R. Decker/GNWT

▲ Bonnie Fournier

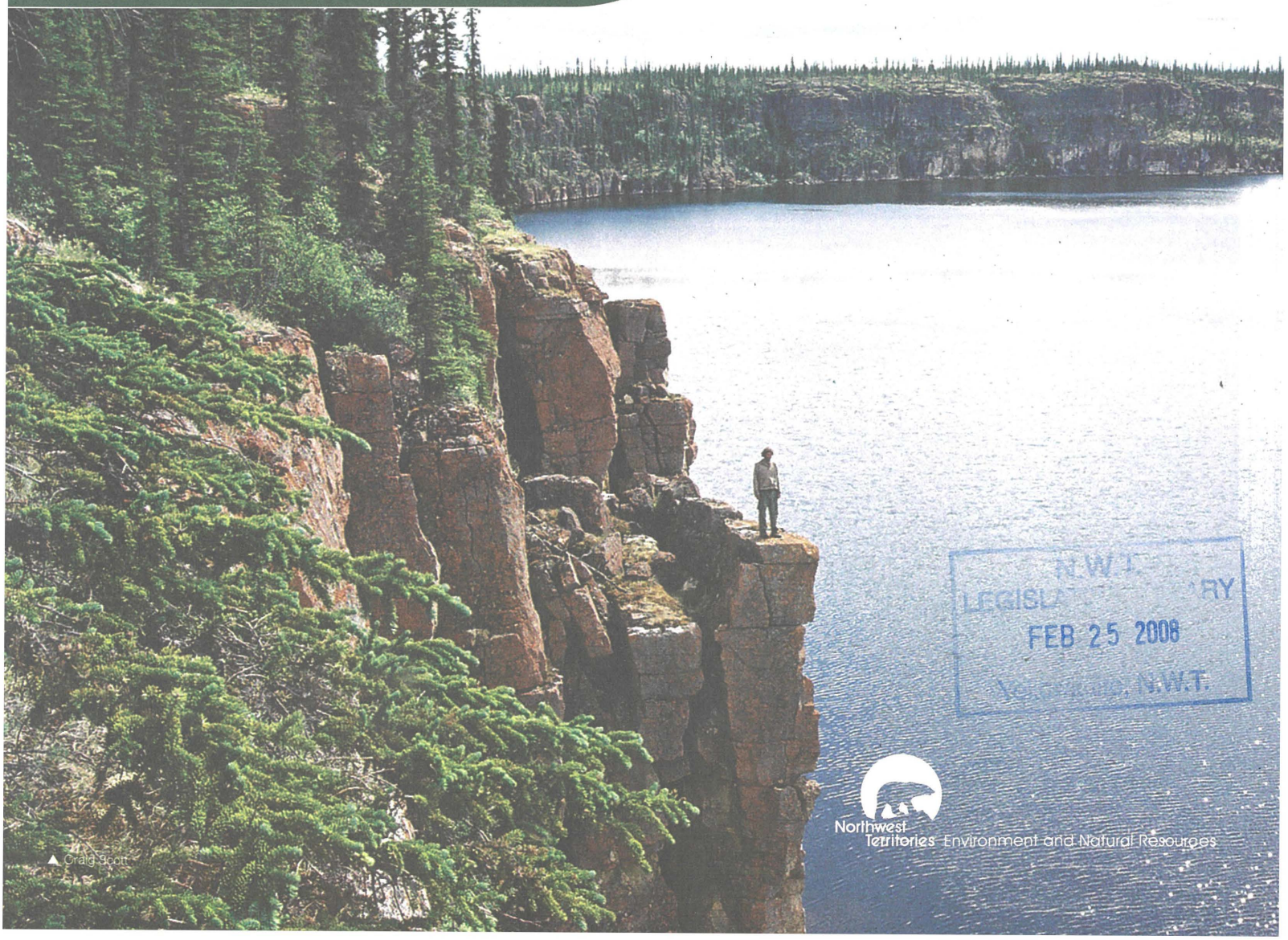
▲ John Nagy

▲ NWT Archives

▲ GNWT

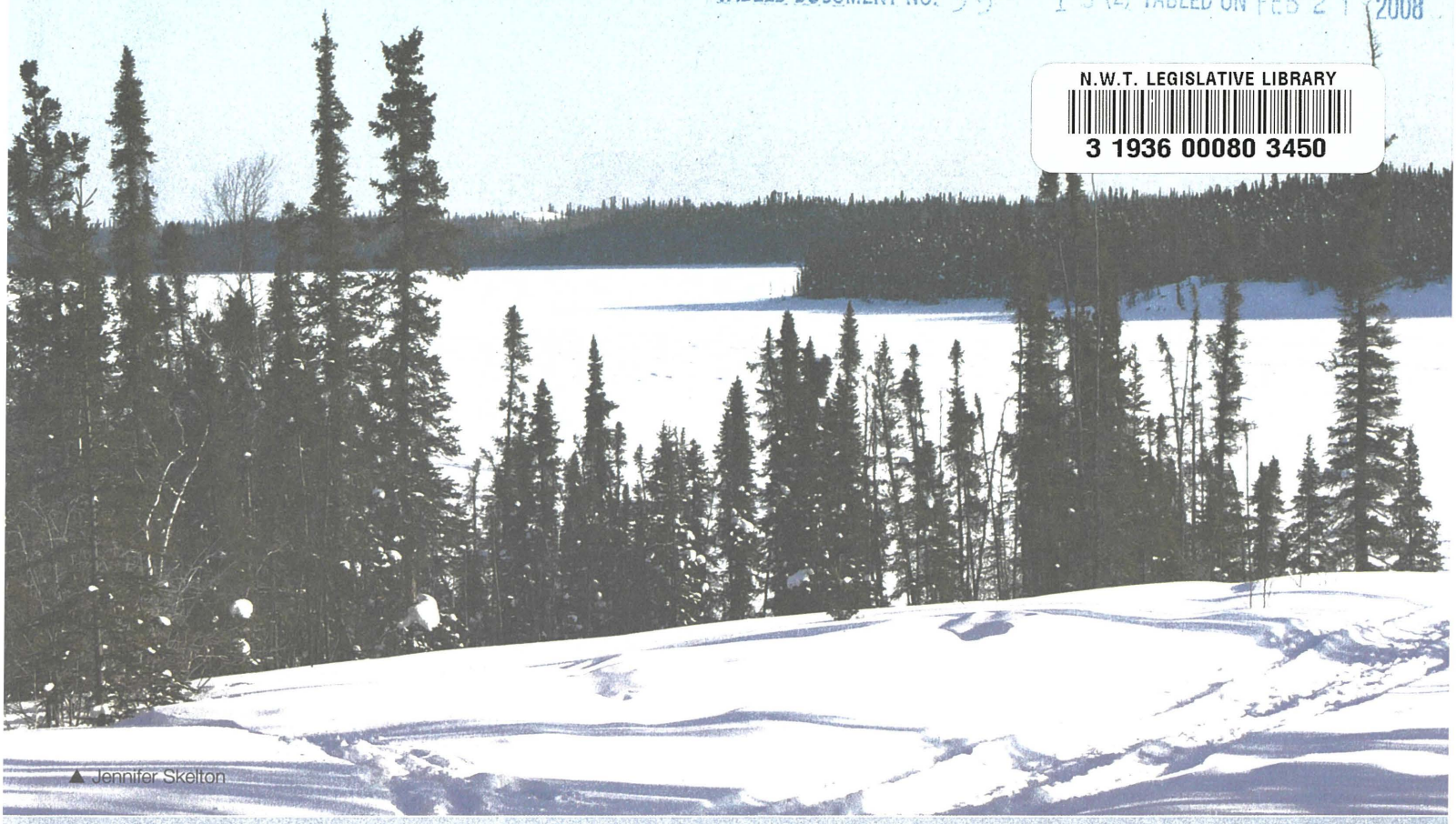
NWT CLIMATE CHANGE IMPACTS AND ADAPTATION REPORT

2008



▲ Craig Scott

Northwest Territories Environment and Natural Resources



▲ Jennifer Skelton

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▲ Jennifer Skelton

INTRODUCTION

The Northwest Territories (NWT) has a cold Arctic climate. The plants, animals and people that live here have adapted to the cold climate and, in many cases, depend on the cold to maintain the conditions they need to be successful. Impacts from the climate warming trends now being experienced in the NWT have required adaptation actions.

Global average surface temperatures have warmed by about 0.74° Celsius (C) over the past 100 years and average circumpolar Arctic temperatures have increased twice as fast. The NWT, especially in the Mackenzie Valley, is a global hot spot for climate change with average annual temperatures increasing about 2°C since the 1940s when records started to be collected. This increase is even more pronounced the further North you travel; for example, annual temperatures in Inuvik, situated at the mouth of the Mackenzie River near the Beaufort Sea, have increased by 3°C.

Scientists project temperatures will continue to warm because of climate change caused by the burning of fossil fuels and other sources of greenhouse gas emissions. Regardless of global efforts to reduce emissions, the NWT will need to continue adapting to climate change impacts. This report is about some of the tangible impacts from climate change that departments of the Government of the NWT (GNWT) are experiencing and the steps they are taking to adapt to those impacts.

During the 2007 revision of the NWT Greenhouse Gas Strategy, developed to control emissions, stakeholders strongly recommended that a companion NWT Climate Change Adaptation Plan be developed. These stakeholders had been experiencing and adapting to many climate change impacts, especially those relating to infrastructure built on ice and permafrost.

▲ GNWT

INTRODUCTION

GNWT departments provided background information for this report to the Department of Environment and Natural Resources (ENR). The report starts with a global perspective on climate change followed by sections describing the impacts of climate change on GNWT activities and actions departments are taking to adapt. The report concludes with a discussion about immediate risks and longer-term vulnerabilities, information gaps and other challenges.

ADAPTATION

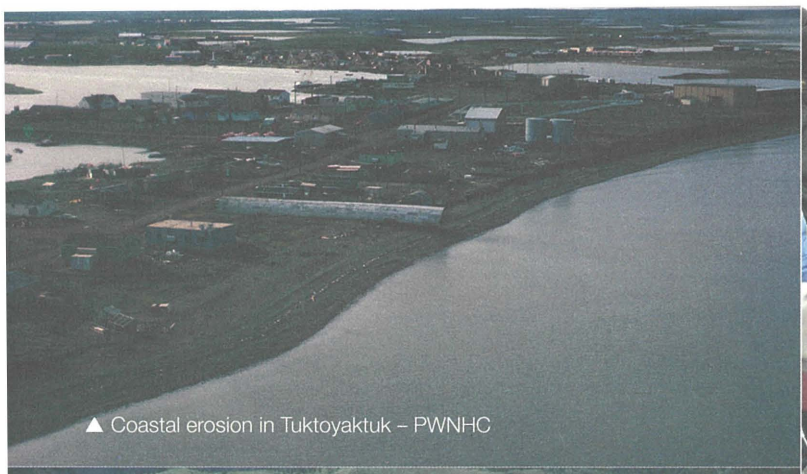
While climate change mitigation involves the reduction of greenhouse gas emissions to lower anthropogenic causes of climate change, climate change adaptation has been identified as an important mechanism to reduce society's vulnerability to the effects of climate change. Climate change adaptation actions can be *reactive*, in response to impacts or changes that have already occurred, or *proactive*, in anticipation of future changes and impacts.

▲ Jennifer Skelton

THE GLOBAL PERSPECTIVE

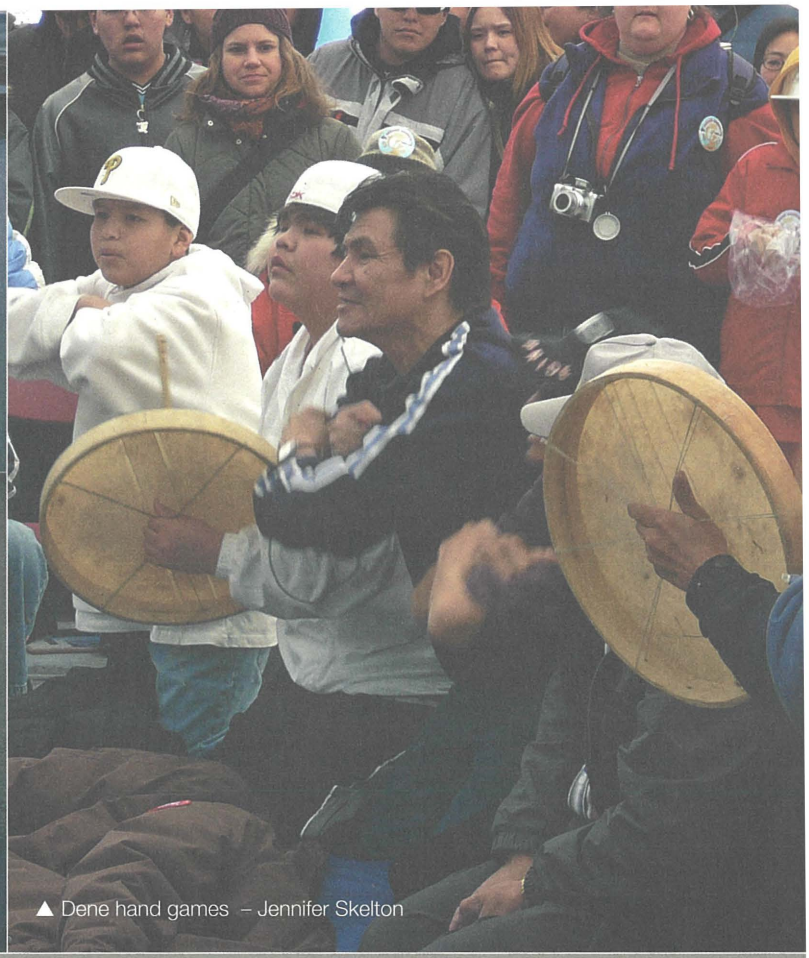
Around the world people are experiencing changes to their climates that are affecting their weather, ecosystems and economies. The Fourth Assessment Report of the International Panel on Climate Change (IPCC) provides a description of these changes. Some of the highlights of that report are:

- **Extreme weather** events such as flooding, tropical storms, heatwaves and droughts are becoming more frequent and intense in many parts of the world.
- **Increased variability in precipitation** has likely contributed to the rise in subtropical areas affected by drought and the increase in total precipitation at high latitudes. In addition, heavy precipitation events are more frequent worldwide and are causing crop damage, soil erosion, waterlogged soils and flooding.
- **Glaciers and polar ice sheets are melting** due to rising temperatures, causing a global rise in sea levels.
- **Global sea-level rise** of about 20 centimetres has already been measured and sea levels are expected to rise a further 18 to 59 centimetres by the end of the century due to glacial melt and warming oceans. Millions of people living at low elevations or in coastal regions may be at risk.
- **Ocean-warming** is being measured in all of the world's oceans. Warmer surface water temperatures disrupt local weather patterns and many marine ecosystems. Water expands when it gets warmer, contributing to sea-level rise. The extra heat that has already built up in water could contribute as much as 0.5°C increase in air temperatures over the next decade as air temperatures come into balance with the extra heat in the water.
- **Species populations and ranges** of plants and animals in many of Earth's ecosystems are changing, with some species vulnerable to extinction. As well, higher temperatures are expected to bring an increased invasion of non-native species to some regions.
- **Health effects** from extreme high temperatures increase the risk of illness and death in people with heart and respiratory problems. Climate change is projected to encourage the movement of tropical diseases such as malaria and West Nile virus northward, where populations have little or no immunity.



▲ Coastal erosion in Tuktoyaktuk – PWNHC

▲ D. Downing/GNWT



▲ Dene hand games – Jennifer Skelton

THE GLOBAL PERSPECTIVE
of Climate Change Impacts

The Arctic Climate Impact Assessment (ACIA), released by the Arctic Council in 2004, provides a more detailed review of climate change impacts in northern regions. This report concluded that the circumpolar Arctic region as a whole is experiencing some of the most rapid and severe climate change on earth. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social and economic changes in the Arctic, many of which have already begun. Key findings of the ACIA were:

- The Arctic climate is now warming rapidly and much larger changes are projected.
- Arctic warming and its consequences have worldwide implications.
- Arctic vegetation zones are very likely to shift, causing wide-ranging impacts.
- Animal species' diversity, ranges and distribution will change.
- Many coastal communities and facilities face increasing exposure to storms.
- Reduced sea ice is very likely to increase marine transport and access to resources.
- Thawing ground will disrupt transportation, buildings and other infrastructure.
- Indigenous communities are facing major economic and cultural impacts.
- Elevated ultraviolet radiation levels will affect people, plants and animals.
- Multiple influences interact to cause impacts to people and ecosystems.

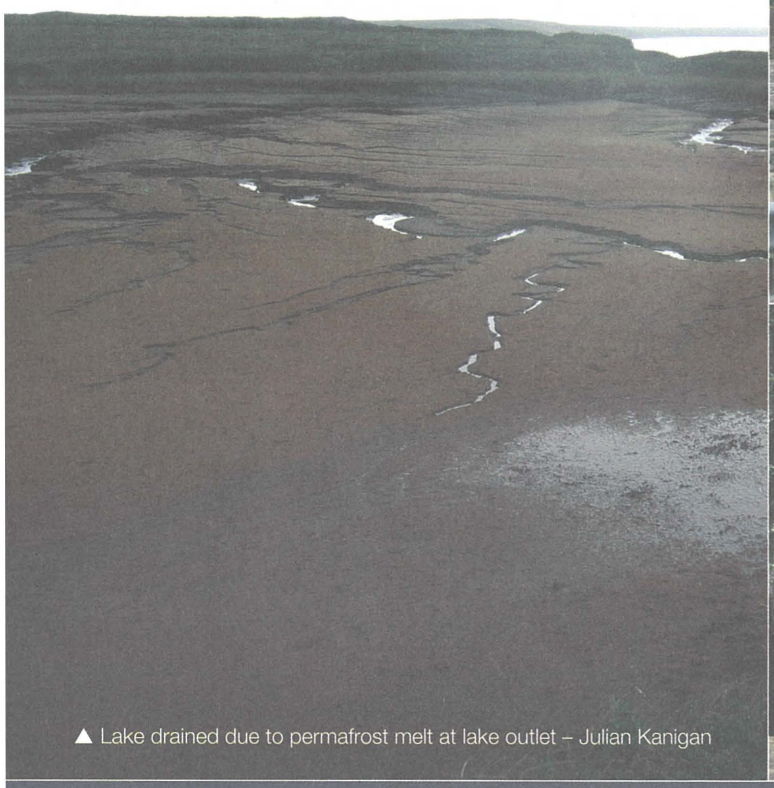
As with the IPCC report, the ACIA report presents information about climate change impacts that is consistent with the impacts now being seen in the NWT.

▲Jennifer Skelton

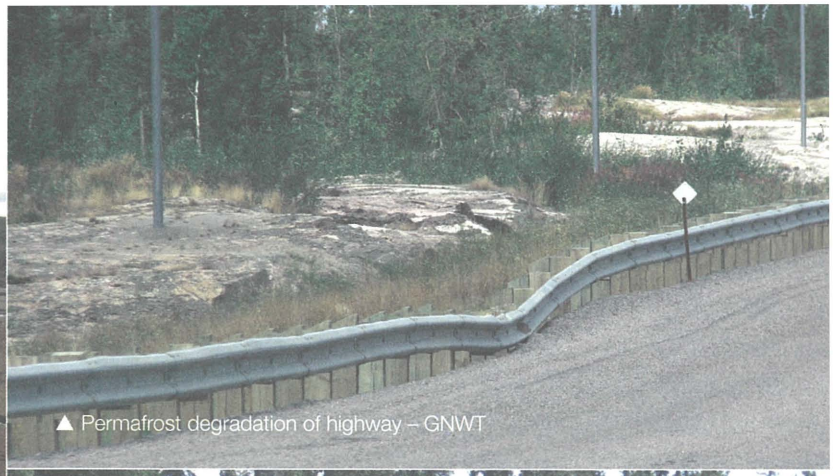
CLIMATE CHANGE IMPACTS
in the Northwest Territories

The Mackenzie Basin Impact Study (MBIS), a six-year collaborative research effort led by Environment Canada and published in 1997, described potential climate change impacts. The MBIS report concluded that lower water levels, permafrost thawing and other problems caused by climate change would offset any potential benefits from future warming. Only a few early impacts were reported in MBIS such as winter road problems identified in 1992. Most of the impacts described in this report have become evident in the ten years since the MBIS was published.

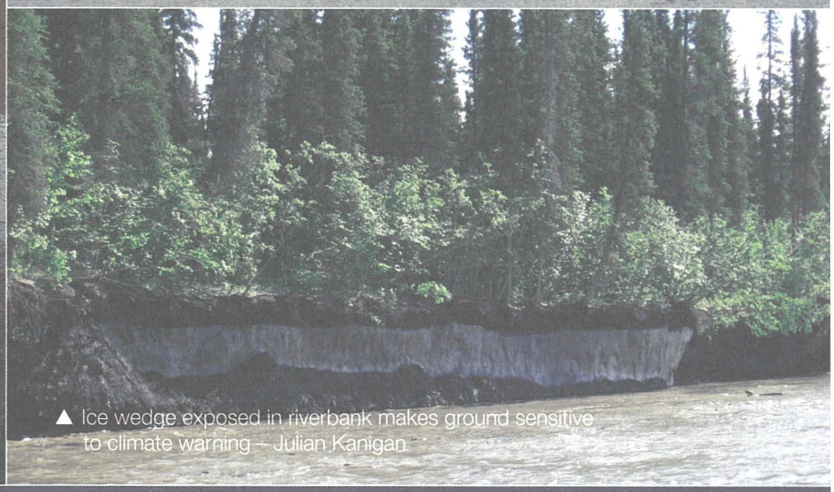
The following pages detail some of the effects of climate change that GNWT departments have observed and the impacts these effects have on infrastructure, ecosystems and people.



▲ Lake drained due to permafrost melt at lake outlet – Julian Kanigan



▲ Permafrost degradation of highway – GNWT



▲ Ice wedge exposed in riverbank makes ground sensitive to climate warning – Julian Kanigan

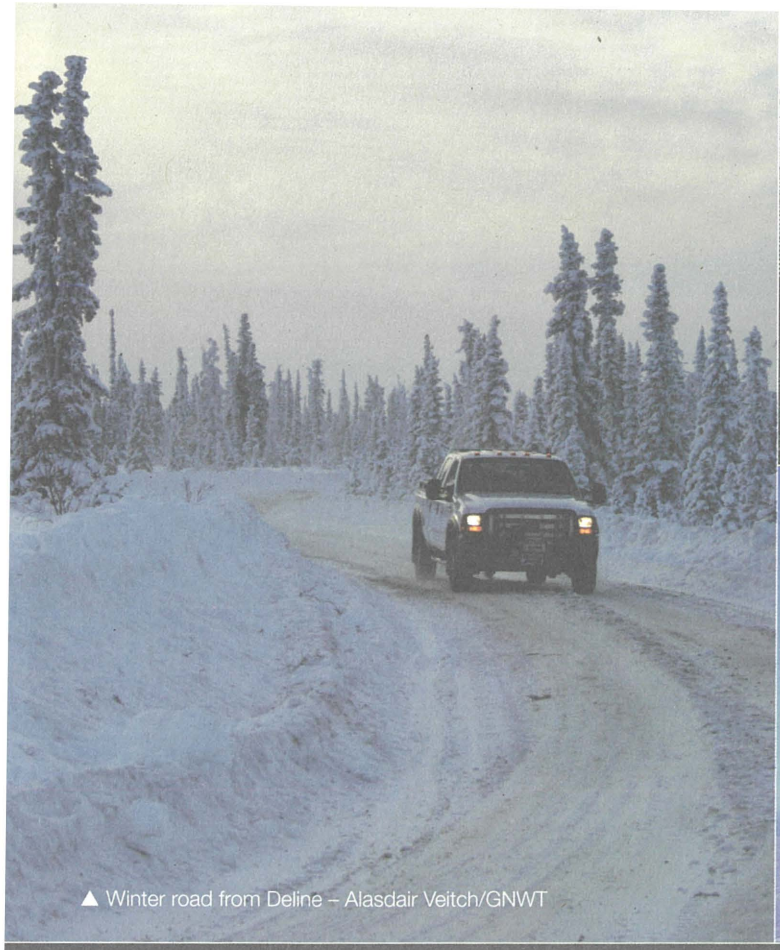
CLIMATE CHANGE IMPACTS
in the Northwest Territories

PERMAFROST

Permafrost provides a strong, frozen support for infrastructure such as buildings, roads and airport runways. Throughout the NWT a lot of infrastructure has been constructed on permafrost, especially at more Northern latitudes where there is no alternative. It has always been an engineering challenge to build on permafrost, but even as construction techniques improve, problems are becoming more evident throughout the NWT.

Ground movement caused by melting permafrost has resulted in the cracking or sloping of building walls and foundations. It has also resulted in heaving, slope failure, sinkholes and potholes, affecting all forms of infrastructure. Permafrost erosion along streams and rivers is threatening dikes, bridges and culverts and slope failures in communities such as Sachs Harbour are becoming unmistakable.

Permafrost is defined as frozen soil, sediment, or rock that remains at or below 0° Celsius for at least two years. All areas of the NWT are underlain by permafrost although in the south the occurrence of permafrost is sporadic. The nature of the frozen ground material and the water content are important factors that affect how much surface disruption occurs if the permafrost melts.



▲ Winter road from Deline – Alasdair Veitch/GNWT

▲ Shoreline erosion in Tuktoyaktuk, 1984 – PWNHC

▲ Sachs Harbour, June 1962, ship wintered over in ice – R. Knights/NWT Archives

ICE CONDITIONS

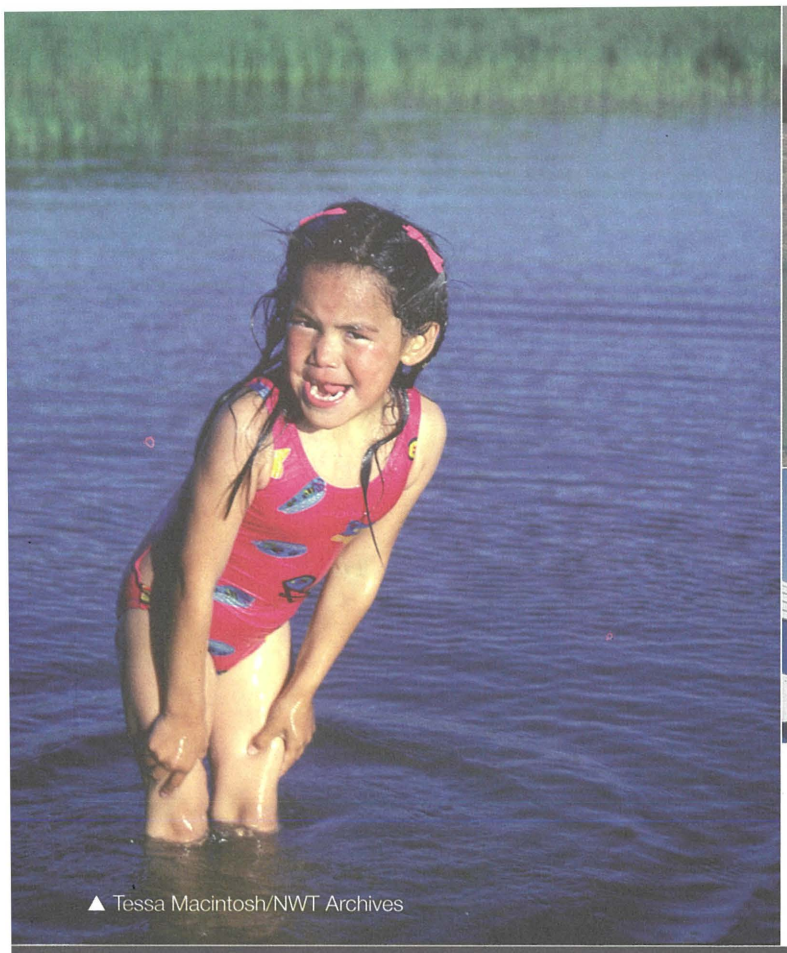
Winter roads use lake and river ice and compacted snow cover on land surfaces to connect remote regions of the NWT. Communities and mining operations not connected by all-weather roads depend on these winter roads to bring in the annual re-supply of bulk goods and to allow residents seasonal travel outside their communities.

The warming climate in the North has delayed freeze-up in the fall and contributed to thinner ice and an earlier spring melt, resulting in a shorter winter road season despite improved technology and more time and effort being applied to construct and maintain roads. Ice conditions also affect load weight limits, causing the cost of delivering supplies to communities and mines to go up because more trips by smaller trucks are required. The impact of the changing climate on critical transportation routes adds uncertainty and increased costs for communities, government departments, and investors in the Northern economy.

Changes to ice conditions are affecting the ability of Northerners to access the land and pursue traditional lifestyles. For example, a late freeze-up can prevent trappers from travelling to their traplines over frozen land and lakes until late in the season when fur is past its prime.

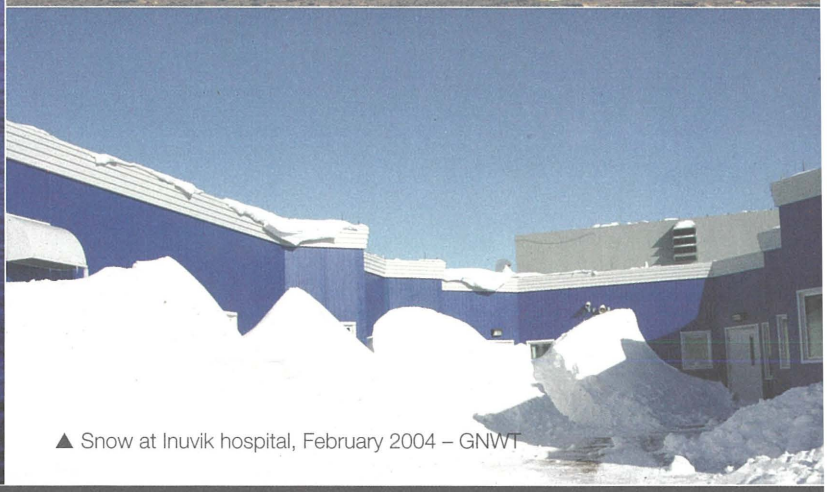
Receding Arctic sea ice has resulted in impacts to some regions of the ecosystem that polar bears, seals, and other Arctic species live in. Reduced sea ice has also contributed to sea-level rise and increased storm surges causing coastal erosion. People in Tuktoyaktuk have had to remove buildings that were close to the shoreline because of the erosion that continues to threaten the community.

The melting of Arctic sea ice at a faster than expected rate means the Northwest Passage could become a viable commercial shipping route within the next few years. The summer of 2007 saw sea ice levels in the Northwest Passage at a record low. This melting trend is leading to an increase in maritime activity in the Arctic archipelago and the associated challenges to security, environmental regulation and disruptions to traditional lifestyles. The retreat of sea ice also makes resource exploration in the Beaufort Sea more feasible.



▲ Tessa Macintosh/NWT Archives

▲ Mackenzie River ferry at Fort Providence – GNWT



▲ Snow at Inuvik hospital, February 2004 – GNWT

CLIMATE CHANGE IMPACTS
in the Northwest Territories

PRECIPITATION AND WATER

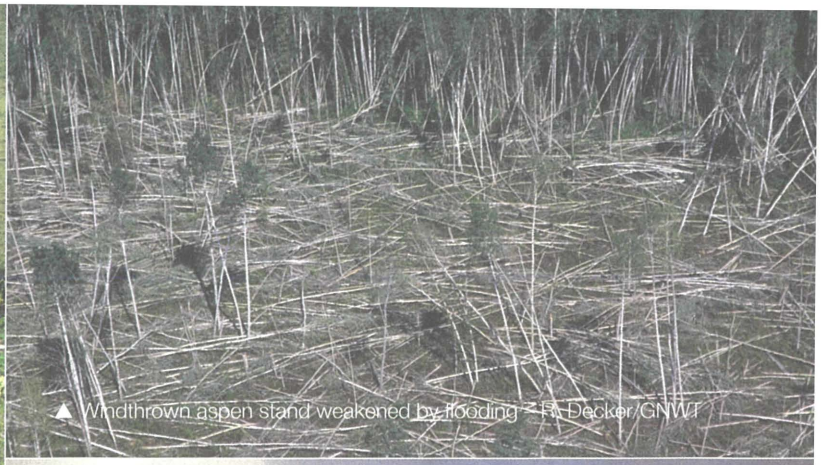
The amount and timing of precipitation events in the NWT are becoming highly variable between seasons and between communities. Snow loads on buildings have caused roof structures to collapse in some cases because of unusual heavy and wet snowfalls in the spring. An abundance of snow has also led to increased snow removal expenditures in some communities and hindered access to buildings for water and sewer services. Accumulated snow increases spring run-off and this can lead to wash-outs and damage supplies that have been delivered over the winter.

Spring and fall in the NWT have traditionally been short transition seasons, ensuring that freeze-up happens quickly and that freezing rain is not a common occurrence. The changing climate has lengthened the transition seasons so that freeze and thaw cycles have become more common. This can have implications for road safety and air transport. In recent years, there has been increased use of salt and sand on highways and glycol for de-icing aircraft. This also results in increased financial costs and environmental impacts.

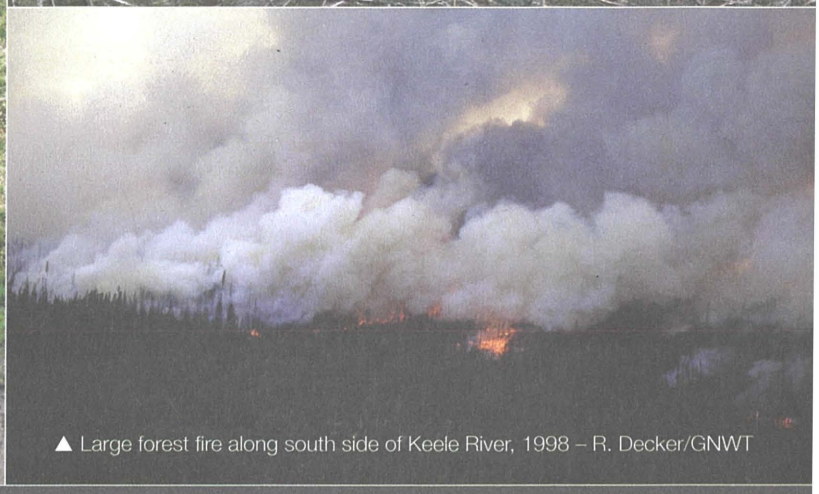
Groundwater from increased precipitation carries heat content that enhances degradation of permafrost already melting due to warmer air temperatures. The resulting ground saturation has caused problems for earthworks and building infrastructure in some communities.

In the Mackenzie River Valley, Aklavik and Fort Good Hope have experienced significant flooding events in recent years because of changing precipitation patterns and spring run-off conditions. In contrast, low water levels on the Mackenzie River at other times have restricted barge traffic and, combined with unpredictable weather, caused delays or cancellations of deliveries to communities.

▲ Land slump due to unstable ground resulting from permafrost melting – D. Downing/GNWT



▲ Windthrown aspen stand weakened by flooding – R. Decker/GNWT



▲ Large forest fire along south side of Keele River, 1998 – R. Decker/GNWT

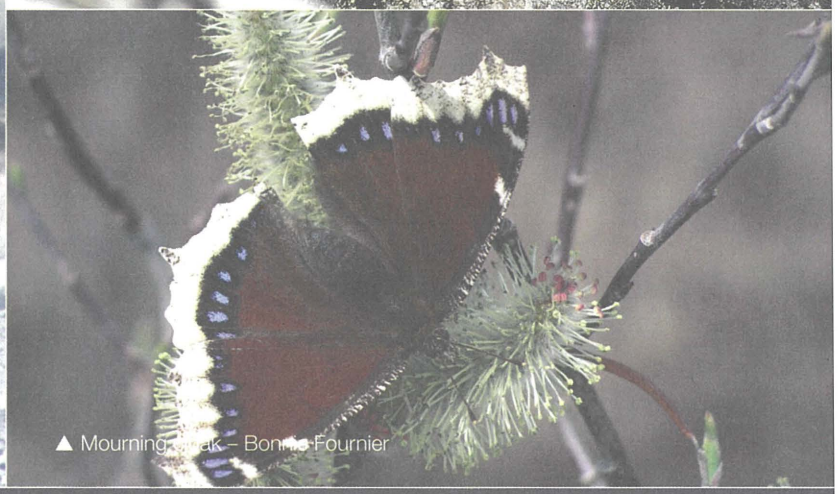
FORESTS

The impacts of climate change on forests are less obvious because forested landscapes are dynamic by nature. Even so, there have been some observed changes to forests in the NWT likely due in part to climate change. Recent changes include flooding, changes in insect activity, forested slope instability and earlier sap runs, with earlier associated spring needle and leaf flush.

Warmer weather, along with changes in precipitation and evaporation, is increasing the risk of forest fires in some parts of the boreal forest, while areas in the NWT may be experiencing a decreased risk due to higher levels of spring and summer rainfall in recent years. Combined with melting permafrost, changes to forest conditions extending onto the tundra can have broader ecosystem consequences.

▲ Barren-ground caribou – Anne Gunn

▲ Collared pika – John Wagner



▲ Mourning cloak – Bonnie Fournier

CLIMATE CHANGE IMPACTS
in the Northwest Territories

WILDLIFE

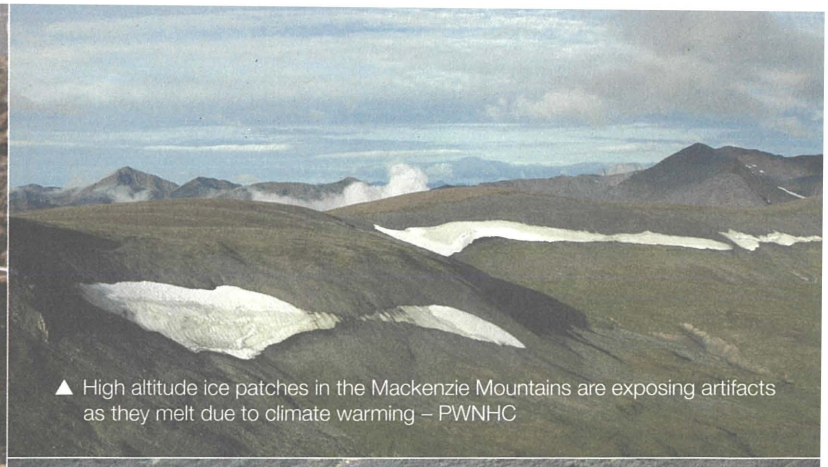
As with forests, the impacts of climate change on wildlife are not as immediately obvious, but because of the changes in ecosystem conditions that are known to be occurring, effects on wildlife are expected in the longer-term. The climate in the NWT is naturally variable and the wildlife has evolved and adapted to this variability. For example, barren-ground caribou herd numbers fluctuate naturally and this may be linked to long-term climate patterns. When climate change combines with natural fluctuations such as the Arctic Oscillation, the effects to wildlife may be more noticeable.

There has been an increased incidence of some southern species in the NWT, including magpie, skunk, coyote, white-tailed deer, elk, cougar, raccoon, salmon and some insect species. It is too early to tell what role climate change is playing in these species range expansions. It is possible that increased road corridors are the cause or that some species were always present but never recorded.

New species have brought new diseases and parasites that might become established in resident wildlife species. There have been observed changes in the types of parasites and their distribution as well as the frequency, intensity and rate of development of infections. Wildlife parasites are strongly influenced by relatively subtle changes in climate such as increases in temperature or moisture.

A decrease in the number of days per year in which sea ice covered the continental shelf coastline has been linked to decreases in the height and weight of cub and male polar bears in the southern Beaufort Sea polar bear population. There has also been increasing evidence that the timing of insect hatch is shifting, so that some bird species are arriving on their Northern breeding grounds too late to take advantage of the peak in insects. Over time this will probably lead to population declines for ducks, geese and shorebirds.

▲ Timbers preserved in permafrost at dwelling that is around 500 years old – PWNHC



▲ High altitude ice patches in the Mackenzie Mountains are exposing artifacts as they melt due to climate warming – PWNHC

▲ Collapsed pingo – D. Downing/GNWT

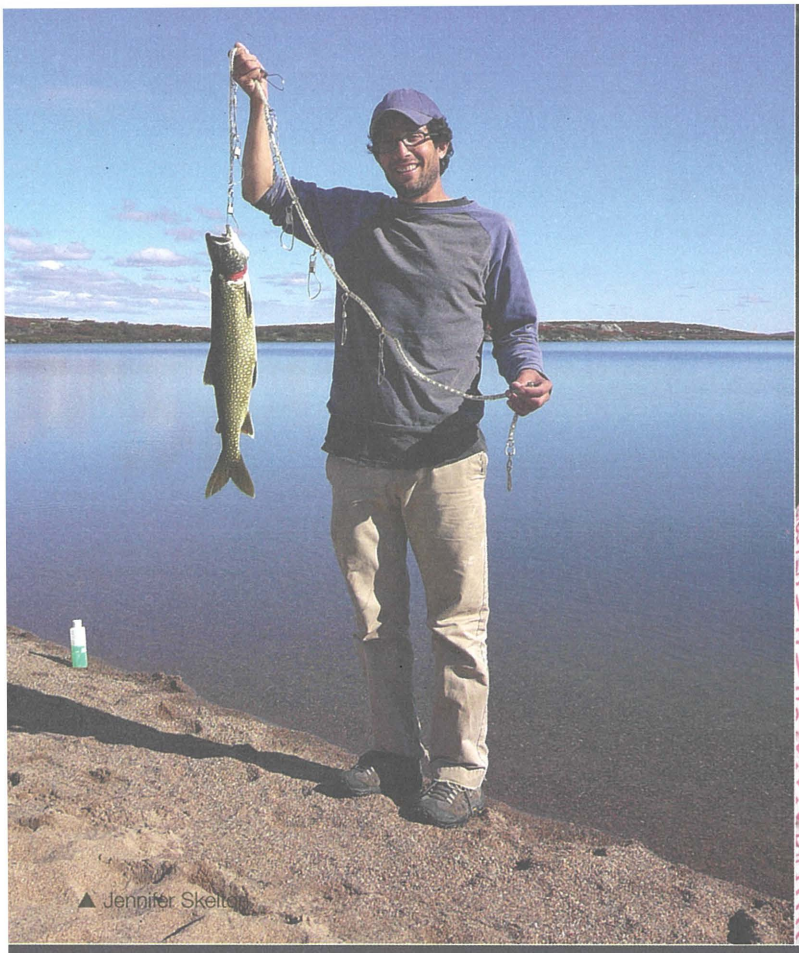
CULTURE AND HERITAGE

The most immediate impacts on traditional activities of Aboriginal people arise from the difficulties now being experienced with travelling on the land to their hunting and fishing camps. Weather is more uncertain and ice is more unpredictable and dangerous because of changes in freeze and thaw cycles. At the same time, changing wildlife migrations or the timing of birch sap flows are affecting the subsistence harvest of resources important for food and income.

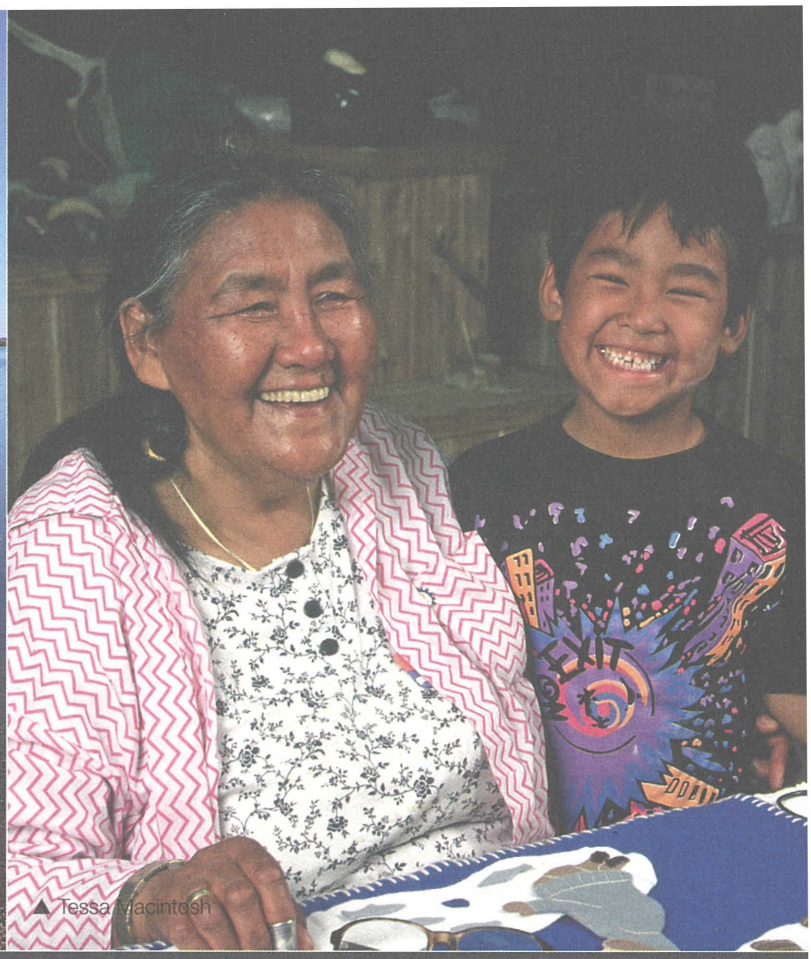
Environmental effects from climate change are affecting heritage sites with archaeological, historical or cultural significance. In Arctic regions, archeological materials beneath the ground are preserved by permafrost. Degradation of the permafrost exposes those materials so they are no longer preserved.

High altitude ice patches in the Mackenzie Mountains have been used for thousands of years by caribou seeking refuge from biting insects. People in turn have been attracted to those locations in order to hunt the caribou that congregate there. Ice patches are melting due to climate warming, often exposing fragile archeological materials. These ice patches are also important sources of information about past climate conditions.

Storm surges and degradation of permafrost are causing many coastal regions to erode. This erosion is erasing archaeological evidence of people who have constructed camps and dwellings near shorelines. Pingos, a unique permafrost formation found in the outer Mackenzie Delta region, are traditional landmarks and in some cases have legends associated with them. Climate warming may accelerate the normal, centuries-long cycle of growth and collapse. In addition, drying of vegetation due to longer warm periods increases the risk of tundra fires that leave the surfaces of pingos vulnerable to erosion.



▲ Jennifer Skelton



▲ Tessa Macintosh

CLIMATE CHANGE IMPACTS
in the Northwest Territories

HUMAN HEALTH

Aboriginal people in the NWT have experienced a recent shift away from traditional hunting and gathering practices towards a greater reliance on a processed Western diet. While numerous factors influence this shift, it is thought that climate change is having some impact because of difficulties with travel and access to traditional harvests discussed earlier, reducing the availability of wild foods traditionally used by Aboriginal people.

Traditional diets high in wild game and fish are healthier than diets high in fat, sugar and salt. In addition, traditional subsistence patterns of hunting and fishing lead to increased physical activity, enhanced mental health and improved social networks. The move to a less healthy diet and more sedentary lifestyle can impact the rates of obesity, lead to a rise in diabetes and cardiovascular health problems, and increase risk factors for chronic and mental health diseases.

▲ Tessa Macintosh/NWT Archives

FROM IMPACTS to Adaptation

Climate change is a relatively new and emerging problem for the North and it is causing tangible impacts that affect people, the environment and the economy in the NWT. The changes that have occurred in the past decade have forced departments of the GNWT to find ways to respond and adapt their activities.

This assessment is a qualitative discussion of the types of impacts that departments of the GNWT are adapting to. Although these actions are having cost implications, departments are still unable to separate out costs due to climate change from those that would have occurred from natural variability. For example, permafrost has always presented challenges to project engineers. Some of the adaptive actions being implemented by GNWT departments are listed on the following pages.

▲ Typical log pile foundation – GNWT

▲ Foundations that distribute weight and absorb stress limit problems caused by ground movement – Triodetic Building Products Ltd.

▲ GNWT

FROM IMPACTS to Adaptation

CONSTRUCTION ON PERMAFROST

The Northwest Territories Housing Corporation (NWTHC) has repaired and replaced pile foundations damaged by ground movement or water accumulation under buildings. Where there are less stable ground conditions, the NWTHC now uses foundation systems that absorb the stress normally imposed on a building through ground movement.

In response to the effects of permafrost melt on pile foundations, engineering design recommendations have begun calling for larger diameter and deeper installation of piles and increased bond breaking material applied to the portion located in the layer of the ground that freezes and thaws every year. The bond breaking material helps prevent frozen soil from gripping the pile and pulling it upward.

Location, drainage and erosion factors are considered in construction project design. Where permafrost melt may cause erosion and drainage concerns, the Department of Public Works and Services (PWS) implements actions to improve drainage and strengthen earthworks.

PWS is also working in partnership with the Public Infrastructure Engineering Vulnerability Committee (PIEVC) on a guideline for using thermosyphons, a type of passive heat exchanger that helps keep permafrost cool, to maintain solid foundations.

The Department of Transportation (DOT) has rehabilitated runways in Inuvik and Yellowknife due to damage caused by permafrost degradation. Styrofoam insulation has been used to protect and reestablish permafrost underlying the Yellowknife airport.

In reconstructing a portion of the Yellowknife Highway, changes were made to the design and construction that would minimize future effects from permafrost degradation. Monitoring of permafrost is also done to identify areas of the Yellowknife Highway vulnerable to warming temperatures.

The Department of Municipal and Community Affairs (MACA) has conducted public infrastructure assessments in all 33 NWT communities to facilitate maintenance planning. These assessments offer a baseline of the current state of the infrastructure and will assist in measuring the impacts of climate change over a period of time.

▲ Ice spray technology on Mackenzie River crossing – GNWT

▲ Bridge on Mackenzie Valley winter road – GNWT

▲ Craig Scott

WINTER ROADS

Because of the shorter winter road season, the NWTHC has begun awarding contracts to supply vendors one month earlier. This gives the vendors additional time to assemble materials for delivery, adjust load movement schedules for the shorter road season and prepare for the possibility of reduced road weight limits.

The construction of bridges at stream crossings along the Mackenzie Valley Winter Road was initiated ten years ago by DOT because the operational length of the winter road season was getting shorter. The permanent bridges reduce the amount of time required to construct the winter road and protect stream crossings from early spring melt, a measure that extends the operational season of the road. Ice spray technology is used at the Mackenzie River ice crossing near Fort Providence to create thick, load-bearing ice earlier and reduce the disruption of goods and services to Yellowknife and the nearby mining operations. The ability to assess ice thickness and locate areas of thin ice has been enhanced through the use of improved ground-penetrating radar.

▲ Richard Popko/GNWT

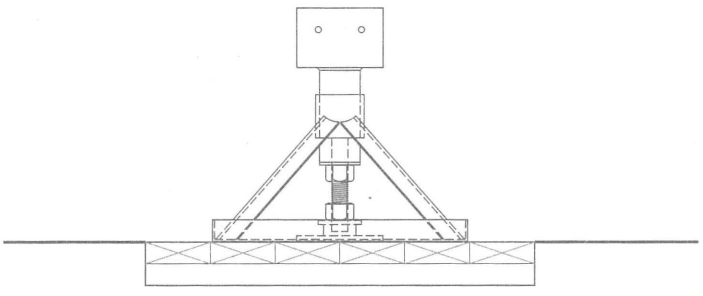
FROM IMPACTS to Adaptation

SNOW AND RAIN EFFECTS ON INFRASTRUCTURE

There are a number of actions that the NWTHC takes as a matter of standard practice that have proved helpful in dealing with the impacts of a warming climate. For example, when designing roof structures the NWTHC uses climate data from the NWT communities with the highest amounts of snow, rain and wind as outlined in the National Building Code of Canada. The result is that buildings in all communities will be better able to handle changing conditions caused by climate change.

The NWTHC uses above ground screw jack foundation supports in lieu of wood blocking in some communities. These foundations minimize the amount of obstructed area under the building, which increases airflow, reduces snow accumulation and allows the wind to scour the unobstructed space. This helps reduce snow build up both under and on the leeward side of the building. The improved airflow under the building also ensures that heat loss from the floor will not lead to deterioration of the permafrost.

PWS has begun taking higher snow loads into consideration in building design and has produced a brochure on this topic. PWS is also participating in policy research with the National Round Table on the Environment and the Economy (NRTEE) about what changes might need to be made to building codes and standards stemming from climate change in the Canadian North.



FOUNDATION SCREW JACK

▲ Ecological monitoring near Kakisa – Jennifer Skelton/GNWT

▲ Peary caribou, Bank Island – John Nagy

▲ Monitoring insects – Jennifer Skelton/GNWT

MONITORING ENVIRONMENTAL CHANGE

The Forest Management Division (FMD) of the Department of Environment and Natural Resources (ENR) has created better baseline data and information sources to add to the knowledge base and improve accuracy in assessing environmental changes brought on by climate change. Specifically, FMD has installed permanent monitoring sites, conducted plant inventories, created accurate base maps, and interpreted and mapped ecological zones.

The FMD weather-monitoring network has been expanded to include additional sites and more frequent recording of observations. FMD has also completed a report that assesses the long-term temperature and precipitation trends in the NWT and is examining changes in local climate factors that have been traditionally assumed to stay the same. Adaptation to the new and changing climate is being incorporated into future forest management decisions and recommendations.

The Wildlife Division of ENR, with the support of other GNWT departments, is preparing an NWT State of the Environment Report (SOTE). It will include indices for climate that can be monitored and reported in future SOTE reports.

The Wildlife Division is monitoring the possible influx of new diseases; for example, it could become easier for the species of mosquito that carries the West Nile virus to extend its range North from Alberta as the climate warms. The Division is evaluating the effects of climate change on diseases and parasites already present in Northern wildlife. A risk assessment will look at pathways by which invasive plants and insects could enter the NWT. Sightings of species new to the NWT are recorded and there is an attempt to increase the monitoring of insects, likely the first group of species to rapidly increase their presence in the NWT as a result of climate change. Research on insect harassment of caribou is underway and will help to understand how climate change and natural variation in climate affect caribou.

▲ Wolverine study – Jennifer Skelton/GNWT

▲ Craig Scott

▲ Warble fly larvae on caribou – GNWT/ENR

FROM IMPACTS to Adaptation

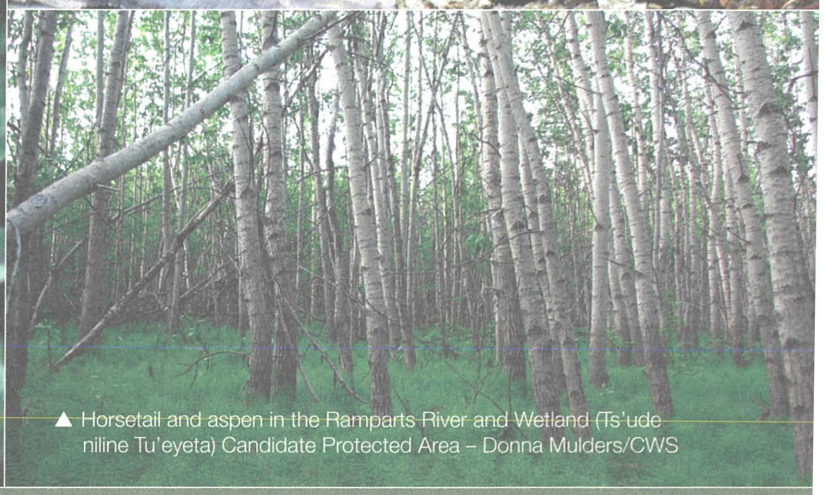
The effects of climate change on the frequency of unusual weather events are being tracked to see how this might affect wildlife. For example, rain events in winter are known to have caused dramatic declines in Peary caribou numbers by forming an ice barrier over their foraging habitat. These are natural events that have always taken place, but may become a problem if their frequency increases. As well, a recent and apparently unprecedented surge of seawater, due to a strong storm in the Beaufort Sea at a time when sea ice was not present, resulted in an extensive die-out of vegetation in the outer Mackenzie Delta.

The Wildlife Division has reviewed natural variation in the climate to better understand the effects on landscapes and the harvest of furbearing animals. Government biologists routinely consider climate change as a possible source of stress in their existing study designs. New programs to monitor the impacts of climate change on wildlife are being considered.

Integrating traditional knowledge into resource management is required under land claim agreements and the GNWT's Traditional Knowledge Policy. Traditional knowledge provides information on historic conditions and picks up changes to the land. In assessing impacts from climate change, traditional knowledge has pointed out significant changes in the NWT that have been presented to international forums. The GNWT is committed to continuing to integrate traditional knowledge with scientific information to document changes from climate change and develop adaptation actions.

▲ Donna Mulders/CWS – Buttercup in Labrador tea

▲ Ermine or short-tailed weasel – Anne Gunn/GNWT

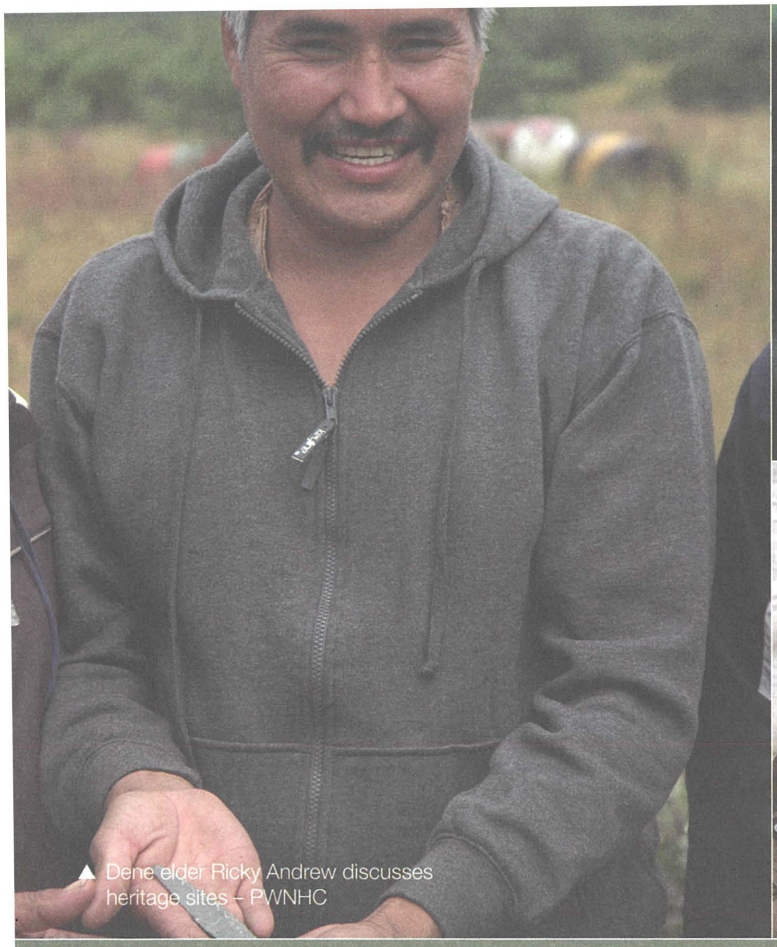


▲ Horsetail and aspen in the Ramparts River and Wetland (Ts'ude niline Tu'eyeta) Candidate Protected Area – Donna Mulders/CWS

BIODIVERSITY CONSERVATION

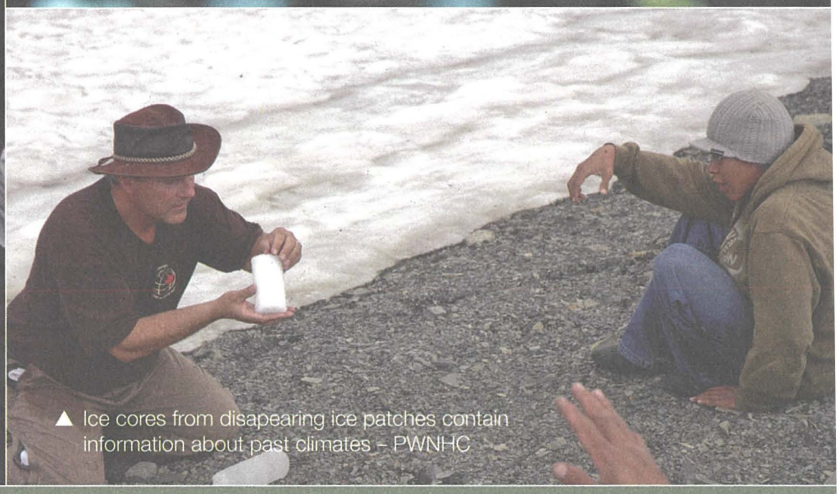
The NWT has a relatively intact natural landscape compared to jurisdictions in southern Canada. The present industrial economic boom in the NWT is bringing change to this landscape at a time that coincides with changes resulting from the warming climate. Establishing parks and protected areas has been identified as an important way to minimize the impacts of climate change on biodiversity, especially in areas undergoing additional landscape pressures. In addition to existing protected areas, such as national parks and the Thelon Game Sanctuary, additional sites are being identified through the NWT Protected Areas Strategy (PAS) process, land use planning and the national parks process.

The Wildlife Division of ENR is working with other partners to implement the PAS, a process to identify and establish new protected areas in the NWT. The PAS is using several 'best practices' that increase ecosystem resilience to climate change, including protecting a range of different ecosystem types, latitudes, elevations, habitat types and enduring features.



▲ Dene elder Ricky Andrew discusses heritage sites – PWNHC

▲ Amulet recovered from permafrost at an archeologist site near mouth of Mackenzie River – PWNHC

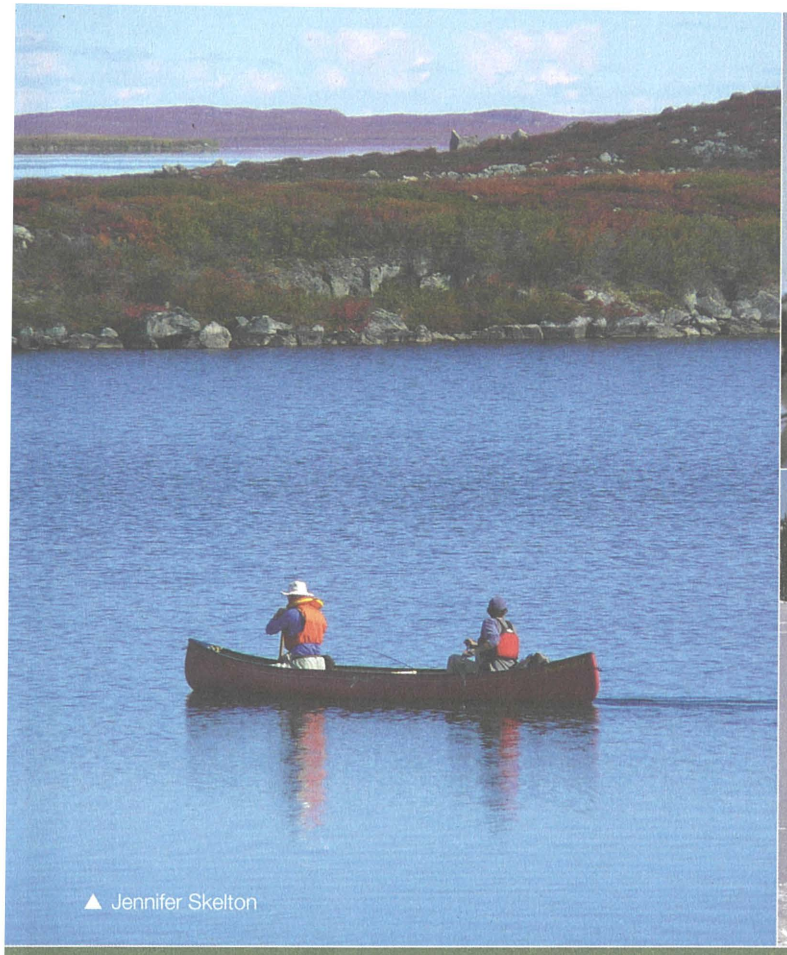


▲ Ice cores from disapearing ice patches contain information about past climates - PWNHC

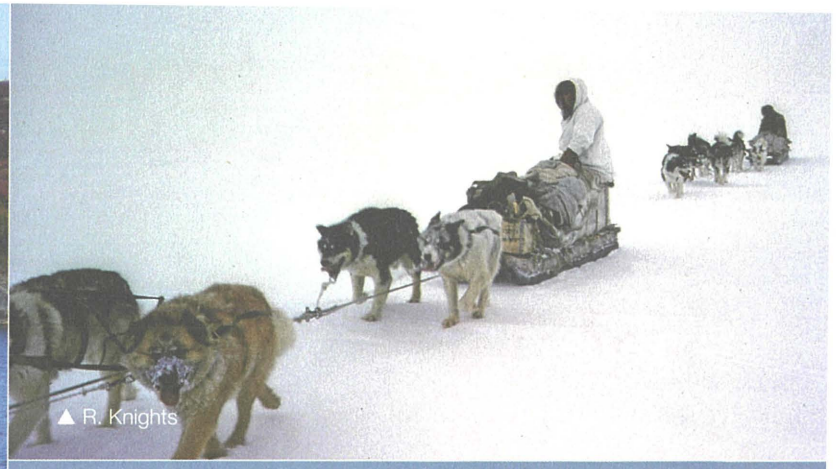
FROM IMPACTS to Adaptation

HERITAGE CONSERVATION

The Department of Education, Culture and Employment (ECE) has been responding to the loss of heritage sites due to climate change by documenting information through excavations of archaeological sites. ECE has also been documenting the history and architecture of built structures and working with traditional knowledge holders to record oral histories. This information provides valuable insights into past climatic variability and how inhabitants of the land responded to it.



▲ Jennifer Skelton



▲ R. Knights

▲ Jennifer Skelton

HUMAN HEALTH

The Department of Health and Social Services (HSS) has a number of programs in place that will also help address possible changes to diet and physical activity that climate change could contribute to. HSS produces the NWT Health Status Report that measures trends in health indicators and chronic disease and undertakes research on obesity rates and the link to healthier food choices in the NWT.

In partnership with the Canadian Public Health Association and Nunavut, HSS delivers a diabetes prevention project called Healthy Foods North. The aim is to work with local communities to promote a healthy diet from traditional and store-bought food sources. Food intake information, collected by the communities, is used to plan appropriate actions, including the recognition of the health benefits of eating locally harvested foods and to encourage people to diversify traditional food choices; for example, by eating fish when caribou populations are low.

HSS works with MACA on the Healthy Active Living Strategy to improve physical activity in those who no longer get out on the land. HSS works with ECE on school programs, such as the Pan-Territorial Drop the Pop campaign, to promote healthy eating.

▲ Tessa Macintosh/NWT Archives

FROM IMPACTS to Adaptation

COMMUNITY PLANNING

MACA is involved in community energy planning in all NWT communities. Through this process, MACA has heard many examples of how communities are already feeling the effects of climate change, and observed the growing awareness of the need to develop community adaptation plans. MACA participated in the City of Yellowknife Adaptation Plan process both to support the City and to learn how to assist smaller communities with their adaptation plans.

MACA is also working on a template for emergency plans and will include hazard identification relating to climate change as one item for communities to consider.

Jennifer Skelton

PLANNING
for the Future

The information provided in this report offers a first synthesis of the overall impacts of climate change on GNWT activities and the actions that are being taken to adapt. Projections about future climate change point to the necessity of taking a more proactive approach to adaptation responses in order to minimize risks and vulnerabilities for people living and working in the NWT. The climate is expected to continue warming for decades, even with global efforts to reduce greenhouse gas emissions.

The study of climate change has been integrated in the school curriculum for kindergarten to grade12 students in the NWT. This includes a significant number of learning outcomes related to climate change, encompassing demonstrated care and concern for the land and respect for Aboriginal traditional knowledge in relation to climate change and adaptation.

This section highlights immediate considerations, longer-term vulnerabilities and potential challenges for future adaptation planning in the NWT.

▲ NWT pipeline construction – Tessa Macintosh

▲ Wekweti – Tessa Macintosh

PLANNING for the Future

IMMEDIATE CONSIDERATIONS

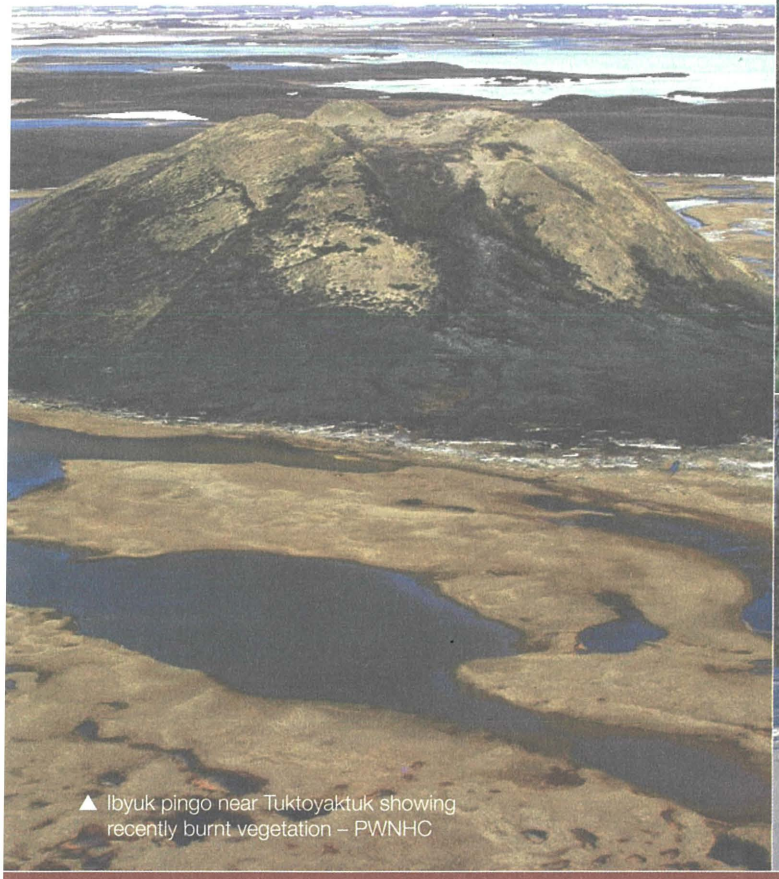
The effects of future climate warming on permafrost, ice and precipitation conditions are likely to further impact building and transportation infrastructure and communities. Finding efficient ways to respond to these impacts is becoming increasingly important.

There is need for industry-standard design guidelines for buildings and foundations to allow for anticipated changes over the next 50 or more years. New standards will very likely increase construction cost; for example, higher performance foundation systems, suitable for less stable soils, could add $20,000 to the cost of a new home.

Transportation infrastructure in the NWT is highly vulnerable to the effects of climate change. Costs associated with the repair of roads and runways from damages caused by climate change are already in the range of $1 million per year. Continued warming would likely result in a greater frequency and severity of the impacts, especially as permafrost melt advances further north. In addition, the long-term sustainability of winter roads and ice crossings is uncertain and alternatives may need to be sought. Air transport of supplies to remote areas greatly increases costs.

DOT is preparing a report on Climate Change and Transportation in the NWT to better understand climate change impacts relevant to transportation networks, assess vulnerabilities and identify measures that will be needed to adapt, and their associated costs.

Flooding of the Mackenzie River in Fort Good Hope in May 2005 and Aklavik in May 2006 caused damages in the millions of dollars. Flood zones in communities may have to be redefined due to changes in water levels, heavy precipitation events and melting permafrost. New flood zone definitions might call for the relocation of infrastructure as well as limit community lands available for future development. Also, the eroding shoreline of Tuktoyaktuk is vulnerable to further sea-level rise and storm surges.



▲ Ibyuk pingo near Tuktoyaktuk showing recently burnt vegetation – PWNHC

▲ Spruce budworm defoliation of white spruce – GNWT

▲ Caribou in deep snow – John Nagy

LONGER-TERM VULNERABILITIES

Collecting environmental baseline data and implementing long-term monitoring programs will help track and anticipate future effects of climate change on ecosystems. Although ecosystem changes are slow, they can have major implications over the long-term. Changes that affect forests and wildlife can have large impacts on tourism and the traditional economy. Planning for these possible impacts from climate change can alleviate some of the risk. Some potential threats to natural systems in the long-term are listed here.

New species to the NWT are bringing in new diseases and parasites that could have a long-term impact on local wildlife populations as well as people. Changes to wildlife habitats could have impacts on local wildlife populations. For example, continued change in Arctic sea ice might affect some populations of polar bears, seals and other species in this ecosystem. Changes to snow events, plant communities and insect activity could influence the movements, condition and productivity of caribou. These and other climate change influences on wildlife populations would impact traditional harvesters and the tourism and outfitting industries.

Potential changes in the frequency and severity of forest fires will depend on seasonal precipitation patterns and could affect the risk to communities and other areas used by people. There have been isolated incidents of tree death where trees are perched on Canadian Shield bedrock with a limited moisture-holding capacity. The deaths occurred due to moisture deficits that may have been influenced by climate change. This is a potential concern if future climate warming influences the moisture regimes in areas with naturally low moisture.

Spruce budworm infestations have natural cycles and their intensity is controlled by cold winters. If climate warming continues it could limit the control of these pests in winter. Other pests that could become a problem include forest tent caterpillars and the mountain pine beetle that is threatening forests in BC and Alberta. The mountain pine beetle has not been seen in the NWT, but scientists are concerned about its potential to reach the boreal forest, putting jack pine trees in the NWT at risk.

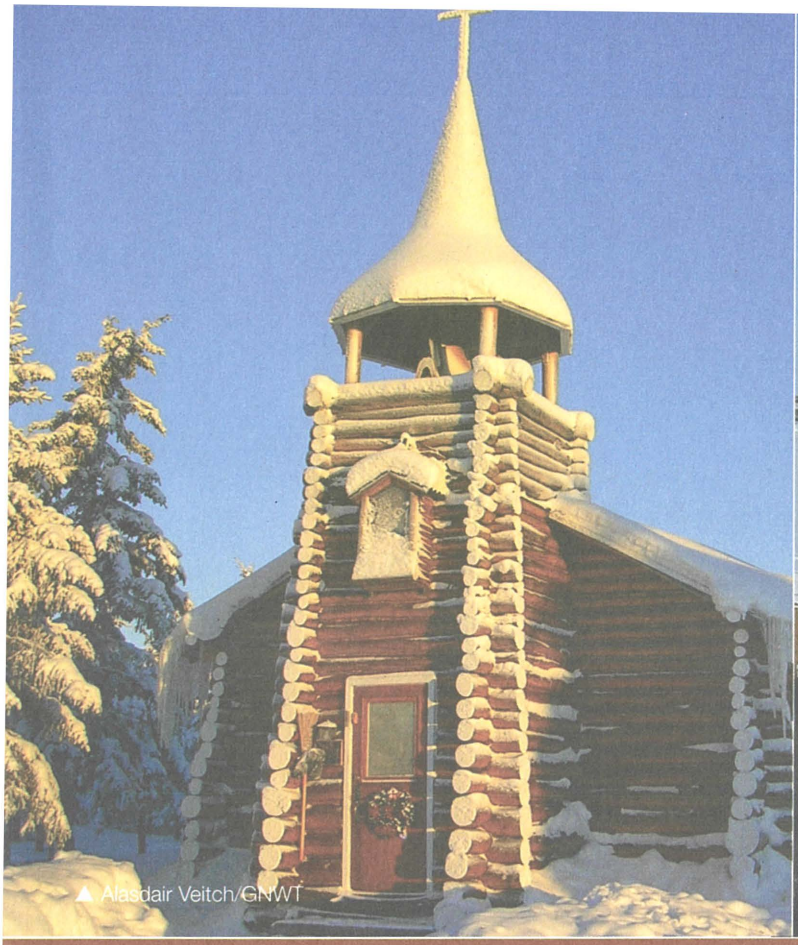
▲ Recently burnt jackpine – R. Becker/GNWT

PLANNING
for the Future

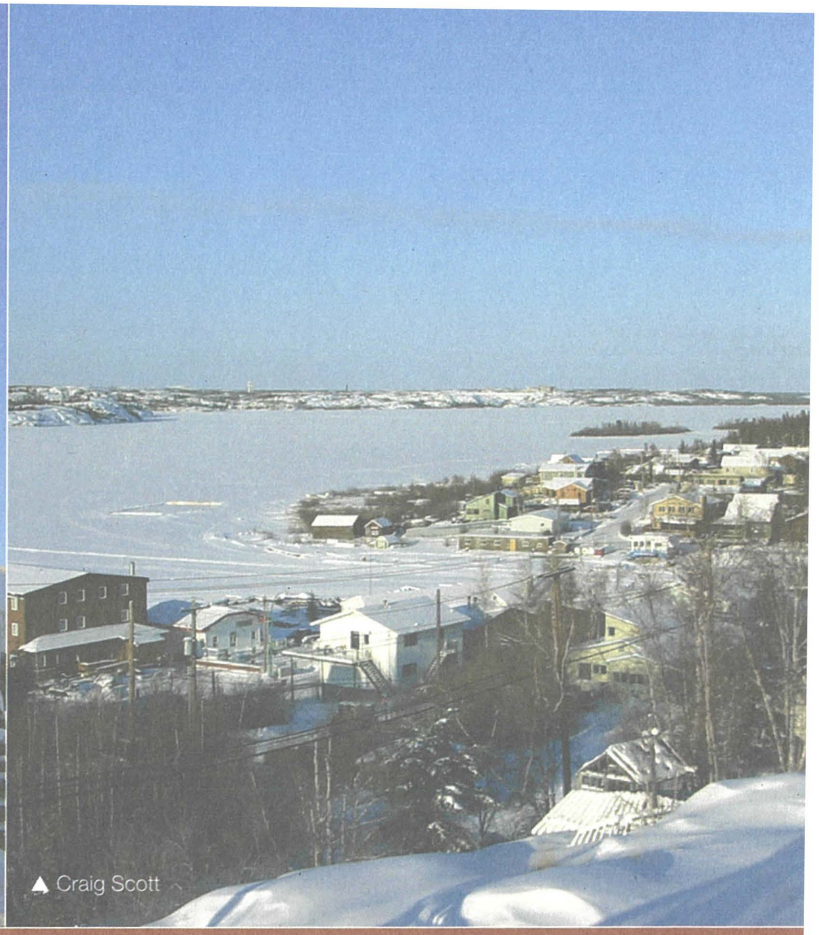
Climate change may influence the range of trees such as balsam poplar, birch and willow, potentially moving the treeline northward and affecting the tundra. If the existing dwarf birch and willow shrubs on the tundra grow taller, it could create a warmer and moister micro-climate because they will trap more snow that would otherwise be scoured by winter winds.

Climate change effects on the natural environment can impact tourism through the flooding of areas of interest, the permanent alteration of landscapes caused by insect infestations, reduced aurora borealis viewing opportunities caused by increases in cloud cover or landscape features that disappear altogether such as pingos that are undergoing erosion.

Sea ice disappearance and the opening of the Northwest Passage to ocean vessel traffic could bring about changes with significant long-term consequences.



▲ Alasdair Veitch/GNWT



▲ Craig Scott

CHALLENGES TO ADAPTATION PLANNING

Better resolutions of regional and sub-regional climate model projections are needed. This information is needed by all departments to better understand future impacts on their operations.

Research on adaptation techniques, tools and best practices would inform community long-range adaptation planning. This research will also assist government departments that deal with building and transportation infrastructure. Adaptation planning for all infrastructure projects would benefit from better mapping information about the type and location of permafrost. Research into how changes in climate affect the life cycle and maintenance costs for infrastructure is also necessary.

While long-term monitoring programs by nature tend to require a lot of resources, this fact is accentuated in the NWT due to the over one million square kilometres of land and the challenges to the accessibility of that landscape. Increased demands on operations and maintenance resources of all departments are likely to result from the impacts of climate change.

▲ Tessa Macintosh

NEXT STEP:
NWT Climate Change Adaptation Plan

The impacts that are being experienced in the NWT have caused many sectors to undertake adaptation actions. Future vulnerabilities and challenges are beginning to be identified and there is an obvious need for additional adaptation planning.

This report is not the only initiative underway to address climate change impact and adaptation issues in the NWT.

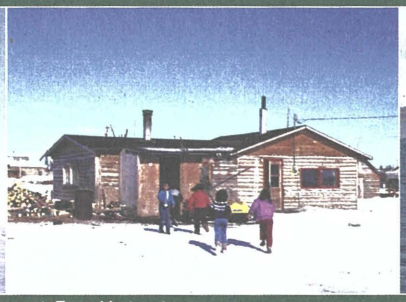
- Ecology North and the Dene Nation hosted a Leadership Summit on Climate Change in early 2007 that provided a considerable amount of awareness about the issue as well as recommendations for next steps.
- The City of Yellowknife has begun to develop its own Community Adaptation Plan.
- Dehcho First Nation has worked with Ecology North to start a regional adaptation plan.
- The private consortium that operates the winter road to diamond mine operations is considering alternatives because of problems they have experienced due to unanticipated shortening of the operational season.

The Department of Environment and Natural Resources will continue to work with GNWT departments and a broader range of stakeholders in 2008 to understand these problems better and develop a NWT Climate Change Adaptation Plan to support continued actions.

For more information please visit our web site: www.enr.gov.nt.ca

▲ Tessa Macintosh/NWT Archives

▲ R. Knights



▲ Tessa Macintosh

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