



Climate Change - Boon or Bust for Northern Waters?

High School Grades

Lesson Summary

Students do research and then engage in a role-play debate on the potential benefits and costs of climate change on northern hydrological systems.

Prior Knowledge & Skills

- Analytical skills
- Research skills
- Public speaking skills

AAAS Science Benchmarks

The Nature of Technology

Issues in Technology

The Living Environment

Interdependence of Life

Human Society

Cultural Effects on Behavior

Group Behavior

Social Tradeoffs

NSES Science Standards

Life Science

Interdependence of Organisms

Science in Personal and Social Perspectives

Environmental Quality

Natural and Human Induced Hazards

NCGE Geography Standards

Human Systems

Standard 11

Teaching Time: 1.5 hours

Materials

- Props: appropriate items of clothing for each role-play character

Advanced Planning

Preparation Time: ~10 minutes

1. Review the instructions
2. Gather the necessary supplies.

Recommended Reading: (attached)

- High School Backgrounders: #6, 10, 11



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Lesson Plans



Student Exchange

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Curriculum Links

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Glossary

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Climate Change – Boon or Bust for Northern Waters?



In a Nutshell:

Students do research and engage in a role-play discussion on the potential benefits and costs of climate change on northern hydrological systems and related environmental and human factors.



Goal:

To learn about and evaluate the potential impacts of climate change on northern hydrological systems.



Background Learning:

Teachers and students should be familiar with the basic science and impacts of climate change as reviewed in:

- High School Backgrounder #6: [A Changing Land](#)
- High School Backgrounder #10: [Impacts on Northern Marine Life](#)
- High School Backgrounder #11: [Northern Community Impacts and Adaptations](#)

Learning Outcomes:

Click on the icon for your territory to review the learning outcomes that are addressed by this lesson:



Nunavut



NWT



Yukon

Grade Level: 9–12

Subjects: Sciences, Social Studies, Northern Studies, English Language Arts

Enrichment: English Language Arts

Time: 1.5 hours

Setting: Classroom

Materials: Props: appropriate items of clothing (e.g., hat, nametag, necktie, briefcase, fishing rod, etc.) for each role-play character (optional)

Skills: Analysis, hypothesizing, problem solving, public speaking, research

Key Vocabulary: Greenhouse effect, climate change, hydrological cycle, limnology, hypolimnion, aquatic ecosystems

Introduction to Lesson Plan:



In this lesson the students, working in small groups, will research the background to climate change in the north with a particular focus on lakes and rivers (limnology). They will use the information they have learned to brief their “speaker” – the person from their group who takes on an assigned role and participates in a role-play discussion about the stance the community should take towards climate change.

Activity:



1. The subject of the greenhouse effect will likely be familiar to most students but a discussion of the causes and mechanics of how it generally takes place is the best way to start this activity. You may want to brainstorm some of the basic key words (greenhouse effect, global warming, fossil fuels).
2. Brainstorm the hypothetical effects of warming on the northern hydrological system. Be sure to include as many aspects of this system as possible; for instance rivers (earlier break-up may make caribou crossing difficult), lakes (thinner ice, earlier break-up), wetlands (some drying up, some being formed), permafrost (melting), snow (deeper, crustier), spring run-off (earlier), etc. As the discussion proceeds, students should record a list of these effects, and then spend a couple of minutes identifying each effect as positive or negative. (Note: This discussion is just a preliminary overview of information that the students already know; they will get more information during the course of this lesson.)
3. Introduce the role-play scenario: An oil company wants to build a pipeline very close to your community. Members of the community have called a meeting to discuss the question: *When we know that the northern climate is changing due to climate change, should we be supporting oil development (which will bring in immediate jobs), or should we be switching to alternative energies?*
4. Divide the class into groups, each group taking one of the roles in [Student Handout #1: Role-play – Pipeline or Not?](#) Give each group an information package, including one copy of each of [Student Handout #2: Climate Change & Limnology](#), and Backgrounders 6–11. Ask the students to divide up the reading material within their group, so that each student reads a different piece of information. Ask them to use a highlighter or pencil to identify important points their character should raise in the discussion.
5. Assign roles for the role-play (either by student group or by you). Give each of the role-players an appropriate item of clothing (e.g., hat, nametag, necktie, briefcase, fishing rod, etc.) to identify the part they will play.
6. When the students have had long enough to prepare, hold the discussion. You, as the teacher, should be the mayor (unless you have an outstanding student who can take this on). Encourage the students to really act their parts and stay in role the entire discussion – this will make the activity much more fun. It will help students remain in role if you fully participate in your role.
7. Students not involved in the discussion should: a) be the support team sending suggestions and notes to their speaker; or b) take notes and write a short news report on the discussion. (Note: designate students to do one or the other.)



8. When the discussion has concluded, do a debrief with the class:

- o Which points of view came through most strongly?
- o What did they learn from this research and discussion (that they had not known before) about the effects of climate change on rivers and lakes?
- o What are the problems facing small communities that want to change?
- o Do a secret ballot vote (on pieces of paper put in a hat – no names associated with the vote) on the following question: If this were your community, would you vote for or against the pipeline? Count up the results and read them out.

9. For evaluation purposes and a follow-up to the discussion/discussion, ask students to write about the positive and negative effects of climate change on northern lakes and rivers (and affected plants and animals).



Handouts:

The complete set of handouts that support this lesson are attached at the end:

[Student Handout #1: Role-play – Pipeline or Not?](#)

[Student Handout #2: Climate Change & Limnology](#)



Student Web-Exchange:

Students could post their news reports of the debate, and/or short write-ups on the positive and negative effects of climate change on northern lakes and rivers. Click on the icon for information on how to post material.



Evaluation:

Assess student participation in group research and role-playing, on their news reports, and on their reports about the positive and negative effects of climate change on northern lakes and rivers (and affected plants and animals).



Enrichment Ideas:

English Language Arts:

The Unknown Future: Students could write science fiction short stories about your community in the year 2095 in relation to how the greenhouse effect has influenced local hydrological systems (e.g. fisheries, stream flows, snow cover, etc).



More Information:

For additional information and some interesting figures on:

Effects Of Climatic Warming On Boreal Lakes, Past And Future Globally Averaged Temperatures, Possible Northern Shifts To Permafrost Boundaries Due To Global Warming

http://siksik.learnnet.nt.ca/archives/09_13%20takePlunge/default.html



About the Author:

Jamie Bastedo's work is all about taking science to the streets. Whether playing zany environmental songs around a campfire, hosting lively nature shows on CBC radio, performing as an arctic explorer, leading eco-tours, portraying a backwoods nature nut on video, or writing fiction or non-fiction works, Jamie spreads a catching enthusiasm for the land. Well established as a popular science writer, he has written five books on northern nature, the latest being *Falling for Snow – A Naturalist's Journey into the World of Winter* (fall 2003, Red Deer Press), plus hundreds of natural history features in magazines such as *Up Here*, *Backpacker*, *Winter Living*, and *Canadian Geographic*. Jamie's passion for popularizing natural science brought him national honour in 2002 when he won Canada's Michael Smith Award for Science Promotion. His outstanding contributions to the conservation and promotion of northern nature also earned him Queen Elizabeth's Golden Jubilee Medal. Jamie lives in Yellowknife, NWT.

This lesson plan was adapted from "*Take the Plunge – Teaching Resources on Water Education for Secondary Schools in the NWT*" a resource created by Jamie Bastedo, Cygnus Environmental Consulting & Rosanna Strong, Interpretation, for Water Resources Division, Indian and Northern Affairs Canada. The YCS Curriculum team further modified this lesson.





Student Handout

Student Handout #1 Role-play – Pipeline or Not?

An oil company wants to build a pipeline very close to your community. Members of your community have got together to discuss an important question: *When we know that the northern climate is changing due to climate change, should we be supporting oil development (which will bring in immediate jobs), or should we be switching to alternative energies?*

Characters

Limnologist – You are a scientist the scientific study of bodies of fresh water for their biological and physical and geological properties. You are concerned about the effects of climate change on water, on temperatures and particularly on fish.

Oil company executive – You are promoting a pipeline to pipe oil to the United States. You hate hearing all this negative stuff about climate change. Personally, you feel that if global warming happens, it'll be good for the north: warmer, more species of fish and animals, etc.

Fishing lodge operator – Your lodge is built on a small lake. You are worried about what's happening to the fish in your region. If the fish decline, no one will come to your lodge.

Elder – You love to fish and to smoke fish in the traditional way. You are also a hunter, and concerned about northern animals and your people's way of life on the land. You wonder what effect climate change will have on the fish and the animals.

Unemployed worker – You are hoping for a job with an oil company, or some other company. If the north slows down industries in order to prevent climate change, you're afraid that job opportunities will disappear in the north.

Fisherperson – You make your living fishing on a river. You're worried about the declining fish stocks. If you could be sure that some new species of fish would move northward, it might not be so bad – but who can tell what will happen?

Environment Canada official – You are concerned about the impacts of climate change, and are traveling across the north to encourage northern communities to switch to renewable energies and reduce the GHG emissions that are causing climate change.

Process

Your group will be assigned to one of the roles above. Here are some steps to follow:

- Each choose a different background reading to read and make notes on any points that would be of interest to your character.
- Everyone shares his or her points with the rest of the group. Together, make a list of all the points that your character should raise in the discussion.
- Sit behind your speaker and pass notes if you think of another point he or she should raise in the discussion.



Student Handout #2

Climate Change & Limnology

What will climate change do to lakes and rivers in the north?

By Jamie Bastedo

In the North, the greenhouse effect will be a mixed blessing from the perspective of the northern hydrological cycle and aquatic ecosystems. At worst, it will result in widespread depletions or local extirpations of some organisms that are tied to these systems.

- Large areas of permafrost will likely disappear, reducing future construction and engineering headaches created by frost heaving.
- Water bodies could remain ice-free for 30 to 40 days longer, which would extend opportunities for water-based recreation or transportation.
- Some scientists predict that water-dependent amphibians and reptiles may benefit from warmer waters and spread much farther north. However, many other organisms adapted to the North's cold waters may undergo significant declines.

Long-term study of lakes in northern Ontario

Over a period of 20 years, biologists measured changes in just about every ecological variable imaginable such as air temperature, lake temperature, precipitation, ice-free season, wind speed, spring run-off, phytoplankton, and so on. Their research provides what they call "a preview of how climatic change may affect boreal lakes and catchments in the next century." One of their most disturbing discoveries was that a number of cold-adapted species including lake trout and lake whitefish may disappear completely from many smaller lakes as water temperatures increase and the cold, oxygen-rich bottom layers (hypolimnion) shrink.

The likely problem of declining lake trout in northern lakes provides just one illustration of the complex ecological interactions our species has unwittingly set into motion because of the greenhouse effect. During the course of Schindler's lake study, from 1969 to 1987, many of the changes one would expect from climatic warming were recorded: a rise in air temperature of about 20C, an increase in the frequency and intensity of forest fires, stronger winds, a longer ice-free season, and an earlier disappearance of snow. A combination of these factors contributed to increased warming and thermal mixing of lake waters. The scientists predict that, in some shield lakes, the cold, oxygen-rich bottom layers that lake trout depend on in summer may shrink significantly or disappear altogether. Once the trout and other cold water species are gone from a lake, there is no guarantee that other warm water species like northern pike or walleye will simply move in and take over the "empty" habitat or that ecosystems of comparable diversity would be re-established quickly.

Other proposed impacts of the greenhouse effect on northern waters include:

- increased evaporation in lake-rich areas creating increased atmospheric humidity and increased local rainfall
- an increase in early winter snowfalls
- shrinkage of glaciers and more rapid alpine run-off
- a dramatic rise in sea level causing possible flooding of coastal communities
- reduced sea ice resulting in more ship traffic bringing greater potential for marine oil spills.

Only time will tell how northern hydrological systems and the organisms that depend on them will be affected by the greenhouse effect. In the meantime, the scientific debate goes on as to the potential benefits and costs of this phenomenon.

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Impacts of Climate Change
High School Backgrounder 6

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A Changing Land

When you look out the window, you expect that the land will look different depending on the time of year. Snow comes and goes. Plants grow and die. Fall colours flare and then fade. These are the natural seasonal changes we all notice.

However, if you live in places like Resolute Bay, Nunavut or Paulatuk, NWT, you don't expect to open your curtains one morning and see a forest instead of the arctic tundra! But forests are slowly expanding north thanks to climate change. The shape of the land is also changing and shifting.

These changes are happening slowly and you might not notice them from day to day. Still, the land around us is changing! This backgrounder takes you on a tour of some of these changes.

Disappearing Act: Permafrost

Permafrost is a layer of permanently frozen ground that is under nearly half of Canada! It exists wherever ground temperatures remain below 0°C (on average) throughout the year. When it is above freezing the top layer – called the “active” layer – may melt. But it will freeze again in the colder temperatures.

By 2080, winter temperatures over the land areas in the Arctic could rise 2.5° to 14°C above current normal temperatures. Summer temperatures are expected to increase by 4° to 7.5°C above what we now usually get. So there's going to be a whole lot of melting of permafrost going on!

When ice-rich sections of frozen ground melt, underground cavities are created. Unfortunately, there isn't a permafrost dentist that can come and fill these cavities. So, as the ice melts and the water flows away, the ground above sinks and slumps into the cavities. Trees can topple and ponds can be created in these new low areas. This can have an impact on wildlife that live in the neighbourhood.

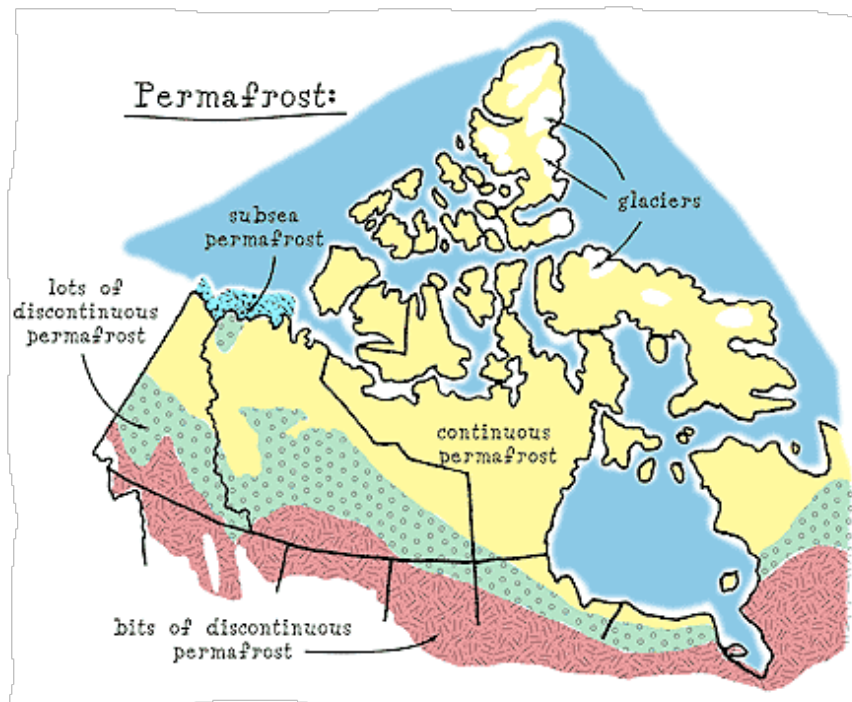
“Permafrost is melting. There are lots of slides, some really big ones especially along the highway. I bet it's blocking up some creeks. Someone got a video about that. Can't do anything about that. Affects the fish too.”

Participant from Fort MacPherson, Arctic Borderlands Ecological Knowledge Co-op 7th annual Gathering, 2002.



For example, in some areas near Fairbanks, Alaska, the permafrost has melted underneath forested areas. The trees have toppled and new low areas have filled with water. So now, instead of forests, these areas are mostly grasslands and wetlands. This change has attracted moose and ducks which like the new habitat, but the woodland caribou have moved away to forested areas because that is what they prefer. This means local people have had to change their hunting practices as the species around them have changed.

People in the north have also seen more landslides because of melting permafrost. Like warmed icing on the side of a cake, the wet, melted slopes slide downwards. Sometimes melted riverbanks give way and fall into the water. This causes more dirt – more sediment – to go into streams and rivers. Increased sediment in the water can harm some types of fish as it makes it harder for them to breathe. Increased sediment can also bury spawning sites.



Withering Wetlands?

On the one hand, melting permafrost can create new wetlands (like the ones near Fairbanks) because new low areas are created that will fill with water. And some climate models project that the Arctic will get more rain and snow than it used to.

On the other hand, warmer temperatures caused by climate change could also mean some wetlands will dry up. This is because more water will evaporate as temperatures rise. In addition, if permafrost under the wetlands melts, water can quickly drain away. If the water level in some wetlands drops, the plants and wildlife that currently thrive in these wetland areas could have a hard time

"Models predict that land areas in the Arctic will receive substantially increased snowfall in winter and that the climate will be markedly warmer. Summer could be much warmer and wetter than present... [S]mall rises in temperature will result in increased melting of snow and ice, with consequent impacts

surviving.



and ice, with consequent impacts on the water cycle.... There will be more ponding of water in some areas, but peatlands may dry out because of increased evaporation and transpiration from plants.”

Climate Change 2001: Impacts, Adaptation and Vulnerability, Intergovernmental Panel on Climate Change

Right now, wetlands cover about 14% of Canada. Most of these wetlands are found in the Prairies and southern NWT but there are also important ones in the northern Yukon. All of Canada’s wetlands provide important homes to rare or threatened species. Huge numbers of birds hang out in the wetlands in the summers, having their babies and fattening up for winter.

A few years ago, the Gwitch’in people from Old Crow argued that the wetlands in their area were drying up. So government scientists looked at satellite images of these internationally significant wetlands taken in 1973 and 1999. The satellite images confirmed what the Gwitch’in were saying – the wetlands in the Old Crow Flats had lost about 6.8% of their surface area in the 26-year period.

Plants and Trees on the Move



When plants and trees start to move into new places, it is not like you can sit and watch them travel by your door. But trees might not be as slow as you think!

Do you currently spend time near the edge of the boreal forest? Some computer models predict that an expected increased temperature of just 0.2°C per decade could create growing conditions that would allow the boreal forest to move northward an average of 30 kilometres every ten years! If these computer models happen to be right, by the time you are ten years older, you should notice that the edge of the forest has moved further north!

However, other computer models look at more than just temperature and moisture levels when they try to predict what our forests will look like in the future. These other models also look at things like soil conditions and how plant and animal species migrate. These models say we can’t really be sure how fast the forests will move north. But it is safe

to say that the most of the species in the forests will move northward. How fast and how far they will move is up in the air.



A forest is more than trees!

It's important to remember that a forest is more than plants and trees. For example, a healthy forest needs little microbes – bacteria and fungi – to live in the soil because these microbes help turn dead plants into nutrients in the soil. These nutrients help the live plants and trees grow.

Some people think that the microbes in the soil will not be able to travel northwards quite as fast as the trees and shrubs. So, although the warmer weather will help new plants and trees survive farther and farther north, they need their microbe buddies to come along if they are going to make a healthy forest.

The boreal forest is also made up of many different tree and plant species. The seeds of some of these species are spread by the wind. The seeds of other plants and trees are spread by birds and animals. So even if the temperature and moisture levels improve over time in the north, the rate of spread of the different seeds will influence how far and fast the forest moves north.

The amount of water, the amount of nutrients in the soil, the frequency of fire and the number of insect outbreaks are also things that could affect how fast forests move northwards.

In other words, plants and trees will need more than just warmer weather before they can speed north. A forest is a connected network and all the parts in the network need to be able to make the trip. This is why some scientists don't think the forests will move very quickly towards the North Pole.

As forest ecosystems move north, this means they will take up space that tundra ecosystems now occupy. This will affect the plants and animals that call the tundra home. Tundra plants and animals may get squeezed out by new forests and have to move even farther north.

The vegetation in northern Canada is already changing in some areas. Shrubs and vegetation that need more moisture have been seen farther north as the north has been getting more rain and snow. Willows are one example of a shrub that has been observed farther north than usual. Moose do well where willows and other shrubs grow so they are benefiting from this increase in shrubs. Berries have also been reported to be more plentiful after wetter weather, which is good news for the animals – including humans – that eat them!

However, mosses and lichens, important foods for caribou, are declining as the climate changes and as other species move into their space! This is bad news for the caribou and, therefore, for people and other animals that eat caribou!

Plants and trees react mostly to two things – temperature and moisture. A banana tree can't survive outdoors in the north, as the temperature is too cold. A lodgepole pine tree can't survive near the equator, as the temperature is too hot! And plants that can live in a desert, can't survive in a wet coastal area.

In other words, every plant and tree needs a certain temperature range and amount of water to survive. As climate change is all about changes in temperatures and amounts of precipitation, it is bound to have an impact on our plants and trees.

If the temperature and moisture levels change quickly, plants have two options for survival: adapt or move. However, a plant can't just pull up its roots and move to a place with better conditions. If a species of plant or tree can't adapt quickly enough to changes in the climate, or migrate fast enough to a more suitable area, then it may die out. Competition for space from other, newer species can also cause problems for native plant or tree species.

Have you noticed any changes in the plants and trees in your area? Have you heard others tell stories of new plants or shrubs?





Too hot for comfort

The forests in the north are called boreal forests. They are made up mostly of spruce, pine and aspen trees. The boreal forests are drier than the temperate or coastal forests you would find in wetter regions in Canada.

Right now, forest fires in the boreal forests of Canada burn an average of 2.5 million hectares every year. Fire is a natural part of the life cycle in a boreal forest. It helps shape the landscape and provides a rich patchwork of young and old forests, each with different types of vegetation.

However, as climate change will result in warmer temperatures, forests will likely be drier than usual. With drier forests, we can expect to get bigger and more frequent forest fires.

Larger and more frequent fires will have a number of impacts. For one, if forests burn more frequently, it will mean that forests don't get a chance to get as old as they used to. This will impact birds and animals that are suited to living in old, mature forests because there will be fewer old forests around. For example, some birds only nest in holes in old, dead trees. They won't be able to find a place to nest in a young forest!

More fires will also cost more money to fight and threaten more communities.

More forest fires will also release more carbon dioxide (a greenhouse gas that causes climate change) into the atmosphere. Even though trees breathe in a lot of carbon dioxide when they are alive (through a process called photosynthesis), when they burn they release a lot of the carbon they absorbed (see [Backgrounder 3](#)).

The Intergovernmental Panel on Climate Change estimates that two-thirds of the world's boreal forests could disappear – from fires and insect damage – if we continue to put lots of greenhouse gases in the atmosphere.

So What Else is Happening in the North?

As the land changes, and the plants and trees come and go, the animals that live on the land will be affected. To get a better idea of what northern wildlife might be facing with climate change, read [Backgrounder 8](#). Check out [backgrounder 7](#) for information on how the northern world of ice and water is being affected by climate change.



Key Points


- ★ As the climate warms up, a lot of the permafrost that is in the ground in the north will melt. This will cause trees to topple and new wetlands to be created.
- ★ Although the north is expected to get more rain and snow as the climate changes, some wetlands will dry up or get smaller as warmer temperatures will cause more water to evaporate, or permafrost under them to melt so they drain.
- ★ Plants, shrubs and trees will move northwards as the temperatures warm up and moisture levels change. However, the speed of movement will depend on a number of factors.
- ★ As forests move northwards, they will replace the tundra environment. This will affect plants and animals that now live on the tundra.
- ★ There will be larger and more frequent forest fires as the climate warms up.



Want to Know More?

Check out these sites to find out more about the impacts of climate change in the north and the rest of Canada:

- **Arctic Borderlands Ecological Knowledge Co-op:** <http://www.taiga.net/coop/projects/plantcol.html> – Do it yourself project! Start a community plant collection.
- **Climate Change in Canada Poster Site:** <http://adaptation.nrcan.gc.ca/posters/> – Click on regional names under the Canadian map to bring up lots of information about climate change specific to Nunavut and Western Arctic (Yukon and NWT).
- **Climate Impacts Map:** <http://www.climatehotmap.org/> – Click on the map in your region, and you'll link into a description of climate change indicators in that area.
- **Community Adaptation and Sustainable Livelihoods:** <http://www.iisd.org/casl/projects/inuitobs.htm> – Don't miss the video, Sila Alangotok: Inuit Observations on Climate Change. You can view a short version at this site, or get information on buying it.
- **Government of Canada Climate Change (Regional Impacts):** http://www.climatechange.gc.ca/english/affect/prov_territory/ – Click on northern sections of the map to see what the impacts are in NWT, Yukon and Nunavut.
- **NASA Earth Observatory:** http://earthobservatory.nasa.gov/Study/BorealMigration/boreal_migration4.html – All about boreal forest migration.
- **Plantwatch Canada:** <http://www.devonian.ualberta.ca/pwatch> – A plant-watching project for classes.
- **UNEP (Report on impacts in the Polar regions):** http://www.grida.no/climate/ipcc_tar/wg2/592.htm – An amazing collection of scientific information on climate change impacts in the Arctic and Antarctic.

Impacts of Climate Change High School Backgrounder 10

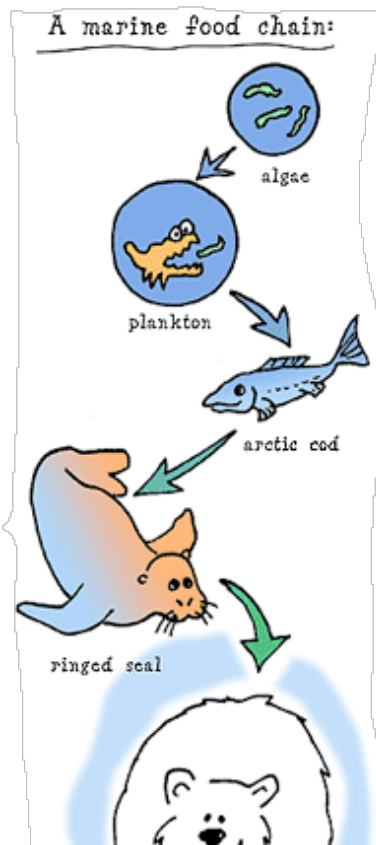
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Impacts on Northern Marine Life

As our planet warms up, there will be many changes in our northern environments, including ocean (marine) environments. For example, the oceans are getting warmer and the sea ice is getting thinner.

These changes are already having some significant impacts on animals that live in or by the oceans. This backgrounder describes how the lives of these animals are being affected.

The Marine Food Chain



In the Arctic Ocean, tiny plants called algae grow under the sea ice. The algae are food for small floating organisms called plankton. The plankton, in their turn, are food for Arctic codfish. Ringed seals like to eat cod, and polar bears chow down on ringed seals. This set of links – between eaters and eaten – is called a food chain.

In warmer parts of the world, food chains are usually much more complex as there are more plants and animals to make links in the chain. But the Arctic food chain is short and simple.

Because there are fewer links in the Arctic food chain, any changes to one link in the chain can have a serious impact on the rest of the chain.

In this example, the polar bears are at the top of the chain. So if there were less plankton, then there would be less food for the cod and their numbers would decrease. Then the seals would suffer. And if seal numbers went down, the polar bear would start to get pretty hungry. So the polar bears' survival is dependent on every other link in the food chain staying strong.

A strong food chain also needs the connections between the links to be strong. For example, if there were a lot of seals hanging out on the sea ice, but the polar bears couldn't get out to the sea ice, then the chain would be weak. There would be no direct connection between the seals and the polar bears. It would be like having your dinner waiting for you on the table but not being able to get to it because you are locked out of the house!

In a way, this is what is happening to polar bears in the Hudson Bay area. There are a lot of seals in Hudson's Bay for these polar bears to eat, but the bears are having a harder time getting to where the seals hang out in order to chow down!

Read on to see what is making it hard for these polar bears to get to their dinner table.



Polar Bears On A Diet

Polar bears are well suited to living on snow and ice. For instance, a polar bear's very large paws spread out like natural snowshoes and distribute the bear's weight over a large area. These big feet allow polar bears to walk on ice that a person might fall through. Polar bears are also white like the snow and ice, which makes it harder for their prey – mainly ringed seals – to see them coming.

In other words, polar bears are adapted to a specific climate. If the climate changes, they either have to adapt, or move to other places where the climate fits their physical nature.

Polar bears live in many northern countries around the world. The ones that live near Churchill, Manitoba, in the Western Hudson Bay area, are at the southern edge of where polar bears are found in the world.



The Hudson Bay Polar Bear

Ian Stirling, a wildlife biologist from the University of Alberta, has been studying polar bears in the Hudson Bay area for almost 30 years. His studies help us to understand how these large bears might be affected by climate change.



In the Hudson Bay area, polar bears are at their lowest weight in March. The bears start packing on the weight in April by eating young seal pups that are born out on the sea ice. The seal pups are 50% fat when they are just six weeks old so they are a huge source of energy for hungry polar bears!

The bears keep eating the seal pups until the annual sea ice breaks up in the early summer. The bears hunt the seals when the seals are in the birth lairs (their dens) in the ice, at the holes in the ice where the seals come up to breathe, or when the seals are lying out on the sea ice.

But something has been changing and these polar bears are not able to get as fat as they used to in the spring. Since 1981,

the weight of the Hudson Bay polar bears has been decreasing. Studies show that these polar bears are about 90 kilograms lighter than they were 15 years ago.

Seal populations have not really changed during this time. So there are still lots of seal pups for the bears to munch on.

The likely reason for the decrease in the polar bears' weight is that they can't get to the seal pups. Polar bears need to be able to travel on the sea ice in the spring because that is where the fat little seal pups are found. But records show that the sea ice in the Hudson Bay area has been breaking up earlier and earlier in the year. This means that the bears can't get to their dinner table for as many weeks as they used to. Their mealtime is being cut short by the early break-up of the ice and the bears aren't getting as much hunting time to fatten up.

After the ice melts, and the bears can't get to the seals, these Hudson Bay polar bears travel inland and basically do not eat.



They hang out, trying not to overheat in the warmer summer weather. The fat the bears pack on from feasting on the seal pups helps them get through this time.

Although the Hudson Bay polar bears are losing weight because of the earlier break-up of the ice, researchers have not noticed a significant decrease in the actual number of polar bears in this area since 1981.

However, Ian Stirling believes the condition of these bears will continue to go downhill if climate change continues to make the ice melt earlier every year. He doesn't think the bears will be able to survive if that happens. He worries that this population of polar bears he has studied for so long may not be around the Hudson Bay area in 30-50 years.

And as this population of polar bears gets hungrier, they might increase their trips into nearby camps and towns in search of food. No one likes to have a hungry polar bear barging into their tent or wandering the streets of their town!

Not all polar bears stop eating during the summer months like the Hudson Bay polar bear. But polar bears everywhere in the north spend most of their hunting time on the ice. As global temperatures increase, this will mean less and less ice. What people are now seeing with the Hudson Bay polar bear could also happen to other polar bear populations in the north.



Limited accommodation?

Female polar bears used to den in snow banks near Coral Harbour on Southampton Island in Nunavut. However, people who live in Coral Harbour have noticed that permanent ice and snow on the hills to the east of town have gone. The bears don't use this area any more as there is not enough permanent snow to make their dens.

In the north Yukon, 75% of Yukon polar bears make their dens on drifting pack ice. Sometimes these dens are found up to 550 kilometres offshore. Thinning and smaller pack ice could reduce the number of places they have to make their dens.

It is expected that warmer winters will mean heavier snowfalls in some northern areas. Too much snow (or even rain) in the late winter could cause polar bear dens across the north to collapse. This could trap mothers and cubs that might be hibernating at that time.

Other Life In The Sea

Seals

- Thinning sea ice will likely have a negative impact on seal populations as seals mate and have their babies on the sea ice. They also use the ice as a place to rest and a platform to hunt from. As the ice thins, there will be less ice surface for the seals to use.
- Seals make their lairs (their dens) in the sea ice along the coast (which is also called land-fast ice). After they are born, the seal pups nurse for about six weeks. However, this important nursing period could be shortened when

the land-fast ice breaks up earlier in the year. If the seal pups don't get to nurse for as many weeks as they used to, this will lower their chance of survival.

Walrus

- Walrus can weigh up to two tons each! As the sea ice thins, some areas may not be able to support the weight of the walrus, especially when they hang out in a group. This means the walrus will lose important habitat because they need ice to rest on and have their young.
- Walrus feed mostly on mollusks (clams and mussels) and other spineless creatures (invertebrates) that live on the sea floor. Warmer weather will cause the sea ice to melt and retreat farther from land so the edge of the ice will end up being over deeper water. This means nursing mothers and their young will have to swim farther to reach their food.



Other marine animals:

- Less ice could benefit beluga and bowhead whales. Their populations should stay the same or even possibly increase. This is because the whales should have more open water to move around in which means they should have more access to food.
- Some large breeding colonies of sea birds like the Common Murre and Northern Gannets in Newfoundland will be threatened by rising sea levels. Increased storms could destroy nests, chicks and eggs.

No One Knows For Sure, But You Can Find Out More!

This backgrounder highlights some of the impacts that climate change might have on animals that live on or by the ocean. A lot is still unknown and uncertain. Many people continue to study and observe animals across the north to see how they are being affected by climate change.

You can read about the impacts to animals that live on land – like caribou, moose or even ground squirrels – in [Backgrounder 8](#). To read about those that have scales or feathers (fish or ducks), check out [Backgrounder 9](#). To learn more about how the world of water and ice is changing, look for [Backgrounder 7](#).



Key Points

- ★ The food chain in the Arctic is short. Each link in the chain is important and the connections between the links need to be strong.
- ★ Polar bears in the Hudson Bay area are losing weight as they have fewer weeks in the spring to fatten up on seal pups. This is because the sea ice is breaking up earlier in the year.
- ★ Thinning and shrinking sea ice is affecting seals and walrus.
- ★ Some ocean species like whales may benefit from climate change, as there will be more open water so they can move about more and have access to more food.



Want to Know More?

Here are some websites to take you further in your research on the impact of climate change on marine wildlife in the north:

- **CBC TV (The Shrinking Polar Bears):** <http://www.tv.cbc.ca/national/pgminfo/warming/bears.html> – Documents the effects of climate change on the polar bears of Churchill, Manitoba.
- **Polar Bears & Ice Backgrounder:**
Refer to [student handout #3](#) in lesson plan Polar Bears and Ice in this resource for more information on polar bears and shrinking arctic ice.
- **Climate Change Connection:** <http://www.climatechangeconnection.org/pages/wildlife.html#closetohome> – Check this Manitoba-based website for a list of linked articles about the effects of climate change on wildlife in the Arctic and around the world .
- **Defenders of Wildlife:** <http://www.defenders.org/wildlife/new/threatspb.html> – Learn more about threats to the polar bear.
- **Polar Bear Tracker:** <http://www.panda.org/polarbears/> – Track Lena and Yana, two polar bears, as they journey through the Arctic. Be sure to click on 'Polar Bears at Risk' (top bar) and 'Impact of climate change' (right section) for more background information.

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Impacts of Climate Change
High School Backgrounder 11

[Printable Version](#)

**Northern Community
Impacts and Adaptations**

So climate change is causing the world to warm up. “What’s the big deal?” you might ask. “How is it going to affect me?”

No one is *exactly* sure how you and your community will be affected because no one knows *exactly* how things will change. But we do know things on the ground have changed during the past few decades. And people’s lives are already being affected.

Folks are getting a pretty good idea of what the future might bring based on the changes that are happening now and based on the information that is being collected across the north and around the world.

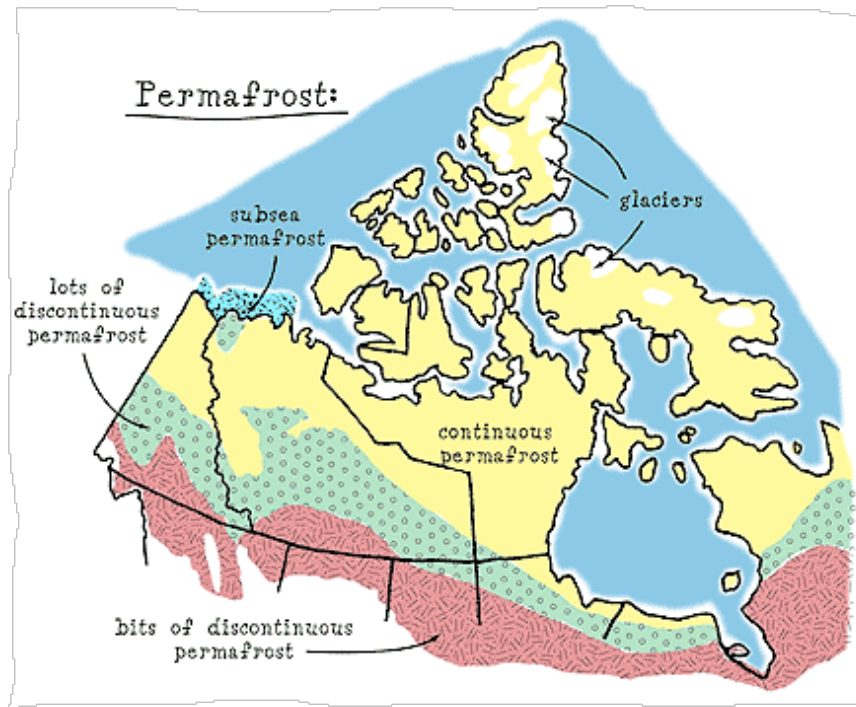
Read on to see how the expected impacts of climate change might affect you, your friends and community.

An Underlying Problem



When many northerners go for a walk or drive, they are cruising over permafrost. This permanently frozen layer of ice in the ground lies under most of Nunavut, Northwest Territories and Yukon. Even where there isn’t solid permafrost, there are often patches of what’s called “discontinuous permafrost”.

As global temperatures increase, some of this frozen ground will start to melt... and things will become topsy-turvy. Roads and airstrips can turn into mini roller coasters. Buildings, water lines, and power poles can all get bent out of shape. It can cost a lot of money to try and straighten things out again.



Over 50% of Canada's land is underlain by permafrost. To stay frozen it needs to maintain a temperature below 0° Celsius all year long.

A lot of Canada's permafrost has an average temperature that is between 0°C and -2°C. By 2080, winter temperatures over the land areas in the Arctic could rise 2.5° to 14°C above current normal temperatures. Summer temperatures are expected to increase by 4° to 7.5°C above what we now usually get. So a lot of permafrost will likely melt.

The speed of change

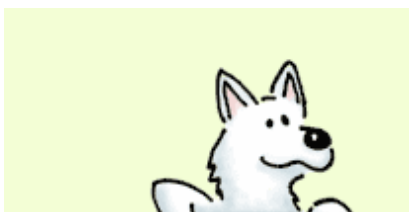


Hunters, trappers, fishers and berry gatherers use generations of knowledge to survive on the land. For example, this knowledge helps them know where the animals and berries can usually be found. People on the land have learned when to expect rivers and lakes to freeze. They know what kind of weather to prepare for at different times of the year. People understand the connections between all the parts of the environment and the weather.

However, people on the land today are finding it difficult to predict conditions on the land or sea ice or where animals will be. Thinner ice, heavier snow, and melting permafrost are also making travel on the land more difficult and dangerous. New wildlife

species are appearing and old ones are changing their behaviour. Salmon are being caught in areas they have never been seen before. Ice is thawing completely in ocean bays, making it difficult for hunters to hunt seals. Caribou are changing their migration routes to deal with different ice or snow conditions and some communities have empty freezers when they should be full of caribou meat.

Although change is normal year to year, the speed of change caused by a warming climate is making it difficult for wildlife and people to adapt. Life on the land is becoming more challenging and uncertain.





“The weather never change that much years ago... it is always cold. Not like today. You can’t even tell when the weather is going to change. Years ago we know when the weather is going to change – mild weather it is going to get storm come, we get ready for it even. But today it changes so much... boy we expecting a big storm. Next day, clear as can be. I can’t predict weather anymore like we used to years ago.”

Peter Esau, Sachs Harbour, 1999. Quoted in “We can’t predict the weather like we used to: Inuvialuit Observations of Climate Change, Sachs Harbour, Western Canadian Arctic.” By Dyanna Jolly et al. in The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change, edited by Igor Krupnik and Dyanna Jolly, 2002.

The Good, The Bad... And The Uncertain

We aren’t sure just how hot it will get, or how fast things will change, or how much rain or snow we will get. So it is hard to be specific about the impacts of climate change.

Here is a list of some of the potential changes we *could* experience. Some are already happening or are likely to happen; the risks of others happening is still very uncertain. Some might be positive impacts... and many might not be. You decide!

- **Cheaper heating costs.** Warmer winters will mean heating costs for our homes and businesses should go down a bit.
- **New shipping routes.** As the ice pack in the Northwest Passage melts, ships should be able to travel farther into the north without help from icebreakers. This would create new economic development opportunities – such as more tourism, more export of oil, gas and minerals, and cheaper transportation costs – in some areas. But there are also risks associated with more shipping in the Arctic’s fragile ecosystems. A shipping accident in the Arctic waters could have a big impact (see [Backgrounder 7](#)).
- **Increased safety outdoors.** For people who work and play outside in the winter, warmer temperatures could mean less risk of frostbite and hypothermia. But before you celebrate, remember that warmer temperatures can also cause thin ice that can be dangerous for people travelling on rivers, lakes and sea ice.
- **More farming opportunities.** Longer growing seasons in the north could be good news for someone who wants to farm or garden! However, before you start running out and planting seeds, keep in mind that northern soils do not have a lot of nutrients that crops need to thrive. And there are no guarantees that rain will come at the right time in the growing season.
- **Shorter season for winter roads and ice bridges.** Some northern communities rely on their winter roads to bring in supplies. These roads are built on top of snow and ice. However, as our winters become shorter and milder, our winter roads won’t last as long. Melting and slumping can create dangerous conditions which means more time has to be spent maintaining the roads. It has already become more expensive to maintain winter roads like the one to Rae Lakes in NWT. Also, it is taking longer in the early winter for ice bridges to get thick enough for safe travel.



- Eroding towns.** Towns along ocean coasts might have to pack up and move farther inland as the land under their feet washes into the ocean. Already Tuktoyaktuk, NWT is seeing more erosion along its shoreline. The community's curling rink was destroyed in the 1980s. The school was closed and torn down in the 1990s, and rebuilt farther inland. Coastal erosion like this is happening more frequently as permafrost melts and sea levels rise. The waves and storms end up washing the melted shoreline away.
- Cancelled flights.** More storms and fog can mean more cancelled flights between communities and to remote work areas (like mine sites).
- Impacts on mining.** Many mines in the north rely on permafrost to keep groundwater out of their pits. Also, toxic mining waste might be released into the environment if there is permafrost in the walls of tailings ponds. If the permafrost in the walls melts, the walls wash away. Melting permafrost can also affect the construction of oil and gas wells.
- Less water for hydropower.** Warmer weather will mean more evaporation of water from our lakes. In some places in the north, like Whitehorse, in the Yukon, electricity is made by hydropower. Hydro dams need water in their reservoirs (the lakes that form upstream of the dam) to make power. If more water is evaporating, then there could be less water to make this power – unless there is a large increase in precipitation to balance what is being lost from evaporation. (Hydro dams can't use all of the water upstream as this would damage fish and wildlife habitat.)
- Impacts on human health.** Because the north is usually a cold place, we don't have as many types of insects, parasites and diseases as places farther south. As the temperatures warm up, we can expect to see more types of insects, parasites and diseases in the north. People may also suffer more on really hot days. Additionally, a lot of northern people currently eat a lot of healthy country foods (such as berries and wild meat). If climate change affects the availability of the northern plants and animals that people eat, this will likely have a negative impact on people's health, both physical and spiritual.
- Impacts on traditional cultures.** Many northern people are finding it more difficult to hunt, fish, trap and gather berries. Climate change is making weather and wildlife movements less predictable. The environment is changing. Traditional cultures have always adapted to change, but if future changes are too rapid, it will be difficult for aboriginal cultures to adapt quickly enough. Rich traditions may be lost.



Do these stories sound familiar?

The SnowChange Project collects observations of climate change from indigenous people in the north. Elders in NWT and Nunavut have told the SnowChange project that the weather isn't as cold as it was when they were young. In some areas the elders say there is less snow while in others the snow is melting earlier. Often the elders say the ice isn't as thick as it used to be. Igloos are harder to build and there is a greater risk of going through the ice. Check out www.snowchange.org for more stories like these from Canada and other northern countries.

The Arctic Borderlands Ecological Knowledge Co-op is a community-based monitoring project involving six communities in northern Yukon, NWT and Alaska. People involved in this project have described how it is harder to travel on the land because there is more frost on the trees and willows or there is more

overflow on the rivers. They have talked about how the wind on the coast makes it harder to travel in boats. They have told stories about warmer weather in Old Crow Flats that made it harder to get to people's camps and how people couldn't hunt until it was very late in the fall. For more details go to www.taiga.net/coop.

So What Do We Do?

We can do a number of things to help slow climate change (see *Climate Change Solutions backgrounders 13 to 17*). However, we also know that temperatures will continue to increase for a while even if we all stopped putting any greenhouse gases (GHGs) into the atmosphere today.

So we need to learn how to live with some changes in our climate. We need to adapt.

Some adaptations can be simple. For example, people in Sachs Harbour report using ATVs more often in the spring to go to their camps (they used to only use snowmobiles at that time of year). They also used to use the frozen rivers to get to their camps. However, as these rivers are breaking up earlier, some people are travelling the long way around – along the coastal sea ice – to get to their camps. Everyone in Sachs Harbour is being more careful about going out on the pack ice as it is thinner and breaks up sooner. Changing ways of going out on the land is one way of adapting to climate change.

Tuktoyaktuk is adapting to its eroding shorelines by moving buildings and changing their community plan. By planning ahead for climate change, Tuktoyaktuk is helping to minimize the future impacts of climate change.

Builders and contractors can adapt to climate change by changing the designs of the foundations for their buildings and other projects. These designs need to account for melting permafrost. For example, work on the airport runway in Yellowknife involved digging down 4 metres into the earth – right into the permafrost – and laying down 100mm of rigid insulation. The insulation is then covered with sand, a special liner, crushed rock and other materials. Then it will all be resurfaced. This should protect the permafrost from melting further.



Climate change isn't the only thing impacting our northern environments and communities. There are also other forces of change at work. For example, the north is affected by pollution and contaminants that travel on the winds from southern Canada and other countries. An increase in mining and oil and gas developments in some northern areas is also bringing changes to the natural world and to northern communities.

If a lot of change happens at once it is harder for our plants, wildlife and people to adapt. To make it easier for the natural world to adapt to climate change impacts, decision makers need to find ways to minimize the impacts of other types of change that they can control. For example, they can protect caribou migration routes and limit disturbance to critical wildlife habitat.

All around the world, people are trying to figure out exactly what the impacts of climate change will be. Right now, researchers can predict a range of possible changes in temperature, precipitation and other weather patterns. They do this by using different climate models. But no one is 100% sure exactly how climate change will affect different regions of the world. There are just too many unknowns right now. But we do know stuff is happening!

People are making changes and planning ahead to help reduce the impacts of climate change. Many are also collecting information that will help us figure out what individuals, communities, businesses, and governments need to adapt to. For more details on how some of this information is being collected, check out [Backgrounder 5](#). To find out how other people around the world are being impacted by climate change, read [Backgrounder 12](#).



Key Points

- ★ A warmer climate is going to have a range of impacts. Some of the impacts might be positive, while some will be negative.
- ★ Melting permafrost will create some of the biggest changes. It will affect our roads, buildings and industries.
- ★ People on the land are already noticing changes that are affecting their hunting and trapping lifestyles.
- ★ We need to learn how to prepare for the changes that may be coming, even if we can't be 100% sure of what they will look like.



Want to Know More?

Here are some websites to help you look further into impacts of climate change on northern communities:

- **CKUA Radio Network:** <http://ckua.com/climatechange/singleshow13.html> – Listen to an online interview with Andy Carpenter, Inuvialuit elder and mayor of Sachs Harbour about how climate change is affecting their way of life.
- **Government of Canada Climate Change (Regional Impacts):** http://www.climatechange.gc.ca/english/affect/prov_territory/ – Click on northern sections of the map to see what the impacts are in NWT, Yukon and Nunavut.
- **Northern Climate Exchange Knowledge Site (Matrix Maker):** <http://yukon.taiga.net/matrix/index.html> – Use this amazing matrix to see the impacts of climate change on things like waste management, transportation, and other aspects of community life in the north.
- **Snowchange Project:** <http://www.snowchange.org/> – Current stories of changes being experienced by Arctic communities.
- **Yukon Department of Environment:** <http://www.environmentyukon.gov.yk.ca/epa/climate.shtml> – Click on “Climate Change in the Yukon” for information about Yukon communities.