



# Signs of Change: Studying Tree Rings

High School Grades

## **Lesson Summary**

Students gather information from real tree core samples and compare them to local climate history.

## **Prior Knowledge & Skills**

- Knowledge of connection between yearly climatic cycles and tree growth

## **AAAS Science Benchmarks**

### **The Nature of Science**

*Scientific Inquiry*

## **NSES Science Standards**

### **Science as Inquiry**

*Understandings About Scientific Inquiry*

### **Life Science**

*Matter, Energy, and Organization in Living Systems*

### **Science in Personal and Social Perspectives**

*Natural and Human Induced Hazards*

**Teaching Time:** 2 – 3 hours

## **Materials**

- Increment borer and grooved core holders \* ∴.
- Paper
- Dissecting microscopes and/or magnifying glasses
- Dendrochronology sheets to record tree ring information
- Graph paper
- Pencils

## **Advanced Planning**

**Preparation Time:** ~10 minutes

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

## **Recommended Reading: (attached)**

- Intermediate Backgrounders: #1, 2, 5

\* Editor's Note: Increment Borers may be obtained through the County Extension Office or at a local university.

∴ Editor's Note: If an Increment borer is not available you may complete Global Change – Time and Cycles attached at the end of this activity.

ClimateChangeNorth.ca Lesson Plans

<http://www.climatechangenorth.ca>

(Attached lesson) USGS: Global Change Teacher Packets – Time and Cycles

<http://erg.usgs.gov/>



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## Signs of Change: Studying Tree Rings



### In a Nutshell:

In this very hands-on lesson, students will learn about dendrochronology (the study of tree rings to answer ecological questions about the recent past) and come up with conclusions as to what possible climatic conditions might affect tree growth in their region. Students determine the average age of the trees in their schoolyard, investigate any years of poor growth, and draw conclusions about the reasons for the years of poor growth.

### Goal:

To understand the relationship between climate and tree growth.



### Background Learning:



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

- High School Backgrounder #5: [How do we Know?](#)

**Teachers** should also be able to help students identify differences in tree rings (and their significance) as outlined in the [Teacher Handout: Dendrochronology: Investigating the Recent Past](#) (attached to this lesson).

### 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:** 4–8

**Subjects:** Science, Mathematics, Social Studies, Visual Arts, English Language Arts

**Enrichment:** Science, English Language Arts

**Time:** 2–3 hours

**Setting:** Classroom, schoolyard or forested area

**Materials:** Using cross sections: band saw or chain saw, using core samples: increment borer and grooved core holders, and paper, dissecting microscope(s) and/or magnifying glasses, dendrochronology sheets to record tree ring information, graph paper, pencils

**Skills:** Analysis, application, comparison, inference, interpretation

**Key Vocabulary:**

Dendrochronology, tree ring, increment borer, core sample, cross section



## Introduction to Lesson Plan:

The understanding and awareness of historical climate change is steadily growing as people around the world gather information from glacier ice, trees, lake bottoms and oral traditions.

While scientists use glacier ice and muck from the bottom of lakes and oceans to determine that the climate was like thousands of years ago, trees can tell about the more recent past.

Here in the north, close study of the growth rings of a tree can reveal a hundred years or more of climate history. Tree rings can tell us stories about relative temperatures, precipitation and growing seasons, and about extraordinary events, such as fires, that may have affected tree growth.

Before this lesson, go over the basics of climate change and the potential impacts outlined in Intermediate Backgrounders #1 and #2. It is also necessary to teach your students a little bit about dendrochronology and its importance to the study of climate change. A brief overview has been provided below and you may refer to High School Backgrounder #5: [How do we know?](#) for more information. Reading the teacher's handout on dendrochronology that is attached to this lesson will help you to complete the lesson successfully and help the students identify the differences in the tree rings that they might possibly encounter.

It's recommended that you review with your students the process you've chosen for acquiring and studying a tree sample (options described below).

Download and make copies of the [Student Handout: Dendrochronolog Sheet](#) attached to this lesson. Prepare the necessary materials.

## Overview of Dendrochronology:

Dendrochronology is the study of tree rings to answer ecological questions about the recent past:

dendron = tree, chronos = time, logos = the study of

From the study of tree rings, students can determine the approximate age of their trees, as well as the climatic conditions each of their trees might have faced over its lifetime. Every year, trees produce a new ring of wood underneath their bark. The width of a ring tells us about the climate in the past because the growth rate depends largely on precipitation and temperature during the growing season. ~~Trees grow more during wetter years with good temperatures (wider rings) and less during colder, drier years (narrow rings).~~ It is important that students learn that tree rings are an important source of confirmatory data, at least over the near term (the life span of the tree being studied).

### Two ways to get a sample of the tree rings:

1. Students can find dead standing trees, stumps, or cut wood from their woodpile. You may choose to cut cross sections of tree trunks using a band saw or chain saw (depending on the size of the trunk). This is the most destructive way, but tree disks are the best samples since incomplete rings can be detected, narrow rings can sometimes be seen better somewhere else around the stem, and patches of rot can be avoided when dating the disk. (Note: Tree sections can be used year after year. If students mark them with pencil, they can be erased or sanded clean.)
2. Core samples can be taken from trees with an increment borer. Step by step instructions are included in the activity section below. You can obtain an increment borer from your local Forestry office (from Bob Sharp if you are in the Yukon), or purchase one on-line from Forestry Mall, in B.C. at: [http://www.irl.bc.ca/Forestry%20Supplies/increment\\_borer.htm](http://www.irl.bc.ca/Forestry%20Supplies/increment_borer.htm)

Important note: If you use the increment borer, you need to make, beforehand, a small grooved piece of wood to hold the core sample so that you can sand it down to examine the rings.



core sample holder

The following resources were drawn upon for the development of this lesson plan:

“Creating a Climate for Change Teacher Resource, 2001,” developed by individuals from Alberta Environment, Southern Alberta Environmental Group, USC Canada, Helen Schuler Coulee Centre, and the University of Lethbridge.

“Dendrochronology: Investigating the Recent Past,” by Chris Marion; February 1998

Photographs of the process of taking a core sample, and the core sample holder compliments of:

Brian C. McCarthy,  
Dept. Env. & Plant Biology, Ohio University  
Athens, Ohio, USA

<http://www.plantbio.ohiou.edu/epb/instruct/ecology/dendro.htm>



### Activity:

Before you move on to the steps of the activity, review the climate change information referenced above and introduce students to an overview of dendrochronology. Encourage students to speculate about what they might be able to learn about climate change from tree rings.

Steps 1–8 are for acquiring core samples with an increment borer. If you are using tree cross sections for this lesson, skip ahead and start at step 9.

1. Prepare the pieces of grooved wood to hold the cores before going out to get them (see picture of core sample holder, above).
2. If you have an assistant to stay with the rest of the class, take your students out into the schoolyard area four at a time to use the increment borer to get a core sample. Otherwise, you could get them involved in an outdoor activity while you take them aside a few at a time. Select a tree that you wish to get a core sample from. Identify the species. If you are working in a forested area or park-like setting, consider keeping students busy with a nature scavenger hunt or identifying tree species.



The increment borer: handle, bit, and extractor

3. Place the end (bit) of the increment borer against the bark of the trunk about 50 cm up from the ground. Hold the bit just behind the threads and apply as much body pressure as possible. Slowly turn the handle until the threads are fully engaged. You want to core on a slight up angle so that, later, water and fluids will drain out, not into the tree. This reduces the negative effect of coring on the tree. Note: Plugging the tree is not recommended.
4. Once the threads are engaged, step back and turn the handle clockwise. When you've reached the right depth, if the extractor is not already inserted in the increment bit, back the bit out one full turn, and then insert the extractor into the hollow shaft. Note: place a slight up-pressure on the back of the extractor to ensure the leading tip stays under your sample. Insert the extractor to its full length (depending upon the species, this may require that you apply some pressure with the heel of your hand). Do not drive the extractor in with a hammer or other implement. If the extractor is inserted, pull back on the handle and pull out the shaft of the borer.



5. Place the core sample into a straw to transport it back to the class in one piece. Note: It's important to only take one or two cores from any one tree.
6. On returning to the room, glue the core into a piece of grooved wood.
7. Sand the core down with a palm sander (can also be done by hand using a piece of sandpaper) to make a flat surface so that it is easier to see the rings.
8. Count the number of rings, beginning at the outside of the core sample; use a magnifying glass or dissecting microscope for easier recognition of the tree rings.

Note: Some students may have difficulty counting the rings and if there is a rotten section, their core sample may fall apart when it is taken out of the borer. Careful cross dating of the samples collected this way is necessary as very narrow rings or incomplete rings may be missed since the cores represent only a small portion of the trees' cross-section.



9. Use a pencil mark to mark every 10th year (decade).
10. Calculate the age of your tree.
11. Using the [Student Handout: Dendrochronolog Sheet](#) (see Handouts), start counting at the outer most ring. This ring represents the harvest year of the tree if your students are working with a cross section and the present year if they are working with a core. If the ring is narrow, draw a long line on the sheet, and if the ring is wide draw a short line on the sheet. These longer lines represent the poorest growth years.
12. Students can check each other's core samples.
13. Once all the samples have been checked and the information recorded on the sheets, compare the results with the entire class.
14. Make two bar graphs: one graph showing the number of trees cored (on the y axis) and the decade they were planted (on the x axis), and the other graph showing the number of trees cored (on the y axis) and the years of poor growth (on the x axis). Check out the web page for the author's class to see their graphs and pictures of the students at work in the field and the classroom: [http://www.yesnet.yk.ca/schools/jackhulland/classes/colberg/climate\\_change/trees/dendro.html](http://www.yesnet.yk.ca/schools/jackhulland/classes/colberg/climate_change/trees/dendro.html)
15. Correlate the students' findings with climate records from your local weather office (they can tell you what the weather was like in certain years), or with information from the following web site that will give both daily and average records: [http://www.climate.weatheroffice.ec.gc.ca/Welcome\\_e.html](http://www.climate.weatheroffice.ec.gc.ca/Welcome_e.html)

Find out from your local fire office, or possibly from the Internet, when fires came through in your region – were they in the years of poor growth? Have students ask their parents what they remember about unusually dry winters with little snow or very wet summers. Correlate this oral history information with student findings. Follow up these exercises with a discussion about the class' findings.



### Handouts:

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

[Teacher Handout: Dendrochronology: Investigating the Recent Past](#)

[Student Handout: Dendrochronolog Sheet](#)



### Student Web-Exchange

Students can post their findings on the [student exchange](#) portion of the web site and encourage other schools to try the activity and then compare their findings (the age of the trees at their school, what they learned about the history of the area (climate, fires, etc). Click on the icon for information on how to post material.



## Evaluation:

Evaluation will vary depending on the objectives of the learning outcomes. Student tasks for evaluation may include:

1. Have students show you their core sample and explain how they have determined the age of the tree it came from. (You should see the pencil marks to show each decade counted. By counting their marks, they can calculate the age of the tree to the nearest decade.)
2. Have students identify a ring of poor growth and explain why it is from a year of poor growth. (Narrow rings indicate years of poor growth.)
3. Have students suggest possible reasons for this year of poor growth. (Dry and cold summers, late cold falls, and fires can be possible reasons for poor growth rings – see attached “Dendrochronology: Investigating the Recent Past.”)



## More Information:

<http://www.sonic.net/bristlecone/dendro.html>



## Enrichment Ideas:

### English Language Arts:

**Tree-ography:** Have students write a story about their tree, either imagining that they experienced change with it, or telling about changes from the tree’s perspective. Changes that have affected the tree could include climate (wet, dry, warm, cold), the building of the new school, the tree’s arrival from a nursery, the student’s involvement or connection with the tree, fires, or other events apparent from the sample. Students could also write about how they think climate change may have affected their tree.

### Science:

**Investigate:** Students can discover other ways that scientists learn about past climates and monitor today’s changing climate by visiting the following website designed for kids, grade 4–9:

<http://www.epa.gov/globalwarming/kids/detectives.html>

Teachers can also refer to High School Backgrounder #5: [How do we know?](#) for information about ice cores, sediment samples, and so on.

## About the Author:



My name is Nancy Colberg, and I teach grade 4 at Jack Hulland Elementary School in Whitehorse, Yukon. I have a wonderful class of 27 active students, who are very much interested in doing experiments, writing and performing plays, and working on our class website.

Whitehorse is a city of about 30 000, fluctuating up and down according to the economic situation of the day. It’s a beautiful community, with lots of nature right outside our backdoors. In winter you can cross country ski and snowshoe while in summer biking and hiking are popular.

I received a BSc in chemistry and biology from the University of Alberta way back in 1970, went overseas to work with CUSO in Sarawak, East Malaysia, for two and a half years, obtained a teacher’s certificate from U of Manitoba in 1974 and then taught in Snow Lake, Manitoba, a northern mining community, for three years. I needed a change from teaching, so I moved up to the Yukon in 1977 where I lived in the small village of Teslin, with its population of 500 people. I returned to teaching there in 1987, and moved into Whitehorse in 1991 where I began teaching at Jack Hulland School.

Many people who have lived in the Yukon their entire lives or since the 40’s and 50’s have stories to tell about the cold

winters here: How in the 50's it would get to  $-50^{\circ}\text{C}$  and  $-60^{\circ}\text{C}$ , and you could push your car to one side with your finger because the road was so slick with the cold, or how people would have to thaw their car engines by directing heat from a fire through a stove pipe shoved under the car. Even since the 70's it doesn't seem to be as cold in the winter. Then we often had two or three weeks of  $-40^{\circ}\text{C}$  temperatures. Now that seems rare.

I am very much interested in learning, along with my students, how we in our northern communities can make a positive difference with regard to climate change.



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**Basics of Climate Change**  
**High School Backgrounder 5**

[Printable Version](#)

# How Do We Know?

Have you noticed that information on climate change sometimes talks about what the climate used to be like 1,000 years ago or even 100,000 years ago!? For example:

- People say that about 125,000 years ago, temperatures were even warmer than they are today, by about 2°C.
- We are told that since the last ice age – about 10,000 years ago – our temperatures have been pretty stable. However, during the past 100 years things have started warming up rapidly.
- There is far more carbon dioxide in the atmosphere now than at any time in the last 400,000 years.

How the heck do they know this stuff!?

This backgrounder looks at how people figure out what past climates were like. It also provides an overview of how we are monitoring today's changing climate.

## Looking Back



Information on temperatures from around the world is available starting in the 1860s. This temperature information gives us a pretty accurate picture of what has been happening for the last 140 years. For example, over the last 100 years, temperature data show clearly that temperatures around the world have increased an average of 0.6° Celsius.

If there weren't any thermometers thousands of years ago, how can today's scientists claim to know what the climate was like back then? Where do they get their information from?

Believe it or not, people who study past climates (paleoclimatologists) do this by looking at things like ice, trees, and muck from lake or ocean bottoms.

## Icy information

Imagine looking at a chunk of ice from a glacier and being able to figure out what the weather was like since the time the glacier was first formed! That is exactly what many researchers are doing around the world.

Hundreds or even thousands of years of snowfalls form glaciers. Each year, the



snow lands and gets compacted by weather and more snow. Eventually, it becomes ice. The closer to the bottom of the glacier you go, the older the ice will be.

Scientists have figured out how to drill into these glaciers and extract long cylinders of ice that are called cores. In Greenland, they can get core samples that contain 100,000 years of information. In Antarctica, the cores contain 400,000 years of data!

When the scientists look at these cores, they can see layers in the ice. There are a number of things that scientists look for in the layers of ice to get a picture of what our ancient climates were like. These include:

- **Chemical isotopes:** All chemical elements, like oxygen and carbon, are made up of atoms. An isotope is a form of an atom (different isotopes have a different number of neutrons). Scientists look at the isotopes of hydrogen, oxygen and other chemical elements in the ice to help them figure out what the temperatures would have been like at when the layers were being formed.
- **Volcanic ash:** Humans in the northern hemisphere have kept records of volcanic eruptions for the last 1,000 to 2,000 years. So today's scientists look for fine layers of ash in the ice that would have fallen on the glacier during eruptions. This allows them to estimate how old the ice is at that point in the core. They also compare the temperature information (collected by looking at the isotopes) with the volcanic eruptions to figure out the impact of volcanoes on the temperature.
- **Salt:** Scientists might also look for traces of salt in glaciers near oceans. Winter storms over the oceans kick up lots of salt spray that settles on the glaciers. So scientists can sometimes separate one year of winter storms from another because there is less salty layer of summer ice in between.
- **Carbon dioxide, methane and nitrous oxide:** Ice cores also help us figure out how amounts of key greenhouse gases changed in the atmosphere over the period of time covered by the core. Researchers do this by analyzing the tiny air bubbles that get trapped in the glacier as it forms. These bubbles contain carbon dioxide, methane and nitrous oxide.
- **Dust:** Scientists can also see where there were high levels of dust in the ice. This tells them that the climate at that point in time was dry enough to cause dust to get into the atmosphere.

So you might want to think about how much stuff can be found in glacier ice next time you have the chance to take a drink from a glacier fed stream!

## Tree tales

Have you looked at a stump or piece of wood and seen small circular lines? Each line represents one year of growth. In years when trees have enough moisture and good temperatures, they usually grow faster. The rings for these years would be thicker than rings for colder, drier years. In the north, rings are usually very close together because the trees grow very slowly.

With a small tool – a hollow drill – scientists can take a core out of a tree so they can look at the rings. By measuring the size of the rings, they can learn a lot about changes in climate, year by year, since the tree first started growing. Some of the trees being analyzed are hundreds, or even thousands, of years old!

## Messing in the Muck

Some scientists are also figuring out what past climates were like by taking core samples from the mud at the bottoms of lakes, rivers or oceans. Like the snow on glaciers, sediment settles in the bottom of water bodies every year. The layers of muck can help tell the story of past climates.

For example, researchers look at the plant pollen that was trapped in the different layers. This tells them what plants were in the area when the layers of muck were formed (as some of the plant's pollen would have blown onto the water and settled to the bottom). The scientists can then get a good picture of what the climate must have been like if that type of plant was able to survive.

People also look at the fossils of insects, plants and animals that they find in the muck. Carbon dating techniques



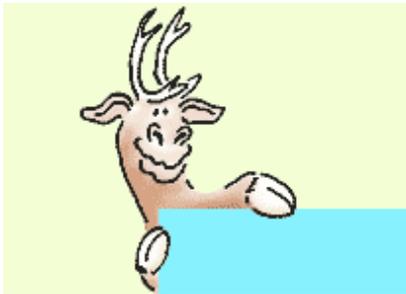
can be used to sort out how old these things are. Knowing what types of insects, plants and animals were around at a certain time helps the researchers understand what the climate would have been like when the fossil started forming.

## Indigenous information

Indigenous people in the North have passed down information on the land and climate from generation to generation. Elders today are sharing their knowledge about the changes they have seen on the land in their lifetime.

But their own observations are enriched by the knowledge they have been given by their elders. This past knowledge includes information about historical changes in wildlife movements, vegetation, conditions on the land and the climate.

These observations and stories from many generations of northern aboriginal people provide a valuable understanding of the relationship between changes in the climate and changes to the land, water, wildlife, vegetation, and people of the north.



## Melting ice reveals some surprises!

In the Southwest Yukon, warming temperatures have uncovered quite the pile of...ummm...caribou droppings.

Old patches of ice in some of the Yukon's alpine areas have been melting rapidly as climate change causes temperatures to warm up in the north. As the ice patches disappear, large areas of caribou dung are being revealed. In some areas, the poop has been up to 30 centimetres thick! And some of it is estimated to be over 8,000 years old!

The melting ice has uncovered important information about the history of both the caribou and First Nation people in the southern Yukon. For example, by looking at the dung, scientists can tell that the caribou mostly ate sedges and lichens thousands of years ago. People studying the ice patches have also found many hunting tools that have been well preserved under the ice. One dart fragment has been estimated to be about 6900 years old.

First Nations and scientists are working together to gather artefacts uncovered by the melting ice.

Everyone is learning more about the rich history of the area.

## Measuring The Here And Now



The understanding and awareness of historical climate change is steadily growing as people around the world gather information from glacier ice, trees, lake bottoms and oral traditions.

There is also a lot of research going on to help us



understand what is happening right now – and how it is affecting our environment and our communities.

Some of this research on the “here and now” involves many countries and hundreds of scientists and researchers. These studies are looking at the global picture of climate change. Other projects are being carried out at the community level and involve local people.

When the white people first came here, the native people said “how” and the white people said “why”. I spent 90% of my time growing up with my grandparents. They taught me about a lot of stuff. I notice in the traditional world, it’s all based on how am I’m going to do this. They never asked why...

Science is always asking why... Science wants to know why it works.

A good thing today is that people have to come together. We have to know why and how. We have to double understand.

Randall Tetlich, Old Crow, Yukon

*Quoted in “Observations on Traditional, Local and Scientific Knowledge: Notes on a discussion from the 7th Annual Gathering of the Arctic Borderlands Ecological Knowledge Co-op”, February, 2002.*

## The international scene

### The Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was set up by the United Nations in 1988 to review the stacks of scientific, technical and socio-economic information that are being gathered on climate change. The IPCC:

- looks at the evidence others are collecting on how the climate is changing;
- tries to figure out what the risks and impacts of climate change are; and
- works to identify ways to slow climate change and ways we can adapt to the impacts of climate change.

As over 2500 scientists from 80 countries have participated in the IPCC, it is an important voice on what is happening globally. Much of the information you read about the current impacts of climate change and many of the predictions for the future are based on reports from the IPCC.

### Arctic Climate Impact Assessment

The Arctic Climate Impact Assessment project (ACIA) was set up in 2000 by the Arctic Council and the International Arctic Science Committee (IASC). The Arctic Council has eight Arctic countries (including Canada) as members and six indigenous organizations from the Arctic region as permanent participants. The IASC is a non-governmental organization that facilitates cooperation on all aspects of arctic research.

The goal of the Arctic Climate Impact Assessment project is to integrate and evaluate knowledge that is being collected about changes in the climate and increased ultraviolet radiation in Arctic regions. The project will examine possible future impacts on the environment, plants, wildlife, and human health. It will also look at the impacts to buildings, roads and other infrastructure. The aim is to provide useful and reliable information to the governments, communities, organizations and peoples of the Arctic to help them deal with the predicted impacts. The reports out of this project are expected in the fall of 2004.



The Arctic Climate Impact Assessment (ACIA) will include the changes observed by different arctic indigenous peoples. ACIA will also look at indigenous perceptions of climate impacts, such as the effects on their way of life, land and water use, diet, and social and cultural activities.

## The local scene

Many of the studies that the IPCC reviews focus on specific pieces of the climate change puzzle. Some might look at ocean temperatures in one region, while others could study melting glaciers somewhere else. They all provide important information on specific issues that IPCC then tries to pull together into one picture.



Community-based studies tend to provide a bigger, more connected part of the puzzle right from the start. Community-based studies collect local observations and knowledge. These studies often look at how climate change is affecting more than one piece of the puzzle. They look at how climate change is impacting the northern environment, people, communities and economies.

Community-based observations also help scientists and other researchers focus in on what needs more detailed study.

Many projects in northern Canada have gathered local information and knowledge. Here is a list of projects and related communities that have provided valuable information on the reality of climate change:

- *Arctic Borderlands Ecological Knowledge Co-op* (Old Crow, Yukon; Aklavik and Fort MacPherson, NWT; Arctic Village and Kaktovik, Alaska)
- *Mackenzie Basin Impact Study* (communities in Yukon, NWT, BC, Alberta and Saskatchewan)
- *Inuit Observations on Climate Change* (Sachs Harbour, NWT)
- *Tuktu and Nogak Project* (Nunavut communities of Ikaluktuuttiak, Kingauk, Kugluktuk, and Umingmaktuuk)
- *Arctic Climate Change: Inuit Observations of Climate Change in the Eastern Canadian Arctic* (Iqaluit, Igloodik, Kangiqtuqaapik, Qamani'tuaq - all in Nunavut)
- *Voices from the Bay* (Sanikiluaq, Nunavut)

Time and time again, people involved in all of these projects are reporting things like:

- earlier spring melting and break-ups
- later freezing in the fall
- melting permafrost
- changes in wildlife behaviour and migration routes
- new species of fish and birds in their area
- deeper or icier snow, and
- tougher conditions for travelling on the land and water.

Northern people have always watched the weather closely. The weather determines when the geese and caribou will migrate, when it is safe to go out in boats, when the rivers will freeze up, and when planes will be able to fly between communities.

People on the land rely on generations of observations about the weather and land to identify and understand the connections between changes to the climate and changes to wildlife migrations or hunting opportunities.



For example, northern people have pointed out how warmer spring temperatures are causing earlier break-up of river ice. They have seen how this makes it more difficult for caribou to survive river crossings. Such dangers for the caribou can cause the caribou to change their migration route. This in turn affects the peoples' hunting opportunities. If the caribou travel too far from the communities, it may mean there will be less healthy caribou meat to eat. It is all connected.

As more and more northerners tell similar stories of climate change, they highlight the connections between the changes and the impacts. The climate change puzzle is becoming easier to see. This information is helping to influence

governments and international organizations that are debating and discussing what to do about climate change.

It is springtime that has changed really much. Fall is not the same every year – some early, some late, but fairly close. But spring is different. Much different from year to year.

*Peter Esau, Sachs Harbour, NWT*

Long ago [it] used to be [a] long spring. Used to stay out there [at his hunting camp] for months. In the springtime... we do fishing first. After that, hunt geese, then go fishing again after that. Now we don't even go fishing after geese hunting because it melts too fast.

*Geddes Wolki, Sachs Harbour, NWT*

*Reported in: Nichols, T., F. Berkes, D. Jolly, N.B. Snow and the Community of Sachs Harbour. Climate Change and Sea Ice: Local Observations from the Canadian Western Arctic. Arctic, 2003 (In Press)*

## Mapping the plants

Across the north, there are also a number of people working on scientific research projects to collect information on the impacts of climate change. People are monitoring things like changes to plant growth and species or changes in the amount of rain and snowfall.

Some of these research studies are part of the International Tundra Experiment (ITEX). There are ITEX project sites set up across the Canadian north.

Some of these ITEX projects look at plants in a very small area called a plot (each plot is one square metre in size). The locations of the plots are marked permanently so that researchers can find them every few years. Researchers place a wire grid over the plot to help them map where certain plant species are growing and how big the plants are. By doing this every few years, they can see what kind of changes are happening.

At some ITEX sites, researchers have set up a second plot that they cover with a transparent material. This raises the temperature in the plot by about 1° to 3°C during the growing season. This is like faking climate change – it allows researchers to get a better idea of how the plants will be affected by climate change.

All of these efforts – at the international, national, regional and community levels – are helping to build our understanding of climate change and how it is impacting people and the environment. Together, the scientific research and the community-based studies provide different but critical pieces of the climate change puzzle.



## Key Points

- ★ World wide, temperatures have only systematically been measured and recorded since 1860.
- ★ Scientists use information from glacier ice, tree rings, and the sediment at the bottom of water bodies to understand what climates were like thousands of years ago.
- ★ Indigenous knowledge is another valuable source of information about what climates have been like over multiple generations. Indigenous knowledge also helps us to understand how changes in the climate have affected plants, the land, wildlife and people.
- ★ The Intergovernmental Panel on Climate Change (IPCC) involves over 2500 scientists from 80 countries in its work. It is the main source of information on global climate change.
- ★ Many local projects in the north are helping to gather information on climate change and its impacts on the environment and people.



### Want to Know More?

These websites will tell you more about how scientists measure climate change:

- **Arctic Climate Impact Assessment:** <http://www.acia.uaf.edu/> – Learn more about this Arctic project that measures climate change and its impacts.
- **Arctic Borderlands Ecological Knowledge Co-op:** [http://taiga.net/coop/reference/indicator\\_assessments/rptperm.html](http://taiga.net/coop/reference/indicator_assessments/rptperm.html) – This page tells about methods of monitoring permafrost and soil temperatures to measure climate change.
- **International Institute for Sustainable Development:** <http://iisd.iisd.ca/climate/arctic/#one> – Outlines a number of ways this IISD is working with Arctic communities to gather information. Click on the three 'Current Projects' at the bottom of the page.
- **International Tundra Experiment (ITEX):** <http://www.itex-science.net/default.cfm> – Find out more about this network of experiments.
- **Northern Climate Exchange Knowledge Site (Matrix Maker) :** <http://yukon.taiga.net/matrix/index.html> – Use this amazing matrix to learn what scientists know about different aspects of climate change in the north.
- **Waiscores Project:** <http://waiscores.dri.edu/index.html> – Gives information about an ice core project in West Antarctica. Go to 'Background Information' to find out what ice cores tell us about climate change.



# Global Change – Time and Cycles

## Logs of Straws: – Dendrochronology

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### Background



Trees are some of nature's most accurate timekeepers. Their growth layers, appearing as rings in the cross section of the tree trunk, record evidence of floods, droughts, insect attacks, lightning strikes, and even earthquakes.

Tree growth depends on local conditions, which include the availability of water. Because the water cycle, or hydrologic cycle, is uneven, that is, the amount of water in the environment varies from year to year, scientists use tree-ring patterns to reconstruct regional patterns of drought and climatic change. This field of study, known as dendrochronology, was begun in the early 1900's by an American astronomer named Andrew Ellicott Douglass.

While working at an observatory in his native Arizona, Douglass began to collect pine trunk cross sections to study their annual growth rings. He thought there might be a connection between sunspot activity and drought. Such a connection could be established, he believed, through natural records of vegetation growth.

Douglass was not the first to notice that some growth rings in trees are thicker than others. In the climate where Douglass was working, the varying widths clearly resulted from varying amounts of rainfall. In drier growing seasons narrow rings were formed, and in growing seasons in which water was more plentiful, wide rings occurred.

In addition to correlating the narrow rings to periods of drought and, in turn, to sunspot records, Douglass had to establish the actual year each tree ring represented. Because absolute ages can be determined through dendrochronology, the science has since proven useful far beyond the narrow study to which Douglass applied it.

Computer analysis and other methods developed since Douglass' time have allowed scientists to better understand certain large-scale climatic changes that have occurred in past centuries. Likewise, highly localized analyses are possible. Archaeologists use tree rings to date timber from log cabins and Native

American pueblos by matching the rings from the cut timbers of homes to rings in very old trees nearby. Matching these patterns can show the year when a tree was cut and, thus, reveal the age of a dwelling.



To determine whether changes now occurring in climate are part of the Earth's normal pattern or are induced by human activity, scientists rely on the history of climatic changes both locally and globally as revealed by tree rings, ice cores, pollen samples, and the fossil record. Computers are used to detect possible patterns and cycles from these many sources. In dendrochronology, large data bases allow scientists to compare the ring records of many trees and to construct maps of former regional climates. The evidence collected so far suggests that climatic change is simply a part of life on Earth. The extent to which human activity affects the way the global climate is changing now is not yet fully

understood.

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## Activity (Allow 45-60 minutes)

In this activity straws will be used to simulate tree-ring core samples. Using the straws, students will work in groups to reconstruct a 50 year climatic history. Students will record this chronology on a 3 meter time line designed to highlight significant social, personal, and scientific events covering the same period.

Dendrochronologists seldom cut down a tree to analyze its rings. Instead, core samples are extracted using a borer that is screwed into the tree and pulled out, bringing with it a straw size sample of wood about 4 millimeters in diameter. The hole in the tree is then sealed to prevent disease.

## Materials

For each group of four students:

- One set of white straws marked with ring patterns (see illustration below). Markings can be produced with permanent black marker on paper or plastic straws.
- One 3-meter strip of adding machine tape for each group
- Colored pencils for each group
- Colored markers for each group
- A notebook for recording results (optional)
- Reference material such as almanacs that provide students with the dates of social and scientific events over the last 4 decades.

events over the last 4 decades.

Prior to the activity the teacher should construct sets of straws similar to the set shown in the illustrations.

Group students in teams of four. The following information on the straw samples can be recorded on the blackboard or copied and handed out. Review with the students some of the tips on reading tree rings described below.

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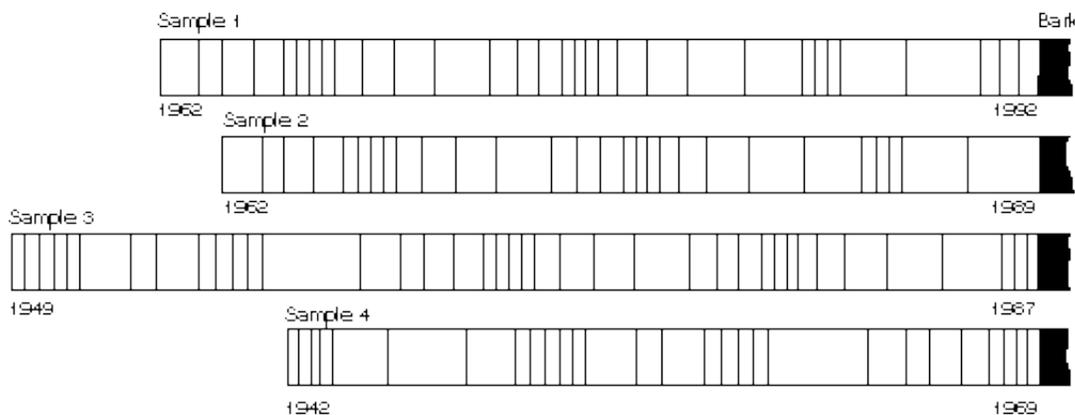
## Reading Tree Rings

Core sample 1 is to be used as a standard against which to compare the others, because a bore date of 1992 has been established. Notice the varying patterns of ring widths in sample 1; look for similar patterns in other samples.

Core sample patterns are alternating dark and light lines. The darker lines of a core sample represent the end of a growing season. The light-toned space between the two darker lines represents one growing season.

Tree rings are formed from the center of the tree outward. The ring closest to the bark is the youngest and final growth ring. The ring closest to the center of the tree is the oldest growth ring. Neither the outer layer of bark nor the central pith layer of a sample is counted when determining the age of a sample.

Similar ring patterns are found between trees growing under the same conditions. The most obvious feature of these patterns is varying widths. Widening of a ring indicates good growing conditions, while narrowing indicates poor ones. Conditions can include climatic factors such as temperature and moisture as well as factors such as erosion, fire, landslides, etc.



## Procedure

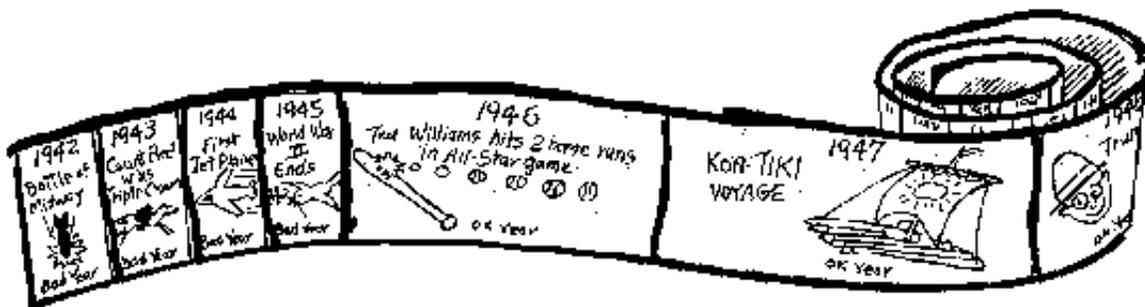
Imagine you have core samples from four trees:

- Sample 1. From a living tree, July 1992, Pinetown Forest.
- Sample 2. From a tree from the Pinetown Christmas Tree Farm.

- Sample 3. From a log found near the main trail in Pinetown Forest.
- Sample 4. From a barn beam removed from Pinetown Hollow.
- Determine the age of each tree (how many years it had been growing) by counting the rings. Record your answers in your notebook or in the first column on the chart below:

	Age of tree	Year tree was cut	Year growth began
Sample 1			
Sample 2			
Sample 3			
Sample 4			

- Look for patterns in the rings. Patterns in this exercise match well, but actual ring patterns will vary among different species of trees. Once a ring pattern has been discovered, line up all the samples. Because you know that Sample 1 was cut in 1992, you can match the patterns of all the other samples and determine when all the other trees were cut or cored and also when they began to grow. Record this information in your notebook or fill in the chart above.
- Make a time line. Spread out the adding machine tape. Beginning at the left end of the tape, record each year from the earliest year identified on the tree-ring samples through 1992. After the years are recorded on the strip, identify years that were good growing years for the trees in Pinetown, and years that were poor. Think of other events that might have happened during this time period such as your birthday, Presidential elections, important scientific discoveries, or record-setting sports achievements. Fill them in on the time line. You can color the time line and illustrate it with drawings, photographs, or newspaper clippings.



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## Questions

- Which ring on each tree represents your birth year?
- What kind of growing season existed that year in Pinetown?

- In which years did droughts occur in Pinetown?
- Is there a pattern to the droughts?
- What buildings in your areas were built during the lifetime of these trees?

## Extensions

Measure the tree rings in the photograph on the back of the poster. Assume the tree was cut in 1992. How old is the tree? Can you determine good and bad years for growth?

Find and map the locations of some of the oldest known trees in your neighborhood. Sketch what you think a core from one of these trees might look like.

Contact your local forestry service or science museum and obtain some actual cross sections of trees that have been cut in your area. Use the techniques applied during this activity to "read the tree." If a tree has been cut in your neighborhood recently, look at the tree rings on the stump or ask if you can keep a small piece of the trunk.

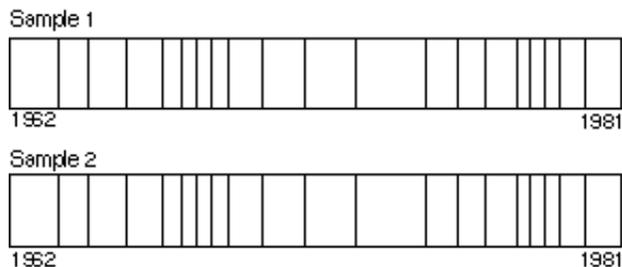
Create some simulated core straws of your own for another group to analyze and report about.

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## For the Teacher

### Aligning the Samples in the Lesson

The following illustration shows how samples 1 and 2 can be aligned. Have the students align all four samples so that the patterns match, and determine the years when each tree was cut and when it began to grow. Have them count all the rings from the oldest samples as they are aligned with the younger samples to determine the total amount of time represented by the rings. Count aligned rings that appear on several samples only once.



## Charts

The charts should be completed as follows:

	Age of tree	Year tree was cut	Year growth began
1	31	1992	1962
2	28	1989	1962
3	39	1987	1949
4	28	1987	1942

The total time covered by the tree rings is 50 years, from 1942 to 1992.

## Answers to Questions

The answers to some of the questions in the activities will depend on the individual class—for example, when they were born or when buildings in their area were built. In looking at the climate record as revealed in the tree rings, notice that there is a significant period of poor growing conditions in each of the four decades covered by the tree samples. This pattern, which can be graphed, is the type of pattern scientists might look for when studying climate change.

## Classroom Resources

Angier, Natalie, Warming?—Tree rings say not yet: New York Times, Tuesday, December 1, 1992, p. C-1, C-4.

U.S. Geological Survey, 1991, Tree rings—timekeepers of the past: Reston, Virginia, USGS, 15 p.

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