ranging from: increasing precipitation; shorter and warmer winters; substantial decreases in snow and ice cover; loss of permafrost conditions in some parts of the NWT; increased erosion of river banks and shorelines; changes in vegetation coverage and animal habitat; increased mobility of nutrients and organic and inorganic contaminants; and, changes in the quality and availability of traditional foods. These projected changes are likely to persist for centuries.

Additional research is required in a number of areas to improve the understanding of the effects of climate change on all components of the environment. The magnitude, frequency, and causes of extreme events in Arctic weather, stream flow, lake and sea ice, snow cover and other climatic-related variables need careful study in order that trends in global climate change are correctly interpreted and understood.

Table ES.1
Summary of Status of the Environment Assessment for Current Conditions and Trends

SYMBOL KEY: Assessment of the Current Condition: ▲ **Favourable;** ▬ **Intermediate;** ▼ **Unfavourable**

Assessment of the Trend: ✔ **Improving;** ? **Uncertain;** ✘ **Deteriorating**

Valued Component	Indicator	Current Condition	Trend	Comments
AIR QUALITY, CLIMATE, AND CLIMATE CHANGE				
Air Quality	Particulate Matter Concentrations	▲	?	**Current Condition:** • The four operating air quality (AQ) monitoring stations provide a good baseline for assessing AQ impacts in the NWT from future oil and gas and other industrial developments. **Trend:** • Future AQ trends are uncertain as the NWT is experiencing pressure for large-scale industrial developments. The GNWT does not have jurisdiction over industrial developments that are not located on community lands, and therefore has no enforcement capability in the event of AQ impacts from such developments. **Gaps:** • Surveillance could be enhanced by adding at least one more monitoring station in the Fort Simpson/Wrigley area to capture the effects of pipelines and compressors in the area. • Need additional monitoring for VOCs and methane for oil and gas developments
	SO_2/NO_x Concentrations	▲	?	
	POPs	▲	✔	**Current Condition:** • In general, the Canadian northern atmosphere contains lower levels of POPs and heavy metals than those found over most other circumpolar countries. • Negotiations for a legally binding global instrument on POPs under the United Nations Environment Programme were completed with the signing of the POPs Convention in Stockholm, Sweden on May 23, 2001. **Trend:** • The coming into being of the POPs Convention should result in a favourable trend. **Gaps:** • Continued monitoring of legacy POPs is required to clearly discern trends for those that are still being used in some parts of the world. • Monitoring of new POPs is also required to determine whether any of these contaminants shows signs of accumulation in the North.
	Mercury	▲	✔ to ?	**Current Condition:** • Generally atmospheric mercury levels are not of concern, however, Current data still make it uncertain whether atmospheric mercury levels are increasing or decreasing. **Trend:** • Current data still make it uncertain whether atmospheric mercury levels are increasing or decreasing. **Gaps:** • Canada has signed onto several plans and protocols demonstrating its commitment to controlling mercury. • More work is needed on the routes taken by mercury to the Canadian North. • Continued research is required to assess the importance and nature of mercury depletion events.
Climate	Temperature	▼	✘	**Current Condition:** • Since 1945, the western half of the Northwest Territories has exhibited a warming trend, mostly in the winter and spring. There is evidence to suggest that in the Mackenzie region, this trend may go back to the late 1900's or before. **Trend:** • Increases in global mean temperatures have been predicted as a result of increases in atmospheric greenhouse gases generated by human activities. These changes have been predicted to be greatest in the polar region. **Gaps:** • As a result of budget cuts several NWT monitoring stations have been closed and the national climatological network of temperature and precipitation monitoring has lost numerous stations. • Particular areas with data gaps in the NWT are the Mackenzie Mountains, Mackenzie River east bank, north of Great Bear Lake, Coppermine River basin, North Slave, and South Slave.
	Precipitation	▲ to ▬	?	**Current Condition:** • Precipitation has shown an increase in the Tundra portion of the Canadian Arctic since 1945, however, there is no clear trend on an annual basis in other regions of the NWT. **Trend:** • Precipitation has shown an increase in the Tundra portion of the Canadian Arctic since 1945, however, there is no clear trend on an annual basis in other regions of the NWT. • Detecting changes in precipitation trends is difficult because precipitation varies widely across even small geographic areas.

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Valued Component	Indicator	Current Condition	Trend	Comments
Climate Change	Changes in Temperature and Precipitation	— to ▼	? to ✖	**Current Condition:** • Traditional knowledge has provided a broad perspective on the issue of climate change. Not only has it reported warmer temperatures, a more variable climate and unpredictable weather, but it has also indicated that the environment has changed in response to these changes in climate. • In the past 40 years, annual temperatures in the western Arctic have climbed by 1.5°C. The average temperature in the Arctic has risen at almost twice the rate as the rest of the world in the past few decades. • Additional evidence of Arctic warming comes from the widespread melting of glaciers and sea ice, and a shortening of the snow season. Increasing precipitation, shorter and warmer winters, and substantial decreases in snow cover and ice cover are among the projected changes that are very likely to persist for centuries. **Trend:** • Climate change is expected to have a profound effect on the Canadian North and more research is needed to increase understanding of the effects of climate change on the physical environment (e.g., erosion) and behaviour of contaminants. **Gaps:** • Factors that influence high-latitude energy fluxes including the Arctic Oscillation are fundamental science questions that need to be addressed. • The magnitude, frequency, and causes of extreme events in Arctic weather, stream flow, lake and sea ice, snow cover and other climatic-related variables need careful study in order that trends in global climate change are correctly interpreted and understood. • Understanding of the magnitude and speed of past and ongoing climate change in the Arctic needs to be improved through continued monitoring and the analysis of already existing time-series data.
	Atmospheric CO_2 Concentrations	▼	✖	**Current Condition:** • Global atmospheric CO_2 concentrations have increased by 33% since the beginning of the industrial age. • Globally, carbon dioxide emissions from energy use have quadrupled since 1950. • Northern CO_2 emissions are approximately 30 tonnes per person compared to the national average of 21 tonnes per person. **Trend:** • CO_2 emissions and population growth in the NWT are both increasing at higher rates than the national average. **Gaps:** • Increased awareness and effective programs are required worldwide to promote reductions in fossil fuel use (<u>note</u>: such reductions would also have a positive impact on local and regional air quality by directly reducing emissions of sulphur dioxide, nitrogen oxides, and volatile organic compounds and indirectly reducing levels of ground-level ozone and inhalable airborne particles formed in the atmosphere).
FRESHWATER AQUATIC ENVIRONMENT				
Surface Water Quality	Turbidity	▲ to —	? to ✖	**Current Condition:** • While turbidity levels in all the sub-basins considered exceed CCME environmental quality guidelines at various times throughout the year the causes are largely natural in origin and are not leading to deteriorating water quality. **Trend:** • The NWT water quality database is not adequate to determine overall trends; however, it is anticipated that climate change impacts will increase turbidity which may have negative impacts on surface water quality. **Gaps:** • Future monitoring of surface water quality needs to be maintained as it will be useful in determining changes in water quality as they relate to climate change effects. • The number of long-term monitoring stations in the NWT is limited in comparison to the geographic size. • Means of expanding current regional surface water quality monitoring to include key locations in unmonitored watersheds would be beneficial. • Integration of more intensive local research (e.g., mine-specific aquatic effects monitoring) into the long-term monitoring network database would be another means of expanding the water quality database.
	Metals	▲ to —	?	<u>**Mackenzie River**</u> **Current Condition:** • Exceedances of aluminium, iron, and copper are measured at stations along the Mackenzie River, however, they are primarily associated with natural conditions, and do not contribute to deteriorating water quality. **Trend:** • The overall trend for this region is uncertain.
		—	?	<u>**Great Slave Lake**</u> **Current Condition:** • Arsenic is elevated in local watersheds draining the Giant Mine and Con Mine sites near the City of Yellowknife; however, in other watersheds levels of metals are generally not of concern. **Trend:** • The overall trend for this region is uncertain.

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Valued Component	Indicator	Current Condition	Trend	Comments
		▲ to ▬	?	**Peel River** **Current Condition:** • Seasonal exceedances of zinc are measured in the Peel River, however, they are associated with natural erosion processes, and do not contribute to deteriorating water quality. **Trend:** • The overall trend for this region is uncertain.
		▲ to ▬	?	**Liard River** **Current Condition:** • Elevated concentrations of copper and zinc have been measured on several occasions in the Liard River, however, the overall frequency of exceedance of CCME guidelines ranges from 0-34%. **Trend:** • The overall trend for this region is uncertain.
Sediment Quality	Metals	▲ to ▬	?	**Current Condition:** • In general the levels of metals in sediments are not of concern; however, there is uncertainty due to few baseline data. • Locally elevated arsenic levels have been measured throughout Yellowknife Bay near Yellowknife. The accumulation of arsenic in the lake sediments has been attributed to uncontrolled releases to the atmospheric and aquatic environments from the Giant Mine during the early years of its operation. **Trend:** • Lack of general monitoring makes the determination of an overall trend impossible. **Gaps:** • Long-term monitoring of river sediments and periodic collection of lake sediment core samples is required to better understand the fate of contaminants in the benthic environment.
	Organic Contaminants	▲	✔	**Current Condition:** • A general decline in POPs in lake sediments has been observed in the NWT and is attributed to international protocols which have led to reduced atmospheric concentrations in northern Canada. **Gaps:** • Information on PCBs, pesticides, polycyclic aromatic hydrocarbons, dioxins and furans, and heavy metals in sediments is very limited with the exception of specific investigations on the Slave River at Fort Smith and the Liard River above Kotaneelee River.
Surface Water Quantity	Discharge Rates	▲	?	**Mackenzie River** **Current Condition:** • Analysis of the flow record has indicated no significant trend in mean annual flows in the Mackenzie River. **Trend:** • Analysis of the flow record has indicated no significant trend in mean annual flows in the Mackenzie River, however, uncertainty related to climate change make an overall trend uncertain. **Gaps:** • Future monitoring of surface quantity needs to be maintained to measure the effects of climate change on long-term average flows, extreme flow events and timing of snow melt and freeze over.
		▬	?	**Great Slave Lake** **Current Condition:** • Flow in the Slave River has been found to be affected by the operation of the Bennett Dam some 1,500 kilometres upstream of Great Slave Lake. Great Slave Lake reached a record low water level in September 2010. **Trend:** • Uncertainty related to climate change make an overall trend uncertain. **Gaps:** • Future monitoring of surface quantity needs to be maintained to measure the effects of climate change on long-term average flows, extreme flow events and timing of snow melt and freeze over.
		▬	?	**Peel River** **Current Condition:** • Flow in the Peel River is affected by spring snowmelt and rainstorms that can result in dramatic increases in steam flow in the river and its tributaries. High flow recorded between the mid 1960s and early 1980s have not been matched in recent years, which possibly reflect effects of climate change. **Trend:** • Uncertainty related to climate change make an overall trend uncertain. **Gaps:** • Future monitoring of surface quantity needs to be maintained to measure the effects of climate change on long-term average flows, extreme flow events and timing of snow melt and freeze over.

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Valued Component	Indicator	Current Condition	Trend	Comments
Fish Habitat	Aquatic Habitat Structure and Quality	—	? to ✖	**Current Condition:** • There is only limited data to define baseline habitat conditions in the NWT. **Trend:** • Climate change is expected to directly and indirectly affect fish habitat and its biodiversity. These effects will be gradually induced as a result of physical and chemical changes. **Gaps:** • There is only limited data to define baseline habitat conditions in the NWT. • Aside from fish habitat assessments near residential, transportation, and industrial sites, fish habitat information is not commonly collected in the NWT. • Within government agencies with objectives to protect and enhance aquatic ecosystems, there has been no consolidation of programs or data, which would allow for an assessment of parameters as indicators of well-functioning aquatic ecosystems over time. • There is a need to compile data on various fish habitats for Great Slave Lake and Great Bear Lake, as they relate to fish harvest data. These data should reach a level of detail that would be useful for future comparisons.
	Spawning, Rearing And Over-wintering Locations	▲ to —	? to ✖	**Current Condition:** • There is only limited data available to define baseline conditions in the NWT. • Changes in the timing of ice break-up will affect water temperatures, dissolved oxygen levels, nutrient supplies, sediment loads, and water levels. A change in any of these physical and chemical attributes has the potential to alter the freshwater species composition. **Trend:** • There may be a deteriorating trend with climate change as changes in the timing of ice break-up will affect water temperatures, dissolved oxygen levels, nutrient supplies, sediment loads, and water levels, which can all have potential impacts on spawning and rearing.
Fish Population	Distribution and Abundance	—	✔ to ?	**Current Condition:** • Of the fresh water fish species whose status has been assessed in the NWT, 10 are "at risk" (1), "may be at risk" (1), or "sensitive" (8). • Overall, the NWT is largely untouched by human activities, and as a result, relatively few species are at risk compared with areas in Canada's south. **Trend:** • Population and stock status of most species is relatively unknown and more work is needed. • Broad whitefish and lake whitefish in the western NWT remain the most sought after species for subsistence. However, status on these species, populations and stocks are unknown. **Gaps:** • Great Slave Lake fish are exploited by several types of fisheries activities, which can affect and deplete populations and stocks. It is therefore imperative to manage the fisheries with proper planning and regulations, record and monitor harvests, and assess the stocks.
Fish Harvest	Population Size and Age/Size Distribution of Fish Stocks	▲	✔	**<u>Rat River Dolly Varden</u>** **Current Condition:** • Significant increases between 1995 and 2007 in size-at-age results, relatively stable sex and maturity composition, and the recent observed pulse of juvenile production indicate improvement to the stock. **Trend:** • Recent DFO studies indicate an improving trend.
		—	✔ to ?	**<u>Great Slave Lake</u>** **Current Condition:** • Commercial fishing is not allowed in certain areas important to subsistence fishing, or the East Arm, which is managed for trophy lake trout sport fishery. The population of lake whitefish, which is fished commercially, appears to be stable; however, the overall current condition is uncertain. The lake trout population is the East Arm, which is set aside for sport fishing, is reported to be doing well. **Trend:** • Harvest appears to be sustainable. **Gaps:** • Fish stock assessment studies are needed on Great Slave Lake to determine the current status of lake trout as well as other important fish species throughout the lake. • Detailed information is required about fish populations and stocks in order to achieve a corresponding good level of fisheries management. • On Great Slave Lake, additional information is needed on the subsistence and sport fisheries to complete the understanding of the fisheries resources.

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Valued Component	Indicator	Current Condition	Trend	Comments
		▲	✔ to ?	<u>**Great Bear Lake**</u> **Current Condition:** • Great Bear Lake fishing includes subsistence and sport. The lake trout stock declined until 1984, when studies demonstrated that conservation measures were warranted and quotas were put in place. The current harvest is considered below the maximum sustainable yield. Trophy lake trout fishing is based on a catch and release policy. **Trend:** • The current data make the trend uncertain. **Gaps:** • Broad whitefish and lake whitefish remains the most important catch. Harvest status on these species is unknown and needed.
Fish Quality	Mercury	— to ▼	? to ✘	**Current Condition:** • Health advisories for ***mercury*** have been issued for some fish species, including northern pike, lake trout, burbot, whitefish and suckers, in several NWT lakes. • ***Mercury*** is the only contaminant that is consistently greater than guideline limits for consumption or commercial sale. • Most data produced with respect to heavy metal contamination in fish is on mercury because of human consumption concerns. However, studies have looked at ***arsenic, cadmium, lead and selenium*** although levels for these parameters are rarely of concern. • ***POPs*** levels measured in fish in the NWT are believed to have a low potential to affect the health of fish. In addition, the levels of POPs such as dioxins and furans have been declining. **Trend:** • There is inadequate information to determine a possible trend. **Gaps:** • More research is needed to understand how climate change and variability will affect the ways in which heavy metals, POPs, and radionuclides are transported to, and within the NWT, as well as how they accumulate and impact biota. • There is a need for information on contaminant levels by species, types of contaminant and geographic areas - especially data collection to statistically elucidate temporal trends. • Specific areas that require more information are Great Slave Lake and Great Bear Lake, because of their importance with respect to human health, and the Slave River to monitor upstream impacts. • There is an overall lack of information with respect to biological effects of contaminants on the NWT fish. • Specific research needs to determine threshold effects for NWT fish species rather than comparison of burden levels to laboratory studies on non-Arctic species.
	Other Metals	▲ to —	?	
	POPs	▲ to —	✔ to ?	
MARINE ENVIRONMENT				
Polar Bear	Population Abundance	— to ▼	? to ✘	**Current Condition:** • Population abundance estimates now provide useful trend over time data for the Northern Beaufort population but the time series of directly comparable data from the Southern Beaufort population is too short to be useful for that purpose. Current estimates for the Viscount Melville Sound population are based on extrapolations from a mark-recapture study completed in 1992. **Trend:** • The Northern Beaufort population appears to be stable; the data available suggest that the Southern Beaufort population may be in decline; and the status of the Viscount Melville Sound population is uncertain. **Gaps:** • The Southern Beaufort population may be particularly sensitive to changing ice conditions and could change rapidly, so temporal trends in its size and composition should be established. • A new survey of the Melville Sound population is needed to provide data for assessing temporal trends in its size and composition, and immigration from other regions.
	Natality (Ratio of live births to population)	— to ▼	? to ✘	**Current Condition:** • Declines in growth, recruitment, and survival suggest a declining trend in nutritional status of the Southern Beaufort bear population that may be related to ecological changes from more extensive and extended open water. **Trend:** • Data from the Southern Beaufort population are insufficient to establish long term trends in natality but studies in 2001-2006 found breeding rates and cub litter survival decreased with increasing duration of the ice free period. **Gaps:** • Linkages to other monitoring research on seals and sea ice should be continued and augmented to improve understanding of the mechanisms by which climatic conditions affect polar bear natality, condition, and survivorship. This information should improve understanding of how populations in different areas may respond to long-term trends in sea ice cover, and inform population management decisions. • Little is known of trends in contaminant accumulation by bears in the NWT, or of how different levels of these substances affect their health and reproductive success

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Valued Component	Indicator	Current Condition	Trend	Comments
	Survivorship and Sex Specific Age Structure of the Harvest	▬ to ▼	? to ✖	**Current Condition:** • In the Northern Beaufort population, the annual survival rates of bears in all age and sex classes were higher in the mid-2000s than in the 1980s. Annual survival rates were higher for prime adult female and male bears than other groups, for adult females than males, and for cubs-of-the-year than yearlings. • In the Southern Beaufort population, survival of adult females was higher in 2000-2003 when the ice-free period was relatively short (mean 101 days) and lower in 2004-2005 when it was longer (mean 135 days). • Over the past 5 years fewer bears were harvested annually from these populations than was permitted under their respective harvest quotas. **Trend:** • The Northern Beaufort population is believed to be stable and able to sustain current harvests. Modelling suggests that the Southern Beaufort population may decline unless conditions typical of 2001-2003 are maintained, regardless of whether harvests are reduced to zero. **Gaps:** • The current structure of the Viscount Melville Sound population is unknown.
Beluga	Composition of the Landed Harvest	▲	✔	**Current Condition:** • The rate of removal of belugas from the Eastern Beaufort Sea stock is small in relation to the expected maximum net productivity rate of this stock. It is also smaller than historical harvests. **Trend:** • No significant trends were observed in the growth (length at age) or survivorship of belugas that were born between 1932 and 1989, and harvested from the eastern Beaufort Sea between 1993 and 2003. **Gaps:** • Limited knowledge of the structure and function of the Beaufort Sea ecosystem makes it difficult to evaluate the cumulative impacts of climate change and hydrocarbon development on this population, and to define and protect key habitats. • Data are also needed on the range, movements, site fidelity, stock structure, and reproductive potential of this stock for developing population models and assessing sustainable harvest potential.
Beluga	Mercury	▬ to ▼	?	**Current Condition:** • ***Mercury*** concentrations observed in the meat and muktuk of belugas exceed the Health Canada human consumption guideline for commercial fish (0.5 µg/g (ww)) and for subsistence fisheries (0.2 µg/g (ww)). • There is also potential for the dietary intake of muktuk to exceed recommended daily intake levels of various ***organic contaminants***, including PCBs. **Trend:** • Over the period 1977 to 2008 no consistent linear trends are apparent in the concentration of mercury (µg/g wet wt.) in the liver, or muscle of Mackenzie Delta belugas. • Temporal trends have not been found in the concentrations of halogenated organic compounds (e.g., PCBs, DDT, toxaphene) in Mackenzie Delta belugas **Gaps:** • Little is known of the biological effects of contaminants on belugas or about linkages between ice-cover and their contaminant uptake; work on these problems is ongoing.
Beluga	POPs	▬ to ▼	?	
Ringed Seal	Harvesting Removals	▲	✔	**Current Condition:** • Despite an increase in the human population, the harvest of seals from the Beaufort Sea region has declined over the past 50 years. Seals are harvested for subsistence, but there is no longer a substantial harvest for the commercial sale of pelts. **Trend:** • The seal population does not appear to be under stress from over-harvesting. **Gaps:** • Harvests have not been monitored since 2003.
Ringed Seal	Body Condition	▬	?	**Current Condition:** • Ringed seals are sensitive to changes in the sea ice. • Declines in the body condition of mature female ringed seals in Amundsen Gulf have occurred in springs when ice breakup is unusually late (e.g., 1974 and 2005). These changes correlated with low ovulation rates and were followed by widespread declines in ringed seal population density, which recovered within about 3 years. • Early breakup in 1998 may have provided favourable energetic conditions for the older animals while causing many pups to be weaned before they were ready. **Trend:** • The body condition of mature females and pups varies in response to changing ice conditions but there are no clear long term trends. Disease and migration may also contribute to these fluctuations. **Gaps:** • The species' ability to adapt to changes in the ice environment is unknown. This is a very important information gap. Better understanding of how changes in the ice environment impact ringed seals at the various stages of their life history is needed to improve predictions of how climate change may impact the species.

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Valued Component	Indicator	Current Condition	Trend	Comments
	Ovulation Rate and Pup Harvest Numbers	▬	?	**Current Condition:** • Major declines in the ovulation rate of ringed seals in Amundsen Gulf have occurred in springs when ice breakup is unusually late (e.g., 1974 and 2005). Pup survival is low when breakup is unusually early (e.g., 1998). Widespread declines in ringed seals population density have occurred following both of these extremes in ice conditions, but populations have recovered within about 3 years. **Trend:** • The ovulation rate and proportion of pups in the harvest fluctuate in response to changing ice conditions but there are no clear long term trends. Disease and migration may also contribute to these fluctuations. **Gaps:** • The range, movements, site fidelity and stock structure of ringed seals is poorly understood. This limits the interpretation and extrapolation of data on changes observed in a particular area.
	Mercury	▬	?	**Current Condition:** • Total mercury concentrations in the muscle of ringed seals remains elevated from pre-industrial levels. Significant interannual variation occurs, with higher concentrations when the ice free seasons are short or long than when they are of intermediate duration. • The levels of persistent organochlorine contaminants in the blubber of ringed seals have changed over time. The direction of change varies with the class of contaminant and reflects changes in the global use patterns of these chemicals. **Trend:** • There is no clear trend over time in average total ***mercury*** concentration in the muscle of Ulukhaktok ringed seals. • Significant declines in the concentrations of PCBs and DDT have been observed; chlordanes and hexachlorocyclohexanes have not changed significantly, but concentrations of polybrominated diphenyl ethers in ringed seal blubber over the past two decades have increased dramatically. **Gaps:** • Little is known of the biological effects of contaminants on ringed seals.
	POPs	▬	✔ to ✖	
Anadromous Dolly Varden and Arctic Char	Population Size and Harvest	▬	?	<u>**Rat River Dolly Varden**</u> **Current Condition:** • The population declined in 2004 but rebounded by 2007. **Trend:** • Results from harvest monitoring suggest that the stock is stable and sustaining the present harvest level. **Gaps:** • Linkages between sea ice cover and the condition of anadromous fishes have not been examined, but may be important determinants of the sustainable harvest level. • More detailed habitat and behavioural studies are needed to understand the impact of the low sex ratio on the annual reproductive capacity of the Rat River Dolly Varden population.
		▼	?	<u>**Big Fish River Dolly Varden**</u> **Current Condition:** • Abundance estimates suggest that the population was reduced substantially between 1972 and 1988, and had stabilized at the lower level by 1998. No new data are available. **Trend:** • Unknown. **Gaps:** • Linkages between habitat changes and the failure of this population to recover are uncertain. If habitat changes are limiting the population, knowledge of the mechanisms by which they act could improve the ability to manage regional fisheries in response to changing climatic conditions.
		▬	✖	**Current Condition:** • From 1997 through 2007 the mean annual CPUE and total catch for the late summer subsistence fishery fluctuated but showed an overall decline. **Trend:** • The decline in the annual catch rate suggests that this stock is unable to sustain current (ca. 2007) harvest levels. **Gaps:** • The level of harvest that the Hornaday River Arctic Charr stock can sustain is unknown.
	Contaminants	▬	?	**Current Condition:** • While some data are available on contaminant levels in fish in the Rat River, Big Fish River and Hornaday River systems, they are too few to provide a useful assessment of the trend of accumulation over time. **Trend:** • Unknown **Gaps:** • Monitoring of contaminant concentrations in Dolly Varden and Arctic Char is important to ensure protection of the people who rely on these species for subsistence.

Table ES.1 (Cont'd)
Summary of Status of the Environment Assessment for Current Conditions and Trends

SYMBOL KEY: Assessment of the Current Condition: ▲ Favourable; — Intermediate; ▼ Unfavourable Assessment of the Trend: ✓ Improving; ? Uncertain; ✗ Deteriorating				
Valued Component	**Indicator**	**Current Condition**	**Trend**	**Comments**
Sea Ice	Duration and Areal Extent of Ice Cover	▼	? to ✗	**Current Condition:** • Satellite observations suggest that there has been a general decrease in the duration and areal extent of the Arctic sea ice cover since the mid-1970s. **Trend:** • Over the period 1979-2005 satellite passive microwave data showed significant trends (98% level) in the Beaufort Sea ice, not including Amundsen Gulf. These trends included earlier onset of the spring melt (-4.7 days/decade) and lengthening of the melt season (9.2 days/decade). A trend toward later freeze-up (4.9 days/decade) was also apparent but was not significant at the 98% level. Over the period 1979-2008 declining trends were observed in the average September total ice and multi year ice areas in Amundsen Gulf, but these declines were not statistically significant at the 95% level **Gaps:** • The factors underlying natural variability of the sea ice cover, atmospheric couplings, and linkages between changes in sea ice and other aspects of the marine ecosystem are uncertain. These information gaps limit the ability to predict how ice cover may change over time, and how species and biological communities may respond over the short or long term, and from one area to another.
TERRESTRIAL ENVIRONMENT				
Caribou	Population Size	▼ ▼ — — ▲ ▼	✗ ✗ ? ? ✓ ✗	**Current Condition:** • Bathurst Herd: a census in 2009 estimates the population to be 31,900, down from 187,000 in 2003 • Porcupine Herd: has been in decline since 1989 when the herd size reached a maximum of about 180,000. The last census in 2001 estimated the population to be 123,000. • Cape Bathurst Herd: declined from an estimate of 17,500 in 1992 to an estimated 2,400 in 2005. In 2009 the estimate was 1,934. • Bluenose West Herd: declined from an estimate of 98,900 in 1987 to an estimated 20,800 in 2005. In 2009 the estimate was 17,897. • Bluenose East Herd: The 2010 census showed the herd to be at 98,646, a 50% increase since the last count in 2006, when the estimate 66,754. • Beverly and Qamanirjuaq Herds: counts conducted on 2008 indicate both these herds to be declining. **Trend:** ▪ Many caribou herds have been shown to be declining. However, only the Beverly and the Bluenose-West have been shown to have declined to the same degree as the Bathurst herd. **Gaps:** ▪ Greater frequency of census surveys is needed. ▪ More research on impacts related to development pressure is needed in the NWT.
	Harvest Rate	▼	✗	**Current Condition:** ▪ In response to the low numbers and the need to reduce all losses from the herd, the NWT instituted a ban of all commercial, resident and non-resident harvest in the North and South Slave regions of the NWT, effective January 1, 2010. Also, a no-hunting zone for all harvesters of barren-ground caribou extending from Yellowknife to an area including all the wintering grounds of the Bathurst herd has been instituted. **Trend:** ▪ Harvesting bans in place.
Moose	Population Size	▲	?	**Current Condition:** • Overall, the moose populations in the NWT appear to be stable, and there are no data to indicate that harvest rates are excessive. **Trend:** • Populations have remained stable since 2005. **Gaps:** • There is very little published in the scientific literature on the status of the moose herd in the NWT. • Population surveys are probably not precise enough to accurately determine desirable harvest rates. For this reason, habitat condition, animal condition, calf productivity, and population size should be monitored more closely.

Table ES.1 (Cont'd)
Summary of Status of the Environment Assessment for Current Conditions and Trends

SYMBOL KEY: Assessment of the Current Condition: ▲ **Favourable;** ▬ **Intermediate;** ▼ **Unfavourable**

Assessment of the Trend: ✔ **Improving;** ? **Uncertain;** ✘ **Deteriorating**

Valued Component	Indicator	Current Condition	Trend	Comments
	Harvest Rate	▲ (Favourable)	? (Uncertain)	**Current Condition:** • Moose harvesting remains relatively successful and does not appear to negatively impact on the population. **Trend:** • Population surveys are probably not precise enough to accurately determine desirable harvest rates. • The lack of NWT-wide data makes a determination of trend uncertain. **Gaps:** • There is a lack of NWT-wide data.
Landbirds	Population Size and Diversity	▲ (Favourable)	✔ (Improving) to ? (Uncertain)	**Current Condition:** • The Working Group on the General Status of NWT Species WGGSNS (2006) reported on a total of 273 bird species in the NWT, of which 33 species are considered to be vagrants and are not normally found in the NWT. Of the 240 resident species; three of those species are "At Risk" of extirpation (i.e., local extinction), six "May Be At Risk" and 40 species are considered to be "Sensitive" to extirpation. **Trend:** • Several changes have been made in the status of NWT bird species from the initial assessment in 2000. The most recent assessment reduced the number of species with "undetermined" status from 28% in 2000 to 19% in 2006. The classification of some species have been upgraded to more conservative status ("At Risk" or "May Be At Risk") because of new data or assessments from other agencies. **Gaps:** • Currently no data are available for long-term trends of any landbirds (e.g., game birds and songbirds) in the Taiga Shield portion of the NWT. Because of this, trends can only be inferred from data from other regions. • There are Breeding Bird Surveys and Christmas Bird Counts conducted which provide critical information on bird species; however, they are not NWT-wide. Their presence should be expanded in the NWT.
Waterfowl	Population Size	▲ (Favourable)	✔ (Improving)	**Current Condition:** • Survey data from the WBPHS program in 2010 show that most waterfowl populations in the NWT have increased in the last few years, with the numbers of some species higher in 2010 than in the previous ten years. **Trend:** • The variability in the current condition makes the overall trend uncertain. **Gaps:** • It is recommended that the NABBS program in the NWT be supported, and improved to provide better coverage of the NWT. More data from more observers over a larger area of the NWT will help to identify trends for more species.
PERMAFROST AND GROUND ICE				
Permafrost	Mean Annual Ground Temperature (MAGT)	▼ (Unfavourable)	? (Uncertain) to ✘ (Deteriorating)	**Current Condition:** • Generally, MAGT within the discontinuous zone is warmer than about -2.5°C while MAGT in the continuous zone above the treeline can be colder than -5°C. • MAGT is locally variable and depends on local conditions including vegetation, snow cover, and proximity to water bodies. **Trend:** • Ground permafrost temperatures are rising across the whole northern hemisphere. • International data which are confirmed by Canadian ground temperature monitoring in permafrost regions show that the permafrost ground temperature is rising; however, the rate and magnitude of change is variable. **Gaps:** • In Canada there is a lack of long-term MAGT monitoring. • There is limited information in regard to the present ground temperature within northeastern NWT and how it is responding to climate warming. • Monitoring MAGT at selected sites is needed since permafrost warming may have a significant environmental impact in time on infrastructure built on ice rich (high ground ice) permafrost and not designed for climate warming. • Lack of long-term support for baseline permafrost monitoring.
Snow	Snow Cover	▬ (Intermediate)	? (Uncertain)	**Trend:** • Annual snowfall precipitation and the snow to total precipitation ratios have increased in most parts of the NWT over the period of 1950 to 2007.

Table ES.1 (Cont'd)
Summary of Status of the Environment Assessment for Current Conditions and Trends

SYMBOL KEY: Assessment of the Current Condition: ▲ Favourable; ▬ Intermediate; ▼ Unfavourable

Assessment of the Trend: ✔ Improving; ? Uncertain; ✘ Deteriorating

Valued Component	Indicator	Current Condition	Trend	Comments
	Ground Ice	▬	✘	**Current Condition:** • Medium to high ice content ground is found mostly in the mid to east northern area of the Northwest Territories **Trend:** • Ground ice conditions are predicted to change as a result of climate warming. The effects of changing ground ice conditions on the stability of river banks, the arctic shoreline are largely unknown. **Gaps:** • No major gaps.
HUMAN HEALTH				
Human Health	Population Demographics – Life Expectancy	▬	✔	**Current Condition:** • For the NWT as a whole, life expectancy at birth compared to the rest of Canada is about 4 years lower for both males and females. • Life expectancy in Aboriginal communities has improved. **Trend:** • There is no reason to believe that the improvement in the current condition will decline.
	Perinatal Health – Birth/Fertility Rate	▲	✔	**Current Condition:** • Data for the period 1981 to 2007 show that infant mortality rates in both Canada and the NWT have decreased, and that infant mortality rates in the NWT and Canada since 2001 may be similar. **Trend:** • The infant mortality rate has been steadily declining in First Nations peoples. **Gaps:** • Birth defect reporting at birth is not mandatory but is being considered now as part of the birth defects monitoring system.
	Perinatal Health – Infant Mortality Rate	▲	✔	
	Population Mortality – Causes and Age- and Sex-specific Mortality	▲ to ▬	✔	**Current Condition:** • Age standardized mortality rates in the NWT appear to have decreased in both males and females between 2000 and 2005. The four major causes of death for the NWT were cancer, circulatory disease, accidents (including suicides), and respiratory diseases. **Trend:** • Improving mortality rates. **Gaps:** • No major gaps.
	Population Morbidity (Incidence of disease)	▬ to ▼	?	**Current Condition:** • Specific data on Infectious Diseases and especially vaccine preventable diseases were not found for the NWT; therefore, the Survey of Inuit and First Nations Health report was used. • First Nations people across Canada experience a disproportionate burden of many infectious diseases compared to other Canadians. **Trend:** • Up to 2007, the trend for reported STIs has increased for the whole population; the rates in Aboriginal people have increased much more markedly since 2000. Currently, the rate of reported STIs among NWT Aboriginal people is 11 times that for non-Aboriginal NWT residents. **Gaps:** • Specific data on Infectious Diseases and especially vaccine preventable diseases were not found for the NWT. • In the NWT there is no specific survey that gives good estimates of diabetes prevalence. • There is no central database available for hypertension, and no prevalence studies. As a major risk factor for cardiovascular mortality, this is an area that should be explored for NWT populations. • Dental health measures are not collected systematically in the NWT.
	Personal Health Practices and Risk Factors	▼	✔ to ✘	**Current Condition:** • The NWT reports lower level of perceived mental health, higher satisfaction with life, lower level of arthritis, higher level of smoking and alcohol consumption, lower consumption of fruits and vegetables, and lower frequency of having a regular medical doctor. **Trend:** • Since 2002 there has been decline in the smoking rate. **Gaps:** • Obesity and physical inactivity data collection needs to be enhanced as these are important health indicators.
	Environmental Factors	▲	✔	**Current Condition:** • All communities in the NWT have access to potable drinking water. • All communities in the NWT have a sewage collection/disposal/treatment system except for Colville Lake. **Gaps:** • All communities in the NWT have a sewage collection/disposal/treatment system except for Colville Lake.

Table ES.1 (Cont'd)
Summary of Status of the Environment Assessment for Current Conditions and Trends

SYMBOL KEY: Assessment of the Current Condition: ▲ **Favourable;** ▬ **Intermediate;** ▼ **Unfavourable**

Assessment of the Trend: ✔ **Improving;** ? **Uncertain;** ✘ **Deteriorating**

Valued Component	Indicator	Current Condition	Trend	Comments
SOCIO-ECONOMIC AND COMMUNITY WELLNESS				
Population	Population change	▲	✔	**Current Condition:** • Between 1991 and 2008, the overall population of the NWT increased by 11.8%. This compares to an overall increase of 18.8% for all of Canada over the same period. **Trend:** • Population change between 2004 and 2009 has been marginal.
	Five Year Population Mobility – Intra-Territorial and Inter-Provincial	▬	?	**Current Condition:** • According to the 2006 census, of the people moving between communities in the NWT, 2.6 times more of them moved from outside of the NWT (inter-provincial) as compared to from within (intra-territorial). • Of the total people who relocated from somewhere in Canada the vast majority moved to a larger centre (53% to Yellowknife, 16% to the Beaufort Delta, 16% to the South Slave, and the remainder divided among the Sahtu, Dehcho, and North Slave). **Trend:** • Between 1986 and 2006 there was a downward trend in population mobility rates in the NWT.
	Population Share by Community Type	▬ to ▼	? to ✘	**Current Condition:** • Between 1976 and 2009 the share of the NWT population residing in Yellowknife increased from 26.6% to 45.4% of the total population of the NWT. In the same period, the smaller communities reported a declining percentage of the total population of the NWT. **Trend:** • There is no reason to believe that the current condition is changing.
Education	Population 15 Years and Older with at least High School **NWT**	▲	✔	**Current Condition:** • The percentage for the whole of the NWT is quite similar to that for Canada, but when compared to the rate for smaller communities it is almost twice as much. • Since 1989, the rate has increased in all regions of the NWT with the highest increases being recorded in the North Slave, South Slave and Dehcho regions. **Trend:** • Education levels in smaller NWT communities substantially improved between 1989 and 2009 but remain 20%-25% lower than in the NWT as a whole.
	Population 15 Years and Older with at least High School **NWT Smaller Communities**	▬	? to ✔	
	High School Graduation Rate	▬	✔ to ✘	**Current Condition:** • For the period 2001 to 2007 the data show: o a gradual improvement in the rate of high school graduation in the NWT, contributing to a much narrower gap between graduation rates in the NWT and Canada. o improved graduation rates in smaller NWT communities. o high graduation rates in Yellowknife that exceeded the Canadian rate in 2007. o improved graduation rates among Aboriginal students. In 2006, graduation rates among Aboriginal students exceeded those of non-Aboriginal students. • Indicators of student achievement such as Alberta Achievement Test results, high school diploma examination results, and functional grade levels show limited or no progress during the same time period. **Trend:** • Improvements to school graduation, but not to same level as some jurisdictions.
Crime and Safety	Violent Crime Rate	▼	✘	**Current Condition:** • Between 1999 and 2008, the rate of violent crime in the NWT increased by almost 15 incidents per 1000 of population. The crime rate in the Beaufort Delta, Dehcho and Tłı̨chǫ regions is more than 100 incidents per 1,000 population, more than eleven times the Canadian average. **Trend:** • There is no reason to believe that the current condition is improving. **Gaps:** • Data for the violent crime rate are not available for NWT smaller communities. • Shelter admission data are collected by the NWT Department of Health and Social Services. Similar data are not available at the community level, for Canada or other provinces and territories.
	Rate of Juvenile Crime	▼	✘	**Current Condition:** • NWT youth crime rates were marginally lower in 2008 than in 2001, but continued to be far greater than the Canadian average. **Trend:** • There is no reason to believe that the current condition is improving.
	Shelter Admissions	▼	✘	**Current Condition:** • Per capita rates of shelter usage in the NWT are higher than the rest of Canada. **Trend:** • According to the 2003-2004 Transition Home Survey, per capita rates of shelter usage were considerably higher in the NWT than in the rest of Canada. Between 2000-01 and 2007-08, there was little variation in shelter admissions of women in the NWT, however admission of children declined.

Table ES.1 (Cont'd)
Summary of Status of the Environment Assessment for Current Conditions and Trends

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Valued Component	Indicator	Current Condition	Trend	Comments
Housing	Percentage of Households in Core need **NWT**	—	✗	**Current Condition:** • The progress made in reducing core housing need to 2004 has been reversed as of 2009. The NWT continues to have a higher percentage of households with core housing need than elsewhere in Canada. • In 2009, households in smaller NWT communities were twice as likely to be in core need as the NWT in general. **Trend:** • There is no reason to believe that the current condition is improving.
	Percentage of Households in Core need **NWT Smaller Communities**	▼	✗	
	Percentage of Households with 6 or More Persons	**Not rated**	**Not rated**	**Statistics:** • In 2009 the percentage of NWT households with six or more persons was more than twice the percentage of Canadian households. NWT smaller communities are nearly 2x more likely to have households with six or more people as compared to the NWT as a whole. **NB –** An assessment of the current condition and trend is not possible as this is a value judgement.
Families and Children	Number of Lone Parent Families	— to ▼	✗	**Current Condition:** • The percentage of lone parent families has increased in the NWT since 1986 at a rate slightly faster the Canadian average. In 2006, there were 5.5% more lone parent families in the NWT than in Canada. **Trend:** • There is no reason to believe that the current condition is improving.
	Children Living in Low Income Families	**Not rated**	**Not rated**	**Statistics:** • Between 1997 and 2006, the percentage of children living in low income families in the NWT declined from 24.5% to 20.7%. This is similar to the Canadian rate. However, the NWT smaller communities rates were consistently five to ten percentage points higher than elsewhere in Canada. **NB –** An assessment of the current condition and trend is not possible as this is a value judgement.
	Child Protection Investigations	—	✔	**Current Condition:** • Child protection investigations have declined since 2005. **Trend:** • Child protection investigations have declined since 2005. **Gaps:** • There are no community data or comparable data for other parts of Canada.
	Population Dependency Ratios	—	?	**Current Condition:** • The dependency ratio for children 15 years and younger declined between 1991 and 2009 across Canada, the NWT, the NWT smaller communities and all NWT regions. • Conversely, the dependency ratio for those aged 60 years and older increased in the same time period, for Canada, the NWT and NWT communities.
Income and Employment	Average Employment Income	▲ to —	✔ to ?	**Current Condition:** • Between 1996 and 2007, the average employment income in the NWT increased by 52%. Over the same period, NWT average employment income was consistently $6,000 to $10,000 higher than the Canadian average. • In 2007, average employment income in smaller NWT communities was about 30% lower than the NWT average and 40% less than average employment incomes in Yellowknife. **Trend:** • These patterns did not change noticeably between 1996 and 2007.
	Income Disparity	—	✔ to ?	**Current Condition:** • Between 1999 and 2007, the percentage of families with annual incomes of greater than $75,000 grew both in the NWT on average and in smaller NWT communities by close to 20%. During the same period, the percentage of families with annual incomes of less than $30,000 declined in the NWT by 9.7% and in smaller NWT communities by 12.3%. **Trend:** • There appears to be a decrease in the income gap.
	Employment Rate	—	?	**Current Condition:** • Between 1986 and 2009, the NWT employment rate increased by 1% and during that period varied between 3 and 10% higher than the Canadian average During the same period, the employment rate in smaller NWT communities grew by about 6%. **Trend:** • Employment rates have declined in the Beaufort-Delta, South Slave and Yellowknife between 1986 and 2009, and over the shorter term, employment rates in all regions and Yellowknife have declined between 2006 and 2009.
NWT Economy	Gross Domestic Product (GDP)	▲	✔	**Current Condition:** • Between 2000 and 2008, gross domestic product grew by 65% ($2.35 billion in 2000 to $3.87 billion in 2008) in the NWT compared to 20% for all of Canada. Territorial GDP lost 6.5% in 2008, a trend that appeared to continue in 2009. **Gaps:** • Traditional activities supported communities prior to the wage economy, but many of these activities lack an economic valuation (e.g., hunting for food) and therefore standard economic measures do not provide a full picture of the importance of traditional activities. • A full understanding of the shift from traditional economy to modern economy is not well known.

Table ES.1 (Cont'd)
Summary of Status of the Environment Assessment for Current Conditions and Trends

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Assessment of the Trend: ✔ **Improving;** ? **Uncertain;** ✖ **Deteriorating**

Valued Component	Indicator	Current Condition	Trend	Comments
	Consumer Price Index (CPI)	▲	✔	**Current Condition:** • The consumer price index for Yellowknife increased by almost 25% between 1996 and 2009 while Canada's index changed by 29% over the same period. Higher living costs were also felt in the other 33 NWT communities.
Aboriginal Culture	Aboriginal People 15 Years of Age and Over Able to Speak an Aboriginal Language	▼	✖	**Current Condition:** • A decline of Aboriginal language ability is prevalent throughout the NWT but is particularly evident in smaller NWT communities. During the 20 years between 1989 and 2009, the percentage of Aboriginal people able to speak an Aboriginal language declined by almost 19% in the NWT and 23.3% in smaller NWT communities. **Trend:** • The percentage is declining across time in all areas. **Gaps:** • Changes in cultural practices are not addressed. • Need to define and develop methodology as to changes in Aboriginal cultural practices. • Traditional activities supported communities prior to the wage economy, but many of these activities lack an economic valuation (e.g., hunting for food) and therefore standard economic measures do not provide a full picture of the importance of traditional activities. • A full understanding of the shift from traditional economy to modern economy is not well known.
	Use of Harvested Meat and Fish	▲	✔ to ?	**Current Condition:** • The percentage of households using harvested meat or fish increased between 1999 and 2008 in the NWT as a whole although increases were slightly less evident in smaller NWT communities. More recent trends (2003-2008) are negative however, especially among smaller communities.

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1.0 INTRODUCTION

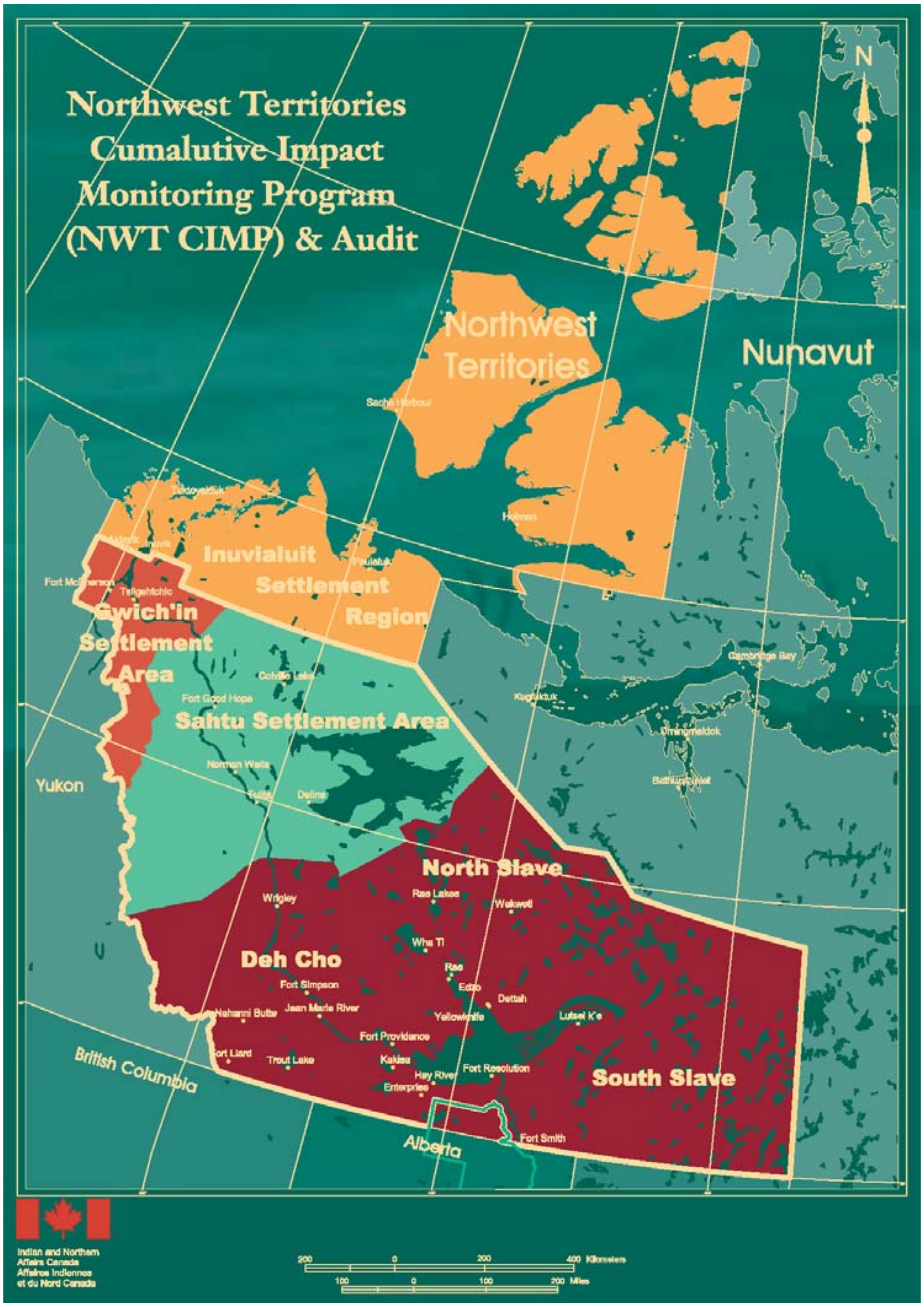
With a land mass of 1.3 million square kilometres, Canada's Northwest Territories (NWT) is roughly equivalent in size to Alberta and Saskatchewan combined. In contrast, the total population of these provinces is more than 100 times greater than that of the NWT. A map of the NWT and its regions is shown in Figure 1.1-1.

The vast geographic expanse of the NWT is accompanied by remarkable environmental and ecological diversity. From south to north, the boreal forest gradually transforms into the taiga, the tundra and ultimately the arctic coast. These environments are home to a tremendous variety and abundance of wildlife. Peary caribou, muskoxen, polar bears, arctic hares and beluga whales are among the mammals that inhabit the far north. The Mackenzie Mountains are home to woodland caribou, Dahl's sheep, grizzly and black bears, lynx, martens, golden eagles and a variety of small birds and mammals. The Mackenzie River delta provides important habitat for muskrats and nesting waterfowl. In the southern boreal forest or taiga, moose, wolves, woodland caribou, lynx, red foxes and several types of weasel are found. Vast networks of lakes and rivers contain numerous fish species including trout, pike, whitefish and many others.

The NWT is also home to a diverse human population that originates from across Canada and around the World. While many residents of the NWT have made the north their home relatively recently, approximately half of the population has a connection to the NWT that is much older. Dispersed in communities across the NWT, the Aboriginal population is far from being a homogeneous group; instead, it represents a wide array of cultures and histories that are reflective of the varied environments their descendants have inhabited for thousands of years. Although differences do exist, the Aboriginal people of the NWT have one particularly important attribute in common: a profound connection to the land. Despite major lifestyle changes over the past 50 years, many Aboriginal households continue to spend part of each year on the land and "traditional foods" form a significant part of their diets. Not surprisingly, the land is at the centre of Aboriginal culture, spirituality, tradition and identity. The role of the environment in the lives of Aboriginal people cannot be overstated.

The modern economy of the NWT has been dominated by activities in the non-renewable resource sector. While some efforts are being made to diversify into other sectors, it is likely that non-renewable resources will continue to underpin the economy of the NWT for decades. Interest in the NWT's resources is substantial and current activity has all the hallmarks of a major resource boom. Three world-class diamond mines are in production and a fourth is in the initital stage of environmental assessment. Commodity markets are likely to stimulate ongoing interest in the development of other mining prospects throughout the NWT, including diamonds, gold, uranium, and base and rare earth metals. The same can be said for the hydrocarbon reserves of the territory. Oil and gas exploration is underway in several areas of the NWT and the review of the proposed Mackenzie Gas Project is near completion.

Figure 1.1-1
Northwest Territories and its Regions



In the eyes of many Northerners and the rest of Canada, the NWT's natural resources can serve as a platform for northern "development". The need for change is undeniable, above all for Aboriginal people facing a daunting set of economic and social challenges. Within Aboriginal communities, levels of basic literacy and educational attainment are well below national averages. At the same time, unemployment levels and the incidence of drug and alcohol abuse, domestic violence and gambling are significantly higher than in non-Aboriginal populations.

Given the current context and the broad scope of the NWT environment, this Status of the Environment report covers seven major components of the NWT environment:

- atmospheric environment (including air quality, climate and climate change);
- freshwater aquatic environment;
- marine environment;
- terrestrial environment;
- permafrost, ground ice and snow;
- human health; and
- socio-economic and community wellness.

In conducting the Status of the Environment report, as a starting point we assessed environmental trends using valued components (VCs) identified in the INAC report, *A Preliminary State of Knowledge of Valued Components for the NWT Cumulative Impact Monitoring Program* (NWT CIMP) and Audit. Key VCs within each VC grouping and key indicators of change for the selected VCs were then identified and carried forward through the study. For these key indicators of change, trends in environmental quality were assessed for the Mackenzie Valley, the Inuvialuit Settlement Region and the NWT as a whole.

In assessing trends, previously completed studies were relied upon extensively, particularly where these studies had assessed trends in environmental quality. Where required, these studies were supplemented with original data analysis; however, conducting original research was not within the scope of the Status of the Environment reporting. In carrying out the review, the specialists used a range of information sources and contacted various individuals as appropriate for the VC being assessed.

For each of the key indicators, available data were analyzed and assessed to identify: trends; potential contributing factors to any changes in the environment; the significance of any trends identified; the likely impact of the trends; activities to mitigate the factors/emissions that are causing the observed trends, and, data gaps. It should be noted that in several instances throughout the review it was difficult to determine the current condition of an environmental component or evaluate trends due to a lack of adequate baseline data for the NWT. It is receommended that the CIMP be used to fill these important data gaps.

Large scale resource development and economic activity can lead to significant social, cultural and environmental changes. With exploration and development intensifying, this Status of the Environment report provides an overview of the current conditions in the major components of the NWT environment and identifies areas where further research, monitoring, or action is required.

2.0 AIR QUALITY, CLIMATE AND CLIMATE CHANGE

2.1 INTRODUCTION

The Arctic Climate Impact Assessment (ACIA) published in 2005 is the first comprehensive regional assessment of an almost continuous circle of land surrounding the Arctic Ocean – a globally unique system. This report addresses the very large changes in climate, ozone and UV radiation which are projected to occur. The report concludes:

> *"It is important to re-emphasize that climate and UV radiation changes in the Arctic are likely to affect every aspect of human life in the region and the lives of many living outside the region. … action must begin to be taken to address current and anticipated changes before the scale of changes and impacts further reduces the options available for prevention, mitigation and adaptation."*

The change in chemical composition of the atmosphere is producing physical changes in the atmosphere with respect to meteorological variables such as temperature, precipitation and cloud cover, and that even greater changes can be expected over the next century as the atmospheric concentrations or loadings resulting from anthropogenic emissions continue to increase.

Air pollution is caused by both natural and anthropogenic (human-induced) emission sources. Pollution is defined as "the presence in the atmosphere of substances that are toxic, irritant, or otherwise harmful to people or damaging to vegetation, animals, or property." This pollution has a number of manifestations on various scales: regional and local – smog and acid rain; continental – transport of persistent toxics (e.g., mercury and PCBs) and global - climate change, ozone layer depletion.

Factors that affect the concentration of air pollutants in the atmosphere include:

- the geometric configuration (e.g., point, line or area source), and geography in the vicinity of the emission site (e.g., lakes, valleys);
- the total amount of pollutant emitted;
- the meteorological conditions; and
- the amount of pollutant emitted.

Air quality is determined by the concentrations of pollutants in the atmosphere, which are, in turn, affected by the dispersion of pollutants from emission sources. Emission sources can be primary or secondary, where primary sources include stack emissions and volatilization from equipment, and secondary sources generally refer to the re-emission of contaminants from large environmental reservoirs.

Weather plays the key role in the dispersion of air pollutants. Meteorology is a vital part of predicting both the current air quality as well as developing any strategies to improve the future situation. The parameters of particular importance are wind speed and direction, and atmospheric stability. The amount of sunshine also directly influences photochemical production of secondary pollutants.

Air quality issues such as regional scale smog, acid deposition, and the concentration of hazardous air pollutants in the lower levels of the atmosphere are linked to climate through temperature, precipitation, humidity, solar radiation, cloudiness and the large scale circulation of the atmosphere which acts to re-distribute air pollutants through long range transport.

The following sections describe the Air Quality, Climate and Climate Change in the Northwest Territories (NWT), with particular emphasis on:

- current monitoring/research programs and data;
- trends in the data and the significance of these trends; and
- information gaps and recommendations for additional monitoring/research.

2.2 AIR QUALITY

2.2.1 Introduction to Air Pollutants

Emissions of air pollutants result in environmental and health impacts through mechanisms such as smog and acid rain. Smog, originally coined as a mixture of smoke and fog, now refers to a noxious mixture of air pollutants - including vapours, gases and particles - that can often be seen as a haze in the air. The two main ingredients of smog that affect human health are ground-level ozone and fine airborne particles. Ground-level ozone is a colourless and highly irritating gas that forms in the lower atmosphere. It is called a “secondary” pollutant because it is produced when two primary pollutants - nitrogen oxides (NO_x reported as NO_2) and volatile organic compounds (VOCs) - react in sunlight through a process known as photochemistry.

Airborne particles are microscopic solid and liquid particles that remain suspended in the air for varying lengths of time. Primary particles are predominantly produced by fuel combustion, industrial processes, as well as natural processes such as wind blown dust. Secondary particles are formed in the atmosphere by gas-to-particle conversion processes of originally emitted gaseous compounds.

Sulphur dioxide (SO_2) is a colourless gas that can be chemically transformed into acidic pollutants such as sulphuric acid and sulphates (sulphates are a major component of fine particles). The main sources of airborne SO_2 are coal-fired power generating stations and non-ferrous ore smelters. Sulphur dioxide is also one of the main causes of acid rain, which can damage crops, forests and whole ecosystems.

Nitrogen oxides (NO_x) are nitrogen-oxygen compounds that include nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is a toxic, irritating gas emitted by all combustion processes. It is both a separate component of smog and a pollutant that contributes to the formation of ground-level ozone and particulate matter. In combination with water, NO_2 in the troposphere can form the nitric acid component of acid rain. NO_2 in the stratosphere can also form nitric acid which can form cloud particles at temperatures near -80°C creating Polar Stratospheric Clouds (PSCs). The surfaces of these particles act as catalysts for the chemical reactions that lead to ozone destruction.

Volatile Organic Compounds (VOCs) are carbon-containing gases and vapours such as gasoline fumes, with the major exceptions of carbon dioxide, carbon monoxide, methane and chlorofluorocarbons. Anthropogenic sources of VOCs are mainly fuel combustion and the evaporation of liquid fuels and solvents. Carbon monoxide (CO) is a colourless and odourless gas that is a product of incomplete combustion.

Ozone (O_3) is a triatomic molecule, consisting of three oxygen atoms. Ozone in the lower atmosphere is an air pollutant with harmful effects on the respiratory systems of animals and will burn sensitive plants; however, the ozone layer in the upper atmosphere is beneficial, preventing potentially damaging ultraviolet light from reaching the Earth's surface. Ozone is present in low concentrations throughout the Earth's atmosphere.

The Environment Division (ED) of the Department of Environment and Natural Resources (ENR), Government of the Northwest Territories (GNWT), monitors air quality in the NWT. The network consists of four monitoring stations located in Yellowknife, Fort Liard, Norman Wells and Inuvik. Each station continuously samples and analyzes a variety of pollutants and meteorological conditions. The Yellowknife and Inuvik stations are operated in partnership with the National Air Pollution Surveillance (NAPS) program - a joint federal/provincial/territorial network tracking urban air quality across Canada. ENR also monitors acid precipitation at Snare Rapids, in co-operation with the Canadian Air and Precipitation Monitoring Network (CAPMoN) and undertakes seasonal particulate sampling at Daring Lake.

Table 2.2-1 shows the substances and meteorological parameters monitored at each station.

Table 2.2-1
Substances and Parameters Monitored

Substances Monitored by Station											
Stations	**Particulate Matter**			**Gaseous**					**Precipitation**	**Meteorlogical Monitoring**	
	TSP – Particulate	$PM_{2.5}$ – Fine Particulate	PM_{10} – Particulate	SO_2 Sulphur Dioxide	H_2S Hydrogen Sulphide	NO_x Nitrogen Oxides	O_3 Ground Level Ozone	CO Carbon Monoxide	Acidic Deposition	Wind Speed and Direction	Air Temperature
Yellowknife	√	√	√	√		√	√			√	√
Inuvik		√	√	√	√	√	√			√	√
Norman Wells		√		√	√	√	√			√	√
Fort Liard		√	√	√	√	√	√			√	√
Snare Rapids									√		
Daring Lake		√									√

Source: Table 1 from Northwest Territories Air Quality Report 2008. GNWT, 2009

The GNWT has adopted a number of ambient concentration limits for the protection of air quality in the NWT. The limits for SO_2, ground-level ozone, TSP and $PM_{2.5}$ are listed in the *Northwest Territories Air Quality Report 2008* (GNWT 2009). These standards are used in the assessment of air quality monitoring data as well as in determining the acceptability of emissions from proposed and existing developments. Where NWT standards are not available for a particular pollutant the Canadian National Ambient Air Quality Objectives (Environment Canada 1981) or limits established in other jurisdictions are used.

The *Northwest Territories Air Quality Report 2008* (GNWT 2009) shows that the air quality in the NWT continues to be good.

2.2.2 Air Quality Indicators

The key indicators of air quality addressed in this SOE and the rationale for their selection are presented in the Table 2.2-2.

Table 2.2-2
Rationale for Selection of Indicators for Air Quality Valued Component

Valued Component	Key Indicators	Rationale
Air Quality	**Particulate Matter Concentrations**	• primary air quality contributor to local human health issues • emitted from local sources • monitored by GNWT and private companies at various locations
	SO_2/NO_x Concentrations	• emitted and measured locally • potential local human health and ecosystem effects • also transported from long-range sources • chemically converted in the atmosphere to acid rain • precursor to ground level ozone
	O_3 Concentrations	• created in the atmosphere through the action of sunlight and HC on O_2 • indicative of the amount of UV light able to get to the earth's surface • can be transported long distances

2.2.2.1 Particulate Matter

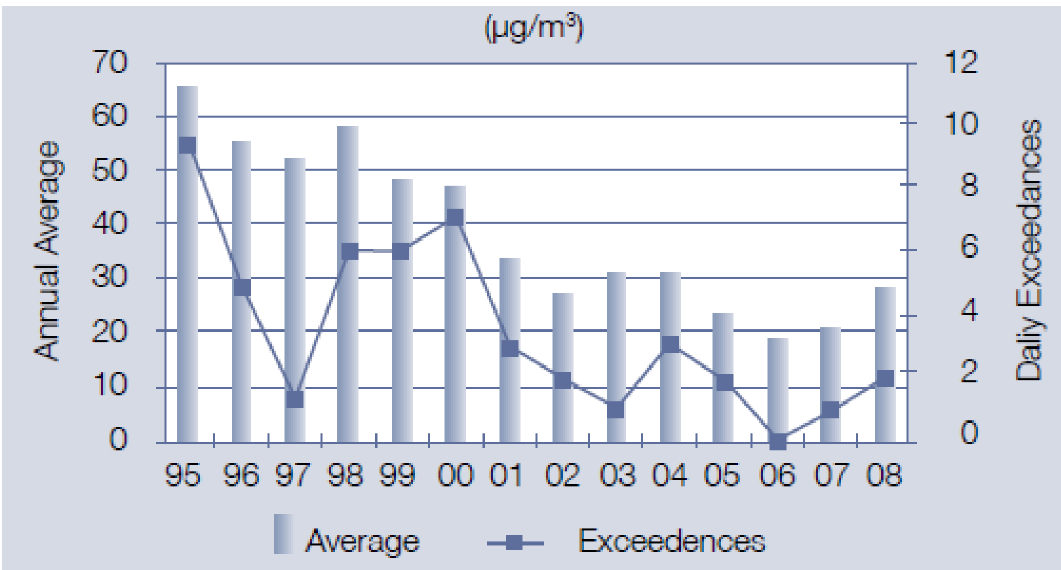
Airborne particulate matter consists of particles ranging in size from 0.005 to 100 µm in diameter. For convenience in air quality assessment and regulation, the various size fractions are generally subdivided into several distinct size categories. These include total suspended particulate matter (TSP) consisting of all particles with a mean diameter less than 30 µm, inhalable particulate matter (PM_{10}) consisting of particles with a mean diameter less than 10 µm, and fine particles ($PM_{2.5}$) consisting of particles with a mean diameter less than 2.5 µm (1 micrometre = 1 millionth of a metre). In part, the distinctions between these size categories reflect the changing focus of regulations over the past three decades from coarser to finer size fractions of particulate matter.

Monitoring levels of inhalable particulate matter (PM_{10}) is important because inhaling particulates can aggravate asthma and other cardiac and respiratory disorders, damage plants and cause corrosion and soiling of buildings and cars. Fine particulate matter ($PM_{2.5}$) can penetrate deep into the lungs and pose the highest risk to human health.

What is being measured?
TSP (since 1974 in Yellowknife), PM_{10} (since 2002 at Daring Lake) and $PM_{2.5}$ (since 2003 at Daring Lake) are being measured as outlined in Table 2.2-1.

What is happening?
Figure 2.2-1 shows the trend in annual average TSP levels in Yellowknife since 1995. The graph shows a downward trend, with some fluctuation. The annual TSP levels have remainder consistently below the NWT annual standard of 60 µg/m^3 since 1995. The line in Figure 2.2-1 shows the number of times during the year that the NWT 24-hour TSP standard (120 µg/m^3) was exceeded. There were 2 or less daily exceedances of the 24-hour standard over the 4-year period from 2005 to 2008.

Figure 2.2-1
Yellowknife Annual Average TSP and Number of Exceedances of the Daily Standard



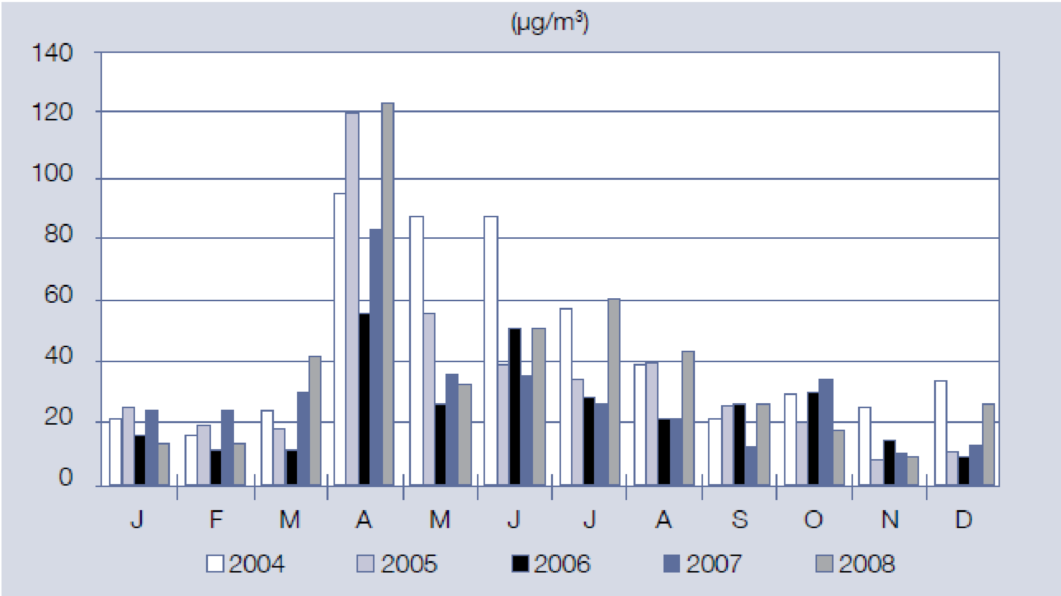
Source: Figure 1 from Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-2 presents the average TSP for each month over the 2004-2008 period. This figure shows a typical springtime dust event occurring in April. The annual average $PM_{2.5}$ level in Yellowknife has remained consistently low, ranging from 2 to 7 µg/m^3 over the 2004-2008 period. There were 7 exceedances of the $PM_{2.5}$ 24-hour standard of 60 µg/m^3 in 2008.

Figure 2.2-3 summarizes all of the Yellowknife $PM_{2.5}$ data over the 4-year period between 2005 and 2008. The figure shows the overall mean and daily maximum for each month.

Figure 2.2-4 summarizes the Inuvik $PM_{2.5}$ monthly average and daily maximum data for 2008, respectively. The annual average $PM_{2.5}$ was 5 µg/m^3. The maximum 24-hour $PM_{2.5}$ value of 16 µg/m^3 occurred during February and was linked to dust generated from construction in the area.

Figure 2.2-2
Monthly TSP in Yellowknife for the 2004-2008 Period



Source: Figure 2 from Northwest Territories Air Quality Report 2008. GNWT, 2009

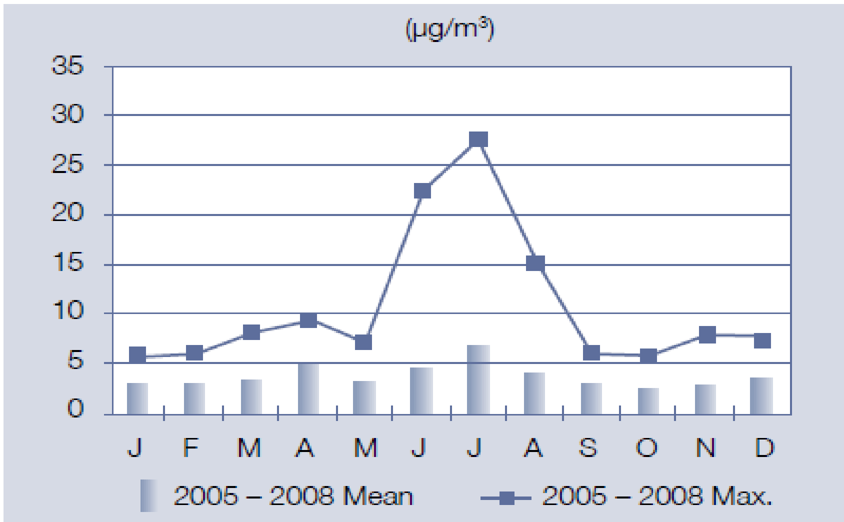
The annual average $PM_{2.5}$ level in Yellowknife has remained consistently low, ranging from 2 to 7 µg/m^3 over the 2004-2008 period. There were 7 exceedances of the $PM_{2.5}$ 24-hour standard of 60 µg/m^3 in 2008.

Figure 2.2-3 summarizes all of the Yellowknife $PM_{2.5}$ data over the 4-year period between 2005 and 2008. The figure shows the overall mean and daily maximum for each month.

Figure 2.2-4 summarizes the Inuvik $PM_{2.5}$ monthly average and daily maximum data for 2008, respectively. The annual average $PM_{2.5}$ was 5 µg/m^3. The maximum 24-hour $PM_{2.5}$ value of 16 µg/m^3 occurred during February and was linked to dust generated from construction in the area.

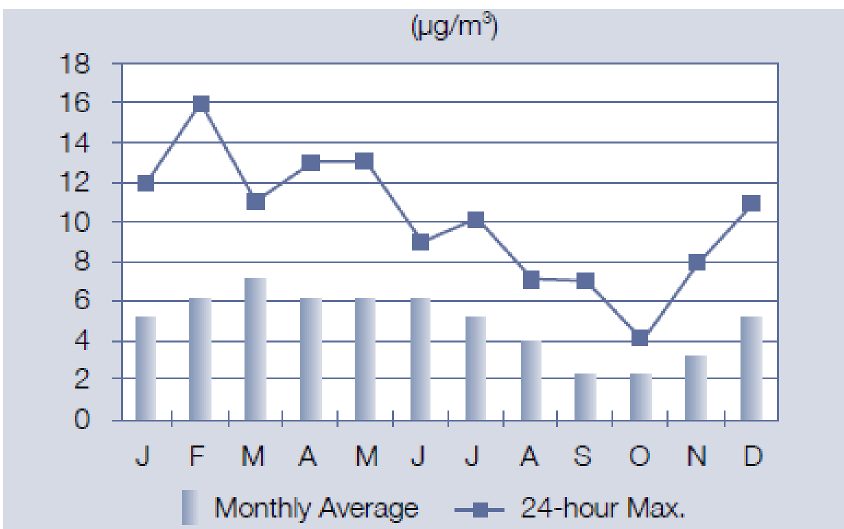
Figure 2.2-5 summarizes the Inuvik PM_{10} monthly average and daily maximum data for 2008. The highest daily maximum of 70 µg/m^3 was recorded in May and there were three exceedances of the 50 µg/m^3 acceptable limit used in other jurisdictions. Also the data shows the typical "springtime dust maximum" associated with residual winter gravel similar to that in Yellowknife.

Figure 2.2-3
Summary of Yellowknife $PM_{2.5}$ Data for the 2005-2008 Period



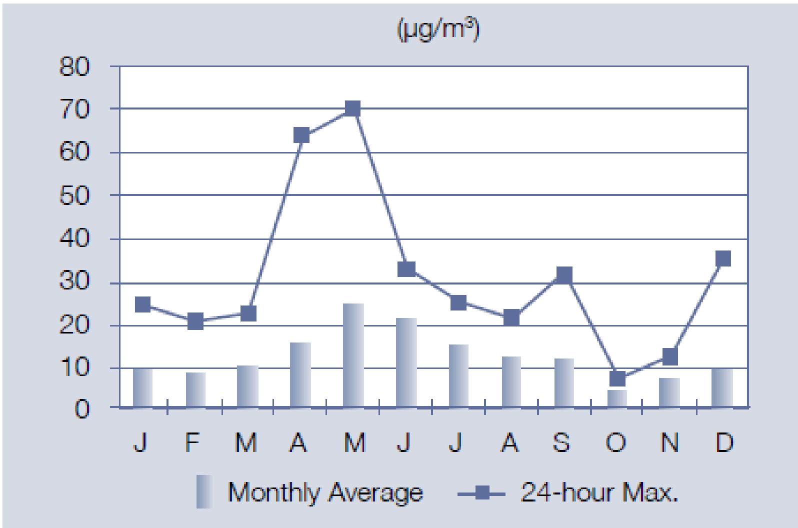
Source: Figure 4 from Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-4
Summary of Inuvik $PM_{2.5}$ Data for 2008



Source: Figure 14 from Northwest Territories Air Quality Report 2008. GNWT, 2009

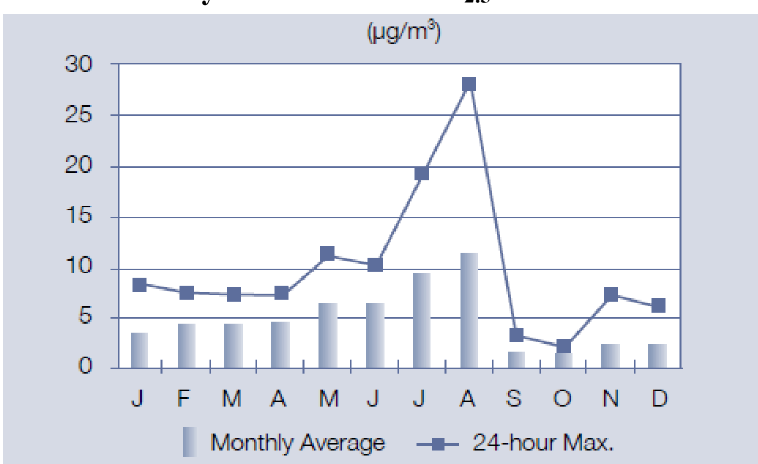
Figure 2.2-5
Summary of Inuvik PM_{10} Data for 2008



Source: Figure 15 from Northwest Territories Air Quality Report 2008. GNWT, 2009

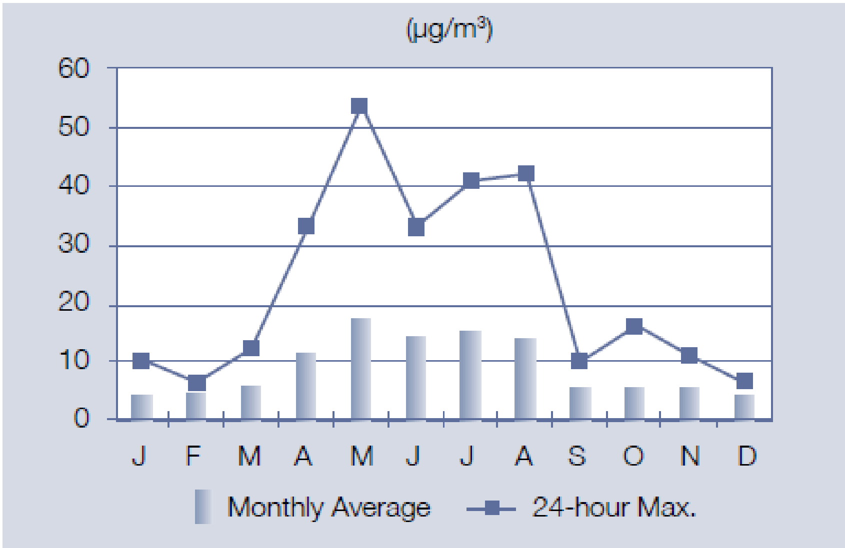
Figure 2.2-6 summarizes the Fort Liard $PM_{2.5}$ monthly average and daily maximum data for 2008, respectively. The 2008 annual average $PM_{2.5}$ was 4 µg/m^3. The maximum 24-hour $PM_{2.5}$ value of 28 µg/m^3 showed negligible impacts from forest fire smoke in 2008. Figure 2.2-7 summarizes the Fort Liard PM_{10} monthly average and daily maximum data for 2008. The highest daily maximum was 54 µg/m^3 recorded in May and was the only exceedances of the 50 µg/m^3 acceptable limit used in other jurisdictions. Also the data shows the typical "springtime dust maximum" associated with residual winter gravel similar to that in Yellowknife and Inuvik.

Figure 2.2-6
Summary of Fort Liard $PM_{2.5}$ Data for 2008



Source: Figure 17 from Northwest Territories Air Quality Report 2008. GNWT, 2009

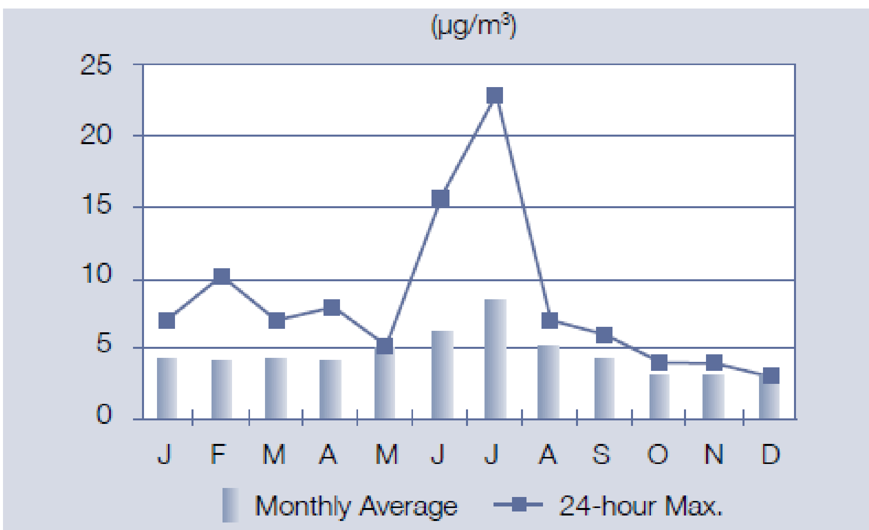
Figure 2.2-7
Summary of Fort Liard PM_{10} Data for 2008



Source: Figure 18 from Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-8 summarizes the Norman Wells $PM_{2.5}$ monthly average and daily maximum data for 2008, respectively. The maximum 24-hour $PM_{2.5}$ value of 23 µg/m^3 and the annual average was 5 µg/m^3 in 2008.

Figure 2.2-8
Summary of Norman Wells $PM_{2.5}$ Data for 2008



Source: Figure 20 from Northwest Territories Air Quality Report 2008. GNWT, 2009

Why is it happening?
Since the early 1990s, dust conditions in Yellowknife have improved, largely due to the City of Yellowknife's efforts to clean roads throughout the spring and summer, as well as ongoing paving of gravelled areas. The overall downward trend in TSP seems to have levelled off in recent years as the dust control actions approach their lower limit of achievable reduction. The recent 4-year fluctuations in TSP appear to be typical of the annual variability that is caused by weather and sampling schedule.

The maximum 24-hour PM_{10} concentrations coincide with high April TSP values, confirming that PM_{10} concentrations are heavily influenced by the effects of road dust. Low PM_{10} concentrations are seen during the winter months when snow cover suppresses wind blown dust.

The 2008 $PM_{2.5}$ exceedances occurred in July and coincided with forest fires burning in the North Slave region near Hardesty Lake as well as fires near Behchoko.

What does it mean?
The greatest source of TSP in Yellowknife is dust from roads, especially in the spring. Forest fires, industrial activities and combustion products, heating and electricity generation also contribute to TSP levels. PM_{10} concentrations are also largely influenced by road dust. $PM_{2.5}$ concentrations are consistently low, with the greatest short-term influences being vehicle emissions, smoke from forest fires and extreme spring dust events.

What is being done about it?
The data point out the efficacy of diligent and timely road sweeping by the City of Yellowknife during spring to minimize road dust sources. Ongoing road maintenance (e.g., sweeping and paving of dirt roads) and dust suppression activities on exposed areas throughout the summer remain important.

To address the health impacts of fine particulate matter, $PM_{2.5}$ is monitored in Yellowknife, Fort Liard, Inuvik, Norman Wells and Daring Lake. PM_{10} concentrations are measured in Yellowknife, Fort Laird and Inuvik.

At the national level, the Canadian Council of Ministers of the Environment (CCME) endorsed Canada-Wide Standards (CWSs) for ground-level ozone and fine particulate matter ($PM_{2.5}$) in 2000. These standards set targets for ambient concentrations that have to be achieved by the year 2010.

What are the information gaps?
Current monitoring data are providing a good baseline for air quality in the NWT, for future oil and gas and other industrial development projects. The four permanent stations have significant

distances between them. A fifth station at Daring Lake in eastern NWT also measures $PM_{2.5}$ during the summer.

2.2.2.2 SO_2/NO_x Concentrations

Sulphur dioxide (SO_2) can cause breathing difficulties, is toxic to vegetation and is a precursor of acid rain causing acidification of natural ecosystems and damage to buildings. Measuring sulphur dioxide (SO_2) is important because of the health effects caused by exposure. SO_2 is linked to an increase in daily respiratory hospital admissions and an increase in cardiac and respiratory mortality.

Nitrogen oxides are toxic to plants and nitrogen dioxide can cause breathing difficulties in humans. Nitrogen oxides are one of the main precursors of ground level ozone, which can also affect breathing and damage crops and vegetation. Deposition of oxidized nitrogen causes acidification and eutrophication.

What is being measured?
Continuous monitoring of SO_2 has been conducted in Yellowknife since 1992. Significant oil and gas development in the Fort Liard region prompted the establishment of an air quality monitoring program in 2000. In 2003, a climate-controlled trailer housing continuous SO_2 and H_2S analysers was installed in Norman Wells. A similar station was brought on-line in 2003 in Inuvik.

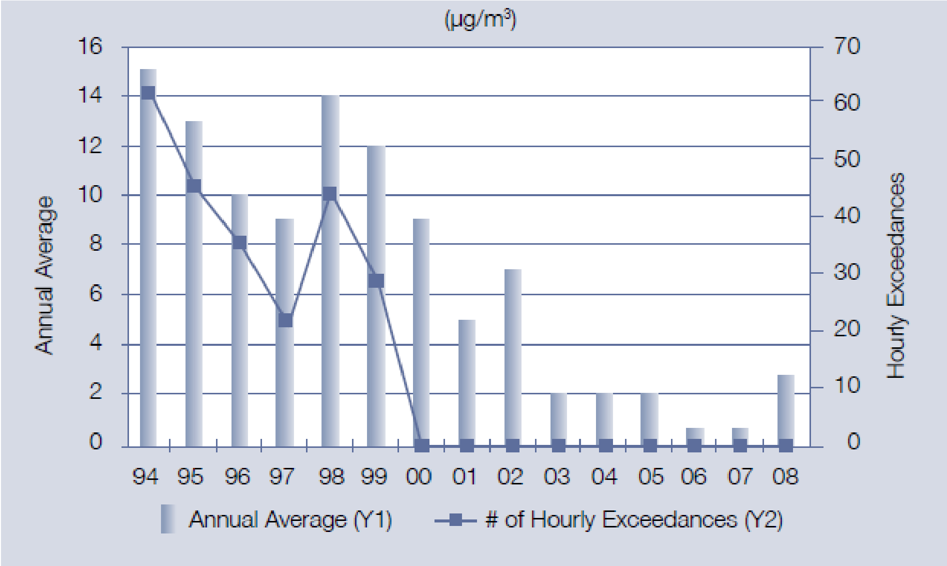
NO_x analysers are installed in Yellowknife, Inuvik, Norman Wells and Ford Liard.

What is happening?
Figure 2.2-9 shows the trend in annual SO_2 concentrations measured since 1994 in Yellowknife. The line shows the number of times in each year that the NWT 1-hour standard of 450 $\mu g/m^3$ was exceeded. The number of exceedances has fallen to zero since the closure of Giant Mine in 1999. The annual averages indicate only background levels of SO_2 exist in ambient air in the Yellowknife region.

SO_2 concentrations measured in Fort Liard are within the expected range of background values and there appears to be no impact on community air quality from oil and gas development in the area, at the present time. SO_2 concentrations measured in Norman Wells and Inuvik in 2003, were also well below the NWT ambient standards.

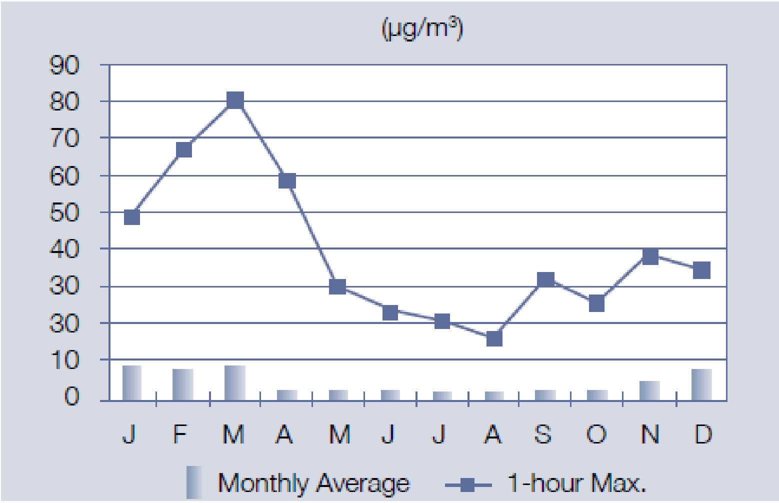
Figure 2.2-10 presents the NO_x data collected in Yellowknife in 2008 which indicates no exceedances of the 1-hour and 24-hour national acceptable limits for NO_2.

Figure 2.2-9
Summary of Yellowknife Annual Average SO_2 Data and Number of Exceedances of Hourly Standard



Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-10
Summary of Yellowknife 2008 NO_2 Data

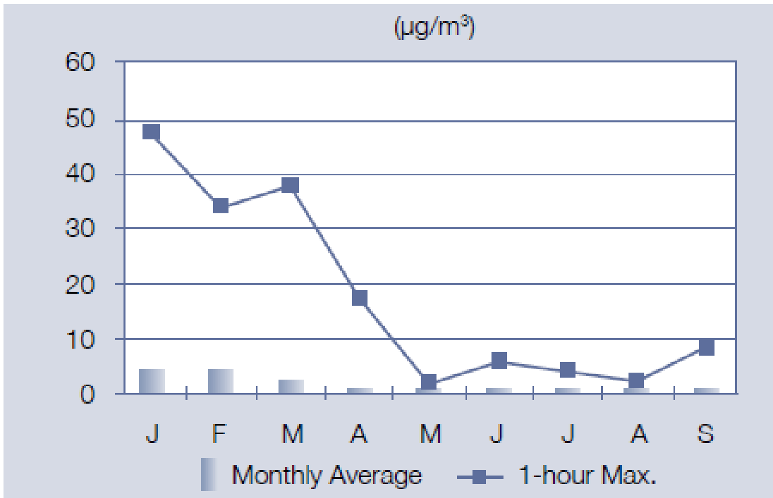


Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-10 shows that both the highest monthly averages and hourly concentrations occurred during the winter months, most likely caused by combustion of fuel for heating and idling vehicles. During the winter cold, calm days can also produce atmospheric inversions which can trap pollutants near the surface.

Figure 2.2-11 presents the monthly average and 1-hour maximum NO_x data collected in Inuvik in 2008. The highest monthly averages and the highest 1-hour maxima occurred in the winter months. Inuvik is prone to winter inversions having more inversion days than other areas.

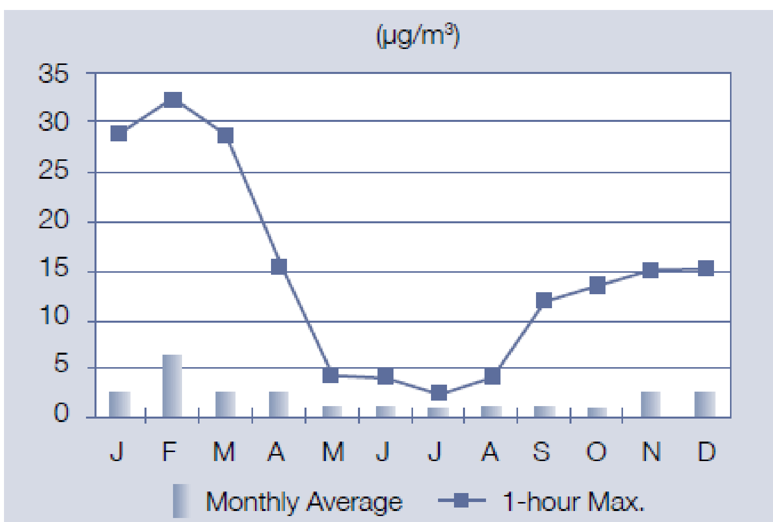
Figure 2.2-11
Summary of Inuvik 2008 NO_2 Data



Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-12 presents the 2008 monthly average and 1-hour maximum NO_x data collected in Norman Wells. There were no exceedances of the national standards for NO_2 in 2008. The annual average was 2 µg/m^3 and the maximum 1-hour average was 33 µg/m^3.

Figure 2.2-12
Summary of Norman Wells 2008 NO_2 Data



Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Why is it happening?
Following the closure of Giant Mine in late October 1999, SO_2 levels in Yellowknife have decreased significantly. The concentrations measured in 2004-2008 reflect naturally occurring SO_2, usually in the range of 1 to 3 µg/m^3, and small amounts from the burning of fossil fuels. Similar background levels were noted in Fort Liard, Norman Wells and Inuvik.

Measurements of nitrogen oxides show no exceedances of the relevant standards.

What does it mean?
Current SO_2 concentrations measured at four stations in the NWT indicated background (naturally occurring) levels of SO_2. Measurements from the NO_x analysers indicated similar background levels.

What is being done about it?
A sophisticated data acquisition system (DAS) and communications software has been in place since about 2005 that automatically transmits data every hour by telephone line and government Intranet to ENR headquarters in Yellowknife. This allows almost real-time review of the data by ENR staff. The data also undergoes a series of validity checks before being archived by ENR's data management, analysis and reporting system.

Starting in 2005, low-sulphur gasoline (that is gasoline with an average sulphur level of less than 30 mg/kg) was required throughout Canada. This level reduces the sulphur content of gasoline by more than 90% from current levels.

What are the information gaps?
Current monitoring data (from the four operating stations) is providing a good baseline for air quality in the NWT, for future development projects. The four permanent stations have significant distances between them. The air quality monitoring infrastructure is well established.

2.2.2.3 Ground Level Ozone

Ground level ozone (O_3) is not the same as stratospheric O_3, which occurs at much higher elevations and forms a shield that protects life on the planet from the suns harmful ultraviolet radiation. The gas is the same but, at ground level, O_3 is associated with a variety of human health concerns, environmental impacts and property damage. O_3 is a highly reactive gas and is defined as a secondary pollutant. This means that is not emitted in large quantities from any source, but rather is formed through a series of complex chemical reactions involving other pollutants called precursors (e.g. NO_x and volatile organic compounds or VOCs) in the presence of sunlight.

The national standards provide a Maximum Acceptable Level of 160 µg/m^3 for O_3 based on a one-hour average. The Canada-wide Standards (CWS) process has also set an acceptable limit of 65 ppb or 127 µg/m^3 based on an eight-hour average. The CWS eight-hour limit has been adopted under the NWT *Environmental Protection Act* as the NWT Ambient Air Quality Standard for O_3.

What is being measured?

Ozone has been monitored in Yellowknife since 1998.

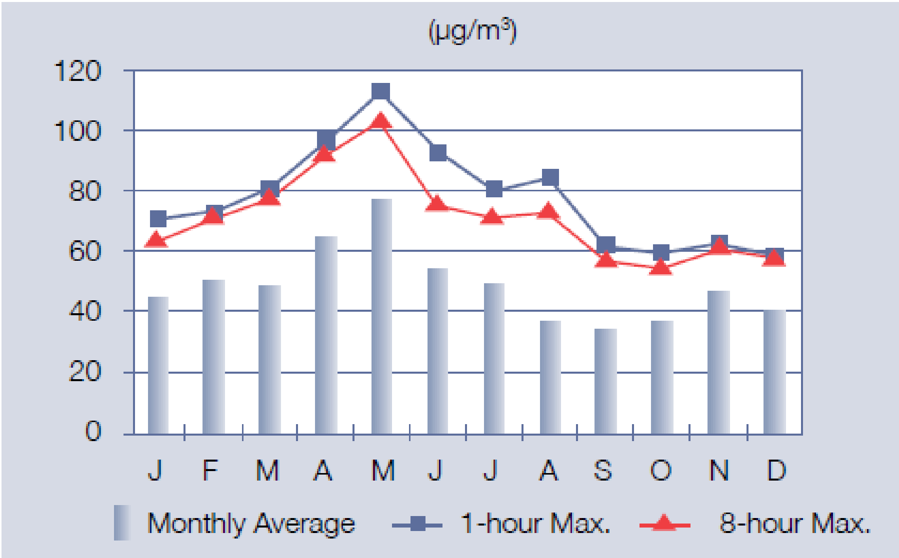
Figure 2.2-13 shows the monthly average and the 8-hour and 1-hour maxima for the Yellowknife station for 2008.

Figure 2.2-14 presents the monthly average and 8-hour and 1-hour maxima for the Inuvik station for 2008.

Figure 2.2-15 presents the monthly average and 8-hour and 1-hour maxima for the Fort Liard station for 2008. This was the first full year of data for this location.

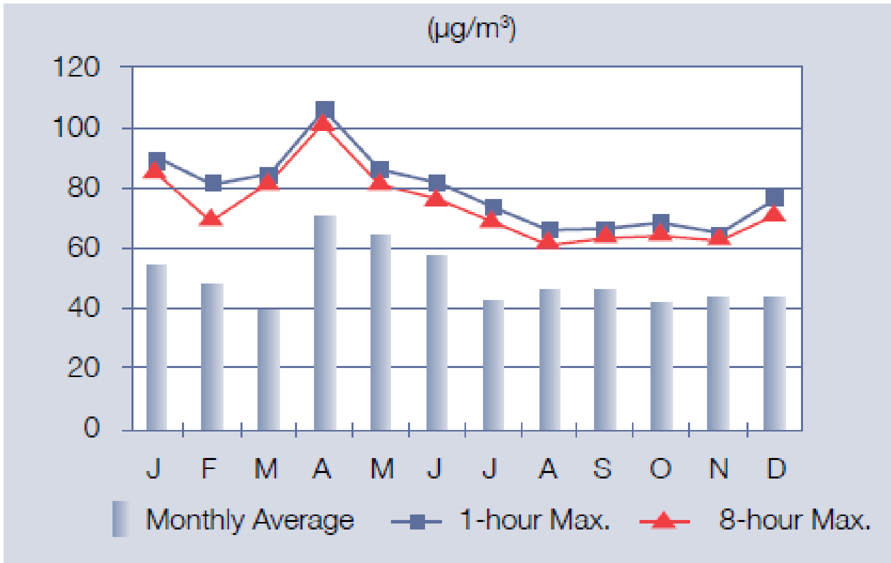
Figure 2.2-16 presents the monthly average and 8-hour and 1-hour maxima for the Norman Wells station for 2008.

Figure 2.2-13
Summary of Yellowknife 2008 O_3 Data



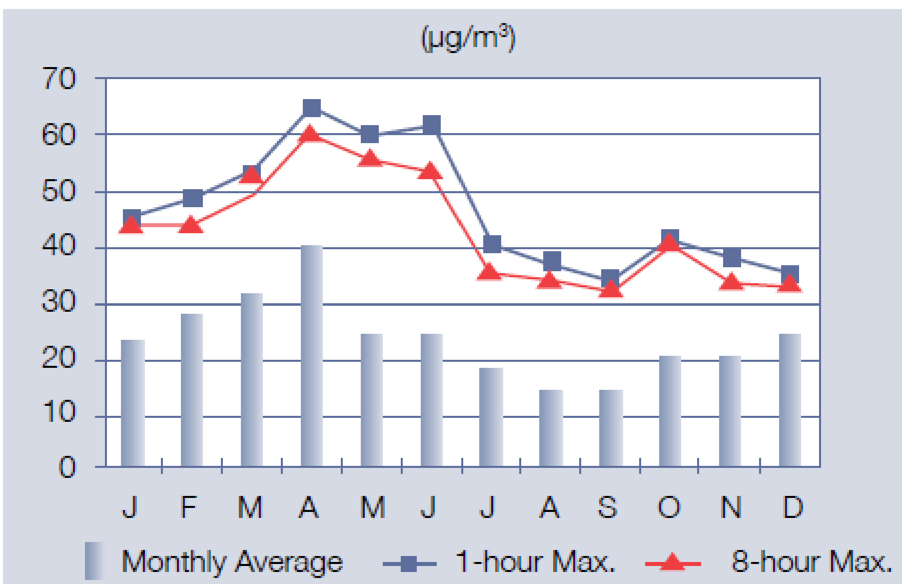
Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-14
Summary of Inuvik 2008 O_3 Data



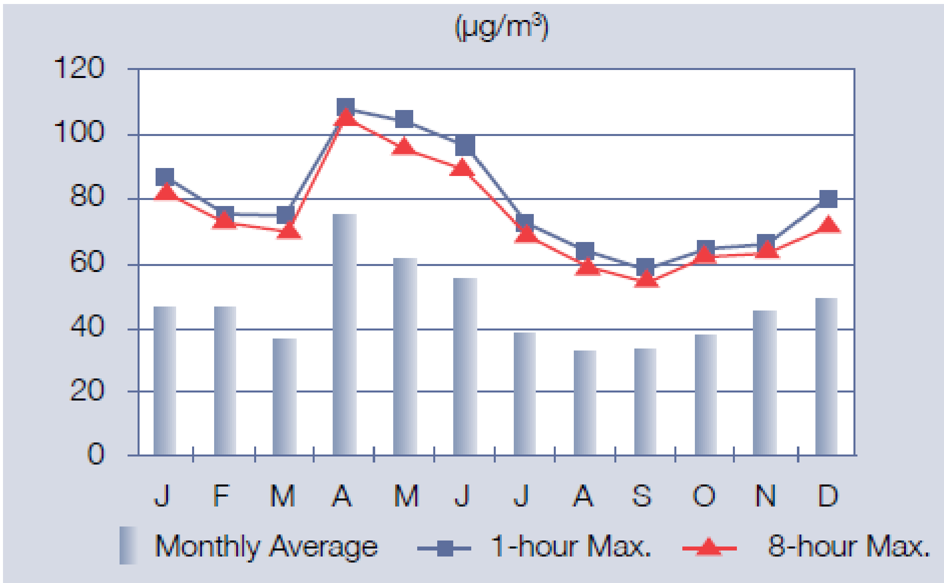
Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-15
Summary of Fort Liard 2008 O_3 Data



Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

Figure 2.2-16
Summary of Norman Wells 2008 O_3 Data



Source: Northwest Territories Air Quality Report 2008. GNWT, 2009

What is happening?
Neither the 1-hour national standard nor the 8-hour NWT standard was exceeded in 2008 at any of the four stations in the NWT. All stations show a late spring maximum which is typical of remote northern locations. All monthly averages are typical of background levels.

Why is it happening?
Typically in remote areas background levels of O_3 occur in the range from 40-80 $\mu g/m^3$. Downwind of large urban areas, ozone concentrations will be much higher because of the additional sources of precursor gases.

What does it mean?
All locations monitoring ozone are reporting what was expected to be found in remote northern locations.

What is being done about it?
No action is necessary.

What are the information gaps?
There are no information gaps with respect to ozone.

2.2.3 Other Air Quality Issues

The movement of weather systems in the Northern Hemisphere is such that the air moves towards the Arctic and eventually carries pollutants into Northern Canada. Subsequently, these pollutants become trapped in the cold temperatures and can enter the food chain. Local sources of air pollution in the Northwest Territories include electrical power generation from diesel engines, residential emissions from home heating, motor vehicle emissions and dust from gravel roads.

2.2.3.1 POPs and Heavy Metals

Legacy Persistent Organic Pollutants (POPs)

In general, the Canadian northern atmosphere contains lower levels of POPs than those found over most other circumpolar countries. Levels of most contaminants are declining slowly right across the circumpolar Arctic. The following definitions of Legacy POPs are presented to set the stage.

PCBs

Polychlorinated biphenyls (PCBs) are a group of chemicals that have been used in a number of applications including transformer and capacitor oils, hydraulic and heat-exchange fluids, lubricating and cutting oils, and as plasticizers and joint sealants. The manufacture and use of PCBs are banned under the Stockholm Convention but they are still present in some existing products, such as old electrical equipment. Countries have until 2025 to take action to phase out use of existing equipment with PCBs and have to eliminate or treat the recovered PCBs by 2028. The Convention also requires that countries take steps to limit emission of PCBs with the aim to eventually eliminate releases into the environment. PCBs have a range of toxic effects. The most significant is that they affect the immune system and disturb behaviour and reproduction in birds, fish and mammals. In the Arctic, they affect the polar bear population in particular. As one of the most ubiquitous pollutants, they also play a major role in impact of POPs on human health.

DDT AND DDE

DDT has been used widely to kill insects and is still used against mosquitoes to control malaria in some parts of the world. The Stockholm Convention limits the production and use of DDT to controlling disease. It also allows DDT as an intermediate in production of the pesticide dicofol in countries that have registered this exemption. Measurements often refer to DDE which is a toxic and persistent breakdown product of DDT. DDT-DDE affects sex hormones and thus reproduction. It has been identified as the major cause of egg-shell thinning and decline of populations of predatory birds such as the peregrine falcon. The decreasing levels in the environment have been important for the recovery of bird populations although the previous

AMAP assessment concluded that egg-shell thinning was still a concern for several bird populations.

CHLORDANE

Chlordane is used to control termites and is also used as a broad-spectrum insecticide for agricultural crops. The Stockholm Convention limits the production and use to narrowly prescribed purposes and to countries that have registered for exemptions. Chlordane affects reproduction and the immune system.

HCB

Hexachlorobenzene (HCB) is a past-use fungicide and has also been emitted to the environment as a by-product from the production of chlorinated pesticides, incineration, and metallurgical processes. The Stockholm Convention limits the production and use to narrowly prescribed purposes and to countries that have registered for exemptions.

HCHS

Hexachlorocyclohexane (HCH) comes in several different chemical forms (isomers). The gamma-isomer (γ-HCH) is the same as the insecticide lindane. Mixtures containing alpha (α-) and beta (β-) isomers were banned or its use was phased-out in the 1980s. Use of lindane has declined from the 1980s and 1990s. Canada, a major North American user, deregistered use of lindane in agriculture in 2004. Lindane has a range of toxic effects including effects on the nervous system, reproduction, and the immune system.

DIOXINS AND FURANS

Dioxins and furans are created as by-products in high-temperature processes, such as waste burning and metallurgical industries, and as trace contaminants in some herbicides and in PCB mixtures. The Stockholm Convention and the UN ECE LRTAP POPs Protocol regulate their emissions. The toxic mechanism is the same as for dioxin-like PCBs and includes effects on reproduction, the immune system and increased risk of cancer.

TOXAPHENE

Toxaphene is an insecticide that was widely used until the 1990s. Its use is regulated by the Stockholm Convention and the UN ECE LRTAP POPs Protocol.

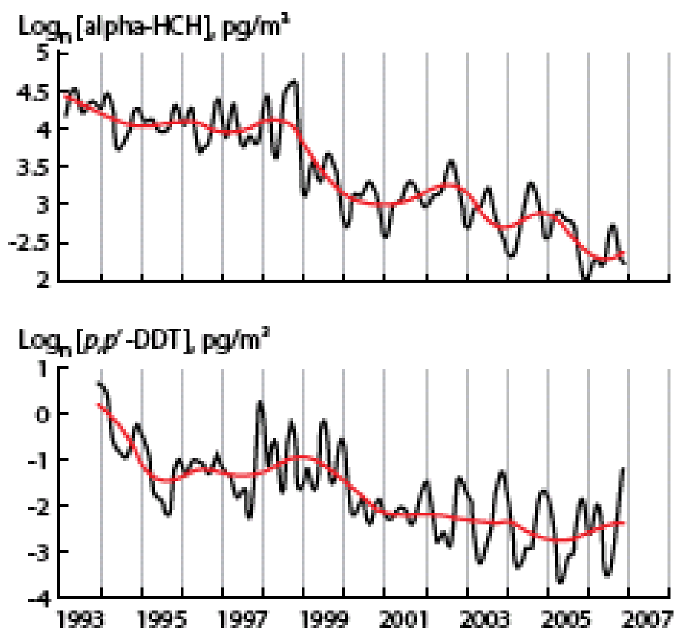
MIREX

Mirex was used as insecticide and fire retardant until 1978. It is regulated by the Stockholm Convention and the UN ECE LRTAP POPs Protocol.

Levels in Air and Time Trends

The atmosphere transports POPs from the areas where they are used to the Arctic. Polluted air masses only take a few days to travel several thousand kilometers. They are a major pathway for pollution into the region. Since the early 1990s, AMAP has systematically monitored levels of pollutants in Arctic air. The data are used for evaluating time trends contributing to the effectiveness and sufficiency evaluations of the Stockholm Convention and the UN ECE LRTAP POPs Protocol. They are also used to validate models helping to identify the sources of these pollutants. Continuous monitoring data are only available for PCBs, HCB and DDT. Three stations also report data for chlordane. As might be expected from their discontinued use, levels of legacy POPs in air are declining. Most PCBs decline with a half-life of less than 10 years. Some intermediate weight PCB congeners show longer half-lives (~20 years) at some locations in the Arctic. This mirrors the historical decline rates of PCB emission estimates derived from production and consumption data of PCBs from 1930 to 2000. The emission of lighter and heavier PCB congeners declines faster than intermediate congeners in the polar region. This indicates that the rates of decline in air concentrations of PCBs were mostly driven by declines in primary emissions. It is now understood, through modelling, that when primary emission stops, soil becomes the major global PCB reservoir and the rate of decline in air will depend solely on that emitted from soil. The half-lives of organochlorine pesticides (i.e. DDT, HCHs, chlordane) in Arctic air generally range from 3 to 16 years. Figure 2.2-17 gives some examples of time trends for POPs in the Arctic.

Figure 2.2-17
Time Trends of Two Pops in the Arctic



(Source: AMAP, 2009; page 26)

For some POPs, there are local variations in patterns over time which may be important. The most significant finding, and in contrast to the general declining trends, is that the levels of PCB, HCB and DDT have *increased* at the Zeppelin station during the four year period 2002-2006. A possible explanation is that climate change, along with changes in ocean currents, has led to declining ice cover and an ice-free western coast of Spitsbergen (Svalbard, Norway) during the winters of 2003 to 2006. The open water may have allowed POPs that have previously been trapped in the ocean water to escape to the air. For some POPs, the Arctic Ocean has been a sink for global emissions. If, or when, the sea ice disappears, this store of old POPs may become an important source to the atmosphere long after direct releases into the environment have ceased. This is suspected to be happening for alpha-HCH, which shows higher levels in Arctic air when the ice breaks up. Its chemical signature confirms that the "extra" alpha came from the sea, not from long-range transport. Climate change may thus delay the policy actions against POPs.

Another anomaly is episodes of increased levels of PCBs in air at Zeppelin Station in July 2004 and spring 2006. These were possibly caused by boreal forest fires in Yukon/Alaska and agricultural fires in Eastern Europe, respectively, where the biomass burning enhanced volatilization of previously deposited organic chemicals, such as PCBs, from soil. Similarly, episodes of chlordane and DDE were observed at Alert and Zeppelin in 2004, which may also be the result of biomass burning. Thus, changes in local climate regimes, such as that at Zeppelin (Svalbard), may already be affecting temporal trends. Increased frequencies of forest fire events at northern latitudes due to climate change may also result in enhanced input of pollutants to the Arctic. The overall message in terms of temporal trends is that the legacy POPs are declining in air but that this decline may be complicated by climate change via e.g. decreasing sea-ice coverage and an increase in forest fire events. Change in pesticide use, such as an increase of use of chlorothalonil and quintozene which are contaminated with HCB (a legacy POP), may be another complicating factor (AMAP, 2009).

Emerging and Current-Use Pops

Many chemicals in commercial use today have the potential to transport to and accumulate in the Arctic but are not yet regulated by international agreements. Although knowledge about these chemicals in the Arctic remains much more limited than for legacy POPs, new monitoring efforts have extended the information concerning their presence in the Arctic. This information is relevant to ongoing consideration of new chemicals for inclusion under existing national, regional and global agreements to regulate use and emissions of POPs. Many of these compounds transport over long distances and accumulate in Arctic food webs. New knowledge highlights the potential importance of ocean transport pathways. In contrast to atmospheric pathways ocean currents are slow. This may delay the environmental response to regulations (AMAP, 2009). Compounds that have some POP characteristics and that are documented in the current AMAP assessment include:

BROMINATED FLAME RETARDANTS (BFRS)

The current AMAP assessment (2009) includes new information on three groups of chemicals used as flame retardants: polybrominated diphenyl ethers (PBDEs) (including Penta-, Octa and Deca-BDEs), Hexabromocyclododecane (HCBD) and tetrabromobisphenol-A (TBBPA). The assessment shows that: Penta-BDE transports over long distances and bioaccumulates in biota. Penta-BDE and Octa-BDEs have been banned / restricted in Europe, and parts of North America. They are no longer produced in Russia and use there is very limited. Penta-BDE and Octa-BDEs are under consideration for inclusion under the international Conventions regulating POPs; Deca-BDEs are now restricted in the EU. HBCD is ubiquitous in the Arctic. It undergoes long-range transport and accumulates in animals. It has also been proposed as a candidate for inclusion under international regulations. There is some evidence that environmental levels of Penta- BDE are now starting to level off or decline due to national regulations and reductions in use and production. TBPPA is present at low levels in several Arctic animals and plants, but more data are needed to assess its potential to undergo long-range transport. Some BFRs that are used as substitutes for phased-out substances have been detected in occasional Arctic samples. Their presence in the Arctic is a warning sign that they may have some POP characteristics (AMAP, 2009).

FLUORINATED COMPOUNDS

Fluorinated compounds reach the Arctic both through the atmosphere and on ocean currents. They are extremely persistent and accumulate in animals that are high in the marine food web. Production of products containing perfluorooctane sulfonate (PFOS) was substantially reduced in 2001, but PFOS continues to be produced in China. Products that contain PFOS and other fluorinated compounds can still serve as sources to the environment. PFOS and related compounds are currently subject to review for both international and national regulation. Perfluorooctanate (PFOA) and other perfluorocarboxylates (PFCAs) continue to be produced. Fluorinated substances can also degrade to PFOA and other PFCAs. Canada is the only Arctic country so far to ban some import and manufacture of several products that are suspected to break down to PFOA and PFCAs. Precursors of PFOS and PFCAs have been detected in Arctic air and may be a source of PFOS and PFCAs in Arctic wildlife. Concentrations in Arctic air are one order of magnitude lower than in more southern, urban regions. Time trends of PFOS in wildlife show an initial increase starting in the mid-1980s. In recent years, some studies show a continuing increase while others show a sharp decline. The declines follow reduction in PFOS production. PFCAs have increased in Arctic wildlife since the 1990s, reflecting continued production of their precursors (AMAP, 2009).

POLYCHLORINATED NAPHTHALENES

Polychlorinated naphthalenes (PCNs) are no longer manufactured and levels in the environment peaked almost half a century ago. However, PCNs are still present in the Arctic with indications of further input from a combination of combustion sources and emission from old products. There are no studies to assess their temporal trends in the Arctic. They contribute to dioxin-like toxicity in Arctic animals but are generally much less important than PCBs (AMAP, 2009).

ENDOSULFAN

Endosulfan is a pesticide that is still in use in many parts of the world. Endosulfan and its breakdown products appear to be persistent in the environment. The presence of endosulfan in the Arctic confirms its ability to transport over long distances. There is clear indication of bioaccumulation in fish but there is no evidence for biomagnification by marine mammals. Long-term trend analysis of samples taken at Alert (Ellesmere Island, Canada) indicates that endosulfan concentrations have remained unchanged in the remote Arctic atmosphere, unlike most legacy POPs. Calculations based on air and seawater concentrations suggest that endosulfan enters open (i.e. ice-free) waters of the Arctic Ocean. The limited information available in wildlife indicates that concentrations of endosulfan and its breakdown product endosulfan sulphate in blubber of marine mammals are an order of magnitude lower than those of major legacy POPs such as DDT and chlordane. Endosulfan is currently under discussion for inclusion under the UN-ECE LRTAP POPs Protocol and the Stockholm Convention (AMAP, 2009).

OTHER CURRENT-USE PESTICIDES

Previous AMAP assessments have highlighted lindane (gamma-hexachlorocyclohexane [HCH]) as a current-use pesticide that is ubiquitously present in the Arctic. Several other current use pesticides (including chlorpyrifos, chlorothalonil, dacthal, diazinon, diclofol, methoxychlor, and trifluralin) have been detected in the Arctic. The levels are often low, but their presence shows that they can transport over long distances and accumulate in the food web (AMAP, 2009).

Heavy Metals

In general, the Canadian northern atmosphere contains lower levels of heavy metals than those found over most other circumpolar countries. Levels of most contaminants are declining slowly right across the circumpolar Arctic.

Mercury is listed as a "toxic substance" under the Canadian Environmental Protection Act. It is a liquid heavy metal that can volatize into the air and be carried by the atmosphere all over the world. In Canada, airborne mercury emissions come mainly from coal-fired power plants in the United States and base metal smelting plants and incinerators in Canada.

Scientists have concluded that in Canada and the United States, mercury originates from both domestic and international sources and is deposited in sensitive ecosystems. Mercury is found in many lakes, streams, forests and fields. It can convert to a very toxic and bioaccumulative form known as methyl mercury -- a substance that can affect both humans and wildlife. For example, methyl mercury levels in traditional foods in northern Canada are above those established as acceptable by the World Health Organization.

Cole and Steffen (2010) analyzed gaseous elemental mercury (GEM) measurements at Alert, Canada, from 1995 to 2007 for statistical time trends and for correlations with meteorological and climate data. A significant decreasing trend in annual GEM concentration is reported at Alert, with an estimated slope of −0.6% per year over the 13-year period. The paper showed that there has been a shift in the month of minimum mean GEM concentration from May to April due to a change in the timing of springtime atmospheric mercury depletion events (AMDEs). These AMDEs are found to decrease with increasing local temperature within each month.

Atmospheric elemental mercury measurements show a significant decrease in local GEM concentration over the period 1995–2007 in every month except May. This is the first time that a significant annual trend has been reported at this long-term monitoring site. The results presented by Cole and Steffen provide additional information about the conditions for both low and high concentrations of atmospheric mercury based on multi-year high-resolution observations. A month-by-month analysis revealed a robust correlation between local temperature and depletion events at Alert. While this correlation could indicate a potential decrease in AMDEs with increasing temperatures in the future, until the mechanism for the temperature effect is known this correlation is primarily useful as a guide to refining the parametrization in models. Cole and Steffen advise caution in extending that relationship into future Arctic conditions that deviate significantly from what has been experienced in recent history. Other parameters, such as local wind speed, total sea ice area, and climate indices, did not correlate with AMDEs. Wind direction was an important factor in both depletion and emission events observed at Alert.

Recommendations for Future Actions

AMAP, 2009 makes a series of recommendations to address gaps in knowledge concerning human health related to POPs and metals. The ones relevant to the NWT are as follows:

Monitoring

- *Continue and extend the laboratory intercomparison and testing schemes introduced and promoted by AMAP for laboratories engaged in analysis of Arctic human media to cover emerging POPs. The quality assurance group for the human health program should approve all data that is used in AMAP human health assessments;*
- *Continue to monitor for trends in legacy POPs, mercury, and lead in human tissues and traditional food items. Dietary assessments should combine contaminant and nutrient analyses in traditional foods as consumed;*
- *Conduct further studies combining dietary assessments with contaminant and nutrient analyses in the traditional foods as consumed;*

- *Continue and expand monitoring for emerging POPs in human tissues and traditional food items, including development of analytical methods; and*
- *Continue gathering basic health statistics on a regular basis by all circumpolar jurisdictions at appropriate regional levels.*

Research

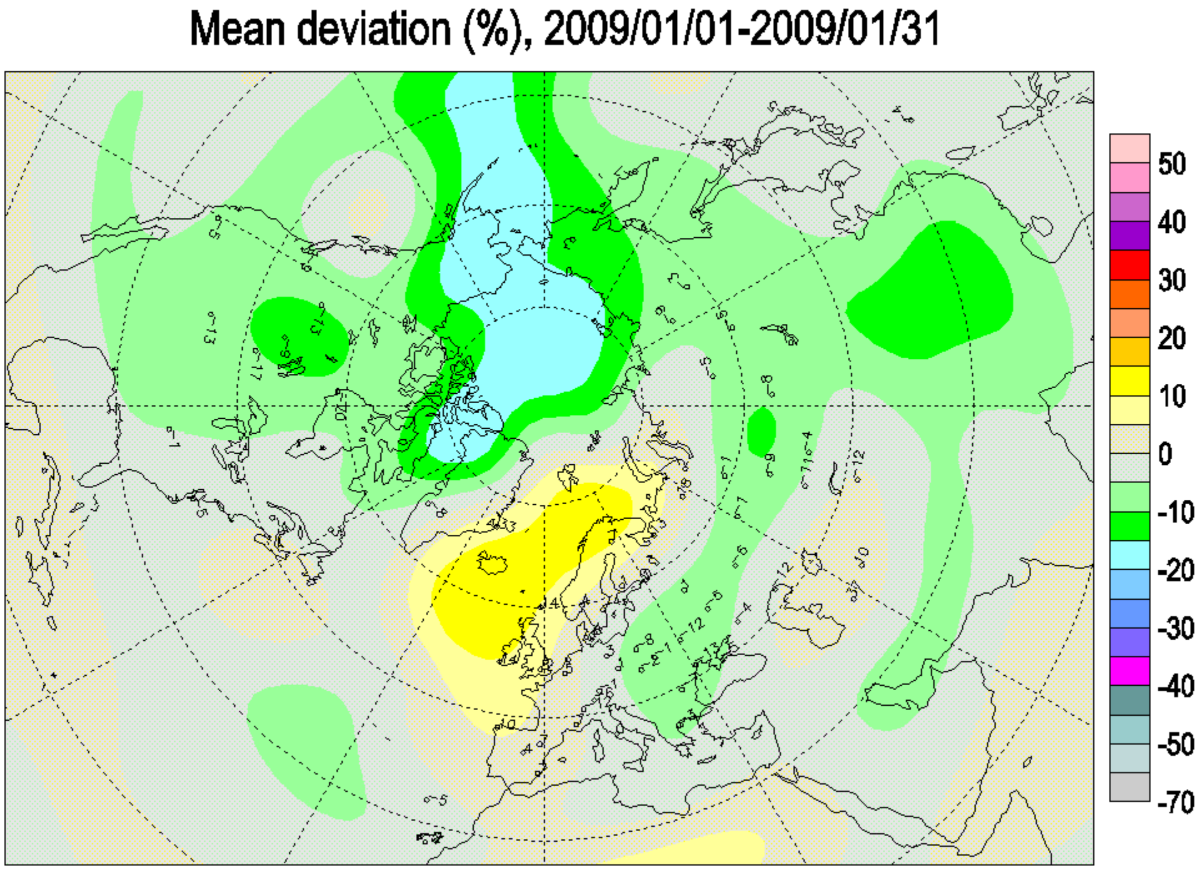
- *Maintain and expand current human population cohorts in the Arctic in order to provide the information needed to track adverse health outcomes associated with contaminants and changing conditions related to climate change, socio-cultural conditions, and diet;*
- *Conduct further research on contaminant effects in humans, including interaction between POPs and mercury and other factors such as genetic susceptibility, diet, and lifestyle, and the resulting health impacts on the cardiovascular, reproductive, neurological or metabolic systems;*
- *Conduct further studies to determine causes of regional variations and discrepancies in exposure to contaminants;*
- *Conduct further toxicological studies of POPs mixtures, and emerging compounds where a lack of information is limiting human health risk assessment; and*
- *Conduct further studies on risk perception, dietary patterns, and determinants of food choice to improve risk communication.*

2.2.3.2 Stratospheric Ozone

The depletion of the stratospheric ozone layer is mainly caused by chlorine- and bromine-bearing compounds such as chlorofluorocarbons (CFCs), bromofluorocarbons (halons), hydrochlorofluorocarbons (HCFCs), carbon tetrachloride, methyl chloroform and methyl bromide. In addition, however, gases such as methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) can have both direct and indirect effects on the ozone layer. Since the ozone layer is largely responsible for filtering out the solar UV-B radiation, projected long-term trends in decreasing concentrations of ozone in the atmosphere have led to concerns about potential future increases in skin cancers and cataracts, as well as concerns about ecological effects such as decreased primary production in terrestrial ecosystems, altered plant species composition, altered secondary chemistry with implications for herbivores, litter decomposition and biogeochemical cycles.

The Canadian Ozone and UV Measurement Program run by Environment Canada (http://exp-studies.tor.ec.gc.ca/cgi-bin/selectMap) has a mapping feature that allows the user to produce ozone maps. Figure 2.2-18 shows the deviation, in Dobson units, from the 10-year ozone normal (1978-1988) in 2009 in the northern hemisphere. The average ozone levels over the NWT in 2009 ranged from 325 to 375 Dobson units.

Figure 2.2-18
2009 Mean Deviation of Column Ozone from the 1978-1988 Normal



The figure shows a 5-15% decrease over the Northwest Territories from the 1978-1988 ozone normal.

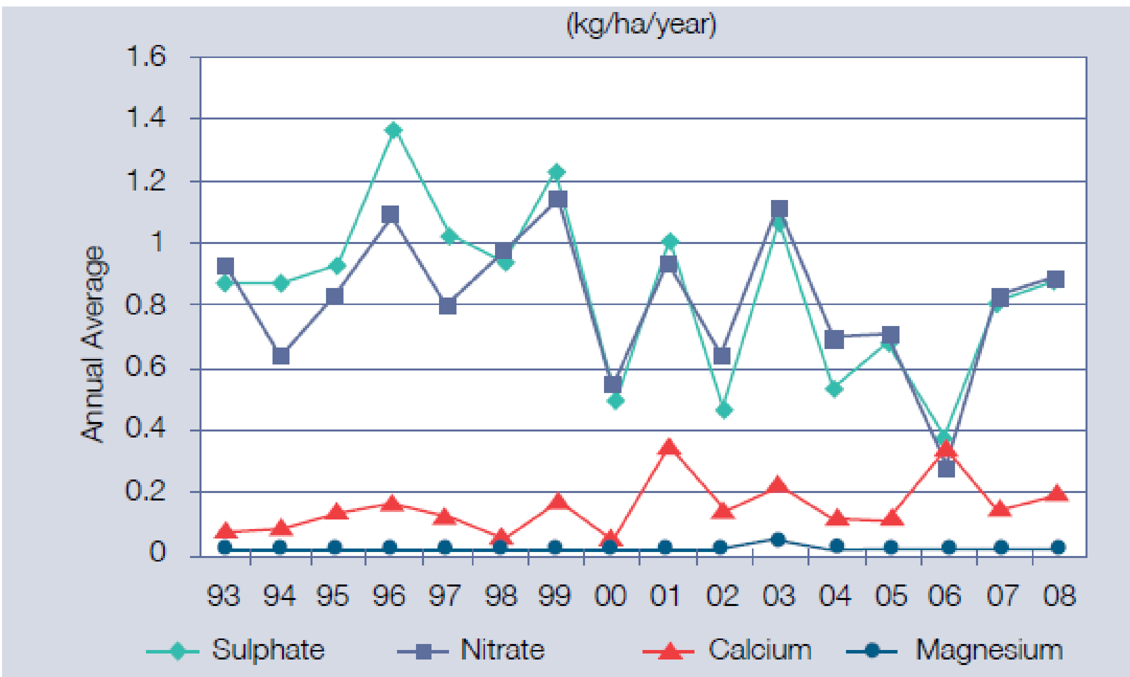
2.2.3.3 Acid Deposition

Acid deposition refers to the dry deposition of acidic compounds (in gaseous or particulate form), as well as the wet deposition of acidic compounds in rainwater, fog water and snowfall. Since 1989, ENR has operated a Canadian Air and Precipitation Monitoring Network (CAPMoN) station at the NWT Power Corporation's Snare Rapids hydro site.

SO_2 and NO_x emissions can result in an increase in acidic compounds in the atmosphere, often in areas far removed from the original emission sources. The removal of these sulphur and nitrogen compounds through atmospheric washout is reflected in the increased acidity (lower pH values) of precipitation. Calcium and magnesium ions, mostly from natural sources, act to neutralize acidity in precipitation. Assessment of acid precipitation is usually based on deposition to an area over a specified time period (e.g., kilograms per hectare per year, kg/ha/yr).

Figure 2.2-19 shows the deposition rates of certain ions measured in Snare Rapids precipitation between 1993 and 2008. While the magnesium deposition rate has remained relatively constant, calcium has started to rise slightly since 2000. Both sulphate and nitrate deposition rates show a decrease over the period of record but with a lot of year-to-year variability. Sulphate and nitrate deposition rates remain well below levels that could cause an environmental effect in sensitive ecosystems (7 kg/ha/year).

Figure 2.2-19
Acid Deposition at Snare Rapids



Source: Northwest Territories Air Quality Report 2008. GNWT, 2009)

2.3 CLIMATE

2.3.1 Introduction

Climate can be defined as the average weather that occurs in a specific area over a period of time. The northern and arctic areas of Canada experience the coldest and driest weather in the country. From 1948-2007, this area has also seen some of the largest increases in temperature, increasing by 2.1 degrees C in the Mackenzie District (Statistics Canada, 2009). This rate of change (+0.035ºC/year) will have profound effects on the Northwest Territories.

2.3.2 Climate Indicators

The key indicators of climate that are addressed in this SOE and the rationale for their selection are presented in Table 2.3.1.

Table 2.3.1
Rationale for Selection of Indicators of Climate Valued Component

Valued Component	Key Indicators	Rationale
Climate	**Temperature**	• long temperature record available in the North (50+ years) • direct local impacts on humans and the ecosystem
	Precipitation	• reasonable precipitation record (not as reliable as temperature record) • direct local impacts on humans and the ecosystem

2.3.2.1 Temperature

The near-surface temperature controls the reaction rate of contaminants as well as how fast the surface dries out. If the temperature is low, the moisture in the surface may stay there or it may even freeze, sealing the surface from the effects of wind erosion, thereby reducing wind-blown dust. Temperature near the surface also controls the buoyant component of turbulence (vertical motion). Heat from the earth's surface heats the air near the ground, causing it to rise. This mechanism reaches a maximum in the early afternoon, and a minimum near sunrise.

i) What is being measured?

Temperature records date back to about 1930 for most of the Canadian Arctic (some stations began in 19th century or early 20th century, e.g., Hay River, Fort Selkirk and Fort Simpson, Northwest Territories). For the purposes of this report, data from four (4) stations across the NWT were examined.

ii) What is happening?

Figures 2.3-1 to 2.3-4 show the climate normals (1971-2000) in monthly mean temperature for four stations across the NWT, Norman Wells A, Yellowknife A, Inuvik A and Fort Liard A, respectively. Temperatures across the NWT range from a mean daily maximum of 23°C in July to a mean daily minimum of -32°C in January/February.

Figure 2.3-1
Climate Normal - Norman Wells A – Monthly Mean Temperatures

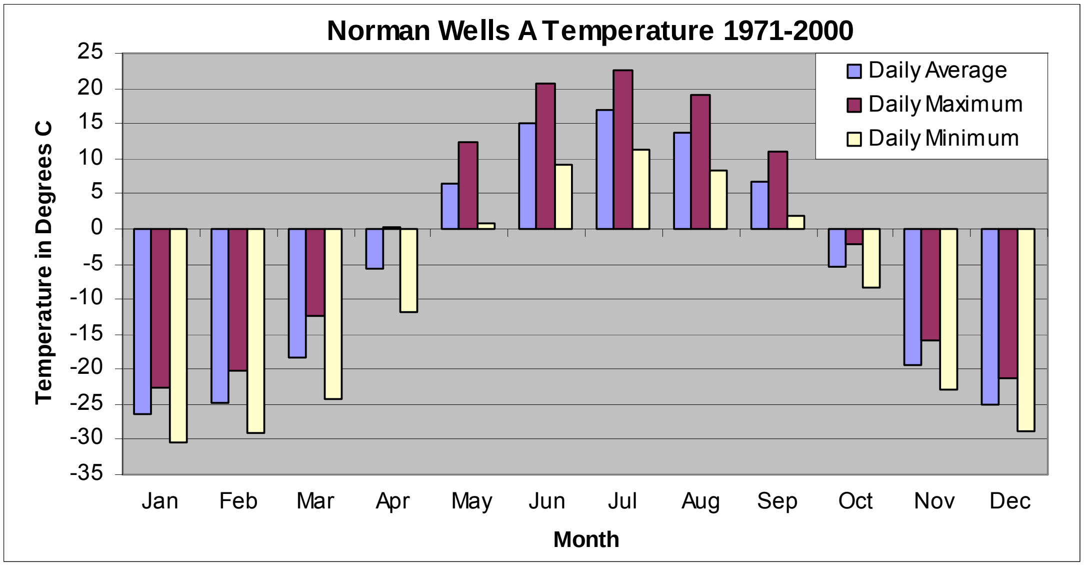


Figure 2.3-2
Climate Normal - Yellowknife A – Monthly Mean Temperatures

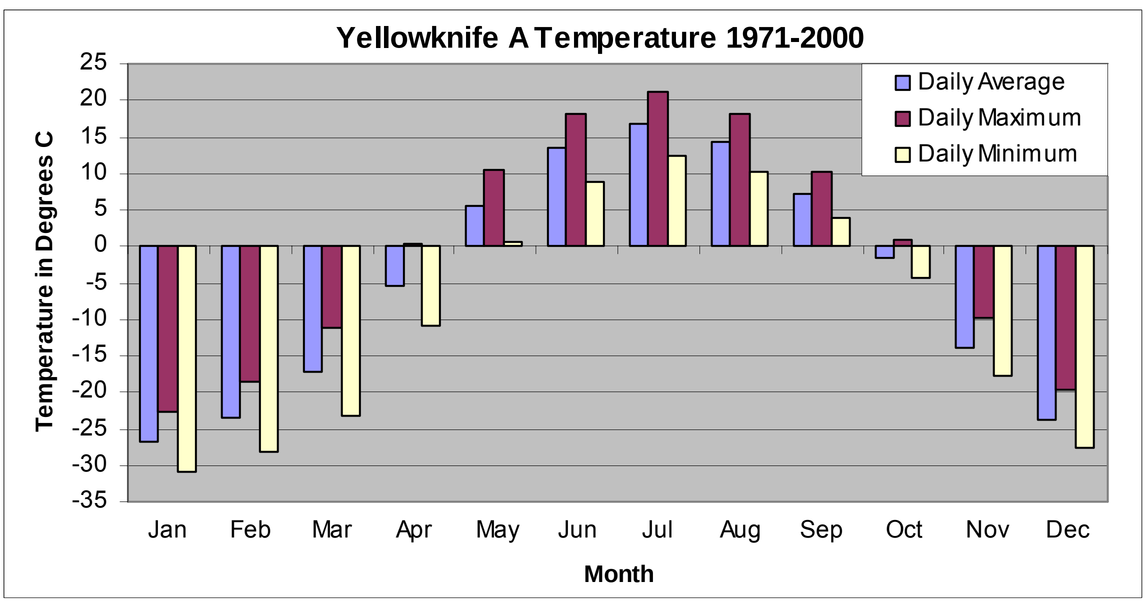


Figure 2.3-3
Climate Normal - Inuvik A - Monthly Mean Temperatures

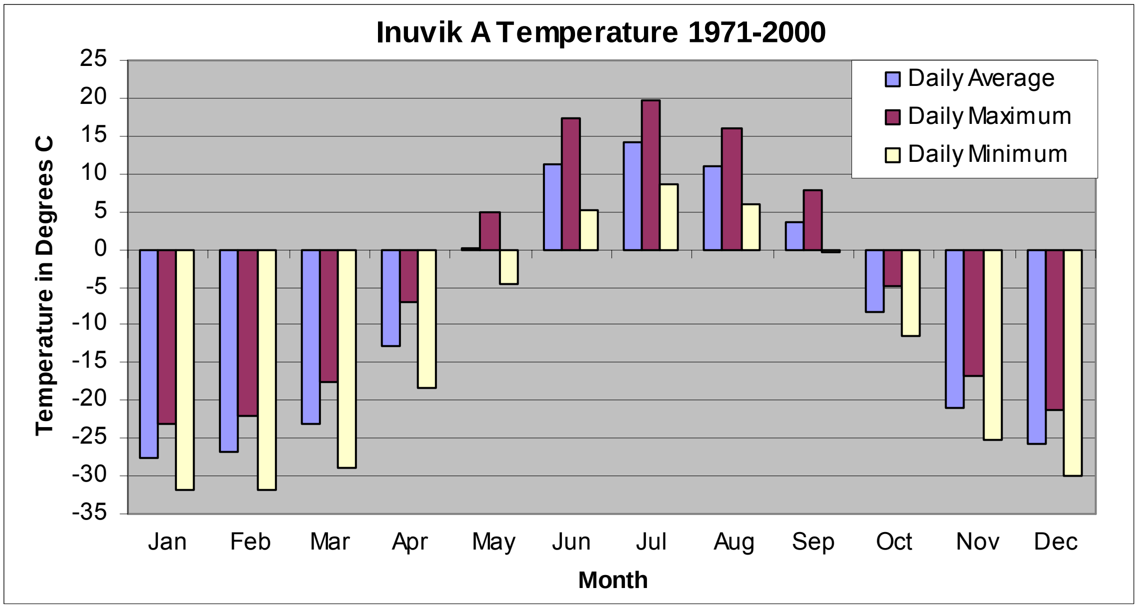
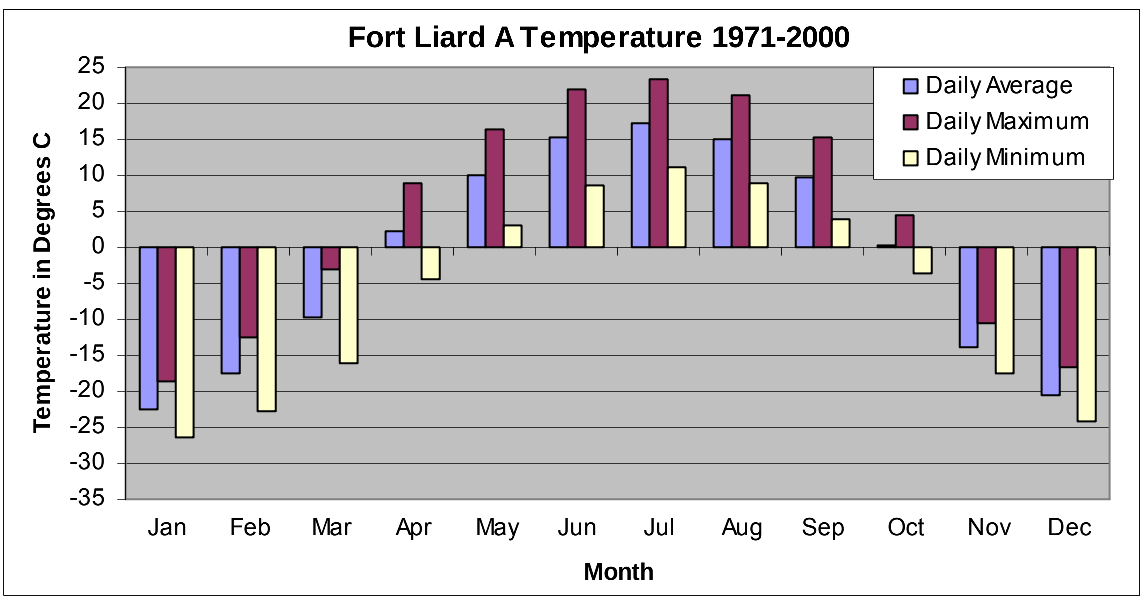


Figure 2.3-4
Climate Normal - Fort Liard A – Monthly Mean Temperatures



Figures 2.3-5 through 2.3-8 present the long term temperature trends for the same four stations. All four stations show a trend of increasing temperature by 1 to 3 degrees C over time. The largest change in temperature has occurred in Inuvik.

Figure 2.3-5
Norman Wells A - Temperature in Degrees C Trend

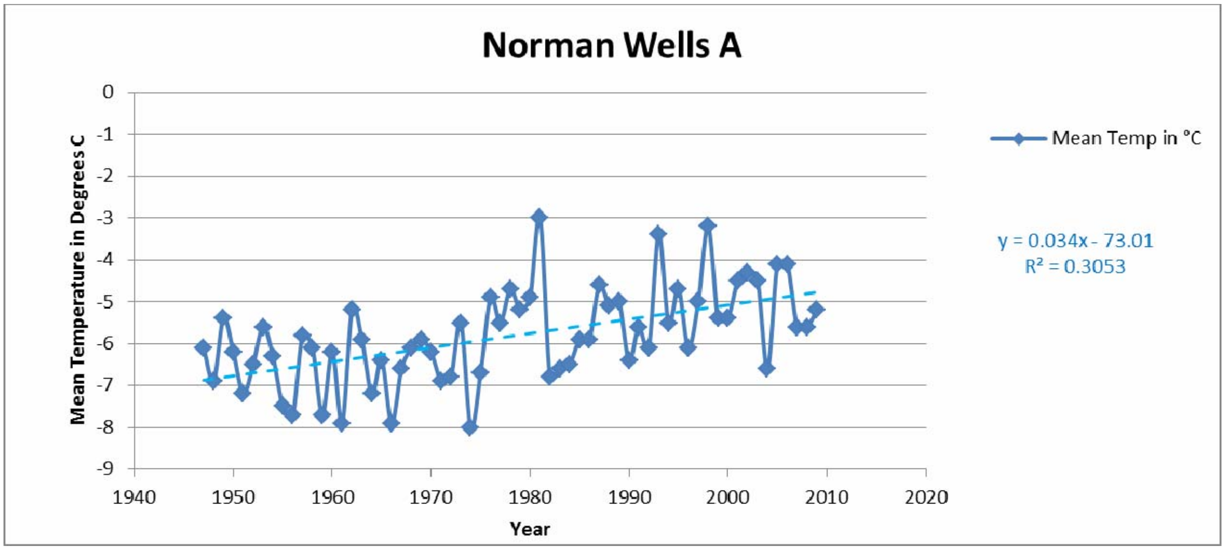


Figure 2.3-6
Yellowknife A - Temperature in Degrees C Trend

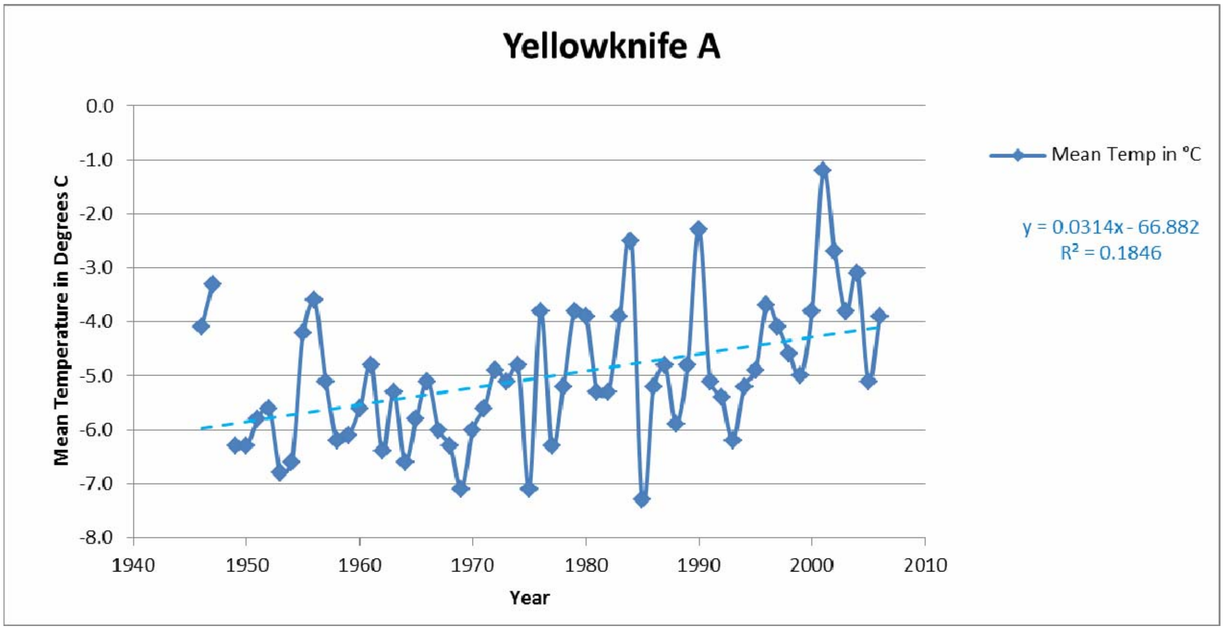


Figure 2.3-7
Inuvik A - Temperature in Degrees C Trend

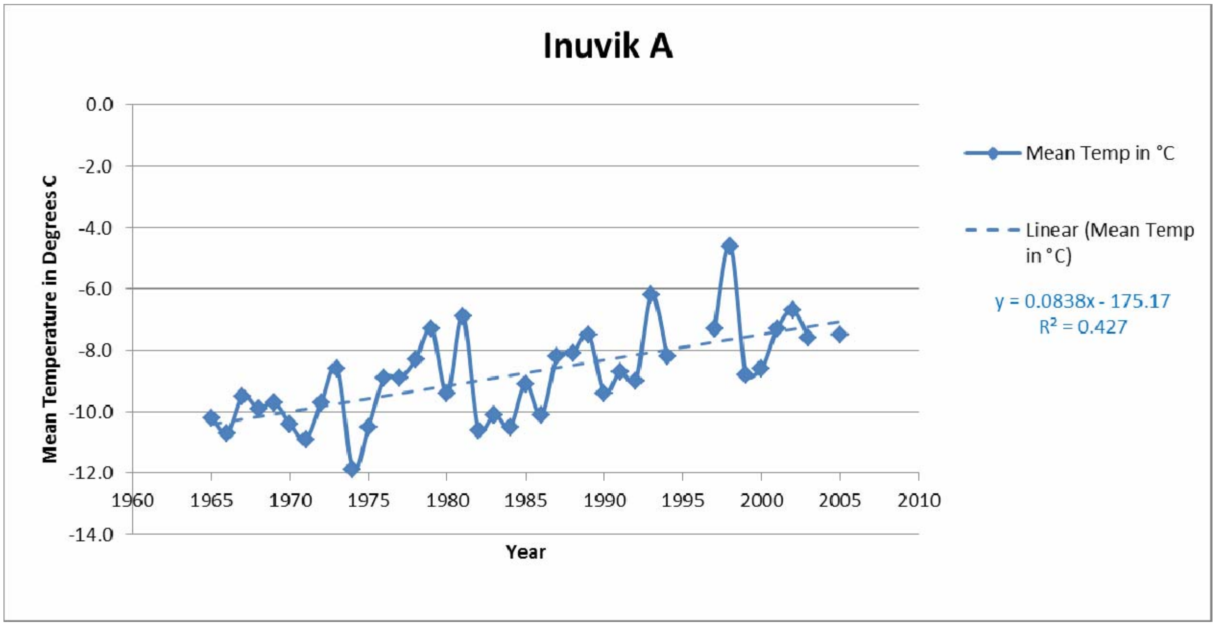
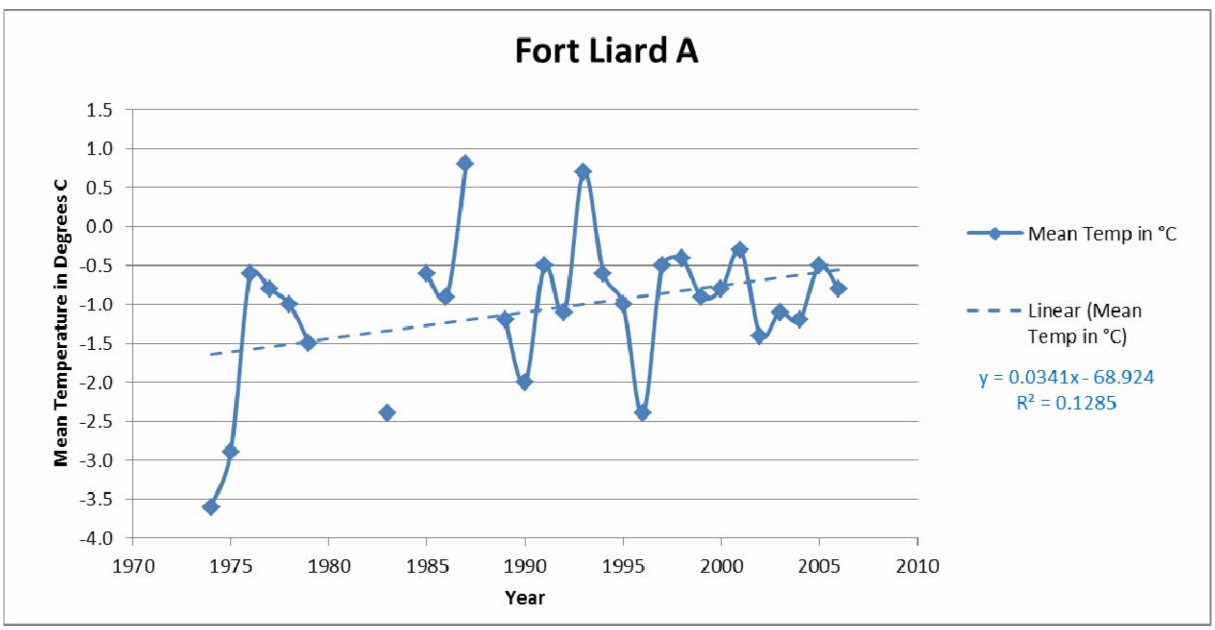


Figure 2.3-8
Fort Liard A - Temperature in Degrees C Trend



Why is it happening?
Increases in global mean temperatures have been predicted as a result of increases in atmospheric greenhouse gases generated by human activities. These changes have been predicted to be greatest in the polar region. Temperature changes may also result from natural climate variations, such as the decrease in temperatures that brought about the "Little Ice Age" cooling period in the 19th century for much of the northern hemisphere.

What does it mean?
Changes in global and regional climate have important implications for many aspects of the environment. In the North, temperature warming may bring about changes in sea, lake and river ice, snow conditions, permafrost, habitat for plants and animals, occurrence and distribution of species, and other changes. For human communities, this may mean changes in agricultural productivity, sustainable harvesting and hunting levels, heating fuel consumption, and patterns of land use. These effects may be either beneficial or harmful, and vary from region to region.

What is being done about it?
Annual variability in mean temperatures is shown to be up to 3 degrees, and the detection of trends in climate generally requires long-term data sets. The data presented here is for the complete period of record available at the four stations selected. Individual communities in the NWT, like Délı̨nę, are starting to make there own measurements as well as using state-of-the-science weather models to retrospectively examine weather trends over an historical period.

What are the information gaps?
With the new generation of weather models that are capable of recreating accurate hour-by-hour weather on a fine scale (4x4 kilometres or less) a very dense examination of climate over the recent past (10 years) could be created at a reasonable cost as a baseline from which future changes could be measured. An example of such a database was completed for the Great Bear Lake region in 2010 (SENES, 2010).

2.3.2.2 Precipitation

Precipitation plays a role in both control of emissions and removal of pollutants from the air. For example, low precipitation will leave a soil surface mostly dry, and susceptible to wind erosion, whereas a lot of precipitation effectively seals the surface. Dew will effectively hold dust on the ground in the early morning. The contaminants in the air are washed out by precipitation - more precipitation produces more washout.

What is being measured?
About 65 precipitation gauges throughout Northwest Territories and Nunavut are monitored by Environment Canada (Isaac 1998); precipitation records go back to 1893 for Hay River, Northwest Territories.

What is happening?

Figures 2.3-9 to 2.3-12 show the climate normals (1971-2000) in monthly mean precipitation for four stations across the NWT, Norman Wells A, Yellowknife A, Inuvik A and Fort Liard A, respectively. Total monthly precipitation can be as high as 85 mm in August and as low as 13 mm in January. There are extreme cases of total daily precipitation being as high as 100mm.

Figure 2.3-9
Climate Normal - Norman Wells A – Monthly Precipitation

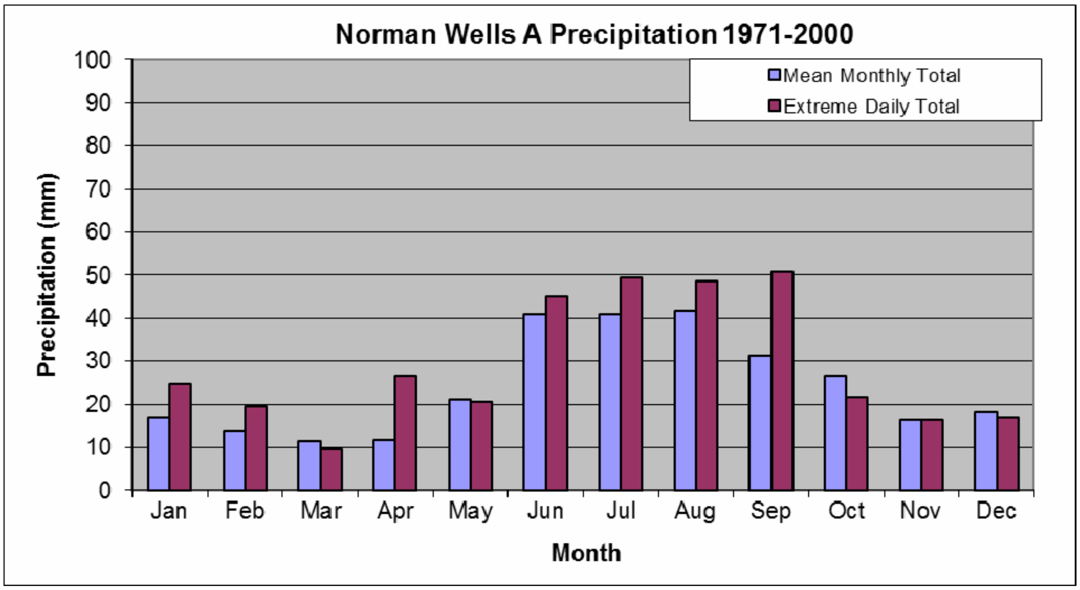


Figure 2.3-10
Climate Normal - Yellowknife A – Monthly Precipitation

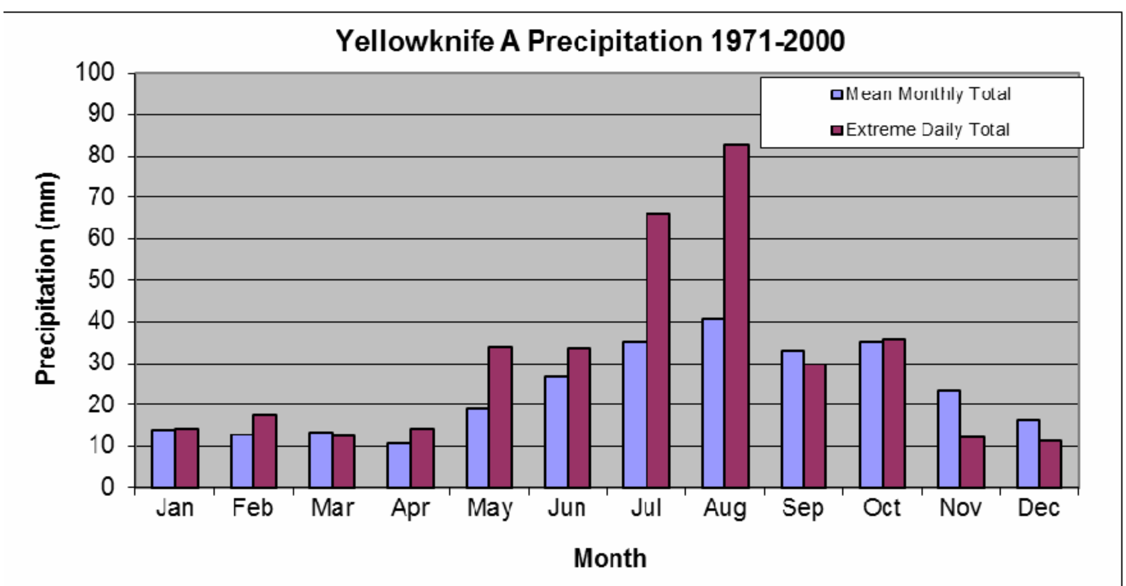


Figure 2.3-11
Climate Normal - Inuvik A – Monthly Precipitation

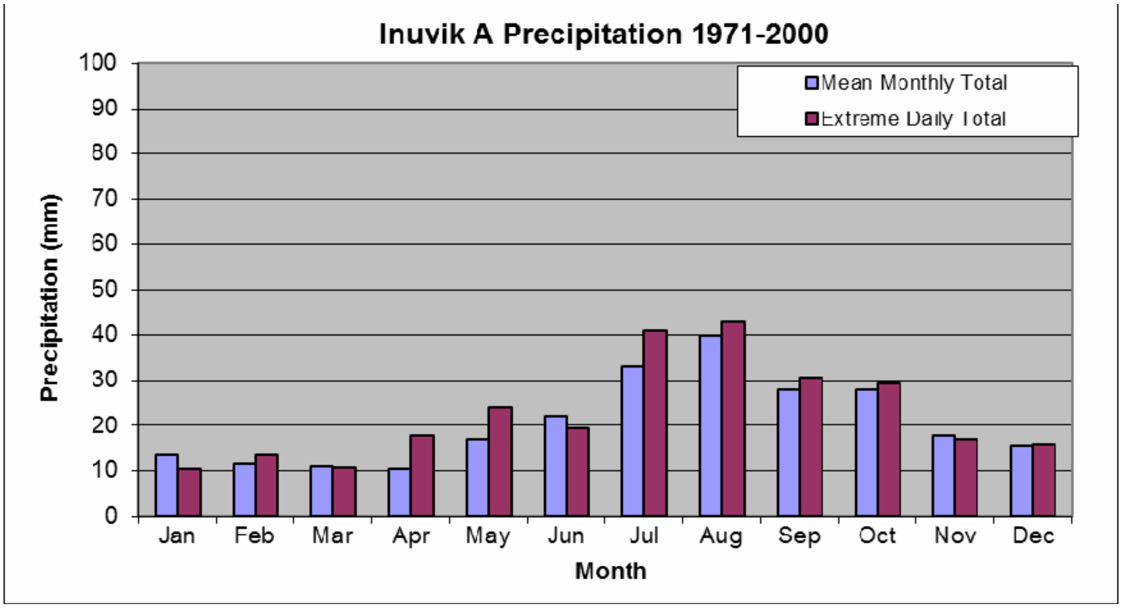
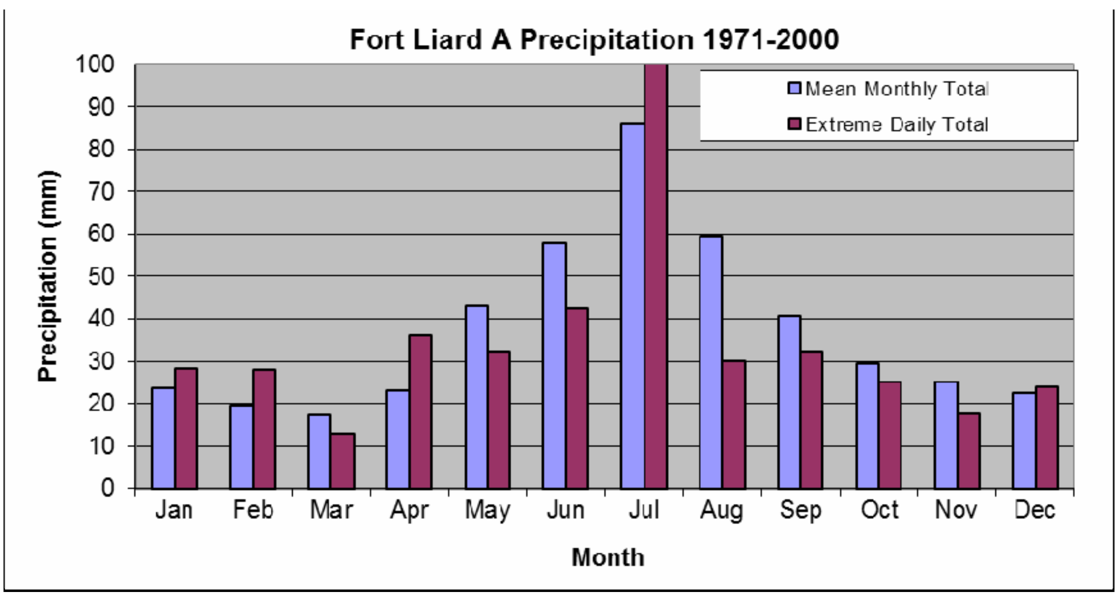


Figure 2.3-12
Climate Normal - Fort Liard A – Monthly Precipitation



Figures 2.3-13 to 2.3-16 present the period of record precipitation totals by year as well as the breakdown between rainfall and snowfall. The trends show both increases (Yellowknife), decreases (Norman Wells) and essentially no change (Inuvik and Fort Liard). All stations examined show significant year-to-year variability.

Figure 2.3-13
Norman Wells A – Precipitation Trend

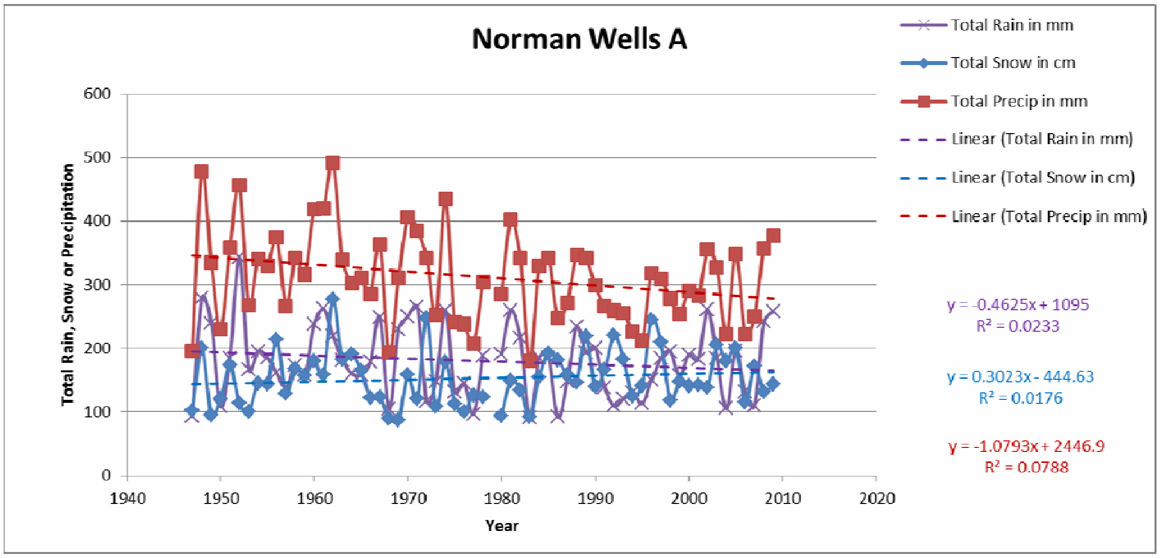


Figure 2.3-14
Yellowknife A - Precipitation Trend

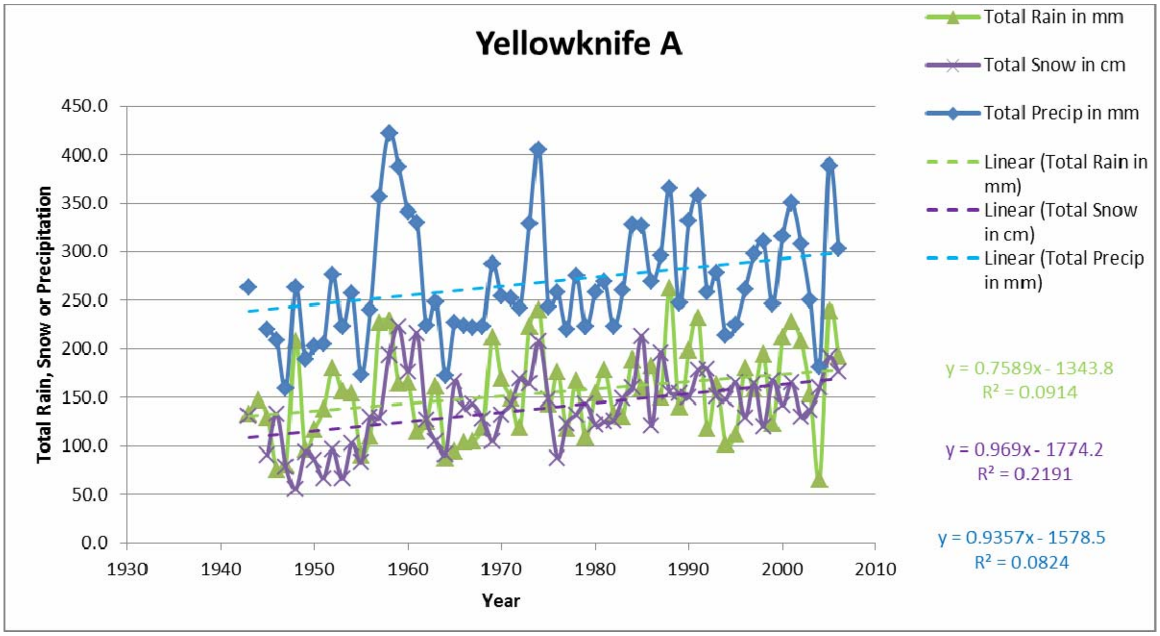


Figure 2.3-15
Inuvik A - Precipitation Trend

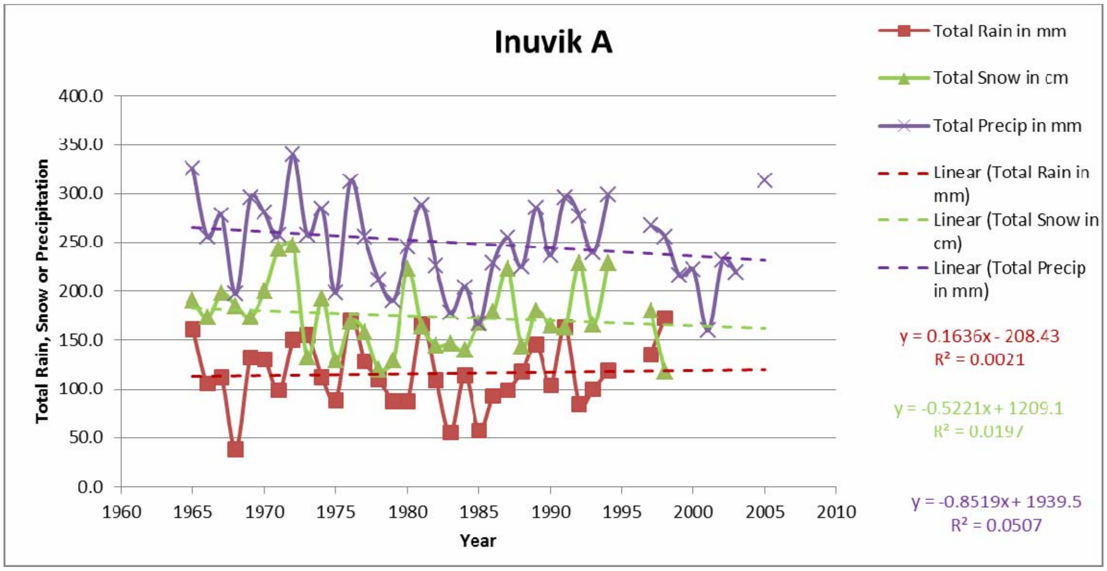
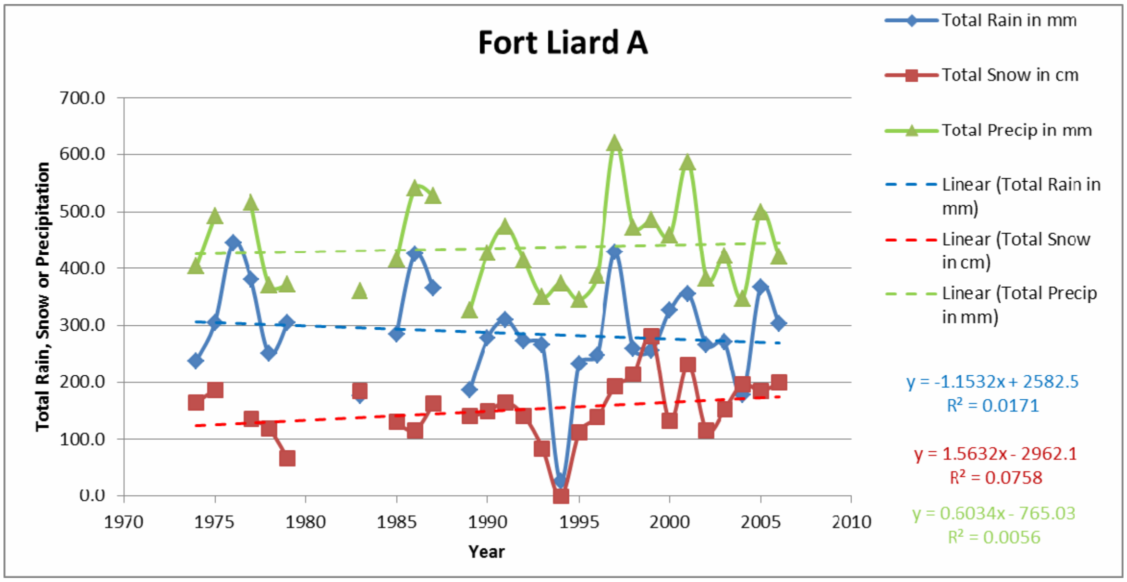


Figure 2.3-16
Fort Liard A - Precipitation Trend



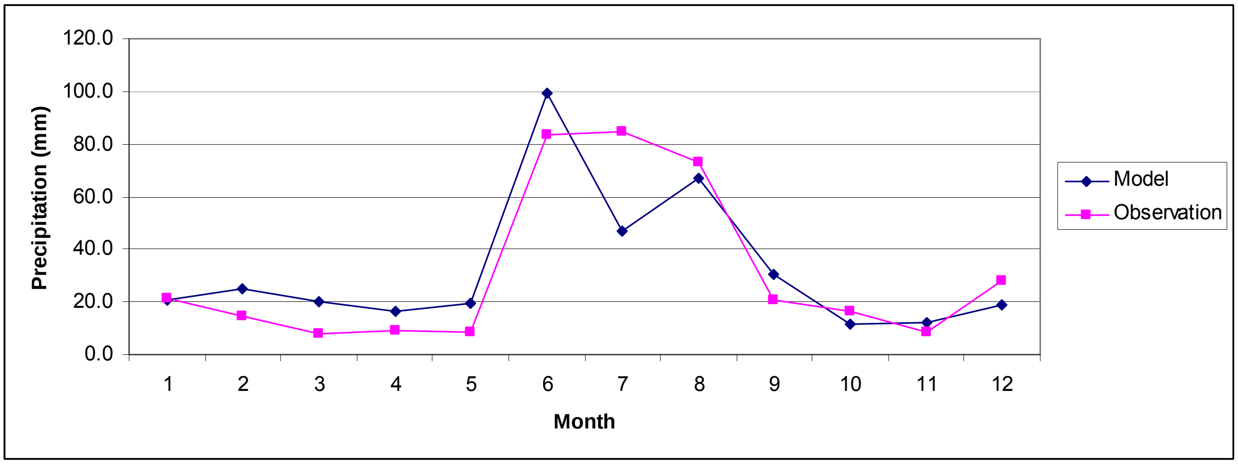
Why is it happening?
Detecting changes in precipitation trends is difficult because precipitation varies widely across even small geographic areas as is evidenced by the differences among the four stations examined.

What does it mean?
Human activity aside, surface and groundwater quantity is driven by the balance between atmospheric input from precipitation, and losses due to evapotranspiration. The impacts of changes in precipitation are described in other sections of this report.

What is being done about it?
The inherent nature of snow (e.g., varying density and wind effects) and snow cover (sublimation, the effects of land cover, temporal metamorphosis and redistribution by the wind) makes snow very difficult to measure. Both municipal and industrial demands for water are tempered by the ability of water managers to quantify water supply, which includes the contribution from snow melt.

The recent re-creation of a 5-year historical archive (2005-2009) over the Great Bear Lake watershed (SENES, 2010) showed that it was possible to simulate, using historical daily global observations and a state-of-the-science weather model, precipitation patterns that compared very well with observed data. Figure 2.3-17 shows a comparison of a model predicted vs. observed precipitation data for the Norman Wells A station. With the paucity of data across the North and the possibility of errors in that data, and notwithstanding the apparently large errors in June and July in the figure below, the comparison shown is very good for precipitation which is one of the hardest parameters to forecast even in a data-rich area.

Figure 2.3-17
Monthly Total Precipitation - Norman Wells 2009

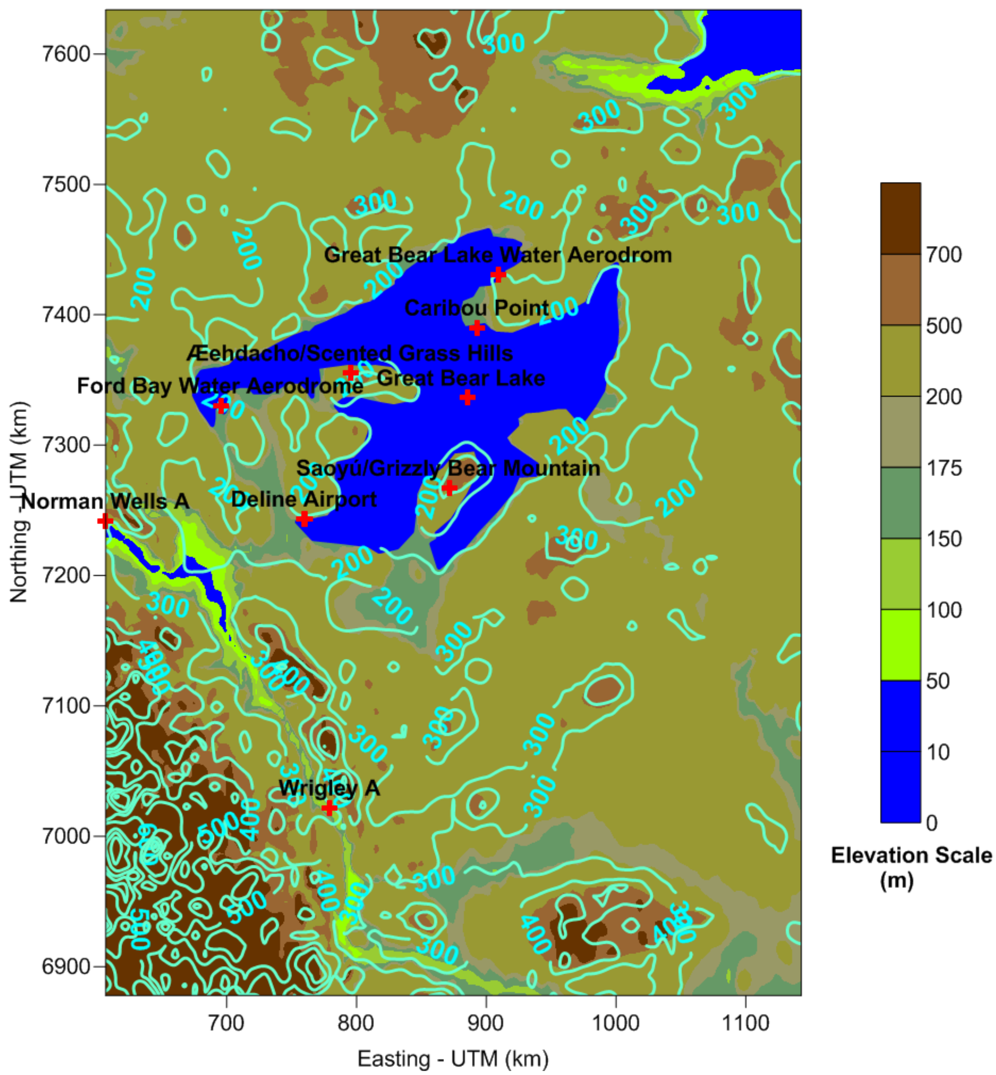


This means that fairly accurate historical precipitation patterns could be re-created for all of the Northwest Territories for a significantly lower cost than installing monitoring stations every 2 square kilometres across the NWT. An example of the total precipitation pattern over the Great Bear Lake Watershed is shown in Figure 2.3-18 (reproduced from Figure 5.1 in SENES, 2010 and based on a 5-year simulation on a 1x1 kilometre grid). This is not to say that more monitoring is not required – it is, in order to better estimate the error involved in the modelling approach.

What are the information gaps?
While there remains a marked lack of precipitation recording stations in the north relative to southern Canada, the state-of-the-science of weather prediction and the wealth of historical daily global observations make it possible to re-create the historical precipitation patterns across the Northwest Territories.

There are often significant errors in measuring precipitation, particularly when snow falls in trace amounts, due to factors such as wind and wetting. Equally there can be errors in model simulations. However, comparisons between model-simulated precipitation and measured precipitation show excellent agreement.

Figure 2.3-18
Modelled Distribution of Annual Precipitation in the Sahtú (2005-2009)



2.4 Climate Change

2.4.1 Introduction to Climate Change

The meaning of the term "climate change" within this report is consistent with its definition by the United Nations Framework Convention on Climate Change:

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

Within the context of this definition, climate change refers to any human-induced changes that are superimposed onto a background of natural climate variability in the climate system. Occurring over a large range of timescales, natural climate variability results from either internal instability in the ocean-atmosphere system, or triggering influences such as the El Niño - Southern Oscillation phenomenon, major volcanic eruptions or solar variability. Human-induced changes in climate are assumed to occur over time scales ranging from several decades to centuries. Since all natural ecosystems have established there bounds within natural climatic variability, climate change effects are most readily apparent along ecosystem boundaries. moreover, global climate warming is most dramatic at high latitudes, as heat surpluses redistributed upwards from the surface, and poleward from the tropics, have resulted in dramatic declines of snow, ice and permafrost.

The Arctic has some special features that make it an important focus for climate research. Physically, the Arctic islands are entirely snow-covered for more than half the year, and the region contains mountain glaciers, ice caps and extensive areas of permafrost. Arctic waters are also covered with sea ice for most of the year. Changes in the amount of sunshine are extreme since the Arctic experiences periods of 24-hour sunlight and 24-hour darkness at different times of year. Also, while large parts of the Arctic are essentially desert-like, large expanses of open water do occur during the short summer, making the Arctic a significant source for moisture and clouds. Northward-flowing rivers such as the Mackenzie empty their waters into the Arctic Ocean, influencing the ocean's physical characteristics. There are also important large-scale climate patterns, such as the Arctic Oscillation, where atmospheric pressure in the Arctic switches between high and low, causing shifts in climate and weather patterns in the Northern Hemisphere. These factors produce a complex interplay among climate processes in the Arctic.

The Intergovernmental Panel on Climate Change (IPCC) has been established by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.

To determine how the composition of the atmosphere, and consequently how climate may change in the future, it is necessary to construct scenarios of greenhouse gas and sulphate aerosol emissions for the next 100 years and beyond. This requires assumptions to be made about how society will evolve in the future. These emissions scenarios are then used in global climate models to simulate the evolution of climate over time. The IPCC has recommended a series of emissions scenarios, which describe plausible future changes in atmospheric composition. These are known as the SRES emissions scenarios after the IPCC's Special Report on Emissions Scenarios (IPCC 2000).

General Circulation Models (GCMs), and in particular, coupled Atmosphere-Ocean GCMs are the primary tools used to generate global-scale scenarios of climate change at broad spatial and temporal scales. Although there has been much progress in the refinement of GCM projections in recent years, the accuracy of GCM predictions is still uncertain, even with respect to representations of current climate conditions. Moreover, GCMs differ in their internal parameterizations so that, for any given scenario, there exist a range of possible outcomes depending on which model is used. Nevertheless, data from currently available GCMs project increasing global average temperatures in response to increases in greenhouse gas concentrations.

The lives of many Canadians are closely tied to the land. This is especially true for aboriginal communities, who hold the land in sacred trust and get much of their food and medicines from hunting, fishing and harvesting of beneficial plants and berries. These traditional activities are also an important part of aboriginal culture, have coexisted for many generations in harmony with the environment, and which contain a wealth of knowledge about climate and how it affects these activities and the environment that it supports (CCME 2003).

Climate change is a major concern throughout Canada's arctic and sub-arctic regions, and many communities have begun to record through their traditional knowledge observations and linking them to scientific observations of how climate change is affecting their environments and their lives. They see their cultural traditions of environmental observations as invaluable to promoting a global awareness of climate change, so they have now begun to share these traditional observations with a wider global community for the greater good of all.

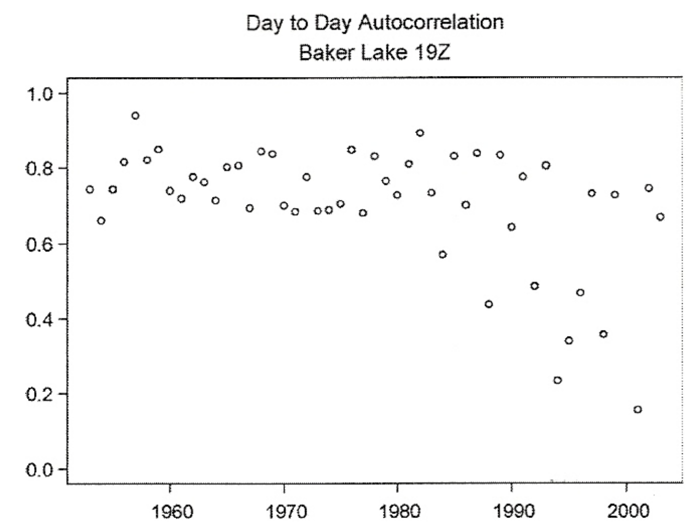
Changes in Northern Canada's climate are affecting many aspects of the environment, such as ice and terrain conditions and the supply of game, wild plants and fresh water. As a result, native peoples are finding it harder to rely on the traditional knowledge and practices they have used for many generations to survive in a region that is usually frozen for more than half the year (CCME 2003).

The Kitikmeot Inuit have noticed dramatic changes in the local climate and environment. Winters and summers have become warmer, and sea and lake ice have been melting earlier in the spring. Fall freeze-up, which occurred in August or September a few decades ago, now happens mostly in October or November. The weather has also become more variable, and short-term temperature swings that cause repeated thawing and freezing have become more common. With a more variable climate, weather and ice conditions have become harder to predict, and that has made it more difficult and dangerous for hunters and others traveling on the land and ice (CCME 2003).

People in most parts of the North are noticing the arrival of birds, fish and animals that have not been seen in their regions before. They are also noticing more unusual weather and more storms. Thunder and lightning, once very rare in the Arctic, are now being experienced more often. A recent paper by Kochtubajda *et al*., 2006, examined the lightning and fire characteristics within the NWT jurisdiction of the Mackenzie Basin between 1994 and 1999 using data from a lightning detection network and the national Large Fire Database maintained by the Canadian Forest Service. The convective storms are intense and occur over a short period peaking during July. Lightning activity is influenced by local moisture and topography. The paper indicates a link between cloud-to-ground flashes and thunderstorms initiated by daytime heating. The longer, warmer and drier summer seasons projected to occur due to climate change are expected to increase the frequency and intensity of forest fires by the end of the 21^{st} century.

Traditional knowledge has provided a broad perspective on the issue of climate change. Not only has it reported warmer temperatures, a more variable climate and unpredictable weather, but it has also indicated that the environment has changed in response to these changes in climate. Traditional Knowledge also underpins, and is supported by, a recent scientific study by Weatherhead *et al*. (2010). The day-to-day autocorrelation for temperature at Baker Lake, computed for 2 pm local time each June between 1953 and 2004, is reproduced as Figure 2.4-1. The autocorrelation represents how persistent temperature variations are. It is not understood why some years show typical near-historical levels of persistence (making weather forecastable by Traditional Knowledge) while other recent years show less persistence. Figure 2.4-1 shows clearly that the level of persistence began dropping in the early 1980's, providing scientific evidence of what the elders have been reporting based on their traditional observational practices.

Figure 2.4-1
Daily Temperature Persistence at Baker Lake



2.4.2 Climate Change Indicators

The earth's climate has always changed. During the last ice age, glaciers covered much of Canada and temperatures were much colder than today in the Arctic. Rapid warming followed the ice age and global temperatures were 2°C warmer than in the early 20th century. The key indicators of climate change and the rationale for their selection are presented in Table 2.4-1.

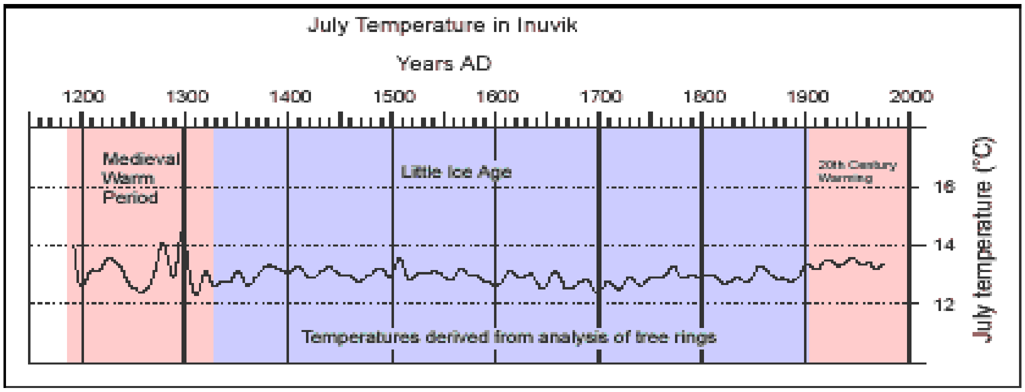
Table 2.4-1
Rationale for Selection of Indicators of Climate Change

Valued Component	Key Indicators	Rationale
Climate Change	**Changes in Temperature and Precipitation**	• demonstrated changes in the North due to climate change • directly linked to climate change predictions in Global Climate Models • direct local impacts on humans and the ecosystem
	Atmospheric CO_2 Concentrations	• measured in Alert, NWT since 1976 • strongly linked to increasing greenhouse gas emissions and hence the greenhouse effect • concentrations have increased dramatically since industrialization
	Emissions of Greenhouse Gases (GhG)	• direct measure of NWT contribution to this global phenomenon

2.4.2.1 Temperature and Precipitation

Figure 2.4-2 is a plot of estimated July temperatures at Inuvik over the last 800 years, reconstructed using tree-ring data from Eskimo Lakes. During the Medieval Warm Period (1200 to 1300 AD), temperatures were higher than the mid 20^{th} century. A cool period called the Little Ice Age followed this, which ended about 100 years ago. Warming has generally occurred over the last 100 years with average annual air temperatures for the western Arctic increasing by 1.5°C.

Figure 2.4-2
Historic Record of July Temperatures In Inuvik



Source: http://adaptation.nrcan.gc.ca/posters/articles/wa_02_en.asp?Region=wa&Language=en.
Adapted from: Begin, C., Y. Michaud and S. Archambault, 2000.

What is being measured?
Temperature and precipitation are being measured as outlined Section 2.3. The change in climate variables over the period of record at Norman Wells A, Yellowknife A, Inuvik A and Fort Liard A has been analyzed and is summarized in Table 2.4-2. Table 2.4-2 also summarizes the rate of climate change as decadal means over the period of record.

Table 2.4-2
Mean Decadal Rate of Change of Climate Parameters over the Period of Record in the NWT

Station	Parameter				Period of Record
	Mean Temp in °C	Total Rain in mm	Total Snow in cm	Total Precip in mm	years
FORT LIARD A	0.331	-11.18	15.16	5.85	33
INUVIK A	0.818	1.60	-5.09	-8.31	41
YELLOWKNIFE A	0.309	7.47	9.54	9.21	64
NORMAN WELLS A	0.335	-4.55	2.98	-10.62	63
Average	0.448	-1.67	5.64	-0.97	50

What is happening?
Table 2.4-2 shows a mean rate of change of temperature increase per decade ranging form about 0.331 to 0.818°C with an average over the four stations of 0.448°C. The average rate of change in precipitation decreases over the four stations by 0.97mm/decade, ranging for a positive rate of change of over 9mm/decade at Yellowknife A to a negative rate of change of about -11mm/decade at Norman Wells A. Over the period of record, total rainfall decreases by about 2mm/decade over the 4 stations ranging from an increase of about 7.5mm/decade at Yellowknife A to a decrease of about 11mm/decade at Fort Liard A. Total snowfall has increased over the 4 stations by almost 6 cm/decade ranging from a reduction of about 5cm/decade at Inuvik A to an increase of about 15 cm/decade at Fort Liard A.

Additional evidence of Arctic warming comes from the widespread melting of glaciers and sea ice, and a shortening of the snow season. Increasing precipitation, shorter and warmer winters, and substantial decreases in snow cover and ice cover are among the projected changes that are very likely to persist for centuries (ACIA 2005).

According to Overland *et al*. (2009) (http://www.arctic.noaa.gov/reportcard/atmosphere.html), the annual mean Arctic temperature for the year 2008 was the fourth warmest year for land areas since 1990. This continued the 21st century positive Arctic-wide surface air temperature (SAT) anomalies of greater than 1.0° C, relative to the 1961-1990 reference period. The mean annual temperature for 2008 was cooler than 2007, coinciding with cooler global and Pacific temperatures. During October through December 2008 SAT anomalies remained above an unprecedented +4° C across the central Arctic. This was linked to summer sea ice conditions. The summer of 2008 ended with nearly the same extreme minimum sea ice extent as in 2007, characterized by extensive areas of open water. This condition allows extra heat to be absorbed by the ocean from longwave and solar radiation throughout the summer season, which is then released back to the atmosphere in the following autumn.

Overland *et al*. (2009) further report that the main climate pattern for the Arctic is known as the Arctic Oscillation (AO) with winds that blow counter-clockwise around the pole when the pattern is in its positive phase. They report that a second wind pattern, known as the Arctic Dipole (AD) pattern, has been more prevalent in the 21st century. The AD pattern has high pressure on the North American side of the Arctic and low sea-level pressure on the Eurasian side, which implies winds blowing more from south to north increasing the flow of heat into the Arctic. The AD pattern occurred in all the summer months of 2007 with resulting reductions in sea ice extent. The fall of 2008 and the winter/spring of 2009 showed the return of the AO pattern but with considerable month to month variability.

Why is it happening?
Increasing global concentrations of carbon dioxide and other greenhouse gases due to human activities, primarily fossil fuel burning, are projected to contribute to additional Arctic warming of about 4-7ºC over the next 100 years (ACIA 2005).

What does it mean?
Scientists use models called General Circulation Models (GCM) to predict future climate. Teng *et al*. (2006) looked at Arctic climate change in the 21st century by simulating it with the Community Climate System Model version 3.0 (CCSM3). The simulations from three emission scenarios (A2, A1B and B1) were analyzed using eight (A1B and B1) or five (A2) ensemble members. The model simulated a reasonable present-day climate and an historical climate trend. The model projected a decline of sea-ice extent in the range of 1.4–3.9% per decade and 4.8–22.2% per decade in winter and summer, respectively, corresponding to the range of forcing that span the scenarios. The model predicted that at the end of the 21st century, the winter and summer Arctic mean surface air temperature would increase in a range of 4–14 °C (B1 and A2) and 0.7–5°C (B1 and A2) relative to the end of the 20th century. The Arctic was predicted to become ice-free during summer at the end of the 21st century in the A2 scenario (worst case emissions). Similar to the observations, the Arctic Oscillation (AO) was found to be the dominant factor in explaining the variability of the atmosphere and sea ice in the 1870–1999 historical runs. The AO shifted to the positive phase in response to greenhouse gas forcing in the 21st century. But the simulated trends in both Arctic mean sea-level pressure and the AO index were smaller than what has been observed. The 21st century Arctic warming was predicted to mainly result from the radiative forcing of greenhouse gases.

What is being done about it?
The Arctic Climate Impact Assessment (ACIA) was an international project of the Arctic Council and the International Arctic Science Committee (IASC). It focused on the evaluation and synthesis of knowledge on climate variability, climate change and increased ultraviolet radiation and their consequences in the circumpolar Arctic. The aim was to provide useful and reliable information to governments, and to the Arctic Peoples and their organizations.

Several Northern Communities are starting to undertake monitoring and research in to establishing a baseline for future climate change studies.

The IPCC's Fourth Assessment Report identifies that global temperatures are on the rise as a result of increased greenhouse gases in the atmosphere and current observational evidence shows that higher latitudes are experiencing, and will continue to experience, the greatest warming in the future (IPCC, 2007). As a means to reduce northern communities' vulnerability to the effects of climate change, the Government of the Northwest Territories (GNWT) has initiated climate change adaptation planning (Decker *et al.*, 2008). To aid in such planning, the GNWT emphasizes the importance of collecting baseline climate data and implementing long-term monitoring programs as a means to monitor and anticipate changes to local environments (Decker *et al*., 2008).

What are the information gaps?
At the global level, climate in the Arctic is a result of the general circulation of the atmosphere and heat transfer by the oceans. It is generally agreed that fluctuations in the upper atmosphere control or influence surface conditions. The factors that influence high-latitude energy fluxes including the Arctic Oscillation (AO) are fundamental science questions that still need to be addressed.

The magnitude, frequency, and causes of extreme events in Arctic weather, stream flow, lake and sea ice, snow cover and other climatic-related variables need careful study in order that trends in global climate change are correctly interpreted and understood. Understanding of the magnitude and speed of past and ongoing climate change in the Arctic also needs to be improved through continued monitoring and the analysis of already existing time-series data and retrospective weather modelling driven by observed global data over the last 10-20 years.

2.4.2.2 Atmospheric CO_2

A small group of greenhouse gases, mainly carbon dioxide, methane, nitrous oxide, and water vapour, help to regulate the Earth's climate by trapping solar energy that reradiates from the Earth's surface as heat. Emissions from human activities enhance this natural process. Since industrialization, human activities such as burning fossil fuels have increased the amount of greenhouse gases emitted into the atmosphere. The increased emissions have enhanced the greenhouse effect, causing the atmosphere to warm and the climate to change.

What is being measured?
Global concentrations of carbon dioxide have been measured since the mid-1950s. A unique Canadian record of increasing concentrations of carbon dioxide in the global atmosphere is being measured by Environment Canada in Alert, Nunavut, at the northern tip of Ellesmere Island, about 800 km from the North Pole. The measurements are being taken at the Dr. Neil Trivett Global Atmospheric Watch Station, which is the world's most northerly site in an international network of monitoring stations coordinated by the World Meteorological Organization. The remote location of the site ensures that the measurements indicate changes in the global atmosphere, as there is virtually no contamination from nearby sources of carbon dioxide.

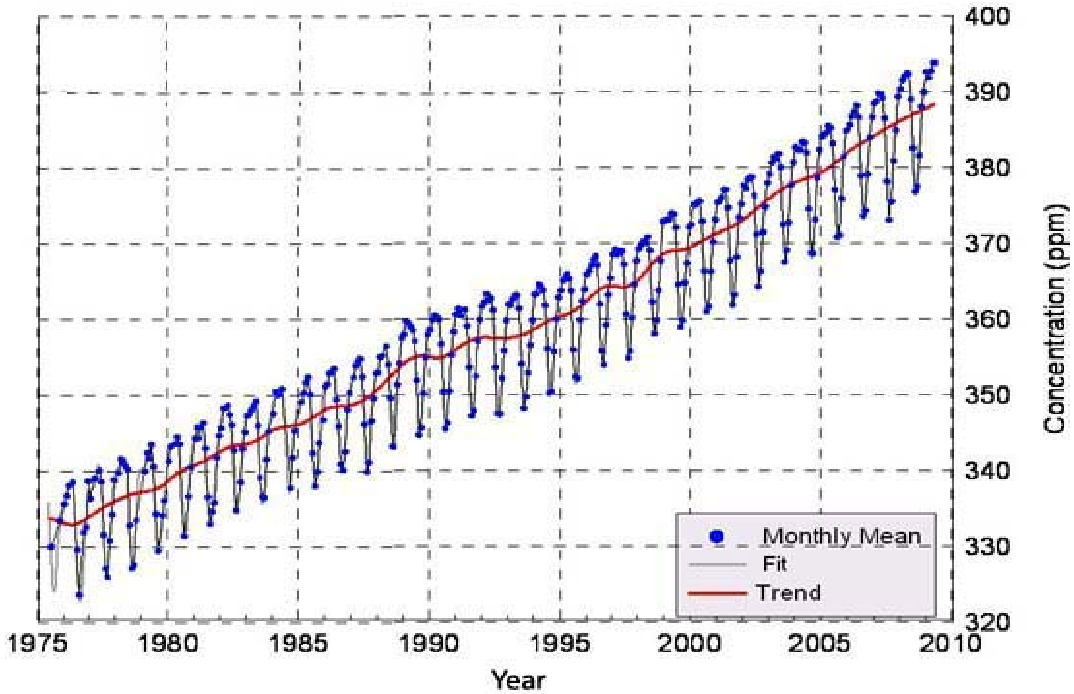
What is happening?
Figure 2.4-3 indicates that carbon dioxide in the global atmosphere has been rising rapidly since 1975. The red line indicates the average upward trend, while the blue line shows annual fluctuations. The figure shows that each year carbon dioxide decreases during the summer in

Northern Hemisphere, as plant growth absorbs carbon from the atmosphere; and increases during the winter. Since carbon dioxide is a well-mixed gas in the atmosphere, measurements made at any place on the globe are considered representative.

Why is it happening?

Globally, carbon dioxide emissions from energy use have quadrupled since 1950. In 1998, Canada's share of these emissions was approximately 2%. Canadian emissions of six key greenhouse gases have grown 20% since 1990. See Section 2.4.2.3 following.

Figure 2.4-3
Trends in Atmospheric Carbon Dioxide Levels at Monitoring Stations in Nunavut



What does it mean?

The weight of scientific evidence supports a link between weather extremes and greenhouse gas-induced climate change. There is little debate that Canadians have experienced recent changes in weather patterns and a substantial increase in the number of weather-related disasters.

What is being done about it?

In 1992, Canada ratified the United Nations Framework Convention on Climate Change, which set out a framework for action to limit emissions of greenhouse gases. In 2002, Canada ratified the Kyoto Protocol to the Convention, committing to reduce its greenhouse gas emissions to 6% below 1990 levels by 2008-2012.

Reductions in emissions from fossil fuel combustion will not only reduce greenhouse gases, but will have a positive impact on local and regional air quality by directly reducing emissions of sulphur dioxide, nitrogen oxides, and volatile organic compounds and indirectly reducing levels of ground-level ozone and inhalable airborne particles formed in the atmosphere.

What are the information gaps?

Since CO_2 is a regional parameter, the Nunavut measurement location is representative of the northern part of Canada. The impacts of increasing CO_2 are key to the future of the NWT. The time is right for the use of state-of-the-science atmospheric models coupled with a Regional Climate Model (RCM) to look at the possible changes that this increasing CO_2 will have over the next 90 years. These models can be validated against the existing measured data, and against paleo-time-series data sets. This forward-looking as well as retrospective look will help determine regional variability in Arctic climate and the impacts into the future.

2.4.2.3 Emissions of Greenhouse Gases

Greenhouse Gases (GhGs) help regulate the planet's climate by trapping solar energy. There is a natural greenhouse gas warming that maintains an average temperature of about 15 degrees C – warm enough for humans to live. Without this natural warming, the average temperature would be about -18 degrees C. There is also an enhanced greenhouse gas warming caused by GhG emissions from human activities over the last 200 years. The effects of these additional GhGs will persist over 100's of years.

What is being measured?
The territory of Nunavut was created in 1999 when the Northwest Territories was split into a western part (still known as the Northwest Territories) and an eastern part. Prior to 1999, the entire area's GhG emissions were reported as Northwest Territories.

Estimating Greenhouse Gases (GhG) emitted from industrial and economic activity began in earnest in about 1990. Effective in 1999 a separate accounting for each of Nunavut and the Northwest Territories was available.

What is happening?
The Northwest Territories and Nunavut generated about 1.81 Mt of GhGs in 2008 which is a 19.4% increase from 1990 levels (Environment Canada, 2009). Figure 2.4-4 presents the Northwest Territories GhG emission by major category for the period 1999-2008. The figure shows that emissions have been fairly flat over the 10-year period 1999-2008. Figure 2.4-5, developed from Statistics Canada (2009) data, presents the total GhG emissions for Canada by the same categories. Comparing the two figures shows that the NWT, like Canada generally

generates most of its GhG emissions from the Energy Sector. The figures also indicate that, in 2008, the total NWT emissions accounted for about 0.2% of Canada's emissions.

Figure 2.4-4
Northwest Territories GHG Emissions (1999-2008)

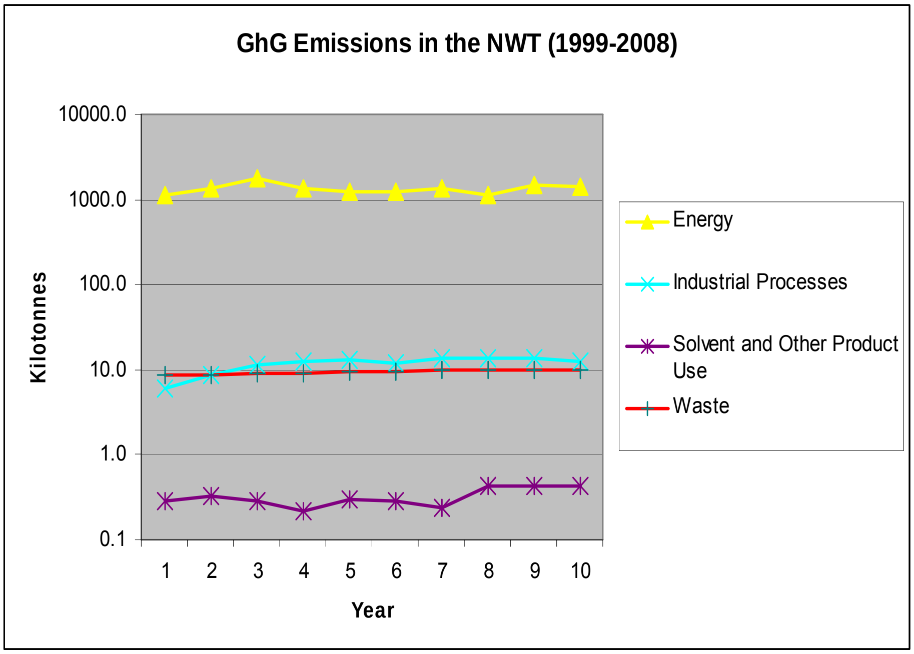
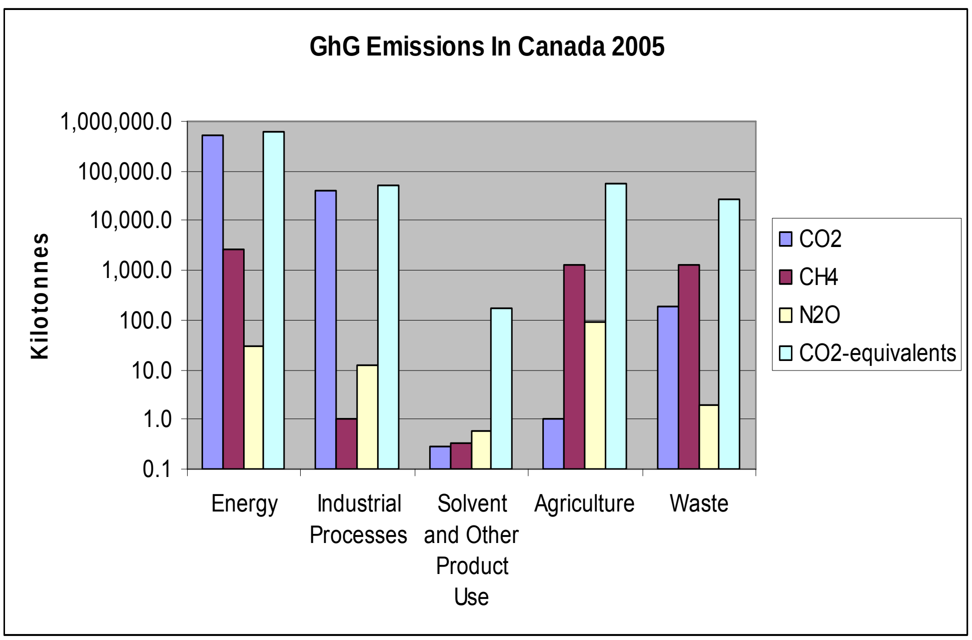


Figure 2.4-5
GHG Emissions (in Kilotonnes) for Canada in 2005



Why is it happening?
The increase in GhGs in NWT and Nunavut since 1990 has been driven mainly by increases in the Electricity and Heat Generation and Road and Other Transportation sectors. This is caused by the long distances between industry and population centres. Since 1990 the combined population of these two areas has increased by 26% while GhG per capita decreased by 5.2% over the same period. The Northwest Territories has seen a decline in natural gas production from a peak in 2001. Electricity in the NWT is primarily hydro-based, with diesel supplying most of the rest (Environment Canada, 2009).

What does it mean?
The uncertainty and variability in the year to year data make estimating short-term changes difficult, since the variability/uncertainty is bigger than the economically driven inter-annual changes (Environment Canada, 2009).

What is being done about it?
Since 1990, there have been significant improvements in the utility industry to reduce diesel consumption and increase hydroelectric supply. There has been an increase in natural-gas-fired generation to offset diesel generation (Environment Canada, 2009).

What are the information gaps?
A more consistent approach needs to be taken to data collection and analysis in order to reduce the variability and uncertainty in the year-to-year emission estimates.

2.4.3 Other Climate Change Issues

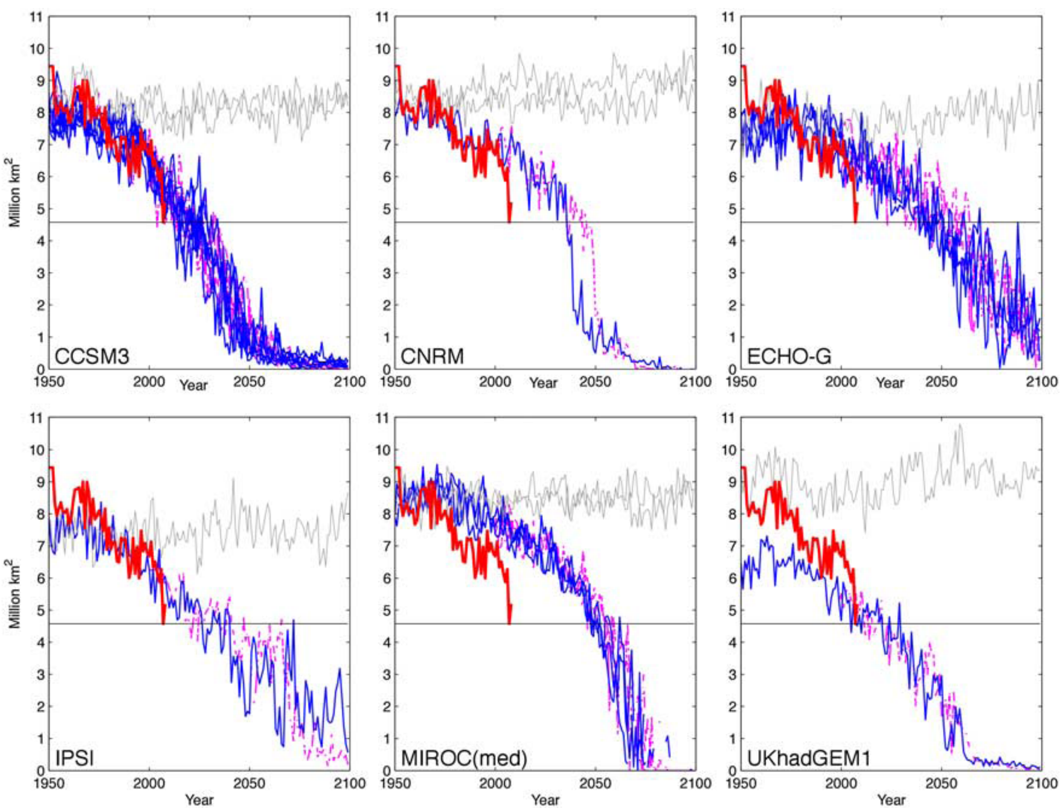
2.4.3.1 An Ice-free Arctic

Wang and Overland (2009) reported that September 2008 followed 2007 as the second year in a row with an extreme summer Arctic sea ice extent minimum. Although the possibility of a sea ice loss of this magnitude was not indicated until much later in the century in the Intergovernmental Panel on Climate Change 4th Assessment Report, many models show an accelerating decline in the summer minimum sea ice extent during the 21st century. Using the observed 2007/2008 September sea ice extents as a starting point, Wang and Overland predict an expected value for a nearly sea ice free Arctic in September by the year 2037. The first quartile of the distribution for the timing of September sea ice loss will be reached by 2028. Their analysis was based on projections from six IPCC models, selected subject to observational constraints. Uncertainty in the timing of a sea ice free Arctic in September was determined based on both within-model contributions from natural variability and between-model differences.

Figure 2.4-6 shows the September sea ice extent as projected by the six models that simulated the mean minimum and seasonality with less than 20% error of the observations. The coloured thin line represents each ensemble member from the same model under A1B (blue solid) and A2 (magenta dashed) emission scenarios, and the thick red line is based on HadISST analysis. Grey lines in each panel indicate the time series from the control runs (without anthropogenic forcing) of the same model in any given 150 year period. The horizontal black line shows the ice extent at 4.6 M km^2 value, which is the minimum sea ice extent reached in September 2007 according to HadISST analysis. All six models show rapid decline in the ice extent and reach an ice-free summer (<1.0 M km^2) before the end of 21^{st} century.

Boé *et al*. (2009) analysed the simulated trends in past sea-ice cover using 18 state-of-art-climate models and found a direct relationship between the simulated evolution of September sea-ice cover over the 21^{st} century and the magnitude of past trends in sea-ice cover. Using this relationship together with observed trends, they projected the evolution of September sea-ice cover over the rest of the 21^{st} century. They found that under a scenario with medium future greenhouse-gas emissions, the Arctic Ocean will probably be ice-free in September before the end of the twenty-first century with one model showing this to occur as early as 2055.

Figure 2.4-6
Modelled Future Sea-Ice Extent By Six Different Models



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3.0 FRESHWATER AQUATIC ENVIRONMENT

3.1 FRESHWATER IN THE NORTHWEST TERRITORIES

Canada is a freshwater-rich country with Canadian rivers discharging, on an average annual basis, close to 9% of the world's renewable water supply. Water is also highly visible in Canada with no other country in the world having as much of its surface area covered by freshwater. The NWT covers a total area of 1.35 million square kilometres, or approximately 13.5% of the total area of Canada. Of its area, about 163,000 square kilometres (or 13.8%) is covered by freshwater; an area equivalent to nearly 20% of all of Canada's surface freshwater. The two largest lakes entirely within Canada's borders are located in the NWT; they are Great Bear Lake (31,328 km^2) and Great Slave Lake (28,568 km^2). There are also several important river systems; the most notable being the Mackenzie River, the drainage basin of which accounts for about 1/5th of Canada's land mass (Mackenzie River Basin Board (MRBB), 2004). The principal lakes and rivers in the NWT are shown in Figure 3.1-1.

The predominant freshwater system in the NWT is the Mackenzie River Basin which covers nearly 75% of the territory and drains an area equivalent to about one-fifth of Canada's land mass. Drainage along the eastern border of the NWT is captured in the Coppermine River and Thelon River watersheds that drain into Nunavut. The northern mainland area of NWT runoff flows into Amundsen Gulf and the Beaufort Sea. There are seven primary watersheds in the NWT (see Figure 3.1-2). The main features of these watersheds are described below.

3.1.1 Great Slave Lake

The Great Slave basin has a drainage area of 971,000 square kilometres (Hydat, Water Survey of Canada: Mackenzie River near Fort Providence 10FB001). Of this area, about 315,000 square kilometres are in the NWT. The major tributaries of the Great Slave Lake sub-basin are the Peace River with its headwaters in BC, the Athabasca River with its headwaters in Alberta, and Lake Athabasca with its headwaters in Saskatchewan. The confluence of these three major systems in northeastern Alberta becomes the Slave River which contributes about 77% of the inflow to Great Slave Lake. Other major inflows to Great Slave Lake include Taltson, Lockhart, and Hay rivers which, collectively, contribute about 11% of the flow into Great Slave Lake. Ten other smaller drainage areas in the sub-basin provide the remaining 12% of the inflow to Great Slave Lake (MRRB 2004).

Great Slave Lake 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. Great Slave Lake is also the deepest in North America with an average depth of about 73 metres and a maximum depth of 614 metres.

The Great Slave basin straddles two distinct physiographic regions: the Precambrian Shield to the east; and the Interior Plains to the west. The shield region land cover is generally an open, taiga forest but the headwaters of the Snare, Yellowknife and Lockhart Rivers have the tundra vegetation of the Low Arctic ecosystem. The Interior Plains are characterized by a more dense boreal forest in a landscape that was sculpted and smoothed by till deposits from continental glaciation. As a result of geological and vegetative differences between these areas, annual runoff is greater in the Shield than in the Interior Plains. 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 without lake storage (MRBB 2004).

3.1.2 Mackenzie River

The Mackenzie River mainstem and its many tributary sub-basins are almost entirely in the NWT and cover 475,000 square kilometres. The Mackenzie River begins at the outflow of Great Slave Lake and is Canada's longest river at 1,800 kilometres in length. The major tributaries of the Mackenzie include the Liard River (Sec 3.1.3), Peel River (Sec 3.1.4), and Great Bear Lake (the largest lake entirely within Canada at 31,328 square kilometres). The Mackenzie Delta is Canada's largest delta at 13,500 square kilometres. Many smaller tributaries join the Mackenzie River from the Horn Plateau (Horn River, Rabbitskin River, Willowlake River), from the Interior Plains (Trout, Blackwater, Hare Indian), and from the Mackenzie Mountains (Redstone, Keele, Mountain and Ramparts). The Mackenzie River transports 60% of Canada's freshwater that drains to the north, and also transports more sediment to the Arctic Ocean than any other circumpolar river (MRBB 2004). The main sediment sources are from the Liard River and the other mountain tributaries.

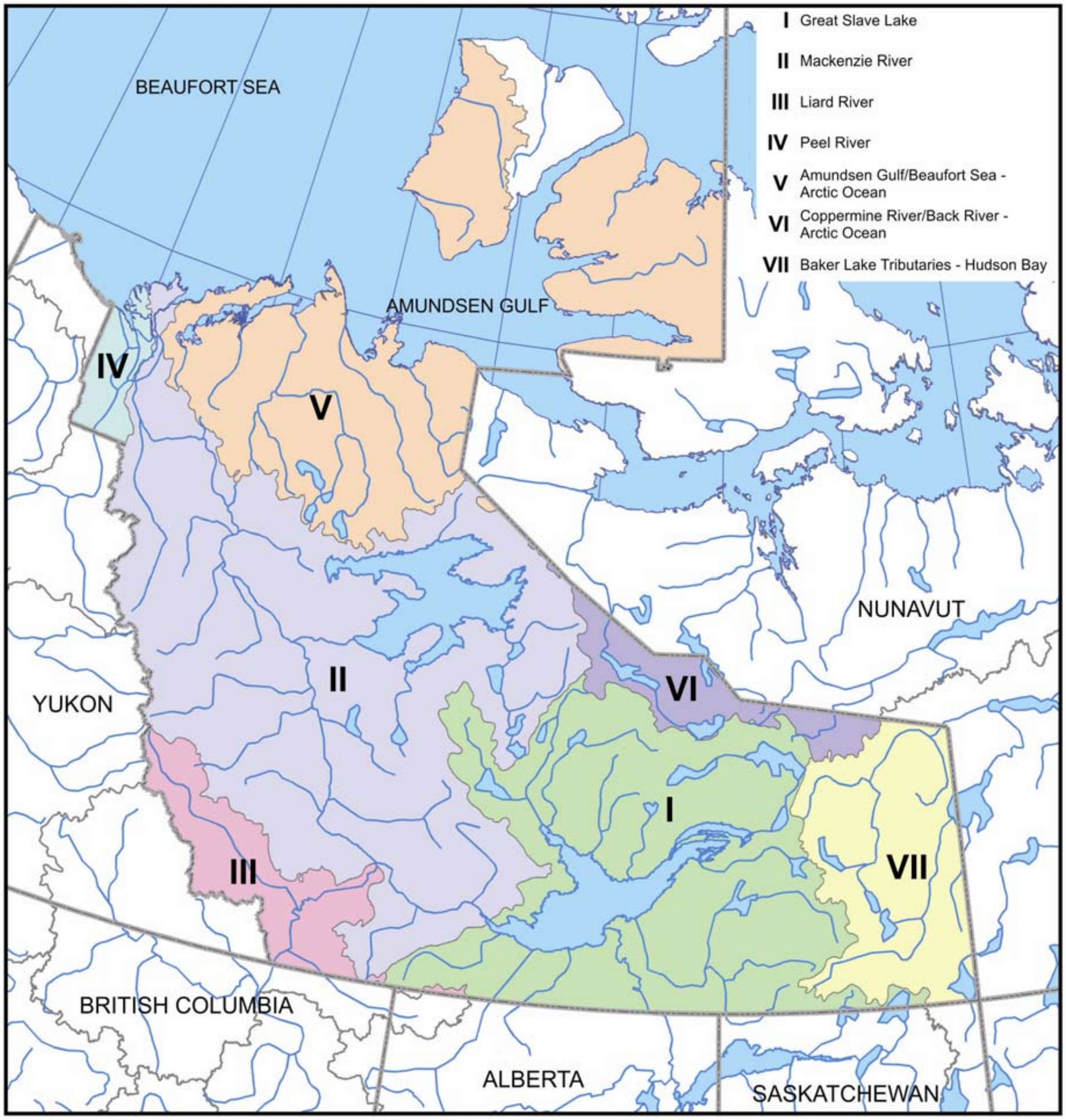
3.1.3 Liard River

The Liard River basin is 275,000 square kilometres (Hydat, Water Survey of Canada: Liard River at the mouth 10ED002) making it Canada's ninth largest watershed. The Liard River begins its journey in the Pelly Mountains of southeastern Yukon, flows through northeastern British Columbia and then crosses into NWT above Fort Liard and joins the Mackenzie River near Fort Simpson. At 1,115 kilometres, the Liard is Canada's eleventh longest river. With an average annual discharge of 2,520 cubic metres per second at its mouth, it ranks seventh among Canadian rivers in volume of water discharged.

Much of the sub-basin is covered by coniferous and mixed-wood forest. There are extensive mountainous areas, especially in the headwaters along the Yukon-NWT border and in the western portion. Some of the mountainous areas along the Yukon-Northwest Territories border are prone to massive landslides. Heavy summer precipitation, melting permafrost, deforestation and land disturbances from industrial development may cause landslides, which can affect local l water quality and quantity. (MRBB 2004)

Figure 3.1-1
Principal Lakes and Rivers in the Northwest Territories

Figure 3.1-2
Watersheds in the Northwest Territories



3.1.4 Peel River

The Peel River basin has an area of 70,600 square kilometres (Hydat, Water Survey of Canada: Peel River above McPherson 10MC002), most of which is in the Yukon. The Peel River mainstem has a length of approximately 350 kilometres from the confluence of the Blackstone and Ogilvie rivers. The Peel basin is within both the Taiga Cordillera Ecozone and the Taiga

Plains Ecozone. Mountainous terrain and permafrost determine the flow of water in the tributaries of the Peel basin. Wetlands are abundant within the Taiga Plains Ecozone (MRBB 2004).

3.1.5 Amundsen Gulf/Beaufort Sea – Arctic Ocean

The main rivers in the Amundsen Gulf/Beaufort Sea watersheds are the Hornaday, Horton, Anderson and the Husky Lakes.

3.1.6 Coppermine River

The Coppermine River flows into Coronation Gulf on the Arctic Ocean. The Coppermine River watershed is 50,800 square kilometres at the the mouth. Approximately half of this area lies to the south in the NWT. The Coppermine watershed is mostly within the Tundra Shield physiographic region and is located between the Great Slave Lake watershed to the south, the Great Bear Lake watershed to the west and the Burnside River/Bathurst Inlet watershed to the east. The headwaters of the Coppermine River are in the Ursula Lake/Lac du Sauvage region.

3.1.7 Baker Lake Tributaries – Hudson Bay

The headwaters of the Thelon, Dubawnt and Kazan Rivers are in the extreme south-eastern part of the NWT, flow north-eastward to Baker Lake, and are sub-basins of Hudson Bay. Baker Lake ultimately flows into Hudson Bay via Chesterfield Inlet.

3.2 SURFACE WATER AND SEDIMENTS

3.2.1 Monitoring and Research Activities

Water monitoring activities have been conducted in the NWT by governments, communities, industry and other parties for many years. Historical information provides a window to the past and helps us understand our current environmental conditions (INAC 2010). A summary of monitoring and research initiatives and databases is provided below (GNWT 2010). Figure 3.2-1 provides an overview of water monitoring stations in the NWT (INAC 2010).

Federal Water Quality Monitoring Programs

Programs for the collection of long-term baseline water quality data on northern river systems include 25 NWT sites operated by Environment Canada (some of which are located on proposed pipeline routes and at transboundary locations) and 12 water quality sites operated by Indian and Northern Affairs Canada. Water and suspended sediment quality are measured at sites at four transboundary rivers which enter the NWT (Slave, Hay, Liard and Peel Rivers).
www.ainc-inac.gc.ca/ai/scr/nt/env/wr/mn/index-eng.asp

Figure 3.2-1
Water Monitoring Stations in the NWT

Source: INAC 2010. Water Today: Water Quality and Quantity in the NWT. http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/wt10-eng.asp

National Hydrometric Network

The National Hydrometric Network is operated by the Water Survey of Canada in partnership with Indian and Northern Affairs Canada and others. It provides near real-time water level data from 85 stations in the NWT. The data is used to calculate stream flow and analyze trends and flooding. Some sites also collect water quality data. www.ec.gc.ca/rhc-wsc

NWT Snow Survey Network

The snow survey network is operated by Indian and Northern Affairs Canada in partnership with the NWT Power Corporation. This network and the Weather Station Network, which is operated by Indian and Northern Affairs Canada in partnership with the Government of the Northwest Territories' Department of Environment and Natural Resources, collect evaporation data from multiple sites in the NWT. www.ainc-inac.gc.ca/ai/scr/nt/env/wr/dt/ss/index-eng.asp

Canadian Aquatic Biomonitoring Network Program (CABIN)[1]

This program collects samples of benthic invertebrates as an indicator of water quality. It includes 16 sites operated by Environment Canada and some operated by other parties such as Parks Canada, Fisheries and Oceans Canada and Indian and Northern Affairs Canada. www.ec.gc.ca/rcba-cabin

NWT Cumulative Impact Monitoring Program (CIMP)

This program is designed to monitor the cumulative impacts of land and water uses in the NWT. CIMP uses both traditional and western scientific knowledge, placing emphasis on biophysical and human valued components of the environment. CIMP supports a number of projects and programs annually. www.nwtcimp.ca

Marian Lake Watershed Stewardship Program

This program was initiated by the Wek´èezhìı Land and Water Board, Tłı̨cho Government and Wek´èezhìı Renewable Resource Board. Partly funded through the Cumulative Impact Monitoring Program, it was established to increase inter-connectedness between the different boards and departments. It aims to create a platform for monitoring projects in the Marian Lake area that gathers data, communicates research and supports decision making in a cumulative effects context at the community level.

[1] During preparation of this SOE chapter, requests were made to access the database and to have a listing of NWT sites. These requests were denied.

Little Buffalo River Water Quality Program

This program collects a wide range of biophysical information and is run by the NWT Métis Nation in collaboration with Fisheries and Oceans Canada.
www.nwtcimp.ca/documents/cimpProjects/0708/NTFN_LBRWaterQuality_07_08.pdf

Aboriginal Aquatic Resource and Oceans Management Program (AAROM)

This program provides funding to qualifying Aboriginal groups to facilitate the formation of aquatic resource and oceans management organizations that are capable of hiring or contracting skilled personnel to help them effectively participate in decision-making and advisory processes.
www.pac.dfo-mpo.gc.ca/tapd/aarom_e.htm

Ducks Unlimited Canada

Ducks Unlimited Canada conducts wetland inventory work across Canada.
www.ducks.ca/conserve/programs/boreal/projects.html

Canadian Heritage Rivers System

The Canadian Heritage Rivers System is Canada's national river conservation program which promotes, protects and enhances Canada's river heritage and ensures that Canada's leading rivers are managed in a sustainable manner. www.chrs.ca

Arctic Climate Impact Assessment

This 2006 report is an integrated assessment of climate change across the Arctic region. A specific section of this assessment deals with climate change impacts on freshwater and fisheries.
www.acia.uaf.edu/pages/scientific.html

Northwest Territories Protected Areas Strategy Freshwater Classification

The Northwest Territories Protected Areas Strategy has developed a draft coarse-scale freshwater classification system and is compiling finer information on freshwater special features. The classification, along with information compiled in various cultural, ecological and renewable resource reports, helps contribute to a comprehensive inventory of watershed information. www.nwtpas.ca

NWT Drinking Water Quality Database

The NWT Water Quality Database is updated on a regular basis and shows information about the drinking water quality in the NWT communities.
www.maca.gov.nt.ca/operations/water/homepage.asp

3.2.2 Government Policy

In response to growing concern about water quality as a result, primarily of downstream industrial activities and climate change, INAC, the Government of the Northwest Territories and Aboriginal governments have partnered to develop the NWT Water Stewardship Strategy, a made-in-the-North plan that establishes a vision for the future of NWT water resources (GNWT 2010). The Strategy outlines a number of monitoring and research initiatives that will contribute to overall environmental knowledge and sets out a framework for sound water management decisions based on both western science and traditional knowledge, allow for effective evaluation of past decisions and provide the ability to change management practices as required.

3.2.3 Focus of the Assessment

This assessment was conducted by reviewing the scientific literature, reports, and scientific and government on-line resources. The objective of the review of background material was to develop a consensus from several perspectives of the status of the indicators. The VCs and indicators investigated in this assessment are listed in Table 3.2-1 together with the rationale for their selection.

3.2.4 Surface Water and Sediment Quality

Good water and sediment quality are important to the health of both the natural and cultural environments. The Canadian Council of Ministers of the Environment (CCME) has established Environmental Quality Guidelines (EQG) for protection of aquatic life in water and sediment and for a number of water uses. These guidelines are threshold concentrations of chemical, physical and microbiological substances that are deemed to be safe for most forms of freshwater aquatic life or for various types of uses (e.g., livestock watering, irrigation, recreation and aesthetics, community water supply).

Water and sediments are inextricably linked as a result of biogeochemical processes taking place at the sediment-water interface of lacustrine and riverine environments. Within the NWT the important relationship between water and sediment is of particular note in the Mackenzie River which has the largest sediment load of any river in the Arctic circumpolar world. Its sediments contain very large amounts of non water-soluble organics and metals (up to 20 times greater than larger northern rivers). Many of these contaminants (e.g., POPs and radionuclides) are typically found at very, very low concentrations in surface waters. Hence, only those contaminants which have been found to exceed Environmental Quality Guidelines on a frequent basis are discussed below.

Table 3.2-1
Water Quality and Quantity Valued Components and Indicators

Valued Component	Indicators	Rationale
Surface Water and Sediment Quality	• Contaminants of primary concern (COPC): turbidity, aluminum, iron, copper, zinc, and mercury	• Water quality in the Mackenzie River and several of its tributaries is affected by a high natural sediment load. • Water quality reports such as the 2004 Mackenzie River Basin State of the Aquatic Ecosystem Report have shown there are only a limited number of COPCs that frequently exceed water quality guidelines at routinely monitored stations. • Besides the noted COPCs, arsenic is also a concern in the area around Yellowknife due to historic releases from the Giant Mine and Con Mine. • There are only limited data on bacteriological parameters and organic compounds to use in analysis of trends. • There are only limited sediment quality data and mostly what is available is of short duration.
Surface Water Quantity	• Discharge rates • Lake levels	• The Mackenzie River Basin, as Canada's largest watershed, has a discharge rate of over 9,900 m^3/s. • Long-term streamflow records show an overall annual increase. • Flow in the Mackenzie River has not shown the same trend to date, presumably due to the influence of Great Slave Lake in particular but also Great Bear Lake in moderating the river flow. • Monitoring data on Great Slave Lake suggest a possible lowering of the average lake level although the trend is not conclusive given the large size of the lake.

3.2.4.1 Surface Water Quality

What is being measured?

Regional surface water quality monitoring is carried out routinely at a number of locations in the NWT, primarily by Environment Canada and INAC. Project specific water quality monitoring is carried out by proponents of mining operations or oil and gas developments and by INAC at several abandoned mine sites and former military sites. Limnological research has been carried out recently on lakes of the Mackenzie Delta/Tuktoyaktuk Peninsula, Mackenzie Valley, Great Bear Lake Area, Fort Simpson-Trout Lake Area, Nahanni NPR, Tuktut Nogait NP and Aulavik NP. The Canadian Environmental Sustainability Indicators (CESI) initiative of the Federal Government reports on water quality for nine sites throughout the NWT (CESI 2010).

As part of the Peel River Water and Suspended Sediment Sampling Program, INAC sampled water at a site located south of Fort McPherson from 2002-2007. Aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc were measured. INAC will perform follow-up water and suspended sediment sampling in 2012 (Czarnecki 2008).

What is happening?

For the 2005 to 2007 period, monitoring conducted through CESI indicates water quality to be fair to good for the nine NWT stations (CESI 2010). A summary of the stations and the parameters measured at each is presented in Table 3.2-2. The locations of the stations and the water quality index ratings for each are shown in Figure 3.2-2. Of the nine stations, seven were rated as having "good" water quality, and two were rated as "fair", meaning water quality measurements sometimes exceeded water quality guidelines and, possibly, by a wide margin. These two stations were located on the Hay River near the NWT/Alberta border and the Mackenzie River at Norman Wells.

In the Peel River monitoring, all metals in surface water [except aluminum (routinely) and lead (on one occasion)] met Health Canada's drinking water quality guidelines. Some metals were found at levels that did not meet the National freshwater aquatic life guidelines (but at levels not likely to cause adverse affects). All metals were found to be within historical range of water quality at Peel River above Fort McPherson (1980-2000) (Czarnecki 2008).

Table 3.2-2
Summary of NWT Water Quality Monitoring Conducted by the Canadian Environmental Sustainability Indicators Initiative for the 2005-2007 Period

Station Name	River Drainage Basin	Sampling Year	Water Sampling Variable	WQI Category*
Peel River at Fort McPherson	Lower Mackenzie	2005-2007	Chloride, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good
Yellowknife River upstream of Yellowknife Bay	Lower Mackenzie	2005-2007	Arsenic, Chloride, Chromium, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good
Hay River near Alberta/NWT Border	Lower Mackenzie	2005-2007	Chloride, Copper, Iron, Ammonia, Nitrogen, Oxygen, Phosphorus, Lead, pH, Zinc	Fair
Marian River at Frank's Channel	Lower Mackenzie	2005-2007	Arsenic, Chloride, Chromium, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good

Table 3.2-2 (Cont'd)
Summary of NWT Water Quality Monitoring Conducted by the Canadian Environmental Sustainability Indicators Initiative for the 2005-2007 Period

Station Name	River Drainage Basin	Sampling Year	Water Sampling Variable	WQI Category*
Cameron River below Reid Lake	Lower Mackenzie	2005-2007	Arsenic, Chloride, Chromium, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good
Liard River at Fort Liard	Lower Mackenzie	2005-2007	Chloride, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good
Mackenzie River at Strong Point	Lower Mackenzie	2005-2007	Chloride, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good
Mackenzie River at Norman Wells	Lower Mackenzie	2005-2007	Chloride, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Fair
Mackenzie River above Arctic Red River	Lower Mackenzie	2005-2007	Chloride, Copper, Iron, Ammonia, Nitrogen, Phosphorus, Lead, pH, Zinc	Good

*Description of Water Quality Index Category
Good – Water quality measurements rarely exceed water quality guidelines and, usually, by a narrow margin.
Fair – Water quality measurements sometimes exceed water quality guidelines and, possibly, by a wide margin.

Source: Canadian Environmental Sustainability Indicators http://maps-cartes.ec.gc.ca/indicators-indicateurs/waterTable.aspx

Turbidity levels measured at three locations on the Mackenzie River have fairly consistently exceeded the guideline level for protection of freshwater aquatic life as demonstrated in Figure 3.2-3. At the downstream location above Tsiigehtchic, the turbidity level has consistently exceeded the guideline on approximately 80% of the samples collected since the 1960s. A consequence of the elevated suspended sediment levels in the Mackenzie River is elevated levels of certain metals (aluminum, copper and iron) as demonstrated in Figure 3.2-4. A similar observation was made for the Peel River – metal exceedances are associated with metals attached to suspended sediments (Czarnecki 2008). On the Great Bear River near the outlet of Great Bear Lake the turbidity level was mostly below the guideline and the frequency of exceedance of the respective guideline values for the metals was lower.

Figure 3.2-2
Locations and Ratings for Canadian Environmental Sustainability Indicators (CESI) Water Quality Monitoring for the 2005-2007 Period

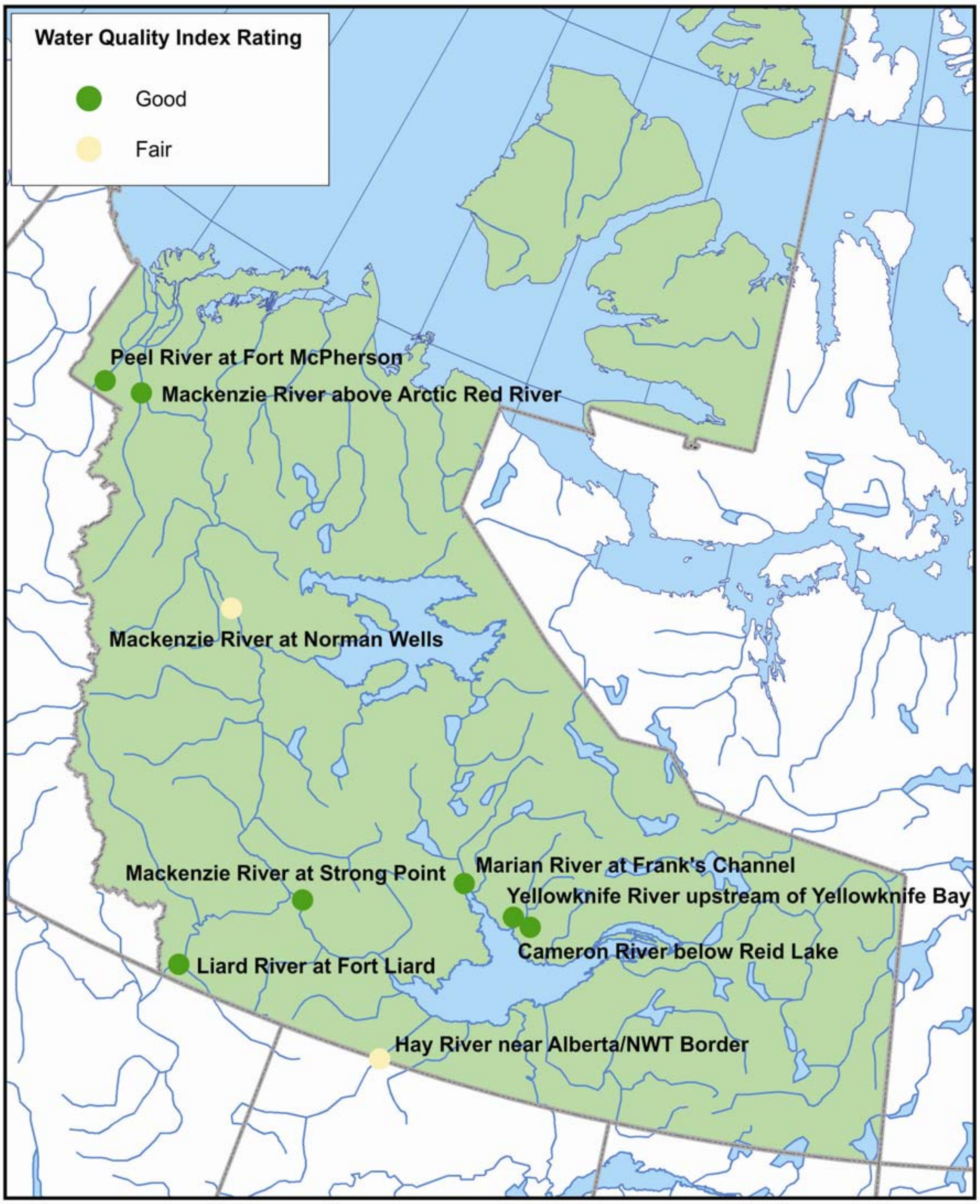
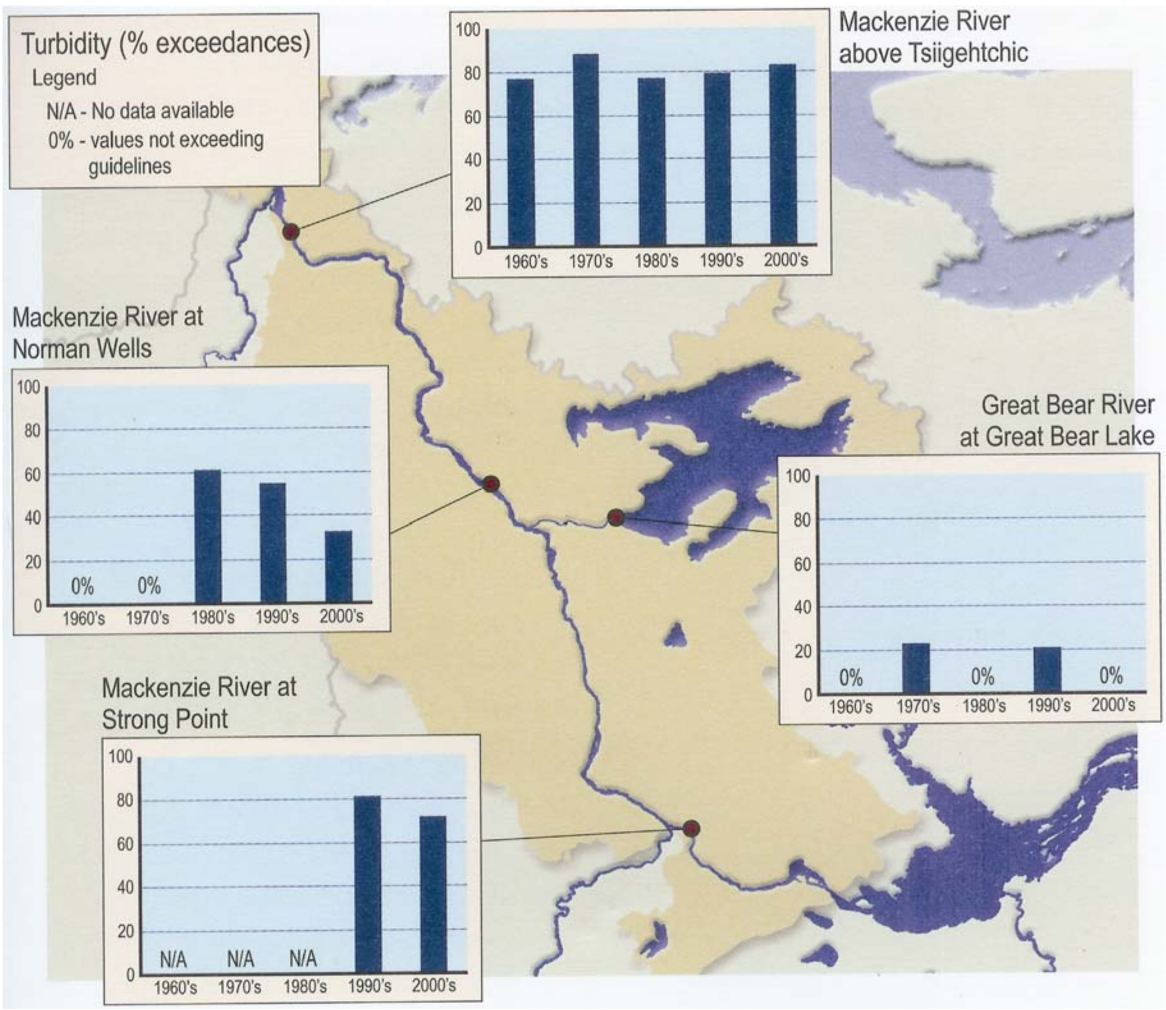
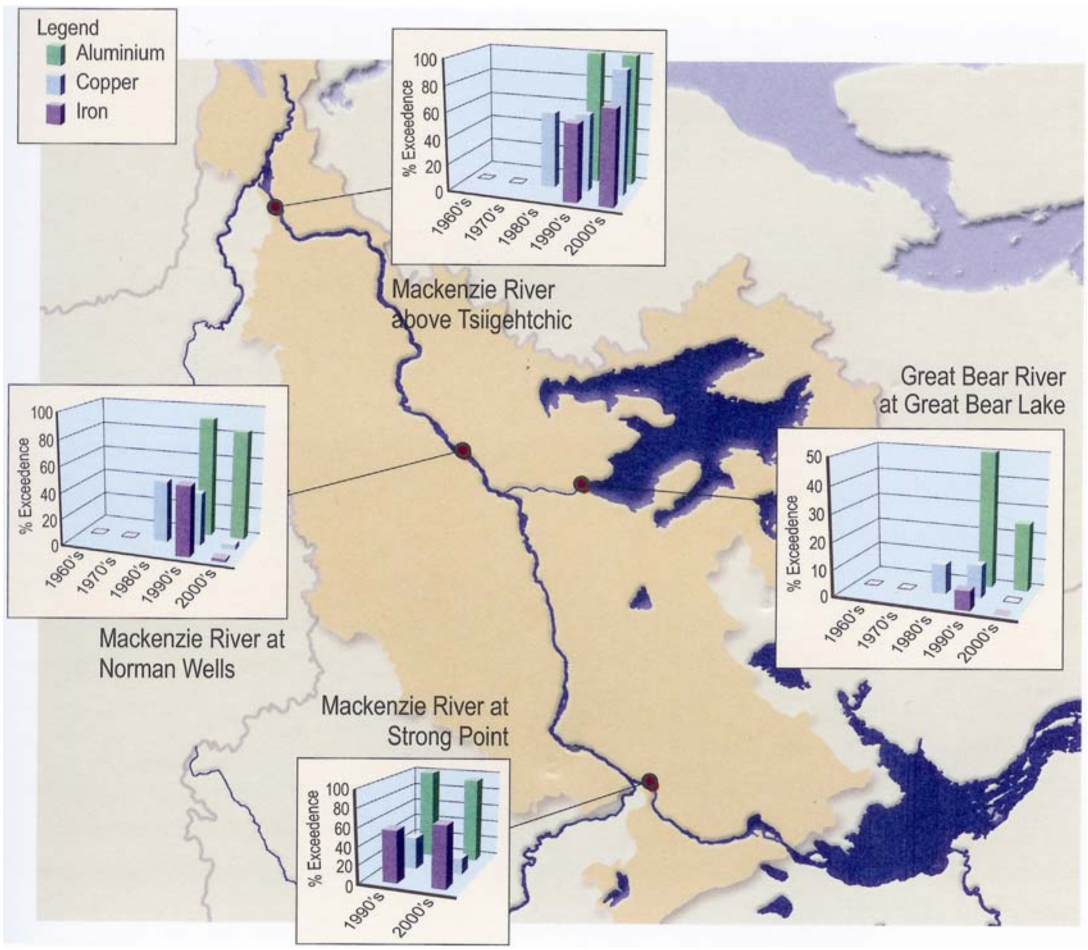


Figure 3.2-3
Temporal Turbidity Monitoring and Exceedances from Various Locations along the Mackenzie River and Great Bear River



Source: Mackenzie River Basin Board 2004.

Figure 3.2-4
Temporal Metal (Aluminium, Iron, Copper) Monitoring and Exceedances from Various Locations Along the Mackenzie River and Great Bear River



Source: MRBB 2004.

Besides the metals noted above, arsenic is also elevated in local watersheds draining the Giant Mine and Con Mine sites near the City of Yellowknife. For example, on Baker Creek, which flows through the Giant Mine site, arsenic concentrations immediately upstream of the mine typically range from 20 to 60 µg/L (INAC and GNWT 2010). By comparison, the arsenic concentration in the Yellowknife River, which is the city water supply, averages less than 0.3 µg/L.

Why is it happening?

High levels of several metals have been observed to occur mostly in the spring and summer when river flows and turbidity levels are highest. The main factor contributing to elevated turbidity, suspended solids and metal concentrations in rivers is erosion of soils. River sediment loads are affected by the landscape and underlying geology of a region. For example, the sedimentary rocks and glacial tills of the Interior Plains are more easily eroded than the crystalline bedrock that characterizes the Precambrian Shield.

At the local level, elevated metal concentrations around many of the abandoned mine sites in the NWT are attributable to historic releases and in most cases ongoing discharges of either treated or untreated waters. These waters originate from tailings basins, waste rock piles, mine site contaminated areas, open pits and/or underground mine workings.

What does it mean?

The CCME Environmental Quality Guidelines were developed as national reference guidelines. When using the guidelines, the natural environmental conditions and unique aspects of specific water bodies or watersheds must be considered. Therefore, the fact that several exceedances of the guidelines have been observed in the NWT does not necessarily mean that plants and animals that are native to these waters are at risk. Metals attached to suspended sediments makes their availability for uptake by fish and other aquatic life very low.

Metals, including aluminum, copper, iron and zinc, exist in various chemical forms in water, depending on numerous characteristics of the water. Depending on the metal form, it may or may not be toxic to aquatic life. Because some metals have likely been present at elevated concentrations for thousands of years in rivers on the Interior Plains, it is likely that the plants and animals present in these waters have adapted to these conditions or that the metal of concern is not bioavailable to the organism (MRBB 2004).

What is being done about it?

Water quality monitoring continues be carried out by federal, territorial and municipal governments at long-term sites and by industrial proponents at new developments. Federal, territorial and regional legislation is in place to regulate the discharge of wastewaters to the natural water bodies in the NWT. Water licences are required by communities and industries for the use of water and discharge of wastewater. The licences set limits on the amount of water that can be used and on the quality and quantity of wastewater that can be discharged. When developments are proposed, environmental and health impact assessments must be carried out and submitted to the appropriate authorities for review.

Under the federal contaminated sites action plan (FCSAP) being administered by INAC, corrective action is being taken at a number of priority sites to remediate existing conditions and minimize the future release of untreated mine waters. As part of the process, detailed environmental risk and impact assessments are required to ensure that adequate protection of the environment is incorporated into the remediation design.

What are the information gaps?

While turbidity and levels of some metals exceed CCME environmental quality guidelines in numerous rivers, the causes are largely natural in origin. Future monitoring will be useful in determining changes in water quality as they relate to climate change effects. The number of long-term monitoring station is limited however, in comparison to the geographic size of the NWT. Logistical and cost considerations have limited the number of stations and frequency of sampling that has been undertaken in the past. Means of expanding the current regional surface water quality monitoring to include key locations in unmonitored watersheds would be beneficial. Integration of more intensive local research into the long-term monitoring network database would be another means of expanding the water quality database.

Although snow is known to be important for bringing contaminants to the surface (e.g., mercury), more needs to be understood about how this happens, and what happens to the contaminants once they reach the surface.

3.2.4.2 Sediment Quality

What is being measured?

Measurement of contaminant levels in sediments is important for several reasons. First, even trace levels of contaminants in surface water can be removed and accumulate in river or lake sediments. Second, contaminated sediments have been demonstrated to be toxic to sediment-dwelling organisms and fish. Third, sediment core samples can provide insight to trends in environmental contaminant inventories in the environment. For example, many contaminants make their way in the north via atmospheric dispersion processes. Steps taken to reduce or eliminate the usage of certain contaminants are reflected in the levels measured in sediments. In this regard, a number of sediment core investigations have been undertaken in the NWT.

What is happening?

Various types of POPs have been found in sediments in Great Slave Lake and some high Arctic lakes. In Great Slave Lake, POPs are usually found at higher levels in the sediments at the mouth of the Slave River in the West Basin than elsewhere in the lake (INAC 2003). Sediment cores taken close to the mouth of Slave River showed increased trends in PCB concentrations with time and a similar trend in PAHs with most of the increase associated with lightweight PAHs of probable petrogenic origin. Concentrations of PCDDs were highest in the 1950s and decreased thereafter. No trend was evident for PCDFs, which occurred in substantially lower concentrations than PCFFs (INAC 2003).

Investigations into the fate of POPs and mercury in Amituk Lake on Cornwallis Island have shown that a majority (greater than 95%) of the POPs are not removed to lake sediments but rather either remain in the water column or disappear over time (INAC 2003). For example, half of the HCHs and over 90% of the endosulfan were observed to disappear within a year. For these contaminants, microbial degradation has been identified as an important reason why some POPs have disappeared. In contrast, it was found that approximately 25% of the mercury entering Amituk Lake was removed to the lake sediment. A large portion (approximately 70%) of the mercury input to the lake was attributed to atmospheric deposition on the watershed.

A number of studies of mercury in sediments have been undertaken in the NWT and are summarized in NCP Phase I and II reports. In general mercury levels in sediments were below the CCME Interim Sediment Quality Guideline (ISQG)[2] of 170 nanograms per kilogram. Mercury levels measured on a series of sediment cores taken from the Mackenzie Delta showed no enrichment of mercury in the upper layers suggesting no increase in inputs of mercury from any sources. A notable exception to the above observation is seen in Giauque Lake, which was impacted historically by the operation of a gold mine that used mercury in the gold recovery process. Core samples taken from Giauque Lake were found to provide accurate accounts of the history of the mine operation. Elevated mercury levels have also been recorded on sediment samples collected from the east end of Great Bear Lake near former silver mine operations.

Arsenic has been measured in sediments in the northern portion of Yellowknife Bay on Great Slave Lake, in the vicinity of the former Giant Mine. Total arsenic concentrations ranged from 6.9 µg/g to 2250 µg/g, with a median of 171 µg/g (dry weight = dw) (INAC and GNWT 2010). In contrast, the CCME guidelines for arsenic in sediment are: ISQG = 5.9 µg/g (dw) and Probable Effect Level[2] (PEL) = 17 µg/g (dw). The highest concentrations were generally found along the western side of North Yellowknife Bay from the mouth of Baker Creek to the north of the historic tailings deposit, with concentrations generally decreasing with distance from this zone. The measured concentrations are comparable to those of previous sampling in Back Bay and Yellowknife Bay (INAC and GNWT 2010).

[2] CCME provides what are designated Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL). An ISQG represents the concentration below which adverse biological effects are expected to occur rarely (i.e., an ISQG represents the upper limit of the range of sediment constituent concentrations dominated by no effects data). A PEL defines the level above which adverse effects are expected to occur frequently (i.e., the PEL represents the lower limit of the range of constituent concentrations that are usually or always associated with adverse biological effects).

Why is it happening?

The decline observed in most POPs in lake sediments is related to declines in atmospheric concentrations over northern Canada. Decreases in the HCH pesticides are due to restricted usage of chemicals and to microbial degradation of residual levels found in the environment. The main exceptions are the insecticides dieldrin and endosulfan, which are still being used in some parts of the world (INAC 2003). There is no clear indication whether mercury levels in the atmosphere, which is the main source of mercury input to the aquatic environment, are increasing or decreasing over northern Canada.

What does it mean?

The concentrations of POPs in lake sediments in the NWT are generally not considered to pose a risk to sediment-dwelling organisms or to fish. As a consequence of restrictions on the use of several toxic insecticides and pesticides, the concentrations in lake sediments are decreasing. While some POPs are amenable to biodegradation, most are only slowly degradable in the environment. The cold conditions prevalent most of the year in the NWT also does not favour biodegradation of POPs.

Of the metals, mercury is of the greatest concern due to the fact that it biomagnifies in the food chain. Elevated mercury levels in some fish species in some parts of the NWT has caused consumption advisories to be issued. Monitoring data on mercury levels in lake sediments do not indicate an increasing trend which suggests that there has not been an increase in mercury input sources in the NWT. Atmospheric levels of mercury, which is the principal source of mercury input to the aquatic environment, similarly do not show an increasing or decreasing trend.

What is being done about it?

Actions to reduce or eliminate sources of POPs and mercury have been initiated by several countries including Canada. Continued initiatives through the United Nations and other international bodies are being pursued to research the toxicity and global transport of contaminants in the Arctic circumpolar regions.

What are the information gaps?

Information on PCBs, pesticides, polycyclic aromatic hydrocarbons (PAHs), dioxins and furans and heavy metals in sediments is very limited with exception of specific investigations on the Slave River at Fort Smith and the Liard River above Kotaneelee River. Long-term monitoring of river sediments and periodic collection of lake sediment core samples is required to better understand the fate of contaminants in the benthic environment.

3.2.5 Surface Water Quantity

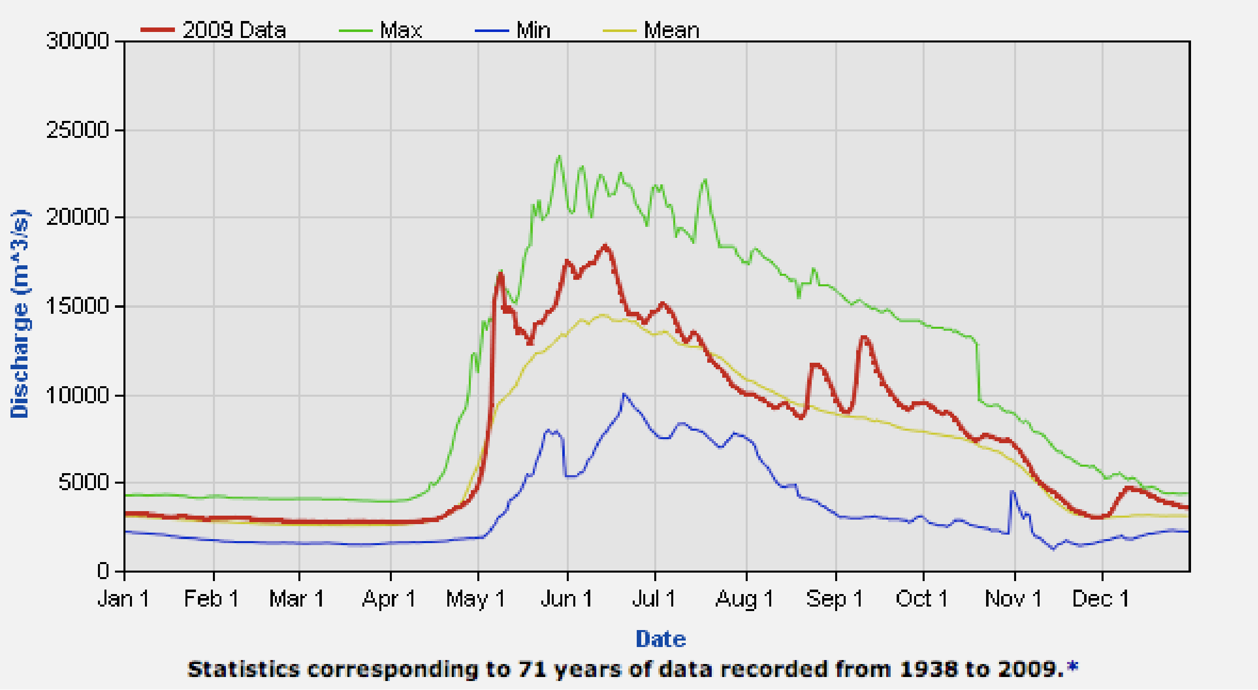
What is being measured?

Stream flows and water levels have been measured throughout the NWT since the early 1960s. A few stations were installed in the 1930s and operated only seasonally in summer, but most are now operating annually. Flow monitoring is generally done by the Water Survey of Canada, with additional financial support by INAC and the NWT Power Corporation. Records of water usage are maintained by the Land and Water Boards, GNWT and INAC.

What is happening?

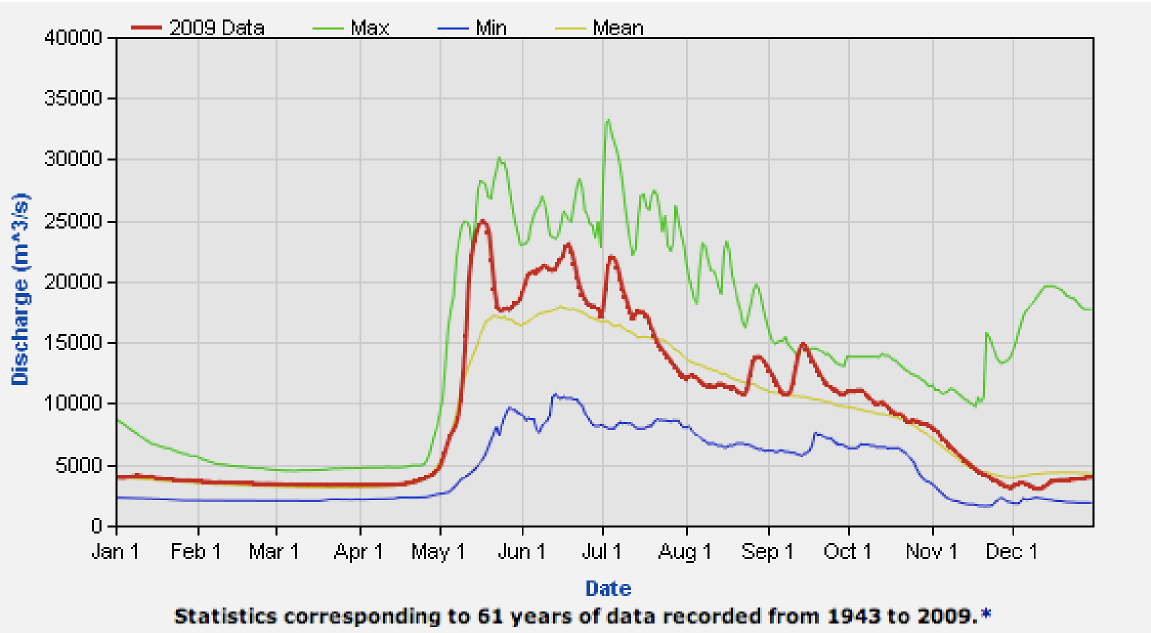
Flow at the mouth of the Mackenzie River averages 9,130 cubic metres per second, of which approximately 50% originates from Great Slave Lake and about 30% from the Liard River. Great Bear Lake provides about 4% of the flow in the summer and 12% in the winter when flow in other tributaries is reduced. The seasonal flow in the Mackenzie River is seen to vary substantially over the 60 to 70 year period of record (see Figures 3.2-5 and 3.2-6 for flows at Fort Simpson and Norman Wells, respectively). Analysis of the flow record shows a stable trend, with no significant changes in mean annual flows of the Mackenzie River at Tsiigehtchic over the 37 year record (1973 to 2009). There is evidence of an increasing trend in water flows in NWT rivers. St. Jacques and Sauchyn (2009) analysed long-term (greater than 30 year's worth of measurements) winter baseflow and mean annual streamflow data for 23 hydrometric stations across the NWT. They found a general significant increasing trend in winter baseflow of 0.5-271.6 % per year. For 39 % of the stations studied an upward trend in mean annual flow was also found. Figure 3.2-7 shows mean annual flows for four rivers in the Mackenzie River basin, from the 1960s to 2009.

Figure 3.2-5
Daily Discharge for the Mackenzie River at Fort Simpson (1938-2009)



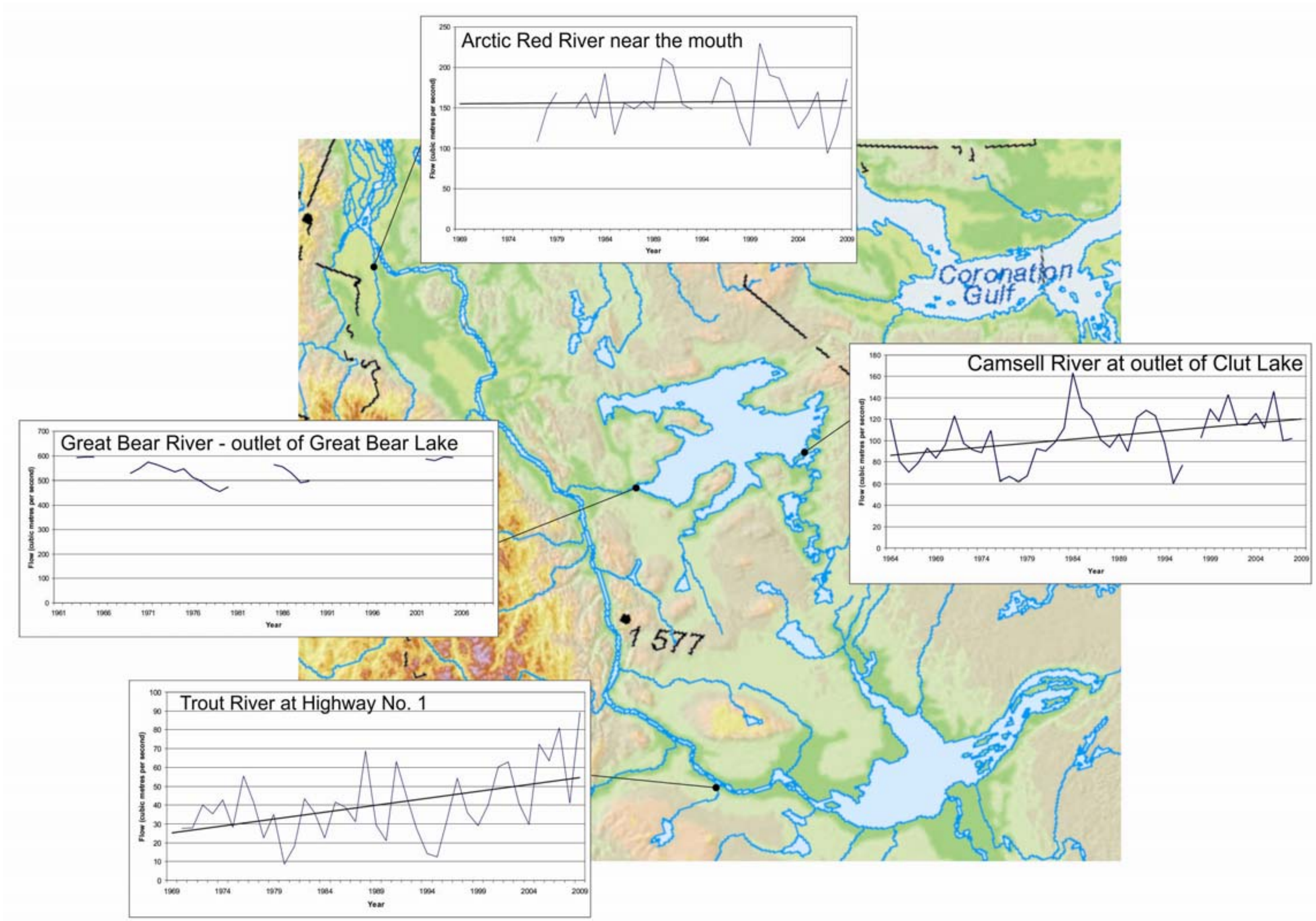
Source: Water Survey of Canada – Archiver Hydrometric Data

Figure 3.2-6
Daily Discharge for the Mackenzie River at Norman Wells (1943-2009)



Source: Water Survey of Canada – Archived Hydrometric Data

Figure 3.2-7
Average Annual Flow in the Mackenzie River Basin

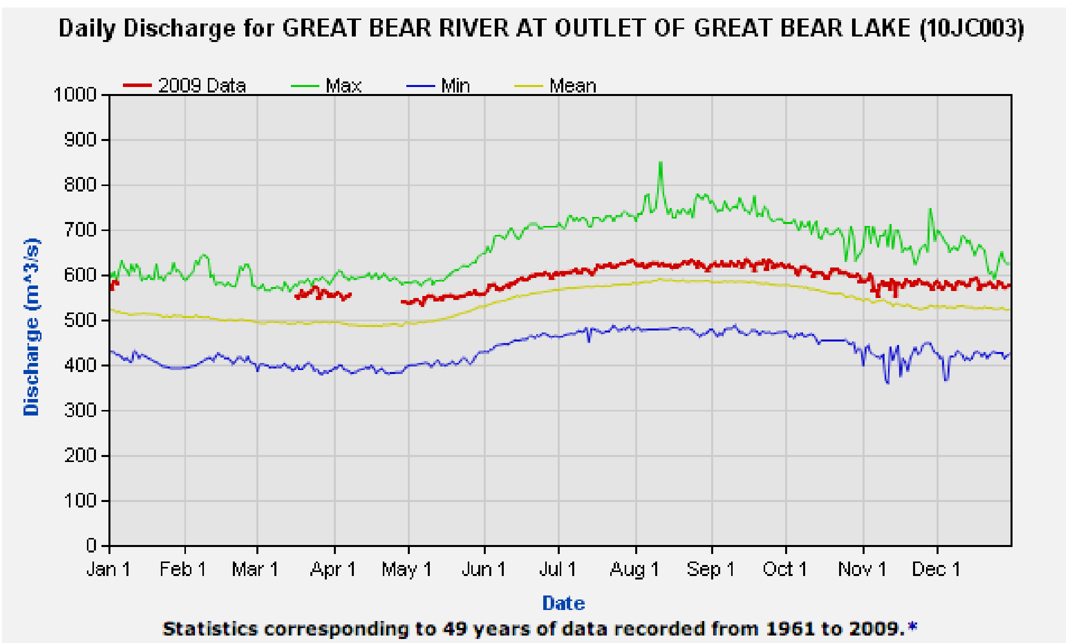


Source: Modified and updated from MRBB 2004

The annual hydrograph for the Great Bear River presented in Figure 3.2-8 illustrates the effect of water storage in Great Bear Lake in attenuating variations in the outlet flow. The mean daily discharge rate only varies by about 100 cubic metres per second over the course of a year (MacDonald *et al*. 2004).

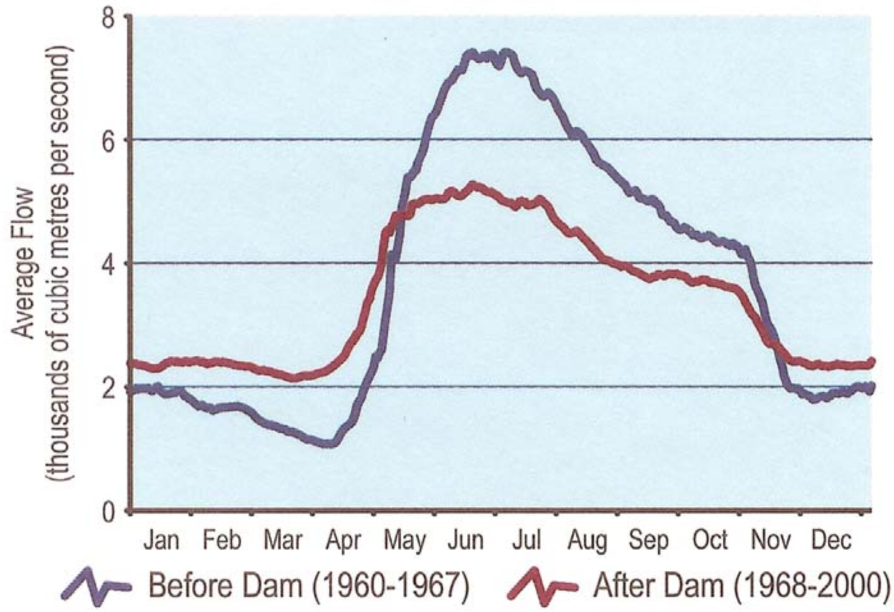
Flow in the Slave River has been found to be affected by the operation of the Bennett Dam some 1,500 kilometres upstream of Great Slave Lake (MRBB 2004). Figure 3.2-9 shows the mean annual hydrographs for flows on the Slave River prior to after construction of the Bennett dam. Average flows from May to October have been reduced by 20% while the average minimum winter flow has doubled. In 2010 Great Slave Lake water levels at Yellowknife Bay reached a record low (see Figure 3.2-10).

Figure 3.2-8
Annual Hydrograph of the Great Bear River, 1961-2009



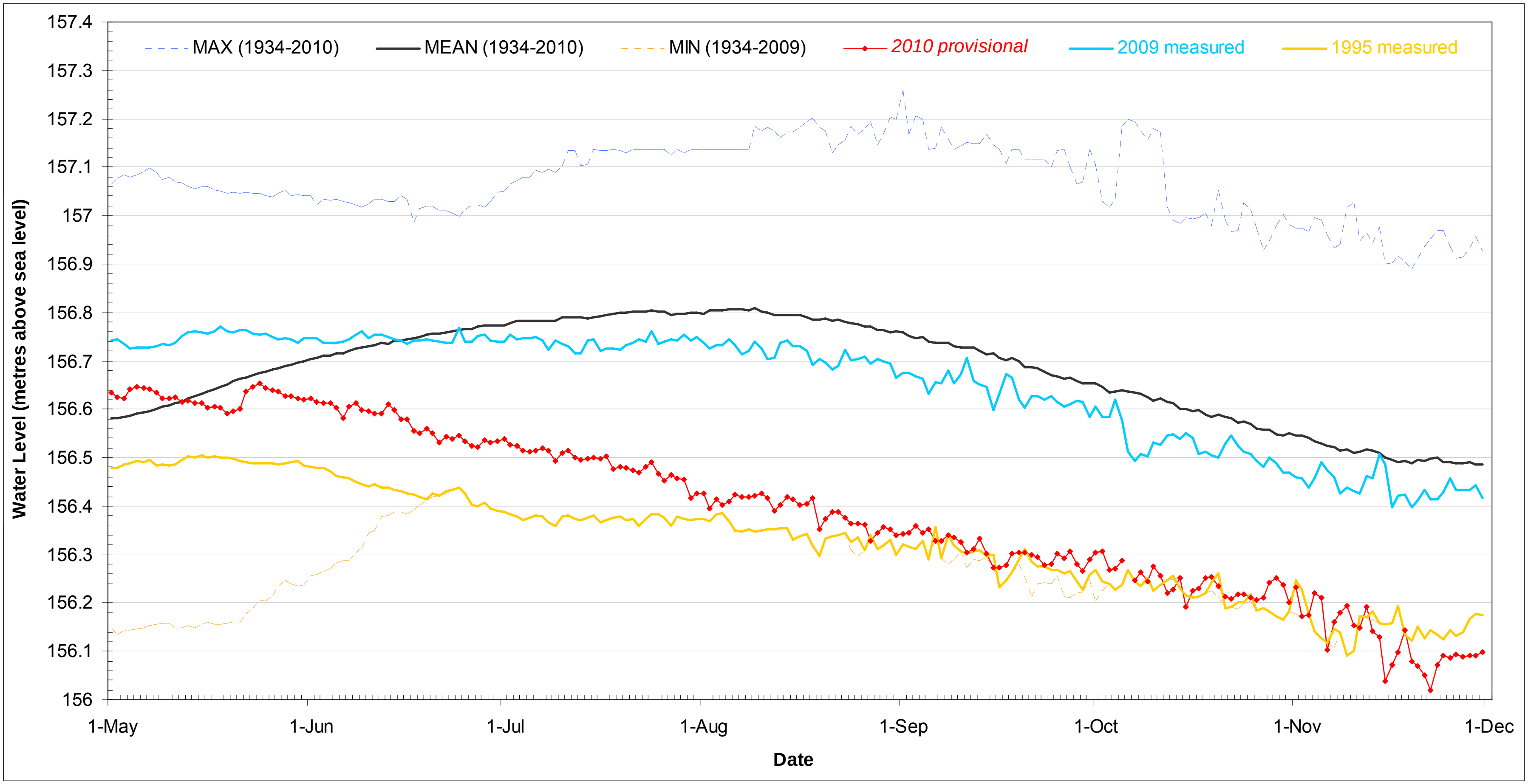
Source: Water Survey of Canada – Archived Hydrometric Data

Figure 3.2-9
Mean Annual Hydrographs for Pre- and Post-Bennett Dam Flows on the Slave River



Source: MRBB 2004

Figure 3.2-10
Water Level of Great Slave Lake at Yellowknife Bay (1934-2010)



Note: "Provisional" data have received limited verification and review for quality assurance.
Source: Water Survey of Canada – Archived and Real-time Hydrometric Data

Why is it happening?

River flow is influenced by several factors including landscape features and climate change effects. On the Slave River, operation of the Bennett Dam has had a marked effect in reducing peak summer flows and augmenting winter flows. Climate variability and regulated flow affect water levels (MRBB 2004). Record low water levels measured for Great Slave Lake in 2010 are the result of drought conditions in northern BC, Alberta and Saskatchewan in 2009 and 2010.

What does it mean?

Changes in river flow rates may affect habitat and populations of fish and other aquatic species. Reduced flows on the Slave River may also limit shoreline erosion and channel scouring, but increase sediment deposition along the river channel. These factors could affect the evolution of the Slave River Delta. Determining the effects of climate change will require many years of additional monitoring.

What is being done about it?

Environment Canada and INAC continue to monitor climate and river flows throughout the region.

What are the information gaps?

River flow data suggest that there may be changes in the peak flow volume, in winter low flow volumes and in the timing of seasonal flow events. Further data analysis is required to determine these trends. Continued monitoring of lake levels and river flows, together with monitoring of climate data are required to gain a better understanding of the effects of climate change and flow regulation on lakes and rivers in the NWT.

3.2.6 Overall Assessment

In 2000, the National Round Table on the Environment and the Economy launched the Environment and Sustainable Development Indicator initiative to identify the assets necessary to sustain a dynamic economy and a healthy society and environment for Canadians. Fresh Water Quality is one of the six national-level environmental indicators that are to be used for reporting on an annual basis. This initiative gave rise to the development of a standardized Water Quality Index (WQI) protocol by the Canadian Council of the Ministers of the Environment (CCME) in 2001. The index summarizes available water quality data into simple terms (e.g., good) for reporting to management and the public in a consistent manner. The index is derived from measured water quality variables that are compared to CCME Canadian Environmental Quality Guidelines (CEQGs) and site-specific water quality objectives where appropriate. The WQI values range from 0 for poor water quality to 100 for excellent water quality. The water quality categories include Excellent, Good, Fair, Marginal and Poor.

For nine sites across the NWT, CESI assessed water quality to be "good" at seven locations and "fair" at 2 locations (CESI 2010). The Peel River monitoring program evaluated water quality to be excellent. The MRBB's State of the Aquatic Ecosystem Report (2004) compared water quality measurements from the Liard, Peel, Great Slave and Mackenzie-Great Bear sub-basins to CCME CWQGs. It was concluded that surface water quality in the Mackenzie River Basin was capable of supporting all the basin's native aquatic plants and animals. Also, they are effectively removed by sedimentation and filtration in drinking water supply treatment plants.

In addition to the above work, water quality data for several sites in the Mackenzie-Great Bear Sub-basin were evaluated against site-specific water quality objectives using several different protocols as recommended by the CCME Water Quality Index technical sub-committee (Sharma 2002, Halliwell 2004). Based on the results of the assessment using the background concentration technique, water quality in the basin was characterized as 'excellent' to 'fair' (Halliwell 2004). Water quality at all sites in terms of major ions (chloride, sulphate, fluoride, calcium and sodium) was categorized as excellent with no obvious increasing or decreasing trends. Due to the high suspended solids load carried in the Mackenzie River and its tributaries, trace metal concentrations frequently exceed guideline values for protection of aquatic life and the waters were categorized as marginal to poor.

In summary, water quality in the Mackenzie River and its tributaries largely reflects natural conditions. There are localized areas with elevated metals or nutrients attributable to wastewater discharges or industrial effluents but the effects are not obvious at the regional level due to the large flow carried by the Mackenzie River and its major tributaries. Stricter regulations and technological improvements have resulted in reductions in contaminant loads entering the environment and in improvements in receiving water quality (MRBB 2004). Current initiatives to remediate abandoned mine sites and former military sites in the NWT will also contribute to improvements in environmental quality near these sites. Similarly, ongoing community-based monitoring should help to ensure that future impacts are minimized.

Continued water quantity and quality monitoring is required to measure the effects of climate change in the North. While flows in some tributaries have remained fairly constant, flows in other tributaries have been seen to show an upward trend consistent with climate change model predictions. Other predicted changes include the timing of ice formation and break-up, loss of permafrost conditions in areas with discontinuous permafrost, frequency and intensity of peak precipitation events. All of these factors may affect not only water quantity but also water quality.

With the exception of some instances of elevated metals at a local scale (e.g., arsenic in Yellowknife Bay), the overall condition and anticipated trends for sediment quality were found to be favourable based upon the information available. However, it was found that information on PCBs, pesticides, polycyclic aromatic hydrocarbons, dioxins and furans, and heavy metals in sediments is very limited across the NWT. Long-term monitoring of river sediments and periodic collection of lake sediment core samples is required to better understand the fate of contaminants in the benthic environment.

3.3 FRESHWATER ENVIRONMENTAL QUALITY

3.3.1 Freshwater Environmental (FE) Indicators

Freshwater fishes total 49 species with valid occurrences in the NWT (Sawatzky *et al*. 2007), and a good number of them offer a potential for monitoring trends and cumulative impacts on the freshwater environment. Some fish species such as non-anadromous Arctic char, Dolly Varden (*Salvelinus malma)*, inconnu (*Stenodus leucichthys)*, or the strictly freshwater Arctic grayling, bull trout (*Salvelinus confluentus)*, burbot, lake trout, northern pike, walleye and whitefish can be monitored for a variety of stressors. It can be argued that such freshwater "resident" fishes are more appropriate species for monitoring changes in the environment than the "migrating" or anadromous fishes such as the sea-run Arctic char, Dolly Varden or inconnu, which have a more complex life-history period in the sea and therefore incorporate a "marine environment" component into their physiology and growth patterns.

Freshwater "resident" fishes positioned high in the food web are particularly sensitive to environmental changes, accumulation of contaminants, and overexploitation due to localized fishing pressure. The large, exclusively freshwater fishes are an important source of fish food to humans year round and are prized sport fish.

The report prepared for the NWT CIMP and Audit Working Group by INAC (2007) entitled "*A Preliminary State of Knowledge of Valued Components*" identified Fish Habitat, Fish Population, Fish Harvest, and Fish Quality as Valued Components (VCs). The report also identified several potential indicators that could be utilized to measure changes and trends over time due to environmental stresses. Table 3.3-1 lists those indicators that are believed to be potentially most useful and the rationale for their selection.

Table 3.3-2 provides a qualitative overview of the availability of data to define baseline conditions. To date, assessment data are generally limited for fish habitat, harvest, and management issues (including contaminant levels in fish) that are of importance to humans. Such information is available for Great Slave Lake and Great Bear Lake, and some inland lakes in the upper Mackenzie River system and northern Mackenzie River. However, as such data are not available on a representative number of waterbodies, from small creeks to large lakes, and on several subwatersheds throughout the NWT, it is not feasible to establish baseline conditions, evaluate the status of the fish Valued Components (VCs), assess cumulative impacts other than in general terms, or analyze data for trends, except on harvest tonnages on a local and regional basis.

Table 3.3-1
Potential Freshwater Environmental Quality Indicators and Rationale for Selection

VC	Indicators	Rationale
Fish Habitat, Population and Harvest		
Fish Habitat	• Aquatic habitat structure and quality • Spawning, rearing and over-wintering locations	• Key determinant of Arctic freshwater processes at all ecosystem levels • Sensitive to climate change, incl. wetlands and lakes drained, increased erosion/siltation and increased landslides frequency associated with melting permafrost; measurable over NWT by satellite • Duration of waters and extent of ice cover; measurable over NWT by satellite • Important determinant of harvesting, transportation, and development activities
Fish Population	• Distribution and abundance	• Low to mid-level consumer, eats invertebrates and smaller fish and is eaten by birds and mammals • Widely distributed over the landscape • Vulnerable to environmental changes and fish species invasions
Fish Harvest	• Population size and age/size distribution of fish stocks • Fish condition (including maturity and fecundity)	• Low to mid-level consumer, eats invertebrates and smaller fish and is eaten by humans • Widely distributed over the landscape • Important traditional food source for residents and supports economically important commercial and sport fisheries • Vulnerable to over-exploitation • Population dynamics and fish condition monitored • Vulnerable to environmental changes and fish species invasions
Fish Quality		
Fish Quality	• Contaminant levels • Diseases and parasites	• Low to mid-level consumer, eats invertebrates and smaller fish and is eaten by birds, mammals, and humans • Widely distributed over the landscape • Important traditional food source for residents and supports economically important commercial and sport fisheries • Contaminant levels, and diseases and parasites monitored

Table 3.3-2
Qualitative Assessment of the Availability of Data to Define Baseline Conditions in the NWT

VALUED COMPONENT		DATA AVAILABLE			
		Poor	Moderate	Fair	Excellent
Fish Presence:	Habitat	√			
	Population	√			
	Harvest		√	√	√
Fish Quality:	Contaminant levels			√	
	Diseases & Parasites	√			

Note: For Great Slave and Great Bear lakes, data available are from fair to excellent.

3.3.1.1 FE Indicator – Fish Habitat

The NWT offers a diversity of aquatic habitats that support a variety of aquatic flora and fauna. The habitats include headwater streams originating high in the mountains on the western flank, numerous small and large rivers (including the Mackenzie River), numerous small lakes, two very large water bodies (Great Bear and Great Slave lakes), extensive wetlands and deltas (including the Mackenzie Delta) and finally the Beaufort Sea. Each of these habitats supports many species that rely on the aquatic environment. The status of these ecosystems and habitats may be affected by a range of factors including changes in land use, industrial developments, construction of pipeline and transportation corridors, long-range transport of contaminants and climate change.

What is being measured?

In response to the environmental impact assessment for the proposed Mackenzie Gas Project (MGP), a series of fishery assessments were conducted through the Sensitive Fish Species Project of the Northern Energy Development Research Program at Fisheries and Oceans Canada. The reviews report knowledge of individual species, with information provided on the species' distribution, habitat use during the various stages of its life history, and about threats posed to the species and its habitat by development activities. Reviews (Stewart *et al*. 2007a, b, c, d) cover the following:

- bull trout (*Salvelinus confluentus*)
- Arctic grayling (*Thymallus arcticus*)
- brook stickleback (*Culaea inconstans*)
- round whitefish (*Prosopium cylindraceum*)

Detailed descriptions on aspects relating to fish spawning, rearing, and overwintering areas; however, are not generally available. The reviews by Stewart *et al*. did not assess habitat but provided a compilation of knowledge from other sources within and outside the NWT. The reports acknowledge data limitations.

Habitat data were collected in 2006 in the Dehcho and Sahtu regions (Mochnacz and Reist 2007a, b) and again in 2007 (Mochnasz *et al*. 2009). The studies focussed on small streams with intermittent flow. Sawatzky *et al*. (2007) compiled existing knowledge to update the taxonomy of the freshwater and anadromous fishes present in the NWT. The report provides maps for fifty-four freshwater and anadromous fish species located in the mainland fresh waters and provides habitat descriptions.

What is happening?

Climate change, species introductions, habitat fragmentation and disturbance, and improved access are possible direct and indirect impacts on fish habitat and its biodiversity. Development pressures are generally localized while climate change impacts are a broader concern. The effects will be gradually induced as a result of physical and chemical changes. Increasing water temperature and precipitation, thawing of permafrost, reductions in durations and thickness of lake and river ice, increases in water infiltration in soils, changes in the timing and intensity of runoff, and increases in the amounts of contaminants, nutrients, and sediments are all predicted to occur (ACIA 2004).

Why is it happening?

Changes in hydrological conditions due to climate warming are expected to affect freshwater habitats. Consequences of climate warming induced changes to aquatic ecosystems were observed and documented by the Mackenzie GEWEX Study (MAGS 2005). These changes have yet to be correlated with changes in life-histories and population dynamics in fishes.

What does it mean?

Increases in water temperature, thawing permafrost, ice cover changes on rivers and lakes, and increasing levels of contaminants, are some examples of changes that will affect fish habitat. Less than optimum thermal conditions may significantly reduce the ranges of some arctic freshwater fishes, including broad whitefish (*Coregonus nasus)*, Arctic char, and Arctic cisco.

With rising temperature and permafrost thawing, drainage from lakes and rivers into groundwater is expected to occur with the consequence that fish habitat may be eliminated in some areas. On the other hand, collapsing of the earth surface will create depressions where new wetlands and water bodies may develop and add new fish habitat to other areas. Major shifts in the landscape may occur along with fish habitat and fish species.

Changes in the timing of ice break-up will affect water temperatures, dissolved oxygen levels, nutrient supplies, sediment loads, and water levels. A change in any of these physical and chemical attributes has the potential to alter the freshwater species composition. A longer ice-free period may also increase evaporation, and lower water levels, however, this effect may be countered by in increase precipitation. Low flows and flood patterns will modify the sediment loads carried by streams and rivers. All of these environmental changes will be reflected by changes in the species composition of freshwater ecosystems (ACIA 2004).

Climate warming is anticipated to increase the rate of contaminant transfer to the Arctic. An increase in atmospheric moisture and precipitation will increase the levels of mercury and persistent organic pollutants (POPs) that are deposited in NWT. With rising temperature, ice and permafrost will melt, mobilizing contaminants. An increase in contaminant levels in arctic lakes can be expected to translate into higher levels in fish, and episodes of high levels of contaminants in watercourses may have lethal effects on aquatic life (ACIA 2004).

What is being done about it?

Fish habitats have been and will continue to be assessed on an as needed basis at new and proposed project sites (e.g., as has been done along the proposed MGP route).

What are the information gaps?

Aside from fish habitat assessments near residential, transportation, and industrial sites, fish habitat information is not commonly collected in the NWT. Within government agencies with objectives to protect and enhance aquatic ecosystems, there has been no consolidation of programs or data, which would allow for an assessment of parameters as indicators of well-functioning aquatic ecosystems over time. As a result, it is not possible to assess changes in fish habitat status. Information on fish habitats and indicators for Great Slave and Great Bear lakes may require some attention to become readily available, and may need to be augmented. Such information for the whole of NWT would be prohibitive and is not considered a gap in the baseline data.

<u>Fish habitat data (spawning, rearing, and overwintering):</u> Effort should be made to compile this data on various fish habitats for the Great Slave and Great Bear lakes, as it relates to the fish harvest data. This data should reach a level of detail that would be useful for future comparisons.

3.3.1.2 FE Indicator – Fish Population

Fish species other than commercially harvested species, have not received much attention, and these account for approximately 36 species of the total of 49 species. For the harvested fish species, data are available on stock status in Great Slave and Great Bear lakes and the upper Mackenzie and northern Mackenzie regions (DFO Science Stock Status Reports), as discussed in a subsequent section.

What is being measured?

Information available on the biology of various fish species, populations and stocks include:

- Distributions of Freshwater and Anadromous Fishes from the Mainland Northwest Territories, Canada (Sawatzky *et al*. 2007).
- The range extension of bull trout in Liard and Mackenzie River basins, with notes on identification and distribution of Dolly Varden in the western Canadian Arctic (Reist *et al*. 2002).
- NWT Species 2006-2010 - General Status Ranks of Wild Species in the Northwest Territories. (Working Group on General Status of NWT Species 2006). One of four ranks was provided: “at risk”, “may be at risk”, “sensitive” or “secure”. In some fishes, the problem with current status was related to lack of information.
- The stock status in Great Slave and Great Bear lakes on some fish species.
- An Assessment of walleye from Tathlina Lake in the Dehcho region (Gallagher 2010).
- A variety of DFO Data and Technical Reports on some fish species and stocks, including round whitefish, brook stickleback, Arctic grayling, and bull trout (Stewart *et al*. 2007a, b, c, d), anadromous Arctic char of the Hornaday River (Harwood 2009), and anadromous Dolly Varden char of the Rat River (Harwood *et al.* 2009, Sandstrom *et al*. 2009).

What is happening?

Some information exists on commercial fish populations and their distribution in the NWT, but it needs to be compiled appropriately and augmented. Research on fish taxonomy, communities and assemblages, life history types, population structures, and biogeography of Arctic fishes, including landlocked and anadromous fishes has been funded through the Sensitive Fish Species Project of the Northern Energy Development Research Program at Fisheries and Oceans Canada. Fish distribution (and communities/assemblages) needs to be well documented as it is expected to change with climate warming.

Of the fresh water fish species whose status has been assessed in the NWT, 10 are “at risk”, “may be at risk”, or “sensitive” (Working Group on General Status of NWT Species, 2006). These are as follows:

- Shortjaw Cisco (*Coregonus zenithicus*) At Risk
- Bull Trout (*Salvelinus confluentus*) May Be At Risk
- Pearl Dace (*Margariscus margarita*) Sensitive
- Brook Stickleback (*Culaea inconstans*) Sensitive
- Walleye (“Pickerel”) (*Sander vitreus*) Sensitive
- Arctic Cisco (*Coregonus autumnalis*) Sensitive
- Dolly Varden (*Salvelinus malma*) Sensitive

- Inconnu (Coney) (*Stenodus leucichthys*) Sensitive
- Arctic Grayling (*Thymallus arcticus*) Sensitive
- Deepwater Sculpin (*Myoxocephalus thompsonii*) Sensitive

The population status of some fish species in Great Slave Lake is summarized in Table 3.3-3. In the 1960s and 1970s, changes occurred in the fish populations and assemblages caused by commercial gillnetting, certainly with some decline in the populations of some species. Lake trout declined dramatically, while inconnu and walleye populations were reduced locally. In recent years, fish stocks in Great Slave Lake are reported as stable (MRBB 2004).

Table 3.3-3
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.

Source: MRBB 2004

Why is it happening?

On Great Slave Lake, exploitation has affected fish populations and stocks. Commercial fishing for instance decimated the lake trout stocks in the West Basin of the lake, as the species is unable to withstand intense commercial gillnetting. In contrast, whitefish is more resilient and commercial fishing has not affected their populations to the same degree (MRBB 2004).

What does it mean?

Overall, the NWT is largely untouched by human activities, and as a result, relatively few fish species are at risk compared with areas in Canada's south. Great Slave Lake fish are exploited by several types of fisheries activities, which can affect and deplete populations and stocks. It is therefore imperative to manage the fisheries with proper planning and regulations, record and continue to monitor harvests, and assess the stocks (MRBB 2004).

On Great Bear Lake, a quota was placed on the trophy lake trout stock in 1987; however, the lake trout population is not believed to be at risk as annual harvests have been well below the quota (MRBB 2004). For Great Bear Lake as a whole, insufficient information is available to determine the abundance of fish species utilizing habitats in Great Bear Lake (MacDonald 2004).

What is being done about it?

Overall, DFO performs management and research activities on fish populations and stocks in co-operation with stakeholders. The Working Group on General Status of NWT Species, the GNWT Department of Environment and Natural Resources, compiles data on the status of fishes, populations and stocks, and uses this information to set conservation objectives.

With respect to Great Slave Lake, the East Arm is managed for a trophy lake trout fishery and some inshore areas are for subsistence fishery. The incomplete fishery information has led DFO to take a conservative approach in protecting fish stocks. On Great Bear Lake, fish management is carried out through a cooperative arrangement between the various local, regional, territorial and federal parties. In 2005 the Great Bear Lake Management Plan was prepared by the Great Bear Lake Working Group.

What are the information gaps?

<u>Information on distribution and abundance of fish species (commercial and non-commercial):</u> Fish distribution, communities and assemblages, life history types, population structures for Arctic freshwaters are relatively unknown. This type of data is most important for the study of cumulative impacts and climate warming. Major changes in fish distribution (communities/assemblages) are expected. It has been postulated that some fish species that are currently present in the southern regions of the NWT will disappear and be replaced by other fish

species found further to the south that have adapted to warmer water conditions. In this regard, the distribution of commercial and non-commercial fish species should be monitored on the most important water bodies in the NWT.

Data from the fish harvest could be useful to derive population and stocks parameters: These data can be used to derive population parameters relating to: (1) Energy Use; growth and reproductive investment, (2) Survival; age structure and length frequency analysis, and (3) Energy Storage; condition. Fish abundance is measured from fishing effort indices. Sufficient information appears available to derive new data, even assess trends at some local and regional levels within the NWT.

Freshwater fishes that "may be at risk": Freshwater fish species that are listed as "may be at risk" is an example of an area where there is a lack of information that should be resolved. Fish species monitoring is important for a continued awareness of changes to the ecosystem.

Freshwater fish populations and stocks: Population and stock status of most species is relatively unknown and more work is needed on that subject. For instance, on Great Slave Lake, fish stock assessment studies are needed to determine the current status of lake trout as well as other important fish species throughout the lake. In the Mackenzie-Great Bear Sub-basin, broad whitefish and lake whitefish remain the most sought after species for food. However, status on these species, populations and stocks are unknown.

3.3.1.3 FE Indicator – Fish Harvest

Fishing is an important activity in the NWT, be it for subsistence, sport or commercial purposes. These different aspects of fishing bring competing demands on the natural aquatic resource and pose a challenge to fisheries managers. Overall, information on subsistence, sport and commercial harvests is diverse making interpretations difficult to apply over the NWT (MRBB 2004).

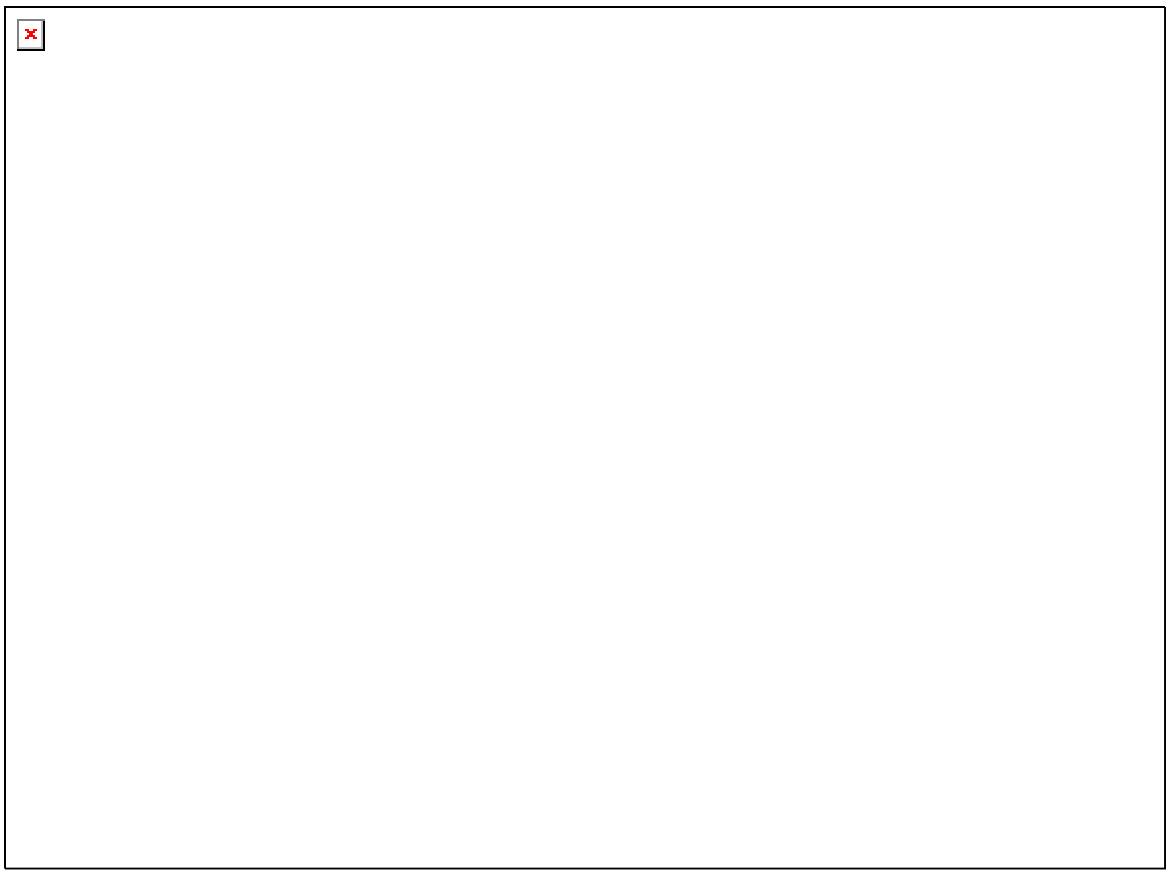
Commercial fisheries harvest whitefish (broad whitefish and lake whitefish, inconnu (coney), lake trout, northern pike, burbot or loche (*Lota lota)*, and walleye (*Stizostedion vitreum)*. While most of the fish populations and stocks remain healthy over the landscape, few populations or stocks have been as overexploited in the past by the localized fishing than Arctic char (*Salvelinus alpinus)*. Through community-based management plans designed at sustaining harvest, Arctic char is rated as "secure" from its previous rating of "extirpated" (Working Group on General Status of NWT Species 2006).

What is being measured?

Fish harvest studies and monitoring have been / are carried out at various locations across the NWT where there are commercial operations or important subsistence fisheries.

On Great Slave Lake, fisheries management is a matter of achieving a balance between subsistence, sport and commercial fishing versus the sustainability of all fish species and stocks. Great Slave is divided into six management areas (Figure 3.3-1), each with its own fisheries plan. Commercial fishing occurs in the western and central areas, while the East Arm area is managed as a trophy lake trout fishery and some other areas are managed for subsistence fishing. In the western area, the commercial fishery has been primarily targeted at lake whitefish since the collapse of the lake trout stocks in the mid 1960s. The Great Slave Lake whitefish fishery is the largest freshwater fishery in the northern territories of Canada. From the 1970s to the present, DFO has conducted systematic sampling of the landings to assess population characteristics (Tallman and Friesen 2007).

Figure 3.3-1
Map of Administrative Fishing Areas in Great Slave Lake



Source: Mackenzie River Basin Board 2004.

In the late 80's, the Kakisa River was considered to be the NWT's 2nd most important sport fishery (Read and Roberge 1989). Kakisa Lake, along with Tathlina Lake and Great Slave Lake, account for almost all of the commercial walleye production in the NWT (Lemm 2002). Kakisa

Lake itself produced on average 44% of the NWT's total walleye production between 1946 and 1986 (Roberge *et al.* 1986). Production records of the Kakisa Lake fishery have been collected since 1953 although relatively little has been published on these numbers over the years (SENES 2008). Harvest data from Tathlina Lake was first collected in 1954 and, after a three year gap, was collected every year since (SENES 2008). Recently, the Fisheries and Aquaculture Management Sector of DFO sought advice on the current status of the stock, recommendations on a total sustainable harvest level for 2010/11, and the development of a long-term monitoring plan for the fishery (Gallagher 2010).

Concerns from residents of Fort McPherson about the status and health of the Rat River Dolly Varden prompted DFO to conduct studies on the Rat River in 1983, 1986 and 1989, and more recently, to assess the status of the stock through sampling of the subsistence catches from 1995-2007, building on earlier years of monitoring (Harwood *et al*. 2009). A separate study at Fish Creek on the Rat River reports on assessments at the spawning site for the same period as the monitoring study of Harwood *et al*. (2009) (Sandstrom *et al*. 2009).

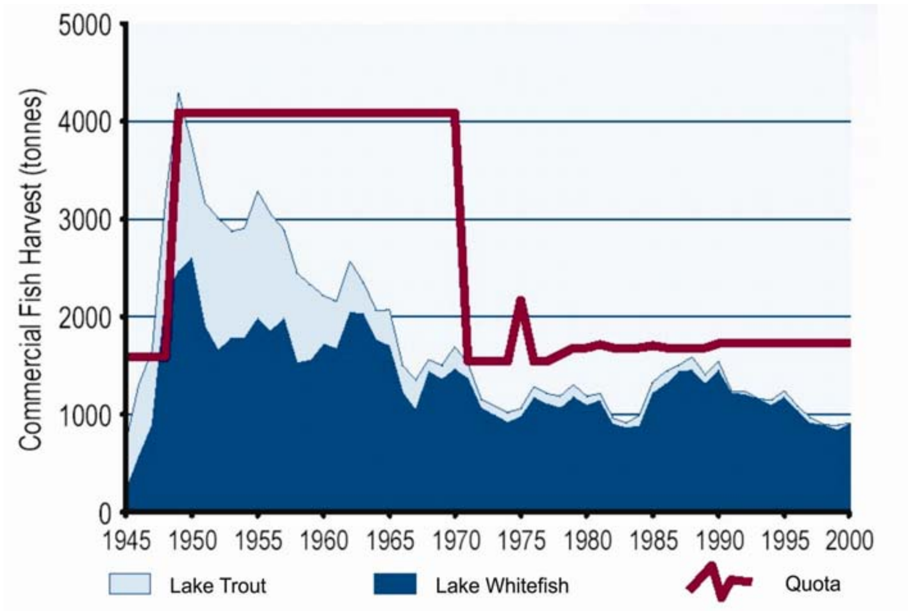
The trophy lake trout fishery on Great Bear Lake is shared between the subsistence and sport fisheries. The lake is divided into five lake trout management areas, with one area (Keith Arm) still without a fishery plan. The lake trout harvest from Great Bear Lake declined steadily from the early 1970s to 1990 but is believed to be in good shape.

What is happening?

The annual harvest from Great Slave Lake has been between 1,000 and 1,500 metric tonnes from the mid 1970s until the present. Figure 3.3-2 shows the whitefish and lake trout harvests through 2000. Lake whitefish currently makes up 93% of the commercial catch, while other species such as lake trout, walleye, inconnu, and northern pike, constitute about 5% of the commercial catch (Tallman and Friesen 2007). Annual production of all species peaked in 1949 at 4,055 tonnes and declined steadily to approximately 1,250 tonnes by the early 1970s where it remained until the early 1980s when it decreased to 900 tonnes. Production climbed steadily during the later half of the 1980s to 1,500 tonnes, but from the early 1990s to the present, production has declined steadily to approximately 900 tonnes (Tallman and Friesen 2007).

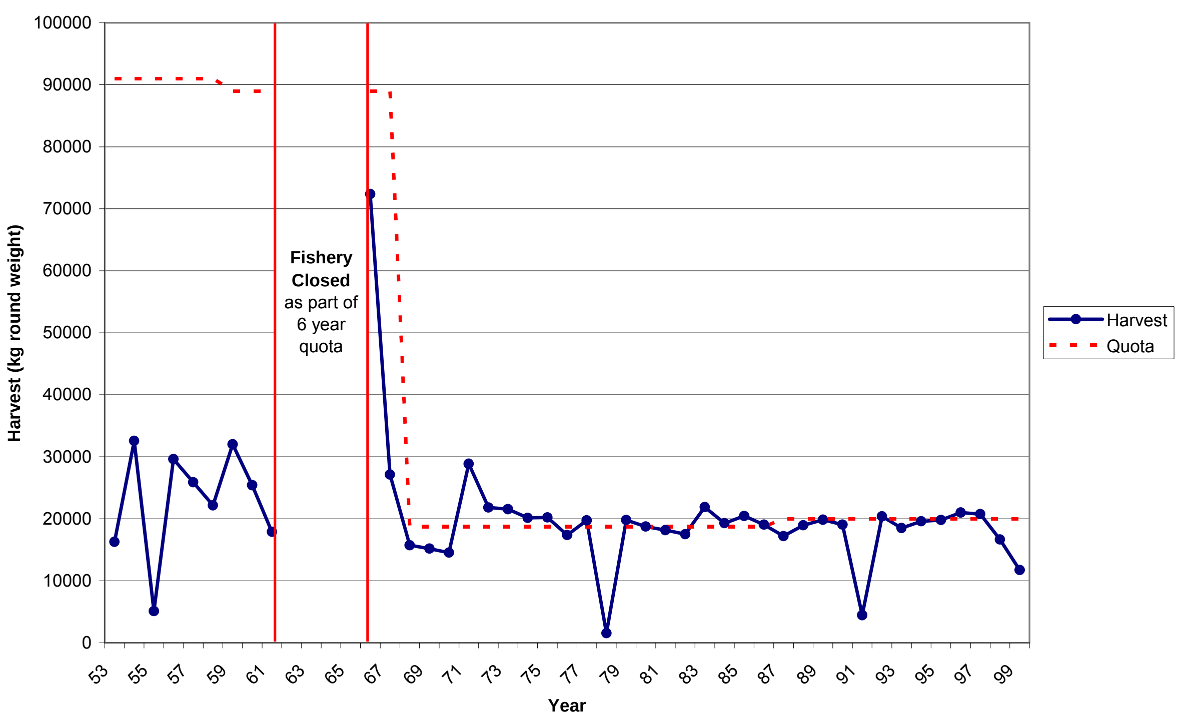
For Kakisa Lake, harvest numbers have fluctuated widely over the years, from 4,452 kg in 1991 to 72,365 kg in 1966 (Figure 3.3-3). During the 1998/1999 season, fishermen expressed concern about the state of the Walleye stocks in Kakisa Lake when they noticed a decrease in their CPUE (Stewart and Low 2000). After assessment, the fishery remained open at the previous regulations. In the 2006/2007 season, with the changes in the operating schedule of the Hay River fish processing plant and a decrease in interest from local fishermen, harvest numbers were only 50% of the quota (SENES. 2008). The quota still stands at 20,000 kg.

Figure 3.3-2
Commercial Fishing Harvest and Quota from Great Slave Lake, 1945 to 2000



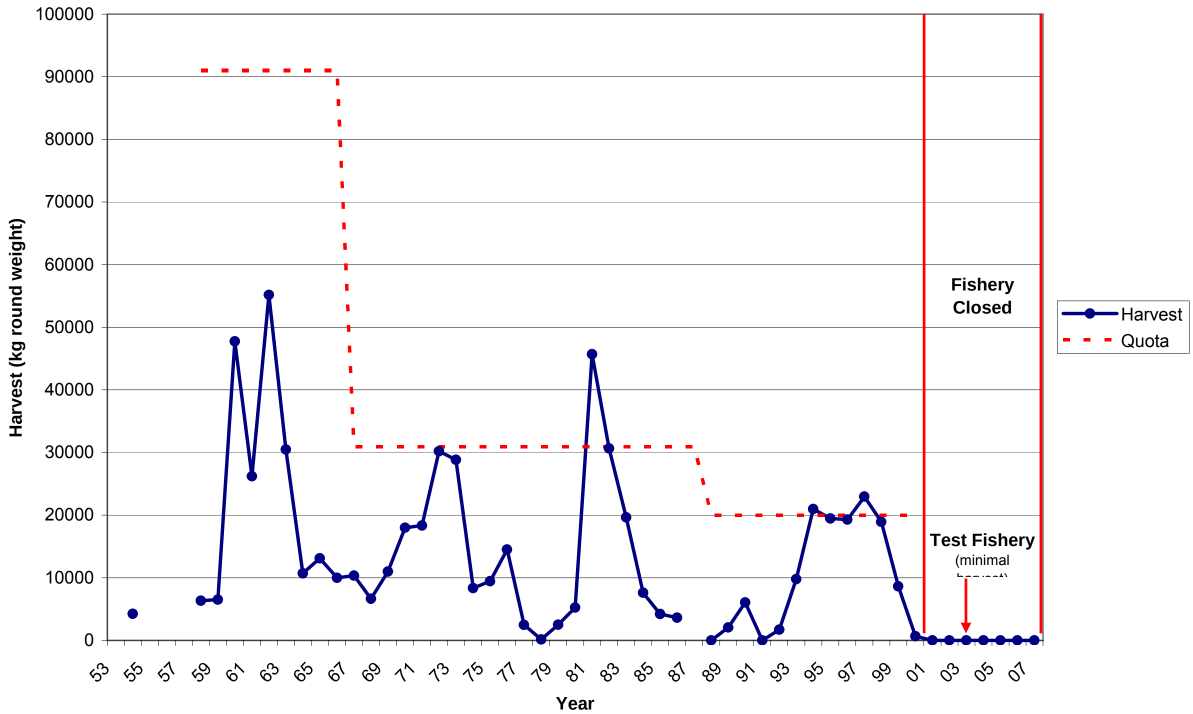
Source: Mackenzie River Basin Board 2004.

Figure 3.3-3
Walleye Harvests From Kakisa Lake, 1953-1999



Available data on Tathlina Lake harvest numbers are summarized in Figure 3.3-4 (SENES 2008). Although producing less walleye for the commercial markets than Kakisa Lake, Tathlina Lake was (until recently) one of the three most productive walleye lakes in the NWT (Lemm 2002). Data collected from experimental gill netting between 2001 and 2007 suggest an improvement in the status of the walleye in Tathlina Lake (Gallagher 2010).

Figure 3.3-4
Walleye Harvests From Tathlina Lake, 1954-2007



In response to community concerns, recent assessments have been conducted on the status of dolly varden char on the Rat River and Fish Creek (Harwood *et al*. 2009, Sandstrom *et al*. 2009). Significant increases between 1995 and 2007 in size-at-age results, relatively stable sex and maturity composition, and the recent observed pulse of juvenile production are encouraging signs for this stock (Harwood *et al*. 2009).

On Great Bear Lake the subsistence and sport fisheries are very important. The management goal of Great Bear is to conserve a world-class trophy lake trout fishery. The lake trout stock declined until 1984, when studies demonstrated that conservation measures were warranted. Quotas were put in place and five management areas were established. A stock assessment of lake trout conducted by Howland and Tallman (2008) found that although there is considerable variation in biological traits between management areas, the size and age structure along with rates of growth and mortality have remained stable over the last 20 years suggesting that current lodge practices under the existing management scheme are sustainable.

Why is it happening?

On Great Slave Lake, the commercial harvest has declined since 1990. This is due to a reduction in fishing effort and number of commercial boats on the lake. As for the sport fishery, it has increased due to a considerable growth in the Yellowknife population, improvements in highways and increased tourism.

In the Kakisa River and Tathlina Lake area, the fluctuations are likely the result of both environmental factors and changing harvesting pressure. Unfortunately, there is a lack of environmental data on the fishery to be able to determine the extent of the environmental effect (SENES 2008).

For the Rat River Dolly Varden, increases in growth rate and somatic condition in certain years, appears related to the timing of break up of the annual sea ice in the SE Beaufort Sea. Timing of break up in turn influences the timing of the zooplankton bloom and thus the Dolly Varden's access to quantity and quality of prey.

The decline in the number of trout harvested from Great Bear Lake is due to a more conservation-oriented sport fishery, including a catch and release policy.

What does it mean?

The use of fisheries resources has the potential to seriously affect populations and stocks of fishes. Therefore, it is important that the fisheries be managed, regulated, recorded and monitored over time, along with fish stocks evaluation when applicable.

What is being done about it?

Established management areas set quotas for commercial fishing as well as daily catch and possession limits for sport fisheries. Continued monitoring, harvest studies, and development or review of management plans by appropriate bodies is very important.

What are the information gaps?

<u>Subsistence, sport and commercial fisheries:</u>

- Regular monitoring of subsistence fisheries is lacking.
- On Great Slave and Great Bear lakes fishing pressures have the potential to affect, even disrupt fish populations. It is imperative that the fisheries are looked at closely and

managed to ensure sustainability of stocks overtime. Detailed information is required about fish populations and stocks in order to achieve a corresponding good level of fisheries management. On Great Slave Lake, additional information is needed on the subsistence and sport fisheries to complete the understanding of the fisheries resources. Current harvest data for subsistence fisheries are available for Fort Resolution and Fort Smith only.

- Harvest status of broad whitefish and lake whitefish is required.

3.3.1.4 FE Indicator – Fish Quality

Fish such as lake trout, northern pike, walleye, burbot, whitefish and inconnu are increasingly subject to degradation in quality because of contaminants, as well as diseases and parasites. Numerous contaminants have been studied, and since fish play an important part in traditional diets for NWT inhabitants, contaminant levels occurring in fish flesh have been of particular concern. There are three basic classes of contaminants that are generally considered to be of concern; heavy metals, POPs and radionuclides.

Heavy metals that have been found at elevated levels in fish include mercury, cadmium, lead, arsenic, copper, selenium and zinc. POPs that have been found in fish include polycyclic aromatic hydrocarbons (PAHs), chlorinated phenolics, hexachloro-benzene (HCB), hexachloro-cyclohexane (HCH), dichloro-diphenyl-trichloroethane (DDT), polychloro-biphenyls (PCBs), chlordane, toxaphene (chloro-bornanes), dioxins and furans and dieldrin. Of the three classes, radionuclides have received the least attention.

The presence or absence of diseases and parasites is a more visual clue for fish quality. Diseases and parasites are often identifiable at a glance either externally or internally upon cleaning. However, easy identification does not necessarily translate into recognition of changes in fish quality either spatially or temporally.

What is being measured?

Availability of baseline fish quality data varies by watershed, lake or river and fish species. Although fair amounts of sporadic information exist on specific fish species in certain water bodies, there is a general lack of long-term, comprehensive monitoring (INAC 2010b, CIMP 2007).

Longer-term monitoring of contaminants in freshwater fish has been conducted at Fort Good Hope, Great Slave Lake and Slave River. Current data collection includes:

- Burbot for heavy metal and POPs contaminants at Fort Good Hope by DFO since 1999.

- Burbot and late trout for heavy metal and POPs contaminants as well as early warning for new contaminants from Great Slave Lake (West Basin and East Arm) by Environment Canada, and DFO since 1999. Some similar information has been collected since the 1970s.
- Burbot for heavy metal and POP contaminants from Slave River by Environment Canada and DFO since 1999. Similar information was also collected from 1993 to 1995.
- Lake trout for metals and POPs in Great Bear Lake by DFO.
- Lake trout or whitefish in 10 other lakes every five years.

Heavy Metal: *Levels of mercury have been measured since the early 1970s. However, these samples have been limited to commercially important species as well as a range of sizes. More recently, the focus has been on capturing a broader range of sizes from fewer locations. However, the overall data is still largely from fish that are of commercial or traditional interest (INAC 2003). The Northern Contaminants Program remains important for studies (INAC 2010b). Current data collection includes*:

- Mercury, selenium and arsenic in western NWT by DFO and Environment Canada since 1996.
- Mercury information was collected from the Sahtu and Dehcho regions from 1996 to 2000.
- Mercury in predatory fish in lakes of the Fort Simpson area by Environment Canada and DFO since 1998. Previous research for some lakes (Cli Lake, Little Doctor Lake, Willow Lake, Sibbeston Lake and Tsetso Lake) is available.
- Metals in whitefish, northern pike, walleye and lake trout from Lac Ste. Therese by DFO.

Observation of diseases and parasites in fish are not regularly monitored in the NWT. Information that has been collected is by traditional knowledge and not using any particular methodology (CIMP 2007). A community-based monitoring survey conducted by the Arctic Borderlands Ecological Knowledge Co-op in the communities of the lower Mackenzie River basin is active. Annual surveys are conducted to record resource users including fish for quantity and quality by species and location.

What is happening?

Most data produced with respect to heavy metal contamination in fish is on mercury because of human consumption concerns (INAC 2010b). Overall, there is compelling evidence of an increase in mercury in lakes in the NWT with the increases most pronounced in smaller, shallower lakes with large watersheds (Evans *et al*. 2010). This issue was discussed within the Northwest Territories Regional Contaminants Committee with mercury advisories issued in summer 2010 for Kelly and Trout Lakes and extended for Cli and Lac Ste. Therese.

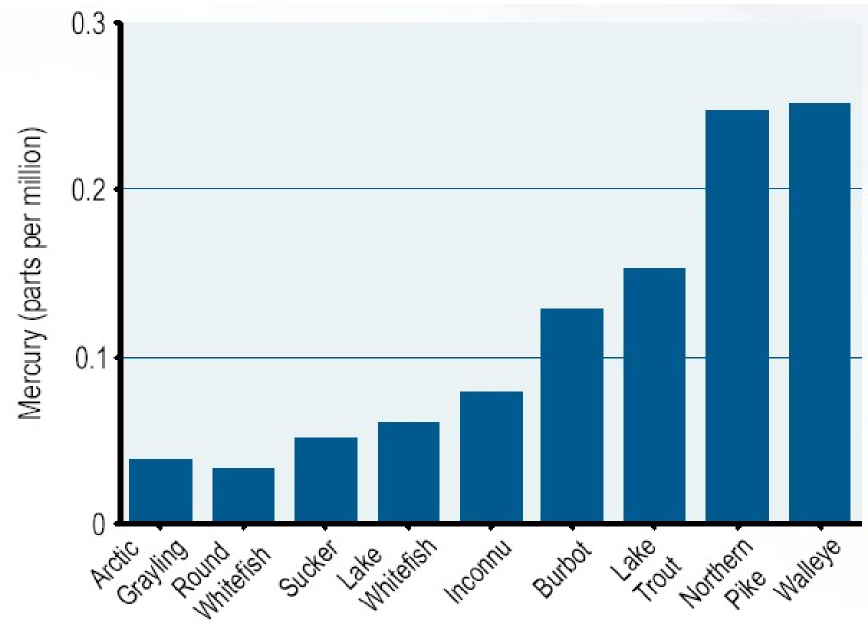
Mercury is the only contaminant that is consistently greater than guideline limits for consumption (<0.2 µg/g (wet weight) by people who eat large amounts of fish) or commercial sale (<0.5 µg/g (wet weight)) (INAC 2003). In a study conducted across Canada's north, Lockhart *et al.* (2008) found that less than one third of lake trout collections had length-adjusted mean values for mercury less than 0.2 µg/g. The problem with mercury in lake trout was somewhat more severe within Nunavut where only 5 of 22 means fell in the lowest range. Overall, muscle tissue of lake trout usually exceeded the subsistence consumption guideline of 0.2 µg/g and often exceeded the higher guideline of 0.5 µg/g for commercial fish sales. The problem in walleye is probably even more severe than it is in lake trout. Figure 3.3-5 summarizes the findings for lake trout (Lockhart *et al*. 2008).

Figure 3.3-5
Map Representation of Mean Levels of Mercury in Muscle of Lake Trout for Lakes in the Yukon, NWT and Nunavut

Source: Lockhart et al. 2008

Frequently, predatory fish like walleye, northern pike and lake trout have higher mercury levels because concentrations biomagnify through the food chain versus fish species that feed lower in the food chain such as lake whitefish, which mainly feed on zooplankton and benthos (AMAP 2002, INAC 2003). Figure 3.3-6 clearly shows biomagnification up the food chain in species from Great Slave Lake.

Figure 3.3-6
Biomagnification of Mercury in Predatory Fish in Great Slave Lake



Source: Mackenzie River Basin Board 2004.

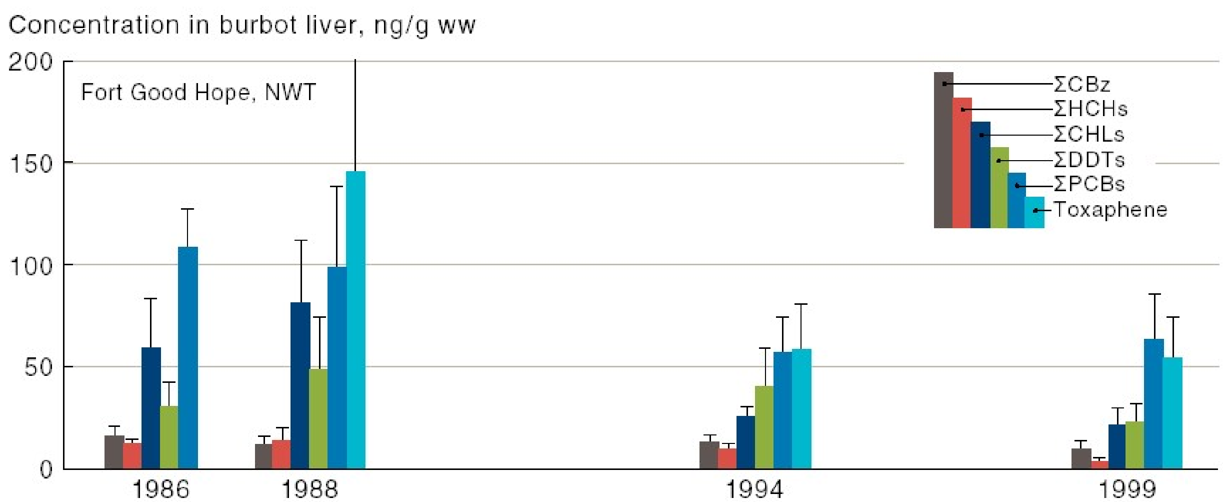
Persistent Organic Pollutants: The same human health driver does not exist for POPs as it does for mercury although a health advisory for burbot from the Slave River near Fort Smith for toxaphene contamination was made in 1992 (MRBB 2004).

Dioxins and furans are among the most toxic POPs because they can affect health in so many ways including wasting, damage to the immune system and liver, endocrine disruptions and problems with fetal development. Because they tend to be fat soluble, they also biomagnify through the freshwater food chain causing higher concentrations in top predators like northern pike and lake trout.

A comparison of burbot livers from Fort Good Hope showed a slow decline in the major organochlorines and toxaphene from the mid-1980s to 1999 (Figure 3.3-7) (AMAP 2002). A more recent study by Stern *et al*. (2009) analysed tissues from burbot collected at Fort Good Hope (Rampart Rapids) in December 2009. They report the following:

- Significant declines, 10- and 4-fold, occurred for both alpha- and gamma-HCH over the 20 year time period between 1988 and 2009.
- Sigma PCBs and Sigma DDT have increased significantly since the mid-1990s.
- Brominated flame retardants such as PBDEs have increased from 8.1 (PBDE 47) to 25.8-fold (PBDE 154) over the 20 year period from 1988 to 2009.
- Current Sigma PBDE levels are approximately one order of magnitude less than those of PCBs.
- Since 1986, a consistent decline was observed in bath PFOA and PFOS concentrations. Conversely, PFDA concentrations show a consistent increase overtime.

Figure 3.3-7
Changes in Pop Concentrations in Burbot Liver from the Fort Good Hope Area



Source: AMAP 2002.

<u>Radionuclides:</u> Although the potential for human health impacts from radionuclide contamination of fish in the NWT exists, only limited data has been gathered on radionuclide levels in fish. An investigation of radionuclide levels in fish near the former Port Radium radium/uranium/silver mine site on Great Bear Lake showed low levels in lake trout and lake whitefish muscle and liver samples and herring whole body samples (SENES 2004). An assessment of the whole body dose to these species using measured levels in the lake water and sediment in combination with fish tissue data demonstrated that the combined dose from internal and external exposures were well below acceptable levels.

Why is it happening?

Atmospheric transport of contaminants to the Arctic is recognised as an important pathway for heavy metals (e.g., mercury) and POPs. Once contaminants are present in the aquatic environment, accumulation of contaminants in aquatic plants and fish occurs. Fish exposure pathways include uptake through the gills, the skin and by direct digestion (INAC 2003).

With respect to mercury, there are suggestions, although not definitive evidence, that the bedrock setting of a lake may have an association with the levels of mercury in the fish. For example, Lockhart *et al*. (2008) found that lake trout from lakes in sedimentary rock tended to have somewhat lower levels of mercury than those from lakes in other types of rock.

Global warming is also expected to play a role via increases in water temperature which would result in an increase in fish metabolic rates and therefore an increase in the volume of water passing across the gills. A consequence of such an increase in the metabolic rate would be an increase in the uptake of metals. This may be exacerbated by an increase in the bioavailability of mercury with an increase in water temperature (Evans *et al*. 2009, MRBB 2004).

What does it mean?

Contaminant levels in fish are affected by not only the concentrations found in lake or river water but also the type of fish, where it lives in the system, how old it is and what it eats. Older fish may have higher levels of contaminants such as mercury which bioaccumulate in species higher in the food chain. Predatory fish, those that primarily eat other fish, like northern pike, walleye and lake trout, typically have the highest levels of contaminants.

As well as being important culturally for many NWT inhabitants, fish are generally an inexpensive, readily available and generally healthy source of protein (MRBB 2004). To protect the health of people living in the NWT, health advisories for mercury have been issued respecting certain species of predatory fish on twelve lakes in the NWT (Giauque Lake, Lac Ste Therese, Lac Tache, Little Doctor Lake, Lac a Jacques, Thistlewaite Lake, Keller Lake, Cli Lake, Turton Lake, and Manuel Lake) (Evans 2009, INAC 2005).

What is being done about it?

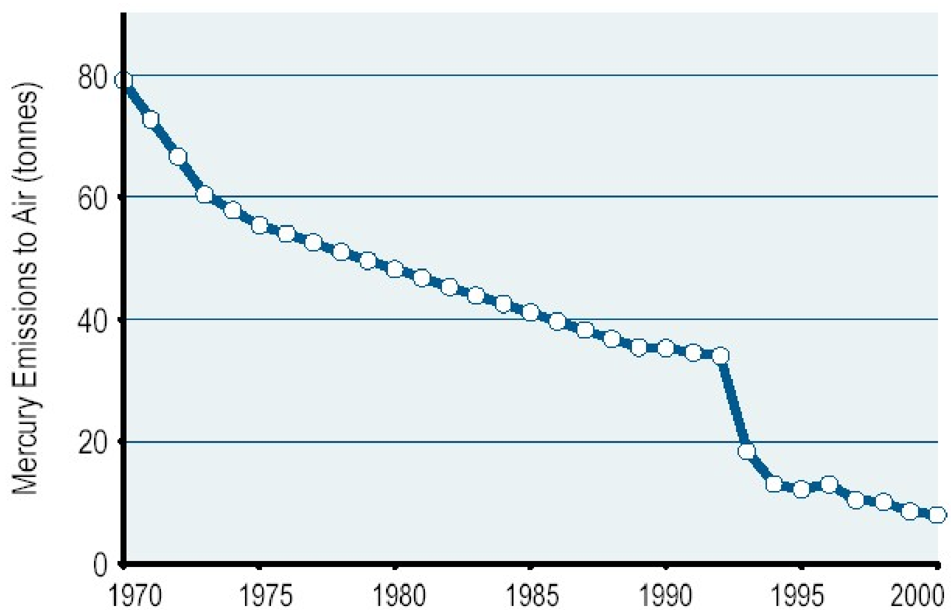
The Northern Contaminants Program (NCP) is an important source of funding for contaminant research across Canada’s north. The NCP was established in 1991 in response to concerns about human exposure to elevated levels of contaminants in wildlife species that are important to the traditional diets of northern Aboriginal peoples.

The Arctic Monitoring and Assessment Programme (AMAP), a joint effort of eight Arctic countries, Arctic aboriginal organizations and other observer countries and organizations, began monitoring and assessing anthropogenic pollution in the Arctic in 1991 with a first report published in 1997. Subsequent state of knowledge reports have been published in 2002 and 2010.

Heavy Metals. *Lead is a great example that demonstrates the effectiveness of pollution control. Emissions of lead in 1995 were nearly two thirds lower than those from 1983 (AMAP 2002). This decrease is primarily a result of restrictions of lead in gas.*

Government regulations, such as the Canadian Environmental Protection Act (CEPA), industry cooperation and technological advances have resulted in a decrease in anthropogenic mercury emissions (Figure 3.3-8). However, there is a need for continued international efforts to decrease mercury emissions.

Figure 3.3-8
Decline in Canadian Anthropogenic Mercury Emissions Between 1970 And 2000



Source: Source: Mackenzie River Basin Board 2004.

Persistent Organic Pollutants. *The largest contributor of dioxins and furans, pulp mills, are no longer permitted to emit these compounds in their effluent under the CEPA. The industry has implemented technological advances to meet these regulations (MRBB 2004).*

Along with ongoing studies to measure POPs like PCBs, DDT and toxaphene, an effort is being made to investigate new contaminants like brominated flame retardants, fluorinated organic compounds and chlorinated paraffines.

Radionuclides. *With little known about quantities of radionuclides in the NWT, clean up and regulation will continue as required when contamination is identified.*

Other than trying to prevent the introduction of new parasites and diseases, little is done and/or can be done to prevent the spread of fish diseases and parasites.

What are the information gaps?

Identification of the impacts of climate change on contaminant pathways and effects: More research is needed to understand how climate change and variability will affect the ways in which heavy metals, POPs, and radionuclides are transported to, and within the NWT, as well as how they accumulate and impact biota. There is, as yet, not enough information collected to understand with any certainty how climate change will impacts contaminants and contamination in the NWT (AMAP 2010).

Comprehensive monitoring of contaminants in fish (geographically and temporally): Information regarding contaminant levels by species, types of contaminant and geographic areas (CIMP 2007) especially collecting data to elucidate temporal trends statistically (INAC 2003). Specific areas that require more information are Great Slave Lake and Great Bear Lake because of their importance with respect to human health risk (MRBB 2004) and the Slave River to monitor upstream impacts (Sanderson *et al.* 1998). There is also a need for larger numbers of samples so that statistical comparisons can be made between age and size differences (INAC 2003).

Improved understanding of the biological impacts of contaminants on NWT fish: There is an overall lack of information with respect to biological effects of contaminants on the NWT fish. Furthermore, there are few guidelines set for the protection of fish (INAC 2003), particularly with respect to body burden versus levels found in water and sediment. Specific research needs to determine threshold effects for NWT fish species rather than comparison of burden levels to laboratory studies on non-Arctic species (INAC 2003).

Improved understanding of the pathways and distribution of mercury: A better understanding is needed of the pathways and processes that influence mercury distribution in the Arctic, as well as that for other metals. The relative importance of freshwater and sediment sources versus atmospheric sources has not been determined (AMAP 2002). More information is required to determine the relative contribution of natural versus anthropogenic sources (INAC 2003).

Identify all heavy metals of concern: Consideration should be given to heavy metals that have not, as yet, received attention including platinum, palladium, rhodium and thallium (AMAP 2002, 2010, INAC 2003).

Monitor POP levels and effects (geographically and temporally): Studies should continue to monitor trends in POP levels, as well as to increase the ability to detect effects at the individual and population levels (AMAP 2010).

Ensure early identification of new POPs: Research must be directed at ensuring our ability to detect new and currently used POPs to stay ahead of emerging issues rather than responding once impacts have been observed (AMAP 2010, INAC 2003). Research should also involve the archiving of tissue, so that as new chemicals are identified, archived tissue can be analyzed to establish baselines (INAC 2003).

Identification of POP sources and particularly local sources: Although it is commonly believed that most POP contamination has its origin outside of the NWT, limited information is available regarding the contribution of local contamination such as from burning municipal waste and the DEW-line sites (INAC 2003).

Improved understanding of the presence, quantification and distribution of radionuclides in the NWT: More research is needed to understand the vulnerability of the NWT and potential impacts from radionuclides. There is also a need to look at the remobilization of radioactive compounds from sediment (AMAP 2010). It is unclear if the extent of radioactive contamination in the NWT has been quantified.

Quantification of dose levels and effects on NWT fish: Up-to-date information is needed with respect to the effects of radiation on fish to minimize uncertainties (AMAP 2002).

Development of fish specific guidelines for dose levels: Past dose limits have been focused on human (AMAP 2002). There is a need to develop limits for the protection of fish during all life-history stages. This is particularly important at chronic low-dose levels.

Conduct surveys to catalogue and document the levels of fish diseases and parasites found in the NWT.

Monitoring of diseases and parasites as indicators of fish quality: This type of investigation could be performed on a need basis, or as part of general monitoring added to community and contaminant monitoring efforts (CIMP 2007).

3.4 CONCLUSIONS AND RECOMMENDATIONS

Based upon the review of previously completed studies looking at components of the freshwater aquatic environment, the current conditions and trends for the NWT were found to be for the most part favourable. For some indicators the condition and/or trends were identified as unfavourable or deteriorating at a local scale, or, for the whole of the NWT, uncertain. Regarding the latter, such a finding was generally the result of inadequate monitoring data from which to draw conclusions, and in other instances uncertainty was associated with difficulty predicting actual impacts of climate change.

Recommendations specific to the components assessed in this review are identified below:

Surface Water Quality

- Future monitoring of surface water quality needs to be maintained as it will be useful in determining changes in water quality as they relate to climate change effects.
- The number of long-term monitoring stations in the NWT is limited in comparison to the geographic size; therefore, expanding the current regional surface water quality monitoring to include key locations in unmonitored watersheds would be beneficial.
- Integration of more intensive local research (e.g., mine-specific aquatic effects monitoring) into the long-term monitoring network database would be another means of expanding the water quality database.

Sediment Quality

- Information on PCBs, pesticides, polycyclic aromatic hydrocarbons, dioxins and furans, and heavy metals in sediments is very limited with the exception of specific investigations on the Slave River at Fort Smith and the Liard River above Kotaneelee River. Regional monitoring would be useful.
- Long-term monitoring of river sediments and periodic collection of lake sediment core samples is required to better understand the fate of contaminants in the benthic environment.

Surface Water Quantity

- Future monitoring of surface quantity needs to be maintained to measure the effects of climate change on long-term average flows, extreme flow events and timing of snow melt and freeze over.

Fish Habitat

- There are only limited data to define baseline habitat conditions in the NWT.
- Aside from fish habitat assessments near residential, transportation, and industrial sites, fish habitat information is not commonly collected in the NWT. Within government agencies with objectives to protect and enhance aquatic ecosystems, there has been no consolidation of programs or data, which would allow for an assessment of parameters as indicators of well-functioning aquatic ecosystems over time.
- There is a need to compile data on various fish habitats for Great Slave Lake and Great Bear Lake, as they relate to fish harvest data. These data should reach a level of detail that would be useful for future comparisons.
- Archiving of high-resolution satellite images of the NWT would allow future comparison of changes in the physical environment that could potentially affect freshwater habitat.

Fish Population

- The data available to define baseline conditions in the NWT are limited.
- Great Slave Lake fish are exploited by several types of fisheries activities, which can affect and deplete populations and stocks. It is therefore imperative to manage the fisheries with proper planning and regulations, record and monitor harvests, and assess the stocks.

Fish Harvest

- Data from fish harvests could be useful to derive population and stock parameters relating to: (1) Energy Use; growth and reproductive investment, (2) Survival; age structure and length frequency analysis, and (3) Energy Storage; condition. Sufficient information appears available to derive new data, even assess trends at some local and regional levels within the NWT.
- Fish stock assessment studies are needed on Great Slave Lake to determine the current status of lake trout as well as other important fish species throughout the lake.
- On Great Slave and Great Bear lakes the fisheries need to be looked at closely and managed to ensure sustainability of stocks overtime. Detailed information is required about fish populations and stocks in order to achieve a corresponding good level of fisheries management.
- On Great Slave Lake, additional information is needed on the subsistence and sport fisheries to complete the understanding of the fisheries resources.

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4.0 MARINE ENVIRONMENT

4.1 INTRODUCTION

Past marine research in the Beaufort Sea-Amundsen Gulf area was summarized briefly in the 2005 NWT Environmental Audit (SENES Consultants Ltd. 2005). Since then a number of large research programs that were ongoing have begun reporting their findings, in particular the Canadian Arctic Shelf Exchange Study (CASES) (Fortier *et al*. 2008), the Circumpolar Flaw Lead (CFL) Study, and ArcticNet. These research programs have contributed significantly to understanding of the marine processes in the region. More information will be forthcoming as programs receiving International Polar Year (IPY) funding wrap up in 2010 and 2011. While CASES and CFL field research has ended, ArcticNet plans to continue and is seeking funding for another seven years of research (D. Barber, Univ. of Manitoba, pers. comm. 2010).

Contaminants research conducted under the Northern Contaminants Program (NCP) and Arctic Monitoring and Assessment Programme (AMAP) is continuing. Many of the NCP studies of the long-range transport of contaminants into the Arctic have been ongoing since the 1990s. Operating on a five-year cycle, their latest results will not be synthesized and published until ca. 2011 (e.g., Smith *et al*. 2009).

Pollution, harvesting, habitat disruption, disturbance, species invasions, and climate change - listed in no particular order, continue to be the chief stressors acting on the marine environment. The following sections describe some indicators of how these stressors may be affecting the marine environment adjacent to the Northwest Territories (NWT), with particular emphasis on:

- current monitoring/research programs and data;
- trends in the data and the significance of these trends; and
- information gaps and recommendations for additional monitoring/research.

4.2 MARINE ENVIRONMENTAL QUALITY (MEQ) INDICATORS

Indicators of marine environmental health can be drawn from the physical, chemical, and biological oceanography. The list of potentially useful indicators is very long but at present few offer data sets that are comparable for a period of over three years, and fewer still are repeatable for future comparison.

A "top-down" approach to selecting indicators, whereby large predatory species such as the polar bear (*Ursus maritimus*), beluga whale (*Delphinapterus leucas*), ringed seal (*Pusa hispida*), and anadromous char (i.e., Arctic Char *Salvelinus alpinus* and Dolly Varden *Salvelinus malma*) are examined offers perhaps the best potential for monitoring cumulative impacts of stressors on the marine environment at present. As high-level consumers, these species are integrators of change in the food web which itself responds to a myriad of stressors. This makes these predators particularly vulnerable to environmental perturbations, and to the accumulation of persistent contaminants. As large, predictably available species they are also very important to the Inuvialuit, who harvest them in quantity for food and materials. Consequently, government and other agencies have studied these animals over a longer period and in greater detail than most other species.

Changes in the composition of marine communities, in the seasonal abundance or availability of species, and in their quality and/or health can be useful indicators of changes in marine environmental health. Because the Arctic food web is relatively simple, the loss of a species or introduction of another may have important consequences, particularly for higher-level consumers, such as bears and people (Welch *et al.* 1992). Monitoring communities is one of the few options for available for lower trophic levels, such as benthos, plankton, and fish. However, its sensitivity as a tool for assessing environmental change is limited by the natural variability among geographical locations, habitat types, seasons and years.

Species with hard parts that grow throughout their lives (e.g., teeth, otoliths, or shells) are particularly useful for monitoring purposes as these parts can be examined to estimate the individual's age. The results of these estimates are however sensitive to the structure and methods used for age determination, which can yield very different estimates. Among invertebrate species, clams such as *Mya truncata* and *Serripes groenlandicus* offer the best opportunities for monitoring as they are long lived and can be aged using shell growth. However, research in the eastern Canadian Arctic suggests that populations may follow an 8-10 year cycle of abundance (T. Siferd, DFO Winnipeg, pers. comm. 2005), which makes it difficult to establish trends in abundance that occur above and beyond these natural cycles.

Subsistence harvesters rely on the predictable abundance of a small number of species for food and materials, and their harvests per unit of effort can provide a useful indicator of changing availability. Depending upon the year-to-year continuity of harvesting efforts, and on how the data are collected, harvest data can serve as an indicator of abundance. Abundant, widely distributed species, such as the ringed seal may be more useful indicators than species like the polar bear, which are harvested under quotas. Hunter experience and observations can also provide an important long-term indicator of abundance. However, this information may be confounded over time if climate change alters environmental conditions such that animals change their seasonal movements and traditional knowledge is no longer valid.

The quality and health of animals, prior to their harvest, is an important consideration for the people who eat them. Qualitative observations of whether animals are fat or skinny, whether they taste different, and are energetic or lethargic can be useful indicators of larger problems. Because harvesters handle many animals over a wide area, they may encounter diseased or parasitized animals, which can be reported and examined. They can also provide insight into why these changes may be occurring. Harvesters are also more likely to capture uncommon species, such as salmon, that may provide an early indication of changes in community structure.

Contaminant levels are an important aspect of the marine environmental health that affects humans directly through their diet. Trends in accumulation can be followed over time, provided variations related to geography and age and sex of the animal are understood. Unfortunately, the value of marine bottom sediment as a record of contaminant deposition over time is limited by the reworking of these sediments by benthic infauna.

Understanding of key atmospheric and oceanographic processes and their linkages to the biological indicators is critical for accurate interpretation of trends in these indicators. Trends in sea ice and water column stratification are particularly useful. Changes in sea ice cover are climate driven and have major oceanographic and ecological implications. While the extent and duration of the ice cover can be measured remotely by satellite over the entire region and compared digitally to identify trends over time, the quality of the ice cover – particularly its thickness, and the depth of the overlying snow cover still cannot be measured remotely. Inuvialuit knowledge of sea ice conditions has an important contribution to make in the interpretation of ice data, particularly in the ground-truthing of remote sensing images for subtle changes in ice formation over time. Changes in the seasonal profiles of light penetration, temperature, salinity, nutrients, and chlorophyll ***a*** in the water column are also useful indicators of change. They can provide important information on freshwater inputs, mixing, and biomass.

To date, the only marine valued ecosystem components identified by CIMP (2007) are marine mammals. The key monitoring indicators identified were: body condition and reproductive status of seals and whales; disease and contaminants loads in individuals; age of first maturity and reproductive rate; and stock size and range. Some of these indicators work better for one species than another.

To correctly interpret trends in these indicators, data must also be collected on other aspects of their environment. Consequently, the quality, extent, and duration of sea ice cover; prey quantity and quality; and ambient and anthropogenic noise levels were also identified as key indicators (CIMP 2007).

The indicators identified by CIMP (2007) are appropriate for the marine mammals but leave gaps with respect to monitoring the cumulative effects of stressors on the marine environment as a whole. They do not, for example, consider the effects on the polar bear, which as the apex predator may be more sensitive to stressors such as climate change and persistent contaminants, nor do they consider the effects on marine birds, fishes, invertebrates, or plants except as food for whales and seals. Because of differences in their diet, habitat use, physiology, and life history the stressors acting on the region's marine environment may affect these species differently.

Fish habitat, populations, and harvests were also identified as valued ecosystem components by CIMP (2007). Anadromous char are included in this consideration. They are an important species for harvesters and can be useful indicators of change. But, the underlying cause(s) of any change can be very difficult to determine because they undertake extensive seasonal movements and use both freshwater and marine systems.

As consumers, the species listed below integrate the effects of environmental changes (Table 4.2-1). This list is essentially unchanged since the 2005 NWT Environmental Audit (SENES Consultants Ltd. 2005). Each species is vitally important to the traditional economy, has been studied in the region, and may provide a useful indicator of the state of the environment through time. At present, few if any other species or parameters, with the exception of sea-ice cover, offer useful trend-through time data. Among the potentially useful indicators, only those with the most useful data records will be discussed further.

4.2.1 MEQ Indicator – Polar Bears

Polar bears are an apex consumer in the Arctic marine food web. They eat primarily ringed and bearded seals (*Erignathus barbatus*), and are eaten by humans. The species was chosen as a VEC because of its high trophic level, and its cultural and economic importance to the Inuvialuit.

Bears from three management populations (SB = Southern Beaufort, NB = Northern Beaufort, VM = Viscount Melville Sound) inhabit the Beaufort Sea/Amundsen Gulf/western M'Clure Strait area year round (Taylor *et al.* 2001). They are widely distributed on the sea ice in winter, with a more concentrated distribution in summer when sea-ice dissipates and they follow the receding ice edge to the permanent pack, or move ashore (Stirling 2002). The Southern Beaufort Population is shared with Alaska, and the others with Nunavut. Birthing dens have been found mostly along the western and southern coasts of Banks Island and on multi-year pack ice, although there are some on the northern coast of Yukon and Alaska.

Table 4.2-1
Rationale for Selection of Species and Parameters as Potential Marine Environmental Quality Indicators

VEC	Parameter*	Rationale
Mammals		
Polar bear	• **population abundance** • **survivorship** • **natality** • **sex and age composition of the harvest** • body condition • contaminants	• High level consumer, eats primarily ringed seals • Widely distributed in winter; more concentrated distribution in summer; den mostly along the western and southern coasts of Banks Island and on multi-year pack ice • Bears from the three management populations (Southern Beaufort/Northern Beaufort/Viscount Melville Sound) remain within the Beaufort Sea/Amundsen Gulf/western M'Clure Strait area year round • Extensive database of monitoring and research • Sensitive to changes in the quality, distribution, and duration of ice cover • Particularly vulnerable to the accumulation of persistent contaminants that bioaccumulate in the food web • Important resource and source of income for residents
Beluga	• **composition of the landed harvest** • **contaminants**	• Mid-level consumer that eats fish and invertebrates and is eaten by polar bears • Widely distributed in summer • Important traditional food source for communities • Composition of the landed harvest and contaminants monitored; growth parameters difficult to obtain in sample sizes sufficient for comparison; migrate east to Lancaster Sound and west to the Bering Sea, making it harder to understand the factors underlying any trends • Returns to the same estuaries each year, making it vulnerable to over-exploitation, might be a useful integrator of the downstream effects of changes occurring in freshwater systems

Table 4.2-1 (Cont'd)
Rational For Selection of Species and Parameters as Potential Marine Environmental Quality Indicators

VEC	Parameter*	Rationale
Ringed seal	• **harvesting removals** • **body condition** • **ovulation rate** • **contaminants** • recent pups in the harvest • population density	• Mid-level consumer between fish and invertebrates and foxes, polar bears, and people • Widely distributed, year-round resident • Major traditional source of food and materials for Inuvialuit • Sensitive to changes in the ice environment • Reproduction, condition, and contaminants can be monitored cost effectively each year by community-based sampling of the harvest • Contaminants monitored in seals from Ulukhaktok since 1971
Birds		
Red-throated loon	• surveys of nesting success • contaminants in chicks and eggs	• Mid-level consumer, eat small fish • Arrive in offshore leads in late May or early June and remain until nesting ponds have open water; these ponds winterkill so the loons must travel to the coast or a large lake to forage for fish to feed their young • Widely distributed and conspicuous nesting species in coastal areas in summer; typically nest within 8 km of the coast or a large lake • Young can be followed from egg to fledging unlike many other species with more mobile young and because they are fed local marine fish from an early age can be used to monitor local contaminants • Very vulnerable to oil pollution • Baseline data available on reproductive success; contaminants samples archived

Table 4.2-1 (Cont'd)
Rational for Selection of Species and Parameters as Potential Marine Environmental Quality Indicators

VEC	Parameter*	Rationale
		Fish
Anadromous Dolly Varden & Arctic Char	• **population size** • **catch-per-unit effort** • **age at harvest** • **fish condition** • **harvest** • contaminants	• Low to Mid-level consumer, eats invertebrates and smaller fish and is eaten by ringed seals and belugas • Widely distributed in coastal areas in summer, winters in fresh water • Important traditional food source for residents and supports economically important commercial and sport fisheries • Individuals return to the same estuaries, rivers, and lakes each year, making populations vulnerable to over-exploitation • Population dynamics and fish condition monitored • May be vulnerable to environmental changes and fish species invasions
		Environment
Sea ice	• **duration of ice cover** • **aerial extend to ice cover** • **ice thickness**	• Key determinant of Arctic marine processes at all levels of the ecosystem • Sensitive to climate change • Duration and extent of cover can be measured over the entire region by satellite; thickness and draft cannot • Important determinant of harvesting, transportation, and development activities

*key indicators are in bold type.

Bears from these populations travel extensively but, with a few notable exceptions (Durner and Amstrup 1995), remain within their management areas (Amstrup *et al*. 2000; Taylor *et al*. 2001; Stirling 2002). Consequently, they are useful for monitoring environmental change and contaminants in these areas. Polar bears are very sensitive to changes in sea ice, which they use as a platform for travel and hunting seals (Stirling 2002; Derocher *et al.* 2004; Regehr *et al.* 2006b; Gleason and Rode 2009). The quality, extent, and duration of ice cover determine how successfully, where, and how long they can hunt seals in a particular area. It also determines where maternity dens can be constructed. As apex consumers, polar bears accumulate contaminants from both the benthic and pelagic food chains. They are particularly susceptible to the bioaccumulation of some persistent contaminants that are biomagnified by the food chain, including mercury, chlordane (CACAR I 1997; Norstrom *et al*. 1986, 1998), and brominated flame retardants (Muir *et al*. 2006). This trait may be useful for the early identification of new persistent contaminants.

What is being measured?

- **population abundance**
- **natality (birthrate)**
- **survivorship**
- **sex and age composition of the harvest**
- body condition
- contaminants

In the Canadian Beaufort Sea and Amundsen Gulf, research on polar bear populations and their ecological interrelationships with seals and sea ice conditions began in the fall of 1970 (Stirling 2002). Its purpose was to address worldwide concern about the conservation of polar bear populations, which had been severely over-harvested throughout the Beaufort Sea and Amundsen Gulf area before quotas were established in Canada in 1968, and Alaska ceased all but subsistence hunting in 1972.

This research has involved the delineation of populations, population assessments, baseline studies of demographic and reproductive parameters, identification of maternity denning areas, studies of the ecological relationships between seals and polar bears, and the examination of data and specimens from the polar bear harvest (Stirling 2002). The Canadian Wildlife Service and NWT Department of Resources, Wildlife and Economic Development (RWED) have conducted much of this work, in cooperation with local hunters and researchers from Alaska, Nunavut, and various universities.

Among the parameters measured, natality and the sex specific age structure of the harvest are perhaps the most immediately useful long-term indicators for monitoring purposes (Stirling 2002). Data on natality (the ratio of live births in an area to the population of that area) provide a measure of the reproductive rate and have been collected during mark-recapture surveys. Data on the age structure of harvested polar bears can reflect both short-term fluctuations in the ecosystem and the overall long-term status of the population in relation to harvesting (Stirling 2002; Derocher *et al*. 2004).

All harvest of polar bears from the Northwest Territories occurs within the Inuvialuit Settlement Region (Lunn *et al*. 2006). The Inuvialuit Game Council recommends any management changes, including quotas, to the NWT Minister of the Environment and Natural Resources and allocates the total quota among the communities.

Successful hunters must provide information about the hunt and submit proof of sex, the lower jaw or a premolar for aging purposes, and tags/tattoos of any marked bears. At the end of the year, data from each population are compiled and reviewed by the Wildlife Management Advisory Committee (WMAC) to ensure that the annual harvest is sustainable. Body condition, contaminants, cub survival, and movement patterns may also provide useful indicators of environmental change (Derocher *et al*. 2004).

Fat samples have been collected from captured bears for contaminant analysis (Norstrom and Schweinsburg 1985; Norstrom *et al.* 1986, 1998; Muir *et al*. 2006; Letcher 2009a). While higher levels of polychlorinated biphenyls (PCBs) have been found in the fat of bears from the Northern Beaufort population than from populations elsewhere in Arctic Canada (Norstrom *et al*. 1986, 1998), too few of these samples have been analysed to assess trends in contaminant levels (Norstrom *et al.* 1998; CACAR II 2003). However, samples of bear fat have been archived for possible future examination (N. Lunn, EC, Yellowknife, pers. comm. 2005). At high levels, organochlorine contaminants can impair immune function (Lie *et al.* 2004, 2005) and may impair reproduction and cub survival (Skaare *et al*. 2002; AMAP 2002). Higher levels of mercury have been measured in the liver tissue of bears from the NWT than elsewhere in Arctic Canada (CACAR I 1997).

Population abundance estimates now provide useful trend over time data for the Northern Beaufort population of polar bears, but the time series of directly comparable data from the Southern Beaufort population is too short to be useful for that purpose. Initially, these estimates were constrained by the inability to delineate populations. Studies in Canada and Alaska were conducted independently, until mark-recapture and satellite tracking studies demonstrated that the Southern Beaufort Sea population was shared. These estimates continue to be constrained by high costs and logistical difficulties, sampling biases (Stirling 2002), the low density of bears (Lunn *et al*. 1995), and poor tag recoveries (Urquhart and Schweinsburg 1984). During these studies, data are typically collected on the size, age (tooth), sex, reproductive state, and fatness of captured bears. Blood, fat and hair samples may also be collected for genetic and contaminants analyses. In the absence of comparable long-term survey data from the Southern Beaufort population, demographic data from the recent capture-recapture surveys are being used in predictive models to project long-term population trends. Current estimates for the Viscount Melville Sound population are now dated, as they are based on extrapolations from a mark-recapture study completed in 1992 (COSEWIC 2008).

Annual maternity denning surveys to estimate cub production are not feasible in the NWT as snow conditions make it difficult to find tracks and locate dens, and the distribution of dens is scattered (Urquhart and Schweinsburg 1984). Mean ashore dates, which are used in Hudson Bay, have less significance in the Beaufort where many bears summer in the permanent pack ice rather than onshore.

What is happening?

Large-scale population assessments of polar bears in the Northern Beaufort population were conducted in the mid-1970s, mid-1980s, and mid-2000s (Stirling *et al*. 2007) (Table 4.2-2). These assessments are not directly comparable with studies in the 1990s, which sampled in different areas, but do provide a useful time series for comparison. Survival, recapture probabilities, and the size of segments of the population were estimated using these capture-recapture data. The model-averaged estimates of population size from these three periods were not significantly different, and may be low. The annual survival rates of bears in all age and sex classes were lower in the 1980s than during the other sampling periods. Annual survival rates were higher for prime adult female and male bears than other groups, for adult females than males, and for cubs-of-the-year than yearlings (Stirling *et al*. 2007). Over the past 5 years fewer bears were harvested annually from this population than was permitted under the harvest quota (i.e., <40 cf. 65) (GNWT 2010; see also Stirling *et al*. 2007).

Table 4.2-2
Northern Beaufort Polar Bear Population Estimates

Period	Average	95% Confidence interval
1972-1975	745	±246
1985-1987	867	±141
2004-2006	980	±155

Source: Stirling et al. 2007

There is no long-term series of directly comparable population estimates for the Southern Beaufort polar bear population, but large-scale capture-recapture population studies involving researchers from Canada and Alaska were conducted annually in 2001 through 2006 (Regehr *et al.* 2006, 2007; Hunter *et al*. 2007). This work provides important information on the structure, survival, breeding, and size of this population. Both the survival rates and total population size of the Southern Beaufort polar bear population appear to be in decline.

These changes are significantly correlated with changes in ice distribution and the duration of the open water season (Regehr *et al.* 2006a, 2007, 2009; Hunter *et al*. 2007). Survival of adult females was higher in 2000-2003 when the ice-free period was relatively short (mean 101 days) and lower in 2004-2005 when it was longer (mean 135 days) (Regehr *et al*. 2006a, 2007, 2009). Breeding rates and cub litter survival also decreased with increasing duration of the ice-free period. These declines coincided with anecdotal reports of emaciated, drowned, and cannibalized bears and of attempts by bears—largely unsuccessful, to claw through solid ice to capture seals (Monnett and Gleason 2006; Stirling *et al*. 2008). Growth of males and females and the mass and body condition index (BCI) of subadult males in the population declined over the period 1982 to 2006 (Rode *et al*. 2007). Over the five year period, 2003 through 2007, the average annual harvest by Canada and Alaska combined was 53.6 of polar bears (Alaska Fish and Wildlife Service 2010). Over the past 5 years (July 2004-June 2009) fewer bears were harvested annually from this population in the Northwest Territories than was permitted under the harvest quota (i.e., <20 cf. 40) (GNWT 2010).

Eastward and landward shifts have occurred in the distribution of bears from the Southern Beaufort population along the Alaskan coast (Gleason and Rode 2009). From 1979 to 1987, polar bears were observed primarily on ice along the shelf break near Barrow, whereas from 1997 to 2005 they were observed primarily on barrier islands or along the mainland coast near Katovik.

Concentrations of polybrominated diphenyl ethers (∑PBDE) in Amundsen Gulf polar bear fat decreased significantly between 2001-02 and 2007-08, while concentrations of perfluorooctane sulfonate (PFOS) were unchanged (Muir *et al*. 2006; Letcher 2009a). The concentrations of both these emerging contaminant groups tend to be lower than in bears from southern Hudson Bay. This work is ongoing.

Why is it happening?

Ice conditions in the northern Beaufort Sea have remained suitable for polar bear feeding through much of the summer and fall in most years, since sea ice adjacent to the coast and over the shelf does not melt completely each year (Stirling *et al*. 2007). Difficult travel conditions and a reduced hunting effort in parts of the area may explain why harvest quotas are not being filled and harvests remain below the maximum sustainable yield. Together these factors have enabled the Northern Beaufort population size to remain stable, although the focus of the sport hunt on the largest adult males may be skewing the sex ratio (Stirling *et al*. 2007).

Differences observed in the North Beaufort and South Beaufort bear populations have been correlated with sea-ice conditions. Polar bears depend upon the presence of ice to serve as a platform for feeding and movement. In the northern Beaufort Sea, reduced survivorship of all age and sex classes of polar bears in the mid-1980s, not just natality as reported by Stirling (2002), may have been related to declines in ringed seal production that began during a year of very heavy ice cover (Stirling *et al*. 2007). This is in contrast to the southern Beaufort Sea where declines in growth, recruitment, and survival suggest a declining trend in nutritional status that may be related to ecological changes from more extensive and extended open water (Regehr *et al.* 2006a, 2007, 2009; Hunter *et al*. 2007; Rode *et al*. 2007). Mortality from bears having to swim long distances may be significant (Monnett and Gleason 2006).

Differences in concentrations of emerging contaminants between polar bears in Amundsen Gulf and those in southern Hudson Bay may be related to dietary changes by the latter in response to changing ice conditions (Letcher 2009a).

What does it mean?

The Northern Beaufort polar bear population is believed to have increased in size from the early 1970s into the 1980s, after which it remained relatively stable and able to sustain current hunting mortality (Stirling *et al*. 2007).

While studies of the Southern Beaufort polar bear population have been ongoing since 1967, past research objectives did not always permit the robust estimation of vital rates. This makes it difficult to distinguish short-term fluctuations from a long-term trend demographic trend. Modelling projections, based on the 2001-2006 data, predict serious declines in this population over the next century unless conditions typical of 2001-2003 are somehow maintained (Hunter *et al*. 2007). These declines may occur regardless of whether harvests are reduced to zero (COSEWIC 2008). Distribution changes may also be occurring similar to those reported from Alaska, which reflect changes in the type, coverage, and timing of formation and ablation of the sea ice (Gleason and Rode 2009).

The apparent sensitivity to changes in the ice environment makes it important, with the threat of global warming, to continue monitoring population parameters for polar bears and their prey. This will permit scientists to evaluate change and develop appropriate responses for conservation and management of marine mammals in the Beaufort Sea. Contaminant levels in the bears may change in response to changes in ice conditions that cause the bears and their prey adjust their diets (McKinney *et al*. 2009).

What is being done about it?

Harvests of bears from the NWT populations are jointly managed with Alaska or Nunavut to avoid over-harvesting of bears that are vulnerable to harvest in several jurisdictions (COSEWIC 2008). In 1988, the Inuvialuit Game Council and North Slope Borough of Alaska implemented the Polar Bear Management Agreement for the Southern Beaufort Sea (Brower *et al*. 2002). It established a total annual harvest quota that, in March 2000, was revised to 80 bears, shared equally between the two jurisdictions. Kills of problem bears and research handling deaths are included in the harvest, of which no more than 27 animals can be female. A review of this agreement in 1998 concluded that it has been successful in limiting the total harvest and proportion of females in the harvest within sustainable limits. It highlighted the need to improve awareness of the need to prevent over-harvesting of females, and the need for better harvest monitoring in Alaska.

Since 2005, there have been a number of new polar bear management initiatives. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) re-examined the status of polar bears in Canada in April 2008, and confirmed its designation as "Special Concern" (COSEWIC 2008). This designation indicates that the species may become threatened or endangered because of a combination of biological characteristics and identified threats. In Canada the Polar Bear Technical Committee (PBTC) conducts an annual review of the status of each polar bear subpopulation and its sustainable harvest, and monitors the annual kill.

In May 2008, Canada and the United States signed the "Memorandum of Understanding Between Environment Canada and the United States Department of the Interior for the Conservation and Management of Shared Polar Bear Populations" to collaborate on polar bear issues, to further the consideration of traditional knowledge, and to promote consistent methods for polar bear population modeling, data capture and research. There are also user-to-user agreements between the Inuvialuit and the Kitikmeot Hunter's and Trappers Association regarding shared use of the Northern Beaufort and Viscount Melville Sound subpopulations (COSEWIC 2008).

Contaminants monitoring is continuing with a number of project cycles nearing completion and anticipating publication of their findings in 2011.

What are the information gaps?

Temporal trends in the size of the Southern Beaufort and Viscount Melville Sound polar bear populations are uncertain. The recent survey of the Southern Beaufort population suggests that it has declined but the rate of decline is uncertain. This population may be particularly sensitive to changing ice conditions and could change rapidly. The rate of change in the population size and parameters should be established. The current size of the Viscount Melville Sound population is unknown. A new survey of this population is needed to provide data for assessing temporal trends in its size and composition. These data will be important for harvest management and for understanding the impacts of changing ice conditions on the population.

Linkages to other monitoring research on seals and sea ice should be continued and augmented to improve understanding of the mechanisms by which climatic conditions affect polar bear natality, condition, and survivorship. This information should improve understanding of how populations in different areas may respond to long-term trends in sea ice cover, and inform population management decisions. Little is known of trends in contaminant accumulation by bears in the NWT, or of how different levels of these substances affect their health and reproductive success (Letcher *et al*. 2010). The analysis of archived samples might establish trends in contaminant accumulation over time that could be followed on an ongoing basis.

4.2.2 MEQ Indicator – Beluga

The beluga whale is a mid-level consumer that eats fish and invertebrates and is eaten by polar bears and people. Whales from the Eastern Beaufort Sea stock undertake very extensive seasonal movements that can take them from wintering areas in the Bering Sea to summering areas in the Beaufort Sea, Amundsen Gulf, and Viscount Melville Sound (Richard *et al.* 2001; Harwood and Smith 2002). As soon as ice conditions permit they move into the Mackenzie Estuary, where belugas are present until mid-July or early August. Females with calves may then make a circuit or two around Amundsen Gulf. Other belugas are widely distributed offshore in the Beaufort Sea and in Amundsen Gulf, and some large males move north into Viscount Melville Sound. During the fall return migration females and subadult males tend to follow the 200 m shelf break, whereas adult males will cross the Beaufort toward Russia (L. Loseto, DFO, pers. comm. 2010). The whales congregate at Wrangle Island in October before moving south through Bering Strait in November and December to their wintering areas. The beluga's use of the Mackenzie Estuary makes them vulnerable to harvesters and other stressors, such as those related to hydrocarbon development.

Belugas are an important traditional food source for Inuvialuit living in communities on the NWT mainland (Byers and Roberts 1995; Harwood and Smith 2002; Inuvialuit Harvest Study 2003). Their harvest is culturally important, and the meat and muktuk are good dietary sources of energy and nutrients (http://www.mcgill.ca/cine/resources/nutrient/). Each summer hunters and their families from Inuvik, Aklavik, and Tuktoyaktuk travel to traditional hunting camps along the eastern Beaufort Sea coast (Harwood *et al*. 2002). Most hunting takes place in July in the Kugmallit Bay, Beluga Bay, and Shallow Bay areas of the Mackenzie Delta (Norton and Harwood 1986). Inuvialuit at Paulatuk and Ulukhaktok also have a tradition of harvesting belugas, usually in late July or August as they pass near the community, although few belugas are harvested in the Ulukhaktok area (Farquharson 1976; Inuvialuit Harvest Study 2003). Harvested animals likely all belong to the same stock, but are taken after the animals leave the estuary and move offshore to feed (Richard *et al*. 2001).

While the beluga stock is believed to be large, population estimates are difficult to obtain due the large geographical extent of their summer range (COSEWIC 2004). Monitoring contaminant accumulation in beluga tissues is important, as the Inuvialuit eat whale products in quantity. However, extensive movements by the belugas make it difficult to relate contaminant levels in belugas to contaminants in the Beaufort Sea.

What is being measured?

- **composition of the landed harvest**
- **contaminants**

Hunter-based monitoring programs have collected data on the number of belugas harvested and the efficiency of hunts in the Mackenzie Delta and Paulatuk areas since 1973 and 1989, respectively (Harwood *et al*. 2002; L. Harwood unpubl. data 2010). Since 1980, data on the standard length, fluke width, sex, and age of the landed whales have also been collected. These "on-the-beach" observations produced somewhat higher counts of landed whales than the recall surveys used for the Inuvialuit Harvest Study (2003). Since 1972, tissue samples have been obtained from harvested belugas for contaminant analyses (de March *et al.* 1998). These analyses include metals, particularly total and methyl mercury (MeHg) but also cadmium, lead, selenium, and arsenic. Persistent organic pollutants such as PCBs and emerging contaminants such as PBDEs and PFOS are also measured in beluga tissues.

Studies of trends in the prevalence of disease among belugas have been ongoing since 1999 (Nielsen *et al.* 2004; Philippa *et al*. 2004; Maggi *et al*. 2008; O. Nielsen, DFO, Winnipeg, pers. comm. 2010). Preliminary results suggest that there was a short-term increase in the prevalence of the Brucella virus between 2000 and 2003, for unknown reasons. This virus causes Brucellosis, which can affect humans. The morbillivirus (distemper), which affects ringed seals and foxes, has not been found in belugas. *Bartonella henselae* infections have recently been reported from harvested belugas (Maggi *et al*. 2008). This bacterium causes "cat scratch disease" which can affect humans. Despite their potential implications for human health both the contaminant and disease studies lack stable funding.

What is happening?

The average number of belugas landed each year continues to decline, despite increases in the human population (Table 4.2-3) (Harwood *et al*. 2002; L. Harwood, DFO Yellowknife, pers. comm. 2010). The number of belugas that are struck and lost also appears to be declining. Harvest efforts are directed mostly at adult male animals (92% >10 years old; 2.3 males/female) (Harwood *et al*. 2002). The annual harvest can vary by 33% from one year to the next.

Table 4.2-3
Beluga Harvest Data from the Mackenzie River Estuary and Paulatuk Hunting Areas

Period	Average number of belugas harvested annually	Standard Deviation (SD)	Total landed harvest over 10 year period
1970-1979	133.7	27.4	1337
1980-1989	124.0	24.5	1240
1990-1999	111.0	19.0	1110
2000-2009	96.5	19.5	965

Sources: ***Harwood et al. 2002: Table 1 –SD corrected; L. Harwood, DFO Yellowknife, pers. comm. 2010—FJMC unpubl. data.***

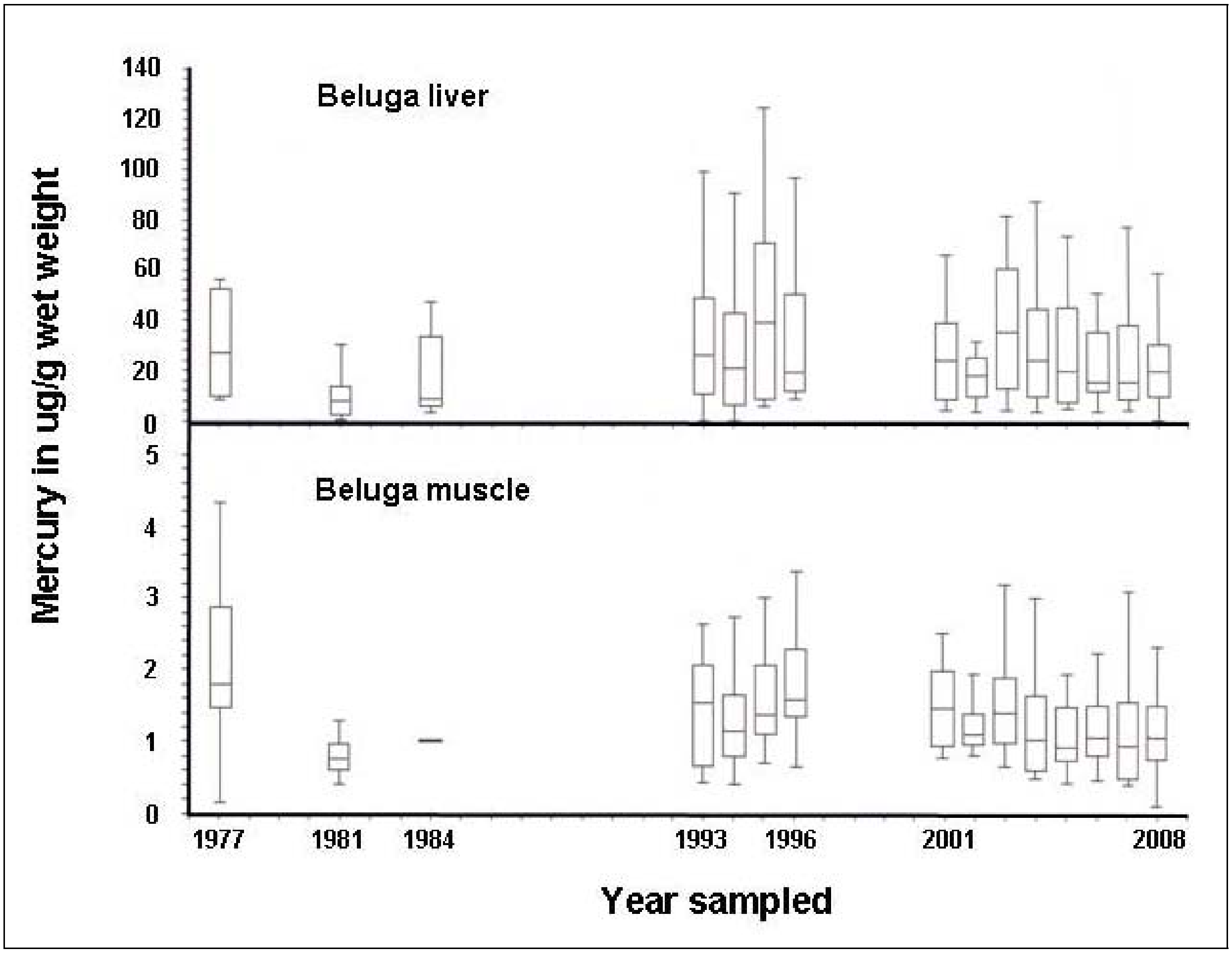
No significant trends were observed in the growth (length at age) or survivorship of belugas that were born between 1932 and 1989, and harvested from the eastern Beaufort Sea between 1993 and 2003 (Luque and Ferguson 2009). Survivorship refers to the number of belugas born in a particular year that survived to be included in the hunt.

Over the period 1977 to 2008 no consistent linear trends are apparent in the concentration of mercury (µg/g wet wt.) in the liver, or muscle of Mackenzie Delta belugas (Stern and Lockhart 2009) (Figure 4.2-1). This work is ongoing and the results presented have not been adjusted for age-related differences among the individual whales. Mercury levels in Mackenzie Delta beluga are higher on average than those in beluga found elsewhere in the Canadian Arctic (Stewart and Lockhart 2005; Stern and Lockhart 2009).

Temporal trends have not been found in the concentrations of halogenated organic compounds (e.g., PCBs, DDT, toxaphene) in Mackenzie Delta belugas (Stern *et al*. 2009). As with mercury, this work is ongoing and the results presented have not been adjusted for differences related to whale age. Belugas accumulate high levels of these persistent organic pollutants in their blubber. These levels are typically intermediate between those found in polar bears and ringed seals (de March *et al.* 1998; Macdonald 2000). Much lower levels are found in the muktuk. Concentrations of hexachlorocyclohexanes (HCHs) in western Arctic beluga blubber have not declined in response to bans on its usage in China and India and subsequent declines in atmospheric levels (Stern *et al*. 2009).

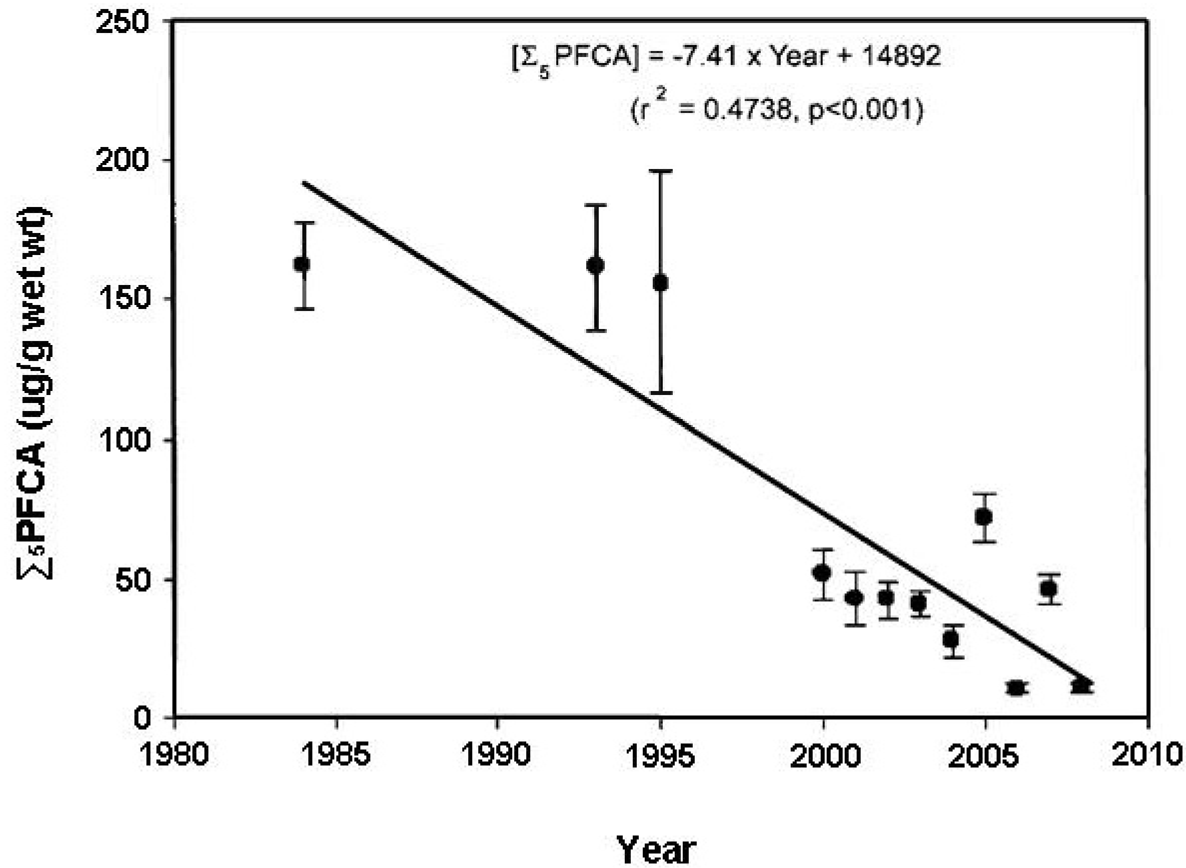
Concentrations of some emerging contaminants have decreased while others have increased. Concentrations of the surfactants C_8-C_{12} perflourocarboxylic acids ($\sum_5$PFCA) (Figure 4.2-2) and perfluorooctanyl sulfonate (PFOS) in the liver of belugas from Hendrickson Island have decreased since ca. 2000 (Tomy *et al*. 2009). There was a small but significant ($P<0.01$) increase in the concentration of flame retardant brominated diphenyl ethers ($\sum_6$BDE) in the blubber over the period 1993 to 2008.

Figure 4.2-1
Mean Total Mercury Concentrations in Liver and Muscle from Mackenzie Delta Belugas



Source: adapted from Stern and Lockhart 2009, p. 117 and 118

Figure 4.2-2
Temporal Trend of ∑5PFCA Concentrations in the Liver of Belugas from Hendrickson Island



Source: adapted from Tomy et al. 2009, p. 103

Pathways by which mercury and manmade organic pollutants enter the Arctic marine food chain are complex and likely to change with shifts in industrial activities and environmental conditions (e.g., Outridge *et al*. 2002, 2009; Macdonald *et al*. 2003b; Leitch *et al*. 2007). During the summer belugas segregate by length, sex, and reproductive status (Loseto *et al*. 2006, 2008a). This leads to differences in habitat use that are reflected in their dietary uptake and accumulation of mercury (Loseto *et al*. 2008b). Belugas hypothesized to feed in the epibenthic and Amundsen Gulf food webs had the highest mercury levels and estuarine-shelf belugas the lowest, matching those in associated food webs. Mercury accumulation increased with length (Loseto *et al*. 2008a, 2008b; Outridge *et al*. 2009). Larger beluga appear to feed mostly on offshore Arctic Cod (*Boreogadus saida*), whereas smaller belugas feed mostly on inshore Arctic Cod (Loseto *et al*. 2009).

Many man-made organic contaminants are also bioaccumulated through the diet. Their chemical stability can enable them to persist and accumulate long after their release to the environment. The production of several BDEs for use as flame retardants has been phased out but the *deca*BDE formulation is likely contributing to the continued increase in BDE concentrations observed in the Hendrickson Island belugas (Tomy *et al*. 2009).

What does it mean?

Current beluga harvests are believed to be sustainable (DFO 2000; Harwood *et al*. 2002). The low rate of removal, continued availability of large and old individuals after centuries of harvesting, and the apparent stability of the size and age structure of the catch in recent years, support this conclusion. Annual fluctuations in the harvest are likely related to a variety of factors, including changes in the need for beluga products and weather, but these have not been quantified. The hunt may be becoming more efficient, as fewer whales are struck and lost.

Beluga growth and survivorship appear to vary independently of the large-scale ecosystem changes that have affected populations of seals (pinnipeds) and marine communities in the region (Luque and Ferguson 2009). This suggests that belugas adjust their feeding behaviour to compensate for changes in the ecosystem, a response that may be important for adapting to climate change.

Mercury concentrations observed in the meat and muktuk of belugas exceed the Health Canada human consumption guideline of 0.5 µg/g (ww) for commercial fish and 0.2 µg/g (ww) for subsistence fisheries (Stern and Lockhart 2009). The implications of these and other elevated levels of contaminants to beluga health are unknown, and their dietary implications to humans must be considered in the context of the nutritional benefits of, and alternatives to, these foods. Deep and sustained cuts in global anthropogenic mercury emissions are required to reduce biotic mercury concentrations in Arctic marine environments, where the response will be slower than in fresh water and in other oceans (Outridge *et al*. 2008).

There is also potential for the dietary intake of muktuk to exceed recommended daily intake levels of various organic contaminants, including PCBs (Macdonald 2000). Lack of response by belugas to declining use and atmospheric concentrations of HCHs may reflect changes in their foraging behaviour in response to changing ice conditions (Stern *et al.* 2009). Declines in the concentrations of surfactants ($\sum_5$PFCA and PFOS) in the livers of Hendrickson Island belugas suggest that they are responding positively to global reductions in the emissions of these contaminants (Tomy *et al*. 2009). However, as other compounds are developed to replace them they too must be monitored for bioaccumulation.

What is being done about it?

The Inuvialuit hunters and Canada Department of Fisheries and Oceans (DFO) prepared the Beaufort Sea Beluga Management Plan (FJMC 1998) to address the management and conservation of belugas in the Canadian Beaufort Sea. On 26 August 2010, Prime Minister Stephen Harper announced that beluga management Zone 1a will be designated as a marine protected area, the Tarium Niryutait Marine Protected Area (TN MPA), under the *Federal Oceans Act*. This will provide the statutory means to ensure sustainable management of the beluga stocks and their habitat, as well as to protect and preserve harvesting traditions. Under the Inuvialuit-Inupiat Beaufort Sea Beluga Whale Agreement (2000), Canadian and Alaskan hunters have agreed to share information and co-manage the harvest to conserve the Eastern Beaufort Sea stock.

Work is ongoing nationally and internationally to reduce the use of persistent organic pollutants (e.g., AMAP 2004), to monitor contaminant concentrations (e.g., Stern and Lockhart 2009; Stern *et al*. 2009; Tomy *et al*. 2009), to improve understanding of how contaminants are cycling in the Arctic ecosystem (e.g., Loseto *et al*. 2006, 2008a, 2009; Macdonald and Loseto 2010), and to identify new contaminants (e.g., Tomy *et al.* 2009; Wania 2009) There are a number of initiatives under the Northern Contaminants Program to inform consumers about the results of contaminants studies (e.g., Loseto and Loring 2009) and to gather further samples (Smith *et al*. 2009; http://www.ainc-inac.gc.ca/ncp/).

What are the information gaps?

Limited knowledge of the structure and function of the Beaufort Sea ecosystem makes it difficult to evaluate the cumulative impacts of climate change and hydrocarbon development on this beluga population and the ecosystem they depend upon. The reason belugas return to the Mackenzie estuary in large numbers each year, for example, is unknown. This limits our ability to define and protect key habitats.

Data are also needed on the range, movements, site fidelity, stock structure, and reproductive potential of the eastern Beaufort Sea beluga stock (DFO 2000; Harwood *et al.* 2002; CIMP 2007). These data are necessary for developing population models and assessing sustainable harvest potential. Harvest monitors could gather data on the reproductive status and history of harvested belugas that would be useful for assessing the reproductive potential of the population.

Little is known of the biological effects of contaminants on belugas or about linkages between ice-cover and their contaminant uptake, but work on these problems is ongoing (Ross *et al*. 2009; Letcher *et al*. 2010). "Normal" levels of hormones, essential fatty acids, and other health-related parameters of belugas are currently being measured so any changes can be assessed.

4.2.3 MEQ Indicator – Ringed Seal

The ringed seal is smaller and more common and numerous in coastal waters of the Beaufort Sea and Amundsen Gulf than the bearded seal (*Erignathus barbatus*), which is the only other seal species common in the Beaufort Sea (Stirling *et al.* 1977; Smith 1987). As a mid-level consumer, it is a keystone species in the Arctic food web between fish and invertebrates, and foxes (*Alopex lagopus*), polar bears, and people. Inuvialuit harvested an average of 1085 ringed seals annually over the period 1988 to 1997 (Inuvialuit Harvest Study 2003).

Ringed seals can maintain breathing holes through the landfast ice (Smith 1987; Reeves 2001). This enables them to inhabit nearshore habitats year-round, and to use the more stable ice as a birthing platform. Birth lairs are built in snowdrifts on the ice. Melting conditions that cause the lair to collapse or ice to dissipate before the pups are ready to leave the lair and feed on their own may increase mortality from predation, thermal stress, and starvation (Harwood *et al*. 2000; Stirling and Smith 2004).

Because individuals are present year-round in the coastal waters the ringed seal has been considered a sedentary species, well suited for local contaminants monitoring. In reality, individual seals are very mobile. Animals tagged near Ulukhaktok Island range northeast to M'Clintock Channel, southeast to Bathurst Inlet, and southwest to Cape Bathurst; those tagged at Paulatuk range west into the Bering and Chukchi seas, some 2625 km (http://www.beaufortseals.com/telemetry.htm). These movements may confound the interpretation of population surveys and contaminants data.

Its widespread occurrence, importance to humans, availability from the harvest, and sensitivity to change in the ice environment makes the ringed seal a useful and cost-effective species for monitoring environmental productivity and the effects of climate change (Stirling and Øritsland 1995). These animals are also useful for monitoring contaminant bioaccumulation, although the sources of these contaminants may be obscured somewhat by their movements.

Little is known of diseases in ringed seals or of their transmissability to humans. A new species of virus (SePV-1) was discovered recently in harvested ringed seals (Kapoor *et al*. 2008).

What is being measured?

- **body condition**
- **ovulation rate**
- **contaminants**
- recent pups in the harvest
- population density
- harvesting

The annual seal harvest in the western Canadian Arctic has been estimated from commercial sales records and harvest studies (Stewart *et al.* 1986; Reeves *et al*. 2001; Inuvialuit Harvest Study 2003; Stephenson 2004). While not always directly comparable, these data do provide a rough estimate of the trend over time in harvest removals over the past 50+ years. The seal harvest was not monitored in 1998-2001, but was monitored by DFO in 2002 and 2003 (Stephenson 2004). The harvests are not currently monitored.

Ringed seals taken in the subsistence harvest at Ulukhaktok (Holman) have been sampled annually since 1992 (Harwood *et al.* 2000; http://www.beaufortseals.com/monitoring.htm; L. Harwood, DFO Yellowknife, pers. comm. 2010). About 100 animals are examined each year to assess their body condition (fatness) and two parameters of seal reproduction, ovulation rate and recent pups in the harvest. Teeth are collected from the seals for aging, and tissue samples have been collected periodically since 1972 for contaminant analyses (e.g., Smith and Armstrong 1975, 1978; Addison and Smith 1998; Stern and Addison 1999; CACAR II 2003; Gaden *et al.* 2009). Some of these teeth have been analysed to assess changes in mercury uptake since the pre-industrial era (Outridge *et al*. 2009). The Ulukhaktok samples are the most complete temporal data set for contaminants in seals in the Canadian Arctic (CACAR II 2003), and a valuable source of data for monitoring ocean health (Strain and Macdonald 2002). Studies to collect similar data have been undertaken at the other NWT coastal communities, such as Sachs Harbour, but seldom provide a time series sufficient for useful trend analysis.

Systematic aerial surveys of the distribution and abundance of ringed seals hauled out on the ice of the Beaufort Sea and western Amundsen Gulf were conducted in June of 1974 through 1979 (Stirling *et al.* 1977, 1982). They were repeated in the area of the Devon Nearshore Lease, using the same flight paths, in late May or in June of 2003 through 2006 (Harwood *et al*. 2007). The value of these surveys for long-term monitoring is limited by the wide variability introduced by differences in the ambient weather conditions, timing of breakup, and other factors (Moulton *et al.* 2002). They do provide useful seasonal information on seal densities among areas and habitats, but further work is required before temporal trends can be assessed.

What is happening?

Despite an increase in the human population, the harvest has declined over the past 50 years. Annual removals were probably highest in the 1960s and 1970s, a period when sealskin prices were high (Stewart *et al.* 1986; Reeves *et al.* 2001). At Ulukhaktok, for example, an average of 2,324 (STD 1312; n = 8 years) sealskins were traded annually to the Hudson Bay Company over the period 1961-74, with an unknown number of animals harvested for subsistence (Reeves *et al.* 2001). Harvests declined substantially in the 1980s following a collapse in sealskin prices related to the 1982 European ban on the import of skins from newborn harp seal (*Pagophilus* *groenlandicus*) and hooded seal (*Cystophora cristata*) pups. A strong subsistence harvest has continued, but there is no longer a substantial harvest of seals for the commercial sale of pelts.

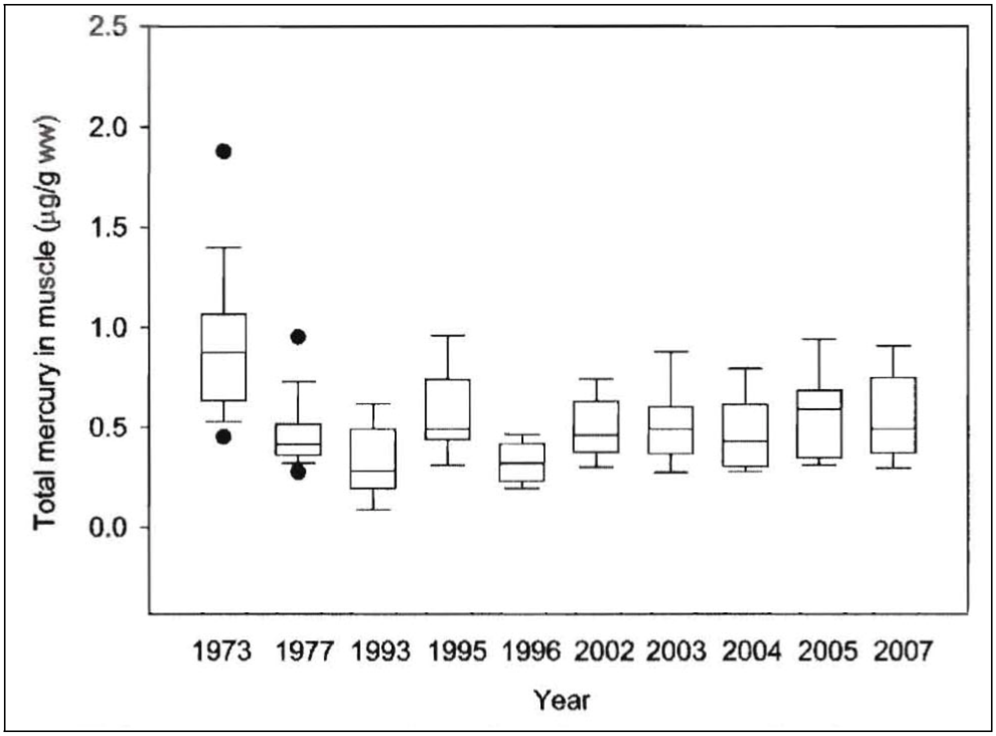
Over the last four decades there have been at least two major declines in the reproductive output of ringed seals in eastern Amundsen Gulf. Under average ice conditions most of the mature female seals ovulate but in 1974 the ovulation rate was only 42.9% (Stirling 2002), and in 2005 it was only 25% (L. Harwood, DFO Yellowknife, pers. comm. 2010). These declines occurred in the spring of years when the break-up of fast ice in the seal's breeding area was unusually late. The body condition indices of mature females with evidence of suppressed ovulation were significantly lower than those of the ovulating females. In extreme years the percentage of pups in the harvest was correlated with the previous year's ovulation rate. A widespread decline in the seal population of the Beaufort Sea-Amundsen Gulf area was also observed between 1974 and 1975 (Stirling *et al.* 1977), and again in the mid 1980s concurrent with heavy ice conditions (Stirling 2002). A similar decline may have occurred in the mid-1960s (Stirling *et al.* 1977).

In contrast, 1998 was a year with a particularly early breakup and long period of open water (Harwood *et al*. 2000). Many starveling pups were found while the older animals were in good condition. Apparently the early breakup provided favourable energetic conditions for the older animals but caused some pups to be weaned before they were ready, particularly those at the periphery of the seal breeding habitat.

Aerial surveys of seals hauled out on the ice found similar population densities among years during the 2003 to 2006 survey (Harwood *et al*. 2007). These densities were within the range reported by the 1974 to 1979 survey (Stirling *et al*. 1982). There was wide interannual variation in the overall seal density during both surveys. In 2006, when the Devon Lease was active with well testing and other activities, seal densities remained within the range of other years (Harwood *et al*. 2007).

Modern (2001-2003) seal teeth from Amundsen Gulf contain significantly more mercury than those from pre-industrial times (1300s) and from the late 1800s (Outridge *et al*. 2009). The average total mercury concentration in the muscle of Ulukhaktok ringed seals varied significantly among years over the period 1973 to 2007, but without any clear trend over time (Gaden *et al*. 2009) (Figure 4.2-3). There is, however, a significant curvilinear relationship between the tissue mercury concentrations and the number of ice free days in the year previous to sampling. Tissue mercury was higher after short (2 month) and long (5 month) ice-free seasons than when the season was of intermediate length, for both male and female seals. Similar relationships were not found for the stable isotopes of carbon and nitrogen, which are an indicator of the trophic level of the seal diet.

Figure 4.2-3
Total Mercury in the Muscle of Adult Ringed Seals Aged 7 – 36 Years from Ulukhaktok, NWT (1973-2007)



Source: Gaden et al. 2009, pg. 48.

The levels of persistent organochlorine contaminants in the blubber of ringed seals from Ulukhaktok (Holman) and Sachs Harbour have changed over time (CACAR II 2003; Addison *et al*. 2009; D. Muir, DFO Burlington, pers. comm. 2010). The direction of change varies with the class of contaminant. Monitoring at Sachs Harbour (1972-2007) suggests that a slow, decline may be occurring in the polychlorinated biphenyls (∑PCB) concentrations of female ringed seals, but there is no significant temporal trend (D. Muir, DFO Burlington, pers. comm. 2010). Concentrations of dichloro-diphenyl-trichloromethane (∑DDT) have declined significantly in these animals. Concentrations beta-hexachlorocyclohexanes (β-HCH) in blubber of female ringed seals from both Ulukhaktok (Addison *et al*. 2009) and Sachs Harbour (D. Muir, DFO Burlington, pers. comm. 2010) have increased significantly. The α-HCH : β-HCH ratio has decreased since the early 1980s likely as a direct result of cessation of technical HCH use and the relative persistence and lag in delivery of β-HCH compared to α-HCH (CACAR II 2003; AMAP 2004). Sample archiving has enabled researchers to revisit samples taken from ringed seals in the 1970s to 1990s to establish that there has been a dramatic increase in the concentrations of polybrominated diphenyl ethers (PBDEs) in ringed seal blubber over the past 25 years (Ikonomou *et al*. 2002, 2005; Macdonald *et* *al* 2003a; Muir *et al.* 2009a). Sampling at Sachs Harbour has been ongoing since 2005 and will continue until 2010 (Muir *et al.* 2009a).

Why is it happening?

Changes in the ice environment have been linked to drastic changes in seal populations and reproduction over periods of several years at intervals of about 10 years. These population changes are likely related directly or indirectly to short-term changes in the ice environment, but disease and migration may also be contributing factors (Stirling *et al*. 1977).

Interannual variations in seal muscle mercury may be related, at least in part, to ecological changes stemming from the length of the ice-free season during the year prior to sampling (Gaden *et al.* 2009). Higher mercury accumulation by seals during years with short ice-free seasons may reflect higher consumption of older, more highly contaminated Arctic Cod, and during years with long ice-free seasons a greater overall consumption of fish.

Body burdens of persistent organic pollutants reflect changes in the global use patterns of these chemicals--albeit with some time lag, and differences in their availability to the food web (Addison and Smith 1998; CACAR II 2003; AMAP 2004). The relatively recent development and use of fire retardant compounds in manufacturing has led to a global increase in the emissions of PBDEs (Macdonald *et al* 2003a). These persistent organic contaminants reach the Arctic by long-range transport mechanisms, and have increased sharply in Arctic biota over the past several decades (Ikonomou *et al*. 2002, 2005; Ikonomou and Addison 2008; Muir *et al.* 2009a).

What does it mean?

Ringed seals appear to be very sensitive to changes in their ice environment, which is a key determinant of their energetics and reproductive success. This makes them a very useful indicator of climate change. Their contaminants levels provide a good indication of trends in the bioaccumulation of some toxic substances by the pelagic food web, and in the exposure of polar bears and people to these persistent contaminants. Mercury concentrations appear to be stable (Gaden *et al*. 2009) but remain elevated from pre-industrial times (Outridge *et al.* 2009). However, longer ice-free seasons in the Arctic may increase mercury uptake in affected ringed seal populations (Gaden *et al*. 2009). Total PBDE levels in Arctic ringed seals are several orders of magnitude lower than those of marine mammals in southern Canada (Ikonomou *et al*. 2005).

What is being done about it?

Studies are continuing under the Arctic Monitoring and Assessment Programme (AMAP) and the Northern Contaminants Program (NCP) to identify emerging contaminants and to assess their impacts. The primary function of AMAP is to advise the governments of the eight Arctic countries on matters relating to threats to the Arctic region from pollution, and associated issues (http://www.amap.no/). The main objective of the Northern Contaminants Program is to reduce and, wherever possible, eliminate contaminants in traditionally harvested foods, while providing information that assists informed decision making by individuals and communities in their food use (http://www.ainc-inac.gc.ca/ncp/index_e.html). Both programs measure the levels and assess the effects of anthropogenic pollutants in the western Canadian Arctic.

Continued community-based monitoring through harvest-based projects has been recommended as a good method for gathering data on trends in seals (CIMP 2007). These studies collect biological data that are otherwise difficult and expensive to gather, and provide more useful information than studies that simply enumerate the harvests.

What are the information gaps?

DFO has identified the need for data and information on the range, movements, site fidelity and stock structure of ringed seals, and on the impacts of climate change related to reduced ice cover (CIMP 2007). Better understanding of seal movements is needed to determine whether animals in the Beaufort Sea belong to a single population or several populations, and the extent to which seals in the Ulukhaktok area represent those elsewhere in the NWT. These gaps are being met in part by research in Hudson Bay on seal movements (S. Ferguson, DFO Winnipeg, pers. comm. 2010) and tissue mercury accumulation (Young *et al*. 2010). The biological implications to ringed seals of the contaminants they accumulated are not well understood (Letcher *et al*. 2010). The species' ability to adapt to changes in the ice environment is unknown, and a very important information gap. Further sampling will be required to detect whether any significant decline is occurring in PBDE concentrations (Ikonomou *et al*. 2005).

Seals collected at Ulukhaktok have been aged by counting growth rings in the dentine (Smith 1987; L. Harwood, DFO Yellowknife, pers. comm. 2010). This method tends to underestimate seal ages, particularly those of older animals with worn teeth (Stewart *et al.* 1996). It limits the comparability of data with that from elsewhere, and its use for age-specific determinations. Aging seals using growth rings in the tooth cementum provides a better record of age (Stewart *et al*. 1996). Consideration should be given to aging seals in future using both dentine and cementum to facilitate comparison and age-specific analyses.

4.2.4 MEQ Indicator – Red-throated Loon

Red-throated loons (*Gavia stellata*) arrive at offshore leads in the Beaufort Sea - Amundsen Gulf area in late May or early June (Dickson 1992, 1993, 1994; Dickson and Gilchrist 2002). They remain there until the shallow tundra ponds they nest beside have open water. These birds are a widely distributed, conspicuous nesting species near the coasts in summer. They typically nest within 8 km of the coast or a large lake and, because the shallow nesting ponds winterkill, those near the coast travel there to forage for fish to feed their young. Unlike other marine bird species in the region, young loons remain at the nesting pond until they fledge, providing an opportunity to obtain reliable data on annual breeding success. Because they migrate, the value of adult loons for local contaminant monitoring is limited. However, young-of-the-year do reflect local contaminant levels. Furthermore, because they dive for food in coastal waters, loons are very vulnerable to oil pollution.

The Canadian Wildlife Service studied the abundance, breeding effort, and breeding success of the red-throated loon along the mainland NWT coast between 1985 and 1989 (Dickson 1992), and again in 2007 and 2008 (L. Dickson, CWS Edmonton, pers. comm. 2010). The species was identified as suitable for monitoring environmental changes caused by offshore oil and gas development in the Beaufort Sea. In the 1980s, little inter-annual variation was observed in the number of loons with breeding territories or in breeding effort, but there was wide variation in breeding success. Breeding success was recommended as the key indicator for monitoring purposes. However, due to wide natural inter-annual variability, only large changes in productivity (31-43%) will be detectable with statistical certainty (95%). This may make human-induced change difficult to identify, and necessitates long-term study to identify natural trends. Recent surveys in 2007-08 indicated little change in abundance of red-throated loon breeding pairs or productivity in the Beaufort Sea region. More frequent surveys are needed in the future to confirm these temporal trends

Red-throated loons feed their chicks small fish from coastal marine waters (L. Dickson, CWS, Edmonton, pers. comm. 2005). Consequently, contaminants accumulated by the young before they leave the nesting territory originate from the local marine environment, making them a useful indicator of the local availability of contaminants to fish-eating marine birds. While an analysis of contaminants has not been done, 11 young-of-the-year were collected in the late 1980s and stored at the National Wildlife Research Center in Ottawa to be used as a baseline should contaminants become a concern in the future. Unfortunately the available data are insufficient to assess trends over time and samples were not collected during the recent work (L. Dickson, CWS, Edmonton, pers. comm. 2010).

4.2.5 MEQ Indicator – Anadromous Dolly Varden and Arctic Char

Anadromous Dolly Varden (*Salvelinus malma*) and Arctic Char (*Salvelinus alpinus*) spawn and winter in fresh water but feed at sea during the summer. The two species are often confused with one another. Dolly Varden typically occurs west of the Mackenzie, while fish to the east and on the Arctic islands are typically Arctic Char (Reist *et al*. 1997). These fishes are low to mid-level consumers that eat freshwater and marine invertebrates and smaller fish, and are eaten by ringed seals, belugas, and people.

Both species show a high degree of fidelity to their natal spawning and over wintering areas, and because of their extensive seasonal movements a particular wintering stock may be vulnerable to harvest at numerous locations. Dolly Varden from the Rat and Big Fish rivers, for example, are vulnerable to capture along the Yukon coast, near Shingle Point, in the Mackenzie mainstem, and in their individual river systems (DFO 2001). This predictability makes them attractive to harvesters and vulnerable to over-harvesting. These fish are harvested in quantity for subsistence, sport and commercial sale, and are important to the culture and economy of the Inuvialuit (Stewart *et al*. 1993; Inuvialuit Harvest Study 2003; Stephenson 2004) and Gwich'in (Stewart 1996; McDonald 1998a, 1998b, 2009) Arctic Char tagged at the Hornaday River system show very strong fidelity to that system (DFO 1999). They feed along the nearby coast and winter in the river system, and tagging studies have not found strays entering other systems. They appear to be vulnerable to harvest only by the Inuvialuit from Paulatuk.

Arctic Char have been recommended as an ideal species for assessing the impacts of climate change on Arctic fishery resources (Reist 2004). Char populations may become more productive over the short term in response to increased nearshore production, but over the long term may be replaced by other salmonid species that move northward to take advantage of increasingly favourable habitats.

What is being measured?

- **population size**
- **catch per unit effort**
- **age at harvest**
- **fish condition**
- **harvest**
- contaminants

Most studies to assess the health of these fish populations have subsampled commercial, subsistence, or sport harvests for data on growth, reproduction, population structure, and condition (Ratynski *et al*. 1988; Stewart and Ratynski 1995; Stewart 1996). Some of these studies have provided tissue samples for contaminant analysis; others have estimated population size based on mark-recapture studies or counts at weirs. Typically, the annual harvest of fish from a particular population is uncertain and difficult to establish, due in part to the species' extensive movements. The sampling programs often have been undertaken in response to community concerns over resource depletion or fish quality. Studies conducted at the Rat (Harwood *et al.* 2009; Sandstrom *et al.* 2009), Big Fish (DFO 2003; N. Mochnacz, DFO Winnipeg, pers. comm. 2010), and Hornaday (Harwood 2009) rivers are examples of this, but are unusual in their longevity and continuity. Populations in other rivers such as the Kagloryuak, Kuujjua, Kuuk, and Nalaogyok have also been studied.

At the Rat River, annual harvest estimates for Dolly Varden are available beginning in 1986, with some earlier data back to 1972 (DFO 2001; Harwood *et al.* 2009). Biological collected before 2000 are reported in Harwood (2001)), and from 1995 through 2007 in Harwood *et al.* (2009). The latter were collected by fishery "monitors" who used consistent sampling protocols, but have been reduced in number from 5 to 3 due to cost constraints. Timing of the peak of the fishery at various locations has been recorded since 1996. Sex, size, age, maturity and catch-per-unit-effort (CPUE) data are available from the subsistence fishery since 1989. Mark-recapture estimates of the anadromous population were conducted in 1989 (Stephenson and Lemieux 1990), 1996, 1998, 2002, 2005, and 2008 (Sandstrom *et al.* 2009). These estimates were based on the ratio of marked to unmarked fish in the summer subsistence harvests. Marking with Floy tags was conducted at the headwater spawning and overwintering site the fall prior to each estimate. In 2000, the monitors began collecting fin and tissue samples for future genetic analyses (Harwood *et al.* 2009).

Population estimates based on mark and recapture studies (Peterson method) and weir counts are available for Dolly Varden in the Big Fish River in 1972, 1984, 1987, 1988, 1991, 1993, and 1998 (DFO 2003). Not all of these studies are directly comparable. The current status of the stock is unknown.

Data are available on the annual harvest of Arctic Char from the Hornaday River since 1968 (DFO 1999; Stephenson 2004; Harwood 2009). A standardized long-term, harvest-based monitoring program has been in place since 1990, with catch and biological data collected each year by community monitors (Harwood 2009). Data are recorded on the location, duration, and timing of the fishery and on the catch effort by mesh size. The overall catch is subsampled for biological data (age, length, weight, sex, maturity, stomach contents), and another 300 fish are weighed and measured for growth data.

While some data are available on contaminants of the fish in these systems, they are too few as yet to provide a useful assessment of the trend of accumulation over time (Macdonald 2000; M. Evans, EC Saskatoon, pers. comm. 2010). Time trends in persistent organic contaminant levels of Rat River Dolly Varden are being investigated (Evans and Muir 2009).

What is happening?

Mark recapture studies suggest that the Rat River Dolly Varden population declined in 2004 but had rebounded by 2007 (Sandstrom *et al*. 2009; Dolly Varden IFMP May 2010 draft). The sex and maturity composition of the catch at the Fish Hole was relatively stable from 1997 through 2007, but the fork length of spawning fish increased and there was a pulse of juvenile production in 2007. Fewer Dolly Varden are being harvested from the Rat River stock than in the past. Over the period 1995 to 2001, the average annual subsistence harvest was estimated at 2,383 fish; this declined to an average of 726 fish over the period 2002 to 2007 (Harwood *et al*. 2009). Declines in the CPUE were observed at all monitoring sites starting in 2000-2002, and remained low through 2007 (Harwood *et al.* 2009). Most biological parameters monitored over the 1995 through 2007 period were stable, but the size at age and proportion of smolts (age 4) in the harvest increased. The ratio of females to males in the spawning population (9:1) remains extraordinarily high.

At the Big Fish River, abundance estimates suggest that the population was reduced substantially between 1972 and 1988, and had not recovered by 1998 (DFO 2003). Over the five-year period ending in 1998 with the most recent population estimate, the number of adult fish in the population remained relatively stable at about 4000 fish.

The stock of anadromous Arctic charr that spawns and overwinters in the Hornaday River supports a subsistence fishery by Paulatuk, and in the past also supported commercial (1968-1986) and sport (1972-1978) fisheries (DFO 1999; Harwood 2009). The duration and timing of the subsistence fishery have been relatively consistent since at least 1990. From 1997 through 2007 the mean annual CPUE and total catch for the late summer subsistence fishery fluctuated but showed an overall decline. During this period the sex and age structure of the population remained relatively stable but the average length and length at age increased, except in 2007 when there was a shift to younger fish. Growth rates increased from 2002 through 2007.

Why is it happening?

The reason(s) for the sharp, temporary decline in the population estimate for Rat River Dolly Varden is uncertain. The decline in 2004 was also evident in the availability of fish at the spawning and overwintering site (Sandstrom *et al*. 2009), which suggests that the lower estimate resulted from a real decline in population abundance and was not an artefact of the sampling methods. Recent declines in the subsistence harvest are related in part to the voluntary closure of the Dolly Varden fishery by the communities of Aklavik and Fort McPherson. Changes in size at age over the period 1996 to 2005 appear to be related the break-up of sea ice earlier in the season, which enables the fish to spend longer feeding at sea (Harwood *et al*. 2009). The reason for the low number of spawning anadromous males is unknown.

The apparent lack of recovery of the Big Fish River stock, despite closure of the fishery in 1987, may reflect habitat changes rather than harvesting pressures (DFO 2003; Stewart *et al*. 2009). The water level of the fish hole is much lower than in the 1960s and 1970s; salinity of this spring-fed pool has declined; and the mean annual air temperature in the area has been increasing. Seismic events in the region may have reduced the rate of groundwater flow into the site.

Declines in the mean annual CPUE and total catch of anadromous Arctic Charr by the Paulatuk late summer subsistence fishery at the Hornaday River suggest that fewer char are available for harvest. This decline does not appear to be skewed towards a particular age or sex of fish. The reason why more young fish were sampled in 2007 is unknown. It could be a sampling artefact, or represent a change in recruitment, timing of movements, or some other factor. Increases in the growth rates have been correlated to earlier breakup of the sea-ice in Amundsen Gulf, which enables the fish to spend longer feeding at sea (Harwood 2009).

What does it mean?

Results from the mark-recapture studies (Sandstrom *et al*. 2009) and harvest monitoring (Harwood *et al*. 2009) suggest that the Rat River Dolly Varden stock is stable and sustaining the present harvest level (i.e., ca. 2007 AD). The increase in size at age of spawners may increase the reproductive output of this Dolly Varden stock, provided the relationship between length and fecundity is similar to other North Slope stocks (Sandstrom 1995; Stewart *et al.* 2009). This could help offset the negative effects of harvesting on reproductive potential when spawners are removed from the fishery. There is concern that the number of anadromous males in the spawning population may be insufficient to successfully mate with all available females, particularly as residual males may be rare or absent in this system (Sandstrom *et al*. 2009).

While empirical evidence is lacking, both fishers and scientist agree that habitat changes may be limiting the recovery of the Big Fish River Dolly Varden stock (DFO 2003). These changes must be taken into account in management of this fishery, which is further complicated by the vulnerability of this stock to harvest by mixed-stock fisheries along the coast and in the Mackenzie River system.

Trends in the annual catch rate suggest that the Hornaday River Arctic Char stock is unable to sustain current (ca. 2007) harvest levels. Earlier ice breakup appears to have a positive effect on the growth rate of anadromous Arctic Char in the Hornaday River stock. The increase in size of char at a particular age increases the food energy (biomass) available to harvesters and may increase the reproductive output of the stock, since fecundity increases with size (Johnson 1980).

What is being done about it?

Working groups have been established to coordinate fishing pressure on these shared populations and prevent over-harvesting. A community based fishery plan has been in place at Aklavik and Fort McPherson for the Rat River since 1995, and is updated regularly. It recommends limits on the annual harvest of Dolly Varden by the food fishery and specifies the number of nets, their size, and depth restrictions. A community-based sampling program has monitored the fishery since 1989 (DFO 2001). Work on a study to document traditional knowledge of the Rat River is ongoing (http://www.grrb.nt.ca/fisheries_research.htm). DFO studies of Dolly Varden habitat in the Rat River are ongoing to identify key habitats and habitat limitations, to develop a baseline for future monitoring, and to provide the data necessary to develop a fish habitat model (N. Mochnacz, DFO Winnipeg, pers. comm. 2010)

The Rat River Fish Hole (Ne'edilee) was last fished in the mid-1980s (Harwood *et al*. 2009), and remains closed (Dolly Varden IFMP May 2010 draft). This measure protects Dolly Varden concentrated in this critical spawning and overwintering habitat. Following the sharp decline in the Rat River Dolly Varden population estimate in 2004 (observed in 2005), Aklavik and Fort McPherson voluntarily closed the Rat River Dolly Varden fishery to all fishing during the upstream run from 1 August to 15 September (Dolly Varden IFMP May 2010 draft). The fishery remained closed from 2006 through 2008 but during this period the fishery monitors were allowed to harvest a total of 120 fish annually to gather biological data. Data collected by the monitoring program on the annual changes in the biological parameters and success of the fishery provide a means by which fishery managers can assess the stock status and sustainability of the fishery. In 2009, the Rat River Working Group recommended a controlled harvest allocation of 1225 fish, of which about 25% was harvested. The Working Group has recommended a controlled harvest allocation of 600 fish for 2010. DFO has recommended the release of any live fish captured that may be anadromous males.

The West Side Working Group (WSWG) made up of fishers from Aklavik, community elders, biologists, and managers is working to develop a long-term, objectives-based Fisheries Management Plan for the Big Fish River and other rivers between the Mackenzie River and the Canada/Alaska border (DFO 2003). In addition, the Aklavik Inuvialuit Community Conservation Plan has designated the Fish Hole and riparian areas of the Big Fish River as Management Category E to protect them from development. A program of community monitoring at the Big Fish River led by the FJMC and WSWG was initiated in 2004-05 (http://www.nasivvik.ulaval.ca/en/community-monitoring-of-the-big-fish-river). This work will include habitat and water quality surveys, traditional knowledge research and integration, and discussions of the implications of changing environmental conditions, and Inuvialuit health and culture, including diet and country foods. It includes a pilot project with the school to establish monitoring sites on the river using the Streamkeepers protocols (Joynt *et al*. 2008). Studies to assess the quality and quantity of Dolly Varden habitat in the Big Fish River system are ongoing (e.g., Joynt *et al*. 2008; N. Mochnacz, DFO Winnipeg, pers. comm. 2010).

An Integrated Fishery Management Plan (IFMP) for Dolly Varden in the Gwich'in Settlement Area and Inuvialuit Settlement Region is being developed (Dolly Varden IFMP May 2010 draft). Its purpose is to identify the main objectives and requirements for the Dolly Varden fisheries in these areas, and the management measures necessary to achieve these objectives. It also communicates basic information on the fishery and its management to government departments and others with an interest in the resource. It is not a legally binding instrument and can be modified at any time.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is assessing the status of the northern form Dolly Varden, which includes fish in the Rat and Big Fish river systems, and is expected to announce its conclusion in 2010. The Government of the Northwest Territories considers Dolly Varden "Sensitive", meaning that it may require special attention or protection to prevent if from becoming "At Risk" (Working Group on General Status of NWT Species 2006).

Char in the Hornaday River are managed under the Paulatuk Char Management Plan, which was developed by the Paulatuk Char Working Group (PCWG) (DFO 1999; PCWG 2002). This plan has recommended the closure of Fish Holes between Coalmine and Aklak Creek to fall and winter fishing and a limit of 2000 on the total annual harvest of char from the river (PCWG 2002). The community does not have an alternative source of anadromous Arctic Char nearby (MacDonell 1989), and wishes to conserve the stock and ensure its long-term well being (DFO 1999). Consequently, fishing for alternate species has been encouraged and fishers will be supported if they fish at alternate locations.

What are the information gaps?

Linkages between habitat changes and the failure of the Big Fish River population to recover are uncertain. Work to address this information gap is ongoing. The current population size and structure are unknown and should be determined so any trends are apparent. More detailed habitat and behavioural studies are needed to understand the impact of the low sex ratio on the annual reproductive capacity of the Rat River Dolly Varden population. The 2005 NWT Environmental Audit identified lack of information on smolts from the Rat River population as an important data gap. Recent studies have collected some data from smolts to improve understanding of recruitment. Sustainable harvest levels and the vulnerability of stocks at various locations are uncertain for most stocks. Linkages between sea ice cover and the condition of anadromous fishes have not been examined, but may be important determinants of the sustainable harvest level.

Concern has been raised that the incidence of parasite infections in the flesh of Rat River Dolly Varden may be increasing (Dolly Varden IFMP May 2010 draft). If parasites are infecting the meat of the fish, and not just encysting on the wall of the body cavity or present in the viscera, samples of these parasites should be collected for identification.

4.2.6 MEQ Indicator – Sea Ice

Changes in the ice cover have major implications for the Beaufort Sea/Amundsen Gulf area. The reduction or loss of seasonal ice cover would reduce or eliminate an important component of the freshwater budget (i.e., sea ice melt) and threaten existing ecosystems (Carmack and Macdonald 2002; Macdonald *et al*. 2003b). Changes associated with light, nutrients, productivity and ice cover will likely be greatest at the shelf-break and margins (Carmack *et al*. 2006). How changes in the ice environment affect each species will depend very much on the exact way in which the animal or plant uses ice, and on the plasticity of that use. The resultant changes are not necessarily linear and there may be a few threshold responses and non-linear surprises. There may also be unexpected cumulative effects when impacts of climate change interact with those from other environmental stressors—particularly contaminants.

What is being measured?

- **duration of ice cover**
- **areal extent of seasonal ice cover**
- **ice draft**

Satellite passive-microwave observations have proven tremendously valuable for monitoring the duration and extent of sea ice coverage. Observations of Arctic ice began in December 1972, following the launch of the Electronic Scanning Microwave Radiometer (ESMR) on board NASA's Nimbus 5 satellite (Parkinson 2000b). The ESMR provided good-quality data for most of the period from January 1973 through October 1976, but had only one channel so the accuracy of derived ice concentrations was ±15% and ice types could not be distinguished from one another. Since October 1978, more advanced passive-microwave instruments aboard subsequent U.S., Canadian, and European satellites have provided a record of ice concentrations that is more accurate and distinguishes between different types of ice (Parkinson 2000b; Parkinson and Cavalieri 2002; http://ice-glaces.ec.gc.ca). But, the interpretation of these remotely-sensed data is not infallible, as the near-surface physical properties of heavily decayed ice sometimes mimic those of multi-year sea ice (Barber *et al*. 2009).

Ice draft has been measured since the late 1980s in the Beaufort Sea area using upward-looking sonars moored to the bottom of the ocean (Melling and Riedel 2004; Fissel *et al*. 2008), and using submarine-based upward looking sonars (Winsor 2001). Sea ice draft is a measure of the subsurface ice thickness, whereas the total thickness also includes the above-surface freeboard which accounts for about 10% of the ice thickness. In the past, the Canadian Ice Service also collected ice thickness data manually at stations along the NWT coast (http://ice-glaces.ec.gc.ca/). The length of the data record varies with station: Sachs Harbour (1956-86), Mould Bay (1949-97), Ulukhaktok (1960-69), Cape Parry (1959-92), and Tuktoyaktuk (1971-77).

What is happening?

The results of ice cover studies vary somewhat depending upon the area, parameters, and length of the observation record examined. Satellite observations suggest that there has been a general decrease in the duration and areal extent of the Arctic sea ice cover since the mid-1970s (e.g., Serreze *et al*. 2003; Johannessen *et al*. 2004, Parkinson and Cavalieri 2008; Barber *et al*. 2009; Deser and Teng 2008). This ice loss appears to be unmatched over at least the last few thousand years, and unexplained by any of the known natural variabilities (Polyak *et al*. 2010).

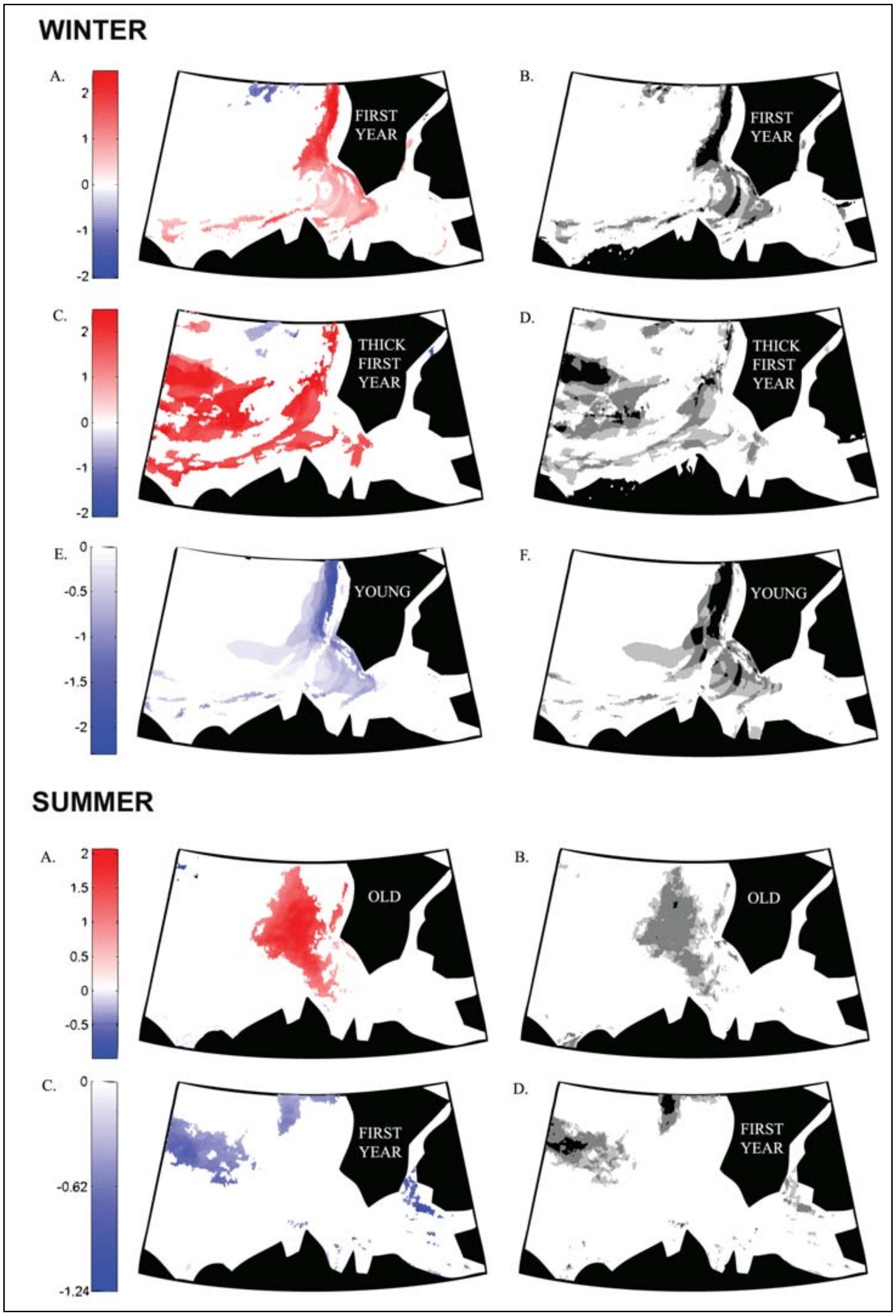
Over the period 1979-2005 satellite passive microwave data showed significant trends (98% level) in the Beaufort Sea ice, not including Amundsen Gulf. These trends included earlier onset of the spring melt (-4.7 days/decade) and lengthening of the melt season (9.2 days/decade) (Stroeve *et al*. 2006). A trend toward later freeze-up (4.9 days/decade) was also apparent but was not significant at the 98% level. Over the period 1979-2008 declining trends were observed in the average September total ice and multi year ice areas in Amundsen Gulf, but these declines were not statistically significant at the 95% level (Howell *et al*. 2009).

The type of sea ice in the flaw lead system, where perennial sea ice of the southern Beaufort Sea interacts in winter with the annual sea ice of Amundsen Gulf, changed between 1980 and 2004 (Galley *et al*. 2008). Over that period, significant (98% level) winter trends were observed in the concentration of thick first-year sea ice, which increased, and in the concentration of young ice, which decreased; summer trends were observed in the concentration old sea ice near the mouth of Amundsen Gulf, which increased, and in the concentration of first year ice farther west, which decreased (Figure 4.2-4). The timing and duration of breakup within Amundsen Gulf varies widely compared to that of freeze-up.

The long-term study of ice thickness in the Beaufort Sea (Melling *et al*. 2005) discussed in the 2005 NWT Environmental Audit is continuing, but a synthesis of results from the past 5 years is not yet available.

Figure 4.2-4
Winter and Summer Sea Ice

(left) CONCENTRATION TREND (% per year) 1980-2004,
(right) STATISTICAL SIGNIFICANCE (99% black, 95% dark grey, 90% light grey)



Source: Galley et al. 2008, figures 11 and 12.

Why is it happening?

While the satellite data show changes in the sea ice, they do not explain their causes or predict future changes (Parkinson and Cavalieri 2002; Stroeve *et al*. 2006). The magnitude of the Arctic sea ice variability associated with oscillatory changes in the climate system, such as the Arctic Oscillation and El Niño/Southern Oscillation, is much smaller than the observed regional ice trends (Liu *et al*. 2004; Deser and Teng 2008). Local, regional, and internal processes may then play a more significant role in shaping the persistence of Arctic change than has previously been recognized (Barber and Hanesiak 2004; Overland and Wang 2005; Barber *et al*. 2008; Asplin *et al*. 2009; Vavrus *et al*. 2010). To understand these trends it will be necessary to consider less understood large-scale processes and their nonlinear coupling to local-scale processes. Changing snow cover, ice circulation and ice deformation may obscure the direct effects of warming on seasonal pack ice (Melling *et al*. 2005).

What does it mean?

Shifts in the type of sea ice in the flaw lead system could reduce its persistence or extent in the southern Beaufort Sea-Amundsen Gulf region (Galley *et al*. 2008). This could lead to substantial changes in the way Amundsen Gulf breaks up in spring, reducing biological productivity of the region and affecting the lives of the area's inhabitants. Diminishing sea ice may play a central role in recent Arctic temperature amplification (Screen and Simmonds 2010a, b) and cause freshening of the surface waters (Yamamoto-Kawai *et al*. 2009). But, uncertainty in the underlying causes of changes in sea ice cover means that extrapolations of recent sea ice conditions into the future should be done with caution (Parkinson 2000a).

What is being done about it?

There is intense concern over the potential impacts of significant changes in the ice cover on the Arctic ecosystem and on human activities. Large-scale Arctic research programs such as CASES and Arctic Net have been working to improve monitoring capabilities and assess changes in the sea ice. The results of these and other studies feed into international programs such as the Intergovernmental Panel on Climate Change (IPCC) and Arctic Monitoring and Assessment Programme (AMAP), which consider their implications.

What are the information gaps?

While synoptic data are available for the duration and extent of ice cover, they are not available for ice thickness or snow cover. In addition, some of the algorithms used to predict the type of ice cover from satellite data are inaccurate (Barber *et al*. 2008). The factors underlying natural variability of the sea ice cover, atmospheric couplings, and linkages between changes in sea ice and other aspects of the marine ecosystem are also uncertain. These are very important gaps in the information necessary to understand changes in ice cover and develop predictive climate models (Laxon *et al.* 2003). They limit the ability to predict how ice cover may change over time, and how species and biological communities may respond over the short or long term, and from one area to another. More ground-truthing of the satellite data is needed to ensure the accuracy of detection algorithms. Comparable spatial and temporal data are required to assess snow cover and ice thickness, and to assess how the timing and amount of snow cover affects sea ice thickness (Dumas *et al*. 2005). Longer time series are needed to detect and understand changes in the sea ice (Melling *et al*. 2005), and their effects on trophic dynamics and contaminant availability.

4.3 RECOMMENDATIONS

Effective monitoring for changes in the health of the marine environment caused by human activities will not be possible until the natural variability and cycles of the indicators used for environmental monitoring has been established (SENES Consultants Ltd. 2005). The solution lies in the design and completion of elegant long-term (>10 y) research designed to develop appropriate monitoring strategies, and the implementation of these strategies over the long term. Effective monitoring requires the proper choice of monitoring parameters; well-designed studies that are repeatable reliably over time; long-term support and continuity; the cooperation and participation of local communities, to ensure the integrity and success of sampling programs; and competent personnel.

Government scientists are often best equipped to conduct this research, and to provide the resources, expertise and long-term stability required for this work. However, fiscal planning must extend past the next fiscal year or next election. Faced with climate change, associated changes in human activities, and long-range transport of persistent contaminants, a coordinated, multi-national, multidisciplinary approach to monitoring may be essential to ensure that adequate information is available to conserve vulnerable biota such as Arctic marine mammals (Simpkins *et al*. 2009).

Community-based harvest sampling programs remain the cornerstones of work to assess temporal trends in the marine environment of the NWT. This top-down approach may be a cost effective method of identifying that change is occurring, but it does not provide the information necessary to understand why change is occurring. Linkages between trends in these harvested species and their environment, and between contaminant burdens and species' health must be established. The applicability of these relatively local studies to other geographical areas, populations, or biota in the region must also be established. Completion of the Inuvialuit Harvesting Study in 1997 left a void in harvest monitoring that was partially filled for fish and seals by DFO (Stephenson 2004). Harvest monitoring should be conducted periodically to provide the data necessary to follow ongoing trends.

As in 2005 (SENES Consultants Ltd. 2005), establishing linkages between the quality, extent and duration of sea ice cover and biological indicators may be particularly important for understanding natural trends and assessing the effects of change. The establishment of a community-based sea ice monitoring system to identify, gather, and integrate the information users need to track, forecast, and adapt to changes should be considered. Sampling protocols have been developed (Mahoney and Gearheard 2008), and a framework for how the studies might be linked with other research has been proposed (Eicken *et al*. 2009).

The polar bear is a top predator in a rapidly changing ecosystem. Further analysis of polar bear populations will not only be important for management of the species, but will play a critical role in understanding the entire ecosystem (Hunter *et al*. 2007). Long-term, individual-based data collected under a consistent sampling protocol are needed to detect, model, and interpret the impacts of ecological changes on polar bears and to delineate demographic trends from short-term fluctuations (Regehr *et al*. 2007). Continued monitoring and assessment of the status of these polar bear populations should be undertaken at regular intervals in the future to quantify the importance of loss of sea ice on the population dynamics of polar bear populations adjacent to the polar basin. A population survey should be conducted for the Viscount Melville Sound Population to establish its current size and structure. This information is needed to support harvest management decisions and to provide a basis for future comparisons. Research on climate change should be incorporated into models for predicting sustainable polar bear harvests to improve the accuracy of their predictions (COSEWIC 2008).

New anthropogenic substances should be screened for properties linked to persistence and bioaccumulation, and their use limited until their contaminant risk has been properly assessed (Gouin 2010). Increasing concentrations in Arctic marine biota of substances that may have a significant delay between emission reductions and concentration declines require a swift regulatory response (Gouin and Wania 2007; Wang *et al*. 2010). Studies of contaminant biomagnification should incorporate studies of predator behaviour within the food web structure to enable better evaluation of dietary sources of contaminants (Loseto *et al.* 2008b). Such studies may become increasingly important in the face of changing ice environments. The archiving of aging structures and banking of tissue specimens will be critical to future retrospective work on temporal trends in emerging contaminants.

In the future, studies for monitoring invasive species, biodiversity, genetic variation, and bowhead (*Balaena mysticetus*) populations may become useful indicators of trends in the marine environmental quality. Work is underway to establish a baseline for aquatic invasive species monitoring in the Canadian Arctic (K. Howland, DFO Winnipeg, pers. comm. 2010). Sampling methods developed for similar work on the east and west coasts are being used to inventory existing biota and environmental conditions in the Tuktoyaktuk area. These studies should be repeated at 5 to 10 year intervals. Bulk genetic sequencing (pyro-sequencing) techniques may also be used to screen for new/different species or high-risk invasive species. The Circumpolar Biodiversity Monitoring Program (CBMP), a program under the Arctic Council, tasked a Marine Expert Monitoring Group to develop an Arctic Marine Biodiversity Monitoring Plan. This Plan is expected to be completed before the end of December 2010. It will include the Canadian Arctic marine environment and several of the species and indicators mentioned here (J. Watkins, DFO Ottawa, pers. comm. 2010). While it will examine species diversity, as well as community diversity at lower trophic levels (e.g., plankton and benthos), the genetic variation of key indigenous species may also provide a useful tool for detecting ecological change (Nelson *et al*. 2009). Species such as the crustacean zooplankter *Calanus glacialis* could serve as indicators of the dispersal of Pacific biota into the Beaufort Sea. Bowhead population surveys conducted in 1981-1986 were repeated in the 2007-2009 (Harwood et al. 2009). They suggest that the population has increased. Future surveys will be required to establish a trend in the population trajectory. As integrators of secondary productivity on a massive scale, these animals may provide important insights into the effects of changing ice conditions.

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5.0 TERRESTRIAL ENVIRONMENT

5.1 OVERVIEW OF THE VALUED COMPONENTS

Environmental and assessment programs use "indicators" or measurements of physical or ecological conditions to monitor the condition of the ecosystem, and to detect changes that may show an improvement or decline in condition. Monitors of the physical environment may report daily temperature or monthly precipitation to illustrate the condition of the abiotic environment, using terms that are easily understood and measured.

For several decades, ecological monitoring programs have used Valued Ecosystem Components (VECs) or Valued Component (VCs) to indicate the status of the biological environment. In the NWT, the most useful VCs are those that are flagstone species, which are integral to the normal functioning of the ecosystem, and have some social significance, especially to Aboriginal people, such as being vital to the social, cultural and nutritional framework of the northern culture. A prime example is barren-ground caribou, which are distributed across the NWT, consume vast amounts of lichen and other vegetation, become prey for major predators like grizzly bear, wolves, wolverines and golden eagles and provide significant underpinning to many aspects of northern life. Less obvious are migratory birds that enter the NWT by the millions during summer, concentrate at several of the most productive wetlands and lakes, and are harvested by the thousands.

A large number of factors may affect the status of a species. Ecological factors such as disease, predation and overpopulation can reduce species numbers, as can external factors such as climate extremes and overharvesting. The interplay between many of these factors is still unclear for northern species.

5.2 IDENTIFICATION OF THE KEY INDICATORS

Ideally, the condition of VCs is monitored using a number of measurements of different aspects of the VC. For many wildlife species, total population size and reproductive rates, as determined by the number of young produced annually, are relatively easily measured and are critical for the maintenance of the population. Other indicators, like the geographical distribution of a species, rates of harvest or loss by natural causes, and population demographic measurements (e.g., male:female ratios, young:adult ratios and the numbers of reproductively active females), provide information on the balance of births and death and the ability for the population to increase, decrease or remain stable. Monitoring and survey programs that record the same indicators over long periods of time produce some of the most useful information for assessing the current status of a species and may be able to show the reasons for declines or increases in populations (e.g. effects of changing environmental condition; loss or improvement of habitat; increasing development).

What is being measured?

Several indicators were used in this assessment to determine the current status of terrestrial species in the NWT (Table 5.2-1). The most common indicator for plants and wildlife is population size, which can be recorded through time to indicate improvements or declines in the health of a species. Demographic measurements of populations, such as the number of each gender or the number of young, are another set of indicators that will be used to determine the health of representative species. Other indicators include an assessment of the harvest rate of a species and the resources dedicated to protect biodiversity and sensitive or rare species. This last category of indicators is important because many species undergo cycles in population size due to natural or human-made conditions, however some species require additional protection, in the form of legislation, protected habitats and conservation efforts to recover.

Table 5.2-1
Summary of Valued Components and Key Indicators used to Assess the Terrestrial System

Candidate Species for Valued Ecosystem Component	Indicators	Rationale
Mammals • Barren-ground caribou • Woodland caribou • Moose • Furbearing species	General Status of Wildlife Population Size Reproductive Rate Calf:cow ratios Harvest rates	Series of indicators provide data on current status and characteristics of the populations that indicate changes in numbers and, possibly, the causes
Landbirds (e.g., grouse, ptarmigan, songbirds)	Population Size and Density Habitat Condition Long-term trends in Population	Some landbirds are resident species and reflect the condition of the terrestrial environment in the NWT. Migrating species comprise a large number of species that maintain biodiversity
Waterfowl	Population Size Long-term trends in populations Nesting habitat condition Harvest Success	Several waterfowl species are used for food and reflect conditions in the NWT and on the wintering grounds.
Plants	Species status	
Protected Areas	Achievement of targets for protection of biodiversity	Protected spaces vital for maintaining natural habitat and biodiversity into the future

5.3 ASSESSMENT

5.3.1 Valued Component 1 – Mammals

5.3.1.1 Overview

Mammals have always had a significant role in northern culture; large and small mammals, ranging from caribou, moose and muskox to hare and furbearers like marten, fox and lynx, have historically provided nutritional food, clothing and tools for survival and were the basis for the early economy. Traditions centered on the hunting and preparation of food and clothing from mammals have formed the basis for much of the traditional knowledge continued through generations. Although dependence on the traditional lifestyle has decreased in modern times, hunting and trapping continue in most communities and an industry has grown around the outfitting and guiding of sport hunting. As a result, the status of mammals, particularly barren-ground caribou, has major repercussions throughout the northern culture and economy.

The status of major mammal species was assessed using a number of indicators. The most important parameter is population size (Table 5.2-1), with changes in numbers often indicating a decline or improvement in the general status of the species. Other indicators, like numbers of age groups or numbers of young produced annually are more difficult to measure and interpret, and often take dedicated research programs, but may provide information on the reasons for changes in population status. Finally, harvest rates indicate if a species is undergoing undue stress due to overhunting and may indirectly show the relative numbers of a species.

Key indicators:

- General Status of Wildlife;
- Barren Ground Caribou;
- Woodland Caribou;
- Moose; and
- Fur Bearing Species.

5.3.1.2 Indicator 1 – General Status of Wildlife

One of the best programs to evaluate the overall health of terrestrial species is NWT General Status Ranking Program by the Working Group on the Status of NWT Species (WGGSNS; www.enr.gov.net.ca). In 2000, the WGGSNS (WGGSNS 2000) evaluated the status of 63 known mammal species and determined that three species (Arctic-Island caribou, Peary caribou and wood bison) are considered to be “At Risk” of local extinction. Two species, the mountain goat and fisher were classified at a lower level of priority of “May Be At Risk”. Seven species were categorized as “Sensitive” due to either their ecological characteristics, limited distribution in the NWT or potential threats to the populations from habitat loss and development.

The 2006 WGGSNS assessment evaluated 65 mammal species, two of which were ranked as “At Risk” and one, the mountain goat, as “May Be At Risk” (Table 5.3-1). The 2006 WGGSNS elevated ranking for the mountain goat is based on its small population (<1,000 individuals) and the potential effects of hunting and human disturbance on the small population. The 2006 WGGSNS assessment includes the elk, which was inadvertently left out of the 2000 assessment, and the raccoon, which has been observed in the NWT. Both of these species have relatively low numbers in the NWT and are at the northern edge of their range, but may increase in numbers as the NWT climate moderates.

A major change in 2006 is the assigning of the rank of “Sensitive” to barren ground caribou from “Secure” based on the drastic declines in major NWT herds in the last five years (see Table 5.3-1).

The fisher, which was ranked as “May Be At Risk” in 2000, has been upgraded to “Sensitive” based on new information. White-tailed deer and the coyote have been moved from “Undetermined” status to “Secure” based on new information and the recognition that the species have small resident populations in the NWT.

The status of some species has changed since 2000 because of new information, a re-evaluation of population numbers and threats, or new assessments by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC provides assessments on the national status of species based on the numbers and distribution of the species and the ability of the species to recover and adapt to threats, such as habitat fragmentation and loss and human disturbance. The findings from the 2006 WGGSNS assessment are consistent with the 2000 WGGSNS assessment and recent assessments (COSEWIC), see Table 5.3-2.

The boreal woodland caribou has been categorized as “Threatened” by COSEWIC because of the recognition that many of the populations in southern Canada are showing declines from habitat fragmentation and human disturbance (COSEWIC 2002) and it is likely that the NWT population will show similar declines in the presence of habitat loss. The protection of large, undeveloped habitat is critical to maintaining stable populations of this species.

Table 5.3-1
Summary of Ranking of NWT Mammal Species with Changes from the 2000 Assessment (WGGSNS 2006)

Common Name	Scientific Name	Status in 2000 Assessment	Status in 2006 Assessment
Wood Bison	*Bison bison athabascae (Bos bison athabascae)*	At Risk	At Risk
Peary Caribou	*Rangifer tarandus pearyi*	At Risk	At Risk
Mountain Goat	*Oreamnos americanus*	May Be At Risk	May Be At Risk
Woodland Caribou (Boreal)	*Rangifer tarandus caribou*	Sensitive	Sensitive
Barrenground Caribou (except Dolphin-Union)	*Rangifer tarandus groenlandicus*	Secure	Sensitive
Barrenground Caribou (Dolphin Union population)	*Rangifer tarandus groenlandicus x pearyi (R. t. pearyi x groenlandicus)*	not specified	Sensitive
Wolverine	*Gulo gulo*	Secure	Sensitive
Fisher	*Martes pennanti*	May Be At Risk	Sensitive
Grizzly Bear	*Ursus arctos*	Sensitive	Sensitive
Polar Bear	*Ursus maritimus*	Sensitive	Sensitive
Little Brown Myotis (bat)	*Myotis lucifugus*	Sensitive	Sensitive
Collared Pika	*Ochotona collaris (O collaria)*	Sensitive	Sensitive
Woodland Caribou (Northern Mountain)	*Rangifer tarandus caribou*	not specified	Secure
North American River Otter	*Lontra canadensis (Lutra canadensis)*	Sensitive	Secure
White-tailed Deer	*Odocoileus virginianus*	Undetermined	Secure
Coyote	*Canis latrans*	Undetermined	Secure
Northern Flying Squirrel	*Glaucomys sabrinus*	Sensitive	Secure

The polar bear was ranked as “Special Concern” in the 2008 COSEWIC assessment (COSEWIC 2008). Four of the thirteen polar bear populations are known to be declining while seven other populations are stable or increasing marginally. Major threats to the polar bear are hunting and human conflict, and the loss of sea-ice and the ringed seal, its major food item. The loss of sea ice due to a warming climate may dramatically affect some populations but other populations may benefit from thinner ice in other areas.

Table 5.3-2
Summary of Recent COSEWIC Assessments of Mammal Species in the NWT

Common Name	Scientific Name	Year of COSEWIC Assessment	COSEWIC Status	SARA Status	Comments
Wood bison	*Bison bison athabascae*	2000	Threatened	Schedule 1, Threatened	Threats include disease and habitat loss through human development
Woodland caribou (Boreal Population)	*Rangifer tarandus caribou*	2002	Threatened	Schedule 1, Threatened	Threats primarily from habitat loss and fragmentation, and predators.[1]
Woodland caribou (Northern Mountain Population)	*Rangifer tarandus caribou*	2002	Special Concern	Schedule 1, Special Concern	Much of habitat is remote, but this population is susceptible to habitat loss and fragmentation, as in the other woodland caribou herds[1]
Peary Caribou	*Rangifer tarandus pearyi*	2004	Endangered	-	Numbers have declined by 72% in the last three generations due to severe icing that covered food resources. Subspecies is considered to be at risk of extinction due to climate change.[2]
Barren-ground Caribou (Dolphin and Union Population)	*Rangifer tarandus groenlandicus*	2004	Special Concern	-	Calve on Victoria Isl.; migrate across Dolphin Union Strait which is becoming hazardous due to climate change[2]
Wolverine (Western Canada Population)	*Gulo gulo*	2003	Special Concern	-	Eastern Canada population endangered; Major threat is loss of habitat and development; reproductive rate very low in this species[3]
Polar bear	*Ursus maritimus*	2008	Special Concern	-	Main limiting factor is human-caused mortality, much of it from regulated hunting, low reproductive rate makes recovery slow when over hunted locally[4]
Grizzly bear (Northwestern population)	*Ursus arctos*	2002	Special Concern	-	Prairie population extirpated; major threats are habitat loss and development as the species is often in conflict with humans.[5]

Table 5.3-2 (Cont'd)
Summary of Recent COSEWIC Assessments of Mammal Species in the NWT

Common Name	Scientific Name	Year of COSEWIC Assessment	COSEWIC Status	SARA Status	Comments
Northern Grey Wolf	*Canis lupus occidentalis*	1999	Not At Risk	-	
Black Bear	*Ursus americanus*	1999	Not At Risk	-	
Canada lynx	*Lynx canadensis*	2001	Not At Risk	-	

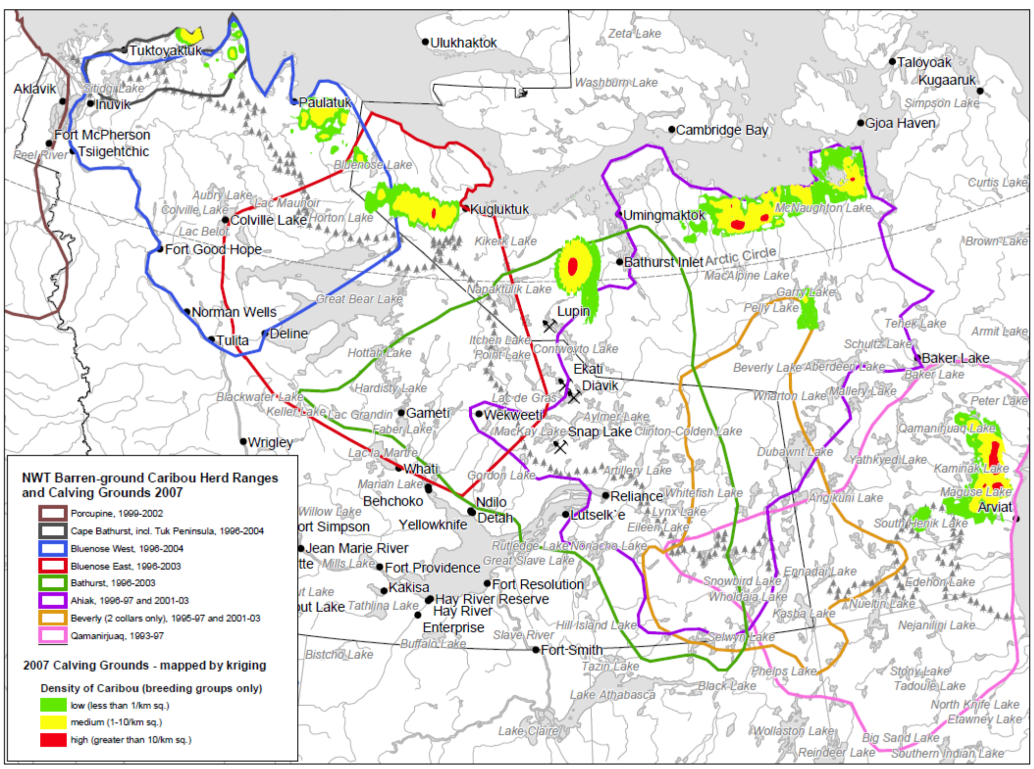
[1]COSEWIC 2002a [2]COSEWIC 2004 [3]COSEWIC 2003 [4]COSEWIC 2002c, 2008 [5]COSEWIC 2002b

5.3.1.3 Indicator 2 – Barren Ground Caribou

Documented Scientific Data

The most significant development in the status of terrestrial mammals in the NWT since the 2005 State of the Environment Report (SENES 2005) is the massive decline in major barren-ground caribou herds. The decline has been observed since 2000, but the extent of the declines has only been recognized since 2005. Many of the mainland herds in the NWT have declined (Figure 5.3-1), but it is most noticeable in the Bathurst, Beverly and Bluenose herds. Populations of these herds have declined from several hundred thousand to tens of thousands over the last five years. The change in population size has led to a re-evaluation of surveying and counting methodologies by the territorial government and major restrictions on hunting. These restrictions have affected all segments of the NWT population, but in particular aboriginal groups and resident hunters that have reduced hunting, and outfitters who rely on sport hunting for business.

Figure 5.3-1
Distribution of NWT Barren-Ground Caribou Herds



Source: Fisher *et al*. 2008

Current Status and Trends

The most recent population counts have shown that all major herds in the NWT have declined markedly in the last ten years (Table 5.3-3; Figure 5.3-2). After reaching 472,000 (SE ±72,900) individuals in 1986, the Bathurst herd has declined slowly during the 1990s and then rapidly to a total of 31,900 (SE ±11,000) in 2009, of which 16,649 (SE ±4,500) were breeding females (Adamczewski *et al*. 2009). After a decline of 5% per year during the 1990s, the herd declined by 70% over a three year span up to 2006. This rate of decline is not unique among herds but indicates that the Bathurst herd, one of the most widely distributed in the NWT, and hunted by residents from 14 communities, has declined by about 93% in twenty years.

Many caribou herds have been shown to be declining, however, only the Beverly and the Bluenose-West have been shown to have declined to the same degree as the Bathurst herd. A survey of the Beverly herd in 2008 reported only 93 breeding cows on the calving grounds, down from the 189 observed in 2007 (BQCMB 2009), compared to 5,737 breeding cows seen in 1994 when the total herd size stood at 276,000 (SE ± 106,600). In fact, the numbers observed in the last survey of the Beverly herd were so low that an accurate count could not be made (BQCMB 2009). The future of this herd, and the relationship with the adjacent Ahiak herd, is still unclear.

The Bluenose-West herd has also declined from 112,400 (CI95% ±25,600) in 1992 to about 18,000 (95%CI ±530) in 2006 and about the same number in 2009 (Adamczewski *et al*. 2009) (Figure 5.3-2). However a survey in 2010 by ENR reported a total herd estimate of 98,646 (95%CI ±7,125), for the Bluenose-East herd, an increase of 50% since the survey in 2006 (ENR unpubl. data 2011). These latest data suggest that major declines are only present in some herds while other herds are remaining stable or recovering to previous levels. Continued monitoring of herd conditions and population size is important.

Table 5.3-3
Status of NWT Caribou Herds in 2010

Herd	Size (Year)	Variability	Survey Method	Status
Ahiak	200,000 (1995)	-	-	Unknown
Bathurst	31,980 (2009)	SE ±5,306	Calving ground photo census	Declining
Beverly	"very few"(2008)	-	-	Declining
Bluenose East	98,646 (2010)	95% CI = ±7,125	Post-calving photo census	Increasing

(Source: CARMA 2010, ENR unpubl. data 2011)

Table 5.3-3 (Cont'd)
Status of NWT Caribou Herds in 2010

Herd	Size (Year)	Variability	Survey Method	Status
Bluenose West	17,897 (2009)	95% CI = ±1,310	Post-calving photo census	Stable
Cape Bathurst	1,934 (2009)	95% CI = ±349	Post-calving photo census	Stable
Porcupine	123,000 (2001)	NR	Post-calving photo census	Declining
Qamanirjuaq	348,661 (2008)	SE = ±44,861	Calving ground photo census	Declining

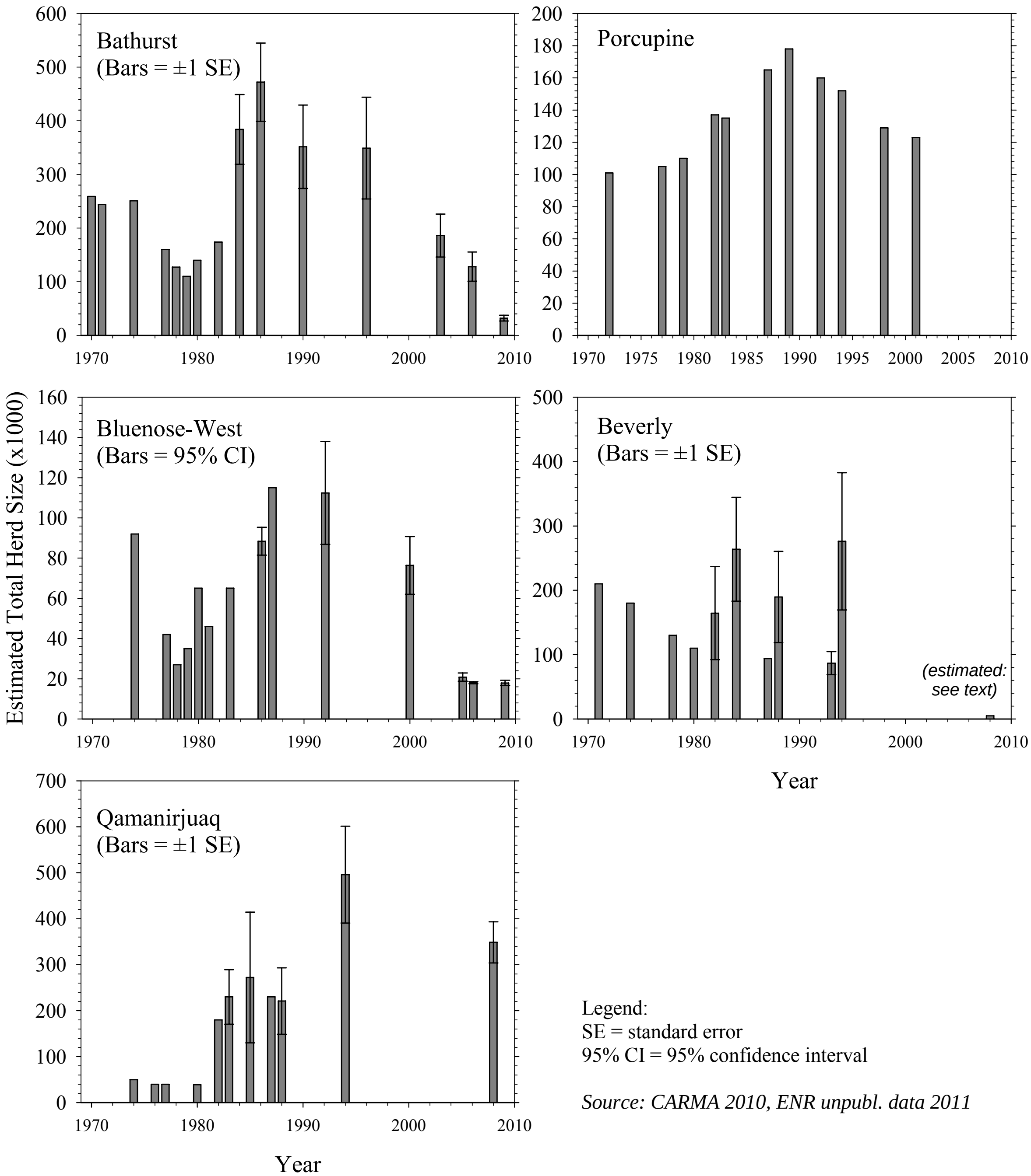
NOTE: SE = Standard Error, 95% CI = 95% Confidence Interval

Why is it Happening?

Herds decline in number when deaths exceed the rate that calves enter the reproducing population. Natural causes of death to adults and the young occur from disease or predation. Calves can also die from severe weather during calving. For this reason, surveys are conducted during calving in June or in the fall to determine the numbers and condition of calves before winter. Declines in productivity, as indicated by the numbers of females that are pregnant or the body condition of the young at first winter, may indicate slow herd growth or declines in a herd as deaths exceed the low numbers of maturing young. Measurements such as the male:female and cow:calf ratio, percent females that are pregnant, birth, death and rate of recruitment of the young into the breeding population are used to define the population demographics of a herd and provide some guidance on the reasons for declines or increases. For many of the NWT herds, demographic measurements are taken when possible, but major data gaps remain (Adamczewski *et al*. 2009).

The critical consideration in determining the number of caribou in a herd is the ability of researchers to accurately count groups of caribou that may be dispersed across a large area. Survey techniques have evolved considerably through the years with developments in technology but are still based on the concept of recording the numbers of each sex and age at the time of year that the caribou congregate and form dense groups, which is usually during and after calving. Originally, counting methods relied on observers in aircraft recording the numbers of caribou and the number of calves and non-calves in each group. Photographic techniques were developed to improve the accuracy of counting the number of calves and non-calves in large aggregations. A major weakness of this method was whether all groups were included in the surveys, leading to uncertainty in the estimates of herd size.

Figure 5.3-2
Temporal Trends of Caribou Numbers in Major NWT Herds



Survey methods improved significantly with the use of radio and satellite collars which are placed on mature females. These females are tracked during or after calving to locate and count all female groups and to estimate the number of calves and males to give a total population (Patterson *et al*. 2004). Increasing the number of collared females improves the chances of locating a greater proportion of groups in each herd. Numbers from direct counts are combined with data on male:female and calf:cow ratios to provide the "demographics" of each herd (Gunn *et al*. 2004b, 2005). These studies require a large number of assumptions and expert opinion to evaluate population status and trends. For example, depending on the methods used, population estimates assume that all major groups of females are located with collars and included in the count. Also, for calving surveys, major demographic measurements like male: female adult ratios or numbers of non-pregnant females must be either measured, or assumed from other studies, to provide total population estimates (Adamczewski *et al*. 2009). Bad weather during surveys that interferes with counting or differences in demographics between herds may cause errors in counting and higher uncertainty in the final estimate.

Calf:cow Ratios

In an attempt to help explain the decline of the NWT herds, Adamczewski *et al*. (2009) and Nesbitt and Adamczewski (2009) compiled all the available published and unpublished survey data and demographic information on the major NWT herds. Surveys of the Bathurst, Bluenose-West and Cape Bathurst herds reported late peak calving times and low calf:cow ratios from 2000 to 2006 (Nesbitt and Adamczewski 2009), two indicators of declining herds. Although a calf:cow ratio of about 0.3 is generally accepted as the value required to maintain a stable herd size, values of 0.3 to 0.5 were reported for the Bathurst herd during the 1990s as the herd began to slowly decline (Adamczewski *et al*. 2009). Drastically lower ratios were observed between 2000 and 2005 (<0.3 and as low as 0.085 in 2006). Slightly higher ratios have been observed in recent years. In the Porcupine herd, adult cow survival of 82.5% was reported for 2006, with a calf survival of 0.39, indicating a stable or increasing herd number (PCMB 2010), although the total number in the herd continues to decline. Unpublished data from ENR shows that calf:cow ratios ranged from 0.251 (2001) to 0.516 (2004) for the Bluenose-East herd and 0.31 (2009) to 0.483 (2008) for the Ahiak herd (Adamczewski *et al*. 2009). A ratio of only 15 calves per 100 cows was reported for the Beverly herd in 2008, far below the level to sustain the herd or allow it to expand (BQCMB 2009).

Harvest Rates

The number of caribou harvested annually is another factor to consider in relation to stresses on each herd. Using a number of assumptions and data from several studies, Adamczewski *et al*. (2009) estimated that, until recently, the total harvest of Bathurst caribou was 4,000 - 5,000 cows and 2,000 bulls annually. Of those harvested, outfitters probably took about 450 bulls annually, 100-200 caribou (primarily bulls) were taken by resident hunters and about 4000-5000 cows and 1000-2000 bulls by aboriginal hunters. Numbers taken by resident hunters of the Cape Bathurst, Bluenose-East and Bluenose-West herds were reduced to zero in 2006, while a small number of bulls from the Bathurst and Bluenose-East herds were hunted by Yellowknife and North Slave residents (Adamczewski *et al*. 2009). Roughly 4,000 (primarily bulls) are assumed harvested from the Porcupine herd, however since the herd has declined to less than 115,000 in recent years, harvests are restricted to bulls only (PCMB 2010).

Herd Mixing
One of the reasons proposed for the significant decline in the Bathurst herd is that a large portion of the herd could have moved to join the Ahiak or Bluenose herds, however this explanation is considered to be very unlikely based on several factors (Fisher *et al*. 2008, Adamczewski *et al*. 2009). Both the Ahiak and Bluenose-East herds have declined at the same time as the Bathurst herd and data from satellite collars do not indicate large-scale movements. Although movement between herds is always possible, the number affected tends to be very low (<1%).

What is Being Done About It?

Initial Actions
Recognition of the low numbers of caribou has led to several actions by the Government of the Northwest Territories. First, Environment and Natural Resources increased the number of surveys of the major herds, and major surveys have been conducted annually for the last several years. ENR has also devoted considerable time and resources into collating and analyzing unpublished data to determine trends. The rapid declines in the herds indicate that this phase of analysis must be done with urgency to permit science-based actions by the government to protect the herds and allow them to expand.

In response to the low numbers and the need to reduce all losses from the herd, the NWT instituted a ban of all commercial, resident and non-resident harvest in the North and South Slave regions of the NWT, effective January 1, 2010. Also, a no-hunting zone for all harvesters of barren-ground caribou extending from Yellowknife to an area including all the wintering grounds of the Bathurst herd has been instituted (ENR 2009b).

Review of Census Methods
In response to criticisms that the methods used for counting caribou numbers were inaccurate or unsuitable, the Government of the NWT requested an independent critical review by the Alberta Research Council of caribou census methods used by ENR (Fisher *et al*. 2008). The major conclusion of the review was that the declines in the major herds as described are correct and are not due to negligence or errors by ENR biologists. As in most large–scale monitoring programs, counting methods and the data management used for estimating herd size can be improved but the review supports the general view of the rates of decline of the barren-ground caribou herds.

The review provided several recommendations to improve estimates and reduce uncertainty. Recommendations for improvement include:

- **Substantially increase collaring efforts for all caribou herds** – population estimates are based on tracking and locating a number of collared female caribou. Although there is considerable expense with increasing the number of collars substantially, the relatively low numbers of collars employed in some studies, which cause a higher level of uncertainty, was considered to be one of the major flaws of the ENR census.
- **Create a standardized, regularly scheduled monitoring program** - population surveys have been very inconsistent and it is difficult to reliably predict trends. Adopting a consistent schedule of surveys markedly improves estimates and the detection of trends.
- **Increase focus on obtaining demographic data on caribou herds** – total population estimates are made by counting females, and extrapolating data on male:female sex ratios and calf:cow ratios. These data should be collected on a more consistent basis.
- **Incorporate population modeling into caribou management programs –** these models help scientists validate field data and model parameters, and allow for some forecasting of population numbers.
- **Provide internal or external peer-reviews for all survey reports** – the review of data reports by experts and the publishing of data in the scientific literature help to avoid errors in estimates and enhances openness of the process.
- **Publicly report survey and research results immediately and transparently**
- **Develop a Territory-wide, consistent and strategic approach to ENR's caribou research.**
- **Program with centralized coordination -** a more centralized approach to research and surveys would aid assessments rather than working on a regional basis.
- **Formulate caribou management decisions within an adaptive management framework –** management of the herds needs to be improved and formalized, including the mechanism with which hunting restrictions are imposed, to reduce political decisions.
- **Form partnerships to increase resources dedicated to caribou research –** research programs should be developed with other jurisdictions with caribou to improve the quantity and quality of research on NWT herds.

ENR responded to the review (ENR 2009a) by accepting most of the findings and the recommendations of the report which largely confirms the general status of NWT herds, as described by ENR. Some of the recommendations have been instituted, in co-operation with co-management boards, and other recommendations will be implemented through the renewed NWT Barren-ground Caribou Management Strategy (2010-2015). ENR commits to improving planning and implementing new activities which will allow improvements in evaluating herd status (ENR 2009a).

Herd Management

Due to land claims agreements, the management of many herds in the NWT falls under the purview of caribou management boards (Table 5.3-4) that are responsible for undertaking studies and providing recommendations to implementing restrictions when the herd size is reduced. Each of these management boards has developed a management plan that outlines the stakeholders and the approach undertaken to manage the respective herds. Most outline actions that should be taken when the herd reaches a particular target value. One important aspect is that the management plans are agreed upon by all stakeholders ahead of time, and it is possible to quickly implement hunting restrictions when the herds fall to target levels.

Table 5.3-4
Caribou Management Boards and Management Plans for the Major NWT Herds

Herd	Management Body	Year	Title of Plan	Website Address
All NWT Herds	Environment and Natural Resources	2006	Caribou Forever – Our Heritage, Our Responsibility. A Barren-ground Caribou Management Strategy for the Northwest Territories 2006 – 2010	www.enr.gov.nt.ca
Bathurst Herd	Bathurst Caribou Management Planning Committee	2004	A Management Plan for the Bathurst Caribou Herd	www.enr.gov.nt.ca
Beverly	Beverly and Qamanirjuaq Caribou Management Board	2005	Beverly and Qamanirjuaq Caribou. Management Plan 2005-2012	www.arctic-caribou.com
Qamanirjuaq	Beverly and Qamanirjuaq Caribou Management Board	2005	Beverly and Qamanirjuaq Caribou. Management Plan 2005-2012	www.arctic-caribou.com
Porcupine	Porcupine Caribou Management Board	2010	Harvest Management Plan for the Porcupine Caribou Herd in Canada	www.taiga.net/pcmb

5.3.1.4 Indicator 3 – Woodland Caribou

Documented Scientific Data

Woodland caribou are the largest of the caribou subspecies found in the NWT. Several ecotypes of the species are present across Canada (Thomas and Grey 2002), with a mountain ecotype and a boreal ecotype present in the NWT. The mountain ecotype, whose range is primarily in the northwestern region of the NWT and into the Yukon, is relatively stable in numbers but is ranked as "Sensitive" by the WGGSNS (2006) and assessed as "Special Concern" by COSEWIC (2002a).

The boreal ecotype (i.e. boreal caribou) is present almost entirely within the Taiga Plains ecozone, from the southern border of the NWT to north of Inuvik. Many of the populations in southern Canada are threatened because of the loss of old forest and the expansion of human development (Environment Canada 2008). The WGGSNS (2006) ranked the boreal ecotype of the woodland caribou as "Sensitive" within the NWT because of the known susceptibility of boreal caribou to habitat loss and fragmentation. Recent surveys have placed the number of boreal caribou at about 7,000 individuals (WGGSNS 2006) with a density in the southern Dehcho and South Slave of about 3 per 100 km^2 (Thomas and Grey 2002; WGGSNS 2006). Research is continuing on boreal caribou in the Dehcho (Gunn *et al*. 2004a, Larter and Allaire 2005, 2006a,b, 2007, 2009) and the lower Mackenzie Valley (Nagy *et al*. 2004). Data from early 2010 show higher calf:cow ratios in recent years, suggesting that the population might be remaining stable, after declining for several years (Larter and Allaire 2010).

The main cause of death in young caribou and adults is by predation from wolves and bears (Zager and Beecham 2004, McLoughlin *et al*. 2003). Because of the effects of predation, boreal caribou are thought to select habitat, such as peatlands, that are not widely used by major predators like wolves (GNWT 2006). This selection of specific habitat types makes boreal caribou sensitive to habitat fragmentation and loss.

Local population condition can be affected by human activities (James and Stuart-Smith 2000) such as forestry and oil and gas developments that cause physical disturbance and fragmentation of habitat (Dyer *et al*. 2001, Weclaw and Hudson 2004). These activities can reduce food and increase predation by reducing forest cover (Environment Canada 2008) and cause avoidance of optimal habitat (James and Stuart-Smith 2000). Woodland caribou may use significant amounts of energy over the winter due to the avoidance of disturbances (e.g., loud noises) near human activity (Bradshaw *et al*. 1998) and cause a significant loss of condition which reduces the reproductive success of the females in the spring (Bradshaw *et al*. 1997).

In 2008, Environment Canada (2008) undertook a scientific review of boreal caribou habitat requirements. The Scientific Review focused on the habitat needed for local populations of boreal caribou to be self-sustaining. This information will assist in the determination of what constitutes critical habitat for boreal caribou. The report determined that, although microclimate and food availability are important for habitat selection, the primary limiting factor is predation, and several factors such as cover and alternate prey that might be available.

The analysis used population size and trends and range disturbance to examine the current range of caribou in 57 regions across Canada and predict whether conditions are suitable to maintain self-sustaining populations (Table 5.3-5). The study indicates that several population are probably declining and their range cannot support a stable populations because of human disturbance. Boreal caribou in the Dehcho are likely declining and it appears that the range cannot support a stable population, although further data are required. The regions with the lowest probability of remaining stable are situated on the NWT/Alberta border where there is a large amount of human disturbance.

Table 5.3-5
Summary of Current Status of NWT Woodland Caribou and Probability that Current Habitat Can Support Self-Sustaining Populations

NWT Management Regions	Probability of Self-Sustaining population[1]	Estimated Population Size	Population Trend	Current Level of Disturbance in Range	Comment
Alberta/NWT Bistcho	0.2	300	Suspected Declining	High	Current evidence suggests that population unit is not self-sustaining
Alberta/NWT Steen River/ Yates	0.2	300	Unknown	High	Current evidence suggests that population unit is not self-sustaining
NWT Inuvialuit	0.6	Unknown	Unknown	Very low	Not definitive but low disturbance suggests range is supportive of self-sustaining population
NWT/YK Gwich'in	0.8	500	Increasing	Moderate	Population above critical; main disturbance is fire
NWT Sahtu	0.6	2000	Unknown	Low	Large population and low disturbance indicate self-sustaining
NWT North Slave	0.5	700	Unknown	Moderate	Can't predict if range allows self-sustaining population. More data required.
NWT Dehcho	0.4	2000	Likely declining	Moderate	Evidence suggests that range does not allow self-sustaining population. More data are required
NWT South Slave/Southeast Dehcho	0.4	600	Likely Declining	Moderate	Evidence suggests that range does not allow self-sustaining population. More data required

Source: Environment Canada 2008
[1] – Legend: Probability of self-sustaining local population or unit of analysis given the current range conditions and extent. Probability <0.5 – not self-sustaining;
= 0.5- self-sustaining/not self-sustaining;
>0.5 - self-sustaining

Why is it happening?

The reasons behind the boreal caribou declines in some NWT regions are not apparent. However, in some areas, the impact of development and loss of habitat are clearly factors, and the caribou in the area are considered to be non self-sustaining. In some regions, there appears to be favourable habitat with little development, yet the caribou appear to be declining. Harvest rates and losses from predation and disease do not appear to be excessive. This indicates that unknown factors, or the unforeseen interaction between known factors, may be partly responsible for the poor status. Population modeling studies may help to determine the reasons behind these declines; however, increased research that will provide rigorous data is also required.

What is Being Done About It

As part of the national boreal caribou recovery strategy, each of the jurisdictions with boreal caribou must prepare their own recovery strategy or action plan (GNWT 2006). The NWT plan is entitled the NWT Boreal Caribou Action Plan 2010-2015 (ENR 2010) and has the following goals:

> *Recognizing that boreal caribou, like other wildlife, are ecologically, culturally and spiritually valued in the NWT, the goals for conservation of boreal caribou are to:*
>
> *1. Prevent boreal caribou from becoming a species at risk in the NWT.*
>
> *2. Maintain the current contiguous distribution of boreal caribou in the NWT for the benefit of all NWT residents and future generations.*
>
> *3. Manage boreal caribou and their habitat to contribute to the healthy biodiversity of the NWT.*

The Plan outlines a number of implications that arise from these goals, including the need to maintain the current distribution of caribou and continuous habitat that requires the management of human impacts (ENR 2010). The current populations of woodland caribou also need to be monitored and management must occur with the cooperation and support of First Nations, Inuvialuit, co-management boards, and all other stakeholders. Threats from habitat loss, human disturbance, parasites and predation are recognized. A total of 21 actions are outlined in six categories to implement the Plan, including a review of the effectiveness of the Plan after a five-year period.

5.3.1.5 Indicator 4 – Moose

Documented Scientific Data

Moose are the largest member of the deer family and are widely distributed throughout the NWT, occupying roughly 82% of the NWT area (WGGSNS 2006). The species lives in early successional forest stages and can consume large quantities of browse and aquatic macrophytes. The species benefits from areas damaged by fire as new, productive vegetative growth is favoured browse. It is a valued large mammal species for harvesting and providing hide and hair for crafts.

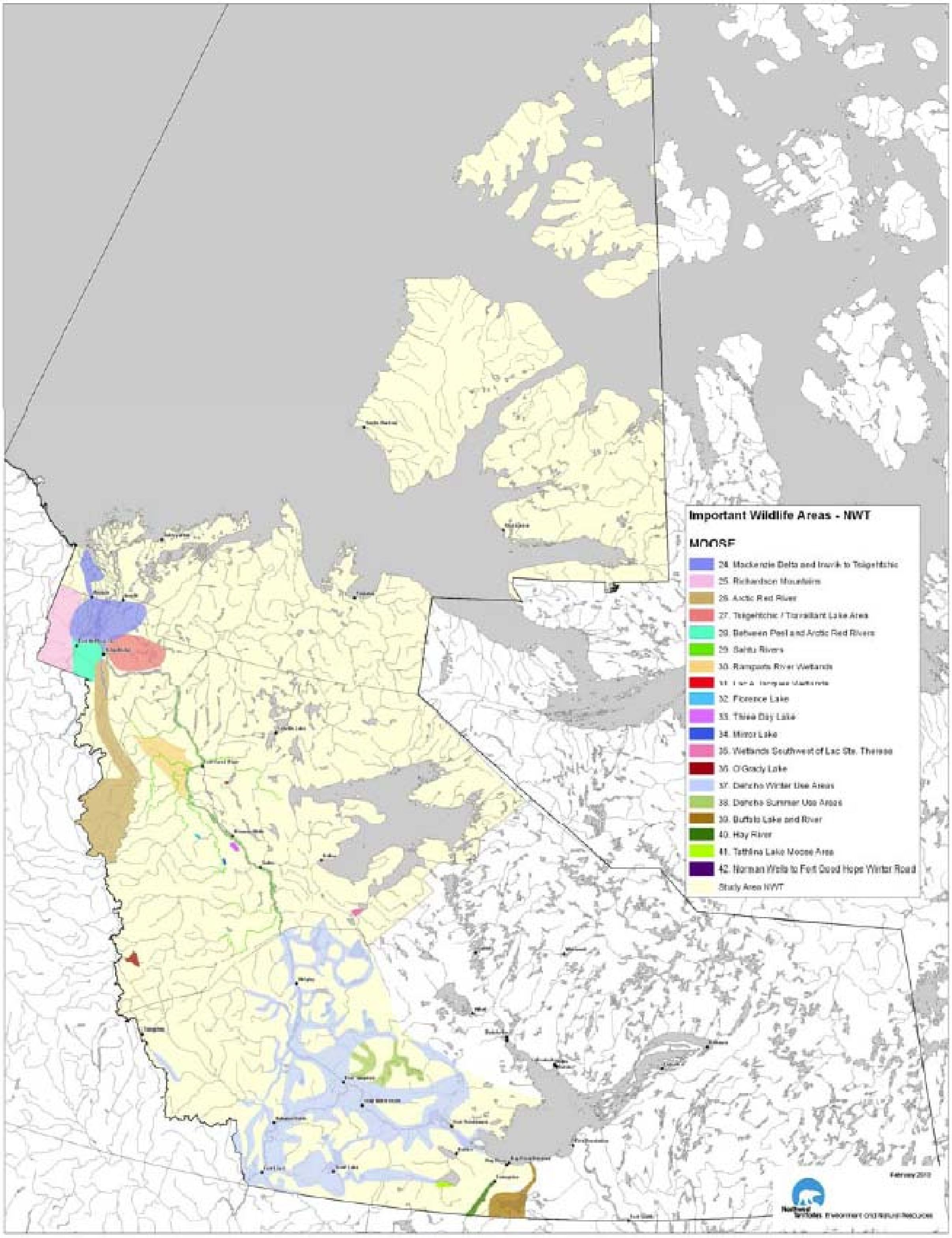
Moose are difficult to survey because they are solitary for most of the year and population counts are conducted by air over large areas. Moose surveys report population densities and the cow:calf ratios (ENR 2007), although it is sometimes difficult to determine the sex of adult moose from the air (ENR 2004). Detailed sampling of moose populations in the Dehcho region in 2003/04 reported a density of 4.4 moose/100 km^2, with a cow:calf ratio of 32.1/100 females in the Lower Mackenzie Valley and a density of 4.9 moose/100 km^2 and a cow:calf ratio of 44/100 females. The ratios were considered to be reasonable, although they are lower than values of 7-8 moose/100 km^2 observed elsewhere in northern Canada (ENR 2004).

Data on areas with higher moose densities were collected in a process identifying important wildlife areas in the NWT. Significant areas were determined through discussions with community members, co-management boards, ENR staff and the general public (Wilson and Haas 2010). Several areas were identified with high densities of moose based on local knowledge and regional surveys. The largest areas are in the northwest sections of the NWT, with densities in some studies reaching 7 moose/100 km^2 (Figure 5.3-3).

Assessment of the Trend

Overall, the moose populations in the NWT appear to be stable, and there are no data to indicate that harvest rates are excessive. Some local populations may become overhunted; however, overall the numbers of moose appear to be constant. Disease, another concern in areas where moose numbers are high, does not appear to be a major concern in recent years.

Figure 5.3-3
Summary of Important Moose Areas in the NWT (Wilson and Haas 2010)



5.3.1.6 Indicator 5 – Furbearing Species

Documented Scientific Data

There are few rigorous surveys to be able to determine the status of major furbearing species in the NWT. Most of these species are widely distributed across the NWT and are difficult to estimate in numbers because most are solitary and are difficult to locate without dedicated regional studies.

One indicator of furbearer species status is the harvest rate of furs within each region and in the NWT as a whole. If it is assumed that trappers cover the same general territory every year, then the numbers of each species harvested should reflect their numbers in the wild. However, several factors affect reported harvest rates. Prices at auction vary annually based on demand and, when low, many trappers may choose not to trap. Severe weather, population cycles of small mammals and predators, and general health of the economy may alter the numbers of furs harvested. Over a long period of time however, the general availability of the species and preferences by trappers becomes evident. On average for the last five reported years, total income from fur sales was >$1 million, with most of that amount from marten (Table 5.3-6).

The general status of most furbearing species remains good in the NWT, with most small mammal species ranked as "Secure" by the WGGSNS (2006) (Table 5.3-6). The grizzly bear and wolverine are both ranked as "Sensitive" due to slow reproductive rates, large ranges and sensitivity to development. The fisher is ranked as "Sensitive" due to its limited distribution and a general lack of information on its ecology in the NWT. The number of marten, beaver and lynx harvested annually have remained relatively constant since 1992 (Rossouw, pers. com), with over 10,000 marten harvested annually (Figure 5.3-4). Of all the species trapped, the muskrat varies the most, ranging from <5,000 annually to over 25,000 in some years.

Trapping remains a significant source of income for several hundred individuals annually. The numbers of trappers vary annually, and ranged from a minimum of 589 in the 2001/02 season to a maximum of 1108 in 1997/98. The 5-year average from 2000/05 to 2008/09 is 725 trappers in the NWT (Rossouw, pers. comm.), down from late 1990s when there were more than 1000 trappers in the NWT. The fur harvest data indicate that the populations of most furbearing species are strong.

Assessment of Current Conditions

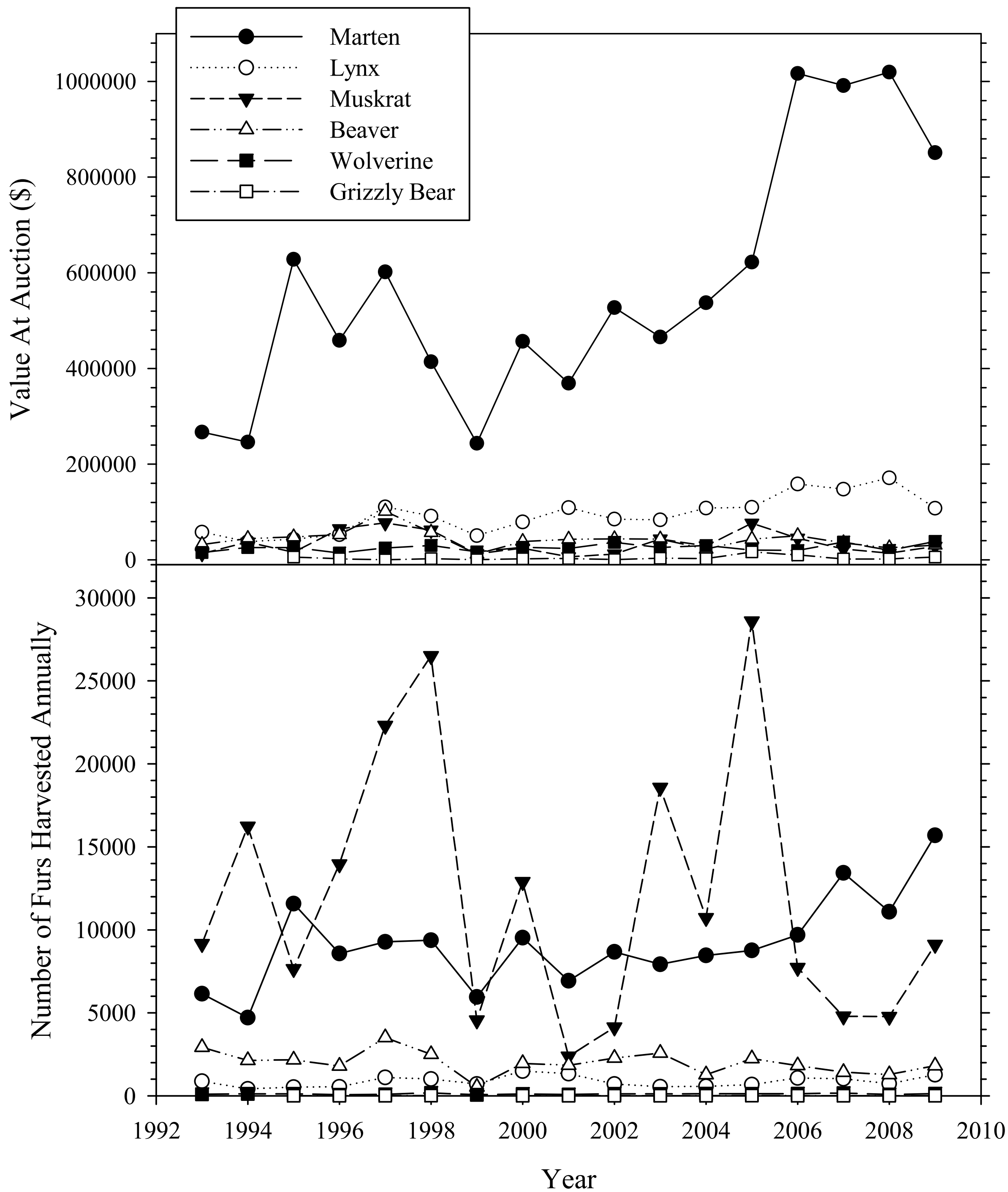
Data from several sources indicate that small mammal populations remain healthy and are widely distributed throughout the NWT. Local depletions in some species appear to result in repopulation from adjacent areas or recovery over a period of a few years. In general, harvest rates are not excessive in relation to the total populations.

Two species that warrant special consideration are the wolverine and the grizzly bear. Both these species have elevated rankings from WGGSNS and COSEWIC because of low reproductive rates, large areas of undisturbed habitat required for the populations and the known sensitivity of the species to human activity and development. Both these species may be attracted to camps and mines and nuisance individuals may have to be destroyed. It seems likely that trapping of the species for their fur will have to be controlled in the future to protect the species.

Table 5.3-6
Five Year (2004/05 to 2008/09) Average and Fur Harvest Value for NWT Furbearing Species

Species	Number Harvested Annually (5-year average)	Fur Harvest Value	NWT Status	Distribution over the NWT (%)
Marten	11734	$900,032.81	Secure	72
Muskrat	10996	$37,107.65	Secure	57
Beaver	1711	$36,985.58	Secure	68
Lynx	952	$139,060.82	Secure	66-75
All fox	931	$23,688.43	Secure	87
White fox	570	$12,655.24	-	-
Red fox	204	$5,649.63	-	-
Cross fox	147	$5,107.36	-	-
Silver fox	10	$276.21	-	-
Ermine	637	$3,739.71	Secure	100
Mink	556	$10,173.14	Secure	100
Squirrel	487	$924.21	Secure	80
Wolverine	121	$27,154.38	Sensitive	98
Wolf	103	$16,817.87	Secure	100
Fisher	35	$2,320.60	Sensitive	9
Otter	21	$1,352.65	Secure	75
All bears	20	$11,604.23	-	-
Black bear	11	$887.78	Secure	77
Grizzly bear	6	$7,224.05	Sensitive	87
Polar bear	3	$3,492.40	Sensitive	16
Coyote	5	$142.87	Secure	8
Total	28,311	$1,211,104.95		

Figure 5.3-4
Number of Furs and Value at Auction for NWT Furbearing Species



Source: Rossouw, GNWT pers. comm.

5.3.1.7 Mammal Indicators – Summary

The status of terrestrial mammalian indicators is summarized in Table 5.3-7. Both caribou species (barren ground and woodland) are showing signs of significant declines and will require dedicated resources to more fully understand the reasons behind the declines and to afford them the protection required to sustain the populations. Improvements in the monitoring and research programs associated with the barren-ground caribou provided in the recommendations of the Alberta Research Council would help to more fully describe the demographic character of the herds, but may not necessarily help the herds to recover. Protected areas for woodland caribou in some areas, with reduced hunting seems the most viable option to sustain the species over the long-term. Unfortunately, large dedicated programs to support the caribou will require large commitments of resources that may not be available.

Moose appear to be maintaining a reasonable population in the NWT, and are considered to be secure, although some areas support greater densities than others. Harvest rates appear to be reasonable and most settlement areas have monitoring programs to assess the status of local populations. Similarly, the most common species of furbearers are widely distributed in the NWT, and are relatively secure. Wolverines and grizzly bear are sensitive to overhunting because of slow reproductive rates and low densities and their populations should be closely monitored. Protecting these species from harvesting may be necessary as development increases in the future.

5.3.1.8 Recommendations

The drastic decline of the barren-ground caribou herds is the most pressing issue in the terrestrial ecosystem because of the impact on smaller communities, people who rely on country foods, and the economy. For some herds, the low numbers of the present populations lead to major questions about long-term viability, and the need for continued protection from hunting. One difficult aspect is that the reason for the declines is unclear despite considerable research in the NWT and elsewhere. To some extent, researchers have adopted a “wait and see” approach to determine if herd demographics begin to change.

The intensive monitoring of the herds over the last five years should be continued, but could be better coordinated and formalized to reduce costs and streamline data analysis. It is unlikely that this situation will change quickly and hunting restrictions will probably be in place for an extended period of time. The NWT should examine innovative ways of improving research, possibly in collaboration with federal agencies and academic and international researchers, to look for the root causes of the declines, and actions to help herds recover.

Table 5.3-7
Status of Indicators for Terrestrial Mammals

Valued Component	Indicator	Comments
Barren-ground Caribou	Population status	All major herds have declined significantly in the past 10-15 years. Some evidence that declines have slowed, although major questions about the viability of some herds (e.g., the Beverly herd) remain.
	Calf:cow ratios	Very low ratios observed in declining herds in recent years but some evidence of improvement. More data recommended.
	Harvest rates	Reasonable harvest rates until herds showed major declines; much lower rates in recent years and switch to primarily bulls when declines became evident.
Woodland Caribou	Population status	Most NWT populations stable. Numbers are small in some regions which may lead to declines from chance occurrences (i.e. severe winters or predators) increasing the chances of decline.
	Population Demographics (i.e. calf:cow ratio)	Caribou in the Dehcho have shown improvements recently after low calf recruitments for several years. Ratios in other regions mixed.
	Management Plan	A plan is in place to monitor and manage NWT woodland caribou.
Moose	Population numbers	Good distribution in the NWT, most populations stable and harvest rates overall are not excessive.
Furbearers	Population status	Populations of most furbearers are stable. Special consideration needs to be afforded to grizzly bear and wolverine
	Harvest Rates	Vary by year, but generally lower harvest than in the past. Fewer trappers than in the past although returns at auction can be reasonable

The GNWT should institute, where possible, the recommendations of the review of census and monitoring methods. Unfortunately, expanding and improving monitoring and research programs will require more resources and funding, which are already limited. Better coordination and centralization of research and monitoring programs may help reduce costs and provide efficiencies that produce results.

Monitoring and research should also be continued on woodland (mountain and boreal) caribou populations and action items in the current management plan need to be rigorously applied. Major questions remain on the reasons behind declines in boreal caribou in areas that appear to be in a suitable habitat and have little human activity or development in their region. Because of the national recovery plan for this species, research in this area, as part of the continuing monitoring program, should be a priority.

Monitoring of moose populations is conducted on a regional level and is not coordinated across the territory. It seems likely that research in this area would benefit from a coordinated approach, similar to the actions recommended for the barren-ground caribou program. This would provide a territory-wide program to coordinate issues (disease, population statistics, harvest rates) related to moose.

5.3.2 Valued Component 2 – Birds

The condition of the bird community in the NWT reflects changes in the general condition of the environment in the NWT as well as the North American and global environment. More than any other major group of biota, birds reflect conditions outside the NWT, as about 94% of species migrate to southern areas for overwintering (WGGSNS 2006). Individual species become susceptible to changes in environmental conditions, climate and threats to the habitat in southern North America, as well as Central and South America. For example, the red knot (*Calidris canutus*), migrates from breeding grounds in the Canadian Arctic to wintering grounds at the southern tip of South America. In 2006, the red knot was assessed as "May Be At Risk" in the NWT due to declines elsewhere (WGGSNS 2006, COSEWIC 2007)). Declines are thought to be due to decreasing food resources on migration and wintering areas. The species feeds on mollusks and crustaceans in coastal areas during its migration route (COSEWIC 2007) and, as a result, is susceptible to changes in the environmental and climate conditions in a number of countries on several continents. Other species undergo similarly complex and extensive migration routes and are susceptible to environmental conditions in a number of countries.

In the summer of 2010, a developing threat is the oil spill in the Gulf of Mexico, where many waterfowl and shorebirds stop during migration, or overwinter in the wetlands of the Gulf Coast. This is but one example of the potential overwintering threats to migrating species that nest in the NWT during spring and summer. Thus, protection of rare or threatened species must be on a national and international scale and enhanced monitoring of these species during their breeding season in the NWT should be a priority.

The need for monitoring the status of bird species in the NWT is clear. The NWT has a wide range of remote, productive, and diverse habitats for virtually all groups of birds. The Canadian Wildlife Service (CWS) has identified 23 key terrestrial habitat sites in the NWT alone that support at least 1% of the Canadian population of at least one species of migratory bird species (Latour *et al*. 2008). There are seventeen areas in the NWT that have been recognized as Important Bird Areas (IBA) due to their international significance for the conservation of birds and biodiversity (IBA Canada 2010). The sites are recognized because a large portion of the national or global population of a species is present for part of the year, or home to a rare or threatened species (e.g., the whooping crane).

The IBA sites include the Mackenzie River Delta (home to large congregations of shorebirds and waterfowl) and the North Arm of the Great Slave Lake (a critical staging are for northward-migrating waterfowl as well as the nesting site for numerous gull and tern species). The IBA also covers the whooping crane nesting area and summer range near Fort Smith (where the population has increased from 15 in 1941 to current numbers of about 178).

5.3.2.1 Key Indicator – Population Status of Bird Species in the NWT

What is being measured*?*

Several programs have been developed to assess bird species in the NWT. These programs are both national and international and include federal, provincial and territorial agencies and a number of non-governmental organizations. Some programs (e.g., Northern American Breeding Bird Survey, Audubon Christmas Bird Count) also rely extensively on volunteers to provide survey data, but have been ongoing for several decades using the same methods and give long-term trend data that can be analyzed using rigorous statistical methods. Within the NWT, the Working Group on the General Status of NWT Species (WGGSNS 2006) provides assessments of NWT species based on expertise from several federal and territorial departments and non-governmental agencies (e.g., Ducks Unlimited). Federal agencies, such as the Canadian Wildlife Service and the U.S. Fish and Wildlife Service, conduct surveys and monitoring program on an annual or multi-year basis to monitor the health of bird species or communities, often in collaboration with NWT agencies.

Other monitoring programs reviewed for this assessment include:

- The Canadian, and Northern, Shorebird Conservation Plans (Donaldson *et al*. 2000);
- Audubon's Christmas Bird Count;
- The Canadian Migration Monitoring Network (Crewe *et al*. 2008);
- Partners in Flight (Rich *et al*. 2004) and The Canadian Landbird Monitoring Strategy;
- Wings Over Water – Canada's Waterbird Conservation Plan;
- North American Waterfowl Management Plan;
- Western Hemisphere Shorebird Reserve Network;
- North American Bird Conservation Initiative (NABCI);
- Program for Regional and International Shorebird Monitoring (PRISM); and
- The Canadian Biodiversity Information Network.

Scientific Data

1 – The General Status of NWT Bird Species

The Working Group on the General Status of NWT Species WGGSNS (2006) reported on a total of 273 bird species in the NWT, of which 33 species are considered to be vagrants and are not normally found in the NWT. Of the 240 resident species; three of those species are “At Risk” of extirpation (i.e., local extinction), six “May Be At Risk” and 40 species are considered to be “Sensitive” to extirpation (WGGSNS 2006).

Several changes have been made in the status of NWT bird species from the initial assessment in 2000 (WGGSNS 2000). The most recent assessment reduced the number of species with “undetermined” status from 28% in 2000 to 19% in 2006. The classification of some species have been upgraded to more conservative status (“At Risk” or “May Be At Risk”) because of new data or assessments from other agencies,

The 2006 assessment affirmed the status of many species but also highlighted the upgrading in status of three species due to population declines outside of the NWT (Table 5.3-8). For example, the status of the ivory gull (*Pagophila eburnea)* has been increased to “At Risk” on the basis of a 2006 assessment by COSEWIC (2006a) which showed declines (up to 80%) in their breeding populations in Nunavut. The red knot (*Calidris canutus)* was also upgraded to “May Be At Risk” due to declines in numbers on the wintering grounds in South America (COSEWIC 2007). Of the three subspecies that may be present in the NWT, one (*c.c. rufa*) has been classified as “Endangered”, while the “*roselaari”* subspecies has been deemed “Threatened” and the “*islandica”* subspecies has been classified under “Special Concern” (COSEWIC 2007). Similarly, the NWT ranking of the rusty blackbird (*Euphagus carolinus)* has been upgraded to “May Be At Risk” due to declining populations in the boreal forest, and the COSEWIC assessment in 2006 which placed the species under “Special Concern (COSEWIC 2006b).

Several designations of individual species were changed from the 2000 assessment because of new information on the NWT population or corrections from the previous assessment. Several species, such as the Hudsonian godwit and the thick-billed murre, have been upgraded in status due to increasing risks to the population. The golden eagle has been downgraded to “Secure” status due to declining risks to the population. For several species, the current status is largely conjectural because their distribution is limited within the NWT and few data are available to allow a proper evaluation.

The WGGSNS process identifies species that may be lost within the NWT and those whose status has improved due to changes in environmental stress or climatic factors. A prime example is the recovery of the peregrine falcon from steep declines in the 1970s due to high levels of the pesticide DDT. The status of the peregrine falcon has been upgraded significantly in recent years due to the declines in the use of the pesticide in overwintering areas.

Table 5.3-8
Summary of the Status of NWT Bird Species of Elevated Concern from 2000 and 2006 Assessments

Common Name	Scientific Name	Status in 2000[1]	Status in 2006[2]	Additional Comment	COSEWIC Designation[3]
Anseriformes – Ducks and Geese					
Harlequin duck	*Histrionicus histrionicus*	May Be At Risk	May Be At Risk		Eastern population under Special Concern - 2001
Northern Pintail	*Anas acuta*	Sensitive	Sensitive		
Lesser Scaup	*Aythya affinis*	Sensitive	Sensitive		
Brant	*Branta bernicla*	Secure	Sensitive	New classification based on new information on population size and wintering range data	
Long-tailed Duck	*Clangula hyemalis*	Sensitive	Sensitive		
Trumpeter Swan	*Cygnus buccinators*	Sensitive	Sensitive		Not At Risk - 1996
White-winged Scoter	*Melanitta fusca*	Sensitive	Sensitive		
Black Scoter	*Melanitta nigra*	Sensitive	Sensitive	Status based on limited distribution (<5% of NWT)	
Surf Scoter	*Melanitta perspicillata*	Sensitive	Sensitive		
Common Eider	*Somateria mollissima*	Sensitive	Sensitive	Limited distribution (<5% of NWT)	
King Eider	*Somateria spectabilis*	Sensitive	Sensitive		
Marine-dwelling and shorebirds - Charadriiformes					
Eskimo Curlew	*Numenius borealis*	At Risk	At Risk	Probably extirpated. Declined at the beginning of the 20th century due to overharvesting; not observed in NWT for several decades.	Endangered – 2009

Table 5.3-8 (Cont'd)
Summary of the Status of NWT Bird Species of Elevated Concern from 2000 and 2006 Assessments

Common Name	Scientific Name	Status in 2000[1]	Status in 2006[2]	Additional Comment	COSEWIC Designation[3]
Ivory Gull	*Pagophila eburnea*	May Be At Risk	At Risk	Significant decline observed in Nunavut; Change in COSEWIC status since 2000 due to detailed assessment	Endangered - 2006
Ross's Gull	*Rhodostethia rosea*	May Be At Risk	Vagrant	Status change due to error correction; Change in COSEWIC status since 2000 due to detailed assessment	Threatened - 2007
Ruddy Turnstone	*Arenaria interpres*	Secure	Sensitive	Change in status due to increasing risk	
Sanderling	*Calidris alba*	Sensitive	Sensitive		
Dunlin	*Calidris alpina*	Secure	Sensitive	Limited distribution (<5% of NWT); status changed since 2000 due to increasing risk	
Least Sandpiper	*Calidris minutilla*	Sensitive	Sensitive		
Semipalmated Sandpiper	*Calidris pusilla*	Sensitive	Sensitive		
Red Knot	*Calidris canutus*	Secure	May Be At Risk	Status changed since 2000 due to increasing risk and declines on wintering grounds	Ssp. *islandica* – Special Concern – 2007; ssp. *roselaari* Threatened – 2007; *rufa* endangered - 2007
Black Tern	*Chlidonias niger*	Sensitive	Sensitive		Not at Risk - 1996
Wilson's Snipe (Common snipe)	*Gallinago delicta (Gallinago gallinago)*	Sensitive	Undetermined	Change in status due to new information	
Long-billed Dowitcher	*Limnodromus scolopaceus*	Sensitive	Sensitive	Limited distribution (<5% of NWT)	

Table 5.3-8 (Cont'd)
Summary of the Status of NWT Bird Species of Elevated Concern from 2000 and 2006 Assessments

Common Name	Scientific Name	Status in 2000[1]	Status in 2006[2]	Additional Comment	COSEWIC Designation[3]
Hudsonian Godwit	*Limosa haemastica*	Undetermined	Sensitive	Limited distribution (<5% of NWT); status changed since 2000 due to increasing risk	
Whimbrel	*Numenius phaeopus*	Sensitive	Sensitive		
Red Phalarope	*Phalaropus fulicaria*	Sensitive	Sensitive		
Red-necked Phalarope	*Phalaropus lobatus*	Sensitive	Sensitive		
American Golden Plover	*Pluvialis dominica*	Sensitive	Sensitive		
Black-bellied Plover	*Pluvialis squatarola*	Sensitive	Sensitive		
Caspian Tern	*Sterna caspia*	Sensitive	Sensitive		Not at Risk - 1999
Lesser Yellowlegs	*Tringa flavipes*	Sensitive	Sensitive		
Buff-breasted Sandpiper	*Tryngites subruficollis*	Sensitive	Sensitive	Limited distribution (<5% of NWT)	
Thick-billed Murre (Brénnich's murre)	*Uria lomvia*	Undetermined	Sensitive	Limited distribution (<5% of NWT); new designation based on increasing risk	
Heron-like birds – Ciconiiformes					
American Bittern	*Botaurus lentiginosus*	Sensitive	Sensitive	Limited distribution (<5% of NWT)	
Birds of Prey – Falconiformes					
Anatum Peregrine Falcon[4]	*Falco peregrinus anatum*	At Risk	Sensitive	Change in taxonomy; changed from At Risk due to decrease in risk	Threatened - 2007
Tundra Peregrine Falcon[4]	*Falco peregrinus tundrius*	May Be At Risk	Sensitive	Change in taxonomy; changed from At Risk due to decrease in risk	Special Concern - 2007
Golden Eagle	*Aquila chrysaetos*	Sensitive	Secure	Declining risk	Not at Risk - 1996

Table 5.3-8 (Cont'd)
Summary of the Status of NWT Bird Species of Elevated Concern from 2000 and 2006 Assessments

Common Name	Scientific Name	Status in 2000[1]	Status in 2006[2]	Additional Comment	COSEWIC Designation[3]
Grouse-like Birds – Galliformes					
Rock Ptarmigan	*Lagopus mutus*	Sensitive	Secure	Change in status due to error correction	
Crane-like birds – Gruiformes					
Whooping Crane	*Grus americana*	At Risk	At Risk		Endangered - 2010
Yellow Rail	*Coturnicops noveboracensis*	May Be At Risk	May Be At Risk		Special Concern - 2009
American Coot	*Fulica americana*	Sensitive	Secure	Change in status due to error correction	Not At Risk - 1991
Perching birds – Passeriformes					
Gray-headed Chickadee (Siberian tit)	*Poecile cinctus*	May Be At Risk	May Be At Risk	Limited distribution (<5% of NWT)	
American (formerly Water) Pipit	*Anthus rubescens*	Sensitive	Sensitive		
Olive-sided Flycatcher	*Contopus cooperi*	Sensitive	Sensitive		Threatened - 2007
Blackpoll Warbler	*Dendroica striata*	Sensitive	Sensitive		
Canada Warbler	*Wilsonia canadensis*	Undetermined	At Risk		Threatened
Rusty Blackbird	*Euphagus carolinus*	Sensitive	May Be At Risk	Change due to increasing risk; southern populations have shown declines in last ten years	Special Concern - 2006
Barn Swallow	*Hirundo rustica*	Sensitive	Sensitive		
Boreal Chickadee	*Poecile hudsonicus*	Sensitive	Sensitive		
Bank Swallow	*Riparia riparia*	Sensitive	Secure	Change in status due to declining risk	
American Tree Sparrow	*Spizella arborea*	Sensitive	Sensitive		

Table 5.3-8 (Cont'd)
Summary of the Status of NWT Bird Species of Elevated Concern from 2000 and 2006 Assessments

Common Name	Scientific Name	Status in 2000[1]	Status in 2006[2]	Additional Comment	COSEWIC Designation[3]
White-throated Sparrow	*Zonotrichia albicollis*	Sensitive	Sensitive		
Harris's Sparrow	*Zonotrichia querula*	Sensitive	Sensitive		
Pelican-like birds – Pelecaniformes					
American White Pelican	*Pelecanus erythrorhynchos*	May be At Risk	May be At Risk	Limited distribution (<5% of NWT)	Threatened – 1978 Not at Risk - 1987
Woodpecker-like birds – Piciformes					
Northern Flicker	*Colaptes auratus*	Sensitive	Secure	New information	
Nightjars - Caprimulgiformes					
Common Nighthawk	*Chordeiles minor*	Undetermined	At Risk		Threatened
Grebes – Podicipediformes					
Pied-billed Grebe	*Podilymbus podiceps*	Sensitive	Sensitive	Limited distribution (<5% of NWT)	
Horned Grebe	*Podiceps auritus*	Secure	Secure		Special Concern
Owls – Strigiformes					
Short-eared Owl	*Asio flammeus*	Sensitive	Sensitive		Special Concern - 2008

References
1 – WGGSNS 2000
2 – WGGSNS 2006
3 – SARA Registry (www.sararegistry.gc.ca/status/status_e.cfm) accessed June 2010.
4 – COSEWIC has combined the *anatum* and *tundrius* subspecies for assessment purposes and has listed the peregrine falcon as "Special Concern"

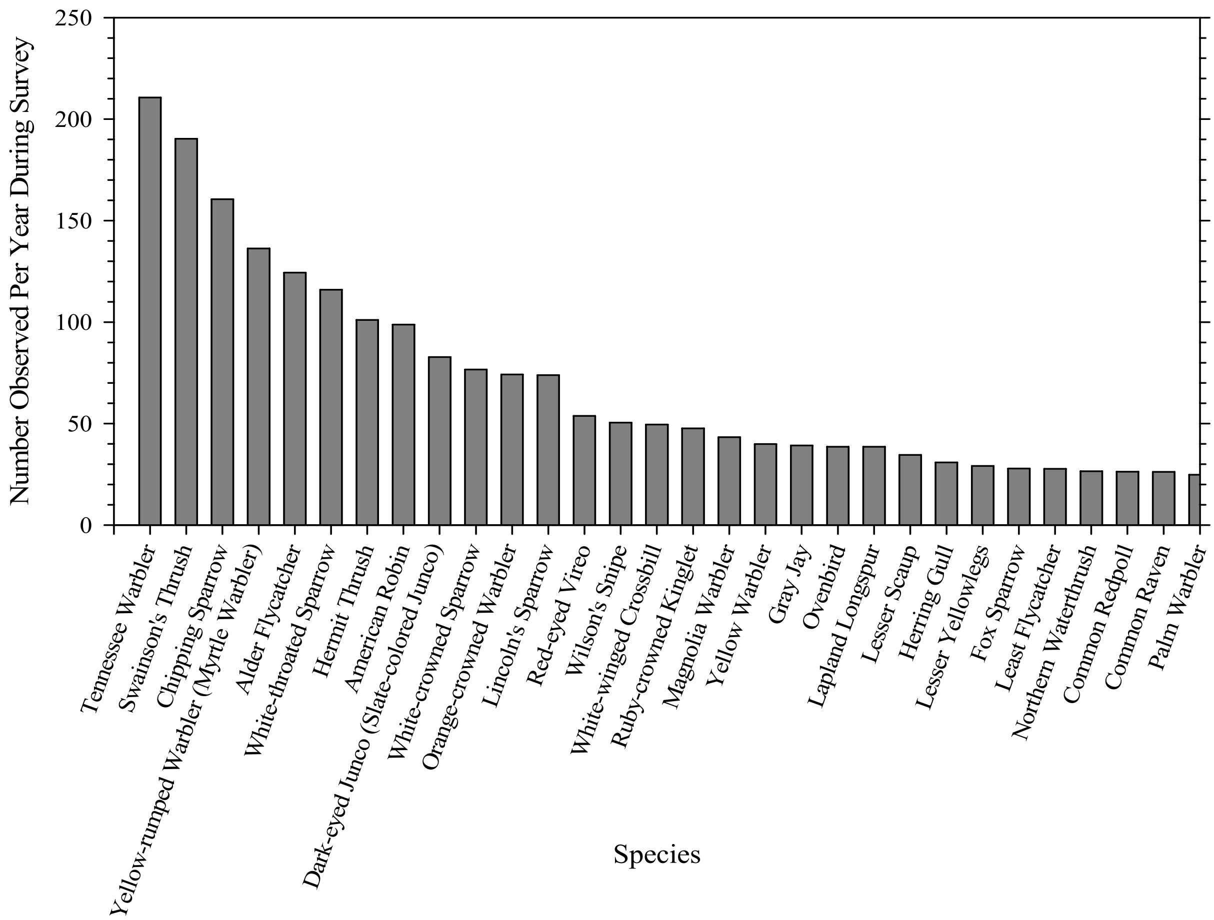
2 - The North American Breeding Bird Survey

The North American Breeding Bird Survey (NWBBS) is a cooperative program between the Patuxent Wildlife Research Center and the Canadian Wildlife Service and monitors the status and trends of North American bird populations (http://www.pwrc.usgs.gov/BBS/). The program has been run since 1966, although data are only available for the NWT since 1989. Volunteers travel specific routes (41 km in length with stops every 0.8 km) during nesting season and count the species along the transect. In the NWT, the program has been conducted at 1 to 7 routes since 1989 in major communities, providing a measure of the most common bird species at several sites. The data are compiled annually and used by several national and international agencies to monitor the status of birds throughout North America.

The program reports data (NABBS 2010) for the abundance of 197 species from 1987 to 2009, although a large proportion of those species are observed very infrequently (once or twice over a ten-year span). The most common species in the NWT, which may be observed hundreds of time annually, are shown in Figure 5.3-5. Depending on the number of routes conducted, the survey reports data on the presence of about 90 bird species annually (over 2700 individual birds). Major criticisms of the program relate to the few routes conducted annually (some recent years as low as three routes in all the NWT), are only available near major communities in the NWT and the only route conducted in the Taiga Region, that comprises a large portion of the eastern NWT, is at the extreme southern in Yellowknife..

Since 2006, the data have been analyzed (Sauer *et al*. 2008) to provide long-term trends (1966 to 2007) for most species within a region. Because of the small number of routes conducted annually in the NWT, the data cannot be analyzed specifically for the territory, however trend analysis is possible for the Boreal Taiga Plain, much of which lies within the NWT. The trends observed in most species in the Boreal Taiga Plain as a whole are probably consistent with trends in the same species in the NWT. The analysis is not available for the Taiga Shield or Arctic ecozone areas of the NWT.

Figure 5.3-5
Abundance of the Most Common Bird Species Observed During the Breeding Bird Survey From 1989 to 2009



Source: Nabbs 2010

The analysis indicates that 30 species in the NWT show statistically significant declines since 1980 (Table 5.3-9). Eight species showed significant increases during the same time period. The trends through time for two examples of each group are shown in Figure 5.3-6. One notable species is the ruffed grouse that appears to have declined in the Boreal Taiga Plains, although the statistical relationship is not significant. The authors caution that variability is high within the data, but the trends observed in these species are statistically significant ($P<0.05$) at the level indicated in Table 5.3-9.

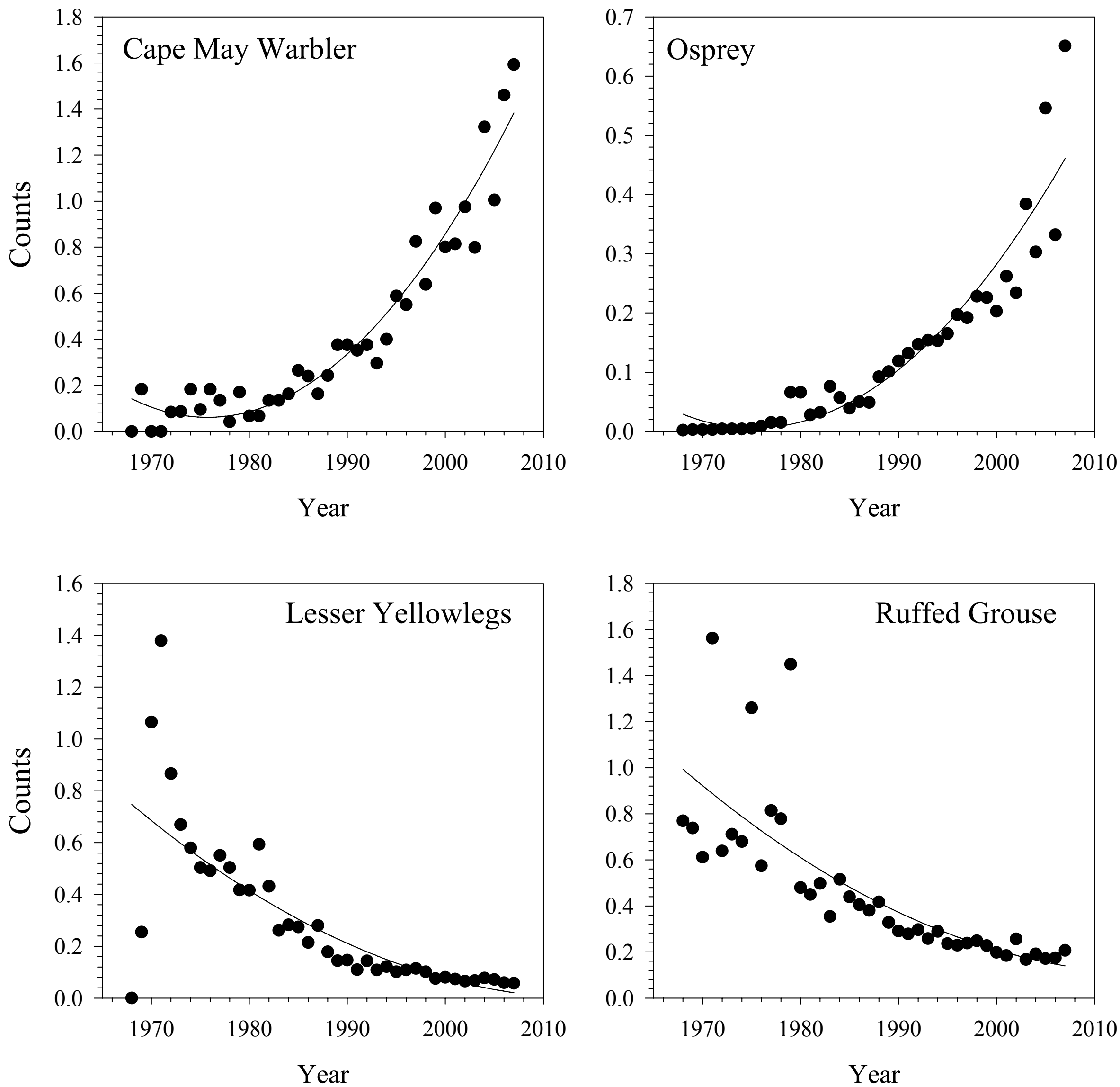
Table 5.3-9
Rates of Change in Bird Species in Boreal Plains Ecozone

Species	Rate of Change (%/annum)	P Value	Sample Size (n)
Increasing Populations			
Bay-breasted Warbler	29.9	0.08	8
Cape May Warbler	18.5	0.03	12
Osprey	17.6	0.18	5
Marsh Wren	15.9	0.32	23
Canada Goose	10.1	0.00	54
Bald Eagle	9.5	0.01	8
Wilson's Warbler	6.4	0.26	22
Three-toed Woodpecker	5.9	0.73	6
Decreasing Populations			
Common Nighthawk	-22.2	0.0000	16
Lesser Yellowlegs	-14	0.0100	30
Lesser Scaup	-11.4	0.0100	40
Horned Lark	-11.1	0.0000	25
Ruffed Grouse	-7.4	0.2800	40
House Sparrow	-7.2	0.0000	62
Killdeer	-6.7	0.0000	79
Eastern Kingbird	-6.6	0.0000	51
Brewer's Blackbird	-5.7	0.0000	76
Barn Swallow	-5.5	0.0000	92
Pine Siskin	-4.9	0.0000	73
Northern Harrier	-4.9	0.0000	40
Red-winged Blackbird	-4.7	0.0000	95
Alder Flycatcher	-4.6	0.0000	101
Willow/Alder Flycatcher	-4.6	0.0000	101
Eastern Phoebe	-4.1	0.0000	77
American Bittern	-3.9	0.3300	30
Common Yellowthroat	-3.8	0.0000	91
Least Flycatcher	-3.6	0.0000	102
Mourning Warbler	-3.5	0.0000	55
Gray Jay	-2.8	0.0100	58
Warbling Vireo	-2.3	0.0100	66
Song Sparrow	-1.5	0.0400	90
Clay-colour Sparrow	-1.4	0.0000	102

Source: NABBS 2010

These data indicate that monitoring of individual species, through the BBS or other programs, are vital in determining the ongoing status of NWT bird species. Data from another program, the Canadian Migration Monitoring Network (Crewe *et al.* 2008), has been monitoring over 150 species of migrating birds in spring and fall at about 20 stations and has confirmed some of the trends reported by the NABBS.

Figure 5.3-6
Changes in Counts of Four Bird Species in the Boreal Taiga Plains During the Breeding Bird Survey From 1966 to 2007



Source: Sauer *et al*. 2008

3 - Waterfowl

Waterfowl, as well as migratory landbirds, waterbirds and seabirds, are protected in Canada under the Migratory Bird Convention and the *Migratory Bird Convention Act* of 1994. Nationally, the Canadian Wildlife Service (CWS) administers programs to monitor waterfowl populations and also sets waterfowl harvest levels annually based on surveys of the status of the productivity of individual species and the quality of the nesting habitat.

One of the key programs in monitoring the status of waterfowl nesting success in Canada is run by the CWS and the U.S. Fish and Wildlife Service, who have conducted surveys of waterfowl habitat and breeding numbers since 1955. The Waterfowl Breeding Population and Habitat Survey (WBPHS) is an annual survey of the population size and habitat conditions for ducks and geese throughout Canada and the U.S. The program surveys a total of six “strata”, or prime waterfowl areas within the NWT, and reports on the numbers of breeding waterfowl. Surveys are conducted on specific transects during June and July every year, with the numbers of breeding individuals reported for 18 duck species and Canada geese. The data are used to adjust fall hunting limits throughout North America, particularly for species that have low population numbers or poor reproductive success.

Survey data from the WBPHS program in 2010 (Zimpfer *et al.* 2010) show that most waterfowl populations in the NWT have increased in the last few years, with the numbers of some species higher in 2010 than in the previous ten years (Table 5.3-10). The total populations of ducks in the traditional waterfowl habitat in North America, which includes the NWT, western provinces and central/northern U.S. states, was 40.7 million birds in 2010, 21% higher than the long-term (1955-2009) average. In the NWT, the total number of ducks (Table 5.3-10) was estimated at over 6 million birds in 2010, about 20% higher than the long-term average (Figure 5.3-7).

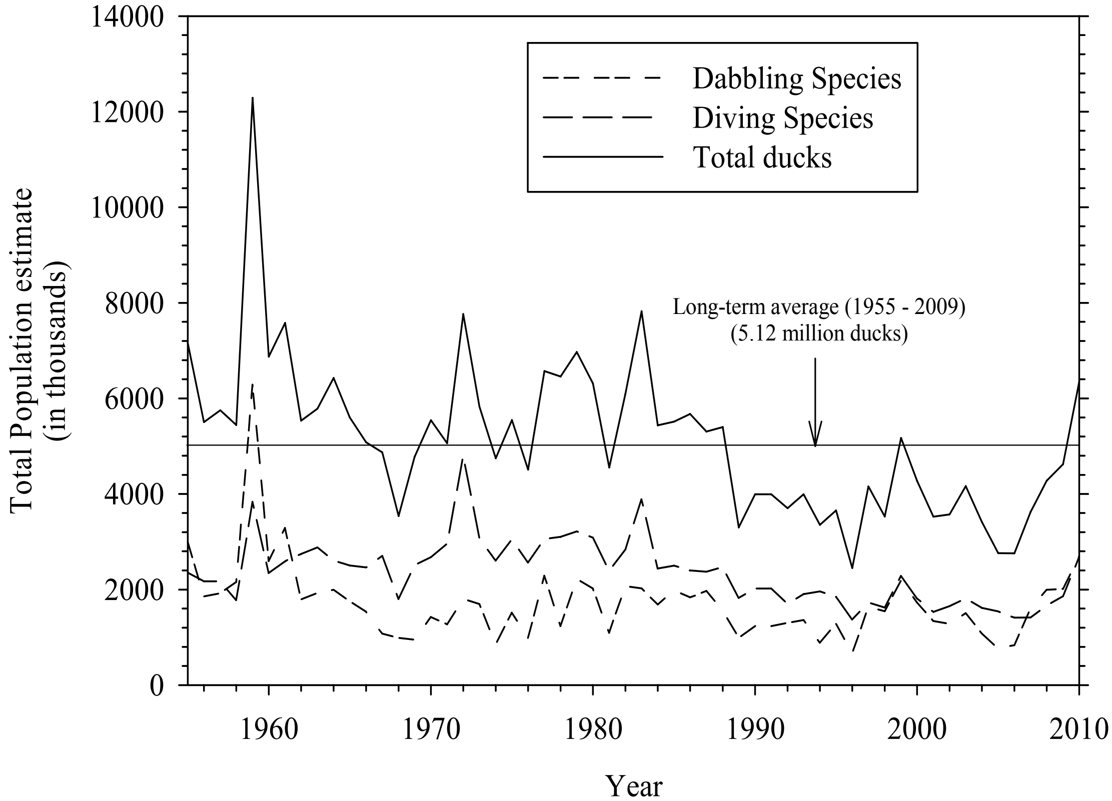
The 2010 population estimates reported for individual species in the NWT were generally higher than long-term averages, primarily due to an early spring and ice break-up, and favourable climate conditions during nesting. The majority of waterfowl habitat in the NWT was judged to be good in 2009 and 2010 (Zimpfer *et al.* 2010), with habitat deemed to be only fair in the extreme southern portion of the NWT in 2010. The mallard, one of the most common species, increased 66% in 2010 over the number in 2009, and exceeds the long-term average for the species (420 thousand) by about 80% (Table 5.3-10; Figure 5.3-8). The greatest increase in the NWT was observed in the green-winged teal, whose numbers have tripled over the long-term average (319 thousand). This trend is also reflected nationally, with green-winged teal at levels about twice the target value for the North American Waterfowl Management Plan.

Table 5.3-10
Estimated Numbers (In Thousands) of Ducks and Canada Geese in the NWT in 2010 Relative to the Long-Term Average

Year	2009	2010	5-year average (2005-2009)	10 year average (2000 to 2009)	55 year average (1955 to 2009)	5 year average Versus 55 year average (%)
Dabbling Species						
Mallard	457.7	759.5	291.0	350.9	420.1	-30.7
Gadwall	4.4	0.0	10.4	13.8	8.2	25.7
American wigeon	588.9	430.0	529.6	515.9	573.6	-7.67
Green-winged teal	583.7	1018.0	347.2	309.4	319.1	8.80
Blue-winged teal	44.1	48.5	21.5	20.8	29.2	-26.4
Northern shoveler	156.6	173.1	87.6	80.6	80.4	9.03
Northern pintail	177.7	264.2	153.0	140.0	261.5	-41.5
Total Dabblers	2013	2693.4	1440.3	1431.3	1692.1	-14.9
Diving Species						
Redhead	7.7	2.4	7.3	5.3	5.4	36.2
Canvasback	41.0	30.2	35.8	50.2	35.6	0.46
Generic scaup	1380	1962.3	1124.8	1266.9	2020.7	-44.3
Ring-necked duck	205.1	269.8	144.1	131.8	85.1	69.3
Generic goldeneye	31.2	52.6	75.5	44.1	53.4	41.5
Bufflehead	176.0	347.9	174.3	164.5	144.0	21.1
Ruddy duck	17.8	14.5	13.7	9.3	9.6	41.9
Total Divers	1859	2679.7	1575	1672	2354	-33
Miscellaneous Species						
Generic merganser	57.4	114.3	60.6	71.4	59.4	2.03
Long-tailed duck	62.7	87.1	53.3	71.6	216.3	-75.4
Generic eider	0.0	1.6	2.3	1.1	0.8	191.1
Generic scoter	629.1	771.7	475.3	505.7	797.0	-40.4
Total ducks	4621	6348	3607	3753	5119	-29.5
Canada goose	134.1	247.3	127.1	111.0	121.8	4.38

Source: Zimpfer *et al*. 2010

Figure 5.3-7
Estimated Number of Breeding Ducks in the NWT in 2010



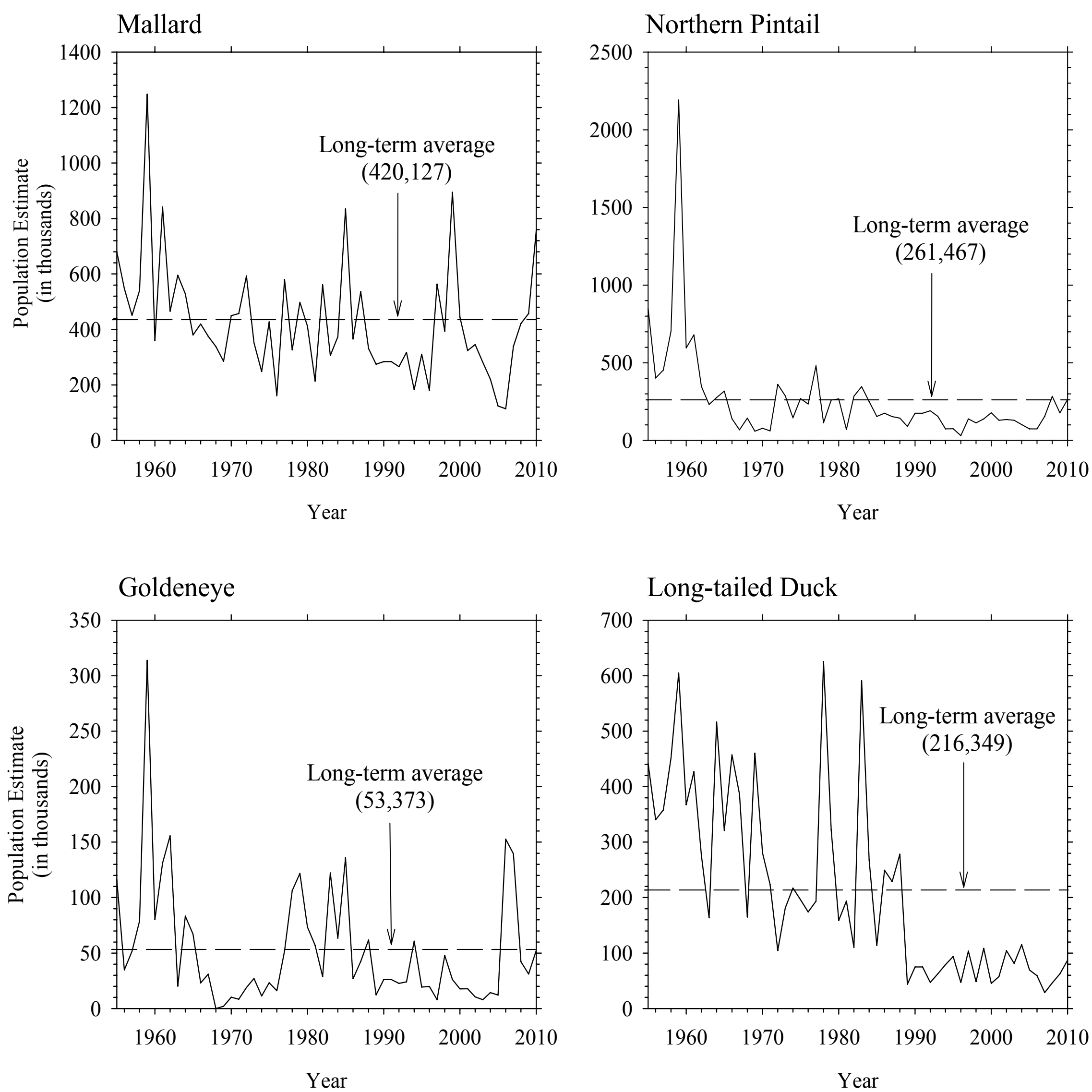
Source: Zimpfer *et al*. 2010

Although some species of scaup are declining in North America, the most abundant group of waterfowl in the NWT surveys was the scaup, at almost 2 million individuals, close to the 55 year long-term average. Although no gadwalls were reported in the NWT in 2010, the North American population exceeds historical numbers for the species. The low value is probably due to variability in the counting methods, as a zero count in the past (in 1982) was followed by a normal count number the following year.

A few species that have shown declines over the last few years showed an increase in 2010. The northern pintail, which has been at very low levels for several years, showed an increase in 2010, and is currently at levels consistent with the long-term average for the species. The redhead did poorly in 2010 in the NWT, and is still about half of its long-term average population. Similarly, the long-tailed duck, which increased about 50% in 2010 over the 2009 estimate, is still about half of the 55-year average, and still lower than numbers in the 1960s and 1970s. Both the canvasback and the ruddy duck declined in 2010 relative to 2009, but the latter species is still higher than the long-term average for the species (USFWS 2009).

Canada geese are assessed during the WBPHS program, and by mid-winter counts on the wintering grounds and on the flyways during migration (USFWS 2009). The dominant form of Canada geese in the NWT are the short grass prairie variety that migrate in the flyway in central North America, one of three main routes used by migrating species. This group nests from northern Alberta to the Queen Maud Gulf. Population counts have shown that the numbers in the NWT increased about 6% per year since 2000, with current numbers at about 250,000 (USFWS 2009).

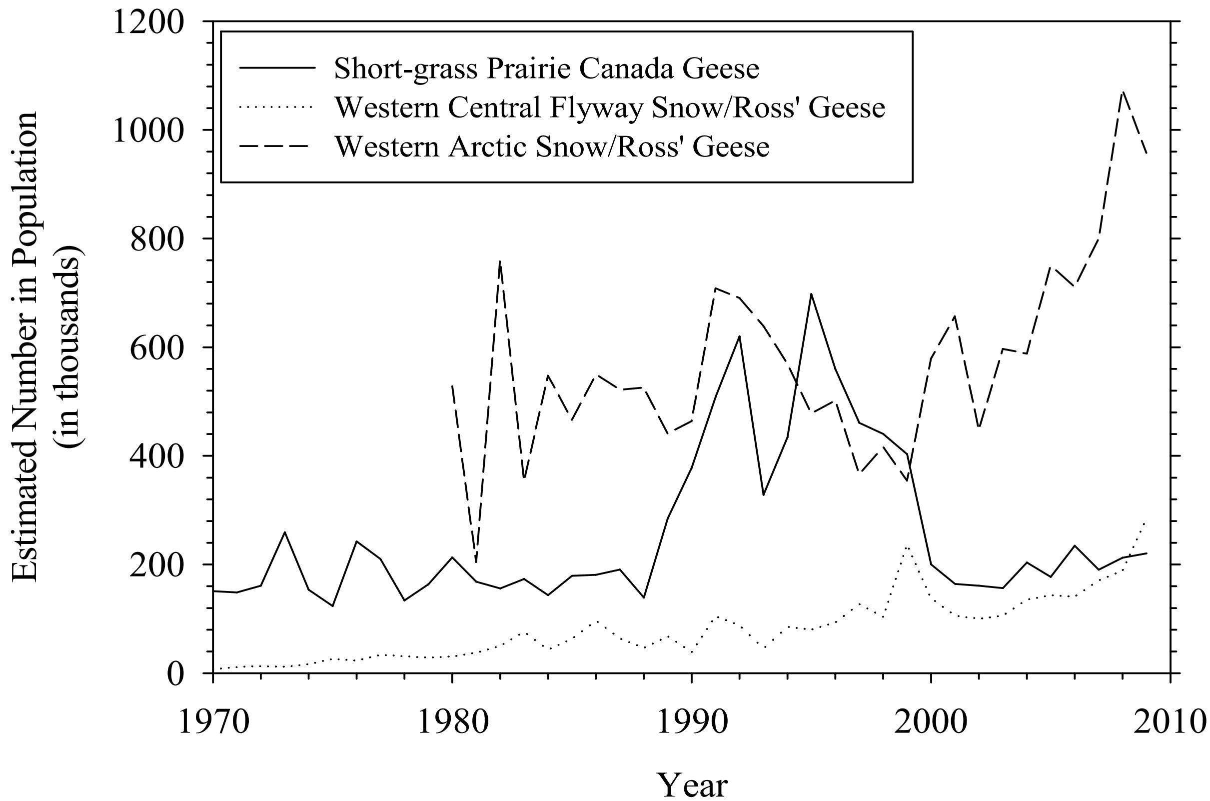
Figure 5.3-8
Long-Term Trends in Population Estimates for Four Duck Species



Source: Zimpfer *et al.* 2010

Other geese have shown a similar degree of increase in recent years (Figure 5.3-9). Light geese, a term which refers to all phases of snow geese and Ross' geese, are present in the NWT from the Western Central Flyway and the Western Arctic Flyway populations. The estimated spring population in the NWT in 2009 was 134,000, roughly 15% greater than in 2008 (USFWS 2009), although still lower than their long-term average. Winter counts of the Western Arctic population have shown an increase of 7% per year since 1999, with a fall population of 957,000, while the Western Central Flyway population has increased at roughly 9% per year since 2000 (USFWS 2009). Although winter populations continue to expand rapidly, average temperatures and snowfall on the nesting grounds on Banks Island and the Queen Maud Gulf indicate that production of young was average in 2009.

Figure 5.3-9
Winter Population Estimates for Light Geese that Nest in the NWT



Source: USFWS 2009

It important to note that, although the waterfowl populations are generally in good condition in 2010, with numbers equal to, or exceeding, long-term averages, the historical data show that all species can show rapid declines over a short period of time. Drought conditions in western and northern Canada, or severe weather conditions during nesting for one or two years in a row, can cause significant declines over a very short period of time. Also, drought on the prairies may cause changes in nesting distribution as waterfowl move to more suitable habitat in the NWT. In 2010, the condition of most NWT waterfowl species is good, or improving.

4 - Harvest data

Harvest rates of migratory birds are an important consideration in determining the current status of individual species. The bag limits for regulated hunts are determined annually, based on the population size and productivity of a species. Significant declines in the abundance of a species, such as has occurred in the past when drought conditions occur, may lead to reduced limits for hunters and a reduction in the total number of birds harvested. Unsustainable harvest rates place a major stress on species that are undergoing declines from other factors, such as climate or disease.

Harvest rates within the NWT remain consistently low relative to the total number of ducks and geese harvested annually in North America. The USFWS (Kruse 2009) reported that a total of 1000-2000 ducks have been harvested annually by permitted hunters in the NWT since 2000 (Figure 5.3-10), out of a total of about 1.2 million harvested annually in Canada and an estimated 13.2 million in the U.S. The much higher harvest levels reported in the mid-1970s match the larger populations found in the major duck species at that time. In the last 10 years, 200-2000 mallards have been harvested in the NWT under permit, relative to 550,000 in all of Canada and 4.5 million in the U.S. Harvests of pintails in Canada are about 50,000 annually, compared to >500,000 in the U.S, while about 250 are harvested annually in the NWT under permit. Clearly, although much of the nesting and raising of the young takes place in the NWT, very few of the birds are harvested in the Territories relative to the total number harvested. Data for goose harvests that are specific to the NWT are not available.

Data extracted from wings submitted from hunters indicate that more males than female adults (ratio of 5.53 for 2008) are harvested for NWT ducks migrating in the fall, while for juveniles, about 3 times more males are harvested than females (Kruse 2009). The ratio >1 indicates that fewer females are hunted, helping to protect the productivity of the population in future years.

The number of waterfowl harvested during aboriginal hunts is higher than the numbers reported through permits, but are still a small fraction of the number of birds harvested in southern Canada and the U.S (Kruse 2009). Harvest surveys conducted in the Sahtu (SRRB 2002, 2003, 2004), Gwich'in (GRRB 2009) and Inuvialuit Settlement Region (ISR; The Joint Secretariat 2003) show that about 4000 ducks are hunted annually in the Sahtu region, although the numbers are much lower in the other two regions. Far more geese, primarily snow geese, are harvested in the ISR than elsewhere, with a total of >8,000 geese in four species. Together these regions account for several thousand ducks and >10,000 geese harvested annually (Kruse 2009). Large numbers of landbirds, such as grouse and ptarmigan are also harvested in these regions, with about 1,000 grouse, predominantly sharp-tailed grouse, hunted in the Sahtu and roughly the same number of ptarmigan harvested in the ISR. Although data are currently not available, it is likely that similar levels of grouse are hunted in the more southern regions, placing the grouse harvest at several thousand birds within the NWT. These data suggest that hunting within the NWT is currently not a major stress on populations and provides valuable nutritional and cultural benefits to NWT residents.

Figure 5.3-10
Harvest Estimates of Mallads, Pintail and All Duck Species in the NWT Since 1975

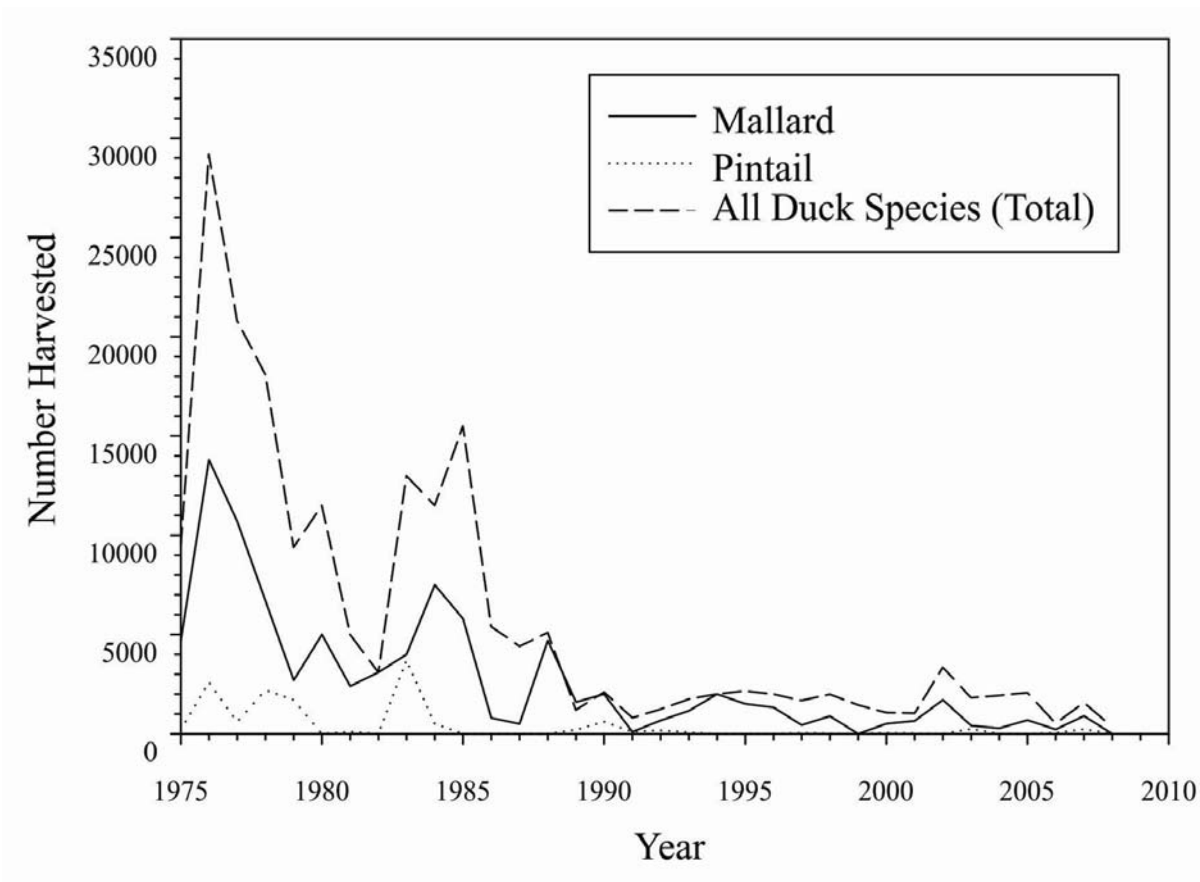
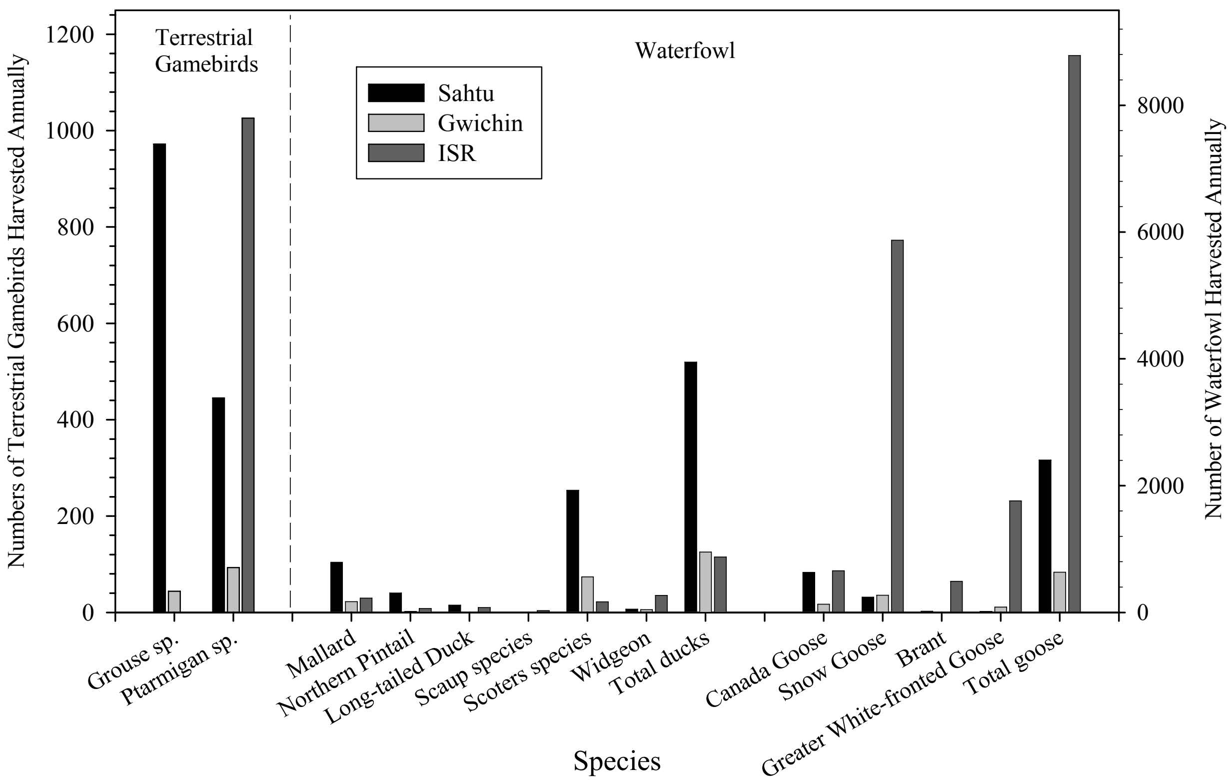


Figure 5.3-11
Annual Harvest Rates of Waterfowl and Terrestrial Gamebirds for the Sahtu, Gwich'in and Inuvialuit Settlement Regions



5.3.2.2 Recommendations

A number of programs are providing data on the status of birds within the NWT, however the NWT should examine ways of improving and enhancing the number of routes conducted during the Breeding Bird Survey and Christmas Bird Counts. These programs provide valuable long-term data on trends for individual species with very little investment.

In addition, it is recommended that the NABBS program in the NWT be supported, and improved to provide better coverage of the NWT. More data from more observers over a larger area of the NWT will help to identify trends for more species. The benefits gained from these international programs balance out the modest costs of participation. Furthermore, partnerships with national and international birding organization, although many of these links are currently in place, should be enhanced and strengthened.

Currently no data are available for long-term trends of any landbirds (e.g., game birds and songbirds) in the Taiga Shield portion of the NWT. Because of this, trends can only be inferred from data from other regions and the long-term impacts of climate change on many species will be unknown.

In recent years, most waterfowl species in the NWT have increased or remained at levels similar to long-term averages. This picture can change quickly however, if environmental conditions change, such as under the influence of climate change where nesting areas dry. Important bird areas for migratory waterfowl have already been identified and are good candidates for increased protection from development.

5.3.3 Valued Component 3 – Plants in the NWT

5.3.3.1 Key Indicator – Population

Scientific Data

Plants are one of the most difficult groups to evaluate because of the large number of species present and the relatively little information available for most. Nationally, 22 vascular plant species have become extirpated (locally extinct), 1200 species "At Risk" and 552 species "May Be At Risk" out of a total of 5074 species across the country (Environment Canada 2009). Roughly half of the plant species in the country are considered to be "Secure" and approximately 1200 species are considered to be "exotic". By comparison, mammals, one of the most commonly cited groups, has 218 species, of which 139 species are secure (Environment Canada 2009)

The 2000 assessment of NWT plants by the WGGSNS indicated that at least 1200 species of vascular plants are present in the NWT, with an additional 300 lichen species and 500 species of moss. The assessment placed one fern and two orchid species in the "May Be At Risk" category and 5 other species as "Sensitive". The assessment focused solely on the fern and orchid groups.

A lot of new information was obtained for the 2006 assessment which expanded the coverage of species and provided an assessment by expert botanists (WGGSNS 2006). Data on the presence of rare plant species and the general distribution of more common varieties have been obtained from baseline work for the Mackenzie Gas Project and in surveys for the NWT's Protected Area Strategy. These new data are being used to re-evaluate the status of most plant species in the NWT and to identify species that may require additional protection.

Because of the inclusion of other plant groups, the 2006 assessment places more plant species in the "May Be At Risk" and "Sensitive" categories. The current database reports 159 plant species in the "May Be At Risk" category (WGGSNS 2006), largely because of limited distribution in the NWT and because many of the plants are at the northern edge of their range. Plant distributions will continue to change under the influence of climate change and as the range of plants in northern Alberta and Saskatchewan extend further north. The NWT Species database also lists 182 species in the "Sensitive" category. Again, many species are placed in this category because of their restricted distribution within the NWT.

In all, the new assessment places 341 plant species in elevated protection status ("May Be At Risk or Sensitive"). This places about 14% of known vascular plants in the NWT in the "May Be At Risk" category, slightly higher than the national average of 11% (552 species out of 5074) reported by the Canadian Endangered Species Conservation Council (CESCC 2006). This assessment will continue to evolve as new data are collected and new locations are found for some species.

Of particular concern is the presence of up to 97 exotic or invasive species that have been observed in the NWT. Introductions can occur from southern areas on vehicles travelling on highways or as wildlife transport seeds. It is not known how quickly these alien plants will spread within the NWT; however, their presence should be monitored and, if necessary, controlled.

5.3.3.2 Recommendations

The largest impediment to understanding trends of plants in the NWT is the lack of data on distribution and general ecology of individual plants. The WGGSNS made significant advancements in 2006 by re-assessing all species using new expertise, but the lack of information for many species led to a ranking of "May Be At Risk" because of low numbers and limited distribution. The status of many of these plants may change in the coming years as climate moderates and many species become firmly established. The assessment should be refined with new data and research, for improved understanding of species.

5.3.4 Valued Component 4 – The Protection of Biodiversity

Scientific Assessment

Several initiatives have been conducted in recent years to understand and preserve the unique natural biodiversity in the NWT (GNWT-NWTBT 2010). The NWT has adopted a Biodiversity Action Plan to meet national (Canadian Biodiversity Strategy) and international (Convention on Biological Diversity) commitments. The program contains a number of goals to conserve biodiversity, understand ecosystems in the NWT and to use biological resources in a sustainable manner (NWT Biodiversity Team 2004). Initiatives include monitoring the general status of species (WGGSNS 2006), the protection of rare and threatened species through the NWT Species At Risk Act and the formation of protected areas.

A comprehensive gap analysis by the NWT Biodiversity Team rated the effectiveness of the programs conducted for biodiversity (NWT Biodiversity Team 2006). The report outlines the context within which biodiversity studies are currently working in the NWT. Important considerations include the presence of traditional and wage employment economies, and increases in development in the form of mines, roads and infrastructure.

Two of the science-based programs were deemed to have moderate success in achieving their goals in preserving biodiversity. The NWT Species At Risk programs were ranked relatively poorly (2.5/5) because of the need to dedicate more resources to understand rare/threatened species and to develop recovery plans. Protected areas were assessed as being more successful because of the progress of the Protected Area Strategy (NWTPAS).

The Protected Areas Strategy is one of the major programs designed to protect biological resources in the NWT. The need to manage natural landscapes in the presence of development and to protect ecological and cultural resources has been recognized globally for several decades (IUCN 1994, 2010). The protection of ecological resources is based on the need to protect the biodiversity in individual ecozones by maintaining self-sustaining populations of plants and animals. Through a series of conferences and workshops spanning about 20 years, the IUCN has developed a general target of 10% of terrestrial lands should be protected, which is defined by the IUCN (Langhammer *et al*. 2007) as:

> *"An area of land or sea especially dedicated to the protection and maintenance of biological diversity, and its associated natural and cultural resources, managed through legal or other effective means.*

The 10% value is generally accepted as the area of land needed to protect the distinct character and ecology of an ecological zone. It has become a guiding principle in conservation biology that species must be protected by maintaining a reasonable population size and allowing for exchanges with adjacent populations. Reviews of protected spaces around the globe have placed the global average at about 11%, although the coverage of some biomes is much better than others (Langhammer *et al*. 2007). Examples of protected areas include national and territorial parks, national wildlife areas and migratory bird sanctuaries, ecological reserves and associated lands (Wiersma *et al*. 2005).

The Canadian Council on Ecological Areas (CCEA) reviewed the characteristics of protected areas that would protect ecological integrity in northern environments (Table 5.3-11). In addition to large minimum land area (>3000 km^2), the group recommended at least one large protected area per eco-region, with additional smaller areas to supplement diversity of species and gene pools. Protected areas are intended to preserve ecological integrity (Beechey 1989), facilitate scientific research and monitoring, protect wildlife and habitat, plus protect aesthetic, cultural, spiritual and recreational values (Wiersma *et al*. 2005). The areas should also include a number of aquatic habitats and a range of species of all trophic levels, with rare and threatened species, whenever possible. The CCEA review in 2007 concluded that a substantial foundation for protected areas in northern Canada (which includes the northern sections of most provinces) has been built, however the protected areas are relatively isolated, and hence do not allow the movement of wildlife between protected areas (Wiersma *et al*. 2005).

Table 5.3-11
Characteristics of Protected Spaces in Northern Environments

Attribute	Minimum Recommendation	Rationale
Size	>3000 km^2	Based on minimum reserve area estimates for mammals in southern Canada; this area may also be large enough to allow fires to occur naturally.
Replication	At least one large protected area per ecozone or ecoregion, with additional smaller ones to capture fine-resolution features of interest.	A single, strategically placed, protected area may capture the majority of mammalian diversity in an ecologically defined region.
Physical attributes	A range of habitat and micro habitat types, e.g., locating some protected areas along latitudinal or altitudinal gradients.	Protecting a range of habitat types increases the probability of conserving a high proportion of a region's biodiversity. Locating protected areas along latitudinal or altitudinal gradients may mitigate the effects of climate change.
Aquatic habitats	A range of aquatic features (i.e., lakes, rivers, streams, marshes, bogs, etc.). Lakes should include bodies of varying depth, orientation and size.	Protecting a range of aquatic habitats will ensure a diversity of aquatic biodiversity is maintained. Further, terrestrial species that depend in part on aquatic habitats for some part of their life cycle will have a better chance of persistence.
Priority species	A range of taxa to include all trophic levels and to include species that occupy a range of habitat types. Threatened and endangered species to be included whenever possible.	Protecting a range of different taxa and trophic levels for which distribution and detailed habitat data are known increases the probability of protecting species for which data are unavailable.
Boundary geometry	Follow natural boundaries (e.g., watersheds, heights-of land), or as round as possible.	Following natural boundaries reduces the possibility that critical parts of a species habitat will be left outside of the protected area and attempts to incorporate physical processes within the boundaries. A round shape minimizes the edge-to interior ratio (although this is less of an issue for most large protected areas).

Table 5.3-11 (Cont'd)
Characteristics of Protected Spaces in Northern Environments

Attribute	Minimum Recommendation	Rationale
Inter-reserve distance	Small enough that wide ranging species (e.g., birds, caribou) can travel between them as required	Allowing wide-ranging species to travel between protected areas can mitigate reproductive and genetic isolation within protected areas. Appropriate distances can maintain connectivity between seasonal habitats.
Surrounding land-uses	Compatible with the principles of 'ecological integrity'.	Buffer zones from 10-50 km are effective to 'soften' the boundaries around protected areas.
Allowable activities	A variety of activities (including subsistence harvest of animals and plants), as long as populations and the ecological integrity of the protected areas are not compromised.	Certain types of activities are not anticipated to have an adverse effect on the ecological integrity of a protected area; the nature of the activities is dependent on the site and values in questions.
Zoning	No adverse affects on the ecological integrity of the protected area; ideally infrastructure (if any) to be minimal, planned for one small, high-density area, rather than many low density areas throughout the protected area.	Certain types of infrastructure will not have an adverse effect on the ecological integrity of a protected area; the nature of the activities is dependent on the site and species/values in question.

Source: Wiersma et al. 2005

Since 1999, the Protected Area Strategy (PAS) has been developed in the NWT specifically to address the issue of protecting natural and cultural areas in the NWT and is part of the national strategy to increase the amount of protected spaces in Canada (NWTPAS 1999). The committee of eight aboriginal groups, two industry groups, two non-governmental organizations and the federal and territorial governments has been given the task of protecting core representative areas within the 42 eco-regions of the NWT. The process involves identifying areas of interest from scientific information or traditional knowledge, obtaining support from aboriginal organizations and communities, and obtaining support from a sponsoring agency (NWTPAS 2009). In all, the process involves eight steps of identifying, negotiating, locating a sponsoring agency, surveying and assessing the site and placing it under legal protection.

The NWTPAS 2009/2010 Annual Report (NWTPAS 2010) indicates that progress has been made in protecting ecologically representative areas in 29 of the 42 NWT eco-regions to some degree, and with permanent protection received for two sites, Saoyú (Grizzly Bear Mountain) and ʔehdacho (Scented Grass Hills) on Great Bear Lake. The 2007/08 PAS Annual Report (NWTPAS 2008) states that 5% of NWT lands had surface and subsurface protection, with 14%

under temporary protection. The Biodiversity Report (NWT Biodiversity Team 2010) indicates that while the overall percentage of protected areas is increasing (6.7% in 2003 to 9.5% in 2010), the amount of land protected only includes 3% of the Taiga Shield and 4% of the Taiga Plains. This is significantly below the goal of 10% of each major eco-zone recommended by the IUCN.

A map of protected areas in the NWT as of 2009 (Figure 5.3-12, NWTPAS 2010) shows the distribution of national parks, national historic sites and wildlife sanctuaries with surface and subsurface protection. Surface protection only is secured for migratory bird sanctuaries, Kelly Lake/the Canol Trail and territorial parks. A map of the established, interim and proposed areas includes sites under a range of protective measures is shown in Figure 5.3-13. Although relatively few of the areas in Figure 5.3-13 have permanent protection in 2010, several candidate areas and areas of interest have been identified and are in the process of review. Progress reports for a number of other sites are posted on the NWTPAS website (http://www.nwtpas.ca/).

The need to protect the biodiversity of NWT in light of development and changing climate conditions is clear. The Protected Area Strategy has identified a number of unique areas that are in various stages of review, with the ultimate objective of protecting the sites. The size of the lands protected through this mechanism is currently small but should reach a number of its goals in the next decade.

5.3.4.1 Recommendations

The protection of 10% of the major ecoregions is an important benchmark for preserving NWTs unique combination of ecological resources and landforms. The Protected Area Strategy has made significant progress in identifying candidate areas and working with communities to provide protection for ecological and cultural resources. The process needs to continue over the long-term to ensure ecological and cultural areas are protected before large areas become developed. The criteria for the selection of lands for protected status includes consideration of a number of cultural, social and ecological factors and relies on political support at all levels of government, but also relies on good communication with communities and leadership in areas covered by land claims to ensure that critical cultural and ecological areas are considered for protection.

Figure 5.3-12
Map of Established Protected Areas in the NWT

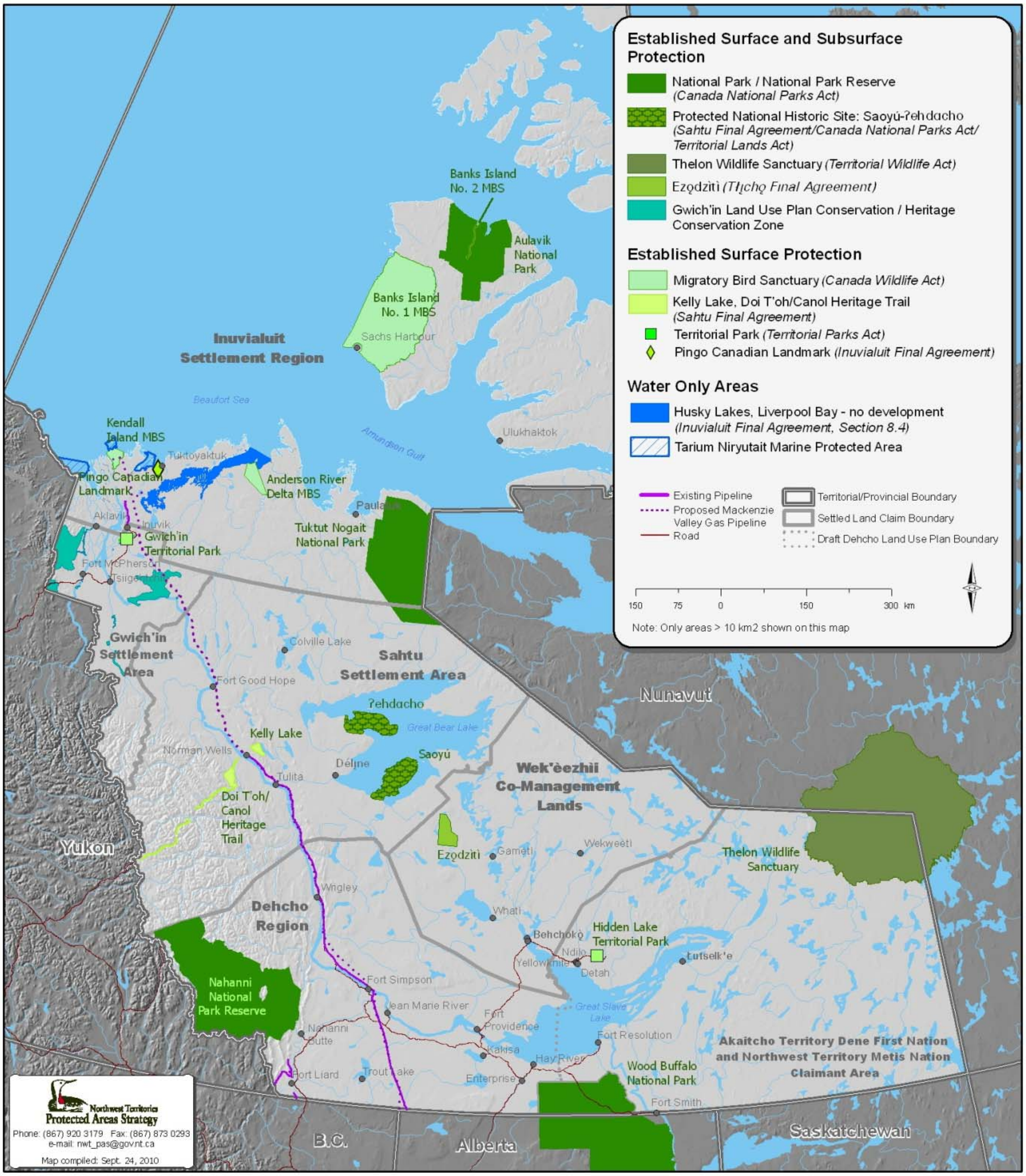
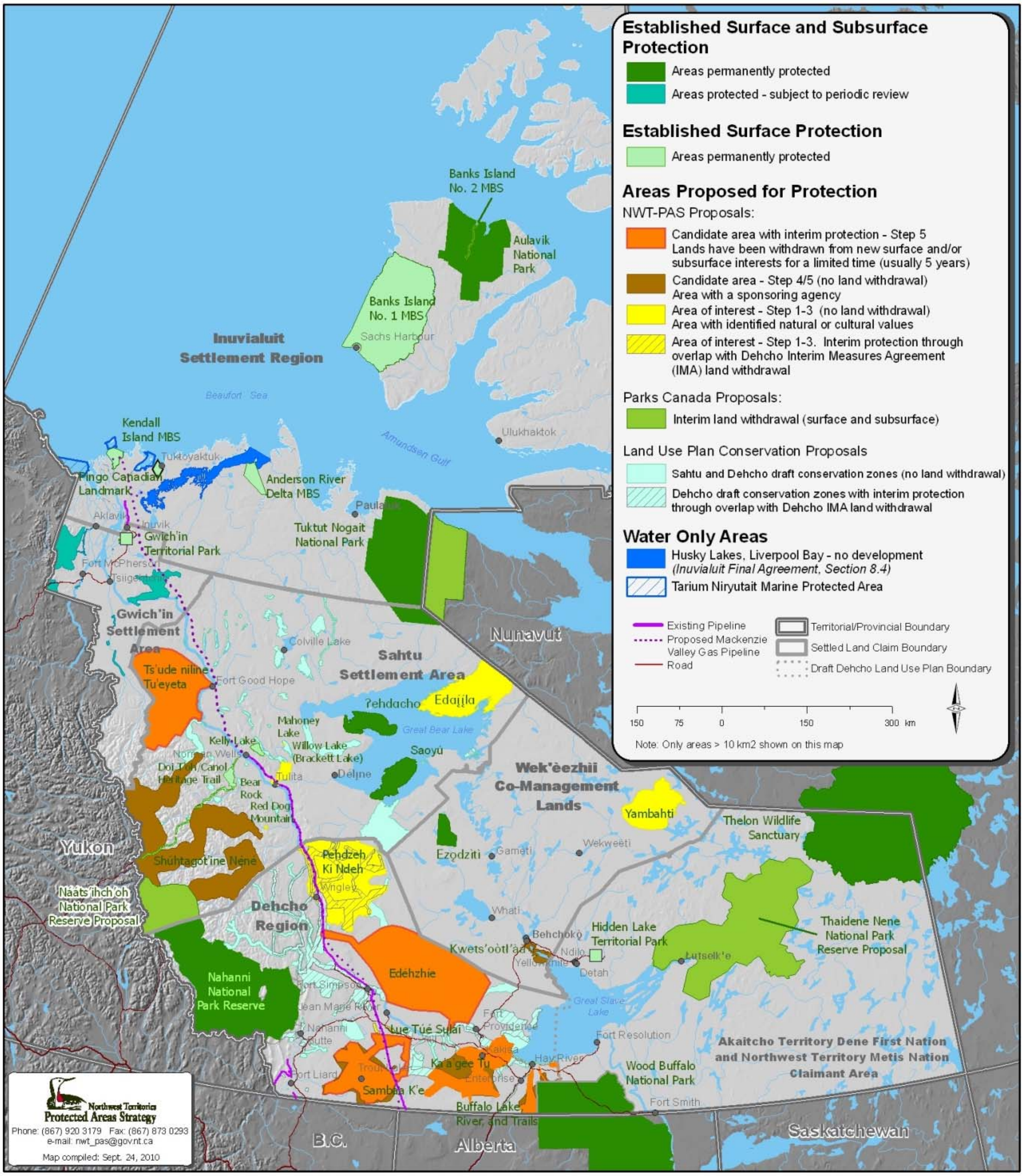


Figure 5.3-13
Map of Established, Interim And Proposed Protected Areas



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6.0 PERMAFROST, GROUND ICE AND SNOW COVER

6.1 INTRODUCTION

The uniqueness of the NWT is that a large part of it is underlain by permafrost and it is difficult to access large parts of the territory. Many communities and resource projects in the NWT depends on winter roads for fuel, construction material and non-perishable supplies and movement of heavy machinery etc. that are dependent on permafrost and ice covers over rivers and lakes. More than 50% of the permafrost is classified as sporadic and discontinuous which represents fragile permafrost terrain. Given the importance of permafrost conditions in the NWT, it was selected as a Valued Component (VC) warranting separate investigation in the SOE. Three VCs adopted by the NWT CIMP Working group are: permafrost, ground ice and snow.

Permafrost as defined by the International Permafrost Association (first defined by Everdingen 1998) '*Ground (soil and rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years'* provides limited information on the many factors that determine its physical characteristics. Permafrost distinguishes the NWT from provinces south of the 60^{th} latitude because perennially frozen ground underlies the majority of its area and climate warming is impacting its physical properties. Climate (air temperature) is the primary factor determining the occurrence of permafrost and the intensity of landscape-forming processes (Dyke and Brooks 2000). However, the air temperature impact on permafrost is modified by a buffer zone (Luthin and Guymon 1974) consisting of snow cover, vegetation and organic layer at the surface and the mineralogy and water/ice content of the ground. The sum of these elements determine the permafrost ground temperature regime and the annual thaw (active) layer at the ground surface. The distribution of the buffer zone components and the sensitivity of permafrost to climate warming was addressed by Smith and Burgess (2004).

The NWT CIMP Working group classification was modified to consider permafrost as an umbrella description of the surface condition and to discuss permafrost VC under the indicators of permafrost conditions: air temperature, ground temperature, ground ice and snow cover. Brief observations on the active layer are also given in this document. It is suggested that this be considered as a separate VC in future NWT CIMP studies.

Because the NWT covers a large area, there exists a large climate variant from the south to the north. Two major climatic zones, the Arctic and Subarctic, divide the NWT at the tree line into two almost equal parts. The Arctic zone is associated with tundra vegetation. Here the summer may bring only a few warm days. With such short summers, tree growth is not possible. Precipitation is low; often less than 100 mm, and most of it occurs in the summer. A Subarctic climate prevails over the remainder of the NWT, particularly in the Mackenzie Valley. This climate is characterized by much longer and warmer summers. Precipitation is sufficient to support a boreal forest; a northern forest consisting of pine, spruce, fir and larch.

Climate, as given by air temperature, is the primary factor determining the occurrence and properties of permafrost. Its narrow definition, namely; 'ground that remains at or near 0°C for at least two consecutive years', does not portray its physical characteristics. It is necessary to employ ground temperatures to define the state of permafrost and to appreciate how close the permafrost at given locations is to thawing. Ground temperature also provides engineering properties for the design of infrastructures founded on permafrost. The ground temperature in turn is predominantly governed by air temperature. In most general terms, the near surface ground temperature is about 4°C warmer than the air temperature (Johnston 1981, Smith & Burgess 2000 and Holubec & D'Uva 2011).

Herein ground temperatures considered are at near surface (less than 15m depth) and identified as the mean annual ground temperature. The stability of natural slopes, roads, infrastructures, and mine embankments are normally governed by physical stability of the near surface permafrost. It is noted that the ground temperature in the upper 5 to 10m varies greatly throughout the year reflecting the air temperature changes. It also has to be noted that near surface mean annual ground temperatures are influenced greatly by proximity of large water bodies and the buffer zone components mentioned earlier.

The vastness of Northern Canada, including NWT, its varied terrain factors and climate changes challenges the portrayal of ground temperatures across NWT. The first presentation of ground temperature regime in Canadian permafrost region was provided by R.J.E Brown (1963). This was followed by Hegginbottom (1984) work that produced a permafrost and ground ice condition map that has been published in several National Atlas of Canada in 1995 (Hegginbottom *et al.* 1995). The ground temperatures were measured at different years and ground temperatures at sites adjacent to water were included. Ground temperature data for Northern Canada were updated by Smith & Burgess in 2000. Since 2000 NRCan and others have collected considerable amount of ground temperature data along the proposed Mackenzie Valley Gas pipeline located near the Mackenzie River for most part and several locations in Yukon, northern Manitoba and Quebec and the Arctic Islands (Smith *et al* 2005, Smith *et al* 2008, Smith *et al* 2009, Lipkovsky & Yoshikawa 2009, Burn & Kokelj 2009, Kanigan *et al* 2009, Burn & Zhang 2009, Smith *et al* 2010a, Smith *et al* 2010 etc being some of the publications. Most of these measurements are in natural undisturbed terrain. Ground temperatures in disturbed terrain has been collected by mines since about 1990 and reported in environmental assessment reports and annual geotechnical inspection reports submitted to the Water Boards. Limited ground temperature information are available from settlements. Many of these are for one time measurements and one time readings. Recently Public Works and Services of NT has been requesting ground temperature measurements to be taken greater depths (15 to 20m) for at least over one year.

To provide clarity to status of present mean annual ground temperatures across Northern Canada, that includes NWT, and how these may be impacted by future climate warming, Holubec & D'Uva (2011) considered ground temperatures from near surface depth to estimate mean annual ground temperatures. These were then scaled a common year, 2008. Ground temperatures from sites near major water bodies were not used. This study included analysis of historic and present mean annual air temperatures since air temperature is the major parameter influencing the ground. Furthermore, the air temperature changes over the last 30 years provide indications as to how the ground temperatures may increase over the near future.

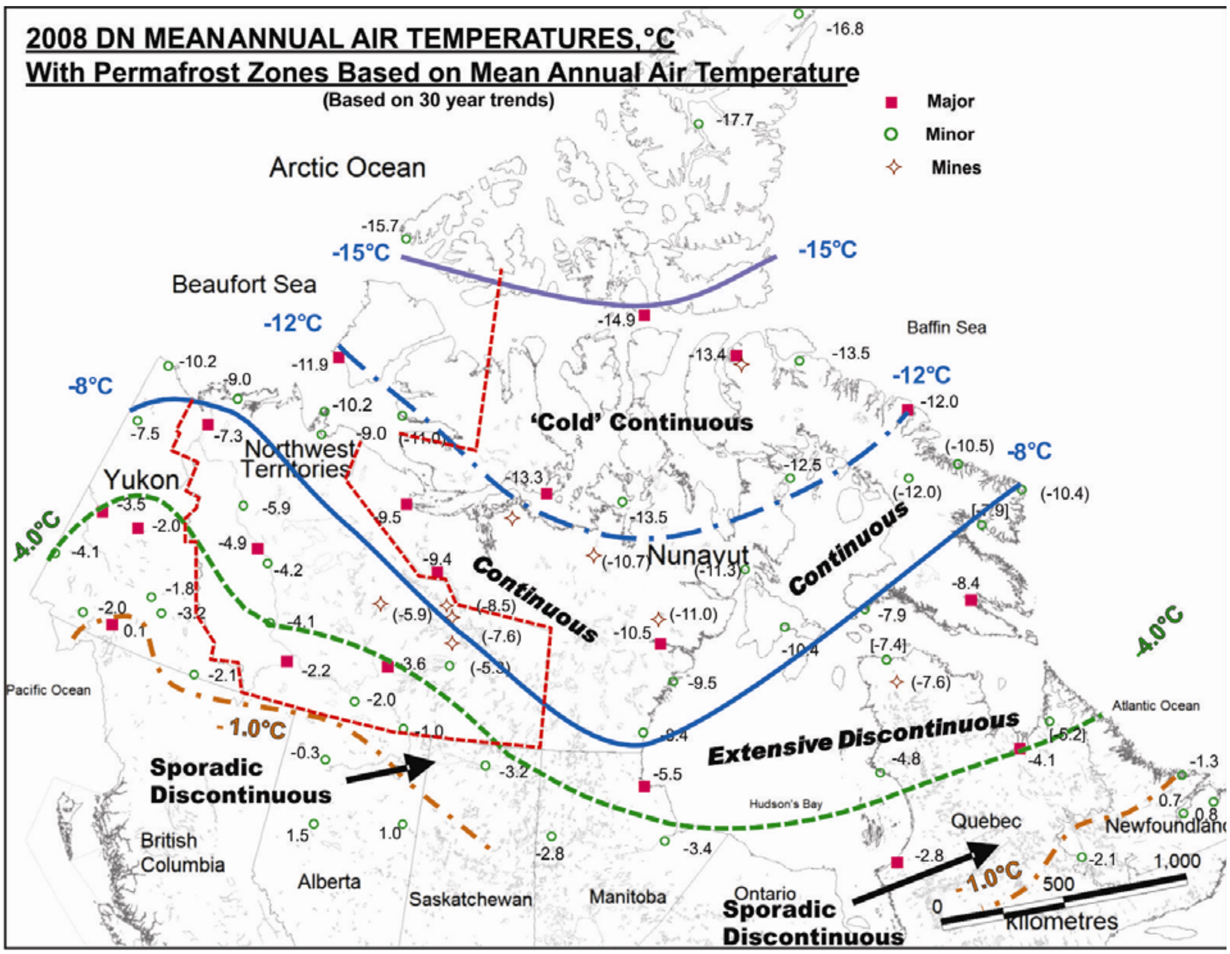
6.1.1 Background

There are better and more detailed records of historic and present air temperature than ground temperature measurements. It is suggested that since air temperature is the most significant parameter influencing ground temperatures, it can be used to portray the permafrost conditions in NWT in broad terms.

Johnston (1981) suggested mean annual air temperature (MAAT) values that describe the permafrost as sporadic discontinuous, extensive discontinuous and continuous. He suggested that: a) the southern limit of permafrost coincides roughly with -1°C MAAT; b) the zone between -1°C and -4°C experiences limited permafrost (sporadic discontinuous); c) the zone between -4°C and -8°C experiences increasingly widespread and thicker permafrost (extensive discontinuous); and, d) continuous permafrost is located north of -8°C. A cold continuous area represented by MAAT colder than -12°C was added to Johnston descriptions. The four permafrost zones based on 2008 MAAT are shown in Figure 6.1-1.

As illustrated in Figure 6.1-1, about half of NWT, the southerly portion, is underlain by extensive to sporadic discontinuous permafrost and the northerly half is underlain by continuous and cold continuous permafrost. The sporadic to discontinuous permafrost conditions in the southern half of NWT have design implications for infrastructure, dams and waste encapsulation facilities that are built on, or rely on, permafrost. As stated by Smith and Burgess (2004): '*About half the present permafrost region in Canada contains permafrost at a temperature greater than -2°C and models suggest that most of this could ultimately disappear in response to climate warming*'.

Figure 6.1-1
Permafrost Conditions Based on 2008 Mean Annual Air Temperatures
(Holubec & D'Uva 2011)



Warming and eventual thawing of permafrost will have significant impact on the natural and human environment. As early as 2000 Aylsworth *et al* (2000) and Dyke (2000) identified the increase of landslides in the Mackenzie valley and adjacent to mountainous and coastal regions. This concern has also been expresses Azelton and Zufelt (2008) and Natural Resources of Canada by Lemmen and Warren (2004, 2007). There have been numerous papers written on the instability of infrastructure and transportation components across polar nations, some of these are: Krustalev (Russia 2003), Instanes (Norway 2008), US Arctic Research Commission (US 2003), Shur and Goering (US 2009), instabilities of waste ponds, mine wastes, landfills, dams, etc. (Furgal and Prowse 2007) and finally emission of methane gas from thawing peat deposits (Kirpotin and Maruand 2006 Mongabay 2008. Some of these impacts are already being experienced in permafrost regions and these will continue and possibly increase as permafrost keeps warming and eventually thawing.

Some of the impacts on the population and resource industry due to permafrost warming and eventually thawing in NWT may be as follows:

- Denying access to about half the NWT population by winter roads and supplies to mines that depend on ice roads;
- Jacking and settling of infrastructure foundations; resulting in physical damage;
- Instability and settlement of road embankments;
- Seepage and instabilities of water reservoirs and sanitary lagoons located on frozen ground;
- Endanger stability of dams;
- Rescind permafrost encapsulation of closed and rehabilitated mine, radar site and municipal waste deposits; leading to contaminant release; and,
- Increase erosion of covered wastes leading to contaminant release.

The impact of climate warming on permafrost warming and thawing in the southerly NWT region has to be considered in the NWT CIMP for reasons given in the next four sections.

6.1.2 Natural Environment in the Southern NWT

The southern NWT is sensitive to climate warming as the mean annual ground temperature at it is near zero degree Celsius and it is more vegetation, especially swamps and peat deposits. Any physical disturbed readily leads to thawing and physical instability and greenhouse gases emission will increase as the permafrost thaws. A typical peat bog in these ecozones is shown in Figure 6.1-2. The greatest vegetation cover is found in the three Taiga ecozones.

The warming of permafrost terrain in this region is prone to thaw settlement, slope instability and increase in erosion in predominantly ice rich ground that is concentrated along the Mackenzie Valley drainage basin within the Interior Platform. The instabilities along the Mackenzie River banks that are already occurring are likely to increase (see Figure 6.1-3). This will increase the river sediment concentrations and imperil any infrastructures located near river banks.

Figure 6.1-2
Peat Bog in NWT

Source: http://gsc.nrcan.gc.ca/surf/yellowknife/images/

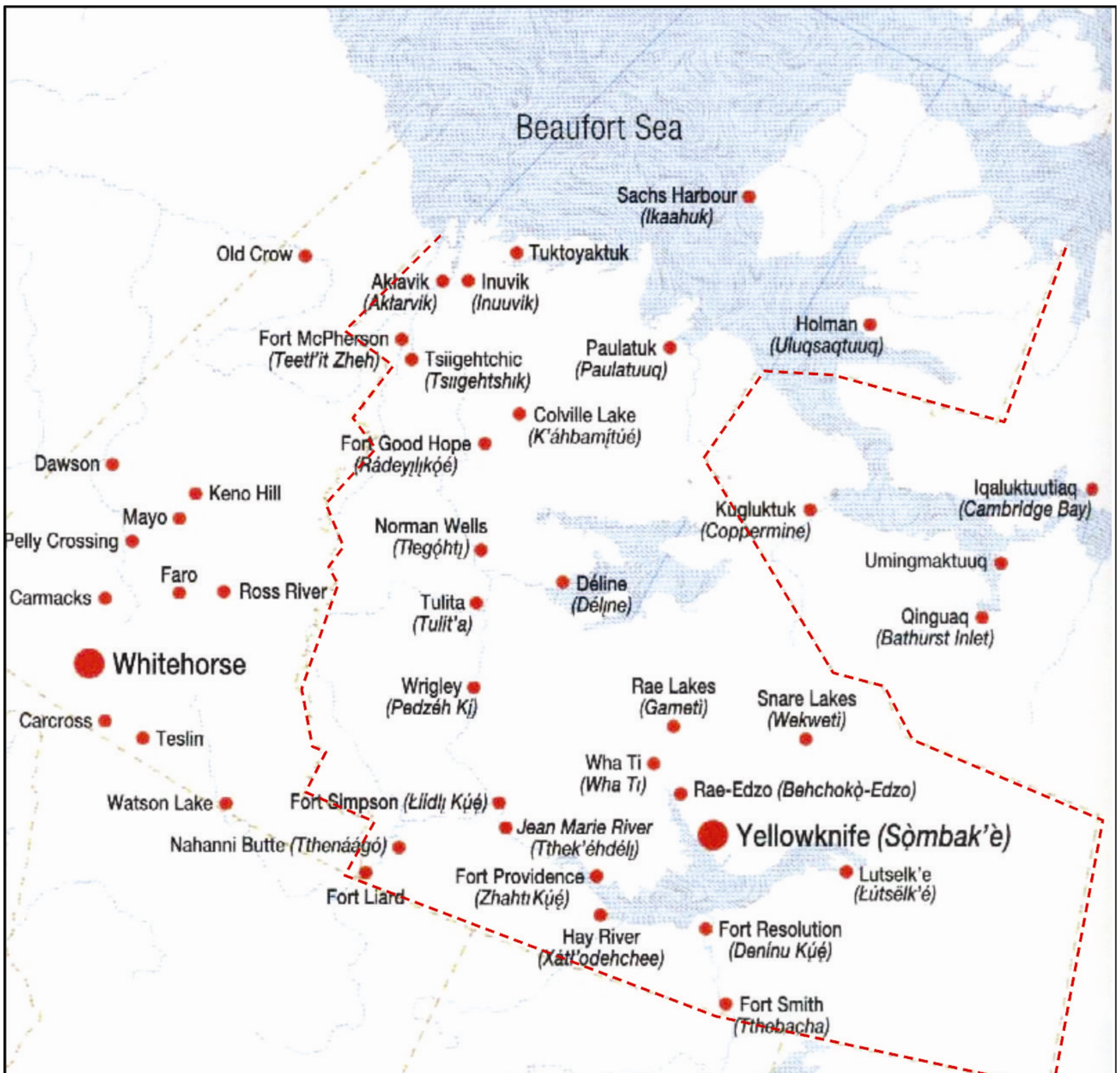
Figure 6.1-3
Landslide along the Mackenzie River Between Norman Wells and Tulita, NWT

(Smith & Burgess 2004)

6.1.3 Anthropological Environment in Southern NWT

The size and intensity of infrastructure in the NWT is a function of the distribution of communities and the size of their populations (Figure 6.1-4). Based on NWT Bureau of Statistics[3] (2007), the NWT has a population of 42,637 distributed in 33 communities. Of these, there are 5 communities with populations greater than 1,000 with the remainder having populations between 100 and 1,000 (communities with less than 100 are not listed).

Figure 6.1-4
NWT Communities (Northern Contaminants Program 2003)



3 (http://www.stats.gov.nt.ca/population/population-estimates)

With the exception of three small communities, the remaining NWT communities are located in zones that are experiencing extensive climate warming and have sporadic permafrost. The three northerly communities and the communities with populations greater than 1,000 are identified in Table 6.1-1.

The three most northerly communities have more benign ground conditions, have smaller infrastructures because of smaller populations and will most likely not be impacted in the near future by climate warming because of the colder permafrost conditions.

Table 6.1-1
NWT Northern and Largest Communities (2007)

Community	2007 Population
Communities in Continuous Permafrost	
Sachs Harbour	130
Ulukhaktok (Holman)	406
Paulatuk	324
Communities in Extensive and Sporadic Permafrost	
Yellowknife	19,155
Hay River	3,651
Inuvik	3,420
Fort Smith	2,400
Behchokǒ (Rae-Edzo)	2,016
Fort Simpson	1,264

Source: NWT Bureau of Statistics, 2007

6.1.4 Resource Industries

Major resource industries in NWT are oil and gas extraction and transportation (petroleum resources) and mining (mineral resources). The big environmental impacts created by the petroleum industries are the exploration phase and the construction and the operation phases. In the mining industry the biggest environmental impacts are the construction and operation phases and the then closure phase. Most proposed, existing and closed projects are located in the southern NWT with most of them in the extensive and sporadic permafrost zones. Because of their location in the southern NWT zone, they have the greatest potential to create environmental impact caused by climate warming and loss of permafrost in the near long-term.

The best source of historic, present and potential projects is the NWT Geoscience Office[4] in Yellowknife. An overview of these projects is given in Principal Mineral Deposits & Petroleum Resources of the NWT map (Irwin and MacFarlane 2005). What is of interest in this map is that it shows that the principal mineral and petroleum projects are concentrated in several areas. In a simplistic overview, it can be said that the mineral deposits and projects are located in the eastern NWT of the Bear, Slave and Churchill Provinces (Canadian Shield) and the western NWT in the Cordilleran Oregon Province. The concentration of the resources in specific regions makes it easier to identify likely environmental impacts and provide general guidelines for monitoring for each of these areas.

6.1.5 Impact of Climate Warming on Permafrost in NWT

The southern half of the NWT where the majority of the communities and mineral and petroleum industries are located has fragile permafrost that will warm or thaw within next the 30 to 100 years, depending on location within the NWT. Regional projections given by the IPCC AR4 for North America (IPCC 2007. "Climate Change 2007: The Physical Science Basis", *Working Groups I and III, Summary for Policymakers,* Cambridge University Press, Intergovernmental Panel on Climate Change, 2007) indicate that climate warming near the end of this century north of 60ºN latitude across Northern Canada may range from a median of 4.3ºC to a high of 7.4ºC (projection from 1980-1999 period to 2080-2099 period). This is supported by Natural Resources Canada work "From Impacts to Adaptation: Canada in a Changing Climate 2007"[5] (Lemmen, Warren & Lacroix 2008).

Similar observations were obtained by studying the historic air temperature changes across Northern Canada (Holubec & D'Uva 2011). This document shows historic climate warming over the last 50 years for various locations across Northern Canada. The historic climate warming rates for mainland NWT over the last 50, 30 and 20 years ending in 2008 are given in Table 6.1-2.

Table 6.1-2
Historic Climate Warming Rates over the Last 50, 30 and 20 Years

Region	MAAT warming rates, °C /decade to 2008		
	50 years	30 years	20 years
Northwest Territories	0.51	0.56	0.61

[4] www.nwtgeoscience.ca
[5] http://adaptation.nrcan.gc.ca/2007/

The historic climate warming rate increases in the NWT over the last 50 years have been smaller than Central and Eastern Northern Canada (Holubec & D'Uva 2011) but they still show increases with time. It has to be noted that mean annual air temperatures over small a span of years, 10 to 20 years, are influenced by single years records and that for even 30 year records there are significant variations of warming rates within a large region, such as the NWT. This also reflects on the mean annual ground temperature records and warming rates of permafrost. Considering these complexities, it is still of interest to view how the permafrost regions may change with time considering the broad air temperature/permafrost boundaries suggested by Johnston (1981) mentioned in Section 6.1. Predicting the likely permafrost changes over time based likely air temperature changes appear to be the best method at this time because there are insufficient historic ground temperature changes with time available.

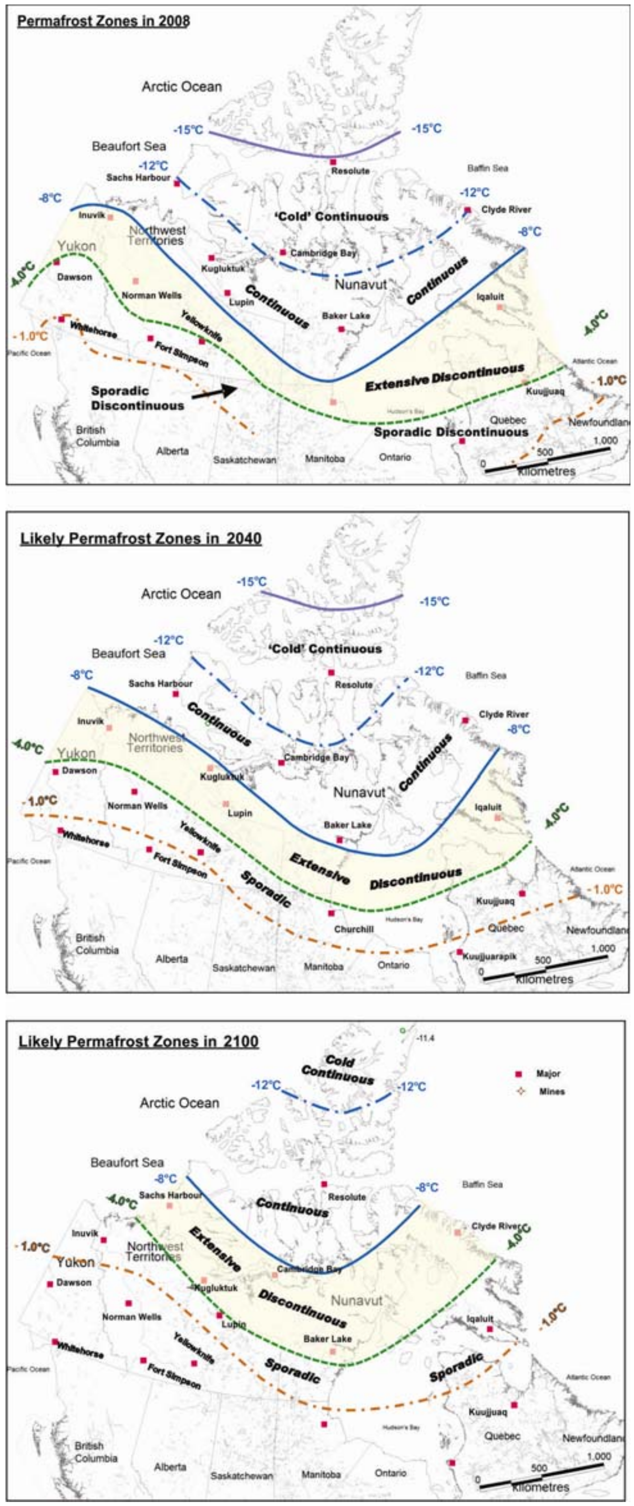
Based on recent historic warming rates (Holubec & D'Uva 2011) and Johnston's (1981) suggested permafrost boundaries based on air temperature criteria. The changes of permafrost regions in the NWT were estimated using the 25 year recent historic climate warming rates. Likely permafrost zones in years 2040 and 2100 are depicted in Figure 6.1-5. Figure 6.1-5 indicates that the boundary between sporadic and extensive discontinuous permafrost will be moving north by 50 to 60 km per decade, which will result in all of mainland NWT being either in the sporadic or extensive discontinuous permafrost by 2040 and practically all of mainland NWT being in sporadic permafrost by 2100.

The above predictions are based on the assumption that the climate warming rate will be constant for the next 92 years to 2100. The average climate rate of 0.58°C per decade may be low considering that climate models for the North by Frugal and Prowse (2007) showed median and high warming rates of 0.6°C to 1.25°C per decade respectively. This means that the warming and thawing of permafrost in NWT could advance faster as illustrated in Figure 6.1-5.

6.1.6 Ground Temperatures in NWT

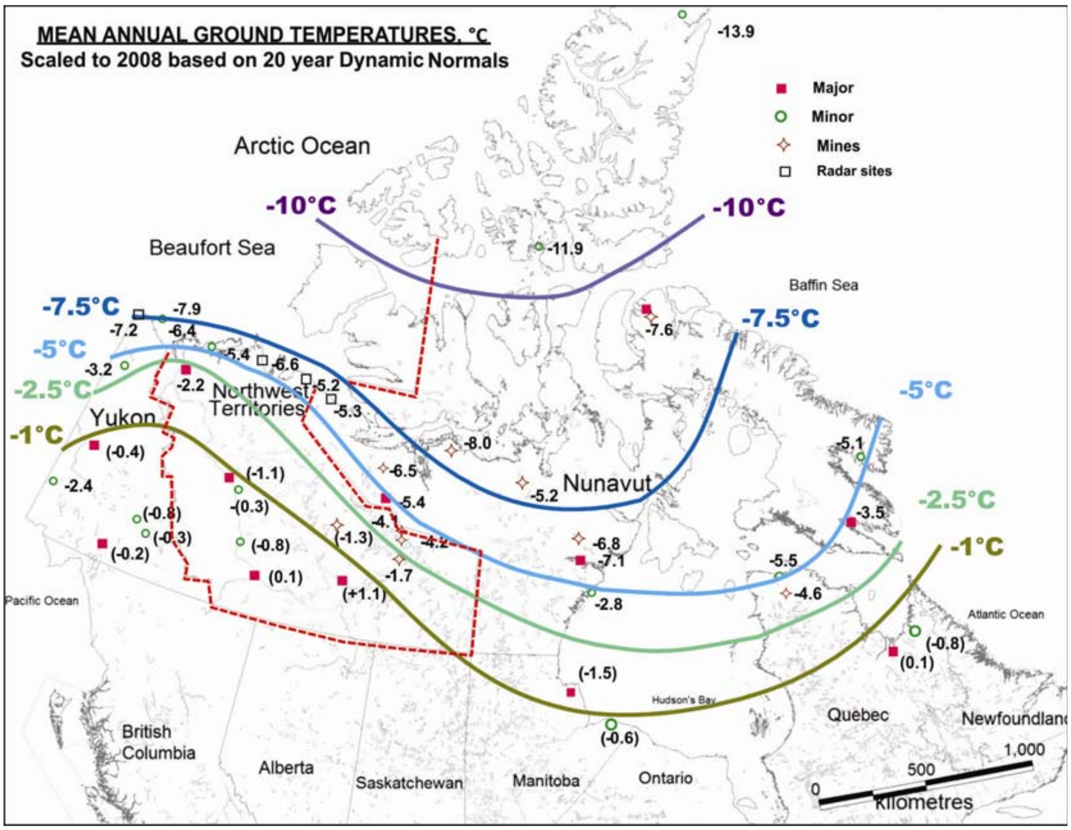
The perilous state of permafrost in mainland NWT as illustrated by permafrost zones, interpreted from mean annual air temperatures, in Figure 6.1-5 are confirmed by available mean annual ground temperatures scaled to 2008 shown in Figure 6.1-6. In this figure the zone between ground isotherms of -1 to -2.5°C can be considered as being in the extensive discontinuous permafrost and the zone south of the -1°C isotherm as being in the sporadic permafrost. Ground temperature values in brackets indicate frozen ground temperatures in local areas; surrounded by unfrozen zones.

Figure 6.1-5
Predicted Changes of Permafrost Zones with Time Based on Mean Annual Air Temperature Increases and Constant Climate Warming Rate (Holubec & D' Uva 2011)



In Figure 6.1-6, ground temperatures measured in or scaled to 2008 indicate that most of the NWT mainland where the majority of population resides and most of the mineral and petroleum resources are located is already in a critical state where any warming will raise the ground temperature above design criteria for infrastructure foundations, reservoirs and municipal, petroleum and mine closed waste facilities depending on permafrost presence may have significant environmental impact.

Figure 6.1-6
Ground Temperatures in NWT as Measured or Scaled to 2008
(Holubec & D'Uva 2011)



6.2 PERMAFROST AND SUBCOMPONENTS

6.2.1 Ground Temperature

Introduction

Ground temperature is the main parameter that determines the stability of natural terrain and human earth structures in permafrost. It determines frozen ground engineering properties and indicates how close the frozen ground is to melting. The ground temperature is especially needed for ice rich frozen soils and fractured bedrock with ice.

The remoteness and the harsh cold environment of the NWT delayed the development of the NWT until about the 1940's. The desire to tap into the oil resources of Norman Wells to supply fuel for Alaska, start of gold mining in Yellowknife and the construction of the Early Radar Warning system was the start of the permafrost and collection of ground temperature data. This was led by the Division of Building Research, National Research Council (NRC), Canada. Results of these were presented in the proceedings of the Canadian Permafrost Conferences, first one held in 1962 (Brown 1963) and numerous NRC publications. The first comprehensive study of mean annual air and ground temperatures in the permafrost regions of Canada was presented at the Proceedings of the 1st Int'l Permafrost Conference in Indiana, U.S. by Brown (1963).

A major compilation of permafrost data and scientific, engineering design and construction information was provided in the text book, Permafrost, Engineering Design and Construction sponsored by the Associate Committee on Geotechnical Research, NRC in 1981 (Johnston 1981). The lead in the collection and analyses of permafrost data and dessimating information was transferred to the permafrost scientists in the Natural Resources of Canada, Geological Survey of Canada. This group has published their results in GSC Bulletins, Open Files, and scientific Journals and Conference Proceedings.

The measurement and study of the ground temperature in permafrost up to about the early 1980's was oriented towards understanding the physical processes in permafrost regions and improve the design of roads, infrastructures and resource industry physical components. The interest in ground temperatures in permafrost has increased to assess and design adaptive measures for the rise of ground temperatures due to climate warming.

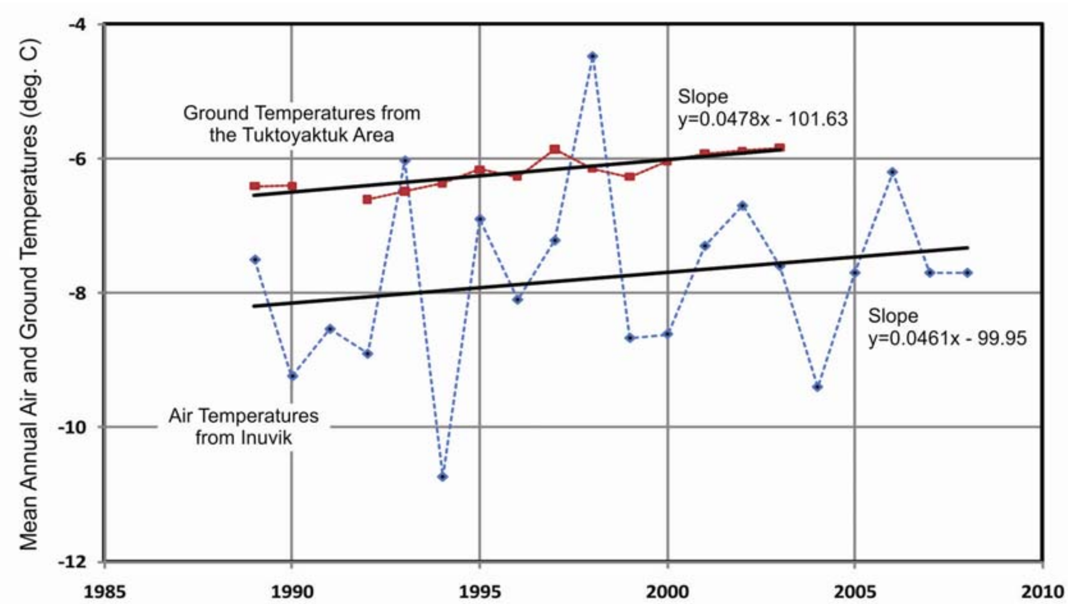
Where is it being measured?

Ground temperature is being measured in the NWT by four project proponents/groups: proponent of the Mackenzie Gas Project; new and operating mines, communities; university researchers and, the Geological Survey of Canada. Geological Survey of Canada being the largest source of ground temperature data. The greatest concentration of ground temperature measurement locations is along the proposed Mackenzie River gas pipeline route as can be seen by numerous recent publications (Smith *et al* 2005, Smith *et al.* 2008, Burn & Koklj 2009, Kanigan *et al* 2009, and Smith *et al* 2010a.

What is happening?

The rate of ground temperature change is highly variable and can be quite different than the change in air temperature especially in warmer permafrost of the discontinuous zone. Rates of ground temperature change range from no discernible trend for warm permafrost in southern NWT to small changes in central NWT of < 0.3 °C per decade to changes on the order of 0.5°C per decade in the colder permafrost of the tundra. Trends for NWT have been presented in Smith *et al*. (2005) and updated in Smith *et al*. (2010). An example of change in colder permafrost is shown in Figure 6.2-1 with air and ground temperatures from Inuvik and Tuktoyaktuk. Tuktoyaktuk ground temperature is the mean observations from two sites at the Involute Hill reported by Smith *et al* (2005).

Figure 6.2-1
Ground and Air Temperature Rise in Northern Mainland of NWT Illustrated By Tuktoyaktuk Data



Both air and ground temperatures in Tuktoyaktuk are warming at a rate of about 0.5°C per decade. Considering the ground temperature in most of mainland NWT is at or above -2°C, this warming of permafrost in mainland NWT is expected to have a significant effect on both the natural and anthropological environments.

What are the information gaps?

Large amount of data has and is being collected along the Mackenzie valley; especially along the proposed Mackenzie valley pipeline route. Most of these measurements were taken in undisturbed terrain with vegetation and organic layer. This data is important for studying how climate warming and resulting permafrost warming and progressive thawing will disturb the natural environment. Data are also needed for disturbed areas in communities, and physical structures constructed by resource industries.

- Larger effort should be made to measure, collect and analyze ground temperature from disturbed ground; such as communities, and resource projects. Many communities lack any ground temperature records.

- Majority of ground temperature records from mines are measured at dam locations which are not representative of disturbed ground with little or no vegetation. Water Boards should require present and new mines to install reference ground temperature thermistors.
- Longterm ground temperatures should be measured at representative communities and major resource projects.
- Present permafrost mapping provided in the Atlas of Canada is based on ground temperatures measured over a wide number of years, the earliest being 1966, and with the latest being 1990. Map showing the present condition should be prepared.

What is being done about it?

Several organizations have recognized the lack of data and uniform standard ground temperature information and have sponsored projects to enhance present and future ground temperature data collection. Ground temperature measurements and permafrost studies are by being sponsored by various government departments (NRCan, Federal Government sponsoring of the International Polar Year, Natural Sciences and Engineering Research Council, etc., Governments of Nunavut and Northwest Territories, several universities, resource industry etc. The need for obtaining ground temperatures for the design of infrastructures and resource projects has been recognized by NRCan who has started to sponsor collection of ground temperature monitoring in communities and Government of Northwest Territories (GNWT). Two documents that are on GNWT Public Works and Services web site http://www.pws.gov.nt.ca/publications/ are:

- Geotechnical Site Investigation Guidelines for Building Foundation in Permafrost that provides guidance to install sensors and measure ground temperature; and,
- 2008 Present and Historic Air and Ground Temperatures across Northern Canada.

6.2.2 Active Layer

Introduction

Active layer is *The layer of ground that is subject to annual thawing and freezing in areas underlain by permafrost* (Everdingen 1998). Its magnitude and annual changes are influenced by the same climatic and terrain factors that affect the permafrost and interact in a complex manner (Johnston 1981). As a result its depth varies greatly from as low as 0.4m in undisturbed terrain with thick organic layer and high ice content permafrost (Smith *et al* 2009) to as high as 9 to19m in bedrock (Holubec 2011). In general terms there are two different active layer depth regimes and these are of interest for two different reasons.

Great amount of study work of the active layer has been done in the undisturbed permafrost areas along the Mackenzie valley for the pipeline route and hydrocarbon development. Information presented by Shiqiang Ye (2005) and Smith *et al* (2009) indicate the active layer depth varying from 0.35 m in northern NWT mainland (Tuktoyaktuk) to greater than 2m in the south in Fort Simpson. Greater active layer depths have been observed in areas with little no vegetation and little water/ice at the surface. These areas are common in communities, dams, resource plants and mine infrastructures and mineral waste disposal areas. For example, the active layer in disturbed areas in dam abutments and at the former tank at Colomac mine were observed to be 9 m and 19 m respectively (Holubec 2011).

What is happening and what does it mean

The active layer is responding to climate warming similar to the mean annual ground temperature. However, occurring at the ground surface, the air temperature changes over a year have a much greater impact on the active layer than they have on the mean annual ground temperature.

Both the active layer thickness in the undisturbed vegetated regimes and the disturbed with little or no vegetation are of interest for two different impacts. These are of interest for two different environments.

The magnitudes and changes of an active layer thickness is of interest in the study of how climate warming will impact the natural environment. Changes/increase of the active layer due to climate warming will increase the erosion, solifluction and instability of natural slopes. The changes/increase of active layer in the human environment will decrease the stability of infrastructure foundations, likely increase the seepage of reservoirs and decrease or eliminate the protective layer over mine and municipal wastes.

What are the information gaps

There is a lack of active layer thickness for low or no vegetated natural and human earth structure permafrost ground.

What is being done about it?

Information should be collected and analyzed of the active layer for low or no vegetated natural ground and human earth structure permafrost ground. This could be obtained from future ground temperature monitoring in communities and data submitted by projects to the Water Boards. Also information could be solicited from consultants who have ground temperature data measured for one year or more of projects they have worked in the past.

6.2.3 Mean Annual Air Temperature

Introduction

An important factor governing the presence of permafrost and its properties is air temperature. There is a general correlation of ground and air temperatures with the mean annual ground temperature being about 4°C warmer than the mean annual ground temperature. However, there is regional variability in the range of change in ground temperature and also the variability of ground temperature within an area under similar air temperature conditions.

The greater coverage of air temperature monitoring stations with good data being taken according to standards at regular frequency of measurement is available at the following website: http://www.climate.weatheroffice.ec.gc.ca/. This source provides suitable data for approximating ground temperature and for assessing how ground temperature has changed over time.

What is happening and what does it mean?

Climate warming, and hence permafrost changes in NWT, are reported to be occurring at a much greater rate in Northern Canada than elsewhere in North America or globally. The National Oceanic and Atmospheric Administration states that the past several decades have been the hottest on record and the first six months of 2010 may result in 2010 being the warmest year in recent history.

Should the rate of climate warming increase then permafrost warming and thawing may occur at a much earlier date than currently anticipated.

What are the information gaps

Environment Canada weather office has been shutting down some of the climate stations in Northern Canada, including NWT and delaying and reducing the publishing of detailed climate information. In the past the weather office published historic hourly, daily and monthly air temperatures. Lately, some of the station records are missing the monthly, and in some instances even the daily records.

Climate information for the eastern part of the NWT is lacking. It could be supplemented with climate data collected by mines operating in this region.

Furthermore, the climate normals used for design purposes are provided in terms of average values over a 30 year period. These are published every 10 years and appear in print 3 years after the last year of record. As a result the climate information may be as much as 28 years out of date.

6.3 SNOW

6.3.1 Introduction

The presence and depth of snow on the ground affects both the natural and anthropological environments. As far as the natural environment is concerned, snow cover affects: the mobility of animals and as a result their availability of their food source; permafrost ground temperature; the volume of spring runoff; reflection of radiation, etc. As far as the anthropological environment is concerned, snow cover affects travel by snowmobiles for hunting; transport of supplies by winter road to remote communities and mine sites, and other outdoor activities.

Major information sources for NWT are the collection of data by Environment Canada weather office[6] and the Snow Survey data prepared by the Water Resource Division of INAC[7] .

What is happening and what does it mean?

Historic changes of snow depth measured at the end of February from about 1950 to 2000 were shown by Dyke and Brooks (2000). Six stations along the Mackenzie valley showed decrease of snow depth with time in the 5th northern station and nearly constant at Fort Smith that is the most southerly station in NWT. Projections to the end of 2080's differ with the historic information. Projections of precipitation during the 2100 century suggest that precipitation by the 2080's will increase about 30% in NWT (Furgal & Prowse 2008). Larger increases will be in the winter months and the total increases will the largest in northern NWT.

Of interest to the northern communities in NWT is the availability of snow for transportation. This is indicated by snow depth, duration of snow and snow cover extent. Atlas of Canada provides three maps that illustrate the snow cover over NWT[8]. The three maps are: Average Maximum Snow Depth (see Figure 6.3-2), Median Start Date of Continuous Snow Cover and Median End Date of Continuous Snow Cover. These maps illustrate:

- Average maximum snow depth ranging from 30 to 49cm for most of NWT; large depths occur around Great Slave Lake and Mackenzie River Delta.
- Median start date of continuous snow begins in September across the islands, first half of October in northern NWT mainland and second half of October in southern NWT mainland.

[6] http://climate.weatheroffice.gc.ca/advanceSearch/searchHistoricData_e.html?timeframe=1&Prov=XX&StationID=9999&Year=2008&Month=8&Day=26
[7] http://nwt-tno.inac-ainc.gc.ca/wrd/SWE2008tab.txt
[8] http://atlas.nrcan.gc.ca

- Median end date of continuous snow cover ranges from early May in the south to early June in the islands.

Brown *et al* (2010) found that there is a close relationship between the cysphere and surface air temperatures. Their analyses show that there is a correlation between the air temperature in June over the period of 1979-2008 and the snow and ice covers.

Climate warming will likely shorten the period that snow will cover the ground surface and may also change snow depth in the Northwest Territories. Knowledge of historic changes in snow cover is limited because of the scarcity and low number of snow measurements over a long period and the difficulty climate models have in predicting future snow changes. It is likely that these difficulties are due to the lack of cloud cover information during the winter and the rapid changes of the Arctic Sea ice cover.

Vincent and Mekis (2006) indicated that the annual snowfall precipitation and the snow to total precipitation ratios have increased in most parts of the NWT over the period of 1950 to 2007. However, this information is from only three climate stations for the annual snow precipitation and covers over a period during which the air temperature changes from 1950 to 1975 experienced an anomaly. Furthermore Vincent and Mekis' work is primarily related to the overall changes occurring across Canada and may not accurately show the changes in the NWT.

It is worthwhile to view the distribution of: a) annual mean total precipitation (mm); and, b) average maximum snow depth (cm) for the period of 1971 to 2008 provided by Atlas of Canada shown on Figures 6.3-1 and 6.3-2, respectively. These figures show:

- Annual mean total precipitation varies greatly from the North to the South in NWT from a minimum (100 mm and less) in the Arctic Islands to a maximum of 601 to 800 mm) in the southwest along the mountains.
- Average maximum snow depth is in the range of 30 to 99 cm; with smaller depth in the Arctic Islands.

The great ranges of precipitation and average mean annual snow depth indicate that there is a need for more accurate data for site specific locations across the NWT. This is illustrated by the analyses of the precipitation and snow data for Inuvik and Yellowknife provided by Environment Canada web site. Precipitation and snow data plots from 1979 to 2008 for these two locations are given in Figures 6.3-3 and 6.3-4.

Climate data for Inuvik and Yellowknife show that there is considerable variation from year to year with the trend lines providing an indication of what is happening. The trend in the precipitation information given for Inuvik, NWT in Figure 6.3-3 shows a decrease in snow fall and an increase in rain over a 30 year period from 1979 to 2008; and total precipitation increased by 7% for the same period.

Similar analysis of the Yellowknife climate data shown in Figure 6.3-4 shows that both snow fall and rain increased over the 30 year period resulting in the total precipitation having increased 21% over the 30 year period.

Figure 6.3-1
Annual Mean Total Precipitation (Mm) For 1971-2008 Period

(Atlas of Canada 2009)

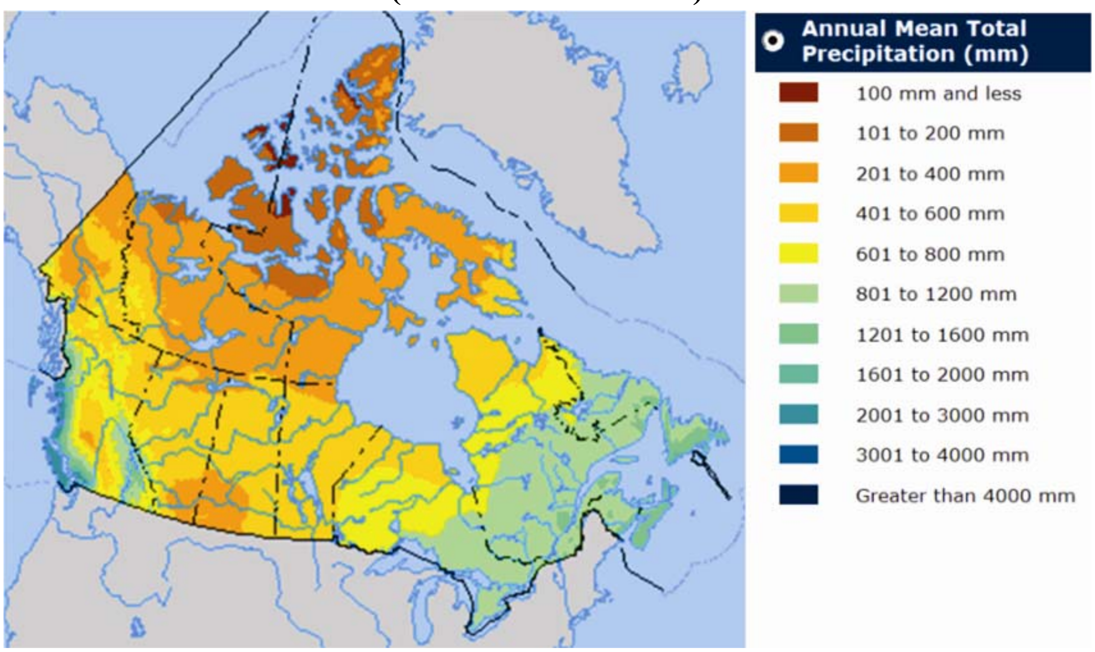
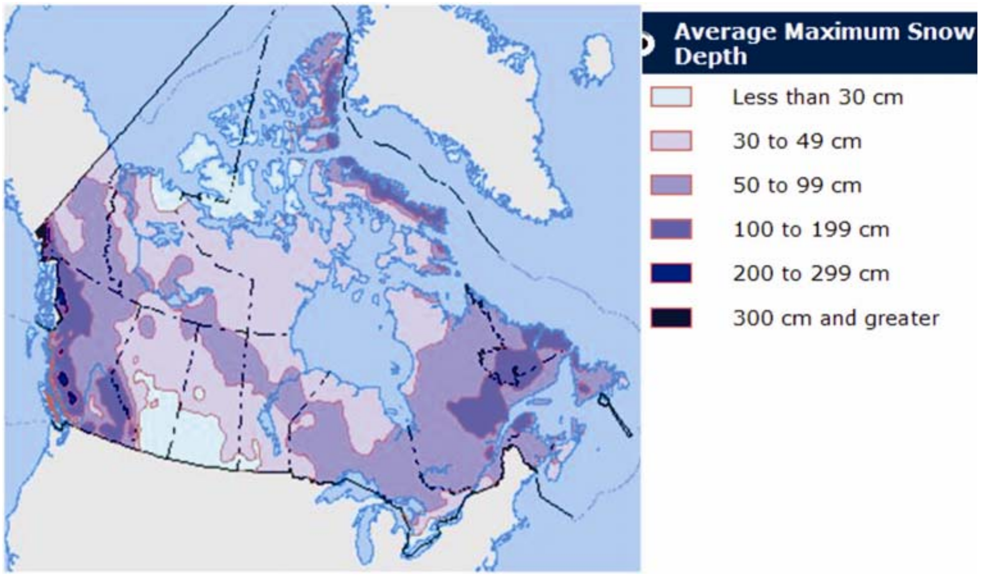


Figure 6.3-2
Average Maximum Snow Depth in cm for 1971-2008



Source: Atlas of Canada 2009

Figure 6.3-3
Mean Monthly Snow, Rain and Total Precipitation for Inuvik, NWT for 1979 to 2008

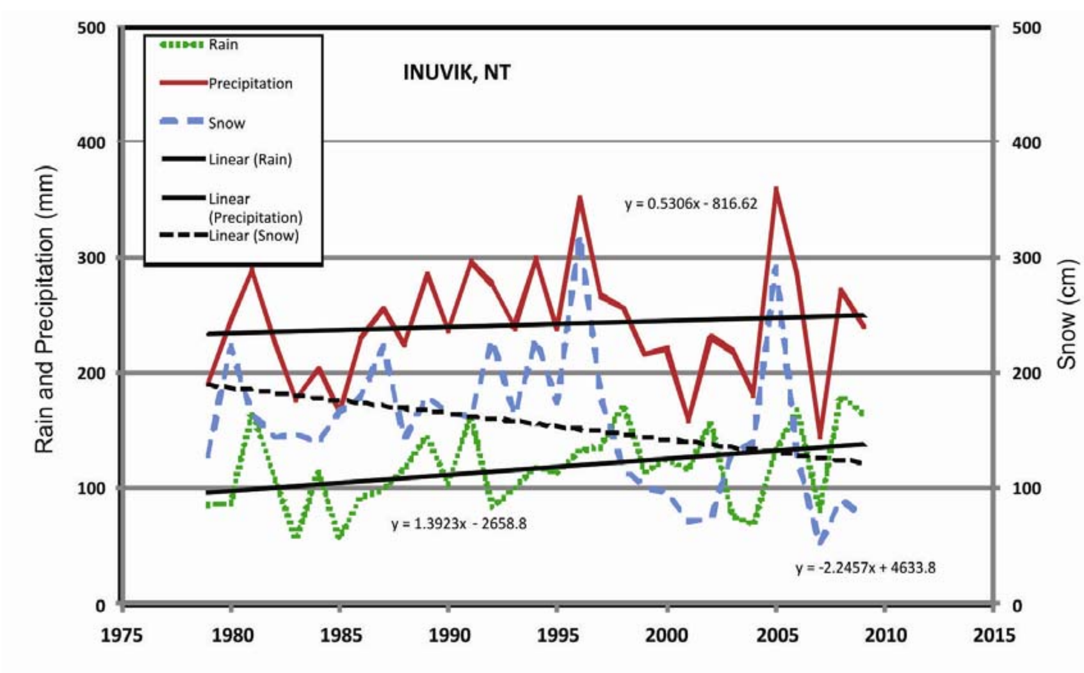
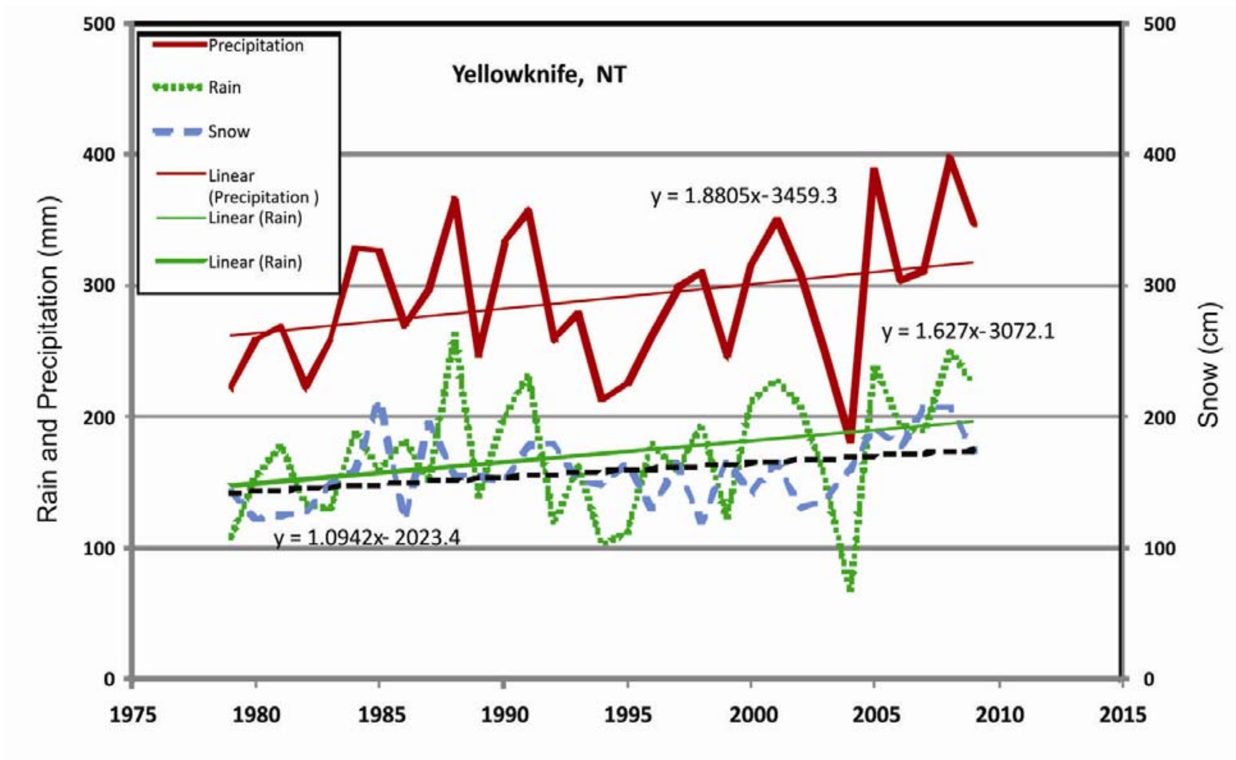


Figure 6.3-4
Mean Monthly Snow, Rain and Total Precipitation for Yellowknife, NWT for 1979 to 2008



Aside from the detailed information shown in the graphs, information that could be derived for Inuvik and Yellowknife representing 2008 are given in Table 6.3-1.

Table 6.3-1
Snow and Precipitation Trend Normals for Inuvik and Yellowknife, NWT

Totals for 2008	**Units**	**Inuvik,**	**Yellowknife**
Snow fall	cm	124	174
Snow in water equivalent	mm	112	122
Rain	mm	137	195
Precipitation	mm	249	317
Mean values for 1979 – 2008			
Mean snow depth on ground[1]	cm	45	31
Maximum snow on the ground	cm	116	61

[1] Mean values are the average monthly snow depths from end of November to end of March from 1979 to 2008.

It is suggested that this type of information may be needed to provide base line data and to understand future snow and precipitation changes that may occur in the NWT. Likely changes of snow cover are illustrated by simulations of future snow cover performed by the Canadian Cryospheric Information Network shown in Figure 6.3-5.

What are the information gaps

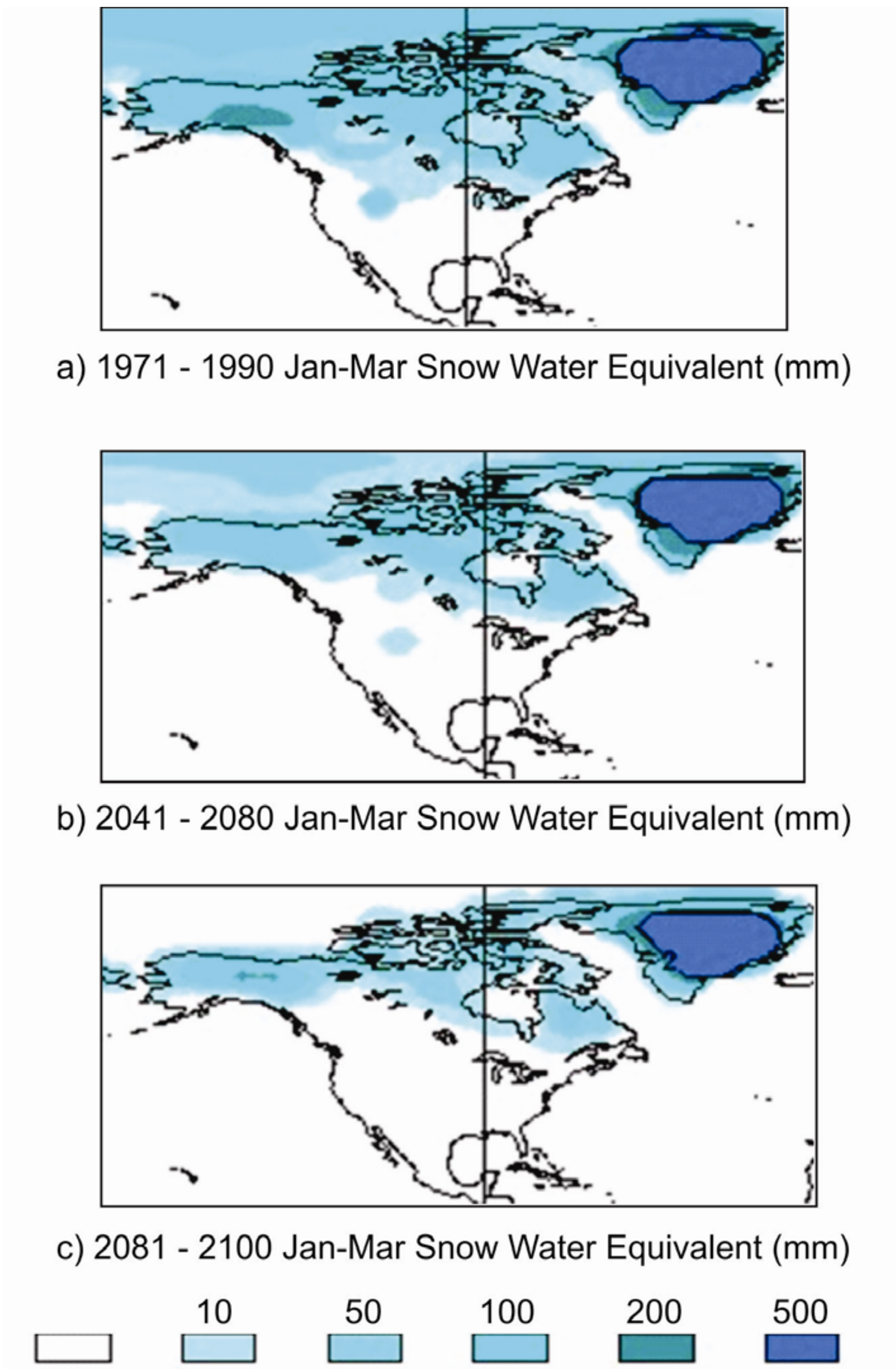
Change of snow cover with time due to climate warming will impact both the natural and anthropological environments in Northwest Territories. The term snow itself is inadequate to assess the impact of changes to the snow cover over the NWT due to climate change. To assess the impacts over time one should consider some of the following information: snow fall, snow depth and its density, start and end of snow cover and the extend of snow cover. The complexity of these suggest that as a first step an analyses of available information should be made and this can form base line information. Much of this information is already available. This needs to be combined in a logical format.

6.3.2 Recommendations

Snow cover is predicted to decrease rapidly during the next century, as illustrated in Figure 6.3-5; this will affect both the natural and anthropological environments. To address the current deficiency in snow cover measurements the following recommendations are made:

- CIMP should produce a base line report on the present and historic snow conditions in the Northwest Territories that is similar to “2008 Present and Historic Air and Ground Temperatures across Northern Canada” that will be available on the GNWT Public Works web page in the fall of 2011.
- Encourage the collection of reliable snowfall and snow depth data. This information is presently collected by the NWT INAC Water Resources Division and a number of Environment Canada climate stations. This collection should be increased to other EC climate stations and also be collected at operating mine sites.

Figure 6.3-5
Canadian Cryospheric Information Network Simulations of Future Snow Cover



Source: http://www.ccin.ca/cms/en/socc/snow/future.aspx

6.4 GROUND ICE

6.4.1 Introduction

Ground ice exists in frozen ground in voids within a soil matrix or fractures within bedrock or large ice lenses. Excess ice in voids or fractures or ice lenses may be detrimental to natural slopes or anthropological made structures (roads, airfields, buildings/plants and dams) as the frozen ground warms and eventually thaws.

Presence of ground ice is site specific and requires site specific geotechnical investigation accompanied by laboratory tests to determine the ice volume. The Geological Survey of Canada, Natural Resources Canada, has produced two maps that indicate regional ground-ice content of the upper 10 to 20 m of the ground and thermal response to warming maps that can be used as reference information for cumulative impact monitoring.

Likely ground-ice conditions in the Northwest Territories obtained from the Geological Survey of Canada Bulletin 548 (Smith *et al.* 2001) are shown in Figure 6.4-1. This map illustrates that medium to high ice content ground is found mostly in the mid to east northern area of the Northwest Territories. This information is expanded by GSC Bulletin 579, Sensitivity of Permafrost to Climate Warming in Canada (Smith & Burgess 2004) as illustrated in Figure 6.4-2.

What is happening and what does it mean?

Climate warming will impact areas with high ground-ice content. Locations in Northwest Territories underlain by ground with high ice content may experience natural environmental effects due to slope instabilities along rivers and valleys. At sites with manmade structures, the effects of climate change may result in instabilities in roads, airstrips, structures, dams and waste containment covers.

What are the information gaps?

There are no major information gaps in this valued component. The Geological Survey of Canada has identified the general areas with likely high ground ice content and areas that will be most adversely impacted by climate warming. The remaining information needed is site specific that has to be collected as need is determined. The site specific information will have to be collected by means of geotechnical site investigation programs. Guidance for these investigations can be obtained from "Geotechnical Site Investigation Guidelines for Building Foundations in Permafrost" (Holubec 2009) available on the GNWT Public Works and Services web site http://www.pws.gov.nt.ca/publications/index.htm.

Figure 6.4-1
Ground-Ice Conditions in North Western Canada from GSC Bulletin 548 (Smith *et al* 2001)

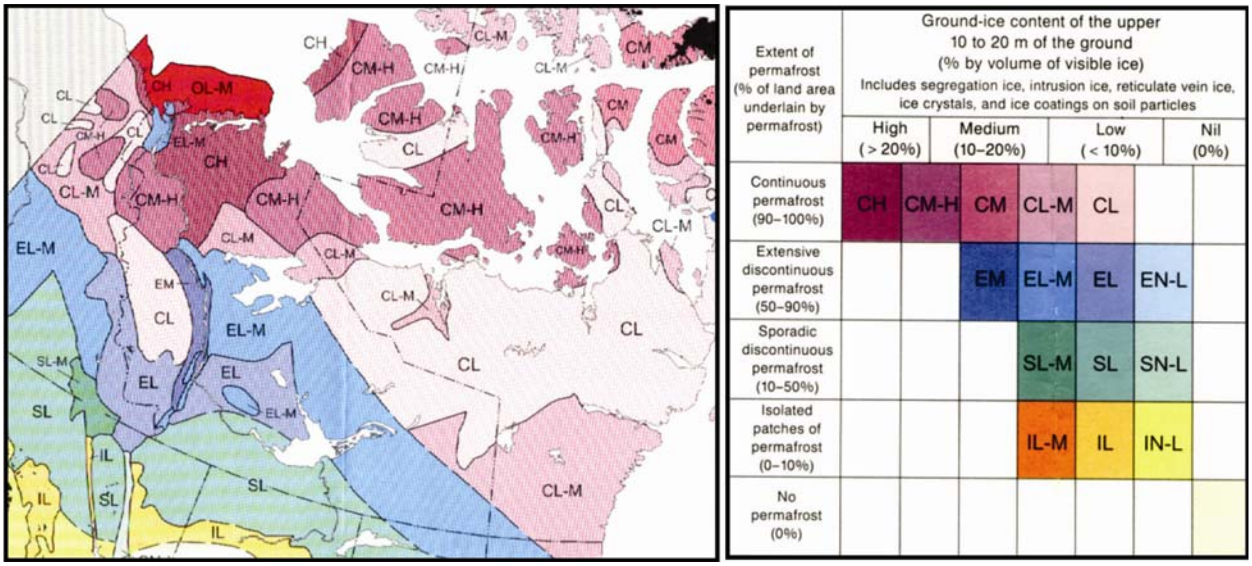
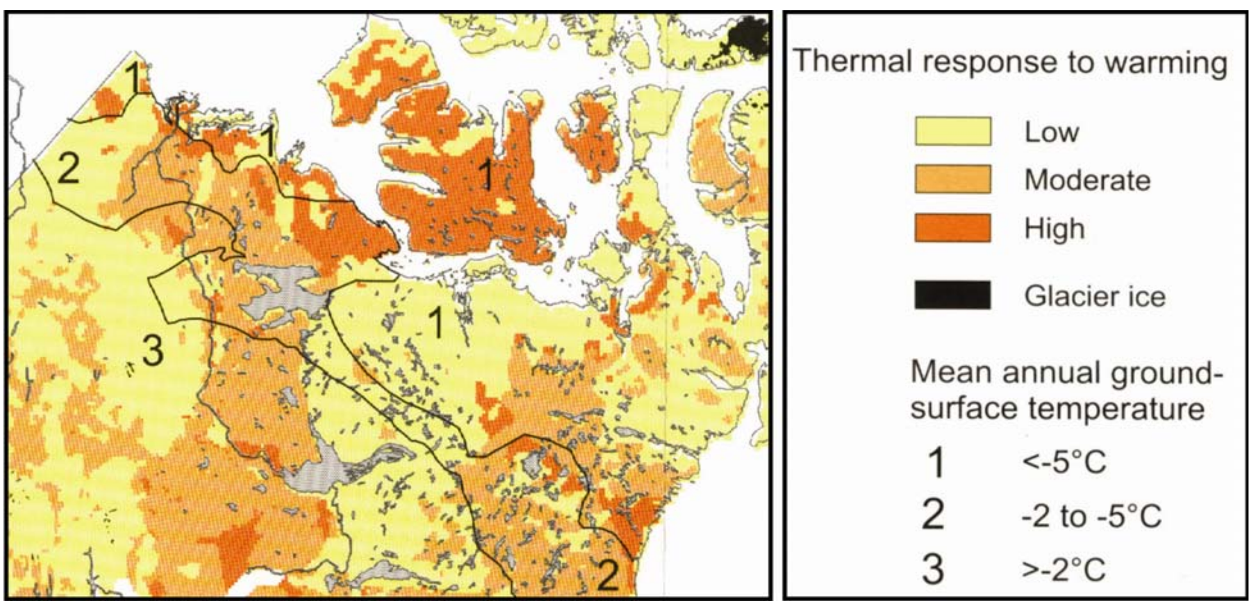


Figure 6.4-2
Relative Thermal Response of Permafrost to Climate Warming from GSC Bulletin 579 (Smith & Burgess 2004)



6.5 RECOMMENDATIONS

6.5.1 Overview

The NWT has varied and complex geology and permafrost conditions that are and will continue to be impacted by climate warming. It is vital that the CIMP have good baseline information that can be used to evaluate changes to the environment that may be produced by climate change and anthropogenic activities.

It is difficult for one organization, such as the CIMP, to produce baseline information in numerous areas. Fortunately, much of this information is already available from the work of various other government departments.

6.5.2 List of Recommendations

It is recommended that the CIMP concentrate on the following areas:

1) There need for long-term support for baseline permafrost monitoring. Although a great deal of effort over the past few years has resulted in an enhanced permafrost monitoring network, there is a lack of long-term commitment and resources to ensure ongoing network maintenance and data collection. The continued operation of the network is essential for adequate baseline characterization and to understand the natural permafrost conditions, including fluctuations in these conditions. This information is essential for identification of impacts associated with resource development projects and also for cumulative effects assessments.
2) Identify the sources from which base line information can be obtained and act as a portal for this information.
3) Prepare summary reports that depict the available information.
4) Prepare guidelines for monitoring and reporting information relevant to the NWT.
5) Sponsor or co-sponsor preparation of base-line information reports in areas that are lacking; such as the present and recent historic snow fall and accumulation.
6) Prepare annual reports on most recent research work in progress and that were recently completed.
7) Expand the present web data base.

Some government organizations are already collecting and publishing this information:

- Water quality and stream flow by INAC Water Resource Group.
- Permafrost group of the GSC is collecting ground temperature data.
- NWT Geoscience Office has records of all land use, exploration and project permits for mines and petroleum projects.

- GNWT Public Works has information on buildings, water reservoirs and municipal wastes in communities.
- GNWT Transportation Department has the location of all-year and winter roads.
- INAC Contaminant and Rehabilitation Directorate has identified all existing and clean mine and radar sites in the NWT.
- Water Boards collect large volumes of data annually from mines, energy companies and large projects.

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7.0 HUMAN HEALTH

7.1 INTRODUCTION

Human health exists as a continuum from fully integrated physical, emotional, spiritual and social functioning to complete dysfunction and death. Measures of human health vary with respect to how they will be used in order to improve a particular aspect of health status. Each measure is conceptualized with respect to how it will be implemented into programming to improve health.

This chapter updates the most recently available data for human health valued components and indicators first presented in the 2005 NWT SOE Report. As in the previous health valued components report, the focus is on measures of human health and its relationship to environmental quality. The World Health Organization (WHO) reflects on this relationship in its definition of environmental health and human health:

> *"Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations."*

In keeping with the WHO definition and the objectives of the NWT CIMP and Audit, the areas of human health which have been chosen for the human health valued components are those measures collected on the population through various data collection mechanisms (Statistics Canada and the NWT Bureau of Statistics). These measures of health are generally accepted as signals of disease occurrence and of risk factors affecting disease occurrence which potentially point toward assessing, correcting, controlling, and preventing adverse outcomes. In order to quantify these measures and to follow them in temporal sequence, statistical samples representative of the population must be collected on a regular and systematic basis. Collection of data on vital events (births and deaths), demographics (age and sex), and residence (geographic distribution) of the reported events, allows rates to be calculated and compared to referent population when appropriate. Data collection also involves the acquisition of information on acute and chronic diseases occurring throughout life stages, as well as on the important determinants of health (e.g., income, education, employment, health care events and access) which have a significant impact on the expression of specific health states in the population. Self perceptions of health and well being are important, and these are now covered within this report.

7.2 HUMAN HEALTH INDICATORS

The provision of health services in the NWT is the responsibility of the Government of the Northwest Territories. In 2009, approximately 43,000 people live in the Northwest Territories. Aboriginals compose about 22,000. About 45% of the population lives in Yellowknife census agglomeration area (i.e., 18,700 of 41,464) based on the 2006 NWT Community Profile based upon the 2006 census.[9] The remainder of the population is spread amongst twenty eight other communities, several of which have no outside road access during most of the year. Trends in the components of population growth from 2001 to 2009, migration patterns, births and deaths, are provided in Table 7A.1-1 (Attachment 7A).

As demonstrated in Figure 7.2-1, approximately 2,000 more males than females reside in NWT. The relative proportions have remained fairly consistent since 1996 but the total population has been increasing since 2000 as seen in Figure 7.2-1. The number of aboriginal residents has increased steadily between 2000 and 2009 while the number of non-aboriginal residents grew sharply between 2000 and 2004 and then levelled off (Figure 7.2-2).

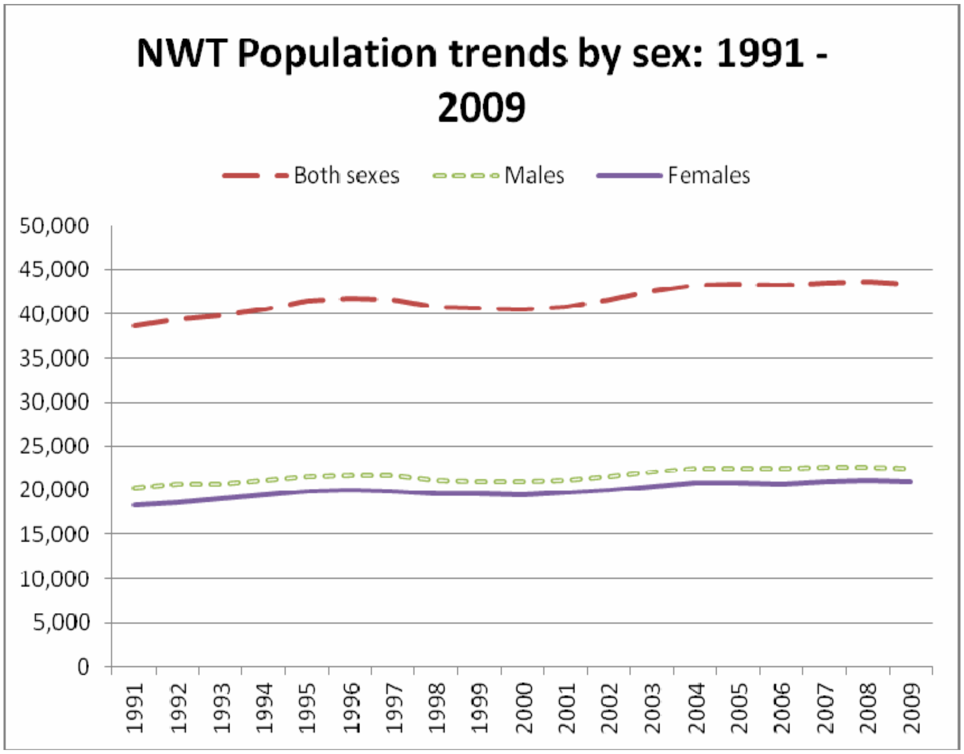
The list of potential indicators (measures) of the human health valued component (VC) was presented in the NWT SOE 2005. Information was gathered from a literature search of the medical and social sciences literature as well as an Internet search. Interviews were also carried out with key informants (health specialists) knowledgeable about the data collection and reports on the NWT. No new interviews were conducted for this report and previously collected information was used to organize more recent data.

Similar data collection and population size issues remain and are discussed with relevant data displays. There were areas of data collection distinctly missing. While data for sexually transmitted infections (STIs), suicides, and teen pregnancies are available by community for the NWT, Stout and Kipling (1999) note examples of missing data; disability and injury prevention, early pregnancies, mental health status, and attitudes towards sexuality and reproduction. Some of these still remain an issue for future resolution but data on mental health (self perceived) is now available and presented further on.

A summary of the potential indicators and the rationale for their selection is provided on Table 7.2-2. Some of the chosen indicators are illustrated as examples of how particular health outcomes can be followed over time to determine health status in the population, and by inference, the potential impact of the environment on the population. Among the potentially useful indicators, only those with the most useful data records are discussed in Section 7.2.

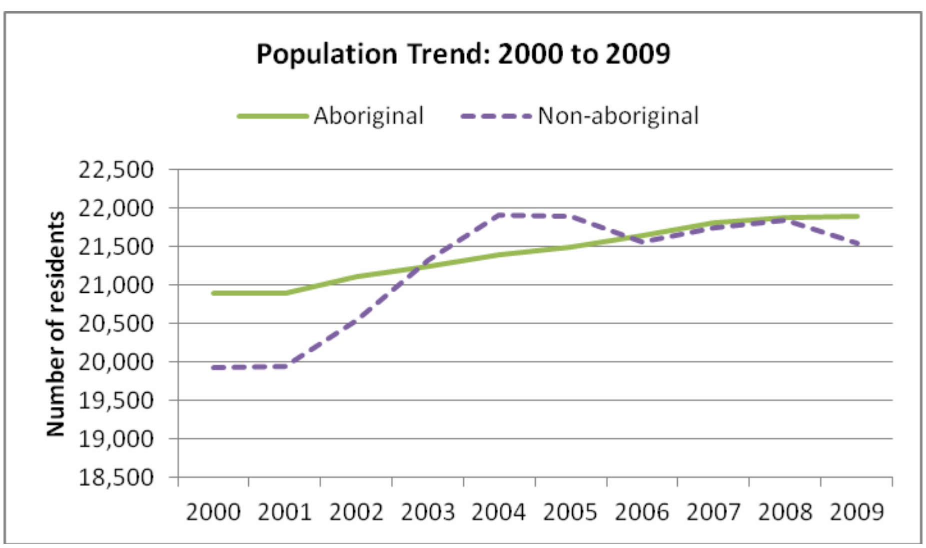
[9] http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CMA&Code1=995__&Geo2=PR&Code2=61&Data=Count&SearchText=Yellowknife&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=&GeoCode=995 (accessed June 17, 2010)

Figure 7.2-1
Population of Northwest Territories by Sex, 1991-2009



Source: NWT bureau of statistics

Figure 7.2-2
Aboriginal and Non-Aboriginal Population of Northwest Territories, 2000-2009



Source: Northwest Territories Bureau of Statistics

Table 7.2-1
2009 Population Estimates By Age, Sex, and Aboriginal Status

Population data					
Sex	**Both sexes[1]**	**Males[1]**	**Females[1]**	**Aboriginals[2]**	**Non-aboriginals[2]**
1991	38,724	20,372	18,352		
1992	39,416	20,680	18,736		
1993	39,820	20,712	19,108		
1994	40,578	21,093	19,485		
1995	41,432	21,544	19,888		
1996	41,741	21,731	20,010		
1997	41,625	21,674	19,951		
1998	40,802	21,191	19,611		
1999	40,638	21,050	19,588		
2000	40,480	20,950	19,530	20,893	19,929
2001	40,844	21,141	19,703	20,897	19,947
2002	41,665	21,587	20,078	21,118	20,547
2003	42,561	22,086	20,475	21,238	21,323
2004	43,301	22,455	20,846	21,395	21,906
2005	43,399	22,565	20,834	21,498	21,901
2006	43,198	22,476	20,722	21,639	21,559
2007	43,545	22,606	20,939	21,808	21,737
2008	43,720	22,655	21,065	21,869	21,851
2009	43,439	22,476	20,963	21,889	21,550

Sources:

[1] Statistics Canada. *Table 051-0001 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted)*, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed: March 29, 2010)

[2] NWT bureau of statistics

Table 7.2-2
Rationale for Selection of Candidate Indicators of Human Health

Potential Measures of Human Health Component	Potential Indicators*	Rationale
Population Demographics	• Population data • Age/sex distribution • Migration (emigration and immigration) • Life expectancy • Potential years of life lost (PYLL)	• Essential for monitoring health of population change • Denominator data essential for deriving rates for comparison with other jurisdictions • Life expectancy reflects survival of population, improvement in life expectancy reflects improvements of determinants of health • PYLL is an index of premature mortality with more weight given to younger people
Perinatal Health	• Birth rates • Fertility rate • Birth weights • Birth Defects • Breast feeding rates • Infant mortality rate	• Birth/fertility rates are important indicators of the health of the population • Low birth weight reflects many complex factors, such as nutrition, prenatal care, age of mother, and others. • Infant mortality is an important measure of health of children • Breast feeding is associated with lower rates of enteric disease, allergies, and other illnesses in children later in life, so are a potentially a valued health component to follow.
Mortality	• Leading causes of death by age and sex • Death rates by age and sex • Causes of death by disease: - Cancer - Cardiovascular - Injuries/poison - Suicides/homicides - Others	• Rates and causes of mortality are important indicator of the heath status of the population • Cancer, cardiovascular diseases and injuries/poison are leading causes of death in the NWT

Table 7.2-2 (Cont'd)
Rationale for Selection of Candidate Indicators of Human Health

Potential Measures of Human Health Component	Potential Indicators*	Rationale
Morbidity	• Leading causes of morbidity • Causes of death by disease: - Cancer - Cardiovascular - Injuries/poison - Asthma - Diabetes - Depression - Infectious diseases - Sexually transmitted diseases - Others	• Rates and causes of morbidity are important health status of the population • Changes in the rates may be due to environmental exposures (e.g., changes in asthma may be due to environmental tobacco smoke, air pollution, others.) • The prevalence of diabetes is high among First Nations people
Social Determinants of Health	• Family size and composition • Percent of lone parent families • Dependency ratio • Employment rate • Percent of families with income less than $30K, more than $75K • Income • Education • Housing and community characteristics • Violent crime rate • Juvenile crime rate • NWT shelter admissions	• The notion that 'health is wealth' does not consider important social determinants which contribute to health such as food security, social networks, social exclusion and discrimination, poor housing, etc. Some of these determinants are related to wellness and social integration. The ones considered in this section are enumerated population measures in databases. • Socioeconomic status indicators (e.g., education/income etc.) provide a proxy measure of health status • Dependency ratio provides an estimate of burden of care on the working-age population.[10]

[10] Dependency ratio is defined as the population of those under 15 divided by the population age 15 to 64, multiplied be 100. More recently, dependency ratios for people 65 and over (the ratio of older people to working age people) have also been collected as the Canadian population ages and elder care becomes a significant dependency issue.

Table 7.2-2 (Cont'd)
Rationale for Selection of Candidate Indicators of Human Health

Potential Measures of Human Health Component	Potential Indicators*	Rationale
Personal Health Practices and Risk Factors	• Smoking rate • Youth smoking rate • Alcohol consumption • Substance abuse • Physical inactivity • Rates of consumption of country foods • Obesity	• Smoking is a major contributor to fatal diseases such as cancer, cardiovascular disorders, and others. • Age of smoking initiation is an important predictor of future behaviour. High smoking rates among youth may be indicator of high smoking rates in adulthood. • Heavy alcohol consumption is related to liver diseases and others, and is also often linked to other socio-economic indicators such as crime rates, violence and injuries. • Moderate level of physical activity is associated with good health. Conversely, physical inactivity is conducive to obesity which in turn is a risk factor for diabetes and other diseases.
Environmental Factors	• Drinking Water and Sewage disposal • Proportion of population with distributed potable water • Proportion of population with adequate sewage disposal	• Access to potable drinking water is related to waterborne disease. Availability of potable drinking water provides an appropriate level of prevention of the burden of waterborne disease morbidity and mortality. • Proper sewage disposal will prevent the contamination of the environment and particularly, of water sources used for drinking and bathing. Fecal transmissions of viral and bacterial infectious diseases are also prevented with proper waste disposal which is a measure of preventive practices in the community.

For general consistency with the presentation of material for the other valued components, the following questions are addressed for the key indicators of human health (population demographics, perinatal health and population mortality):

- What is being measured?
- What does it mean?
- What are the information gaps?

Whereas seven questions were addressed for other valued components, the list was reduced to three key questions for the key indicators of the human health valued component. As insufficient information is available to address other indicators in this manner, only a general discussion of the available information is presented.

7.2.1 HH Indicator – Population Demographics

Important trends in population demographics include total population and age distribution, life expectancy and birth rate.

What is being measured?

Data on population births, deaths including infant mortality, and life expectancy are available through Statistics Canada (Vital Statistics data base) and on-line for NWT via the Bureau of Statistics. These data are collected for the whole population and are considered of good quality. Although regional data is available, small numbers and high population mobility makes analysis at the regional level less meaningful. Infrequent events are reported as aggregated to the community being examined due to privacy issues. Some demographic data are also available by First Nations and non First Nations status.

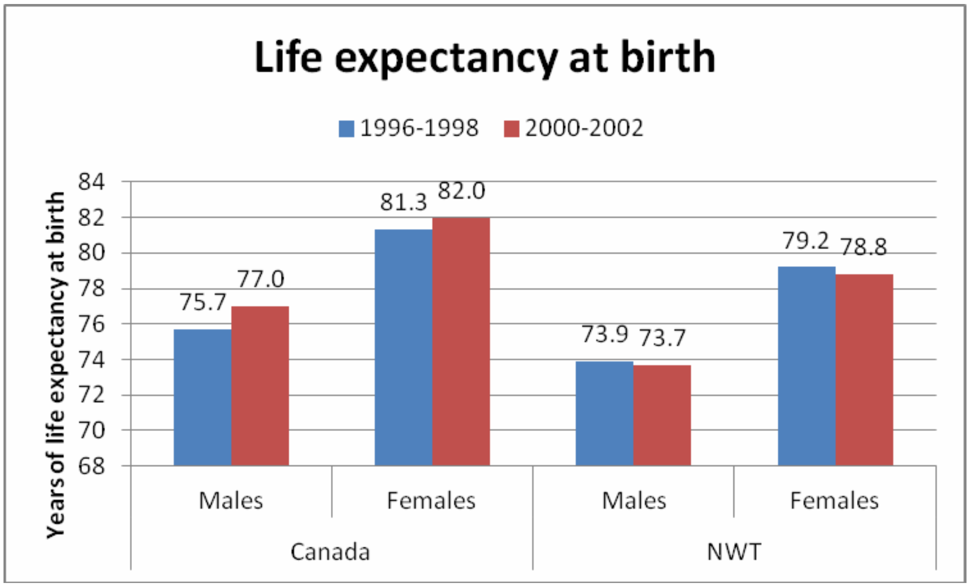
What does it mean?

Historically, birth rates in First Nations communities were higher than they are now, infant mortality was higher and life expectancy was lower than non-First Nations people. Improvements in life expectancy reflect improvements in infant survival, as well as improvements in determinants of health such as income, education, access to health care, and premature mortality due to accidents, better nutrition, etc. Improvements in infant mortality and reduced premature death (e.g., from accidents and suicide) will impact on life expectancy considerably.

For the NWT, life expectancy at birth compared to the rest of Canada is lower for both males and females (Figure 7.2-3). While life expectancy in males and females in Canada increased between 1996-1998 and 2000-2002, life expectancy in males and females in the NWT did not.

Data for 2000 to 2002, the most recently available, indicate that males in the NWT have a life expectancy that is 3.3 years less than males in Canada and that females in the NWT have a life expectancy that is 3.2 years less than females in Canada.

Figure 7.2-3
Life Expectancy at Birth, Northwest Territories and Canada, 1996-1998 and 2000-2002



Source: Statistics Canada. *Table 102-0218 - Life expectancy, abridged life table, by age group and sex, three-year average, Canada, provinces, territories, health regions and peer groups, occasional (years)*, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 1, 2010)

The life expectancy of Inuit in the NWT were estimated by analyzing mortality in communities where the population was more than 33% of the population identified themselves as Inuit in census data[11]. Life expectancy in communities in the Inuvialuit region of the NWT with more than 33% Inuit are shown in Table 7.2-3.

[11] Life expectancy in the Inuit-inhabited areas of Canada, 1989 to 2003. Russell Wilkins, Sharanjit Uppal, Philippe Finès, Sacha Senécal, Éric Guimond and Rene Dion. Health Reports, Vol. 19, no. 1, January 2009. http://www.statcan.gc.ca/pub/82-003-/2008001/article/10463/4149059-eng.htm#a2 (accessed March 31, 2010).

Table 7.2-3
Trends in Life Expectancy at Birth of Inuit in Northwest Territories by Sex, 1989-1993, 1994-1998 and 1999-2003

Period	Males	95% CL	Female	95% CL
1989-1993	68.0	64.7-71.3	79.2	74.9-83.5
1994-1998	66.2	63.1-69.3	73.1	69.8-76.4
1999-2003	68.1	64.4-71.8	73.1	70-76.2

In general, life expectancy at birth has improved among the Aboriginal population in Canada. In 2000, it rose to 68.9 years for males and 76.6 years for females, slightly lower than for the whole of the NWT population, an increase from 1980 of 13.1% and 12.6%, respectively (Health Canada 2003). Life expectancy at birth reflects many factors such as availability of health services, nutrition, quality of life and others. There is improvement is males life expectancy, while female life expectancy remained about the same as the prior period of comparison.

Expectancy of First Nations in Canada may have improved but these data say that the increase has stalled in Inuit in the NWT. The data indicates that among "Inuit communities", life expectancy did not increase between 1989 and 2003, for either women or men. In addition, the average life expectancy within Inuit communities has been almost 10 years lower than the Canadian average and 5 years lower than the NWT average.

Birth rates and death rates both contribute to population growth rate. Although the value of the natural rate of increase in population is affected by both birth rate and death rate, the recent history of the human population has been affected more by declines in death rates than by increases in birth rates.[12] Better nutrition, greater access to medical care, improved sanitation and more widespread immunization against childhood and some adult communicable diseases contribute significantly to this population growth, while decreases in infant mortality affect life expectancy at birth. Improvements in all of these factors, and data to monitor the changes, contribute to the evaluation of valued health components.

The total fertility rate (TFR) can be used as an estimate of the fertility growth factor in a population, i.e., whether the childbearing population is replacing itself or not. A TFR of 2 or above indicates that, on the average, couples are producing at least two children to replace themselves. When the TFR exceeds 2 for an extended period, the next generation of childbearing age will probably be larger than the present population of that age if all other factors affecting the population, such as death rates and migration, remain constant. This means that the population will be growing steadily from within. In 2002 the fertility rate among Aboriginal

[12] Human Population Growth http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Populations.html

women under 29 years of age in the NWT was nearly double that of the Canadian Aboriginal average. In 1999, the First Nations birth rate was 23.0 births per 1,000 females, two times the comparable rate for Canada. Births to women under age 19 were high in the NWT including First Nations. Over half (58%) of First Nations women who gave birth in 1999 were under 25 years of age. This represents an area of importance to follow over time as improvements in education, employment and other determinants are associated with lower birth rates in this age group and may be considered as a positive attribute. However, lower fertility associated with older age with first child may indicate lack of population replacement which could be of concern, and therefore worth following as a valued health component.

Figure 7.2-4 shows that in recent years, NWT women in the age groups 20 to 34 are more likely to give birth than NWT women in other age groups. Birth rates in NWT women in the age group 15 to 19 appear to have decreased between 2000 and 2007. This decline over time may reflect many characteristics of the population including educational opportunities for women, control of fertility and reproduction, socio economic status, in general, and/or others factors. These factors need to be examined further.

Figure 7.2-4
Age-Specific Birth Rates in NWT, 2000 to 2007

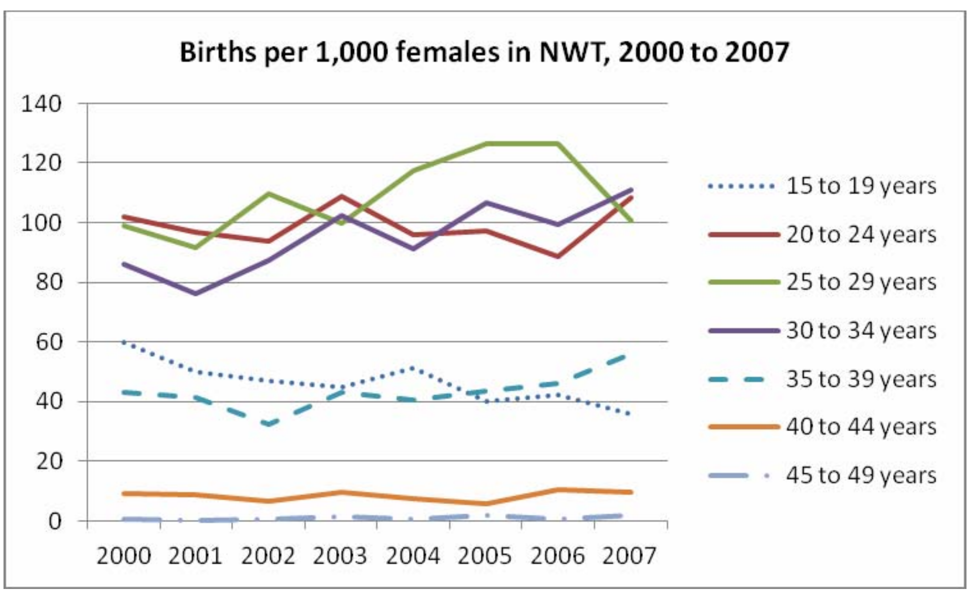
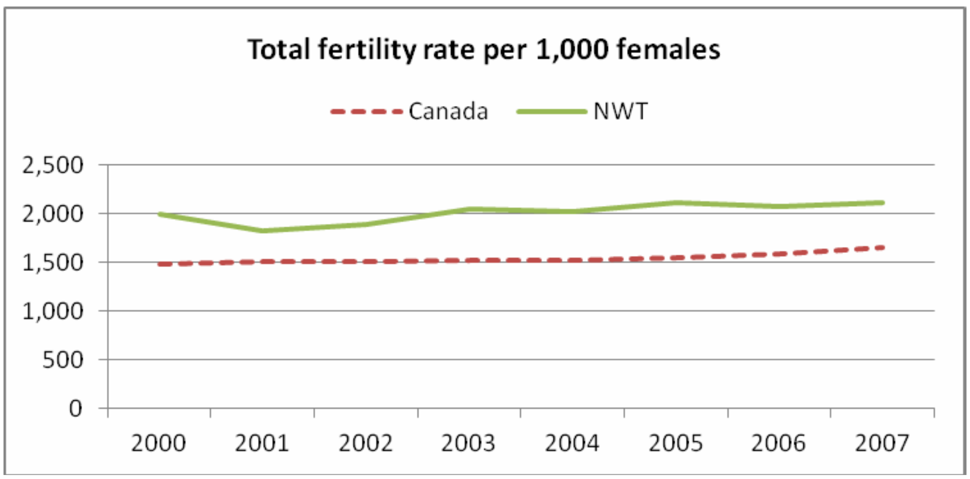


Figure 7.2-5 shows that the total fertility rate for NWT women has increased slightly between 2000 and 2007 and has risen above 2, the rate at which natural growth in the population takes place.

Table 7.2-4
Trends in Age Specific Birth Rates in NWT, 2000 to 2007

Mother's age	2000	2001	2002	2003	2004	2005	2006	2007
15 to 19 years	59.9	49.9	46.9	44.9	51.4	40.1	42.3	35.7
20 to 24 years	102.1	96.6	93.7	109	96	97.1	88.5	108.5
25 to 29 years	98.9	91.7	109.5	99.8	117.6	126.4	126.3	100.5
30 to 34 years	86	76.3	87.2	102.2	91.2	106.5	99.3	110.9
35 to 39 years	43.1	41.4	32.5	42.9	40.6	43.4	45.9	56.1
40 to 44 years	9.2	8.6	6.5	9.6	7.6	5.8	10.3	9.8
45 to 49 years	0.8	0	0.7	1.4	0.7	2	0.6	1.8

Figure 7.2-5
Trends in Total Fertility Rate in NWT and Canada, 2000 to 2007



What are the information gaps?

Information on population demographics was found to be relatively complete with no obvious gaps. However, there is the matter of confidential issues relating statistical measures in populations in small communities.

7.2.2 HH Indicator – Perinatal Health

Perinatal health data includes important indicators about the health of the youngest members of our population.

Table 7.2-5
Trends in Total Fertility Rate in Canada and NWT, 2000 to 2007

Total Fertility rate per 1,000 females		
Year	**Canada**	**NWT**
2000	1,488.0	2,000.4
2001	1,510.4	1,822.9
2002	1,501.4	1,885.3
2003	1,525.1	2,049.0
2004	1,525.8	2,025.3
2005	1,543.4	2,112.7
2006	1,586.2	2,068.6
2007	1,658.9	2,112.3

Source: Statistics Canada. *Table 102-4505 - Crude birth rate, age-specific and total fertility rates (live births), Canada, provinces and territories, annual*, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 1, 2010)

What is being measured?

The GNWT Department of Health and Social Services, through its Vital Statistics, routinely monitors birth outcomes and calculates rates (e.g., birth, fertility, infant mortality). Information is available by region and community.

Infant mortality is an important measure of health of children. Low birth weight reflects many complex factors, such as nutrition, prenatal care, age of mother, and others. Breastfeeding rates are related to children's health outcomes.

What does it mean?

Historically, infant mortality rates in the NWT have been much higher than in Canada. Data for the period 1981 to 2007 show that infant mortality rates in both Canada and the NWT have decreased, and that infant mortality rates in the NWT and Canada since 2001 may be similar (see Figure 7.2-7).

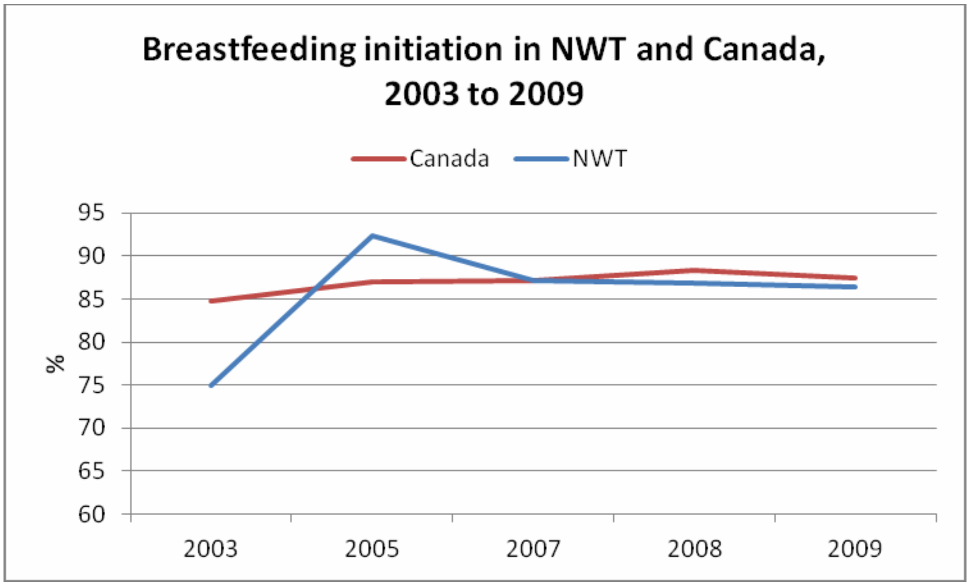
Table 7.2-6
Trends in Breast Feeding in Canada and NWT, 2003 to 2009

Breast feeding initiation (%)				
Year	Canada	95% CL	NWT	95% CL
2003	84.8	83.5-86.0	74.9	59.9-90.0
2005	87.0	86.0-88.1	92.4	85.8-99.1
2007	87.1	85.5-88.7	87.1	80.2-94.0
2008	88.3	86.7-90.0	86.9	76.3-97.4
2009	87.5	86.0-89.0	86.4	75.9-96.9

Exclusive Breastfeeding at least 6 months (%)				
Year	Canada	95% CL	NWT	95% CL
2003	17.2 r	15.9-18.5	24.3 E r	11.2-37.3 E r
2005	20.3 r	19.1-21.6	25.6 E r	13.0-38.2 E r
2007	21.0 r	18.8-23.2	26.1 E r	13.3-38.9 E r
2008	25.1 r	23.0-27.3	F	F
2009	25.4	22.2-26.7	35.8 E	19.6-52.0 E

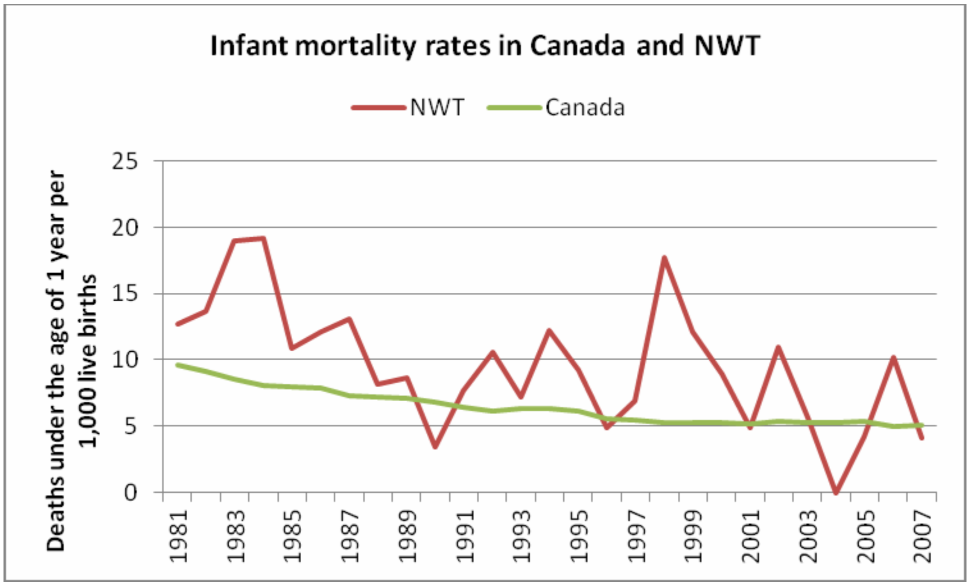
Notes: E Use with caution, F Too unreliable to be published, r revised,

Figure 7.2-6
Trends in Breastfeeding Initiation in NWT and Canada, 2003 to 2009



Source: Statistics Canada, Table 105-0501, Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2007 boundaries) and peer groups, occasional, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed June 17, 1010).

Figure 7.2-7
Trends in Infant Mortality Rate in NWT and Canada, 1981 to 2007



The data in Table 7.2-7 show that the number of infant deaths in the NWT is small which makes it difficult to obtain reliable estimates of the infant mortality rate and helps explain the seemingly wide variation in year-to-year results versus the Canadian average.

Table 7.2-7
Trends in Infant Mortality Rates in Canada and NWT, 1999 to 2007

Geography, place of residence	Canada		NWT	
Year	Number of deaths	Mortality rate per 1,000 live births	Number of deaths	Mortality rate per 1,000 live births
1999	1,776	5.3	8	12.1
2000	1,737	5.3	6	8.9
2001	1,739	5.2	3	4.9
2002	1,762	5.4	7	11.0
2003	1,765	5.3	4	5.7
2004	1,775	5.3	0	0
2005	1,863	5.4	3	4.2
2006	1,771	5.0	7	10.2
2007	1,881	5.1	3	4.1

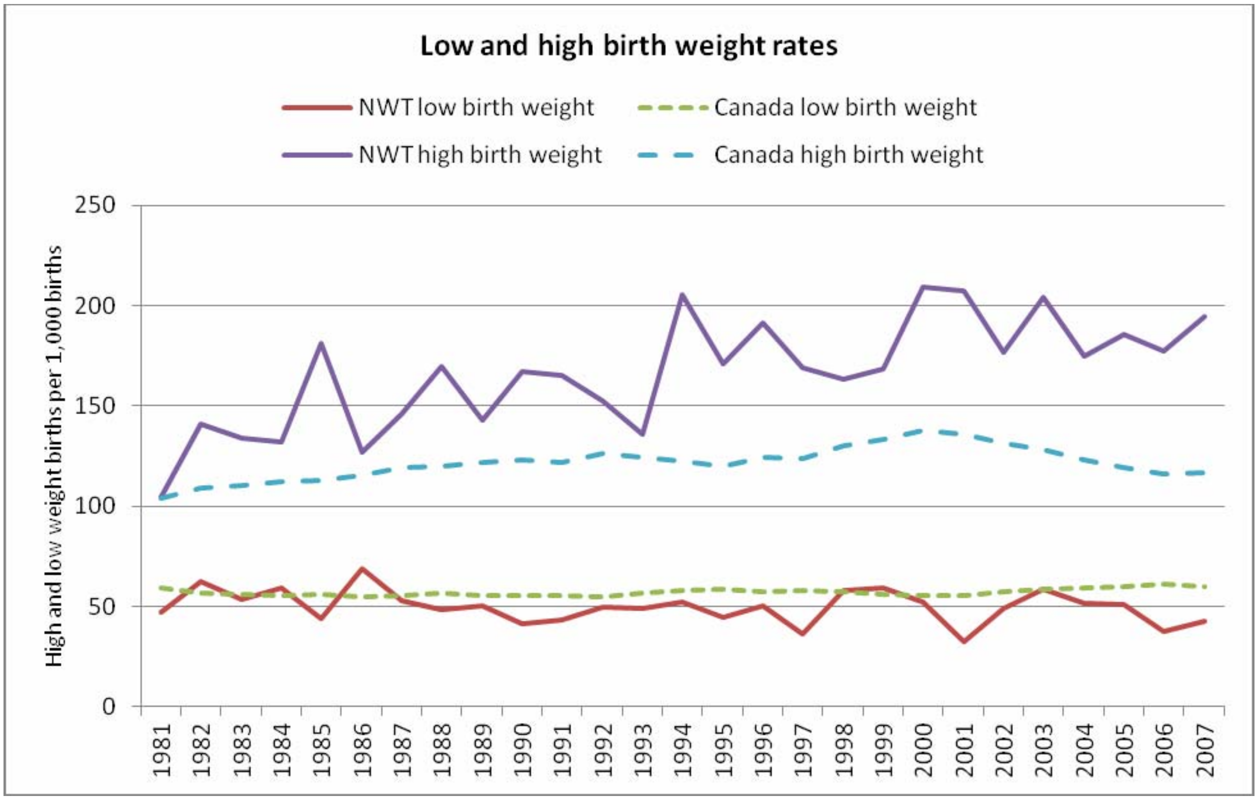
Note: The infant mortality rate is calculated as the number of deaths of children less than one year of age per 1,000 live births.
Source: Statistics Canada. Table 102-0507 - Infant deaths and mortality rates, by age group, Canada, provinces and territories, annual, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed: April 5, 2010)

The NWT experienced higher rates of high birth weight babies than the rest of Canada and slightly lower rates of low birth weight babies (Table 7.2-8 and Figure 7.2-8). Low birth weight is associated with increased risk of infant mortality while high birth weight is associated with maternal diabetes among other risk factors.

Table 7.2-8
Number Per 1,000 Births of Low (<2,500 Grams) and High (4,000+ Grams) Birth Weights for Northwest Territories and Canada, 1981 to 2007

Year	Low Birth Weight per 1,000 births		High Birth Weight per 1,000 Births	
	NWT	Canada	NWT	Canada
2007	42.8	60.1	194.5	116.6
2006	37.8	60.8	177.6	116.1
2005	50.6	60.0	185.4	119.4
2004	51.6	58.9	174.8	122.9
2003	58.5	58.4	204.0	128.0
2002	48.8	57.2	176.4	131.6
2001	32.6	55.2	207.2	135.8
2000	52.0	55.6	209.5	137.5
1999	59.2	56.3	168.4	133.3
1998	57.9	57.6	163.2	130.1
1997	36.1	57.8	169.2	123.4
1996	50.4	57.6	191.6	124.4
1995	44.2	58.4	170.9	120.0
1994	52.0	57.7	205.4	122.5
1993	48.9	56.8	135.7	124.4
1992	49.9	54.9	152.2	126.5
1991	43.5	55.4	165.0	121.8
1990	41.6	55.4	167.4	123.2
1989	50.4	55.5	142.7	121.6
1988	48.3	56.6	169.6	120.0
1987	52.6	55.3	145.8	119.0
1986	68.8	55.0	126.7	115.4
1985	43.8	55.7	181.3	112.6
1984	59.4	55.4	132.1	111.9
1983	53.5	56.0	134.2	110.1
1982	62.3	56.9	141.0	109.3
1981	47.0	58.9	104.4	104.0

Figure 7.2-8
Trends in High and Low Birth Weight Rates in NWT and Canada, 1981 to 2007



Breast feeding is associated with lower rates of enteric disease, allergies, and other illnesses in children later in life, so are a potentially a valued health indicator to track. Results from the most recent survey in 2009 indicate stable favourable levels of initiation of breast feeding[13] and a possible increased trend in exclusive breast feeding at six months (see caveats at bottom of the Table 7.2-6). Breastfeeding rates in the NWT now rival the Canadian average.

[13] Initiated breastfeeding refers to mothers who breastfed or tried to breastfeed their last child even if only for a short time and exclusive breastfeeding refers to an infant receiving only breast milk, without any additional liquid, even water, or solid food.

What are the information gaps?

Birth defect reporting at birth has not been mandatory but is being considered as part of the national birth defects monitoring system. NWT has not yet joined the national system but will start collecting information in January 2011. (Personal Communication, Maria Santos, Territorial Epidemiologist, NWT; June 18, 2010).

Breast feeding rates have been measured and will be available later in 2010 in a report currently in preparation by the NWT Department of Health and Social Services, through its Vital Statistics data collection system.

7.2.3 HH Indicator – Population Mortality

Population Mortality measures the crude mortality, age and sex specific mortality, and major disease specific mortality by age and sex. These data are reported at the territorial level and by region if numbers are large enough to permit analysis.

What is being measured?

The GNWT Department of Health and Social Services, through its Vital Statistics, routinely collects information regarding deaths and calculates death rates by cause.

What does it mean?

The crude mortality rate has increased between 1997 and 2006 (Table 7.2-9 and Figure 7.2-9). Changes in the crude death rate may be the result of changes in the population's age structure or changes in mortality rates from specific diseases. Age standardized mortality rates in the NWT appear to have decreased in both males and females between 2000 and 2005 (Table 7.2-10 and Figure 7.2-10). The four major causes of death for the NWT were cancer, circulatory disease, accidents (including suicides), and respiratory diseases. See Table 7.2-11.

Table 7.2-9
Trends in Crude Death Rate in NWT, 1997 to 2006

Year	Population	Deaths	Crude death rate per 1,000 population
1997	41,625	138	3.32
1998	40,802	146	3.58
1999	40,638	162	3.99
2000	40,480	156	3.85
2001	40,844	163	3.99
2002	41,665	169	4.06
2003	42,561	202	4.75
2004	43,301	153	3.53
2005	43,399	148	3.41
2006	43,198	182	4.21

Source: Northwest Territories Statistical Profile
http://www.stats.gov.nt.ca/community-data/community-profiles/Profile%20PDF/NWT.pdf
(accessed June 26, 2010).

Figure 7.2-9
Crude Death Rates Per 1,000 Residents of NWT

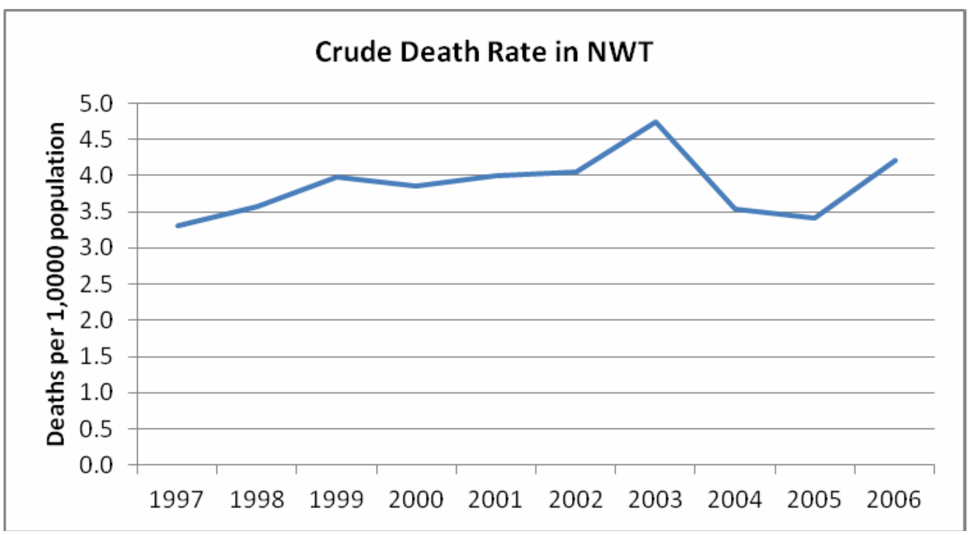


Table 7.2-10
Age Standardized Morality Rates in NWT and Canada, 2000 to 2005

	Age standardized mortality rates			
	Males		**Females**	
Year	**NWT**	**Canada**	**NWT**	**Canada**
2000	1,022.0	778.3	632.0	493.2
2001	865.4	756.4	631.2	483.2
2002	1,072.6	747.8	599.3	485.7
2003	1,037.4	733.4	912.4	475.4
2004	762.0	710.0	535.5	465.6
2005	884.8	696.7	462.6	460.7

Source: Statistics Canada. *Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual*, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 6, 2010)

Figure 7.2-10
Age Standardized Mortality Rates in Canada and NWT By Sex, 2000 to 2005

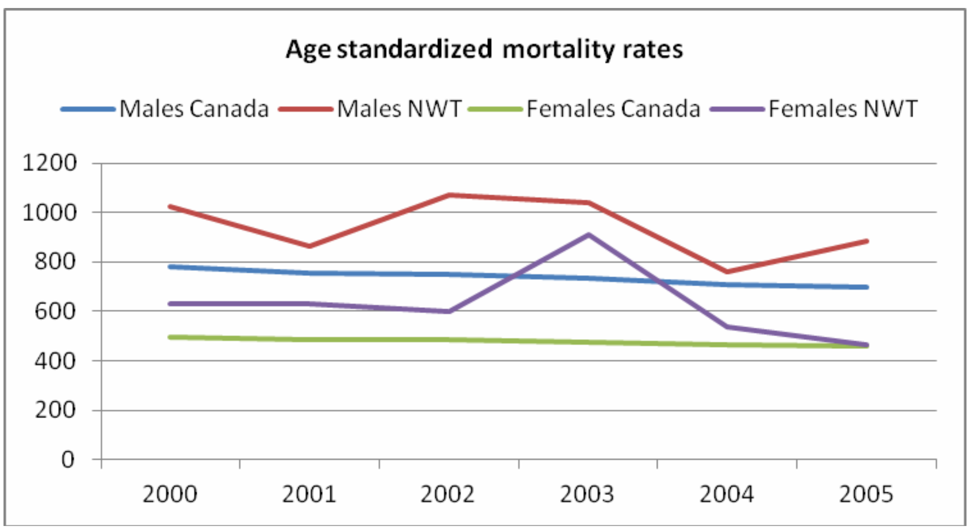


Table 7.2-11
Five Most Frequent Causes of Death in NWT, By Sex 2000 to 2005

Sex	Cause of death (ICD-10)	Number of deaths						
		2000	2001	2002	2003	2004	2005	Total
Male	Malignant neoplasms [C00-C97]	27	23	19	24	26	24	143
Male	Major cardiovascular diseases [I00-I78]	19	19	38	28	24	12	140
Male	Accidents (unintentional injuries) [V01-X59, Y85-Y86]	14	14	9	19	6	14	76
Male	Nontransport accidents [W00-X59, Y86]	5	8	7	14	3	11	48
Male	Intentional self-harm (suicide) [X60-X84, Y87.0]	7	7	6	10	9	4	43
Female	Malignant neoplasms [C00-C97]	16	14	21	35	13	18	117
Female	Major cardiovascular diseases [I00-I78]	8	13	10	22	15	6	74
Female	Accidents (unintentional injuries) [V01-X59, Y85-Y86]	9	6	3	6	3	2	29
Female	Nontransport accidents [W00-X59, Y86]	7	3	3	4	3	1	21
Female	Chronic lower respiratory diseases [J40-J47]	2	4	4	4	1	5	20

Source: Statistics Canada. *Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual*, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 6, 2010)

Between 2000 and 2005, the four leading cancer causes of death in men were lung cancer, colon cancer, prostate cancer and pancreatic cancer. Other and unspecified cancers represent a collection of different cancers. See Table 7.2-12 and 7.2-13.

Table 7.2-12
Five Most Frequent Causes of Cancer Deaths in NWT Males, 2000 to 2005

Cause of death	Number
Malignant neoplasms of trachea, bronchus and lung [C33-C34]	34
Malignant neoplasms of colon, rectum and anus [C18-C21]	20
All other and unspecified malignant neoplasms	20
Malignant neoplasm of prostate [C61]	11
Malignant neoplasm of pancreas [C25]	5

Source: Statistics Canada. *Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual*, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-in/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed: April 6, 2010)

Table 7.2-13
Five Most Frequent Causes of Cancer Deaths in NWT Females, 2000 to 2005

Type of cancer	Deaths
All other and unspecified malignant neoplasms	25
Malignant neoplasms of trachea, bronchus and lung [C33-C34]	23
Malignant neoplasm of breast [C50]	18
Malignant neoplasms of colon, rectum and anus [C18-C21]	8
Malignant neoplasm of stomach [C16]	4

Source: Statistics Canada. Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 6, 2010)

Between 2000 and 2005, the leading causes of death among cancers in females were other or unspecified cancers, lung cancer, breast cancer, colon cancer and stomach cancer. See cancer statistics for both males and females in Table 7.2-14 and Table 7.2-15.

The data indicate that mortality from heart disease in both NWT males and females may have declined between 2000 and 2005.

Table 7.2-14
Age Standardized Cancer Mortality Rates in Canada and NWT in Males, 2000 to 2005

MALES	Geography	2000	2001	2002	2003	2004	2005
Total, all causes of death [A00-Y89]	Canada	778.3	756.4	747.8	733.4	710.0	696.7
	NWT	1,022.0	865.4	1,072.6	1,037.4	762.0	884.8
Malignant neoplasms [C00-C97]	Canada	225.3	223.8	220.5	215.3	212.1	207.7
	NWT	303.0	216.4	166.6	287.7	227.4	263.5
Malignant neoplasms of colon, rectum and anus [C18-C21]	Canada	24.0	22.8	24.1	23.0	23.5	23.7
	NWT	62.0	16.2	18.9	73.0	43.2	23.2
Malignant neoplasm of pancreas [C25]	Canada	10.1	10.3	9.8	10.3	10.4	9.8
	NWT	0.0	15.5	0.0	4.4	26.0	21.2
Malignant neoplasms of trachea, bronchus and lung [C33-C34]	Canada	64.3	64.6	64.5	62.7	60.6	59.8
	NWT	108.4	59.8	64.0	55.8	65.7	47.1
Malignant neoplasm of prostate [C61]	Canada	26.7	26.6	25.2	24.1	23.4	21.9
	NWT	37.2	53.1	0.0	50.9	6.4	50.5
All other and unspecified malignant neoplasms	Canada	30.2	29.8	28.2	27.7	26.9	26.3
	NWT	24.9	60.0	15.2	73.3	46.1	79.8
Major cardiovascular diseases [I00-I78]	Canada	268.3	252.6	244.9	238.4	223.7	212.0
	NWT	273.6	208.1	486.7	283.7	214.1	149.3
Nontransport accidents [W00-X59, Y86]	Canada	21.1	21.0	21.6	20.9	19.9	21.1
	NWT	29.7	44.2	29.3	95.6	23.1	64.8
Intentional self-harm (suicide) [X60-X84, Y87.0]	Canada	18.0	18.0	17.7	17.8	16.6	16.9
	NWT	48.9	30.7	33.7	42.1	38.7	17.2

Source: Statistics Canada. Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 6, 2010)

Table 7.2-15
Age Standardized Mortality Rates in NWT and Canada in Females, 2000 to 2005

Cause of death	Region	2000	2001	2002	2003	2004	2005
Total, all causes of death [A00-Y89]	Canada	493.2	483.2	485.7	475.4	465.6	460.7
	NWT	632.0	631.2	599.3	912.4	535.5	462.6
Malignant neoplasms [C00-C97]	Canada	149.4	147.6	149.3	148.1	147.0	143.8
	NWT	167.2	163.4	165.1	312.9	146.6	163.6
Malignant neoplasms of trachea, bronchus and lung [C33-C34]	Canada	34.4	34.4	35.3	35.4	36.2	36.0
	NWT	0.0	37.4	63.1	76.6	71.7	42.8
Malignant neoplasm of breast [C50]	Canada	25.0	24.9	24.4	24.1	23.1	22.6
	NWT	23.9	32.9	12.6	63.8	12.8	22.1
Major cardiovascular diseases [I00-I78]	Canada	164.0	155.4	151.9	144.0	137.9	132.4
	NWT	106.5	129.4	126.1	274.5	170.8	64.1
Chronic lower respiratory diseases [J40-J47]	Canada	19.8	19.4	19.6	19.9	19.4	19.8
	NWT	27.5	49.1	59.6	50.4	13.6	62.3
Accidents (unintentional injuries) [V01-X59, Y85-Y86]	Canada	16.6	15.6	17.0	16.6	16.0	16.5
	NWT	65.0	37.1	30.6	54.8	25.4	15.7
Nontransport accidents [W00-X59, Y86]	Canada	10.8	10.3	11.3	11.2	11.0	10.8
	NWT	55.0	24.2	30.6	44.3	25.4	11.7

Source: Statistics Canada. Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed: April 6, 2010)

The four leading causes of death for NWT Aboriginal people were injury and poisoning, circulatory diseases, cancer and respiratory diseases. For each of the causes of death, the rate has decreased in First Nations when compared with the 1991 to 1993 period, for example by 22.4% for cancer to 40.9% for respiratory diseases such as pneumonia and bronchitis (Health Canada 2003).

The crude mortality rate for First Nations males was 1.3 times higher than the rate for First Nations females in 1999. The rate difference is largely attributable to higher rates among males for injury and poisoning (147 deaths per 100,000 among males and 68 among females) and to circulatory disease (98 deaths per 100,000 among males and 72 among females) (Health Canada 2003).

Age-specific death rates in 1999 were higher in First Nations males than females for almost all age groups. The largest difference between the sexes occurs in the 5 to 9 and 20 to 24 age groups (Health Canada 2003).

Table 7.2-16 demonstrates that for the years 2005 to 2007, the mortality rates of both males and females in NWT and Canada differ in the age groups 1 to 44 years of age. Figures 7.2-11 and 7.2-12 do not yet indicate any systematic trend in age specific mortality rates for NWT males or females in the age group 1 to 44 years. Mortality rates in infants and persons older than 44 years in the NWT and Canada do not appear to differ greatly (see Figures 7.2-13 and 7.2-14).

Table 7.2-16
Age Specific Death Rates in Canada and NWT, By Sex in Three Year Periods from 1999 to 2007

			Canada				**NWT**	
Age	**Sex**	**1999-2001**	**2002-2004**	**2005-2007**		**1999-2001**	**2002-2004**	**2005-2007**
	Number of deaths							
<1	Male	2,968	2,916	3,056		11	8	6
1-14	Male	1,592	1,419	1,328		3	1	3
15-24	Male	5,041	4,832	4,929		23	14	17
25-44	Male	18,658	17,373	16,665		40	59	46
45-64	Male	63,305	66,964	70,407		73	87	89
65+	Male	245,841	249,171	253,438		144	146	149
<1	Female	2,284	2,386	2,459		6	3	5
1-14	Female	1,163	1,014	974		4	5	3
15-24	Female	1,975	1,904	1,949		5	7	7
25-44	Female	10,079	9,389	8,877		18	19	18
45-64	Female	39,178	42,697	45,223		41	49	59
65+	Female	265,035	276,280	284,102		114	125	99
	Population							
<1	Male	517,105	511,167	539,365		1,005	963	1,098
1-14	Male	8,525,624	8,390,102	8,162,543		15,672	15,187	14,207
15-24	Male	6,411,335	6,624,429	6,863,922		9,805	10,609	11,116
25-	Male		14,421,225	14,219,791		22,170	22,755	22,264

			Canada				NWT	
Age	**Sex**	**1999-2001**	**2002-2004**	**2005-2007**		**1999-2001**	**2002-2004**	**2005-2007**
44		14,537,156						
45-64	Male	10,668,755	11,821,602	13,006,449		11,901	13,832	15,963
65+	Male	4,948,353	5,265,847	5,661,305		2,588	2,782	2,999
<1	Female	491,992	485,088	510,073		960	1,018	999
1-14	Female	8,122,085	7,994,012	7,758,091		15,169	14,842	13,945
15-24	Female	6,089,660	6,295,586	6,517,122		8,974	9,763	10,199
25-44	Female	14,335,203	14,165,852	13,993,378		21,377	21,445	21,067
45-64	Female	10,846,804	12,027,858	13,204,463		9,993	11,761	13,319
65+	Female	6,611,964	6,931,234	7,316,737		2,348	2,570	2,966
	Deaths per 100,000 population							
<1	Male	5.74	5.70	5.67		10.95	8.31	5.46
1-14	Male	0.19	0.17	0.16		0.19	0.07	0.21
15-24	Male	0.79	0.73	0.72		2.35	1.32	1.53
25-44	Male	1.28	1.20	1.17		1.80	2.59	2.07
45-64	Male	5.93	5.66	5.41		6.13	6.29	5.58
65+	Male	49.68	47.32	44.77		55.64	52.48	49.68
<1	Female	4.64	4.92	4.82		6.25	2.95	5.01
1-14	Female	0.14	0.13	0.13		0.26	0.34	0.22
15-24	Female	0.32	0.30	0.30		0.56	0.72	0.69
25-44	Female	0.70	0.66	0.63		0.84	0.89	0.85
45-64	Female	3.61	3.55	3.42		4.10	4.17	4.43
65+	Female	40.08	39.86	38.83		48.55	48.64	33.38

Source: Statistics Canada. *Table 102-0504 - Deaths and mortality rates, by age group and sex, Canada, provinces and territories, annual*, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed: April 15, 2010)

Figure 7.2-11
Age Specific Mortality Rates in Males in NWT in Three Year Periods from 1999 to 2007

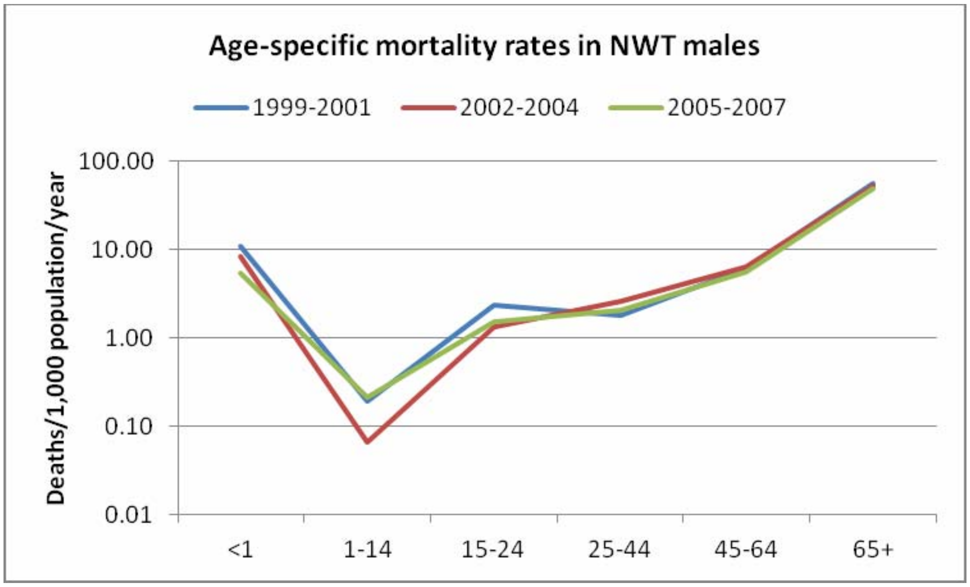


Figure 7.2-12
Age Specific Mortality Rates in Females in NWT in Three Year Periods from 1999 to 2007

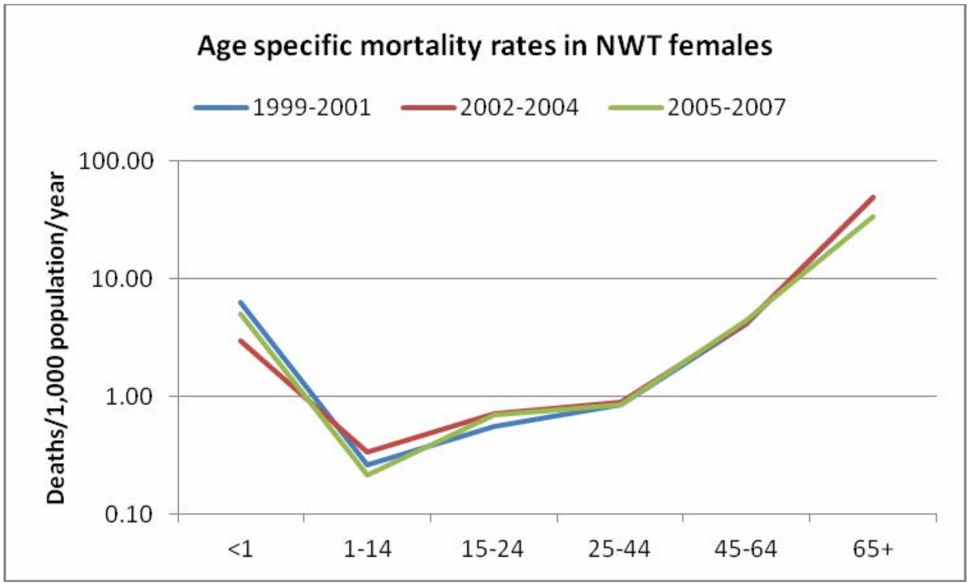


Figure 7.2-13
Age Specific Mortality Rates in NWT and Canada in Males, 2005 to 2007

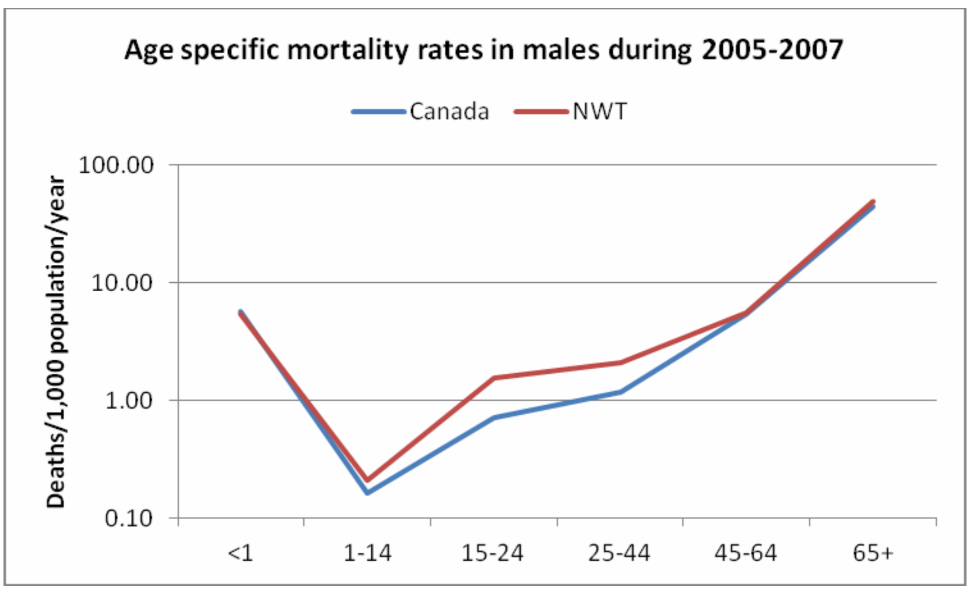
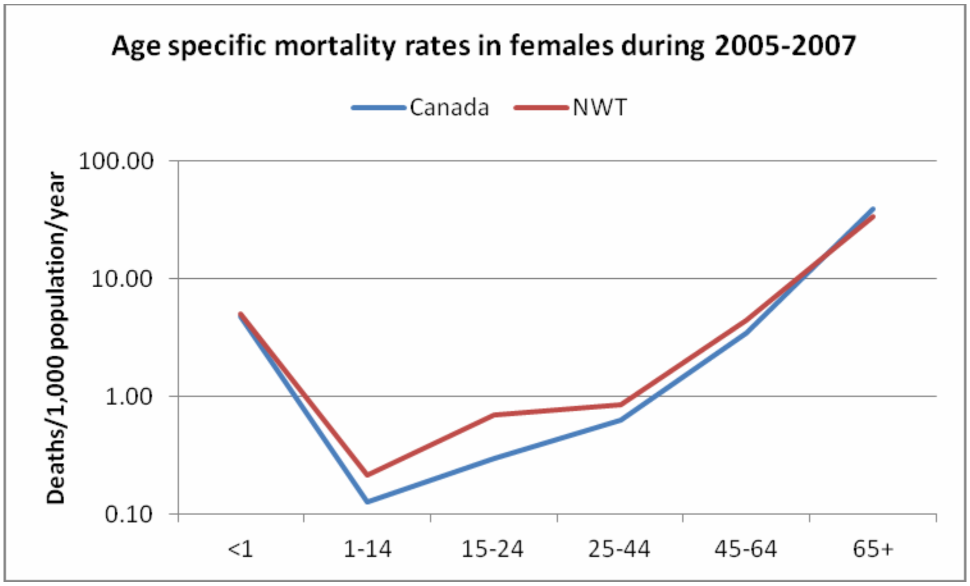


Figure 7.2-14
Age Specific Mortality Rates in NWT and Canada in Females, 2005 to 2007



With respect to First Nations people, the most common cause of death for those aged 1 to 44 was injury and poisoning. Among children under 10, deaths were primarily unintentional (accidental). Suicide and self-injury were the leading causes of death for youth and adults up to age 44. Motor vehicle collisions were a leading cause of death in all age groups (Health Canada 2003). For First Nations aged 45 and older, circulatory diseases were the most common causes of death. This trend parallels the Canadian population as a whole (FPT 1999).

With respect to death from accidents, suicide, and homicide for the NWT and Canada, the NWT has shown higher rates from 2000 to 2005, as seen in Figure 7.2-15. The data in Figure 7.2-15 and Table 7.2-17 indicate that mortality from violent causes of death in the NWT may have declined between 2000 and 2005. Further follow-up is needed to determine if these trends persist.

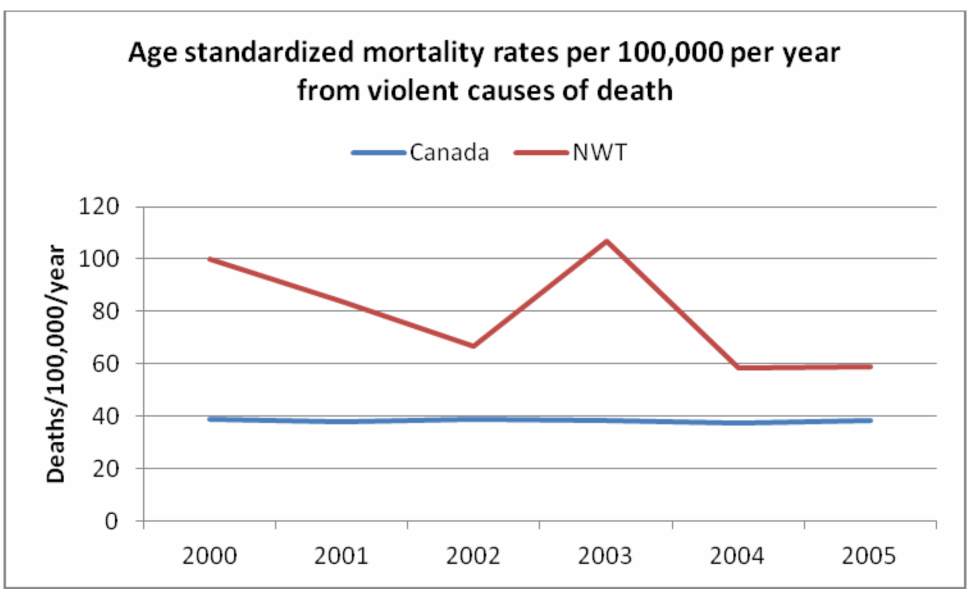
First Nations age groups up to age 65 are at increased risk from death due to accidents, suicides and homicide, compared with the Canadian population. First Nations males are at higher risk than females. The greatest disparity with the Canadian rates is for females aged 15 to 24 and aged 25 to 39 (approximately eight and five times the Canadian rates, respectively) (Health Canada 2003).

Table 7.2-17
Age Standardized Death Rates from Accidents, Suicide and Homicide in Canada and NWT, Both Sexes Combined 2000 to 2005

			Age-standardized mortality rates per 100,000					
Cause of death	ICD 10 codes	Area	2000	2001	2002	2003	2004	2005
Accidents	V01-X59, Y85-Y86	Canada	25.8	25.1	26.0	25.5	24.7	25.6
		NWT	71.0	60.1	36.1	82.8	29.8	50.1
Suicide	X60-X84, Y87.0	Canada	11.4	11.4	11.2	11.3	10.8	10.9
		NWT	21.9	18.9	22.2	21.7	24.2	8.8
Homicide	X85-Y09, Y87.1	Canada	1.6	1.5	1.5	1.5	1.7	1.9
		NWT	7.1	4.7	8.5	2.2	4.5	0.0
Total		Canada	38.8	38.0	38.7	38.3	37.2	38.4
		NWT	100.0	83.7	66.8	106.7	58.5	58.9

Source: Statistics Canada. Table 102-0552 - Deaths, by selected grouped causes and sex, Canada, provinces and territories, annual, CANSIM (database).
http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm
(accessed April 16, 2010).

Figure 7.2-15
Age Standardized Mortality Rates from Accidents, Suicide and Homicide in NWT and Canada for Both Sexes Combined, 2000 to 2007



What are the information gaps?

Information on population mortality was found to be relatively complete with no major gaps identified.

7.2.4 HH Indicator – Population Morbidity

Morbidity refers to the relative incidence of disease. Rates and causes of morbidity are important measures of the health status of the population. Changes in the rates may be due to environmental exposures (e.g., changes in asthma may be due to environmental tobacco smoke, air pollution, others), which may in turn be related to social, economic or cultural changes. In this section, health statistics on "Infectious Diseases" and for "Diabetes and Hypertension" are discussed separately.

7.2.4.1 Infectious Diseases

At the time of preparation of this section, specific data on Infectious Diseases and especially vaccine preventable diseases were not found for the NWT; therefore, the Survey of Inuit and First Nations Health report was consulted. In 1999, First Nations people across Canada experienced a disproportionate burden of many infectious diseases compared to other Canadians. These include pertussis (3 times higher), chlamydia (7 times higher), hepatitis A (5.3 times higher) and shigellosis (almost 20 times higher) (Health Canada 2003). The proportion of Canada's total AIDS cases contracted by Aboriginal people in Canada climbed from 1.0% in 1990 to 7.2% in 2001 (Health Canada 2002). Given that about half the population in the NWT is Aboriginal, these statistics indicate there is a need to focus on preventive and follow up actions in these health areas, which are considered good indicators of preventable population adverse health experiences. Over that same period, the tuberculosis rate among First Nations people remained 8 to 10 times than seen in the Canadian population as a whole (Health Canada 2003). This is not the case however, for the NWT population as a whole.

A specific breakdown of infectious diseases in the NWT by First Nations and non-First Nations peoples was not found. Reporting from regions of immunization status and communicable disease may be inconsistent. However, data on sexually transmitted infections (STIs) in the NWT can be seen in Figure 7.2-16 and Table 7.2-18. Gaps exist where people do not seek hospitalization or health care and cases remain unreported, but there is no current evidence to indicate that Aboriginal and non-Aboriginal people have different reporting rates. Up to 2007, the trend for reported STIs has increased for the whole population; the rates in Aboriginal people have increased much more markedly. This too may reflect an artefact of better reporting. However, all things being equal, it is a favourable trend for the non-aboriginal compared to

Aboriginal rates which have increased significantly since 2000. Currently, the rate of reported STIs among NWT Aboriginal people is 11 times that for non-Aboriginal NWTers.

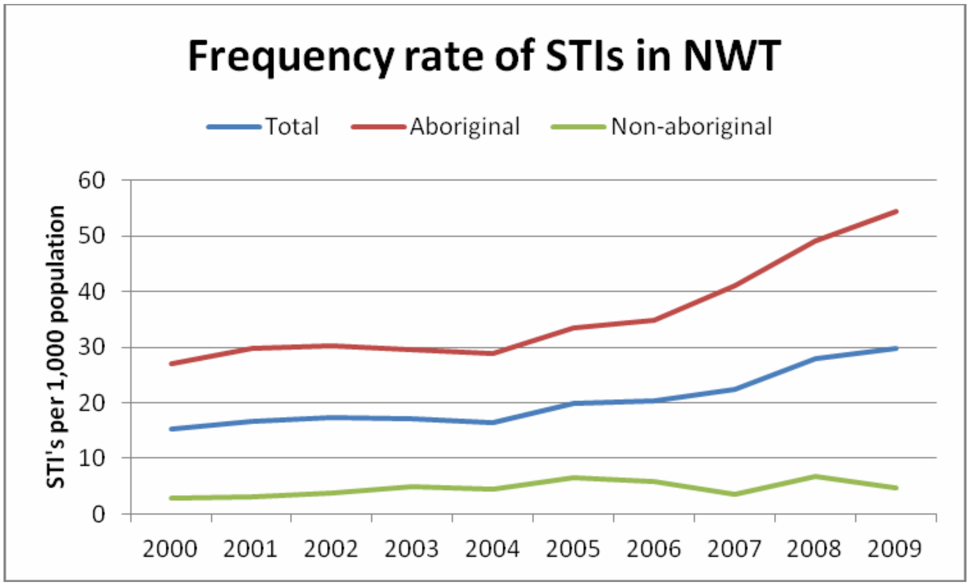
Table 7.2-18
Sexually Transmitted Infection in the NWT, Aboriginals and Non-Aboriginals, from 2000 to 2009

		Number of STI's		Population		
Year	**Total**	**Aboriginal**	**Non-aboriginal**	**Total**	**Aboriginal**	**Non-aboriginal**
2000	620	563	57	40,822	20,893	19,929
2001	685	624	61	40,844	20,897	19,947
2002	719	640	79	41,665	21,118	20,547
2003	730	626	104	42,561	21,238	21,323
2004	716	617	99	43,301	21,395	21,906
2005	865	721	144	43,399	21,498	21,901
2006	880	753	127	43,198	21,639	21,559
2007	974	896	78	43,545	21,808	21,737
2008	1,221	1,075	146	43,720	21,869	21,851
2009	1,296	1,194	102	43,439	21,889	21,550

	STI Rates per 1,000 population, NWT		
Year	**Total**	**Aboriginal**	**Non-aboriginal**
2000	15	27	3
2001	17	30	3
2002	17	30	4
2003	17	29	5
2004	17	29	5
2005	20	34	7
2006	20	35	6
2007	22	41	4
2008	28	49	7
2009	30	55	5

Source: Department of Health and Social Services, NWT Disease Registries
* Includes chlamydia, gonorrhea and syphilis; STIs are reported as incident cases of Chlamydia, gonorrhoea, and syphilis

Figure 7.2-16
Rate of Sexually Transmitted Infections in NWT, 2000 to 2009



For the period 2007-09, NWT had an incidence rate of 31 cases of tuberculosis per 100,000 population per year (Maria Santos, Territorial Epidemiologist, GNT, personal communication, June 18, 2010).

7.2.4.2 Diabetes and Hypertension

Diabetes prevalence - Health Canada has used several approaches to determine the impact of diabetes on the Canadian population. National population health surveys carried out every two years, longitudinal surveys, diagnosis-specific hospital discharge information, and the Aboriginal Peoples Health Survey (1991) provide an insight into diabetes morbidity and mortality. These surveys tend to suffer from several shortcomings in that they constitute self reports, do not capture undiagnosed pre-diabetes, do not differentiate Type I or Type II diabetes, or may miss diabetes as an underlying cause of death.[14] Often, small numbers do not adequately represent the communities of interest. The NWT participates in the National Diabetes Surveillance System and has good data on diabetes prevalence. The Canadian Community Health Survey, conducted regularly in the NWT by Statistics Canada, also asks respondents about diabetes and other chronic health conditions. Data from 2006-7 are from the last survey available. NWT diagnosed diabetes rates are slightly lower for males and slightly higher for females, than the Canadian average, but the same in aggregate. Total male and female rate is the same. See Table 7.2-19.

[14] Public Health Agency of Canada. Diabetes in Canada. National Statistics and Opportunities for Improved Surveillance, Prevention, and Control. http://www.phac-aspc.gc.ca/publicat/dic-dac99/d14_e.html

Table 7.2-19
Age Standardized Prevalence of Diagnosed Diabetes, in 2006/7

Area	Sex	% of population 1 year old or older
NWT	Male	5.0
	Female	5.4
	Both	5.2
Canada	Male	5.8
	Female	4.7
	Both	5.2

Source: Public Health Agency of Canada, using NDSS data as of April 2009.
Age standardized to 1991 Canadian population
"Report from the National Diabetes Surveillance System: Diabetes in Canada", 2009
http://www.phac-aspc.gc.ca/publicat/2009/ndssdic-snsddac-09/2-eng.php#f3
(Accessed April 13, 2010)

Hypertension prevalence - The Canadian Community Health Survey (CCHS) collects information about various aspects of health including high blood pressure. The most recent survey results indicate that the prevalence of high blood pressure in residents of NWT is significantly lower than in Canadians. See Table 7.2-20.

Dental Care - Dental health measures are not collected systematically in the NWT. Dental decay rates for Aboriginal children in Ontario are two to five times higher than rates among non-Aboriginal children. They are far less likely to be decay-free (Health Canada 2003). Similar data could be developed for the NWT.

***Asthma* -** The incidence of asthma is enumerated by prevalence surveys. The CCHS survey sample for NWT was not sufficiently large to reliably measure the prevalence of asthma in NWT but the available survey data may indicate that the prevalenc of asthma in the NWT may be lower than in Canada. See Table 7.2-20.

7.2.5 HH Indicator – Personal Health Practices and Risk Factors

Factors that increase the risk of adverse health effects include smoking, alcohol and substance abuse, obesity and physical inactivity. Details of specific health practices follow. In summary, NWT report lower level of percieved mental health, higher satisfaction with life, lower level of arthritis, higher level of smoking and alcohol consumption, lower consumption of fruits and vegetables, and lower frequency of having a regular medical doctor.

Table 7.2-20
Indicators of Health in Canada and NWT

Indicator	Canada (%)	95% CL	NWT (%)	95% CL	P-value
Excellent or very good perceived mental health	74.4	73.8-74.9	58.8	53.3-64.4	<0.05
Satisfied or very satisfied with life	91.4	90.9-91.8	93.9	91.5-96.2	<0.05
Arthritis	15.3	14.9-15.7	11	7.6-14.4	<0.05
Diabetes	5.9	5.6-6.2	3.8[E]	2.1-5.5[E]	<0.05[E]
Asthma	8.4	8.0-8.7	6.5[E]	3.5-9.4[E]	<0.05[E]
High blood pressure	16.4	16.0-16.8	10.8	8.2-13.4	<0.05
Current smoker, daily or occasional	21.4	20.9-21.9	34.3	29.8-38.9	<0.05
Daily current smoker	16.8	16.3-17.3	27.4	22.9-31.9	<0.05
5+ drinks on one occasion, at least once a month in past year	16.7	16.3-17.2	23.5	18.4-28.6	<0.05
Fruit and vegetable consumption, 5 times or more per day	43.7	43.0-44.3	20.3	16.4-24.3	<0.05
Has a regular medical doctor	84.4	84.0-84.9	37.4	33.4-41.4	<0.05
Influenza immunization less than 1 year ago	31.7	31.1-32.3	36	27.5-44.6	>0.05

[E] Use with caution

Source: Statistics Canada. Table 105-0501 - Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2007 boundaries) and peer groups, occasional, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed: April 12, 2010)

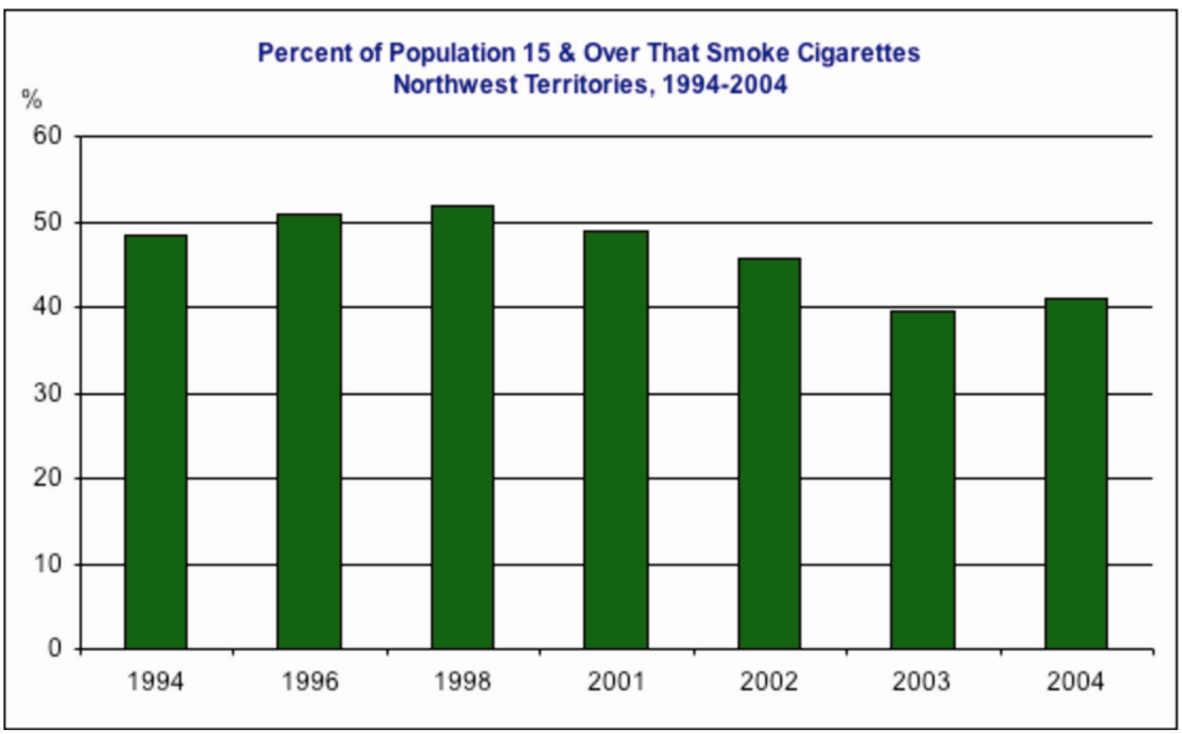
***Smoking* -** Smoking rates for the Northwest Territories have been collected in a variety of household surveys for persons 15 years and over from 1994 to 2007. A summary of these data is provided in Figures 7.2-17 and 7.2-18. Table 7.2-20 indicates that residents of NWT are more likely to be smokers than residents of Canada. The long term trend points to a slow decline in the proportion of the NWT population who are current smokers, although this trend has levelled out in the past several years. Appendix Table 7A.1-8 contains a detailed profile of smoking habits in the NWT in 2002 and 2006.

A reduction in the smoking rate would be desirable for the NWT population as smoking is a risk factor for respiratory and cardiovascular disease as well as cancer. Periodic surveys can capture this information.

Alcohol and Substance Abuse - Figures 7.2-19 and 7.2-20 and Table 7.2-21 indicates differences in the incidence of heavy alcohol use for Canada and the NWT. The NWT has higher rates of alcohol use (incidence of heavy use being just one measure of alcohol use). Heavy use of alcohol is associated with adverse health outcomes, accidents as well as family and social adverse impacts. A detailed profile of alcohol consumption in the NWT in 2002 and 2006 is provided in Table 7.2-22. A trend to reduced heavy drinking may be emerging (Figure 7.2-20).

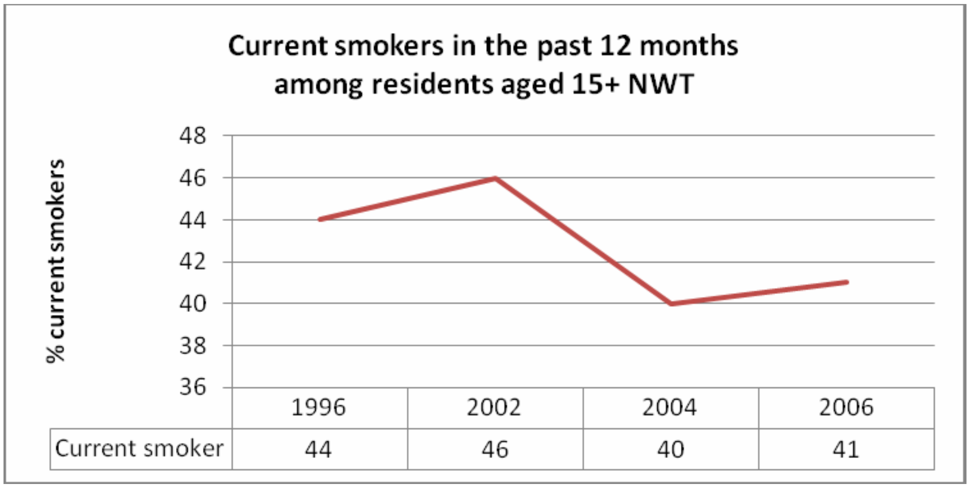
Obesity and Physical Inactivity - Obesity and physical inactivity are important risk factors for cardiovascular disease and premature mortality. This is an important health indicator whose data collection can be enhanced. There is some information in the health status report (Canadian National population health survey), but this is difficult to extract for NWT communities. A larger sample is needed to better identify the extent of this health problem in NWT and its communities and target programming to priority "at risk" demographics and communities/regions.

Figure 7.2-17
Percent of Population 15 Years and Over that Smoke Cigarettes in Northwest Territories 1994-2004



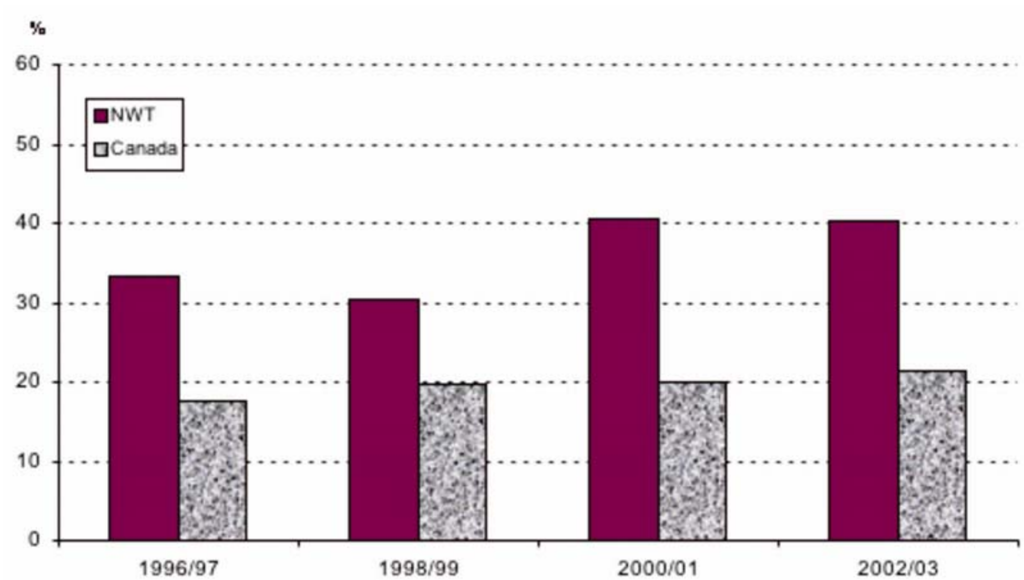
Source: Northwest Territories Bureau of Statistics

Figure 7.2-18
Percent of Population 15 Years and over that Smoke Cigarettes in Northwest Territories 1996-2006



Source: The 2006 Northwest Territories Addictions Report, July 2008. NWT Health and Social Services.

Figure 7.2-19
Incidence of Heavy Alcohol Use for Canada and Northwest Territories, 1996/7 to 2002/3



Source: Northwest Territories Bureau of Statistics

Figure 7.2-20
Incidence of Heavy Alcohol Use for Canada and Northwest Territories, 2003 to 2008

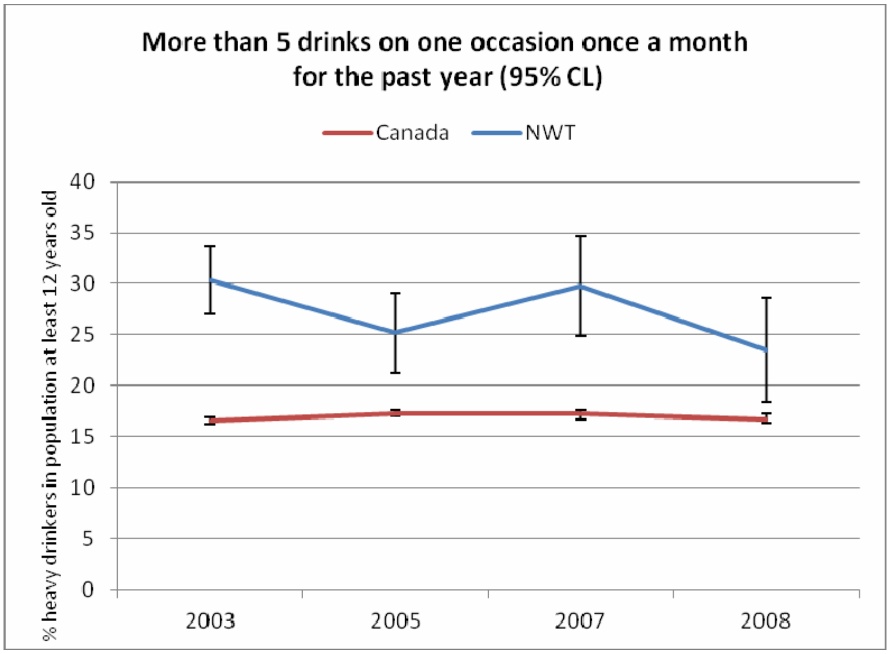


Table 7.2-21
Incidence of Heavy Drinkers in Canada and NWT, 2003 to 2008

	Canada				NWT			
	2003	**2005**	**2007**	**2008**	**2003**	**2005**	**2007**	**2008**
% Heavy drinker	16.6	17.3	17.2	16.7	30.3	25.2	29.8	23.5
95% LCL	16.2	17	16.7	16.3	27	21.2	24.9	18.4
95% UCL	16.9	17.6	17.6	17.2	33.6	29.1	34.7	28.6

Source: Statistics Canada. *Table 105-0501 - Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2007 boundaries) and peer groups, occasional*, CANSIM (database). http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.exe?Lang=E&CNSM-Fi=CII/CII_1-eng.htm (accessed: April 18, 2010)

7.2.6 HH Indicator – Social Determinants

The notion that 'health is wealth' does not consider important social determinants which contribute to health such as income distribution, food security, social networks, social exclusion and discrimination, poor housing, education, etc. Some of these determinants are related to wellness and social integration.

The ones considered in this section are limited to those enumerated on a population basis in databases relevant to the NWT. Some of the enumerated data include family size and composition, lone parent families, dependency ratio, employment rate, families with income less than $30,000 or more than $75,000, education, housing and community characteristics, violent crime, juvenile crime and shelter admissions.

Education **-** A lower proportion of the population in the NWT than in the rest of Canada has attained secondary school education (see Table 7.2-23 High School Graduation Rate). There has been some improvement in the past 10 years with some closing of the gap between NWT and the rest of Canada, a trend that needs to be followed as it is associated with better opportunities for employment, higher lifetime earnings, and better health status. See also Chapter 8 of this SOE Report.

Table 7.2-22
Profile of Alcohol Consumption in the Northwest Territories, 2002 and 2006

	Year	Number	Current Drinker	%	Former drinker	%	Never drinker	%
Persons 15 years and over	2002	30,431	23,748	78%	5,247	17%	1,295	4%
	2006	31,759	24,684	78%	5,300	17%	1,775	6%
Males	2002	15,892	12,783	80%	2,555	16%	461	3%
	2006	16,539	13,816	84%	2,121	13%	602	4%
Females	2002	14,539	10,965	75%	2,692	19%	834	6%
	2006	15,220	10,868	71%	3,180	21%	1,173	8%
Age								
15-24	2002	6,413	5,383	84%	477	7%	454	7%
	2006	6,757	5,392	80%	668	10%	696	10%
25-39	2002	11,466	9,639	84%	1,588	14%	223	2%
	2006	10,571	9,205	87%	1,034	10%	332	3%
40-59	2002	9,602	7,102	74%	2,186	23%	314	3%
	2006	11,121	8,486	76%	2,322	21%	311	3%
60+	2002	2,743	1,444	53%	971	35%	303	11%
	2006	3,258	1,587	49%	1,263	39%	409	13%
Employment status								
Employed	2002	21,371	17,345	81%	3,372	16%	590	3%
	2006	22,338	18,530	83%	3,043	14%	765	3%
Not employed	2002	9,023	6,365	71%	1,876	21%	705	8%
	2006	9,370	6,104	65%	2,258	24%	1,009	11%
Education								
Less than Grade 9	2002	3,542	2,101	59%	1,117	32%	324	9%
	2006	3,262	1,727	53%	1,141	35%	393	12%
Grade 9 to 11	2002	7,843	6,133	78%	1,288	16%	370	5%
	2006	7,592	5,861	77%	1,223	16%	508	7%
High school diploma	2002	6,147	4,991	81%	927	15%	229	4%
	2006	6,471	5,264	81%	1,037	16%	171	3%
Trades certificate or diploma	2002	2,258	1,805	80%	419	19%	18	1%
	2006	2,764	2,072	75%	593	21%	99	4%
College certificate or diploma	2002	4,867	3,945	81%	686	14%	188	4%
	2006	5,556	4,366	79%	897	16%	293	5%
University degree	2002	5,455	4,599	84%	690	13%	166	3%
	2006	6,064	5,343	88%	409	7%	311	5%
Income								
Less than $20,000	2002	11,054	7,881	71%	2,287	21%	834	8%
	2006	9,113	6,266	69%	1,897	21%	949	10%

	Year	Number	Current Drinker	%	Former drinker	%	Never drinker	%
$20,000 to $39,000	2002	5,838	4,785	82%	838	14%	167	3%
	2006	5,310	4,188	79%	1,017	19%	104	2%
$40,000 to $59,000	2002	5,257	4,325	82%	757	14%	159	3%
	2006	5,758	4,500	78%	886	15%	372	6%
$60,000 or more	2002	6,594	5,437	82%	1,084	16%	73	1%
	2006	9,190	7,869	86%	1,121	12%	200	2%
Aboriginal	2002	14,037	9,880	70%	3,431	24%	658	5%
	2006	15,303	10,590	69%	3,654	24%	1,061	7%
Males	2002	7,013	5,122	73%	1,557	22%	266	4%
	2006	7,697	5,954	77%	1,446	19%	298	4%
Females	2002	7,024	4,758	68%	1,874	27%	392	6%
	2006	7,606	4,636	61%	2,208	29%	763	10%
Non-aboriginal	2002	16,087	13,715	85%	1,713	11%	611	4%
	2006	16,411	14,062	86%	1,634	10%	715	4%
Males	2002	8,698	7,558	87%	945	11%	195	2%
	2006	8,797	7,830	89%	662	8%	305	3%
Females	2002	7,389	6,157	83%	768	10%	416	6%
	2006	7,614	6,232	82%	972	13%	410	5%
Yellowknife	2002	13,355	11,438	86%	1,406	11%	495	4%
	2006	14,548	12,110	83%	1,544	11%	895	6%
Males	2002	6,913	6,034	87%	739	11%	124	2%
	2006	7,437	6,355	85%	675	9%	407	5%
Females	2002	6,442	5,404	84%	667	10%	371	6%
	2006	7,111	5,755	81%	869	12%	488	7%
Aboriginal	2002	2,659	2,022	76%	585	22%	36	1%
	2006	2,984	2,144	72%	477	16%	363	12%
Non-aboriginal	2002	10,671	9,416	88%	797	7%	458	4%
	2006	11,550	9,966	86%	1,054	9%	531	5%
Regional Centres	2002	7,335	5,426	74%	1,503	20%	358	5%
	2006	7,233	5,252	73%	1,557	22%	424	6%
Males	2002	3,863	2,963	77%	786	20%	114	3%
	2006	3,753	3,174	85%	488	13%	91	2%
Females	2002	3,472	2,463	71%	717	21%	244	7%
	2006	3,480	2,078	60%	1,069	31%	333	10%
Aboriginal	2002	3,467	2,407	69%	754	22%	306	9%
	2006	3,702	2,303	62%	1,146	31%	253	7%
Non-aboriginal	2002	3,737	2,966	79%	696	19%	27	1%
	2006	3,531	2,950	84%	411	12%	170	5%
Rest of Communities	2002	9,739	6,883	71%	2,338	24%	441	5%

	Year	Number	Current Drinker	%	Former drinker	%	Never drinker	%
	2006	9,977	7,322	73%	2,199	22%	456	5%
Males	2002	5,115	3,786	74%	1,030	20%	222	4%
	2006	5,348	4,287	80%	957	18%	104	2%
Females	2002	4,624	3,097	67%	1,308	28%	219	5%
	2006	4,629	3,035	66%	1,242	27%	352	8%
Aboriginal	2002	7,912	5,451	69%	2,093	26%	316	4%
	2006	8,615	6,143	71%	2,029	24%	442	5%
Non-aboriginal	2002	1,677	1,332	79%	220	13%	125	7%
	2006	1,331	1,147	86%	170	13%	14	1%

Source: NWT Addiction Surveys of 2002 and 2006

Table 7.2-23
High School Graduation Rate for the Northwest Territories and Canada, 1994-2001

Community	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Canada	77.4	76.6	75.9	75.2	76.1	76.6	75.9
NWT	37.5	33.6	37.0	38.8	42.2	38.8	44.6

Source: NWT data – NWT Education, Culture & Employment; Canadian data – Statistics Canada
Rates expressed as graduates per 100 eligible students.

Table 7.2-24
Percentage of Population Age 15 or Older with at Least High School Diploma in Canada and NWT, 1986 to 2006

% of population age 15 or older with at least high school	1986	1991	1996	2001	2006
Canada	52%	59%	63%	67%	76%
NWT					67%
NWT – aboriginal identity					45%

Sources: Statistics Canada, Census of Population. Last modified: 2009-10-06.
http://www40.statcan.gc.ca/l01/cst01/educ42-eng.htm (accessed on April 19, 2010).
Statistics Canada, Community Profiles. http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E (accessed on June 28, 2010)

Table 7.2-25 shows that enrollment in grades 10 to 12 has increased between 2001-02 and 2009-10; Table 7.2-26 shows that the number of students who graduate high school has increased from 2001 to 2009 for both Aboriginals (91% increase) and non-Aboriginals (28% increase). Figure 7.2-21 shows the highest level of schooling in NWT and Canada in 2006 among the population 15 years old or older.

Table 7.2-25
School Enrollment in NWT, 2001-02 to 2009-10

Year	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Total Enrollment	9,766	9,872	9,727	9,608	9,572	9,324	9,048	8,762	8,551
Kindergarten	693	657	613	607	647	597	579	601	590
Grades 1 to 6	4,791	4,690	4,563	4,347	4,101	3,925	3,689	3,521	3,391
Grades 7 to 9	2,217	2,239	2,260	2,297	2,296	2,230	2,206	2,076	1,980
Grades 10 to 12	2,065	2,286	2,291	2,357	2,528	2,572	2,574	2,564	2,590

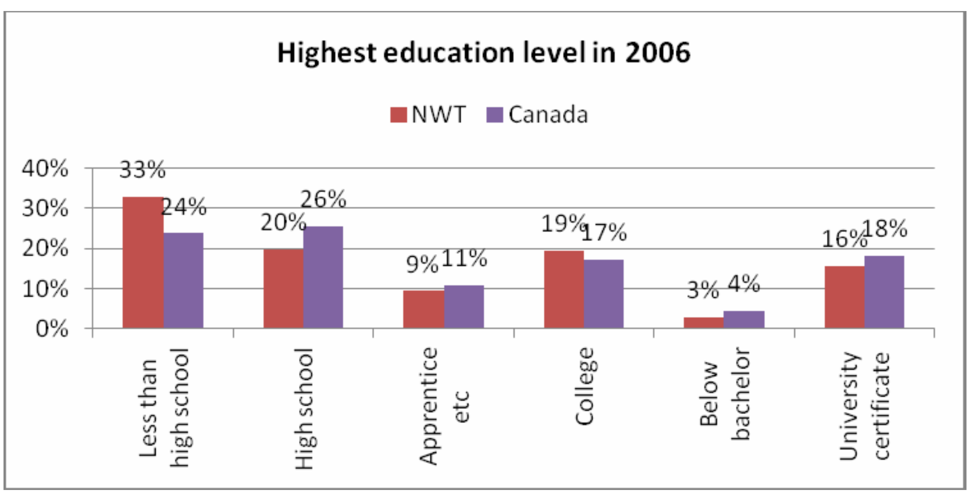
Source: http://www.stats.gov.nt.ca/education/school-enrollment-graduates/

Table 7.2-26
High School Graduates in NWT By Ethnicity, 2001 to 2009

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	285	244	283	304	353	377	377	418	433
Dene	68	67	66	69	112	129	93	117	133
Métis	22	13	21	20	24	29	32	45	32
Inuit	26	16	32	34	37	38	49	48	57
Non-Aboriginal	169	148	164	181	180	181	203	208	211
Aboriginal	116	96	119	123	173	196	174	210	222

Source: http://www.stats.gov.nt.ca/education/school-enrollment-graduates/

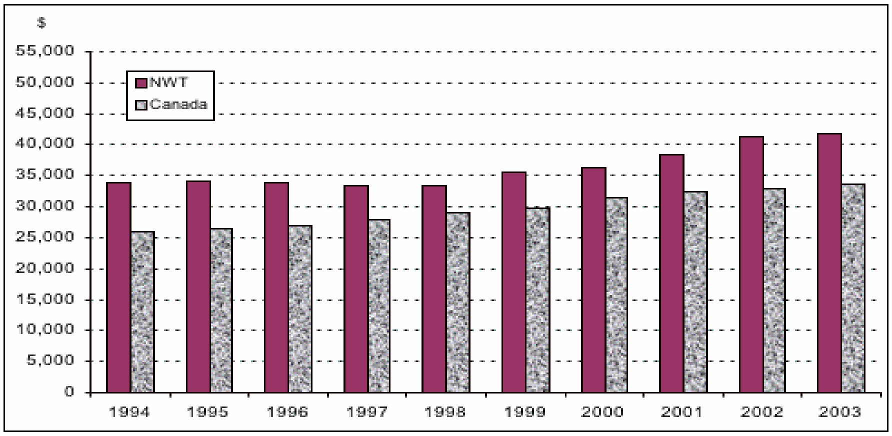
Figure 7.2-21
Highest Level of Education in NWT and Canada among Population 15 Years Old or Older, 2006



Source: Statistics Canada, Community Profiles for 2006 (accessed April 18, 2010)

***Employment income* -** Interestingly, high school graduation rate is lower in the NWT than in Canada but the average employment income is higher for the NWT than the rest of Canada (Figure 7.2-22 and Table 7.2-27). For specific communities, family income is also quite high (Table 7.2-28). These statistics question the adage that "wealth is health", a relationship seen in developed countries. However, discrepancies in this relationship in the NWT as compared to Canada merits investigation with respect to what factors actually contribute to the differences, and indicate areas of intervention to close that gap.

Figure 7.2-22
Average Employment Income for Canada and NWT, 1994-2003



Source: NWT Bureau of Statistics

Table 7.2-27
Average Personal Income in NWT, 2002 To 2006

Year	Northwest Territories
2007	$50,627
2006	$47,856
2005	$45,843
2004	$43,969
2003	$41,904
2002	$41,428
2001	$38,497
2000	$36,187
1999	$35,450
1998	$33,476
1997	$33,364
1996	$33,460
1995	$33,932
1994	$33,931

Source: http://www.stats.gov.nt.ca/labour-income/income/ (accessed June 18, 2010)

Table 7.2-28
Average Family Income By Community in the NWT, 1994-2007

Year	Northwest Territories	Aklavik	Behchokö	Deline	Fort Good Hope	Fort Liard	Fort McPherson
1994	64,985	41,567	36,939	39,021	36,279	42,991	42,357
1995	66,150	37,126	36,616	41,529	38,629	37,983	42,186
1996	65,506	36,222	37,113	42,031	37,843	37,550	41,645
1997	66,367	36,478	37,820	41,123	38,031	39,075	40,163
1998	68,948	41,044	40,252	44,331	37,815	42,800	38,915
1999	70,463	42,625	42,700	43,492	40,400	48,800	40,740
2000	71,864	44,781	43,219	39,523	46,877	52,671	43,274
2001	80,225	51,606	54,871	50,564	50,762	55,273	49,352
2002	87,143	51,141	57,139	49,757	52,231	58,773	57,248
2003	88,244	50,371	58,502	53,057	51,464	56,231	52,350
2004	91,362	50,387	64,379	57,843	54,243	54,359	62,138
2005	96,171	53,140	69,981	62,929	60,346	56,156	63,519
2006	101,622	55,813	69,867	67,457	64,538	56,175	61,348
2007	107,252	56,063	77,936	72,923	65,250	57,906	67,900

Year	Fort Providence	Fort Resolution	Fort Simpson	Fort Smith	Gamètì	Hay River	Inuvik
1994	37,237	27,973	51,263	56,334	36,820	63,022	61,591
1995	39,875	30,193	53,944	56,710	..	62,951	62,833
1996	38,633	32,464	53,214	57,306	32,767	62,521	60,497
1997	40,748	32,900	52,522	59,430	42,040	62,191	60,043
1998	42,114	38,400	54,065	60,095	35,033	65,349	64,908
1999	42,443	34,286	59,717	66,429	40,443	67,662	67,094
2000	41,795	36,377	61,514	64,977	42,457	73,079	67,644
2001	47,591	43,893	65,062	72,156	55,743	80,763	77,417
2002	50,243	45,807	71,632	77,935	55,571	85,307	85,280
2003	53,110	45,838	70,668	77,947	54,357	87,681	87,461
2004	53,290	43,354	76,597	80,899	74,920	90,495	87,750
2005	53,052	49,815	79,654	83,022	55,500	95,902	89,233
2006	54,314	47,271	81,211	88,129	66,343	105,661	95,392
2007	63,833	60,615	91,847	94,072	74,714	116,091	98,005

Year	Lutselk'e	Norman Wells	Paulatuk	Tsiigehtchic	Tuktoyaktuk	Tulita	Ulukhaktok
1994	32,700	75,467	..	..	38,167	34,040	31,209
1995	29,388	80,795	..	..	40,300	39,056	39,480
1996	29,729	86,552	..	..	42,114	31,864	32,882
1997	34,425	90,926	..	..	42,582	38,370	37,764
1998	30,167	92,647	..	..	43,018	35,040	44,756
1999	37,067	93,747	..	..	41,519	40,950	38,330
2000	41,863	94,994	42,183	37,240	38,736	46,550	39,344
2001	44,650	97,953	48,267	..	53,604	49,780	46,527
2002	53,300	104,895	..	45,760	58,733	50,036	54,770
2003	49,978	108,163	42,957	..	54,630	50,927	52,110
2004	47,633	118,814	47,513	55,225	56,904	54,708	56,180
2005	42,878	129,760	50,371	..	68,824	64,358	51,227
2006	45,211	138,495	46,757	..	56,724	66,750	56,770
2007	45,056	155,579	50,429	..	68,575	61,042	60,818

Year	Whati	Wrigley	Yellowknife
1994	35,667	37,275	82,541
1995	37,956	51,700	83,830
1996	40,122	49,175	81,952
1997	38,333	48,300	83,078
1998	35,950	49,133	86,445
1999	43,480	..	86,737
2000	44,109	53,200	88,295
2001	45,427	..	97,377
2002	53,464	..	106,953
2003	62,091	..	107,534
2004	57,169	53,667	111,665
2005	64,618	..	117,023
2006	64,033	..	124,200
2007	70,333	..	128,473

Source: Statistics Canada, Small Area Data Division
Note '..' means data is not available, '-' data is zero or too small to express
Source: http://www.stats.gov.nt.ca/labour-income/income/
(accessed June 18, 2010).

7.2.7 HH Indicator – Environmental Factors

Environmental factors that have been shown to most directly affect human health include the adequacy of potable water and sewage treatment systems. One of the potential consequences of inadequate water supplies is the contraction of waterborne gastrointestinal illness.

Drinking Water – In 2005, all communities in the NWT had access to potable drinking water except for Colville Lake which is a small community of about 135 people in the Sahtu Region. Colville Lake now has a new water treatment (filtration) system (Duane Fleming. Chief Environmental Health Officer, Personal Communication, June 18, 2010). Currently, all communities have appropriate drinking water purification systems.

***Sewage Disposal* -** All communities in the NWT have a sewage collection/disposal/treatment system except for Colville Lake.

Most homes/buildings in small NWT communities have sewage holding tanks, which are pumped out regularly by sewage trucks. The waste water is then disposed of in lagoons for natural treatment. Some communities utilize wetland treatment instead of lagoons. Only one community (Ft. Simpson) has advanced treatment using mechanical/chemical/biological processes prior to river discharge.

Rae/Edzo and Ft. McPherson have both piped and trucked waste water disposal systems (Tam 2005).

7.3 CONCLUSION AND DISCUSSION

Population-based data from census and vital statistics are the most complete sources of data available for the NWT and are considered to be of good quality. These data can be separated by age, sex, and place of residence, and many by First Nations and Non-First Nations ethnic status. Birth outcome patterns can be examined by age of mother, birth weight, and place of residence as well as First Nations status. The systematic and continuous collection of these data allows for meaningful comparisons over time. Good data are also available for many social determinants (education, employment, income, family income) and life style risk factors (smoking, alcohol and substance abuse).

In addition to census and vital statistics data, the NWT Bureau of Statistics and the Health and Social Services Department report results of surveys which monitor the health status of the residents of Northwest Territories. Examples of these include the Alcohol and Drug Survey and health status reports which review data on a periodic basis (5 years) when meaningful rates are more likely to result for smaller communities. The NWT also has a cancer registry established in the early 1990s. This person-oriented database provides continuous and systematic collection of cancer incidence and mortality in the Territory.

Most NWT regions lack data related to chronic diseases, a problem also common to other areas of Canada. Data gaps include information on major chronic diseases such as musculoskeletal (mobility disorders), neurological and degenerative (dementias), hypertension and stroke, and diabetes. Birth defects are not well documented for the NWT although standardized data collection on this factor will begin in January 2010. With some enhancements, it appears that most outcomes of value can be tracked in the NWT and in regions. Small populations in many communities will likely continue to limit data broken down to the community level. Standardized data collection will begin in January 2010. Reporting of communicable diseases and of immunization of children is not complete. Means of improving data collection on chronic diseases needs to be examined.

Despite the excellent efforts in gathering meaningful data in the NWT, there are intrinsic challenges in the collection, analysis, and dissemination of these data related to the NWT's low and dispersed population. Health outcomes in small communities can be measured, but reporting them may result in breach of confidentiality because of small numbers of cases which apply. Also, with few outcomes, rates on a year by year basis are unstable and one may not draw useful conclusions if following them over time.

Overall, most health characteristics considered worth tracking longitudinally are well documented. Longitudinal tracking can provide a good picture of where resources may be best put in order to make the most important interventions and contributions to the improvement of health status. One important indicator not specifically mentioned above is the routine tracking of health status by public health agencies. This important activity, which serves to provide an objective measure of population health change over time, was reported to the public sometime in 2005 (Corriveau 2005) and is the subject of a new report due in fall 2010. Documentation of changes in environmental factors such as drinking water supply and sewage management has improved.

There are some improvements overall in some health measures and determinants with many remaining fairly stable and others requiring more data collection. Emerging trends point to:

- A slowly growing population in the NWT, especially the aboriginal population which is growing because of an increase in the total fertility rate;
- Reductions in the infant mortality rate;
- A reduction in low birth weight births;

- Reductions in the age standardized mortality rates for males and females in the NWT:
    - reductions in mortality from accidents, suicides and homicides;
    - reductions in mortality from cardiovascular diseases;
- Increasing rates of STIs, almost exclusively in the aboriginal population;
- Slow declines in the proportion of current smokers;
- Reduced heavy drinking;
- Increasing number of high school graduates for both aboriginals and non-aboriginals; and,
- Continued growth in personal income.

These emerging trends are based upon changes in recent years and may be the result of chance fluctuations which arise frequently in small populations or when surveys contain small numbers of subjects. Further follow-up will help determine if the trends noted above indicate real change or are simply due to chance.

Reports studied for this State of Environment update indicate that:

- Fewer residents of NWT than Canada report good or excellent mental health;
- Fewer residents of NWT than Canada report having arthritis;
- Diabetes and asthma make be less prevalent in NWT than in Canada;
- Medically diagnosed high blood pressure is less prevalent in NWT than in Canada;
- Prevalence of daily smoking and heavy drinking is greater in NWT than in Canada;
- Fruit and vegetable consumption 5 times or more per day is less common in NWT than in Canada;
- Fewer NWT residents than Canada have a regular medical doctor;
- NWT residents are just as likely to have a flu shot as other Canadians; and,
- More NWT residents are satisfied with their life than other Canadians.

In addition, there are improvements in environmental health measures such as clean, treated drinking water for all, and plans for improvements in data collection of some of the missing data (i.e. birth defects) to be implemented in the near future. Taken together, there have been considerable improvements in the human health measures of the NWT valued components and on the data collection systems that help evaluate these over time.

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ATTACHMENT 7A

POPULATION DEMOGRAPHICS

Table 7A.1-1
Components of Population Change in NWT By Time Period (January 1, 2001 to December 31, 2009)

Year	Period	Beginning Population	Ending Population	Births	Deaths	Inter-provincial Migration			Net International
						In	Out	Net	
2009	Jan-Dec	43,419	43,281	729	201	2,110	2,798	-688	102
	Oct-Dec	43,244	43,281	155	39	354	422	-68	7
	Jul-Sep	43,439	43,244	212	63	572	929	-357	39
	Apr-Jun	43,349	43,439	170	49	581	657	-76	63
	Jan-Mar	43,419	43,349	192	50	603	790	-187	-7
2008	Jan-Dec	43,620	43,419	726	197	2,175	3,054	-879	102
	Oct-Dec	43,615	43,419	153	38	448	786	-338	29
	Jul-Sep	43,720	43,615	209	61	735	984	-249	-16
	Apr-Jun	43,687	43,720	171	49	493	693	-200	84
	Jan-Mar	43,620	43,687	193	49	499	591	-92	5
2007	Jan-Dec	43,175	43,578	725	191	2,230	2,339	-109	100
	Oct-Dec	43,463	43,578	153	36	486	387	99	-41
	Jul-Sep	43,545	43,693	210	59	606	833	-227	20
	Apr-Jun	43,247	43,369	170	48	667	573	94	100
	Jan-Mar	43,175	43,319	192	48	471	546	-75	21
2006	Jan-Dec	NA	NA	NA	NA	NA	NA	NA	NA
	Oct-Dec	43,254	43,358	139	35	360	525	-165	0
	Jul-Sep	43,198	43,326	185	57	704	779	-75	29
	Apr-Jun	NA	NA	NA	NA	NA	NA	NA	NA
	Jan-Mar	NA	NA	NA	NA	NA	NA	NA	NA
2005	Jan-Dec	NA	NA	NA	NA	NA	NA	NA	NA
	Oct-Dec	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-Sep	NA	NA	NA	NA	NA	NA	NA	NA
	Apr-Jun	NA	NA	NA	NA	NA	NA	NA	NA
	Jan-Mar	NA	NA	NA	NA	NA	NA	NA	NA
2004	Jan-Dec	NA	NA	NA	NA	NA	NA	NA	NA

Year	Period	Beginning Population	Ending Population	Births	Deaths	Inter-provincial Migration			Net International
						In	Out	Net	
	Sep-Dec	NA	NA	NA	NA	NA	NA	NA	NA
	Jul-Sep	42,810	42,925	155	48	654	660	-6	14
	Apr-Jun	42,585	42,810	177	44	790	731	59	33
	Jan-Mar	42,629	42,585	166	42	739	944	-205	37
2003	Jan-Dec	41,791	42,629	637	172	2,664	2,439	225	148
	Oct-Dec	42,362	42,629	142	40	510	418	92	73
	Jul-Sep	42,206	42,362	151	48	907	884	23	30
	Apr-Jun	41,964	42,206	178	43	678	605	73	34
	Jan-Mar	41,791	41,964	166	41	569	532	37	11
2002	Jan-Dec	41,107	41,791	635	169	2,724	2,511	213	5
	Oct-Dec	41,674	41,791	142	39	491	465	26	-12
	Jul-Sep	41,489	41,674	151	47	924	818	106	-25
	Apr-Jun	41,239	41,489	177	42	640	533	107	8
	Jan-Mar	41,107	41,239	165	41	669	695	-26	34
2001	Jan-Dec	40,646	41,107	613	163	2,405	2,444	-39	90
	Oct-Dec	41,144	41,107	147	37	389	525	-136	-11
	Jul-Sep	40,822	41,144	162	44	971	832	139	65
	Apr-Jun	40,638	40,822	160	34	595	541	54	20
	Jan-Mar	40,646	40,638	144	48	450	546	-96	16

Note: Net International represents the net total of all Immigrants, Emigrants, Returning Canadians, Non-Permanent Residents and Individuals Temporarily Abroad.
Source: Statistics Canada, Demography Division. http://www.statcan.gc.ca/pub/91-002-x/2009004/t346-eng.htm accessed May 18, 2010

Table 7A.1-2
Potential Years of Life Lost (<75 Years) in Northwest Territories (1999-2002)

Cause	**Year**			
	2002	**2001**	**2000**	**1999**
Total	2,861	2,587	2,570	3,328
Infectious & Parasitic Diseases	35	54	76	38
Neoplasms	717	426	463	582
Endocrine, Nutritional & Metabolic Diseases & Immunity Disorders		54	11	87
Diseases of Blood and Blood Forming Organs		-	70	-
Mental Disorders	25	104	123	49
Diseases of Nervous System & Sense Organs		59	7	26
Diseases of the Circulatory System	205	289	82	330
Diseases of the Respiratory System	81	86	57	34
Diseases of the Digestive System	81	112	108	15
Diseases of the Genito-Urinary System	57	-	5	32
Complications of Pregnancy, Childbirth & the Puerperium		-	-	-
Diseases of the Skin and Subcutaneous Tissue		-	-	-
Diseases of the Musculo-Skeletal System & Connective Tissue		13	-	-
Congenital Anomalies	497	-	-	75
Conditions Originating in the Perinatal Period	75	150	375	375
Symptoms, Signs & Ill-Defined Conditions	160	118	35	250
Accidents (Including Suicides)	928	1,122	1,158	1,435

Source: Prepared by NWT Bureau of Statistics, November 2004

Notes:

1. Potential Years of Life Lost is defined as the difference in years between an average life expectancy (75 years) and the age at which a person dies.
2. The small number of total deaths in the Northwest Territories may cause some variation in the data.
3. The data provided in this table use the ICD-9 classification of cause of death. As of 2000, Statistics Canada began using ICD-10, therefore, to display ICD-10 data in the ICD-9 categories, Diseases of the Nervous System, Diseases of the Eye and Diseases of the Ear were aggregated into Diseases of the Nervous System and Sense Organs. For other differences between ICD-9 and ICD-10, please contact the NWT Bureau of Statistics.

Table 7A.1-3
Potential Years of Life Lost for Both Sexes in Canada and NWT from Suicide and Unintentional Injuries, 1991 to 2004

Year	Canada		NWT	
	Unintentional injuries	Suicides	Unintentional injuries	Suicides
1991	886.6	453.6	1825.1	955.2
1992	836.3	464.2	2463.9	327.2
1993	869.6	461.7	2775.3	919.7
1994	780.8	450.8	1717.4	360.9
1995	780.1	475.5	1786.4	524.3
1996	698.7	456.3	2637.6	399.7
1997	701.0	419.1	1079.2	618.4
1998	682.3	420.2	981.7	747.3
1999	706.6	453.2	1866.7	1515.4
2000	651.3	403.4	2103.1	664.0
2001	635.7	398.9	1665.5	845.2
2002	644.6	385.0	984.8	857.5
2003	612.2	389.6	1382.0	913.3
2004	586.9	371.8	497.7	977.5

Source: Statistics Canada. Table 102-0110 - Potential years of life lost, by selected causes of death (ICD-10) and sex, population aged 0 to 74, Canada, provinces and territories, annual, CANSIM (database) and Statistics Canada. Table 102-0010 - Potential years of life lost, by selected causes of death (ICD-9) and sex, population aged 0 to 74, Canada, provinces and territories, annual, CANSIM (database). (accessed April 19, 2010)

Figure 7A.1-1
Potential Years of Life Lost to Age 75 Per 100,000 Population from Accidents for Both Sexes, 1991 to 2004

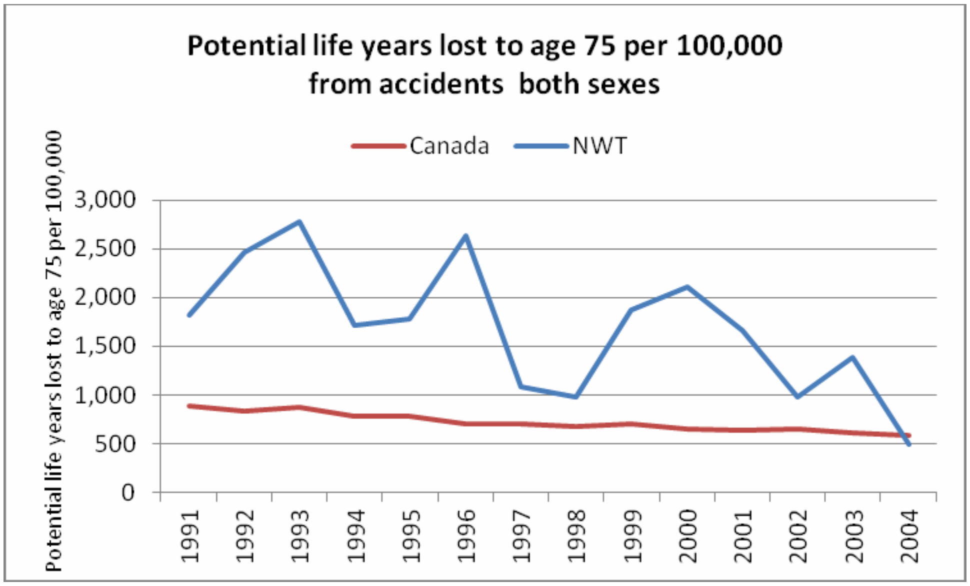


Figure 7A.1-2
Potential Years of Life Lost to Age 75 per 100,000 Population from Suicide for Both Sexes, 1991 to 2004

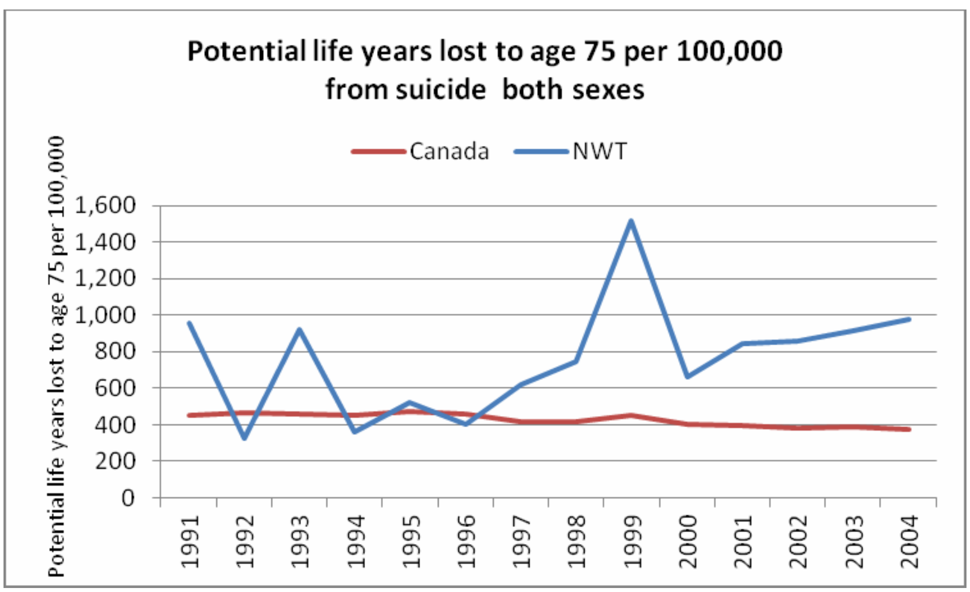


Table 7A.1-4
Census Populations, Females Population Aged 15 to 44, Average Birth and Fertility Rates

Year	Population				Females (15 - 44)				Average Birth Rate				Average Fertility Rate			
	2001	1996	1991	1986	2001	1996	1991	1986	2001	1996	1991	1986	2001	1996	1991	1986
Total NWT	37,360	39,672	36,405	33,830	9,175	10,165	9,630	8,910	17.9	21.1	23.6	24.8	72.7	82.3	89.3	94.1
Inuvik Region	8,536	9,447	8,852	8,714	1,990	2,225	2,145	2,230	19.2	24.9	27.4	29.0	82.3	105.9	113.2	113.2
Aklavik	632	727	801	763	125	135	175	170	15.2	21.2	28.5	26.7	76.8	114.1	130.3	120.0
Colville Lake	102				15				27.5				186.7			
Deline	536	616	551	532	130	145	110	120	20.1	31.8	29.8	4.1	83.1	135.2	149.1	18.3
Fort Good Hope	549	644	602	562	120	135	120	110	18.9	24.8	33.6	33.5	86.7	118.5	168.3	170.9
Fort McPherson	761	878	759	760	160	180	160	180	16.8	23.9	25.6	24.2	80.0	116.7	121.3	102.2
Holman	398	423	361	303	105	120	100	85	16.1	34.5	27.7	26.4	61.0	121.7	100.0	94.1
Inuvik	2,894	3,296	3,206	3,389	730	880	865	990	21.4	25.4	25.1	27.9	84.7	95.2	92.9	95.6
Norman Wells	666	798	627	627	150	210	185	170	18.3	22.1	21.4	18.5	81.3	83.8	72.4	68.2
Paulatuk	286	277	255	193	60	50	50	45	14.7	24.5	40.0	32.1	70.0	136.0	204.0	137.8
Sachs Harbour	114	135	125	158	25	35	25	35	26.3	19.3	33.6	20.3	120.0	74.3	168.0	91.4
Tsiigehtchic	195	162	144	108	50	45	15	25	21.5	25.9	25.0	16.7	84.0	93.3	240.0	72.0
Tuktoyaktuk	930	943	918	929	215	200	220	215	19.6	21.6	29.8	40.0	84.7	102.0	124.5	173.0
Tulita	473	450	375	332	95	95	95	75	15.6	24.0	33.6	27.7	77.9	113.7	132.6	122.7
Fort Smith Region	28,824	30,225	27,553	25,116	7,185	7,940	7,480	6,680	17.5	19.7	22.2	23.2	70.0	75.0	81.7	87.3
Detah	182	190	150	131	45	45	30	20	11.0	11.6	12.0	7.6	44.4	48.9	60.0	50.0
Fort Liard	530	512	485	395	130	120	115	80	20.8	22.3	30.9	18.7	84.6	95.0	130.4	92.5
Fort Providence	753	748	645	588	165	175	145	130	18.1	23.3	27.6	20.4	82.4	99.4	122.8	92.3
Fort Resolution	525	536	515	447	110	100	120	100	16.8	19.4	29.1	7.2	80.0	104.0	125.0	32.0
Fort Simpson	1,163	1,257	1,142	987	270	325	290	260	15.6	21.6	21.2	28.6	67.4	83.7	83.4	108.5
Fort Smith	2,185	2,441	2,480	2,460	495	610	635	645	14.8	18.4	19.9	20.4	65.5	73.4	77.8	77.8
Hay River	3,510	3,611	3,253	3,006	825	880	840	780	18.2	20.2	23.1	25.3	77.6	82.7	89.3	97.4
Hay River Rsrv	269	253	216	180	50	60	45	45	0.9	0.8	1.9	1.1	5.0	3.3	8.9	4.4
Lutselk'e	248	304	286	273	55	60	70	45	40.3	21.7	32.9	26.4	181.8	110.0	134.3	160.0
Nahanni Butte	107				25				18.7				80.0			
Rae Lakes	274	256	252	183	45	45	55	40	22.6	28.9	22.2	16.4	137.8	164.4	101.8	75.0
Rae-Edzo	1,552	1,662	1,521	1,378	335	380	315	280	30.4	30.8	31.8	25.8	140.9	134.7	153.7	127.1
Wekweti	131	135	127	119	30	30	20	20	18.3	14.8	14.2	23.5	80.0	66.7	90.0	140.0
Wha Ti	453	418	392	345	90	90	65	75	22.5	22.5	31.1	27.8	113.3	104.4	187.7	128.0
Wrigley	165	167	174	161	25	35	40	30	19.4	26.3	21.8	21.1	128.0	125.7	95.0	113.3
Yellowknife	16,541	17,275	15,179	11,753	4,435	4,895	4,550	3,440	16.4	18.7	21.0	21.6	61.1	65.9	70.2	73.9

Notes: 1) Source: Statistics Canada, census data and vital statistics databases, prepared by NWT Bureau of Statistics.
2) Birth and Fertility rates represent the number of births per 1000 population and per 1000 females 15 to 44 respectively. For communities with small populations these rates should be used with caution.
3) Figures for unorganized areas and communities with populations less than 100 are not reported. These figures are included in Regional and Territorial totals.

Table 7A.1-5
Infant Mortality Per 1,000 Live Births in Northwest Territories and Canada (1981–2007)

Year	Northwest Territories	Canada
2007	4.1	5.1
2006	10.2	5.0
2005	4.2	5.4
2004	0	5.3
2003	5.7	5.3
2002	11.0	5.4
2001	4.9	5.2
2000	8.9	5.3
1999	12.1	5.3
1998	17.7	5.3
1997	6.9	5.5
1996	4.9	5.6
1995	9.2	6.1
1994	12.2	6.3
1993	7.2	6.3
1992	10.6	6.1
1991	7.7	6.4
1990	3.4	6.8
1989	8.6	7.1
1988	8.2	7.2
1987	13.1	7.3
1986	12.1	7.9
1985	10.9	8.0
1984	19.2	8.1
1983	19.0	8.5
1982	13.7	9.1
1981	12.7	9.6

Source: Prepared by NWT Bureau of Statistics, November, 2004 and **Source:** Statistics Canada. *Table 102-0507 - Infant deaths and mortality rates, by age group, Canada, provinces and territories, annual*, CANSIM (database) (accessed April 5, 2010).

Table 7A.1-6
Leading Causes of Death per 10,000 Populations in Northwest Territories (1999-2001)

Cause of Death	**Canada Age-Sex Adjusted**	**NWT 5 Yr. Avg.**	**2001**	**2000**	**1999**
All Causes Total	31.70	37.17	39.54	38.19	39.54
Infectious & Parasitic Diseases	0.53	1.07	0.49	1.71	1.46
Neoplasms	9.62	9.47	8.97	10.53	10.50
Endocrine, Nutritional & Metabolic Diseases & Immunity Disorders	1.21	1.07	1.94	0.49	1.46
Diseases of Blood and Blood Forming Organs	0.12	0.10	-	0.24	-
Mental Disorders	0.75	0.97	1.21	1.47	0.73
Diseases of Nervous System & Sense Organs	1.29	0.97	1.21	0.98	0.49
Diseases of the Circulatory System	9.25	7.91	7.76	6.61	9.52
Diseases of the Respiratory System	2.14	3.50	3.88	3.92	2.44
Diseases of the Digestive System	1.19	1.56	2.91	1.71	0.73
Diseases of the Genito-Urinary System	0.51	0.44	0.49	0.49	0.73
Complications of Pregnancy, Childbirth & the Puerperium	0.01	-	-	-	-
Diseases of the Skin and Subcutaneous Tissue	0.04	-	-	-	-
Diseases of the Musculo-Skeletal System & Connective Tissue	0.19	0.10	0.24	0.24	-
Congenital Anomalies	0.34	0.44	-	-	0.24
Conditions Originating in the Perinatal Period	0.44	0.78	0.49	1.22	1.22
Symptoms, Signs & Ill-Defined Conditions	0.63	1.70	2.43	0.98	1.22
Accidents (Including Suicides)	3.45	7.10	7.52	7.59	8.79
Suicides	1.13	2.09	1.94	1.71	3.66

Notes:

1. For comparability, Canadian death rates by cause were applied to the NWT population on July 1, 2001 to calculate adjusted Canadian rates.
2. The data provided in this table use the ICD-9 classification of cause of death. As of 2000, Statistics Canada began using ICD-10; therefore, to display ICD-10 data in the ICD-9 categories, Diseases of the Nervous System, Diseases of the Eye and Diseases of the Ear were aggregated into Diseases of the Nervous System and Sense Organs. For other differences between ICD-9 and ICD-10, please contact the NWT Bureau of Statistics.

Table 7A.1-7
Age Standardized Mortality Rates from Selected Causes of Death in Canada and NWT, 2000 to 2005

	Age standardized mortality rates per 100,000					
Cause and location	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Accidents (unintentional injuries)						
Canada	25.8	25.1	26.0	25.5	24.7	25.6
NWT	71.0	60.1	36.1	82.8	29.8	50.1
Alzheimer's disease						
Canada	13.2	13.9	13.7	13.1	12.7	12.7
NWT	6.8	7.4	17.3	7.9	7.5	0.0
Anaemias						
Canada	1.2	1.3	1.3	1.3	1.0	1.1
NWT	0.0	0.0	0.0	7.5	0.0	0.0
Assault (homicide)						
Canada	1.6	1.5	1.5	1.5	1.7	1.9
NWT	7.1	4.7	8.5	2.2	4.5	0.0
Certain conditions originating in the perinatal period						
Canada	3.9	4.0	4.0	4.2	4.3	4.4
NWT	10.6	4.7	2.3	4.1	0.0	0.0
Chronic liver disease and cirrhosis						
Canada	6.5	6.5	6.6	6.4	6.0	6.1
NWT	13.1	28.6	9.1	2.1	3.6	1.8
Chronic lower respiratory diseases						
Canada	27.2	26.3	25.9	25.8	24.8	25.1
NWT	65.0	46.5	90.5	64.9	20.8	68.3
Congenital malformations, deformations and chromosomal abnormalities						

	Age standardized mortality rates per 100,000					
Cause and location	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Canada	3.4	3.3	3.3	3.3	3.1	3.2
NWT	0.0	0.0	22.7	2.0	1.8	0.0
Diabetes mellitus						
Canada	18.9	19.3	20.9	20.5	19.6	19.1
NWT	12.7	28.3	22.5	13.2	24.5	12.9
Hernia						
Canada	0.6	0.5	0.6	0.6	0.7	0.6
NWT	0.0	0.0	0.0	6.2	0.0	9.7
Human immunodeficiency virus [HIV] disease						
Canada	1.6	1.3	1.2	1.3	1.2	1.3
NWT	2.2	0.0	0.0	0.0	0.0	0.0
Influenza and pneumonia						
Canada	13.2	12.2	11.9	12.0	13.4	13.2
NWT	14.3	36.2	29.0	40.5	19.0	35.3
Intentional self-harm (suicide)						
Canada	11.4	11.4	11.2	11.3	10.8	10.9
NWT	21.9	18.9	22.2	21.7	24.2	8.8
Major cardiovascular diseases						
Canada	209.1	197.5	192.1	185.0	175.6	167.4
NWT	184.7	170.8	301.3	279.0	198.1	102.7
Malignant neoplasms						
Canada	180.4	178.7	178.2	175.6	173.7	170.3
NWT	236.5	186.2	167.4	288.6	187.3	195.2
Meningitis						
Canada	0.2	0.2	0.2	0.2	0.2	0.2
NWT	6.7	0.0	0.0	0.0	0.0	5.0

	Age standardized mortality rates per 100,000					
Cause and location	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Meningococcal infection						
Canada	0.1	0.1	0.1	0.1	0.0	0.0
NWT	0.0	0.0	0.0	2.0	0.0	0.0
Nephritis, nephrotic syndrome and nephrosis						
Canada	8.6	8.5	8.8	8.7	8.5	8.5
NWT	14.9	14.1	8.7	12.9	0.0	9.0
Nutritional deficiencies						
Canada	0.6	0.6	0.6	0.6	0.6	0.6
NWT	0.0	0.0	0.0	0.0	0.0	0.0
Other acute lower respiratory infections						
Canada	0.3	0.3	0.2	0.2	0.2	0.2
NWT	0.0	0.0	0.0	0.0	0.0	0.0
Other and unspecified infectious and parasitic diseases and their sequelae						
Canada	2.1	1.3	1.4	1.3	1.1	1.3
NWT	3.2	0.0	0.0	6.6	1.8	0.0
Other diseases of respiratory system						
Canada	5.8	5.7	5.6	5.6	6.1	6.2
NWT	10.4	4.1	15.6	0.0	23.2	23.3
Other disorders of circulatory system						
Canada	1.1	1.1	1.1	1.1	1.0	1.0
NWT	0.0	0.0	2.0	2.6	0.0	1.8
Parkinson's disease						
Canada	4.0	4.2	4.3	4.2	4.0	4.4
NWT	0.0	4.1	5.8	7.5	7.5	0.0
Peptic ulcer						

	Age standardized mortality rates per 100,000					
Cause and location	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Canada	1.2	1.3	1.2	1.0	1.1	0.9
NWT	2.2	0.0	0.0	2.0	0.0	0.0
Pneumoconioses and chemical effects						
Canada	0.2	0.2	0.1	0.2	0.2	0.2
NWT	0.0	0.0	0.0	0.0	0.0	0.0
Pneumonitis due to solids and liquids						
Canada	1.9	2.1	2.3	2.6	2.9	3.1
NWT	17.7	0.0	0.0	5.8	0.0	2.1
Septicaemia						
Canada	3.8	3.8	3.9	4.0	4.0	4.1
NWT	11.3	8.9	6.9	0.0	0.0	0.0
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified						
Canada	8.0	8.7	8.7	8.4	7.2	6.4
NWT	24.9	43.0	27.2	56.6	63.9	70.5
Total, all causes of death						
Canada	615.5	600.8	598.2	586.9	571.9	563.7
NWT	821.1	753.2	834.6	960.3	657.5	657.9
Tuberculosis						
Canada	0.2	0.3	0.3	0.2	0.2	0.2
NWT	11.0	0.0	6.9	0.0	0.0	7.5
Viral hepatitis						
Canada	0.4	0.9	1.0	1.0	1.0	1.0
NWT	0.0	0.0	2.1	0.0	0.0	0.0

Table 7A.1-8
Profile of Cigarette Smokers in the Northwest Territories in 2002 and 2006

Smoking	Year	Number	Current smoker	%	Former smoker	%	Never smoker	%
Persons 15 years and over	2002	30,431	13,894	46%	6,302	21%	10,236	34%
	2006	31,759	12,971	41%	7,836	25%	10,952	34%
Males	2002	15,892	7,342	46%	3,377	21%	5,174	33%
	2006	16,539	7,346	44%	4,348	26%	4,845	29%
Females	2002	14,539	6,552	45%	2,925	20%	5,062	35%
	2006	15,220	5,626	37%	3,488	23%	6,106	40%
Age								
15-24	2002	6,413	3,831	60%	456	7%	2,126	33%
	2006	6,757	3,089	46%	688	10%	2,980	44%
25-39	2002	11,466	5,349	47%	1,911	17%	4,207	37%
	2006	10,571	4,407	42%	2,312	22%	3,852	36%
40-59	2002	9,602	3,732	39%	2,941	31%	2,929	31%
	2006	11,121	4,591	41%	3,634	33%	2,895	26%
60+	2002	2,743	903	33%	943	34%	897	33%
	2006	3,258	844	26%	1,189	36%	1,225	38%
Employment status								
Employed	2002	21,371	8,811	41%	4,767	22%	7,792	36%
	2006	22,338	8,883	40%	5,934	27%	7,521	34%
Not employed	2002	9,023	5,069	56%	1,535	17%	2,419	27%
	2006	9,370	4,088	44%	1,903	20%	3,380	36%
Education								
Less than Grade 9	2002	3,542	1,628	46%	992	28%	921	26%
	2006	3,262	1,524	47%	1,015	31%	723	22%

Smoking	**Year**	**Number**	**Current smoker**	**%**	**Former smoker**	**%**	**Never smoker**	**%**
Grade 9 to 11	2002	7,843	4,985	64%	1,249	16%	1,609	21%
	2006	7,592	4,339	57%	1,228	16%	2,026	27%
High school diploma	2002	6,147	2,803	46%	1,137	18%	2,207	36%
	2006	6,471	2,792	43%	1,725	27%	1,954	30%
Trades certificate or diploma	2002	2,258	1,177	52%	545	24%	535	24%
	2006	2,764	1,250	45%	774	28%	740	27%
College certificate or diploma	2002	4,867	1,929	40%	946	19%	1,993	41%
	2006	5,556	2,104	38%	1,539	28%	1,913	34%
University degree	2002	5,455	1,174	22%	1,356	25%	2,925	54%
	2006	6,064	962	16%	1,556	26%	3,545	58%
Income								
Less than $20,000	2002	11,054	6,342	57%	1,433	13%	3,279	30%
	2006	9,113	4,184	46%	1,535	17%	3,394	37%
$20,000 to $39,000	2002	5,838	2,761	47%	1,304	22%	1,772	30%
	2006	5,310	2,410	45%	1,280	24%	1,620	31%
$40,000 to $59,000	2002	5,257	2,178	41%	1,377	26%	1,702	32%
	2006	5,758	2,482	43%	1,639	28%	1,638	28%
$60,000 or more	2002	6,594	1,827	28%	1,841	28%	2,925	44%
	2006	9,190	2,664	29%	2,936	32%	3,590	39%
Aboriginal	2002	14,037	8,504	61%	2,549	18%	2,985	21%
	2006	15,303	8,261	54%	3,898	25%	3,143	21%
Males	2002	7,013	4,383	62%	1,210	17%	1,421	20%
	2006	7,697	4,448	58%	2,178	28%	1,070	14%
Females	2002	7,024	4,121	59%	1,339	19%	1,564	22%
	2006	7,606	3,813	50%	1,720	23%	2,073	27%
Non-aboriginal	2002	16,087	5,213	32%	3,674	23%	7,199	45%

Smoking	**Year**	**Number**	**Current smoker**	**%**	**Former smoker**	**%**	**Never smoker**	**%**
	2006	16,411	4,710	29%	3,925	24%	7,777	47%
Males	2002	8,698	2,858	33%	2,114	24%	3,727	43%
	2006	8,797	2,898	33%	2,156	25%	3,743	43%
Females	2002	7,389	2,355	32%	1,560	21%	3,472	47%
	2006	7,614	1,812	24%	1,769	23%	4,034	53%
Yellowknife	2002	13,355	4,668	35%	2,941	22%	5,748	43%
	2006	14,548	4,361	30%	3,517	24%	6,670	46%
Males	2002	6,913	2,442	35%	1,447	21%	3,025	44%
	2006	7,437	2,419	33%	1,896	25%	3,122	42%
Females	2002	6,442	2,226	35%	1,494	23%	2,723	42%
	2006	7,111	1,942	27%	1,621	23%	3,548	50%
Aboriginal	2002	2,659	1,356	51%	576	22%	728	27%
	2006	2,984	1,370	46%	817	27%	797	27%
Non-aboriginal	2002	10,671	3,310	31%	2,340	22%	5,020	47%
	2006	11,550	2,991	26%	2,687	23%	5,872	51%
Regional Centres	2002	7,335	3,225	44%	1,722	23%	2,388	33%
	2006	7,233	3,250	45%	1,864	26%	2,120	29%
Males	2002	3,863	1,547	40%	1,128	29%	1,188	31%
	2006	3,753	1,987	53%	954	25%	813	22%
Females	2002	3,472	1,678	48%	594	17%	1,200	35%
	2006	3,480	1,263	36%	910	26%	1,307	38%
Aboriginal	2002	3,467	2,003	58%	618	18%	847	24%
	2006	3,702	1,952	53%	920	25%	829	22%
Non-aboriginal	2002	3,737	1,197	32%	1,051	28%	1,489	40%
	2006	3,531	1,297	37%	943	27%	1,290	37%
Rest of Communities	2002	9,739	6,001	62%	1,639	17%	2,100	22%

Smoking	Year	Number	Current smoker	%	Former smoker	%	Never smoker	%
	2006	9,977	5,360	54%	2,456	25%	2,162	22%
Males	2002	5,115	3,353	66%	802	16%	961	19%
	2006	5,348	2,939	55%	1,498	28%	911	17%
Females	2002	4,624	2,648	57%	837	18%	1,139	25%
	2006	4,629	2,421	52%	957	21%	1,251	27%
Aboriginal	2002	7,912	5,145	65%	1,356	17%	1,410	18%
	2006	8,615	4,939	57%	2,161	25%	1,515	18%
Non-aboriginal	2002	1,677	705	42%	283	17%	689	41%
	2006	1,331	421	32%	295	22%	615	46%

Source: NWT Addiction Surveys of 2002 and 2006

Table 7A.1-9
Educational Attainment in the Northwest Territories

	Pop. 15 & Older	%	Males	%	Females	%
All Persons	29,506	100.0	15,541	100.0	13,965	100.0
Less than Grade 9	3,791	12.8	1,915	12.3	1,875	13.4
High School, No Diploma	5,639	19.1	2,942	18.9	2,697	19.3
High School Diploma	5,790	19.6	2,805	18.0	2,985	21.4
Other Certificate or Diploma	9,588	32.5	5,413	34.8	4,175	29.9
University Degree	4,129	14.0	2,127	13.7	2,001	14.3
Not Stated	570	1.9	338	2.2	232	1.7
All Aboriginal	13,507	100.0	6,866	100.0	6,641	100.0
Less than Grade 9	3,453	25.6	1,706	24.8	1,747	26.3
High School, No Diploma	3,919	29.0	2,005	29.2	1,914	28.8
High School Diploma	1,587	11.7	720	10.5	867	13.1
Other Certificate or Diploma	3,918	29.0	2,064	30.1	1,854	27.9
University Degree	237	1.8	128	1.9	109	1.6
Not Stated	392	2.9	242	3.5	150	2.0
All Non-Aboriginal	15,999	100.0	8,675	100.0	7,324	100.0
Less than Grade 9	338	2.1	209	2.4	129	1.8
High School, No Diploma	1,719	10.7	937	10.8	783	10.7
High School Diploma	4,202	26.3	2,085	24.0	2,118	28.9
Other Certificate or Diploma	5,670	35.4	3,349	38.6	2,322	31.7
University Degree	3,891	24.3	1,999	23.0	1,892	25.8
Not Stated	178	1.1	96	1.1	81	1.1

Prepared by NWT Bureau of Statistics, October 1999

8.0 SOCIO-ECONOMIC AND COMMUNITY WELLNESS

8.1 INTRODUCTION

The Human Health and Community Wellness Value Component (VC) was described in the 2005 NWT Environmental Audit Status of the Environment Report as the least developed of all the VCs. Compared to other VCs, the Human Health and Community Wellness VC lacks in definition, specific indicators, and scope. In an effort to give clarity to the Human Health and Community Wellness VC, in 2005 the auditors separated this VC into two separate categories: 1) Human Health and 2) Socio-Economic and Community Wellness. This approach is continued in the 2010 Audit, with this chapter which focuses on Socio-Economic and Community Wellness and Chapter 7, which focuses on Human Health.

The socio-economic measures or valued components and corresponding indicators first utilized in the 2005 NWT report are the main focus of this chapter. These VCs and indicators are listed in Table 8.1-1 and a rationale for their applicability provided.

8.2 SELECTION OF SOCIO-ECONOMIC AND COMMUNITY WELLNESS INDICATORS

8.2.1 Overview

Twenty (20) social indicators and other selected indicators tracked by the Government of the NWT (GNWT) were the basis for assessing the socio-economic environment for the 2005 NWT Environmental Audit Status of the Environment Report (SOE Report). By updating these previous indicators in the 2010 SOE Report, it is possible to discern certain trends in socio-economic and community wellness in the NWT.

8.2.2 GNWT Social Indicators

A GNWT interdepartmental working group developed 20 social indicators in response to a 2002 Social Agenda Working Group recommendation to describe and monitor social conditions in NWT communities (NWT Social Indicators Consultation Report (undated)). The 20 social indicators identified focused in several areas: population health, education, crime and safety, housing, families and children, income and employment, and Aboriginal culture. These indicators were selected based on a filtering process described in Table 8.2-1.

Table 8.1-1
Socio-Economic and Community Wellness Valued Components and Indicators Identified for the 2005 NWT Environmental Audit

Valued Component	Indicators	Rationale for Continued Use
Economy and Employment	• Changes in economic activity • Changes in economic sector composition. • Shift from mixed economy to a primarily wage-based economy • Labour force change • Seasonal versus full time employment • Local versus external employment • Sources of local labour • Out-migration and in-migration • Inter community migration • Changes in regional wages and salaries • Changes in income distribution • Changes in training programs • Opportunities for local businesses • Creation of local businesses	Significant changes both in the nature and scale have occurred in the NWT economy over the last two decades. Socio-economic change particularly since the early 1990s continues today and is expected into the future despite some interruption during the 2008- 2009 economic downturn. The development and operation of diamond mines by multinational mining corporations have led economic change in the NWT. Other anticipated mine, hydrocarbon, and hydroelectric developments are expected to drive economic change into the future. The shift from a mixed economy to a primarily wage-based industrial economy, and from local or national owned industries to multinational ownership have profoundly impacted the workforce and by extension, families and communities. Immigration from elsewhere in the country and outside Canada has diversified local populations. Internal migration mainly from smaller NWT communities to Yellowknife has affected communities, families, and individuals and changed the make-up and dynamics of local populations. The impacts of these changes are just beginning to be understood.
Population and Government Capacity	• Population change by community • Changes to public and private sector housing • Housing affordability • Local and territorial government infrastructure capacity	The make-up and capacity of local communities are altered by economic and employment patterns as well as demographic trends and changing socio-cultural values and desires. Shifting populations and economic circumstances impact housing and municipal services (social and physical) and create issues regarding basic needs including shelter and the capacity of government to respond to these needs.
Community Well being	• Existing social patterns - divorce, crime, safety • Current social movements / patterns • Characteristics of the existing and incoming residents • Capabilities of existing social organizations • Attitudes towards development • Major issues facing the population • Impact on women's lifestyles	Community well being can be indicated by the strength and nature of social relationships and patterns. The dynamic and inter-related nature of socio-economic and well being indicators mean that the economy, employment, population, and government capacity all impact community well being. For instance, social relationships and patterns are affected by continuity of populations, mobility, and lifestyles.

Table 8.2-1
Filters used by the GNWT to Select Social Indicators

Filter	Description
Availability	Is it currently available or do the data need to be collected?
Frequency	How often is the indicator currently collected?
Time Series	Is there historical information to show change over time?
Geographic detail	Is it available at a territorial level or at a community level?
Responsiveness	Will the indicator change over time?
Variability	Is there extreme variation in the indicator from period to period that makes trend identification difficult?
Outcome Indicator	Outcome indicators are preferred over output, input or other indicators.
Relevance	Is the indicator relevant to social conditions?
Understandability	Is there a reasonable expectation of most people being able to understand the indicator?
Reliability	Is the data source reliable, ongoing and free from bias?
Comparability	Are there comparable data for other jurisdictions?

Source: NWT Social Indicators Consultation Report (undated).

The GNWT's 20 social indicators and the area of focus addressed are listed in Table 8.2-2. The GNWT maintains and publishes data for these indicators on an annual basis. Data are mainly reported on a community, district, territorial, and national basis. The consistency of data collection and reporting allows for comparison across time and geography which are key considerations in an assessment of socio-economic change. However, some data are not disaggregated by important demographic characteristics, particularly age and gender. This limits the extent to which socio-economic trends can be discerned among various populations including those most vulnerable to the effects of socio-economic change.

Table 8.2-2
GNWT Social Indicators

Area of Focus	Indicator
Population Health	• Incidence of Heavy Alcohol Use
	• Death Rates From Accidents, Suicides and Homicides
	• Sexually Transmitted Infection Rate (three year average)
Education	• Percentage of Population 15 Years and Older with at Least High School
	• High School Graduation Rate
Crime and Safety	• Violent Crime Rate by Detachment
	• Rate of Juvenile Crime
	• Shelter Admissions
Housing	• Percentage of Households in Core Need
	• Percentage of Households with 6 or More Persons
Families and Children	• Percentage of Lone Parent Families
	• Percentage of Children Living in Low Income
	• Child Protection Investigations
Income and Employment	• Population Dependency Ratios
	o Less than 15 Years of Age
	o 60 Years of Age and Over
	• Population Mobility
	• Average Employment Income
	• Income Disparity
	o Percentage of Families with Income Less Than $30,000 o Percentage of Families with Income Greater Than $75,000
	• Employment Rate
Aboriginal Culture	• Percentage of Aboriginal People 15 Years and Over Able to Speak an Aboriginal Language
	• Use of Harvested Meat and Fish

Source: NWT Bureau of Statistics http://www.stats.gov.nt.ca/Social/home.html)

8.2.3 Population and Economic Indicators

In addition to the above mentioned social indicators, other demographic and economic indicators were tracked in the 2005 NWT Environmental Audit Status of the Environment Report. These indicators were selected due to the availability of reasonable historical and current data, and comparability with other provincial or territorial jurisdictions or the nation as a whole. These indicators have been updated for the 2010 SOE Report and are shown in Table 8.2-3.

Table 8.2-3
Demographic and Economic Indicators

Area of Focus	Indicator
Population	• Yearly population estimates
	• Components of population change
	• NWT population growth by age
Economic Indicators	• Gross domestic product
	• Consumer price index

Source: 2005 NWT Environmental Audit Status of the Environment Report.

8.3 DATA SOURCES AND PRESENTATION

The main source of socio-economic and community wellness indicator data is the NWT Bureau of Statistics (Bureau). The Bureau accesses Statistics Canada data and data from various GNWT departments. Depending on the indicator, data are reported by community, community type, region (see definitions below), or territory-wide. The definitions of the indicators are taken from the NWT Bureau of Statistics, NWT Social Indicators Consultation Report (undated) and from the NWT Bureau of Statistics website.

8.3.1 NWT Regions

The GNWT defines its administrative regions and associated communities as shown in Table 8.3-1, and reports regional data accordingly unless otherwise specified. Some caution should be used when comparing regional data as some communities may not be consistently included. For instance, Kakisa is served by GNWT agencies such as the Dehcho Health and Social Services and Dehcho Divisional Education Council in the Dehcho Region but is included in the GNWT South Slave administrative region rather than the Dehcho.

Table 8.3-1
NWT Regions and Associated Communities

Region	Communities	
Beaufort-Delta	• Aklavik • Fort McPherson • Holman • Inuvik	• Paulatuk • Sachs Harbour • Tsiigehtchic • Tuktoyaktuk
Sahtu	• Colville Lake • Fort Good Hope • Tulita	• Déline • Norman Wells
Dehcho	• Fort Liard • Fort Simpson • Jean Marie River • Trout Lake	• Fort Providence • Hay River Reserve • Nahanni Butte • Wrigley
South Slave	• Enterprise • Fort Smith • Kakisa	• Fort Resolution • Hay River • Lutselk'e
Tli Cho	• Wekweeti • Whati	• Gameti (formerly Rae Lakes) • Behchoko (formerly Rae-Edzo)
Yellowknife Area	• Yellowknife • Ndilo • Dettah	

8.3.1.1 Data Considerations Respecting Income

The following should be noted regarding data associated with income (e.g. average employment income, percentage of families with income less than $30,000 or more than $75,000, children living in low income).

Regional Aggregates
In this report, the following communities are included in the presentation of regional income data. To remain consistent across time, each region includes communities where data are available for each year from 1994 to 2006. The requirement for consistent data is the reason that Paulatuk is not included in a regional aggregate.

Beaufort-Delta
Aklavik
Fort McPherson
Inuvik
Tuktoyaktuk
Ulukhaktok (Holman)
Sahtu
Déline
Fort Good Hope
Norman Wells
Tulita
Dehcho
Fort Liard
Fort Providence
Fort Simpson
South Slave
Fort Resolution
Fort Smith
Hay River
Lutselk'e
Tlicho
Behchokò (Rae-Edzo)
Gamètì (Rae Lakes)
Whatì
Yellowknife
Yellowknife

Communities not in this report
Income data for the following communities are not reported in this chapter. Data for these communities are included in the NWT total.

Tsiigehtchic
Colville Lake
Dettah
Hay River Reserve
Jean Marie River
Kakisa
Nahanni Butte
Paulatuk
Sachs Harbour
Trout Lake
Wekweètì
Wrigley

Suppression, Confidentiality and Rounding
Statistics Canada does not release data for communities with fewer than 100 tax filers. For communities with 100 or more tax filers, data suppression occurs if a specific entry has less than 15 tax filers, or if it is dominated by a single tax filer. To further protect confidentiality, counts are rounded to the nearest base 10 and dollar amounts to the nearest thousand. This rounding can cause wide fluctuations from year to year, particularly for smaller communities.

8.3.2 Smaller NWT Communities

Information may be organized by community type to distinguish smaller NWT communities from regional centres (Inuvik, Fort Smith, Hay River, and Behchoko) and Yellowknife, particularly where socio-economic conditions differ. Whenever data are presented for the smaller NWT communities, the data are aggregated for what the NWT Bureau of Statistics refers to as the 'rest of the communities'. These communities are:

Aklavik
Ulukhaktok
Paulatuk
Sachs Harbour
Fort McPherson
Tsiigehtchic
Tuktoyaktuk
Déline
Fort Good Hope
Norman Wells
Colville Lake
Tulita
Fort Liard
Hay River Reserve
Jean Marie River
Fort Simpson
Nahanni Butte
Trout Lake
Wrigley
Enterprise
Fort Providence
Fort Resolution
Kakisa
Lutselk'e
Dettah
Ndilo
Rae Lakes
Wekweeti
Wha Ti

8.4 RESULTS – DATA FOR EACH INDICATOR

Data for the GNWT's 20 social indicators and other population and economic indicators describe the socio-economic circumstances for the NWT as a whole and in many cases, a comparison between:

- NWT and Canada;
- Regions within the NWT;
- smaller NWT communities and the NWT as a whole; and
- NWT communities.

8.4.1 Population

Table 8.4-1 presents yearly population estimate for the NWT for the period 1991 through 2009. Statistics Canada did not produce population estimates for the NWT (separate from Nunavut) prior to 1991.

Table 8.4-1
NWT Yearly Population Estimates

Year	Persons	% Change
1991	38,724	-
1992	39,416	1.79%
1993	39,820	1.02%
1994	40,578	1.90%
1995	41,432	2.10%
1996	41,741	.75%
1997	41,625	-.28%
1998	40,802	-1.98%
1999	40,638	-.40%
2000	40,480	-.39%
2001	40,844	.90%
2002	41,665	2.01%
2003	42,561	2.15%
2004	43,301	1.74%
2005	43,399	.23%
2006	43,198	-.46%
2007	43,535	.78%
2008	43,283	-.58%
2009	43,439	.36%

Source: Statistics Canada (as reported in NWT Bureau of Statistics, 2009 Socio-Economic Scan, Statistical Supplement for 1991 to 2008 and Summary of NWT Community Statistics 2010 for 2009).
http://www.stats.gov.nt.ca/Statinfo/Generalstats/Scan/Socio-Econ%20Scan%202009.pdf (April 13)

Between 1991 and 2008, the overall population of the NWT increased by 11.8%. This compares to an overall increase of 18.8% for all of Canada over the same period. Between 1991 and 2008, the NWT experienced eleven years of population growth and six years of population decline. Population decline was concentrated primarily between 1997 and 2000 which coincides with the creation of two new territories, Nunavut and the Northwest Territories. Population change between 2004 and 2009 has been marginal.

Changes in the age structure of the population and community-specific growth rates can impact the type, location, and demand for government programs and services. In the NWT, population is one of the main drivers of Territorial Formula Financing (TFF) between the GNWT and the Government of Canada. Overall population growth is an important fiscal reality in the NWT. The GNWT receives a $22,000 annual transfer payment from the Government of Canada for every person residing in the NWT.

The NWT Aboriginal population is growing faster than the NWT population as a whole. In 2009, slightly more than half of the NWT population described their identity as Aboriginal (see Table 8.4-2). Between 1996 and 2009, Aboriginal population growth of 9% was driven in part by the relatively large population increase in the Yellowknife area (28%) and Tli Cho (16%) region. With the exception of Beaufort-Delta which lost Aboriginal population, below NWT Aboriginal average growth occurred in all other regions and smaller NWT communities. The non-Aboriginal population peaked in 2004 and 2005 and by 2009 had declined to below 1996 levels.

Table 8.4-2
Aboriginal Identity 1996-2009

	1996	2001	2002	2003	2004	2005	2006	2007	2008	2009
NWT	20,118	20,897	21,118	21,238	21,395	21,498	21,498	21,808	21,869	21,889
Smaller NWT Communities	11,502	11,871	11,863	11,775	11,751	11,777	11,787	11,839	11,864	11,875
Beaufort-Delta	5,410	5,387	5,367	5,325	5,256	5,297	5,293	5,292	5,292	5,272
Sahtu	1,953	1,888	1,895	1,905	1,925	1,954	1,974	1,992	1,984	1,986
Dehcho	2,666	2,934	2,925	2,909	2,890	2,879	2,902	2,898	2,881	2,914
South Slave	3,816	3,973	4,006	4,024	4,072	4,029	4,051	4,068	4,023	3,969
Tli Cho	2,397	2,566	2,598	2,638	2,628	2,678	2,713	2,741	2,783	2,788
Yellowknife	3,876	4,149	4,327	4,437	4,624	4,661	4,706	4,817	4,906	4,960

Source: Statistics Canada (as reported by Jeff Barichello, NWT Bureau of Statistics, July 7, 2010)

8.4.1.1 Components of Population Change

Births, deaths, and net migration are components of population change. These components are summarized in Table 8.4-3 for the period 1992 to 2008.

With declining birth rates and aging of the population, natural increase is playing a lesser role than migration in population growth in the NWT. Overall population growth for the territory is largely determined by inter-provincial migration. Over the four years from 2005 to 2008, an average of 614 more people have left the NWT than have moved here.

Between 1992 and 2008 two distinct cycles of net migration out of the NWT occurred. The 1996 to 2001 cycle of net out-migration overlapped with a period of population decline. The second and more recent cycle of negative migration between 2005 and 2008 is marked by a period of marginal to dwindling population growth. Despite these two cycles of net out migration from the NWT, high birth rates and relatively low death rates have resulted in an overall increase in the population. Birth rates declined until 1997 and have since stabilized with minor fluctuations. With the exception of 2005, death rates were slightly higher in recent years than in the 1990s.

Table 8.4-3
Comparisons of Births, Deaths and Net Migrations

Year	Births	Deaths	Net Migration
1992	820	151	8
1993	856	143	-324
1994	833	150	60
1995	823	137	153
1996	894	132	-453
1997	774	145	-646
1998	681	137	-1,267
1999	656	158	-463
2000	659	152	-566
2001	656	175	-53
2002	651	164	160
2003	658	183	246
2004	697	188	56
2005	705	137	-645
2006	707	171	-890
2007	687	184	-166
2008	695	191	-756

Source: Statistics Canada (as recorded in the NWT Bureau of Statistics, 2009 Socio-Economic Scan, Statistical Supplement).
http://www.stats.gov.nt.ca/Statinfo/Generalstats/Scan/Socio-Econ%20Scan%202009.pdf (April 12)

A number of events listed in Table 8.4.-4 from the late 1990s until 2008 may have contributed to annual changes in net migration and subsequent fluctuations in NWT population. In some years, such as 2000, event activities that should have been net draws into the NWT (e.g. the resumption of Giant and Lupin mining operations and the beginning of the Diavik Diamond Mine construction) were contrary to the net outmigration and population stasis or slight decline. In fact, these events may have slightly tempered an even larger out migration or population decline at that time.

Table 8.4-4
Events Potentially Contributing to Net Migration and Population Change

Year	Event	Net Migration	Population Change
1997	Royal Oak Mines Giant Mine lay-off of 40 workers	↓	↓
	Miramar Con Mine layoff of 120 workers	↓	↓
	Ekati Mine construction	↓	↓
	Royal Oak Colomac Mine Closure	↓	↓
1998	Lupin Mine suspends operations	↓	↓
	Miramar Con Mine suspends operations	↓	↓
	Ekati Mine begins operations	↓	↓
1999	Nunavut established - smaller NWT public sector	↓	↓
	Miramar Con Mine resumes operations	↓	↓
2000	Giant Mine resumes operations on a smaller scale	↓	↓
	Lupin Mine resumes operations on a smaller scale	↓	↓
	Diavik Mine construction begins	↓	↓
	Gas production begins at Fort Liard	↓	↓
2003	Diavik Mine begins operations	↑	↑
	Miramar closes Con Mine	↑	↑
	Lupin Mine suspends operations	↑	↑
2005	De Beers begins construction of Snap Lake mine	↓	↑
2007	Gas production ends at Fort Liard	↓	↑
2008	Snap Lake mine begins operations	↓	↑
	Economic downturn – cancellation of projects	↓	↑
	Norman Wells annual oil production declines by 43% from 1999	↓	↑
2009	GNWT signs Northern Mining Workforce Initiative Memorandum of Understanding with De Beers, Diavik and BHP Billiton	↓	↑

Source: GNWT (2009). Communities and Diamonds 2008 Annual Report; Indian and Northern Affairs (2003-2009). Northern Annual Gas and Oil Report

The high cost of living in the NWT may be a deterrent to in migration and overall NWT net migration.

8.4.1.2 Five Year Population Mobility

Five year population mobility is a measure of the percentage of people five years and older who did not live in the same community five years earlier. The higher the rate, the more people have moved in and out of the community. Five year population mobility rates are measured during Canada census years and are presented in Table 8.4-5.

Table 8.4-5
Five Year Population Mobility Rates 1986 To 2006

Area	1986	1991	1996	2001	2006
NWT	36.8	35.2	29.2	24.9	24
Smaller NWT communities	37.7	38.9	30.7	26.3	25.4
Beaufort-Delta	35.6	27.7	26.8	23.3	21.1
Sahtu	29.3	29.0	30.6	24.5	22.8
Dehcho	24.0	21.4	20.6	16.6	15.2
South Slave	33.9	32.1	27.4	22.8	23.3
Tli Cho	6.6	13.0	11.0	10.4	11.9
Yellowknife Area	44.2	46.5	34.9	30.2	29.1

Source: Statistics Canada (as reported by Jeff Barichello, NWT Bureau of Statistics, July 7, 2010)

Between 1986 and 2006, there was a downward trend in population mobility rates in the NWT. This trend suggests a more stable population. This downward trend was noticeable in small communities and in all regions except the Tli Cho region, which had both the lowest mobility rates overall and a slight upward trend during the period. The highest mobility rates were in the Yellowknife area, but it too has been stabilizing over time. Much of the downward change in Yellowknife area population mobility occurred between 1991 and 1996 which coincided with the beginning of diamond exploration in the NWT.

Population mobility is also measured in terms of total migrants comprised of internal and external migrants. Internal migrants are those people who moved from somewhere in Canada and external migrants are from outside of Canada. Internal migrants can be further subdivided into: (i) intra-territorial migrants – those people who moved to a different community from within the NWT; and, (ii) inter-provincial migrants – people moved into the NWT from elsewhere in Canada.

In 2006, about 24% (9,090) of the NWT population five years of age and over (37,825) were migrants. About 70% (6,360) of the migrants were from other Canadian jurisdictions and 22% (2,030) migrated within the NWT. The remaining 8% of immigrants to the NWT (695) were from outside of Canada.

8.4.1.3 Population Share by Community Type and NWT Regions

The data in Table 8.4-6 illustrate the shift in population in the NWT from the more primarily Aboriginal smaller communities and regional centres to urban life in Yellowknife. The distribution of the population among community types is presented in the table as a percentage of the total NWT population.

Table 8.4-6
Percentage of NWT Population – By Community Type

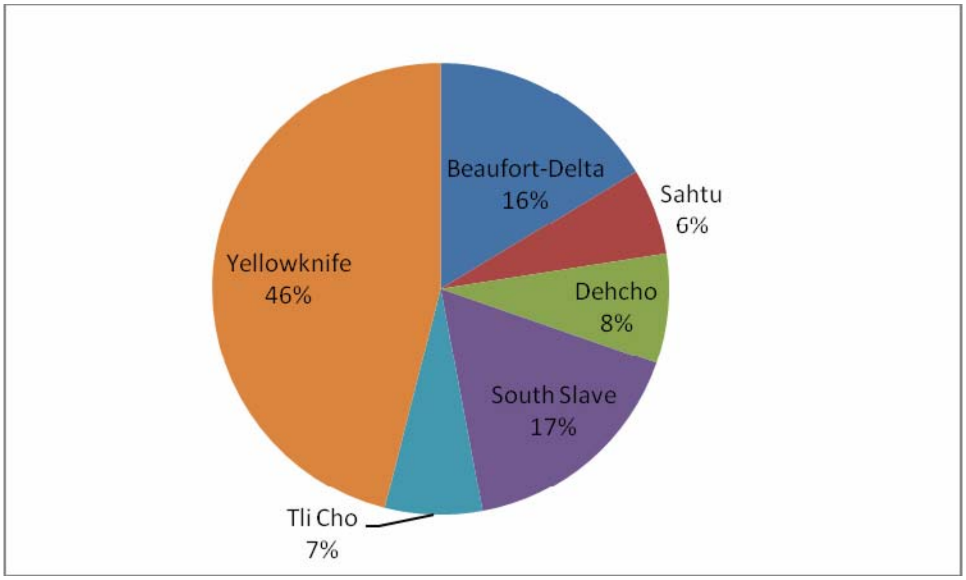
	1976	1981	1986	1991	1996	2001	2006	2009
Yellowknife	26.6	31.4	34.7	41.7	43.5	44.3	45.1	45.4
Inuvik, Hay River, Fort Smith	30.1	27.5	26.1	24.4	23.6	23.0	22.9	22.5
Smaller communities	41.3	41.0	39.2	33.9	32.9	32.7	32.0	32.1

Source: Census of Canada 1976 – 2006 (as recorded in the NWT Bureau of Statistics, 2009 Socio-Economic Scan, Statistical Supplement and Summary of NWT Statistics 2010.)

Slightly less than one-third of the overall population currently lives in one of the 29 smaller communities in the NWT compared to nearly half of the population residing in Yellowknife. Most of the small communities have populations of less than 1,000 and the majority of the residents are Aboriginal. By 1991 when exploration for diamonds began in the NWT, the shift in population from smaller communities and the regional centres of Inuvik, Hay River and Fort Smith to Yellowknife was stabilizing. Between 1976 and 2009, the population of Yellowknife increased from 26.6% to 45.4% of the total population of the NWT. In the same period, the smaller communities and regional centres reported a declining population (e.g. as percentage of the total NWT population). In 2009, populations were smallest in the Tli Cho, Dehcho, and Sahtu regions where people are spread over several smaller communities and no large communities exist.

Yellowknife has low unemployment and high in-migration. This likely reflects the economic opportunities in the city, many of which relate to the diamond mining industry. Services available in Yellowknife may also influence migration from smaller NWT communities.

Figure 8.4-1
Percentage of NWT Population By NWT Region 2009



The Aboriginal population living in Yellowknife represents the largest concentration of Aboriginal people in any NWT community. Although Yellowknife has the largest Aboriginal population in the NWT, these residents are by no means a homogeneous group. Aboriginal people residing in the city come from throughout the circumpolar world and elsewhere in Canada.

8.4.2 Population Health

Statistics on the incidence of heavy alcohol use, death from accidents, suicides and homicides and rates of sexually transmitted infections are reported in Chapter 7.

8.4.3 Education

8.4.3.1 Population 15 Years and Older with High School or Higher Education

Similar to the rest of Canada, NWT education levels are measured as a percentage of the population 15 years of age and over that have a high school diploma or more. The following trends are evident from the data presented in Table 8.4-7:

- education levels are increasing among NWT residents and have generally followed a twenty-year upward trend;

- the gap in education levels between the NWT and the rest of Canada was significantly wider in 2006 than in 1991, with the bulk of the change occurring between 2001 and 2006;
- education levels in smaller NWT communities substantially improved between 1989 and 2009 but remain 20%-25% lower than in the NWT as a whole;
- education levels in each NWT region improved between 1989 and 2009. While education levels were lowest in the Tli Cho region, the greatest improvement was also in that region;
- education levels in Yellowknife were consistently above the NWT and the rest of Canada between 1991 and 2006.

Table 8.4-7
Percentage of Population 15 Years and Older with at Least High School

Area	1989	1991	1994	1996	1999	2001	2004	2006	2009
Canada		61.8		65.2		68.7		76.2	
NWT	59.8	59.9	63.2	63.5	66.1	64.8	67.5	67	69.8
Smaller NWT communities	34.3	38.1	39.2	44.2	42.1	42.7	42.7	43.4	48.1
Beaufort-Delta	50.9	50.9	52.3	56.3	54.5	54.9	55.6	53.7	56.1
Sahtu	45.3	48.3	50.4	57.1	54.3	55.7	52.1	48.6	55.9
Dehcho	37.4	40.7	39.7	47.3	45.3	45.0	46.6	45.3	50.0
South Slave	57.9	58.8	59.2	61.5	67.3	64.5	67.7	67.9	70.7
Tli Cho	20.8	26.0	35.4	29.9	30.8	30.4	35.3	37.4	34.5
Yellowknife Area	78.2	73.9	79.0	75.3	80.6	77.7	82.1	80.9	82.9

Source: 1989, 1994 and 1999 - NWT Labour Force Survey; 2004 and 2009 - NWT Community Survey; 1991, 1996, 2001, and 2006 – Census (as reported in NWT Bureau of Statistics, Summary of NWT Community Statistics 2010).

In 2006, education levels rates in Fort Smith, Hay River, Inuvik, Norman Wells, Enterprise, and Yellowknife were above the NWT education level of 67%. In the same year, education levels in 19 communities were below the average (43%) calculated for small communities.[15] While there has been an overall improvement in education levels, less than 16% of populations in some very small communities (e.g. Colville Lake, Jean Marie River, Nahanni Butte and Wrigley) had graduated from high school in 2006.

[15] Colville Lake, Déline, Fort Liard, Aklavik, Tsigehtchic, Tuktoyaktok, Ulukhaktok, Kakisa, Nahanni Butte, Trout Lake, Fort Good Hope, Tulita, Dettah, Gameti, Paulatuk, Jean Marie River, Wrigley, Behchoko, and Whati.

There is still a marked difference in the educational achievement levels between the NWT's Aboriginal and non-Aboriginal populations, with little change between 1999 and 2004. In 2004, 47% of Aboriginal people reported having at least completed high school (with a high school diploma or a postsecondary diploma or degree). In comparison, 87% of non-Aboriginal people reported having a high school or higher level of education. The difference in education levels in these two segments of the population was most noticeable in smaller NWT communities where 36% of Aboriginal people reported having a high school diploma or a postsecondary degree diploma or degree compared to 90% of non-Aboriginal people.

8.4.3.2 High School Graduation Rate

The NWT graduation rate is calculated by dividing the number of graduates in any given calendar year by the number of 18 year olds in the population. This method of calculating the graduation rate is consistent in jurisdictions across Canada. The data collected from NWT Department of Education, Culture and Employment are summarized in Table 8.4-8. Data are presented for the NWT, Yellowknife, and smaller NWT communities.

Table 8.4-8
High School Graduation Rate (Percent)

Area	2001	2002	2003	2004	2005	2006	2007
Canada	72	73	78	75	76	71	69
NWT	45	36	45	45	52	53	56
NWT Smaller Communities	24	18	26	31	46	47	40
Yellowknife	54	53	53	55	61	63	72
Aboriginal	41	39	42	40	49	51	44
Non-Aboriginal	59	61	58	60	51	49	56

Source: Case management administration System (CMAS), NWY Bureau of Statistics, Statistics Canada, Elementary-Secondary Education Statistics project (ESEP) (as reported in Towards Excellence, A Report on Education in the NWT '07)

Trends emerging from the data presented in Table 8.4-8 are positive for the period 2001 to 2007. The data show:

- a gradual improvement in the rate of high school graduation in the NWT, contributing to a much narrower gap between graduation rates in the NWT and Canada.
- improved graduation rates in smaller NWT communities.
- high graduation rates in Yellowknife that exceeded the Canadian rate in 2007. The Yellowknife graduation rate of 72% in 2007 was the highest ever recorded.
- improved graduation rates among Aboriginal students. In 2006, graduation rates among Aboriginal students exceeded those of non-Aboriginal students.

However, indicators of student achievement such as Alberta Achievement Test results, high school diploma examination results, and functional grade levels show limited or no progress during the same time period.

Increases in high school graduation rates in the NWT are mainly a factor of the availability of more secondary school programs and levels including grade 12 in most smaller communities.

While more NWT youth are graduating from high school, they may not have ready access to postsecondary education or job opportunities even if they have fulfilled the minimum graduation requirements.

8.4.3.3 Adult Literacy Skills

The International Adult Literacy and Skill Survey (IALSS) provides a measure of adult literacy. The IALSS was conducted in the NWT in 2003 for the first time. Prior to IALSS, literacy was measured by educational attainment. Grade nine or less indicated low literacy. IALSS measures literacy in four domains - prose literacy, document literacy, numeracy, and problem solving – at five levels. Persons functioning at levels one and two are considered as having low literacy and lacking the skills necessary to function fully in day to day life within a wage economy.

The 2003 IALSS found that NWT adult literacy levels are very close to the Canadian average in the four skill domains. However, IALSS data show a large gap between the literacy levels of Aboriginal and non-Aboriginal adults in the NWT. Non-Aboriginal adults in the NWT scored significantly above and Aboriginal adults scored significantly below Canadian literacy levels in all skill domains. In the NWT, IALSS data show that:

- about 70% of Aboriginal adults compared to 30% of non-Aboriginal adults lack adequate prose literacy to fully function in society.
- more than 75% of Aboriginal adults compared to 39% of non-Aboriginal adults lack adequate numeracy skills to fully function in society.
- more than 90% of Aboriginal adults compared to 60% of non-Aboriginal adults lack adequate problem solving skills to fully function in society.

Low literacy levels affect the employability of Aboriginal people given that "*in the 21st century work force, people need functional levels in all skill domains*" (NWT Education, Culture and Employment, 2007, p.37).

8.4.4 Crime and Safety

8.4.4.1 Violent Crime Rate

The NWT violent crime rate, measured as the number of violent crimes per 1000 persons in a given year, is almost seven time the national rate.[16] While there has been no discernable trend in the Canadian violent crime rate, the NWT violent crime rate reported in Table 8.4-9 shows a significant increase between 1999 and 2008.

Table 8.4-9
Violent Crime Rate (Incidences Per 1000 People)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Canada	9.6	9.8	9.8	9.7	9.7	9.5	9.5	9.6	9.3	9.2
NWT	50.2	49.0	49.0	57.2	67.5	68.7	63.5	62.9	69.9	65.5
Beaufort-Delta	76.2	70.7	68.5	93.2	102.5	103.6	112.5	115.3	110.5	101.9
Sahtu	74.6	53.5	52.7	55.7	80.3	104.7	79.8	83.6	94.1	95.6
Dehcho	83.1	94.5	75.5	95.2	117.2	104.0	94.7	90.4	115.1	110.3
South Slave	45.2	45.3	54.6	63.3	75.7	65.6	73.4	60.0	74.3	64.4
Tli Cho	54.3	55..5	61.3	83.0	62.8	65.8	62.7	86.1	116.4	114.2
Yellowknife	32.7	32.6	32.8	31.5	43.5	48.0	35.7	37.5	38.2	34.9

**Number of reported violent crimes per 1,000 population*

Source: Statistics Canada, Canadian Centre for Justice Statistics, Uniform Crime Reporting Survey. Statistics Canada (as reported by Jeff Barichello, NWT Bureau of Statistics, 2010 and Summary of NWT Statistics 2010.)

Factors contributing to high violent crime rates in the NWT include:

- a higher proportion of people aged 14-34. This age group is most likely to be involved in crime;
- lower education levels. Low education puts individuals at risk of poverty, alienation, and marginalization, factors that are associated with property and violent crimes;
- High rates of substance abuse. Alcohol, in particular, plays a large role in most of the NWT's violent crime. Heavy consumption of alcohol is often associated with serious crimes such as assaults, sexual offences, and murder. Alcohol consumption plays a prominent role in domestic and community violence, mental health issues, and Fetal Alcohol Spectrum Disorder (FASD), social issues that are prominent in the NWT;
- lingering and residual effects of residential schools on the well-being of subsequent generations. Family conflict, violence, substance abuse, and criminal behaviour are, in

[16] The data are available from the Canadian Centre for Justice Statistics and Statistics Canada (see Table 8.4-9). Violent crimes include homicides, attempted murders, assaults (sexual and other), other sexual offences, abductions, and robberies.

part, social issues rooted in the traumatic experiences of Aboriginal people at residential schools.[17]

The RCMP believes that the presence of more money in the NWT economy from large-scale resource development also contributes to crime rates as it attracts drug dealers and organized crime.[18]

Between 1999 and 2008, the rate of violent crime in the NWT increased by almost 15 incidents per 1000 of population. The crime rate in the Beaufort Delta, Dehcho and Tli Cho regions is more than 100 incidents per 1,000 population, more than eleven times the Canadian average. The incidence of violent crime also more than doubled in the Tli Cho region between 1999 and 2008. In 2008, the communities of Fort Good Hope, Fort Liard, Fort McPherson, Fort Providence, Fort Resolution, Tuktoyaktuk, and Behchoko recorded crime rates over 15 times the national average (i.e. over 150 incidents of violent crime per 1,000 population). With the exception of Behchoko, these same communities recorded rates of over 100 incidents per 1,000 population in 2003. Yellowknife recorded the lowest community violent crime rate at 34.9 in 2008, down from 43.9 in 2003.

8.4.4.2 Rate of Youth Crime

The youth crime rate is defined as the percentage of youth between 12 and 17 years of age charged with a crime in a given year. These data are available from the Canadian Center for Justice Statistics at Statistics Canada. Data are available for NWT communities, Canada, and the provinces and territories. Tables 8.4-10 and 8.4-11 provide a summary of the youth crime data for males and females respectively. To compensate for data volatility, each year's data represent a three-year average of data (e.g., 2001 data are an average of 1999, 2000, and 2001 figures).

[17] GNWT(2008). *Communities and Diamonds, 2007 Annual Report of the Government of the Northwest Territories under the BHP Billiton, Diavik and De Beers Socio-economic Agreements.*

[18] Northwest Territories Justice, 2008, *Justice 2008-2012 Business Plan.*

Table 8.4-10
Rate of Youth Crime (Males, Three Year Average)

Area	2001	2002	2003	2004	2005	2006	2007	2008
Canada	6.9	6.8	6.4	5.8	5.3	5.1	5.0	5.0
NWT	19.9	19.8	21.0	20.5	20.5	19.9	17.4	15.7
Beaufort-Delta	37.2	35.0	32.8	31.5	34.6	32.3	26.2	23.4
Sahtu	52.9	46.0	45.4	32.7	22.8	23.2	21.5	27.7
Dehcho	28.1	23.0	26.0	31.5	29.7	25.4	17.0	12.7
South Slave	18.3	22.4	26.6	26.3	27.7	29.0	26.9	22.8
Tli Cho	5.6	8.8	20.6	23.9	28.0	26.6	23.2	19.1
Yellowknife	10.1	10.0	9.2	9.1	8.3	8.1	8.1	7.7

**Number of male youths (between 12 and 17 years of age) charged with a crime per 100 male youth, three year average*
Source: Statistics Canada (as reported by Jeff Barichello, NWT Bureau of Statistics, 2010)

Table 8.4-11
Rate of Youth Crime (Females, Three Year Average)

Area	2001	2002	2003	2004	2005	2006	2007	2008
Canada	2.2	2.2	2.0	1.8	1.6	1.5	1.5	1.6
NWT	7.3	7.9	8.9	8.9	9.7	9.7	10.0	9.9
Beaufort-Delta	14.4	14.8	16.2	18.4	22.0	22.1	19.0	18.9
Sahtu	12.6	15.8	17.8	15.9	12.6	10.7	11.8	15.6
Dehcho	4.9	6.0	8.4	10.2	11.8	12.5	14.5	14.8
South Slave	9.0	11.3	11.9	10.4	9.9	10.1	11.8	11.8
Tli Cho	0.0	0.5	1.4	3.6	6.1	6.9	6.8	5.0
Yellowknife	4.0	3.8	4.5	4.1	4.3	4.1	4.8	4.2

**Number of female youths (between 12 and 17 years of age) charged with a crime per 100 female youth, three year average*
Source: Statistics Canada (as reported by Jeff Barichello, NWT Bureau of Statistics, 2010)

NWT youth crime rates were marginally lower in 2008 than in 2001, but continued to be far greater than the Canadian average. In particular, NWT female youth crime rates were more than three times the national rate in 2001, but increased to more than six times the Canadian rate in 2007. Increased female youth crime rates in the NWT were contrary to a declining Canadian trend. Between 2001 and 2008 female youth crime increased in all regions in the NWT. The increasing trend was most noticeable in the Tli Cho region where the 2008 rate was five times the 2001 rate and in the Dehcho region where the 2008 rate was three times the 2001 rate.

While NWT male youth crime rates followed a downward trend between 2005 and 2008, they continued to be about three times the Canadian rate. The Tli Cho male youth crime rate which was below national and territorial rates in 2001, increased by five times in 2005 to exceed national and territorial rates. The lowest youth crime rates were consistently recorded in the Yellowknife area.

The trends in youth crime rates in NWT regions may be due to a variety of socio economic factors. In many NWT communities, there is a disproportionate number of children and youth. Factors affecting youth crime rates may include poverty, lack of opportunity for employment, institutional racism and discrimination, a sense of hopelessness and despair, alcohol, drugs, and mental health issues. Family, community, regional and culture group capacity to address these factors may contribute to varying rates among communities in the same region.

8.4.4.3 Family Violence

Family violence is a serious problem in the NWT. It is also a difficult problem to measure (GNWT, 2009).[19] *Criminal Code* offences, such as spousal assault, sexual assault, harassment, and stalking, reported by the RCMP show to some extent, family violence rates but it is widely recognized that not all violent or abusive acts are reported. Shelter admissions and emergency protection orders issued are other indicators of family violence. Again, these data may not accurately reflect the level and extent of family violence due to under-reporting.

An examination of statistical trends in violence against women (2006) reported that spousal violence has psychological, physical, social and economic impacts for victims, their families, and society.[20] Most victims of spousal violence are women. Female victims of spousal violence are more likely than males to report injury, suffer lost productivity, experience multiple assaults, fear for their lives, and experience negative emotional consequences. Four in ten children are witnesses of spousal assault. Spousal violence impacts the Canadian economy through high costs to health, criminal justice and social services, and lost productivity.

Unemployment, social isolation, alcohol abuse, and common-law unions are risk factors associated with family violence in NWT communities.[21] Increases in violent crime,

[19] GNWT (2009). *Communities and Diamonds, 2008 Annual Report of the Government of the Northwest Territories under the BHP Billiton, Diavik and De Beers Socio-economic Agreements.*
[20] Statistics Canada (2006). Measuring Violence Against Women: Statistical Trends 2006. *Cat. No 85-570.*
[21] Canadian Centre for Justice Statistics (2007). *Family Violence in Canada, A Statistical Profile,* Statistics Canada.

overcrowding in shelters, and higher-than-average use of Emergency Protection Orders are commonly used indicators of the level of family violence in the NWT.[22]

Shelter Admissions

Family violence does not necessarily result in women and children seeking shelter. A reason for this is the requirement for women and their children to leave their home communities as most NWT communities do not have shelter services.

Shelter admission data are based on the number of women and children admitted to family violence shelters in the NWT. Admission data are available for the five family violence shelters in the NWT. The data, collected by the NWT Department of Health and Social Services, is summarized in Table 8.4-12.

Table 8.4-12
Admissions of Women and Children to NWT Shelters

Year	Women	Children
2000-01	210	296
2001-02	188	234
2002-03	234	233
2003-04	243	242
2004-05	213	225
2005-06	229	185
2006-07	240	224
2007-08	226	183

Source: Department of Health and Social Services, Family Violence Database. (As reported by Jeff Barichello, NWT Bureau of Statistics, 2010)

According to the 2003-2004 Transition Home Survey, per capita rates of shelter usage were considerably higher in the NWT than in the rest of Canada. Between 2000-01 and 2007-08, there was little variation in shelter admissions of women in the NWT, however admission of children declined. The *NWT Protection Against Family Violence Act* was enacted in 2003. Under this *Act*, Emergency Protection Orders (EPOs) became available in 2005. EPOs may be a reason for changes in shelter admissions. EPOs provide victims of family violence with emergency protection and can grant the victim of family violence sole use of the family home or other

[22] Northwest Territories Justice (2008). *Justice 2008-2012 Business Plan*

property, restrict communication between the people involved, and order the seizure of weapons or firearms by the police. In 2007-08, 87 EPOs were issued.[23]

Spousal Assaults

Spousal assaults often occur several times before the RCMP receive a complaint. In 2004, it was estimated that 36% of female victims of spousal violence and less than 10% of victims of sexual assault reported these crimes to the police in Canada.[24] Reasons for non-reporting are varied but include fear of reprisal, shame and embarrassment, and a reluctance to become involved with the police and courts. Victims of spousal violence in the NWT report these crimes to the police at a higher rate than victims in the provinces. Aboriginal women are more likely to report spousal assault than non-Aboriginal women. This may partially account for higher rates of spousal violence for Aboriginal women than for non-Aboriginal women.

Spousal assault data are collected by the NWT Department of Health and Social Services. They are summarized in Table 8.4-13.

Table 8.4-13
Number of NWT Reported Spousal Assault Cases, 1997-2007

Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
NWT	402	461	486	425	377	333	360	322	--	356	516
Yellowknife	67	94	123	96	110	88	86	59	--	80	94
Smaller NWT Communities	296	381	319	329	267	245	274	263	--	276	422

Note: No data are available for 2005.
Source: Department of Health and Social Services, Family Violence Database. (as reported in Communities and Diamonds 2008)

Between 1997 and 2006, the number of spousal assault cases reported in the NWT declined by 11% then sharply increased by 45% between 2006 and 2007. The pattern in smaller NWT communities is similar to the territory as a whole. In Canada, rates of reported sexual assault have also declined since 1993. In Yellowknife, there were no apparent trends in spousal assault. An average of 79 cases were reported annually between 1997 and 2006.

[23] Northwest Territories Health and Social Services (2009). *Northwest Territories Health and Social Services System Annual Report 2007/2008.*
[24] Statistics Canada (2006). Measuring Violence Against Women: Statistical Trends 2006. *Cat. No 85-570*

8.4.5 Housing

8.4.5.1 Percentage of Households in Core Need

A household in core need is defined as one that has a housing problem of suitability, adequacy, or affordability and does not have the income necessary to correct the problem. Suitability refers to the problem of overcrowding or whether a household has enough bedrooms appropriate for the number of people. The number of bedrooms required for a household is determined by the *National Occupancy Standards.*[25] Adequacy refers to the physical condition of a dwelling or whether a household has basic facilities to provide a safe and healthy environment.[26] Affordability problems exist when a household pays an excessive amount for shelter. A household has an affordability problem if more than 30% of a household's income is spent on shelter. Core housing need data are summarized in Table 8.4-14 for Canada, the NWT, NWT regions, and smaller NWT communities.

Table 8.4-14
Percentage of Households in Core Housing Need

Area	1996	1996 Census	2000	2001 Census	2004	2006 Census	2009
Canada	15.6	15.6	Na	13.7	na	12.7	na
NWT	19.7	25.4	20.3	17.4	16.3	17.5	19.0
Smaller NWT communities	44.4	na	38.4	na	30.3	na	37.7
Beaufort-Delta	23.7	na	22.1	na	22.2	na	26.5
Sahtu	38.1	na	35.0	na	28.0	na	35.7
Dehcho	50.1	na	35.1	na	24.9	na	33.9
South Slave	21.2	na	20.2	na	14.3	na	16.8
Tli Cho	64.6	na	52.1	na	35.2	na	47.8
Yellowknife	4.7	na	11.1	na	9.1	na	9.1

Source: 1996 and 2000 - NWT Housing Needs Survey; 2004 and 2009 NWT Community Survey; CMHC (census-based housing indicators and data) (as reported in NWT Bureau of Statistics, Summary of NWT Statistics 2010). Note: na = not available.

[25] National Occupancy Standards specify a minimum of one and a maximum of two persons per bedroom; each cohabiting couple must have their own bedroom; household members aged 18 or more need a separate bedroom, unless married or cohabiting spouses; and dependants aged five or older of the opposite sex do not share a bedroom.

[26] Absence of basic facilities includes lack of hot and cold running water; an indoor toilet; installed bath or shower; kitchen or bathroom sink; or requiring major repairs in structural, electrical, mechanical and heating systems.)

A declining trend in the percentage of NWT households that were in core housing need occurred between 1996 and 2004. The progress made in reducing core housing need to 2004 had been reversed by 2009. The NWT continues to have a higher percentage of households with core housing need than elsewhere in Canada. Data from the 2006 Census show that:

- affordability and adequacy were evident in 60% of NWT households in core housing need;
- households in the NWT experiencing the highest core housing need are lone-parent female households (40%), lone-male parent households (31%), senior led households (27%), and Aboriginal households (26%); and
- households in the NWT experiencing the lowest core housing need are couples without children (8.7%) and those led by non-Aboriginal (9%) individuals.

A greater number of households in core housing need is related to more dwellings that do not meet adequacy standards or units that are either in poor physical condition or lacking the basic facilities for a healthy living environment. Increases in living costs and the effects of the economic downturn in 2008-2009 have contributed to lack of affordable housing.

Smaller NWT communities have consistently had much higher percentages of households in core need than the territorial average. In 2009, households in smaller NWT communities were twice as likely to be in core need as the NWT in general. In smaller NWT communities, the main problem is adequacy or quality of housing while affordability is the least frequent problem. Major repairs are needed by more than 25% of households in smaller NWT communities. There is a lower frequency of housing problems in the regional centres of Hay River, Fort Smith, and Inuvik than in smaller communities. The most frequent housing problem in regional centres is adequacy. There are fewer housing problems in Yellowknife than in other types of communities. The main housing problem in Yellowknife relates to affordability, exacerbated by high housing costs more so than low incomes. The 2009 NWT Community Surveys found that 59% of Yellowknife households reported spending more than $1,500 per month for housing in 2009 compared to 44% in 2004. Reported housing costs of more than $1,500 per month were reported by 41% of Hay River, Fort Smith, and Inuvik households in 2009 compared to 16% of households in 2004. In 2009, 17% of households in smaller NWT communities reported housing costs of more than $1,500 per month, compared to 5% of households in 2004.

GNWT socio-economic monitoring reports suggest that diamond mining projects have not had the positive impact of reducing the percentage of households in core housing need that might have been expected.[27] For example, from 1996 to 2004, the Tli Cho region made progress toward reducing its very high core housing need. However the trend reversed and by 2009, almost 48% of Tli Cho households were in core housing need.

In 2009, more than 50% of households in Paulatuk, Colville Lake, Deline, Fort Good Hope, Jean Marie River, Nahanni Butte, Trout Lake, Wrigley, and Fort Resolution were in core housing need. The lowest rates of core housing need in 2009 were recorded in Norman Wells (8.5%), Yellowknife (9.1%), and Hay River (9.3%).

8.4.5.2 Percentage of Households with Six or More Persons

Crowding is a main suitability issue for NWT households with more than six people. Health Canada advises that overcrowding can contribute to a host of physical ailments, such as communicable diseases like tuberculosis as well as psychological effects, such as stress between household members.[28]

The data on households with six or more persons are collected through the NWT Housing Needs Survey and the NWT Community Survey. These data are presented in Table 8.4-15.

Table 8.4-15
Percentage of Households with Six or More Persons

Area	1981	1986	1991	1996	2001	2004	2006	2009
Canada	5.5	3.9	3.2	3.3	3.1	na	2.9	na
NWT	13.9	11.5	9.8	8.6	7.2	7.0	6.2	6.7
Smaller NWT Communities	32.1	26.2	19.4	15.3	13.4	12.5	11.5	12.3
Beaufort-Delta	20.3	16.1	12.3	12.0	9.8	9.3	8.4	7.6
Sahtu	22.9	25.2	18.4	14.7	12.2	10.2	8.4	9.1
Dehcho	28.3	21.9	14.4	9.3	8.3	8.2	8.9	8.1
South Slave	11.7	9.0	7.1	7.2	5.1	4.9	5.2	4.9
Tli Cho	50	47.9	40.7	29.4	26.3	23.8	26.3	27.4
Yellowknife	5.7	4.9	5.4	5.1	4.2	4.1	3.3	4.3

Source: 1981, 1986, 1991, 1996, 2001 and 2006 – Census; 2004 and 2009 NWT Community Survey (as reported in NWT Bureau of Statistics, Summary of Community Statistics 2010). Note: na = not available

[27] GNWT (2008). *Communities and Diamonds, 2007 Annual Report of the Government of the Northwest Territories under the BHP Billiton, Diavik and De Beers Socio-economic Agreements.*
[28] Health Canada (2009). *A Statistical Profile on the Health of First Nations in Canada: Determinants of Health, 1999 to 2003*

Although the extent of overcrowding in the NWT has declined over time, there remained more than twice as much overcrowding in the NWT in 2006 than in Canada. Lower rates of overcrowding in the NWT were most noticeable between 1981 and 2002, thereafter flattening. Overcrowding in smaller NWT communities declined significantly (e.g. 32% in 1981 to 12% in 2009). However since 2001, there has consistently been almost twice as many households in smaller NWT communities with six or more persons than the NWT average. The Tli Cho region continues to have much higher rates of overcrowding (e.g. in 2009 27.4% of households had six or more people). In 2009, only the South Slave region and Yellowknife area had fewer households with six or more persons than the NWT average.

In 2009, the highest percentage of overcrowding in an individual community was recorded in Behchoko (28.5%) while other communities with percentages of 25% or higher included Colville Lake, Jean Marie River, Gameti, and Whati. Lowest rates of overcrowding ranged from 3.5% to 5.2% in Yellowknife, Inuvik, Fort Smith, Hay River, and Norman Wells.

8.4.6 Families and Children

8.4.6.1 Lone Parent Families

The percentage of all families that are lone parent families is gathered from national census data which is available for NWT communities, Canada, the provinces, and territories. The incidence of lone parent families is an indication of family structure in NWT communities. Lone parent families are consistently at higher risk than two parent/couples families of low income, poverty, homelessness, and food insecurity. A summary of the lone parent family data in Canada and the NWT is provided in Table 8.4-16.

Table 8.4-16
Percentage of Lone Parent Families

Area	1986	1991	1996	2001	2006
Canada	12.7	13.0	14.5	15.7	15.9
NWT	15.4	15.3	16.4	21.0	21.4
Smaller NWT communities	18.4	17.9	19.1	27.4	28.6
Beaufort-Delta	19.9	19.8	22.2	28.9	30.3
Sahtu	17.3	19.4	19.1	27.8	25.8
Dehcho	18.9	17.7	16.8	19.5	24
South Slave	22.9	17.4	17.0	22.7	23
Tli Cho	17.6	18.6	17.0	29.8	32.6
Yellowknife	12.6	12.2	13.6	15.8	15.6

Source: Census (as reported in NWT Bureau of Statistics, Social Indicator Regional Level Data, 2004 and Summary of NWT Statistics 2010)

The percentage of lone parent families has increased in the NWT since 1986 at a rate slightly faster the Canadian average. In 2006, there were 5.5% more lone parent families in the NWT than in Canada. Much of this increase occurred between 1996 and 2006 during a time period correlated to the beginning of diamond mine construction and operation in the NWT. Increases in lone-parent families may be partially caused by familial stress associated with rotational work schedules associated with diamond mine or other industrial employment.

The changing nature of the family structure in the NWT from traditional (couple) family units to lone parent families is most noticeable in smaller NWT communities. In 2006, more than 25% of families were lone parent families in smaller NWT communities (28.6%) and in the Beaufort-Delta region (30.3%), Sahtu region (25.8%), and Tli Cho region (32.6%). In 2006, over 40% of families were lone parent families in four communities - Kakisa (66.7%), Jean Marie River (50%), Fort McPherson (45%), and Wekweeti (42.9%). The lowest rates of lone parent families in 2006 were in Fort Liard (14.3%) and Yellowknife (15.6%).

8.4.6.2 Children Living in Low Income

Children living in low income is calculated as the percentage of children younger than 18 years living in families with income below the after-tax low income measure. After-tax low income is a measure of relative income that is 50% of the adjusted median family income, re-calculated annually at a national level and adjusted by family size. Families living in low income lack financial security and may not have the resources to afford food, shelter, and other necessities of daily living. Children living in low income in Canada, the NWT, smaller NWT communities, and regions are summarized in Table 8.4-17.

Table 8.4-17
Children Living in Low Income

Area	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Canada	22.8	21.7	21.6	22.3	21.4	22.6	22.1	22.6	20.7	19.6
NWT	24.5	23.3	23.9	24.2	20.3	23.0	22.6	23.2	20.7	20.7
Smaller NWT communities	32.4	29.2	30.5	30.6	26.0	31.2	27.2	31.3	28.1	28.3
Beaufort-Delta	32.2	29.8	30.1	31.7	27.4	28.9	29.5	30.3	26.2	28.6
Sahtu	23.7	21.3	14.9	13.4	21.2	22.0	17.7	22.4	20.8	18.4
Dehcho	31.3	23.9	26.3	25.0	28.4	23.1	23.9	30.3	28.4	21.8
South Slave	24.9	26.6	25.8	23.4	22.8	26.6	20.3	26.4	22.9	23.5
Tli Cho	31.3	30.1	27.3	25.5	25.2	30.7	28.4	31.9	26.4	29.9
Yellowknife	16.5	15.0	17.1	16.8	12.2	14.6	14.7	14.5	14.4	13.7

Source: Statistics Canada (as reported in NWT Bureau of Statistics, Social Indicator Regional Level Data, 2004, Summary of NWT Income Statistics 2008 and in NWT Education, Culture and Employment (2007). Income Security Breaking Down The Barriers of Poverty).

Between 1997 and 2006 the percentage of children living in low income families in the NWT declined from 24.5% to 20.7%. The incidence of children living in low income families in the NWT remained close to the Canadian average throughout this same period. Again, smaller NWT communities have the highest rates; in 2006, the incidence of children living in low income families in smaller NWT communities remained almost 8% higher than the NWT average. However, rates of children living in low income declined in all NWT regions between 2002 and 2006. Between 1997 and 2006, the highest rates were in the Tli Cho and Beaufort-Delta regions, and on occasion in the Dehcho region. In 2006, the highest rates (around 40%) were in Fort Resolution (41.2%), Ulukhaktok (40%), and Aklavik (38.1%). At the same time, the lowest rates of children living in low income families were in Norman Wells (9.5%) and Yellowknife (13.7%).

8.4.6.3 Child Protection Investigations

This indicator is based on the number of reported child investigations recorded by the NWT Department of Health and Social Services. Data are available annually for the NWT and a summary of this information is presented in Table 8.4-18. There are no community data or comparable data for other parts of Canada.

Table 8.4-18
Number of Child Protection Investigations

Area	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
NWT	2638	2383	2637	2460	2463	2020

Source: NWT Health & Social Services (as reported Jeff Barichello, NWT Bureau of Statistics, July 2010)

Child protection investigations in the NWT have declined. Much of the change occurred between 2004-05 and 2005-06. Factors such as reporting practices and staff vacancies may contribute to the change in child protection investigations.

8.4.6.4 Population Dependency Ratios

Population dependency is measured as two different ratios; the ratio of the combined child population (aged 0 to 14 years) and the combined elder population (aged 60 years or more) to the working age population (aged 15 to 59 years). This ratio is presented as the number of dependents for every 100 people in the working age population. Individuals who are 60 or more years of age or under 15 years are more likely to be dependent on those of working age. As well, they may utilize more social services. The elders in particular may have greater need for health care services.

Tables 8.4-19 and 8.4-20 summarize the data for persons less than 15 years of age and those 60 years or older, respectively.

Table 8.4-19
Population Dependency Ratio (Less Than 15 Years of Age*)

Area	1991	1996	2001	2006	2009
Canada	32.5	31.8	29.3	26.9	26.0
NWT	44.0	42.7	39.4	33.5	31.3
Smaller NWT Communities	na	54.6	48.6	42	38.1
Beaufort-Delta	51.2	52.3	44.6	38.7	35.3
Sahtu	55.4	56.2	51.0	41.4	35.8
Dehcho	48.6	43.0	41.2	38.2	33.0
South Slave	43.8	43.3	38.7	34.2	30.7
Tli Cho	na	62.1	54.9	50.8	49.9
Yellowknife	36.9	35.5	34.3	28.1	27.2

**Number of people less then 15 years old for every 100 people between the ages of 15 and 59*
Source: Canadian rates – Statistics Canada; NWT and community rates: NWT Bureau of Statistics (except 1991 – Statistics Canada) (as reported Jeff Barichello, NWT Bureau of Statistics)
Note: Data for Canada 2006 is not available for the same age categories. Information is suppressed, but is included in the NWT total for communities with a population of 50 or less; cells with values of 10 or less, communities with population of less than 100. Note: na = not available.

Table 8.4-20
Population Dependency Ratio (60 Years of Age or Older*)

Area	1991	1996	2001	2006	2009
Canada	24.7	25.4	26.1	28.2	30.5
NWT	7.6	8.2	9.2	10.8	12.7
Smaller NWT Communities	na	13.4	13.7	15.6	16.9
Beaufort-Delta	8.6	10.1	11.4	13.7	14.7
Sahtu	11.2	8.9	12.2	14.0	14.4
Dehcho	13.2	13.8	12.2	16.9	18.3
South Slave	10.6	13.1	13.6	16.2	18.4
Tli Cho	na	14.4	15.2	12.8	13.3
Yellowknife	3.6	4.2	5.3	6.8	9.1

**Number of people 60 years and older for every 100 people between the ages of 15 and 59*
Source: Canadian rates – Statistics Canada; NWT and community rates: NWT Bureau of Statistics ((as reported Jeff Barichello, NWT Bureau of Statistics)
Note: Data for Canada 2006 is not available for the same age categories. Information is suppressed, but is included in the NWT total for communities with a population of 50 or less; cells with values of 10 or less, communities with population of less than 100. Note: na = not available.

The NWT continues to have one of the youngest populations in Canada but this youthful pattern is slowly changing. An aging population has contributed to an overall decline in children and greater longevity has also contributed to a noticeable increase in the number of older adults likely to be dependent on the working age population. Between 1991 and 2009, the rate of decline in the dependency ratio of children 15 years and younger was greater than the rate of increase in the dependency ratio for those aged 60 years and older in the NWT. With the exception of the Tli Cho region where the dependency ratio for children 15 years and younger was close to half of the working age population and almost twice the Canadian average, most regions had a dependency ratio of around one-third of the working age population in 2009.

The dependency ratio for those aged 60 years and older in the NWT is on the rise but remains much lower in the NWT than in Canada as a whole. In 2009, the population dependency ratio (60 years of age and older) in the NWT was about 18% lower than in Canada. The increasing dependency ratio is a factor of an older adult population (60 years and older) that has more than doubled between 1991 and 2009 (e.g. from 1,890 in 1991 to 3,828 in 2009). Between 1991 and 2009, the largest increase (18%) in dependency ratio for those aged 60 years and older was in the South Slave region. At a community level, the highest dependency ratios for children were recorded in Colville Lake (81.7%) and Sachs Harbour (62.5%) in 2009. The lowest dependency ratio for children in 2009 was 19.7%. The highest dependency ratios for adults 60 years and older (2009) were recorded in Aklavik (24.5%), Colville Lake (25.4%), Fort Good Hope (21.4%), Fort Resolution (22.3%), and Lutselk'e (22%). The lowest ratios were noted in Yellowknife (8.6%), and Norman Wells (8.9%).

8.4.7 Income and Employment

8.4.7.1 Average Employment Income

Average employment income is obtained annually by Statistics Canada, based on tax filer information. Data on average employment income in the NWT and Canada are summarized in Table 8.4-21.

Table 8.4-21
Average Employment Income

Area	1996	2001	2002	2003	2004	2005	2006	2007
Canada	26,992	32,322	32,946	33,693	34,910	36,326	38,009	na
NWT	33,364	38,497	41,428	41,904	43,969	45,843	47,856	50,627
Smaller NWT communities	22,708	27,176	28,412	28,703	30,718	32,079	33,489	na
Beaufort-Delta	27,761	33,723	35,559	36,577	38,426	38,656	40,154	42,162
Sahtu	29,751	33,885	35,364	34,496	37,844	39,983	42,604	42,532
Dehcho	23,570	28,035	29,549	30,609	31,738	32,992	34,444	36,956
South Slave	28,673	35,220	37,368	38,387	40,719	41,946	45,572	48,636
Tli Cho	17,399	24,774	26,703	27,368	28,475	30,595	32,287	34,346
Yellowknife	40,118	45,147	49,172	49,370	51,506	54,037	55,579	58,591

Source: Statistics Canada SAADD (as reported in NWT Bureau of Statistics, Summary of NWT Community Statistics 2010 and Summary of NWT Income Statistics 2008) Note: na = not available

Between 1996 and 2007, the average employment income in the NWT increased by 52%. Over the same period, NWT average employment income was consistently $6,000 to $10,000 higher than the Canadian average.

Growth has occurred in all regions on a consistent basis, similar to the Canadian average. While average employment income in the Tli Cho region was consistently the lowest of all the regions, it effectively doubled between 1996 and 2007. In 2007, average employment income in smaller NWT communities was about 30% lower than the NWT average and 40% less than average employment incomes in Yellowknife. These patterns did not change noticeably between 1996 and 2007.

In 2006, the highest average employment incomes were recorded in Norman Wells ($66,442) and Yellowknife ($55,579). The lowest average employment incomes were in Paulatuk ($22,385) and Ulukhaktok ($24,786).

In 2005, average earnings for the NWT population 15 years and older who identified as Aboriginal was $33,687 compared to the $25,961 average for Canadian Aboriginal people.[29] Nonetheless, average earnings for the Aboriginal population in the NWT remain lower than average earnings for the NWT population as a whole. In 2005, average earnings for male Aboriginal populations was almost 9% higher than female Aboriginal populations in the NWT. Higher than NWT average earnings for the Aboriginal population were in Norman Wells ($62,792), Yellowknife ($41,803), Hay River $39,252, Fort Smith ($35,250), and Fort Simpson

[29] Statistics Canada, *2006 Aboriginal Population Profile*

($36,254). The lowest average earnings for Aboriginal population was the Hay River Dene Reserve ($22, 697).

8.4.7.2 Income Disparity

Income disparity is tracked by the percentage of families having less than $30,000 annual income and the percentage of families with more than $75,000 income per year. If the percentage of families with high incomes is increasing, there are correspondingly fewer families with lower income and the family income disparity gap is shrinking. Large income inequality can have adverse effects on communities. Level of income shapes overall living conditions, affects psychological functioning, and health-related behaviours.[30]

Data on income disparity are obtained annually by Statistics Canada based on tax filer information, monitored by the GNWT, and reported in the Communities and Diamonds reports (e.g., GNWT, 2008 and 2009). NWT data for families making less than $30,000 annually are presented in Table 8.4-22 and Table 8.4-23 presents the percentage of families making more than $75,000 annually.

Table 8.4-22
Percentage Of Families With Income Less Than $30,000

Area	1999	2000	2001	2002	2003	2004	2005	2006	2007
Canada	28.1	26.8	24.3	23.6	23.2	22.1	20.6	18.9	17.5
NWT	26.3	26.2	20.8	19.4	20.3	20.2	19.0	18.0	16.6
Smaller NWT communities	41.0	41.2	33.3	31.9	32.6	32.7	30.7	29.6	27.7
Beaufort-Delta	36.7	37.4	28.6	28.0	27.9	28.2	27.2	26.3	26.6
Sahtu	43.6	38.9	30.4	29.8	27.6	27.9	23.7	20.0	20.7
Dehcho	32.9	38.0	33.8	26.7	29.9	31.2	31.6	27.6	27.4
South Slave	31.3	27.8	23.2	21.4	22.2	22.8	19.8	21.4	17.9
Tli Cho	48.3	44.3	36.5	35.9	30.8	31.8	30.8	29.4	27.3
Yellowknife	17.2	16.7	12.8	11.4	12.5	12.1	12.1	10.6	9.5

Source: Statistics Canada (as prepared by NWT Bureau of Statistics, Family Income Distribution % of filers reporting less than $30,000 Northwest Territories: by selected geographic aggregation 1994-2007 and as reported by Jeff Barichello, NWT Bureau of Statistics)

Notes: Due to suppression of data for some small communities, and to permit consistency and comparability across years, Administrative Regions displayed in the document are comprised of the following communities:
Beaufort-Delta: Aklavik, Fort McPherson, Ulukhaktok (Holman), Inuvik, and Tuktoyaktuk
Sahtu: Deline, Fort Good Hope, Norman Wells, and Tulita
Dehcho: Fort Liard, Fort Providence, and Fort Simpson
South Slave: Fort Resolution, Fort Smith, Hay River, and Lutselk'e
Tlicho: Behchokö, Gamètì and Whati

[30] Mikkonen, J., & Raphael, D. (2010). *Social Determinants of Health: The Canadian Facts*

Table 8.4-23
Percentage of Families with Income Greater Than $75,000

Area	1999	2000	2001	2002	2003	2004	2005	2006	2007
Canada	26.2	28.9	31.2	33.0	34.1	36.1	38.4	41.0	43.5
NWT	40.6	41.6	47.4	50.4	50.7	52.7	55.3	57.1	59.5
Smaller NWT communities	20.3	21.3	27.2	28.7	29.1	32.1	35.1	34.9	38.6
Beaufort –Delta	26.5	28.6	35.4	38.4	37.4	38.7	39.5	40.6	40.5
Sahtu	29.1	33.3	33.9	31.6	36.2	37.7	45.8	45.0	44.8
Dehcho	22.9	23.9	25.7	30.7	32.5	33.8	34.2	35.5	39.7
South Slave	34.4	35.3	42.8	45.9	45.3	48.0	50.0	52.4	56.2
Tli Cho	13.3	13.1	23.8	25.0	27.7	34.8	36.9	35.3	39.4
Yellowknife	54.6	55.6	61.0	64.9	64.8	66.9	68.6	71.3	72.8

Source: Statistics Canada (as prepared by NWT Bureau of Statistics, Family Income Distribution % of filers reporting more than $75,000 Northwest Territories: by selected geographic aggregation 1994-2007and as reported by Jeff Barichello, NWT Bureau of Statistics)
Notes: same as in Table 8.4-22

Between 1999 and 2007, the percentage of families with annual incomes of greater than $75,000 grew both in the NWT on average and in smaller NWT communities by close to 20%. During the same period, the percentage of families with annual incomes of less than $30,000 declined in the NWT by 9.7% and in smaller NWT communities by 12.3%. These data suggest some shrinkage in the gap in family income disparity within the NWT and in smaller NWT communities. During the same time period, the narrowing of the family income disparity gap was greatest in the regions and the communities. The largest growth in families with annual incomes greater than $75,000 occurred in the South Slave and Tli Cho regions. The largest decline in families with annual incomes of $30,000 or less occurred in the Tli Cho and Sahtu.

While income disparity is felt in every community in the NWT, it is most evident in smaller communities. In 2006, the highest percentage of families with annual incomes of $30,000 or less was in Lutselk'e (55.6%), Gameti (42.9%), Paulatuk (42.9%), and Uluhaktok (40.0%). Income disparity is least evident in larger communities. In 2006, the highest rates of families with annual incomes greater than $75,000 were in Yellowknife (71.3%), Norman Wells (66.7%), Hay River (60.2%), Inuvik (54.3%), and Fort Smith (52.9%).

8.4.7.3 Employment Rate

The employment rate is calculated as the percentage of person 15 or more years of age who are employed at a job or business, including self-employment. Employment data are collected by Statistics Canada and in the NWT Labour Force Survey and the NWT Community Survey.

Employment rates for Canada, the NWT, smaller NWT communities, and NWT regions are presented in Table 8.4-24.

Table 8.4-24
Percentage of Persons 15 Years and over and Employed at a Job or Business

Area	1986	1989	1991	1996	1999	2001	2004	2006	2009
Canada	59.6	62.1	59.7	58.5	60.6	61.2	62.4	63.0	61.8
NWT	66.2	65.0	69.3	68.2	67.5	69.7	67.8	68.6	67.3
Smaller NWT communities	46.4	39.7	48.9	50.9	48.4	52.4	48.8	50.2	52.5
Beaufort-Delta	58.8	56.7	59.0	59.0	60.1	60.4	59.6	57.6	56.6
Sahtu	53.8	55.1	54.4	62.2	62.3	61.4	62.1	59.8	54.7
Dehcho	47.9	44.9	54.0	54.3	52.4	58.1	53.4	55.1	53.3
South Slave	65.5	60.3	68.3	66.0	66.2	67.5	64.2	68.3	64.2
Tli Cho	31.6	27.0	37.9	36.8	31.7	44.9	37.3	41.6	40.5
Yellowknife	83.0	83.3	82.9	80.0	79.5	80.8	79.7	79.3	78.8

Source: Statistics Canada (except NWT and community data for 1989, 1994 and 1999 - NWT Labour Force Survey; 2004 and 2009 - NWT Community Survey) (as reported in NWT Bureau of Statistics, Summary of NWT Community Statistics 2010 and 2009 NWT Community Survey)

Between 1986 and 2009, the NWT employment rate increased by 1% and during that period varied between 3 and 10% higher than the Canadian average During the same period, the employment rate in smaller NWT communities grew by about 6%. Employment growth in smaller communities contributes to fewer economic and employment gaps between smaller and larger NWT communities. At a regional level, outcomes have varied. Employment rates have declined in the Beaufort-Delta, South Slave and Yellowknife between 1986 and 2009, and over the shorter term, employment rates in all regions and Yellowknife have declined between 2006 and 2009. Overall the Tli Cho region has experienced the largest employment increases but the region continued to have the lowest employment rate in 2009. Employment rates in the Tli cho were 27% lower than the NWT employment rate.

With the economic boom in the NWT in recent years, it is not surprising that the employment rate in Yellowknife (78.8%) in 2009 was well above NWT and Canada's rates. It is surprising however that the employment rate in Yellowknife has been gradually declining in recent years. In 2009, Yellowknife employment rate was lower than in 1991 despite the construction and operation of three diamond mines north of Yellowknife and a 23.4% growth of public sector employment between 2002 and 2009.

While the overall NWT employment rate is the highest in Canada, there are significant differences among communities. Three-quarters of the territorial labour market (population 15 years and over) reside in seven NWT communities - Norman Wells, Yellowknife, Inuvik, Hay River, Enterprise, Fort Simpson, and Fort Smith. The employment rate in these seven communities averaged 72% in 2009. For the remaining 27 NWT communities, which represent 25% of the territorial labour market, the employment rate averaged 44% in 2009.

Employment rates among Aboriginal people in the NWT have continued to improve. Employment rates grew from 41.8% in 1989 to 52.2% In 2006. The overall employment rate for Aboriginal people in the NWT in 2006 was slightly lower (52.2%) than the overall Aboriginal employment rate for Canada (53.7%). Employment rates among Aboriginal workers in the NWT are below the NWT overall average and are similar to the rates recorded for smaller NWT communities.

In 2009, the community of Norman Wells had the highest employment rate (80.3%) in the NWT, followed closely by Yellowknife (79.7%), Hay River (71.1%), and Enterprise (73.6%). Lowest employment rates in 2009 were reported in Ndilo (31.5%), Lutselk'e (34.2%), Fort Providence (36.3%), and Behchoko (37.5%).

There is a positive relationship between educational attainment rates and employment rates in the NWT. In 2009, the employment rate among adults with a high school diploma was 81.2% compared to 35.5% for those with less education. In smaller NWT communities, the employment rates of 70.2% for those with a high school diploma and 28.4% for those with less than a diploma were lower than the NWT rates. The highest employment rates for those with high school diplomas were in Norman Wells (89.2%), Yellowknife (85.7%), Inuvik (84.1%), Hay River (81.1%), Gameti (80%), and Sachs Harbour (79.4%). Adults who did not have a high school diploma had very limited employment in Kakisa (14.3%), Fort Resolution (17.4%), Fort McPherson (18.7%), Fort Providence (19.5%), Aklavik (21%), and Tuktoyaktuk (21.6%).

8.4.8 NWT Economy

8.4.8.1 Gross Domestic Product (GDP)

Table 8.4-25 presents real GDP at market prices in millions of chained (2002) dollars. Chained 2002 dollars remove impacts of price changes. Real GDP therefore more accurately reflects changes in the value of goods and services produced by eliminating variations over time associated with inflation or deflation.

Table 8.4-25
Gross Domestic Product at Market Prices, 2000-2008 in Millions of Chained (2002) Dollars

	Canada	NWT
2000	1,100,515	2,351
2001	1,120,148	2,850
2001 Annual Change	1.8%	21.2%
2002	1,152.905	3,033
2002 Annual Change	2.9%	6.4%
2003	1,174,592	3,440
2003 Annual Change	1.9%	13.4%
2004	1,211,239	3,543
2004 Annual Change	3.1%	3.0%
2005	1,245,064	3,532
2005 Annual Change	2.9%	-.3%
2006	1,284,819	3,711
2006 Annual Change	3.1%	5.1%
2007	1,319,681	4,138
2007 Annual Change	2.7%	11.5%
2008	1,325,718	3,871
2008 Annual Change	.5%	-6.5%

Source: Statistics Canada (as reported in NWT Bureau of Statistics, Statistics Quarterly Volume 31 No.4 December 2009)

The NWT had the fastest growing economy in Canada between 2000 and 2003, but has experienced fluctuations and higher volatility in growth trends than the Canadian average since then. Between 2000 and 2008, gross domestic product grew by 65% ($2.35 billion in 2000 to $3.87 billion in 2008) in the NWT compared to 20% for all of Canada. Territorial GDP lost 6.5% in 2008, a trend that appeared to continue in 2009.

Economic growth in the NWT has largely been the result of the development of three diamond mines, renewed interest in oil and gas exploration and extraction, and a proposal to develop a natural gas pipeline through the Mackenzie Valley. These primary industries have had considerable direct and indirect impact on secondary industries including transportation, retail and wholesale trade, manufacturing and technical engineering and accounting services within the NWT.

8.4.8.2 Consumer Price Index

The consumer price index is a measure of the average change in consumer prices over time. Table 8.4-26 compares change in 'all items Consumer Price Index data' between Yellowknife and Canada using 2002 as the base year. The associated inflation rate is the percentage increase or decrease in consumer prices from one year to the next.

Table 8.4-26
Consumer Price Index – Yellowknife and Canada (All Items and Percentage Change)

	Yellowknife		Canada	
	All Items	Inflation Rate	All Items	Inflation Rate
2009	115.9	.6	114.4	.3
2008	115.2	4.0	114.1	2.3
2007	110.8	2.9	111.5	2.2
2006	107.7	1.4	109.1	2.0
2005	106.2	2.3	107.0	2.2
2004	103.8	1.5	104.7	1.8
2003	102.3	2.3	103.8	2.8
2002	100.0	3.0	100.0	2.2
2001	97.1	1.6	97.8	2.5
2000	95.6	1.7	95.4	2.7
1999	94.0	1.1	92.9	1.8
1998	93.0	-.1	91.3	1.0
1997	93.1	.1	90.4	1.7
1996	93.0	1.6	88.9	1.5

Source: Statistics Canada (as reported in NWT Bureau of Statistics, Statistics Quarterly Volume 31 No.4 December 2009 and 2009 NWT Socio-Economic Scan Statistical Supplement)

The consumer price index for Yellowknife increased by almost 25% between 1996 and 2009 while Canada's index changed by 29% over the same period. Higher annual inflation both in Canada and Yellowknife from the base year 2002, has contributed to higher food and shelter costs in Yellowknife as well as escalating capital costs for major NWT infrastructure projects such as the proposed Mackenzie Gas Project and Deh Cho Bridge Project. Higher living costs were also felt in the other 33 NWT communities. For example, food prices in 2004 were higher in every community and more than double the Yellowknife rate in Paulatuk and Tuktoyaktuk.

8.4.9 Aboriginal Culture

8.4.9.1 Aboriginal People 15 Years and Over Able to Speak an Aboriginal Language

The ability to speak the language that reflects cultural traditions and knowledge is an indicator of cultural identity and well-being. . Loss of language impacts on identity. It also contributes to weaker intergenerational relationships, less knowledge transfer between generations, and the erosion of Aboriginal culture, heritage, and traditions.[31]

The percentage of Aboriginal people 15 years of age and over who are able to conduct a conversation in an Aboriginal language is reported in Table 8.4-27. These data are collected through the NWT Labour Force Survey and the NWT Community Survey conducted by the NWT Bureau of Statistics.

Table 8.4-27
Percentage of Aboriginal People 15 Years and over able to Speak an Aboriginal Language

Area	1989	1994	1999	2004	2009
NWT	55.6	50.1	45.1	44.0	38.0
Smaller NWT communities	73.9	67.2	62.8	61.9	50.6
Beaufort-Delta	34.4	28.8	27.5	24.8	22.1
Sahtu	85.6	68.3	64.0	58.4	53.3
Dehcho	78.6	71.0	64.9	61.7	58.2
South Slave	39.5	38.6	32.7	34.0	25.0
Tli Cho	96.1	96.5	98.1	94.6	90.4
Yellowknife	36.6	33.5	21.9	25.3	21.8

Source: 1989, 1994 and 1999 - NWT Labour Force Survey; 2004 and 2009 NWT Community Survey
(as reported in NWT Bureau of Statistics, Summary of NWT Community Statistics 2010 and 2009 NWT Community Survey)

The decline of Aboriginal language ability is prevalent throughout the NWT but is particularly evident in smaller NWT communities. During the 20 years between 1989 and 2009, the percentage of Aboriginal people able to speak an Aboriginal language declined by almost 19% in the NWT and 23.3% in smaller NWT communities. Although there continues to be a higher percentage of Aboriginal language speakers in smaller communities, by 2009 the incidence of Aboriginal language speakers in these communities had shrunk to just over 50% of the Aboriginal population.

Decline in the use of Aboriginal language is widespread in all NWT regions but is less evident in the Tli Cho region where just over 90% of Aboriginal people are Aboriginal language speakers. Aboriginal language loss is most evident in the Dehcho and Sahtu regions where there were over 20% to 30% fewer Aboriginal speakers respectively, in 2009 compared to 1989.

There are strong concentrations of Aboriginal language speakers in Tli Cho, South Slave and Dehcho communities. In 2009, there were nine NWT communities where more than 75% of the

[31] GNWT, 2008, *Communities and Diamonds, 2007 Annual Report of the Government of the Northwest Territories under the BHP Billiton, Diavik and De Beers Socio-economic Agreements*

population were Aboriginal language speakers (e.g. Wekweeti (93.6%), Gameti (93.3%), Whati (92.8%), Behchoko (89.1%), Trout Lake (87.1%), Deline (84.0%), Wrigley (80.1%), Kakisa (78.6%) and Lutselk'e (76.9%). Other NWT communities have very few Aboriginal language speakers. The lowest rates were in Enterprise (10.7%), Tsiigehtchic (15.2%), Hay River (15.9%) Inuvik (16.2%), Yellowknife (18%), Fort McPherson (18.1%), and Aklavik (19.2%).

8.4.9.2 Use of Harvested Meat and Fish

The use of harvested meat and fish is an indicator of the strength of the traditional Aboriginal economy in the NWT and communities. The percentage of households that reported that half or more of their meat and fish consumed was obtained through hunting and fishing is shown in Table 8.4-28 for 2003 and 2008.

Table 8.4-28
Use of Harvested Meat and Fish

Area	1999	2003	2008
NWT	21.3	28.4	28.1
Smaller NWT communities	48.7	60.5	51.2
Beaufort-Delta	36.5	48.6	43.8
Sahtu	43.4	52.1	60.9
Dehcho	27.1	53.3	52.4
South Slave	18.5	26.6	25.5
Tli Cho	57.3	66.3	73.7
Yellowknife	8.3	9.5	11.3

Source: 2004 and 2009 NWT Community Survey (as reported in NWT Bureau of Statistics, Summary of NWT Community Statistics 2010 and 2009 NWT Community Survey)

The percentage of households using harvested meat or fish increased between 1999 and 2008 in the NWT as a whole although increases were slightly less evident in smaller NWT communities. More recent trends (2003-2008) are negative however, especially among smaller communities. An increasing use of harvested meat or fish was most evident in Dehcho (25.3%), Sahtu (17.5%) and Tli Cho (16.4%) region households. In 2008, the highest percentage of households using harvested meat and fish were in smaller communities such as Kakisa (94.4%), Lutselk'e (91.9%), Jean Marie River (90%), and Trout Lake (81.8%). The fewest households using harvested meat or fish were in Yellowknife (10.7%), Enterprise (15%), and Hay River (15.7%). Between 2003 and 2008, 19.5% more households used harvested meat or fish in Tsiigehtchic compared to 14.9% fewer households on the Hay River Reserve.

8.5 SUMMARY OF TRENDS

NWT Economy

The NWT has had the fastest growing economy in Canada in recent years. Between 2000 and 2008, the gross domestic product grew by 65% ($2.35 billion in 2000 to $3.87 billion in 2008) compared to 20% for all of Canada. The fast growing NWT economy was accompanied by higher annual inflation rates both in Canada and Yellowknife from the base year 2002. The global economic recession/ downturn in 2008 and 2009 slowed the NWT economy. This resulted in worker layoffs, temporary mine and other business closures, and stalled resource development projects. Less industrial development activity had ripple effects in other economic sectors. This highlights the fact that the NWT economy is still highly vulnerable to shifts in non-renewable resource demands, particularly in the mining sector and specifically at present in the diamond mining sector.

Income and Employment

Between 1986 and 2009, the NWT's employment rate increased by 1%. In 2006, the NWT's employment rate was almost 6% higher than Canada's rate. During the same period, the employment rate in smaller NWT communities grew about 6% faster than the territorial rate. Employment growth has narrowed the employment rate gap between smaller NWT communities and the NWT as a whole, from 20% in 1986 to 14.5% in 2009. While the overall NWT employment rate is the highest in Canada, there are significant differences among communities and culture groups. Between 1989-2006, NWT Aboriginal employment rates improved from 41.8% to 52.2% but remained lower than the NWT rate.

Between 1996 and 2007, the average employment income in the NWT increased by 52% and has consistently been $6,000 to $10,000 higher than the Canadian average. Over the same period, average employment income in smaller NWT communities also increased by 48% but remained about 28% lower than the NWT average. Over the decade between 1996 and 2007, about 20% more families in the NWT and in smaller communities had annual incomes greater than $75,000. About 10% fewer families in the NWT and 15% fewer families in smaller communities had annual income of less than $30,000.

Population

Between 1991 and 2009, the NWT's population increased by 12%. This rate of increase was below Canada`s population growth of 19%. As birth rates decline and the population ages, net outmigration between 2004 and 2009 played a greater role than natural factors in the negative to marginal population change in the NWT.

In 2009, Aboriginal people made up 50% of the NWT population. About 45% of the NWT population is concentrated in Yellowknife.

Education

Educational attainment levels have increased in the NWT but remain lower than elsewhere in Canada. The gap between territorial and national educational attainment levels increased slightly between 1991 and 2006. Education levels in smaller NWT communities, while substantially improving between 1989 and 2009, remain 20%-25% lower than the NWT average. Over this period the Tli Cho region recorded the greatest improvements in education levels although levels in the region are considerably lower than the NWT as a whole. Between 1991 and 2006, education levels in Yellowknife were consistently above the NWT and the rest of Canada.

High school graduation in the NWT has improved and the gap between graduation rates in the NWT and Canada has narrowed. Yellowknife graduation rates strengthened against and exceeded the Canadian rate in 2007. Graduation rates among Aboriginal students have improved and in 2006, exceeded those of non-Aboriginal students.

Education and literacy levels among Aboriginal residents are significantly lower than those of non-Aboriginal residents. There was little change in education levels between 1999 and 2004. While there was little difference between adult literacy levels in Canada and the NWT when the IALSS was completed in 2003, the wide gap between Aboriginal and non-Aboriginal adult literacy levels was noticeable. Low literacy levels among a significant number of Aboriginal adults puts them at risk of socio-economic hardship.

Violent crime

The rate of violent crime has declined in Canada but increased in the NWT. In 2007, the rate of violent crime in the NWT was almost eight times higher than the Canadian rate. Crime rates in the Beaufort-Delta, Dehcho, and Tli Cho regions were more than ten times the Canadian rate. The incidence of violent crime more than doubled in the Tli Cho region between 1999 and 2008.

Rate of Youth Crime

NWT youth crime rates were marginally lower in 2008 than in 2001. During the same period youth crime rates in the NWT were well above the Canadian rates. An emerging challenge for communities and the criminal justice system may be the dramatically increasing rate of female youth crime in the NWT.

Family Violence

Between 1997 and 2006, the number of spousal assault cases reported in the NWT declined by 11% then sharply increased by 45% between 2006 and 2007. In Canada, rates of spousal homicide and severity of non-lethal assaults against women have declined in recent years for both women and men.

NWT shelter admissions of women and children were at their lowest in 2007-08 after peaking in 2002-03.

Housing

The percentage of NWT households that were in core housing need declined in the NWT between 1996 and 2004, however the progress made to reduce core housing need had reversed by 2009. The NWT continues to have a higher percentage of households in core housing need than the Canadian average.

The extent of overcrowding in the NWT has declined over time, however there was twice as much overcrowding in the NWT in 2006 than the Canadian average.

Families and Children

The number of lone parent families has increased in the NWT and remained about 5% higher than the Canadian average between 1986 and 2006. Much of the increase occurred between 1996 and 2006.

The incidence of children living in low income families in the NWT remained slightly higher than the national rate between 1997 and 2006. During the same period, the incidence of children living in low income families in the NWT declined from 24.5% to 20.7%.

Dependency

The NWT continues to have one of the youngest populations in Canada but this youthful pattern is changing. An aging population has contributed to an overall decline in children and older adults likely to be dependent on the working age population. Between 1991 and 2009, the rate of decline in the dependency ratio of children 15 years and younger was greater than the rate of increase in the dependency ratio for those aged 60 years and older.

Aboriginal Culture

Aboriginal language loss is prevalent throughout the NWT but is more evident in smaller communities. While the percentage of NWT households using harvested meat or fish increased between 1999 and 2008, these increases were less evident in the smaller communities.

In conclusion, the measures indicate an imbalance in socio-economic and community well being circumstances. NWT economic, population, and education indicators have been improving in comparison to Canadian rates but indicators of community well being have generally declined.

While rising inflation has contributed to a higher cost of living, there are fewer families in the NWT living with low income and a marked increase in the number of families with higher income. Well being in NWT communities is impacted by significantly higher than national rates of violent crime, family violence, core housing need, child protection issues, and loss of Aboriginal language. Decline in some community well being indicators appear even more pronounced in smaller NWT communities, among the Aboriginal population, and in the Tli Cho region.

8.6 ACTIONS TO ADDRESS SOCIO-ECONOMIC AND COMMUNITY WELLNESS TRENDS

This section provides a snapshot of actions and initiatives to address socio-economic and community wellness in the NWT. The responsibility to address socio-economic and community wellness rests with the GNWT and various federal departments (e.g. Indian and Northern Affairs Canada and Health Canada). In certain regions, there are also initiatives to bolster economic development and socio-cultural wellness (e.g., Tlicho Government).

Each GNWT department is involved in annual and four-year business planning. Departmental business plans describe strategic issues linked to trends, key activities, strategic objectives, and resources related to goals and interdepartmental strategic initiatives. Current departmental plans targeting socio-economic and community wellness issues are summarized below. Programs and services evolving from these planning documents or through legislation may be implemented through contribution agreements or other financial arrangements by First Nation or communities governments or by voluntary sector organizations. Economies of scale, aggregate demand, and local capacity are factors that impact on program and service delivery. For these reasons, larger centres in the NWT have a broader array of programs and services than small communities.

Education, Culture and Employment (ECE)

Goals

- Pride in our culture - Northerners who are knowledgeable about and proud of their culture.
- Education of children and youth - Northern families developing a strong foundation for their children's learning.
- Education of adults - Northern adults continuing to learn and grow to meet the requirements of daily living.
- A skilled and productive work environment - Northerners participating in a strong and prosperous work environment.

Strategic Initiatives

- Improve skills for living and working (Maximizing Opportunities Initiative).

- Promote the NWT as a place to visit and live (Maximizing Opportunities Initiative).
- Maximize benefits from resource development (Maximizing Opportunities Initiative).
- Support individuals and families (Reducing Cost of Living Initiative).
- Expand programming for children and youth (Building Our Future Initiative).
- Strengthen service delivery (Refocusing Government Initiative).

Health and Social Services (H&SS)

Goals

- To promote healthy choices and responsible self-care.
- To protect public health and prevent illness and disease.
- To protect children and vulnerable individuals from abuse, neglect and distress.
- To provide integrated, responsive and effective health services and social programs for those who need them.

Strategic Initiatives

- Expand programming for children and youth (Building Our Future Initiative).
- Encourage healthy choices and address addictions (Building Our Future Initiative).
- Implement Phase II of the Framework for Action on Family Violence (Building Our Future Initiative).
- Strengthen continuum of care for seniors (Building Our Future Initiative).
- Increase safety and security ((Building Our Future Initiative).
- Protect territorial water (Managing This Land Initiative).
- Maximize benefits from resource Development (Maximizing Opportunities Initiative).

Justice

Goals

- Communities have increased capacity and a role in addressing justice issues.
- Programs, safe and secure custody, and community supervision are in place to support the rehabilitation of offenders.
- Communities are safer.
- Victims of crime are supported and have meaningful roles in the justice system.
- Families in conflict are supported.
- All residents have access to justice.

Strategic Initiatives

- Increase safety and security (Building Our Future Initiative).
- Implement Phase II of the Framework for Action on Family Violence (Building Our Future Initiative).

- Continue to develop governance (Managing This Land Initiative).
- Maximize benefits from resource development (Maximizing Opportunities Initiative).

Industry, Tourism and Investment (ITI)

Goals

- Promote and support a diversified economy that provides opportunities for NWT residents.
- Promote and support the development of business opportunities, including agriculture, commercial fishing, the traditional economy, tourism, trade, investment, manufacturing, and secondary industries.
- Promote the sustainable development of natural resources that respects the conservation and protection of the environment for our future generations.
- Promote and support the efficient development, utilization and marketing of energy resources to achieve self-sufficiency, maximize economic opportunities, and realize affordable energy costs.
- Secure economic and employment opportunities from responsible resource development for NWT residents.
- Develop partnerships with individuals, businesses, communities, Aboriginal organizations and other governments to foster prosperity and community self-reliance.

Strategic Initiatives

- Support diversification (Maximizing Opportunities).
- Promote the NWT as a place to visit and live (Maximizing Opportunities).
- Maximize benefits from resource development (Maximizing Opportunities).
- Improve quality and cost of shelter (Reducing the Cost of Living).
- Address factors that impact the cost of goods (Reducing the Cost of Living).
- Expand programming for children and youth (Building Our Future).

Northwest Territories Housing Corporation (NWTHC)

Goals

- Increased supply of adequate, suitable and affordable housing stock in communities to meet the housing needs of NWT residents.
- Sufficient land is acquired and developed for the purpose of providing affordable housing in all communities.
- Homeownership programs and services provide easy access for clients and secure and protect NWTHC assets.
- Long term sustainability and energy efficiency of the housing stock.

- Greater personal responsibility for housing through community based training and support, and strengthened collections policies and procedures.

Strategic Initiatives

- Improve quality and cost of shelter (Reducing the Cost of Living Initiative).
- Improve skills for living and working (Maximizing Opportunities Initiative).
- Strengthen service delivery (Refocusing Government Initiative.

Municipal and Community Affairs (MACA)

Goals

- Increase community government authority and responsibilities through policy, legislation and funding arrangements.
- Enhance knowledge, skills and abilities of community staff, officials and other partners to better manage community affairs.
- Contribute to the development of effective, accountable and democratic community governance structures, including self-government arrangements.
- Support communities in their efforts to provide a safe, healthy and vibrant environment for residents.

Strategic Initiatives

- Encourage healthy choices and address addictions (Building Our Future).
- Enhance support for the voluntary Sector (Building Our Future).
- Expand programming for children and youth (Building Our Future).
- Increase safety and security (Building Our Future).
- Protect territorial water (Managing This Land).
- Continuing to develop governance (Managing This Land).
- Maximize benefits from resource development (Maximizing Opportunities).
- Promote the NWT as a place to visit and live (Maximizing Opportunities).

To supplement and enhance core or mandated programs and services, the following actions currently target socio-economic and community wellness issues in the NWT.

NWT Economy

Based on the following factors, there are signs the NWT economy may be poised for recovery from the 2008 – 2009 economic downturn:

- $744 million in accelerated investment by the GNWT in capital projects for the fiscal years 2009-2010 and 2010-2011 to stimulate economic growth.

- In 2009-2010, the GNWT invested $60 million in *Energy Priorities Investment Plan* to reduce the cost of living in the NWT. [32]
- In 2009-2010, the federal government invested in streamlining the regulatory regimes in the NWT to remove barriers to investment. Additional support was made available to support environmental monitoring.
- Investment in mining exploration in the NWT was expected to more than double in 2010 from $29.5 million in 2009.
- The Joint Review Panel (JRP) report (2009) contended that the Mackenzie Gas Project would be good for the economy and gave conditional support to the Project. The National Energy Board decision regarding the MGP's application for a Certificate of Public Convenience and Necessity will be issued in September 2010. The certificate will facilitate the proponent's decision whether to proceed with construction and operation of the natural gas pipeline. The GNWT supports the MGP. The federal government has not publicly committed to fiscal support requested by the MGP proponents.

Income and Employment

- In 2009, the GNWT established the Aboriginal Employees Advisory Committee (AEAC) with an overall mandate to increase the number of indigenous Aboriginal employees hired and retained by the GNWT. In the same year it signed the Northern Mining Workforce Initiative Memorandum of Understanding with De Beers, Diavik and BHP Billiton with the goal of improving northern skills and experience to attract and retain a NWT-based mine work force.
- The Mine Training Society governed by a board of GNWT, industry, Aurora College, and Aboriginal group representatives has trained 803 people and placed 500 northerners primarily in mining industry jobs. In 2008/09, the Society funded 13 programs and accepted 91 of 189 applicants for underground mine training.
- There were 433 registered apprentices employed in construction industry trades in the NWT as of March 2010.
- Between 2008 and 2011, the GNWT significantly increased capital spending on community-based projects such as schools in Fort Good Hope and Inuvik.
- Mineral projects at different levels of development in 2010 could increase employment opportunities as follows:
    - 179 workers at Tamerlane Venture's proposed reopening of the Pine Point Mine south of Hay River;
    - 200 workers at Avalon Rare Metals' Nechalacho rate earth project south east of Yellowknife;

[32] Alternative energy technologies (e.g. biomass, wind energy, and geothermal technology), energy conservation and efficiency, support for the Arctic Energy Alliance, incentive programs, and community energy plans.

- o 150 workers at Fortune Minerals' NICO cobalt gold project near Whati;
- o 400 workers at De Beers Gahcho kue diamond mine 300 km northeast of Yellowknife; and
- o 220 workers at Canadian Zinc's Prairie Creek lead, zinc and silver mine 200 km west of Fort Simpson.

Population

- An investment by the GNWT will ensure that NWT residents will be properly counted in the 2011 Census. This investment is based on a successful approach to reconcile counting irregularities in the 2006 Census.

Education

- The GNWT's Department of Education, Culture and Employment (ECE) funded the Aboriginal Student Achievement Initiative in 2009 to close the educational achievement gap between Aboriginal and non-Aboriginal students.
- ECE has released successive strategic plans since 1984. In 2005, ECE released *Building on Our Success*, a strategic plan with results-based goals, priorities, and actions for the period 2005-2015.
- ECE participates in monitoring and annual reporting on the socio-economic agreements between the GNWT and the operators of three diamond mines (BHP Billiton, Diavik, and De Beers) in the NWT.

Crime and Public Safety

- The GNWT's Department of Justice is working closely with the Royal Canadian Mounted Police (RCMP) to increase police presence in smaller NWT communities. In 2008, Sachs Harbour received a detachment, and planning for detachments in Gamètì and Wrigley is underway. Options are being explored to provide enhanced police services in smaller remote communities without resident RCMP officers, specifically in the following 10 communities: Dettah, Colville Lake, Tsiigehtchic, Nahanni Butte, Wekweètì, Enterprise, Kakisa, Ndilo, Trout Lake and the Hay River Reserve. The RCMP is finalizing the new national Community Officer Program and the NWT is being considered as a pilot location.
- GNWT, RCMP, and community planning are underway for a strategy to reduce drug and alcohol related crime in the NWT. Illegal drug use and importation of drugs are the targets of a tri-partite plan involving the GNWT, RCMP, and federal government to establish a northern drug interception team.
- Youth, adults, and at-risk people are targeted in the GNWT Crystal Methamphetamine and Associated Drugs Strategy. The Strategy is an awareness campaign and role model program designed to assist community-based efforts to deal with drug issues.

- Monitoring of public safety and crime rates and annual reporting on the socio-economic agreements between GNWT and the operators of three diamond mines (BHP Billiton, Diavik and De Beers) in the NWT continues.

Family Violence

- *A Framework for Action: A Call to Action to the GNWT* was submitted to the GNWT by the Coalition Against Family Violence (CAFV) in 2003. The GNWT initially responded with a 2003-2008 action plan and in 2009 collaborated with the Coalition Against Family Violence to produce a follow-up action plan. During the first action plan, an Implementation Steering Committee was established to ensure that the action plan was carried out. Phase II of the *NWT Action Plan on Family Violence: A Framework for Action* is focused on enhancing and expanding the range of supports available for families affected by family violence.
- The *Protection Against Family Violence Act* (PAFVA) was enacted in 2003. In 2005, the PAFVA enabled the implementation of Emergency Protection Orders as a tool to protect victims. A 24-hour crisis line was also implemented that allows victims to access services under the *Act*. A public education strategy was implemented to increase public awareness of the *Act.*
- Abuser programming to address the needs of men who use violence in intimate and partner relationships is planned under the NWT Family Violence Action Phase 2 (2007-2012). The program is intended to reduce violent behaviours and re-offending rates among violent men.
- In 2006, work began to develop the Yellowknife Interagency Family Violence Protocol and toolkit to improve responses to family violence in the city. Since then other NWT communities have been encouraged to establish similar protocols.
- NWT Health and Social Services follows an integrated services model[33] that takes a results management approach. The model and approach are reflected in the department's strategic plan, *A Foundation for Change Building a Healthy Future for the NWT 2009-2012*. The plan focuses on wellness priorities including:
    - increasing supports and services for people who experience family violence through the Family Violence Framework partnership;
    - financial assistance to family violence shelters and expansion of family violence outreach services;

[33] In 2004, the Department of Health and Social Services and the eight authorities moved to an Integrated Service Delivery Model (ISDM), a team-based, client-focused approach to providing health and social services. The ISDM was developed to ensure that people across the NWT had better and more equal access to services.

- reducing the gap in health and wellness status between Aboriginal and Non-Aboriginal northerners through Child and Family Service Committees and piloting culturally appropriate programs and services;
- addressing the issue of homelessness in the NWT;
- developing and implementing community wellness plans to improve community wellness services;
- improving services for children in care; and
- developing ongoing systems of reporting and evaluation.

Housing

- The increase in core housing need between 2004 and 2009 was anticipated by the NWT Housing Corporation. Territorial housing ministers requested a new approach to northern housing to improve housing conditions.
- The NWT Housing Corporation responds to NWT housing needs through investing territorial funds in house construction and repair. Territorial funding is supplemented through the Northern Housing Trust and Canada's Economic Action Plan. $50 million is budgeted for housing for the 2010-2011 and 2011-2012 fiscal years.
- A wellness priority focus of NWT Health and Social Services *A Foundation for Change Building a Healthy Future for the NWT 2009-2012* includes addressing the issue of homelessness in the NWT by continuing the implementation of the NWT Homelessness Framework. Persons experiencing homelessness in all NWT regions and communities will have access to emergency funding and shelter.

Families and Children

- The promotion of healthy choices and lifestyles is a priority of the 16th Legislative Assembly of the Northwest Territories. In 2010, the Legislative Assembly delegated the review of the *Child and Family Services Act* to the Standing Committee on Social Programs. Child protection, apprehension, the discretionary powers of Child Protection Workers, the overall oversight of the NWT child protection regime, the role of the extended family in child protection matters, and the implementation of Child and Family Services Committees in NWT communities will be addressed in the review.
- Six federal First Nation and Inuit wellness programs[34] are implemented in 32 NWT communities. Community-based program information is reported annually.[35]

[34] Brighter Futures, Canada Prenatal Nutrition Program (CPNP – First Nations & Inuit Component), Aboriginal Diabetes Initiative (ADI), Fetal Alcohol Spectrum Disorder (FASD), National Aboriginal Youth Suicide Prevention Strategy NAYSPS.

[35] *Directions for Wellness 2007-2008: A Summary of First Nations & Inuit Health Branch Programs in the Northwest Territories.*

Culture and Language

- ECE promotes culture-based education in schools and education districts throughout the NWT. The goal of culture-based education is to support all students through affirmation of their culture. At the school level, culture-based education is intended to involve elders as part of the program, work with parents as partners, and provide Aboriginal language programs.
- Language nests are preschool immersion programs funded by ECE that offer opportunities for children to learn in an Aboriginal language.
- The *Official Languages Act* is a shared commitment of the Legislative Assembly and the GNWT to the preservation, development and enhancement of the Aboriginal languages of the NWT. The *Act* and subsequent amendments provide for:
  - legal recognition of NWT Aboriginal languages and use of these languages;[36]
  - a Languages Commissioner whose duties are to ensure recognition of the rights, status and privileges of all official languages; that government institutions comply with the spirit and intent of the *Act*; and to investigate complaints and issues arising from the *Act*;
  - establishment of an Official Languages Board and an Aboriginal Languages Revitalization Board;
  - a review of the *Official Languages Act* every five years. The *Act* was reviewed in 2002-2003 and the GNWT's Response to the Final Report of the Special Committee on the Review of the Official Languages Act was tabled in the Legislative Assembly in 2003 providing a detailed response to each of the 65 recommendations.
- Official Languages are represented by Aboriginal language communities which retain an organization and/or an individual as a contact for language issues and the development and implementation of strategic language plans.
- *Canada-NWT Cooperation Agreement for French and Aboriginal Languages* in the NWT includes funding for teaching and learning centres, Aboriginal language programming, Aboriginal language and cultural instructor program, Aboriginal language communities, and school-based Aboriginal language programs. A detailed activity report is issued on an annual basis to account for the use of federal funding provided under the Agreement.
- An Official Languages Division administers and supports language programs and the delivery of translations and program services in official languages.

[36] *Official Languages Act* section 4 recognizes Chipewyan, Cree, English, French, Gwich'in, Inuinnaqtun, Inuktitut, Inuvialuktun, North Slavey, South Slavey and Tlicho as Official Languages of the NWT.

Support for the Traditional Economy

- NWT Industry, Trade and Investment (ITI) provides annual funding assistance to harvesters through the Community Harvesters Assistance Program (CHAP) which local wildlife committees make available to their memberships.
- *Growing Forward* is cost-shared on a 60:40 ratio between the federal government and the GNWT. The Traditional Harvest Program component is designed to assist NWT community and regional wildlife organizations to harvest local plants, berries, caribou, muskox, and other wild species. Funding supports community harvests; purchase of harvesting, processing and storage equipment; and encourages youth to participate in traditional on the land food harvesting practices.

8.7 INFORMATION GAPS

The 2005 NWT Environmental Audit Status of the Environment Report summarized valued components, indicators, rationale, gaps, and challenges. Findings from the 2005 report that remain relevant and information gaps identified in 2010 are summarized in Table 8.7-1.

Table 8.7-1
Summary of Valued Components, Indicators, Gaps and Challenges

Potential Valued Components and Indicators	Gaps	Challenges
Economy, Employment and Income -GNP -Changes in economic sector composition -Traditional economic activities -Income derived from traditional economic activities -Income derived from industrial and non-industrial wage activities -Average income -Income source -Labour force change -Employment, unemployment and labour force participation rates -Seasonal versus full time employment -Local versus external employment -Income disparity -Local business opportunities	The extent of impacts associated with the shift from a mixed wage- subsistence economy to an industrial wage economy on various segments of the population such as elders/seniors, youth, and women are not well known.	Due to small populations, data are often suppressed. Lack of economic valuation of traditional activities, a narrow perspective of the subsistence economy (e.g. limited to food harvesting), and lack of understanding of the interdependence of subsistence and mixed economic activity limit understanding of these economic, employment and income impacts.

Potential Valued Components and Indicators	Gaps	Challenges
Population -Population change -Population mobility -Net migration -Immigration -Population characteristics -Population dependency ratios	Industrial activity in the NWT is driven by global resource industries. Northern workers are increasingly multi-cultural. The changing characteristics of the NWT population are not well known.	Population data earlier than 1991 is aggregated with Nunavut data, making historical analysis difficult. The analysis of inequities in female, Aboriginal, or immigrant populations is limited by the lack of current and historical disaggregated data. Patterns, trends and other important information may be uncovered if more social economic and community wellness indicators were disaggregated by gender and ethnicity. Due to small populations, data are often suppressed.
Families and Children -Number of lone parent families -Income of females -Children living in low income -Child protection investigations -Changes in women's lifestyles	Children living in low income derived from the Statistics Canada Low Income Measure (LIM) is one measure of low income in the NWT. Other measures of low income exist in other Canadian jurisdictions (e.g. Low Income Cut-offs (LICO)[37]). If available in the NWT, LICOs would contribute to a more comprehensive portrait of low-income NWT families raising children. The circumstances of NWT women are not well understood. Little gender-specific data are available.	The GNWT does not officially define 'poverty' and there is no agreement in Canada on what constitutes the best measure of poverty. Data for small populations may be suppressed.
Aboriginal Culture -Aboriginal language literacy -Aboriginal social and cultural practices	Knowledge of Aboriginal culture extends beyond language to include the many social and practices that express the culture.	There is no consensus on indicators of Aboriginal cultural and social knowledge and practices or methodology for

[37] Low income cut-offs (LICOs) are intended to convey the income level at which a family may be worse off because it has to spend a greater portion of its income on the basics (food, clothing and shelter) than does the average family of similar size.

Potential Valued Components and Indicators	Gaps	Challenges
-Cultural change -Use of harvested meat and fish in diet -Number of trappers/ harvesters	Little monitoring of social and cultural practices is done.	monitoring change. Cultural and social practices and associated priorities may vary among Aboriginal groups in the NWT.
Basic Needs -Households in core need -Households with six or more persons. -Housing affordability -Homelessness -Food security	Food and shelter are basic needs. There are gaps in understanding about the extent to which economic change has impacted the basic needs among various segments of the northern population. Homelessness and food security are emerging issues in many NWT communities. The extent of homelessness and food security are not monitored.	Food security and homelessness are complex issues. Some research has been completed in an effort to bring clarity to homelessness in the NWT.[38] More work needs to be done to understand homelessness. Similarly, some work has been done on food security issues but more research is needed to understand and respond to this basic need.[39]
Crime and Safety -Crime rate by RCMP detachment -Juvenile crime rates -Family Violence -Shelter Admissions	The 2010 report expands the view of family violence.	Family violence is a complex issue. Although girls and women are most often the victims of violence and abuse, aggregated data make it difficult to discern whether age, cultural background, economic circumstances, etc. are factors contributing to vulnerability to family violence. Non-reporting of family violence underestimates the seriousness of this issue.
Education -Population with high school diploma. -Population with postsecondary	Gaps in education levels between the Aboriginal and non-Aboriginal populations, and between northerners living in	Census data for small communities or segments of the population may be limited due to response rates and/or

[38] YWCA Yellowknife and the Centre for Northern Families (2007). *Being Homeless is Getting to be Normal: A Study of Women's Homelessness in the Northwest Territories*.

[39] Glacken, Jody (2008). *The NWT Food Security Project – Defining Food Security and A Review of Selected Food Security Initiatives*. and Lutra Associates Ltd. (2010). *Yellowknife, Ndilo and Dettah Food System Assessment and Community Food Action Plan*.

Potential Valued Components and Indicators	Gaps	Challenges
training or education. -Availability of training programs -Participation in training programs	various types of communities is beginning to be understand but require more rigorous monitoring. Information on training programs and participation in them is not tracked.	confidentiality issues.
Community -Capacity of social organizations -Community infrastructure and services -Access to programs and services -Public engagement -Volunteerism	Determinants of individual and community well being can have a broad focus that includes indicators of social connectedness and cohesion, and personal safety, security and control. Indicators of these elements of community well being are not monitored. The capacity of social organizations/voluntary sector and access to programs and services are not monitored.	There is no consensus on the indicators that would provide a more comprehensive view of community well being.

A snapshot of the many initiatives to tackle NWT socio-economic and community well-being issues in the NWT is provided in Section 8.6. More frequent analysis of business plan and strategic initiative outcomes is needed to understand the overall effectiveness of these programs and services supports in improving community well-being indicators and making genuine progress towards reducing the socio-economic and well being gaps in the NWT, particularly among vulnerable populations. This might come from more emphasis on program service evaluation, and more frequent analysis and reporting such as *NWT Health Status Report 2005* and *Towards Excellence, A Report on Education in the NWT '07.*[40]

[40] Northwest Territories Education, Culture and Employment (2007). *Towards Excellence, A Report on Education in the NWT '07;* Northwest Territories Health and Social Services (2005). *The NWT Health Status Report 2005.*

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