A TEACHING KIT

Canada's Forests

A Breath of Fresh Air

Volume Two: Climate Change

Welcome to Canada's Forests Teaching Kit, published by the Canadian Forestry Association (CFA).

The CFA is dedicated to the wise use and conservation of Canada's forest resources through enhanced public awareness and education programs. The CFA Teaching Kit Series provides educators with the tools required to help our children understand the value of forests and the importance of protecting and conserving them.

Healthy forest ecosystems depend on a complex relationship of soils, water, plant communities, wildlife and climate. We offer Canadians an opportunity to learn more about forest ecosystems and the important role they play in the economic and environmental health of our country and the planet.

For more information on the CFA see the list of our programs on page 40 of this teaching kit, or visit our Internet website: www.canadianforestry.com

You Can Help

The CFA is a non-profit organization with over 100 years of history, and a rich legacy of bringing information about forest ecosystems to Canadians. We achieve our goals through partnerships with government and industry, and with the help of individuals and organizations who contribute voluntarily to our various projects.

As an individual citizen, educator, community organization, small business or major corporation, you can help by making a financial contribution to the CFA Forest Education Program. Contact us at:

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since 1900

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Contents

Canada's Forests — A Breath of Fresh Air deals with the serious global issue of climate change and presents the positive role that our trees and forests can play in our world.

Like many other science-based topics, climate change requires careful handling. What we know today will be altered dramatically by new discoveries tomorrow. And, because of the issues this topic brings up, students need time for discussion.

Having said this, we have tried to infuse this teaching kit with positive actions the students can take to make a difference. We have also provided links to many of the organizations working for positive change.

Using this Teaching Kit

Curriculum Links

The activities are designed to integrate into school curriculum and to meet the needs of educators. Given the national scope of this teaching kit, we have specified only broad grade level and subject area categories. Each activity outlines specific learning outcomes (in objective format) for your students and provides information to help with teacher preparation.

The materials in this book are drawn from many sources involved in forest-based education. They have been developed and tested by educators in different regions across Canada.

Instruction Key

In an effort to make this document user-friendly for both educators and students, we have developed a series of icons to highlight specific types of information:

The pencil icon indicates student activity instructions within the body text. This icon also flags the student activity sheets, which have been designed for photocopying and distribution to students.

The light bulb icon indicates supplementary teaching ideas or hints, options, and instructions on how to enhance the student activity.

The magnifying glass icon indicates options for investigating different aspects of an issue.

While the Canadian Forestry Association grants permission for the photocopying of this entire publication, the pages marked with the photocopier icon are designed specifically as student worksheets.

Glossary: For reference purposes we have provided a glossary of many of the terms used in the text (see page 39).

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Climate Basics

To begin to understand climate change we need to understand some basics, for example the difference between climate and weather.

Weather is the day-to-day change of temperature, snowfall and rainfall, winds and clouds that take place in a particular location. Weather is easily observed and measured by thermometers, rain gauges, barometers, and other instruments.

Climate is the average weather that occurs in a given place over a long period of time. The study of climate requires the analysis of daily, monthly and yearly weather patterns over decades, centuries or even longer.

The Earth's natural climate is in a state of constant change. The tropical climate we commonly associate with dinosaurs, and the recurring pattern of Ice Ages, are dramatic examples of these changes. Climate is influenced by slow changes in the oceans, the land, the energy output of the sun, and the Earth's atmosphere. Major events such as the eruption of a volcano can influence our climate very quickly.

Our Atmosphere

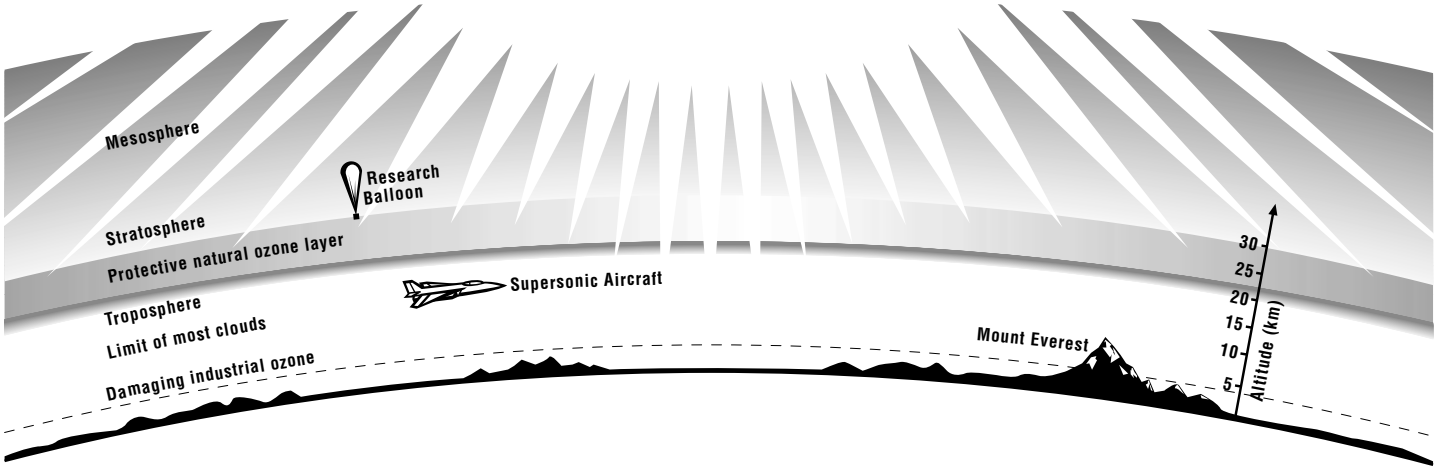
The Earth's atmosphere is a 100-km-deep layer of gases around the planet, held in place by gravity. It is made up of nitrogen (78%), oxygen (21%), argon (0.9%), carbon dioxide (0.03%) and varying amounts of water vapour, hydrogen, ozone, methane, carbon monoxide, helium, krypton and xenon.

Greenhouse Gases and the Greenhouse Effect

Various gases within the atmosphere play a role in insulating and warming the Earth's surface. This process is often referred to as the **greenhouse effect**. In our atmosphere, water vapour, carbon dioxide, methane and nitrous oxide, are referred to as greenhouse gases because they trap the heat of the sun. Without them, the average temperature on Earth would be -18 C instead of the current 15 C. Greenhouse gases regulate the temperature of the Earth and make it capable of sustaining life. Without these gases, Earth would be a frozen planet, and life as we know it would not exist.

Ozone

Ozone is another gas which plays a vital role in the health of the planet because it absorbs ultraviolet (UV) radiation, shielding the surface of the Earth. The **ozone layer** is approximately 10 km deep, located 20 to 30 km above the Earth's surface. Without the protection the ozone layer provides, most, if not all, life on Earth would be destroyed by the UV radiation from the sun.



What is Climate Change and What Causes It?

Climate change refers to an overall change in weather patterns, such as temperature, precipitation and wind. Some of the terms we hear — global warming, the greenhouse effect, ozone depletion, and thinning ozone layer — are references to aspects of climate change or environmental processes that may influence climate.

The problem today is that the climate appears to be changing dramatically, very quickly and on a large scale. While there are many unanswered questions, and a great deal of research to carry out, scientists generally believe that these changes are not part of the natural variation in climate and that there are reasons for concern.

The tropical climate we commonly associate with dinosaurs and the Ice Age home of the woolly mammoth are just two examples of natural climate change that take place over thousands or millions of years. Did you know?

- The 20th century was the warmest in the past 1,200 years.
- The 1980s and 1990s are the warmest decades on record.
- The first 10 months of 2000 were the warmest on record for that period since records first started being kept in 1895.

Global Warming

The problem with global warming is that it is linked to changes in the quantity of greenhouse gases in our atmosphere, caused by human activity. Over the past 10,000 years these gases have remained relatively stable but since the Industrial Revolution began in the late 1700s, we have seen dramatic increases in:

- carbon dioxide: 30 per cent
- methane: 145 per cent
- nitrous oxide: 15 per cent

These greenhouse gases have increased through the burning of fossil fuels, such as wood, oil, gas and coal to meet ever-increasing demands for energy to heat our homes, run our vehicles and operate our factories and businesses.

We are also adding to greenhouse gases in the atmosphere through deforestation. By cutting down forests, we remove trees from the carbon-cycle process of taking up CO_2. And, we release the carbon stored in forest vegetation and soils.

As noted earlier, greenhouse gases help warm the Earth and make it livable. Although they make up only a small part of the atmosphere, these gases are very effective at absorbing heat. Even tiny increases in the level of greenhouse gases can affect the planet's temperature.

Scientific estimates suggest that by 2100 the Earth's average air surface temperature will be warmer by at least 1 C to 6 C. Northern countries, such as Canada, could see significantly greater warming, perhaps by as much as 4 C to 8 C.

So, what's wrong with global warming?

There are probably many icy cold days in the dead of a Canadian winter when you might think that global warming sounds like a good thing. But the research so far suggests that climate change will have many serious consequences, such as:

- droughts, winter storms and tornados
- increased flooding and erosion in coastal regions
- greater risk from pests, diseases and fires
- water quantity and quality
- affects on human health

The Thinning Ozone Layer

In the 1970s scientists discovered that when supposedly harmless substances called **chlorofluorocarbons** (CFCs) reached the **stratosphere** 20 to 30 years after they were released on Earth, they were broken down by the sun's ultraviolet radiation. This process released chlorine atoms that reacted with the ozone, changing it into other substances that were incapable of trapping incoming UV radiation. Since then, scientists have identified other chemicals that may have the same effect.

Known Problems with Ozone Loss

As the ozone layer thins, the amount of UV radiation reaching the Earth increases. UV radiation helps create ozone in our atmosphere but when it reaches Earth it can have serious effects. While only two of the three types of UV radiation (UVA and UVB) reach our planet's surface, they have many potential affects:

- **Human and Animal Health** — Sun exposure becomes increasingly dangerous resulting in severe sunburns, skin cancer in humans and animals, eye disorders such as cataracts and tumors of retina and cornea, and reduced resistance to disease in humans and possibly in animals.
- **Plants and Food Supply** — Tests on over 200 types of food plants show that more than 60 per cent are affected by increased UVB radiation. UVB slows down photosynthesis in food plants such as oats and wheat and is likely to kill the blue-green algae needed to convert nitrogen into a useable form for rice plants. Rice production could drop dramatically.
- **Ecological Balance of the Oceans** — UV radiation reduces the productivity of phytoplankton, one of the primary food sources of the ocean and this could have far-reaching effects on all ocean life.
- **Forests** — The extent of potential effects on forests is unknown but UVB is known to affect photosynthesis, the action of plant hormones and the chemistry within leaf cells.

Learn More About Climate Change

Visit the Environment Canada website <www.ec.gc.ca/climate> for detailed explanations of the science of climate change and the potential long-term impacts.

Protecting the Ozone Layer by William A. Andrews, PhD (DC Heath, 1994), provides in-depth background information, scientific explanations and student activities relating to the ozone layer.

A Concise History of Our Understanding of the Ozone Layer

1974: The first theory is introduced suggesting CFCs were damaging the ozone layer.

1978 to 1980: A consumer boycott results in a dramatic decrease in the sale of products containing CFCs. Canada, the United States and other countries ban CFCs in aerosol cans but not for other uses.

1985: A hole is discovered in the ozone layer over Antarctica. Subsequent analysis of historic satellite data indicates its existence as early as the mid-1970s.

1986: National Oceanic and Atmospheric Administration research looks for a link between CFCs and the hole in Antarctic ozone. Subsequent research by NASA and others confirms the CFC link.

1992: The Antarctic ozone hole is the size of North America. Ozone concentration drops to 40 per cent of the normal level.

1993: The Antarctic ozone reaches the lowest level ever. Seventy per cent of ozone over the South Pole is now depleted.

Canada's Forests and Climate Change

Canada is home to about 10 per cent of the world's forested lands. Almost half of our country, approximately 400 million hectares, is forested. Forests play a key, but not fully understood role, in maintaining the health of our planet and in global climate change.

Lungs of the Planet

Much has been said about the role the Earth's forests, and all plants, play in providing oxygen. Although oxygen makes up about one-fifth of our air supply, animals and plants would eventually exhaust this supply if it weren't for the oxygen produced as a by-product of photosynthesis of plants and trees.

But forests have many other roles that should not be overlooked, especially when dealing with climate change.

Carbon Storage

Related terms: carbon sinks, carbon sequestering.

Carbon plays a significant role in the formation of CO_2, one of the greenhouse gases.

The boreal (taiga) forests are found in much of Canada and northern Europe and Asia. These forests, and similar non-tropical forests in the southern hemisphere, make up only 21 percent of Earth's forested lands. But these forests play a critically important role in the carbon cycle because they hold 56 per cent of all the carbon stored in Earth's vegetation and soils.

Studies show that increasing CO_2 will affect the global climate. The largest changes are expected in the higher latitudes (45°N to 65°N) and the interior of continents. These impacts may include significant increases in summer and winter temperatures, leading to longer, warmer, drier summers and more droughts. These climate changes would likely affect the characteristics of the boreal forest including the types of trees that survive and their growth rates. But these forest ecosystems are complicated. Changes in the forest will lead to changes in the amount of carbon stored or given off by the forest, the operation of the nutrient cycle, and the temperature of the soil and air.

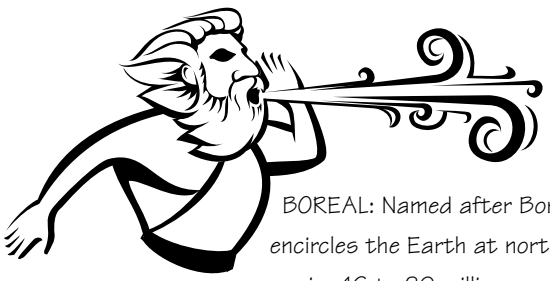
The Boreal Ecosystem-Atmosphere Study (BOREAS) is one of many research programs that has investigated the interrelationships among forests, global climate change and carbon storage (see page 10) in the mid-1990s. The Boreal Ecosystem Research and Monitoring Sites (BERMS) program is continuing the research started by BOREAS.

Impacts of Climate Change Posters

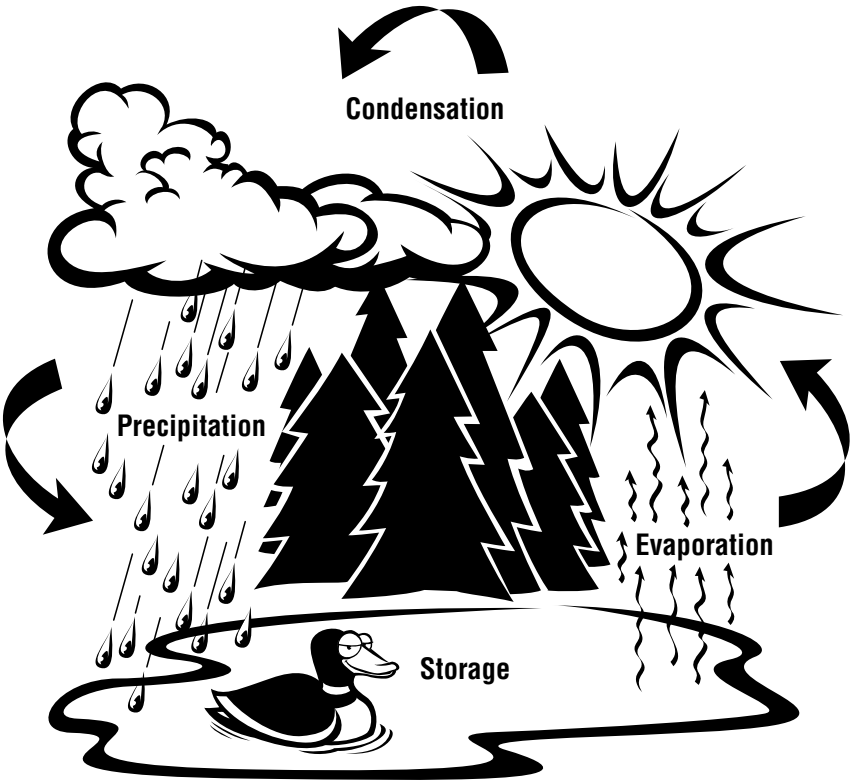
Natural Resources Canada has produced a series of seven posters on the regional impacts of climate change in Canada aimed at the high school level. Each 90cm x 150cm poster has a unique design and regional focus.
http://sts.gsc.nrcan.gc.ca/posters/

Climate Change Teaching Tool

Green Teacher has published a book called *Teaching About Climate Change, Cool Schools Tackle Global Warming*. This book helps tackle the complex topic of climate change through a variety of activities for the school, home and community.
www.greenteacher.com



BOREAL: Named after Boreas, the Greek god of the north wind, boreal refers to the mostly evergreen forest that encircles the Earth at northern latitudes between 43°N and 65°N. It occupies 16 to 20 million square kilometres.



Water Cycle

Without water all life on Earth would perish. It is important not to overlook the role that trees and forests play in maintaining our water supply. Within the water or hydrologic cycle, forests absorb water through their roots and release it into the air where it eventually condenses, falls as a rain or snow, and then enters our rivers, streams and groundwater. But trees also shade water and soils, reducing evaporation and allowing water to accumulate and nourish other plants and wildlife.

Soil Protection

Forests protect soils from drying and from being washed or blown away. Soil is essential to the growth of most plants. Without healthy soils, plants would not survive and would not make their valuable contributions to the atmosphere and the survival of the planet.

Forests Affect Local Weather and Climate

If you have ever walked across a sandy beach on a hot summer day, or sought the shade of tree to shelter you from the midday sun, you have a sense of some of the ways that forest cover can affect local weather and climate. Forest cover affects the amount of radiation from the sun which is absorbed or reflected by the Earth's surface. Forests can lower local temperatures, reduce moisture loss, affect wind patterns and change the local climate in many different ways.

Several activities in this teaching kit provide additional examples of the value of trees and forests, in both urban and rural areas.

Possible Effects of Climate Change on Canada's Forests

Warmer temperatures and increased CO_2 could increase the magnitude and rate of growth of Canada's forests. But it would take time, decades, or even centuries, before the forests adjusted to new climatic conditions. Some regions may also adjust better or more quickly than others. During this period of change, forests are likely to experience:

- **An increase in extreme weather events** (storms, wind, rain, drought, heat waves).
- **More and increasingly severe insect damage** and invasion by new species that were previously held in check by our cold winters.
- **More damage from disease** and possibly diseases new to this region.
- **Increased forest fires** due to drier and warmer conditions and lightning storms.
- **Loss of habitat for wildlife** species that live in forests.
- **Change in the distribution of wildlife** species to reflect the new forest habitats.
- **Change in the type of trees** found in certain forest regions, including competition from species that may affect an ecosystem's natural balance and, perhaps, its commercial timber value.


Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
YUKON TERRITORY
NORTHWEST TERRITORIES
NUNAVUT
BRITISH COLUMBIA
Pacific Ocean
ALBERTA
SASKATCHEWAN
MANITOBA
Hudson Bay
ONTARIO
QUEBEC
NEWFOUNDLAND and LABRADOR
PRINCE EDWARD ISLAND
NEW BRUNSWICK
NOVA SCOTIA
Atlantic Ocean
Northern boundary of the Boreal Forest could move as much as 500 km north but this would be limited by growing conditions such as poor soil, insufficient sunlight.
The Boreal Forest trees species would change. Birch, aspen and other more flexible species with wider seed dispersal, faster growth and early maturation would take over.
Changes to the types of trees that make up the forest could result in a domino effect of changes to plants and wildlife species throughout the system.
Within the Temperate Conifer zone of British Columbia, forests could shift upward in elevation and, under the worst scenario, disappear entirely from some zones due to a lack of the winter cooling (for forest regeneration), drought, stress and increased sensitivity to spring frosts.
The Acadian Forest region could be affected by the melting of northern glaciers resulting in increased ocean levels and a cooling trend.
FOREST REGIONS
PRINCIPAL TREE SPECIES
BOREAL – PREDOMINANTLY FOREST
White spruce, black spruce, balsam fir, jack pine, white birch, trembling aspen
BOREAL – FOREST AND BARREN
White spruce, black spruce, tamarack
BOREAL – FOREST AND GRASS
Trembling aspen, willow
SUBALPINE
Engelmann spruce, alpine fir, lodgepole pine
MONTANE
Douglas-fir, lodgepole pine, ponderosa pine, trembling aspen
COAST
Western red cedar, western hemlock, Sitka spruce, Douglas-fir
COLUMBIAN
Western red cedar, western hemlock, Douglas-fir
DECIDUOUS
Beech, maple, black walnut, hickory, oak
GREAT LAKES – ST. LAWRENCE
Red pine, eastern white pine, eastern hemlock, yellow birch, maple, oak
ACADIAN
Red spruce, balsam fir, maple, yellow birch
GRASSLANDS
Trembling aspen, willow, bur oak
TUNDRA
0 125 250 km
FOREST REGIONS of CANADA

Climate Change: Planning for the Future

The issues affecting climate change are global and cannot be successfully addressed by any single nation or small group of nations acting in isolation. We have seen the important role that Canada's forests appear to play in affecting the Earth's atmosphere and in many of the issues relating to global climate change. People also generally agree that climate change is happening and that we must act to address the extent and severity of the changes it might bring about.

The scope and complexity of this issue requires work on many fronts. In Canada, national, provincial, territorial and regional organizations participate in the research and development of sustainable forest management practices dealing with climate change. Some of these organizations and partnerships are listed here.

International initiatives such as the **Kyôto Protocol** (to reduce greenhouse gas emissions), and the **Montreal Protocol**, (to control ozone-depleting chemicals such as CFCs and related gases), are described on page 36.

Canada Forest Accord and National Forest Strategy

Signed by national, territorial and provincial ministers responsible for forests and representatives of 15 non-government organizations, the Canada Forest Accord states:

"Our goal is to maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations."

The National Forest Strategy, which identifies various means of achieving such objectives, is in turn applied to provincial and local forest strategies.
http://nfsc.forest.ca/home.html

The Ontario Forest Accord

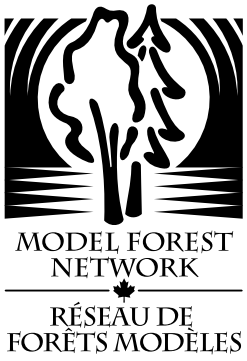
An example of one provincial approach is the Ontario Forest Accord, which is an important component of Ontario's Living Legacy. The Ontario Forest Accord is an innovative partnership of government, industry and environmental organizations, working together to promote the long-term health and sustainable use of the province's natural resources.

This partnership made it possible to establish a series of new parks and protected areas in the province. The new parks and protected areas will help maintain biodiversity and provide study areas to monitor the affects of climate change in Ontario.
www.ontarioslivinglegacy.com

Canadian Forest Service Research Centres

The Canadian Forest Service (CFS) is Canada's largest forest organization. Although the management of Canada's forests is a provincial responsibility, the CFS plays an essential role in undertaking and supporting forest science and technology research. The CFS, with its Head Office in Ottawa, has five forest research centres working together on different aspects of research for sustainable forest management in Canada.

As part of its work, the CFS has a national climate change research program looking at the forest carbon cycle, climate change impacts on forest ecosystems, fire and insect disturbance regimes, and forest-related socio-economics. The mission of this program is to provide "...leading-edge, Canadian expertise related to climate change impacts on forests and forest ecosystems..."
http://www.nrcan.gc.ca/cfs-scf/



Canada's Model Forest Network

Initiated in 1992 by the Canadian Forest Service, Canada's network of model forests stretches from the temperate rainforests of British Columbia to the boreal forests of Newfoundland and Labrador. There are 11 model forests covering over 22 million acres of land and representing all of Canada's forest regions:

- Long Beach Model Forest, BC
- McGregor Model Forest, BC
- Foothills Model Forest, AB
- Prince Albert Model Forest, SK
- Manitoba Model Forest, MB
- Lake Abitibi Model Forest, ON
- Eastern Ontario Model Forest, ON
- Waswanipi Cree Model Forest, QC
- Bas-Saint-Laurent Model Forest, QC
- Fundy Model Forest and Nova Forest Alliance, NB/NS
- Western Newfoundland Model Forest, NF

The Model Forests work toward sustainable forest management involving a wide range of partnerships. Two articles, *Ice Storm Sparks Further Partnership in the Eastern Ontario Model Forest*, and *The Natural Role of Fire*, appear in this booklet (see pages 12 and 19).

www.modelforest.net

ECOLEAP

Extended Collaboration for Linking Ecophysiology and Forest Productivity

ECOLEAP is a multi-disciplinary project of the CFS, involving its three research centres in Eastern Canada, and work at sites in Quebec, Ontario and the Atlantic provinces. The goal is to identify the effects of environmental factors including temperature and fertility on physiological processes such as photosynthesis and respiration, and to link such factors to forest productivity.

www.cfl.forestry.ca/ECOLEAP/home.html

BOREAS

Boreal Ecosystem-Atmosphere Study

BOREAS is a large, international co-operative research program established to conduct scientific research on the inter-relationship between the boreal forest ecosystem and global climate change. Between 1994 and 1997 a multi-disciplinary team of 300 scientists from five countries conducted research on two large tracts in Canada: a southern site near Prince Albert National Park, Saskatchewan, and a northern site west of Thompson, Manitoba. Because of the vast tracts of land involved in this study, remote sensing via satellite played an important role. To learn more about the BOREAS project and the ongoing analysis of its research visit the NASA web site.

http://www-eosdis.ornl.gov/BOREAS/bhs/BOREAS_Home.html

Other Organizations

Since climate change is one of the most critical environmental issues facing us today, there are a large number of organizations dealing with various aspects of the issue. The Government of Canada has an official climate change website <www.climatechange.gc.ca>. The federal government also distributes information through several of its departments including Environment Canada's Green Lane <www.ec.gc.ca>. Be sure to check out these Internet links.

Many non-government organizations and environment groups address climate change in different ways. Some are involved in advocacy, while others work to counter the effects of climate change through tree planting and school yard naturalization projects. Others focus their activities on public education. All are working towards a common goal of reducing the harmful effects of climate change.

Comparing Your Community to Canada's Forest Communities

Activity Info

Level: junior/intermediate
Subject: geography, science
Duration: one class, plus daily research time for a period of five days (10 minutes each)
Group: four per group; class
Setting: classroom
Preparation: access to Internet

Summary

Students will work in groups using a variety of research tools to study the weather and climate of their own community and of communities in forest regions across Canada.

Learning Outcomes

Students will:
- discuss and understand the differences between climate and weather
- research, record and discuss the weather conditions and climate for their community and communities in forest regions across Canada
- compare weather and climate
- discuss how changes to our climate might affect the environment around us

1. As a class, discuss the differences between weather and climate (see page 3).

2. Divide the students into groups and assign each group a community to research from the list below. Choose a cross-section of forest communities to represent different forest types and different parts of Canada:

- Your Community
- Thunder Bay, ON
- Prince George, BC
- Truro, NS
- Trois-Rivières, QC
- Fort McMurray, AB
- Whitehorse, YK
- Labrador City, NF
- Swan River, MB
- Port Alberni, BC
- Fredericton, NB
- Haliburton, ON
- Hinton, AB
- Summerside, PE
- Sept-Îles, QC
- Prince Albert, SK
- Yellowknife, NT
- Corner Brook, NF

3. Ask each group to:
- locate their research community on a map of Canada
- determine the forest region and common trees found there
- determine the hardiness zone for this area (see page 16)

Hint: Information on forest regions and the various tree types can most easily be found in print and on-line resources produced by the Canadian Forest Service or the Model Forest Network. A Canadian atlas or encyclopedia might also help. For plant hardiness zones check this Internet link:
http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness/intro.html

4. Over a period of five school days the students will research and record weather conditions for their research community using the newspaper, television, radio and the Internet. Students can use the chart on page 13 for recording their data.

Hint: Students can link to their research community's newspaper via the Internet, or they may want to link up via the Internet with a school in that community.

5. Have the students research and record the description of their research community's climate using another source, for example a Canadian atlas or encyclopedia.

Each group may choose to do their research together or assign different tasks to individual members.

6. When recording their data, ask each group to use the Community Climate chart on page 13. You may wish to use the following example as a guideline:

Community: Corner Brook

Province: Newfoundland

Forest Region: Boreal, predominantly forest

Hardiness Zone: 4b

Common Trees: black spruce, balsam fir, jack pine, white birch, trembling aspen

Climate Description: Corner Brook is on the east coast of Canada, and the west coast of Newfoundland. Corner Brook is Canada's snowiest city with an annual average snowfall of 414 cm. Average rainfall is 771.0 mm per year. Corner Brook's weather is largely moderated by the Atlantic Ocean. With an average minimum temperature of -10.8 C in the coldest month of the year (lowest temperature on record -31.7 C) it doesn't get as cold as other parts of Canada. July is the warmest month with an average maximum temperature of 21.9 C. Corner Brook experiences measurable precipitation (rain or snow) an average of 201 days each year.

7. Ask the groups to share their results through brief verbal presentations. Create a class comparison chart of the different research communities.

8. As a class, discuss and compare the weather and climate of the various research communities to the one you live in:

Your community:

- Based on the students' research, is the weather in your community different from the description given for its climate (warmer, colder, drier, wetter)?
- Does the climate description match how the students would describe your community's climate? What are their thoughts on why it does or doesn't match?

Research communities:

- Do the five days of weather that the students recorded reflect the description of their research community's climate?

Should we draw conclusions about climate based on the data from a few days, or from one season? How many years of study do we need to determine climate trends?

FOR ADVANCED-LEVEL STUDENTS

- Select two forest regions of Canada. How does the climate help to determine the kind of forest found in each region?
- How does a forest affect climate and on what scale?

Ice Storm Sparks Further Partnership in the Eastern Ontario Model Forest

One of the possible effects of climate change is an increased number of dramatic weather events such as floods, tornados, gales and ice storms. In January 1998 an ice storm wreaked havoc on eastern Ontario, southern Quebec, New Brunswick and parts of Nova Scotia, along with many areas in the northeastern United States.

Whether or not the ice storm is a sign of climate change is open for discussion, but it did provide a learning experience for forest managers. The Eastern Ontario Model Forest (EOMF) was the first to use the model forest partnership and organization to deal with a sudden crisis. This model forest covers 1.53 million hectares of mixed forest. Ninety per cent of it is privately owned, including 2,500 private woodlots and large tracts used to produce maple syrup.

Working together, with the help of the Canadian Forest Service and Ontario Ministry of Natural Resources, the model forest partners — private woodlot owners, Christmas tree growers, paper and timber industries, the Mohawk Council of Akwesasne, and others — developed a co-ordinated approach that gave everyone equal access to financial and scientific information. This helped them respond in a timely, thoughtful manner and expedited the road to recovery.

MODEL FOREST NETWORK
RÉSEAU DE FORÊTS MODÈLES

Name _____ Date _____

Community Climate

Community **Province** **Forest Region**

Common Trees

Climate Description

	Wind	Humidity	Precipitation	Sun/Cloud Cover	Temperature (high & low)
DAY 1					
DAY 2					
DAY 3					
DAY 4					
DAY 5					

The Greenhouse Effect

Activity Info

Level: junior
Subject: science
Duration: one class, plus daily research time for a period of seven to 10 days (10 minutes each)
Group: four per group; class
Setting: classroom
Preparation: Each greenhouse requires a planter or box, seeds (radish or other fast germinating type), two coat hangers and clear plastic. Based on available classroom time, resources and space, decide whether each group will produce one greenhouse as part of a larger class project, or five greenhouses for a group experiment.

Summary

Students will create mini-greenhouses and use them to observe how changes in temperature, moisture/humidity, sunlight and soil can affect the growth of seeds.

Learning Outcomes

Students will:

- create mini-greenhouses and plant and care for seedlings
- predict what will happen when they change one of the climate variables and will compare it with their actual results
- observe and record their findings in a daily log
- compare the seedling in the greenhouse environment with a tree growing in a forest in the Earth's atmosphere
- discuss how changing different aspects of climate might affect nature

Background

Plants need warmth, sunlight, water and soil to grow. By varying these factors we affect the health of plants. When scientists study climate change they observe the effects that various environmental changes (temperature, humidity/water, incoming radiation) have on nature. They use this knowledge to try to predict the long-term effects that these changes might have, alone and in combination with each other.

1. Ask students to construct five nearly identical greenhouses and plant their seeds. Greenhouse #4 will have less soil than the others; see below. Greenhouse #1 will be the control. You should attempt to have the best growing conditions to promote seed growth. Keep in mind, seeds are prone to fungal diseases. Try to maintain good air circulation around the greenhouses.

2. Vary one factor in each of the greenhouses.

Greenhouse #1 — Control: All factors will be constant.

Greenhouse #2 — Temperature: Place near a heater or suspend 2 cm above a heating pad for four to six hours each day to increase temperature.

Greenhouse #3 — Humidity: Provide an equal amount of water to each plant using the control to determine need. Double the amount of water to each plant in this container.

Greenhouse #4 — Soil: Plant seeds in 4 cm of soil in all containers except for this container. Use only 1 cm of soil.

Greenhouse #5 — Sunlight: Place into direct sunlight or supplement with a growing light.

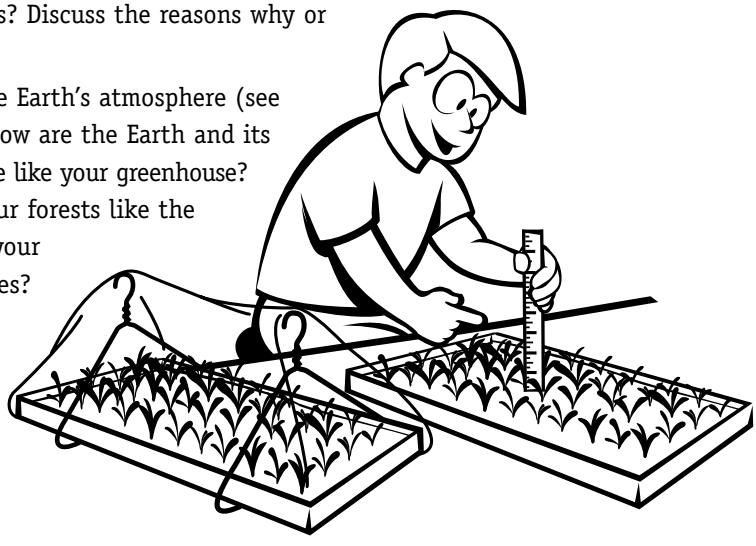
3. Ask students to predict what will happen in each greenhouse. There may be related effects that they should consider. For example, if you increase the sunlight, what will happen to the temperature and moisture?

4. Have the students record their daily observations for seven to 10 days.

5. Ask the groups to share their results through brief verbal presentations to the class. Create a class Greenhouse Comparison chart (see page 15) of the results of the five different greenhouse factors.

6. As a class, discuss and compare:

- What happened in each greenhouse? Did it match the students' predictions? Discuss the reasons why or why not.
- Discuss the Earth's atmosphere (see page 3). How are the Earth and its atmosphere like your greenhouse? How are our forests like the plants in your greenhouses?



Name _____ Date _____

Greenhouse Comparison

	Greenhouse 1	Greenhouse 2	Greenhouse 3	Greenhouse 4	Greenhouse 5
Prediction					
DAY 1					
DAY 2					
DAY 3					
DAY 4					
DAY 5					
DAY 6					
DAY 7					
DAY 8					
DAY 9					
DAY 10					
Results					

Plant Hardiness Map

Climate directly affects the types of plants and plant communities that can survive and grow in a specific area. For example, any gardener will tell you that growing large, vine-ripened tomatoes in a place like Thompson, Manitoba can be a challenging undertaking.

Since 1967 Agriculture Canada has made a map available, indicating the boundaries of plant hardiness zones across Canada. The map is used by gardeners across the country to determine how well specific plants will grow in their areas. The hardiness zones were developed based on things like winter temperature, length of frost-free period, rainfall, and maximum wind speed.

A couple of factors in recent years have reduced the accuracy of the hardiness zone map. Canada's climate has changed. We also have more detailed information about our climate now.

Scientists at the Canadian Forest Service have responded by re-evaluating Canada's plant hardiness zones to create a new map. The new map shows that hardiness zones appear to have changed in many parts of the country.

The new hardiness zones map is available now. We have included it as a pull out in this teaching kit, on the back of the National Forest Week poster. If the map has already been removed from this book visit the hardiness zones web site: http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness/intro.html

Glow-in-the-Dark Seedlings?

What does it mean when a tree seedling glows in the dark? To scientists at the Ontario Forest Research Institute (OFRI) a healthy glow means a healthy seedling.

OFRI is a world leader with a 40-year tradition in seedling research. One of its many projects involves detecting the red light given off by seedlings and plants, called chlorophyll fluorescence.

First, after being stress-tested by exposure to heat and low humidity, special equipment is used to measure the glow of the research seedlings. These seedlings are planted and their growth is monitored for up to five years. Scientists have discovered that plants that recover well from stress tests — as indicated by their glow — also grow best after planting.

In future, scientists hope to develop a similar technology that would allow them to determine if a forest is under stress by conducting glow tests from airplanes. This would provide an indicator of forest health, which could be applied in forest management strategies.

Other Projects

Ontario's forests play an important role in Canada's commitment to reduce the impact of climate change. Forests cover 65 per cent of Ontario's landbase. The Ontario Ministry of Natural Resources is conducting research on the effects of a changing climate on our forest ecosystems, as well as developing strategies to help our forest managers adapt. Some of the projects underway include:

- the Ontario Carbon Budget Model, designed to estimate the amount of carbon stored in forests, and to quantify the effects of disturbances
- effects of changing climate on forest insect populations
- enhanced protection strategies from insects and fire
- potential effects on seed sources and forest genetics
- using genetically improved planting stock and enhanced stand management practices to increase carbon sequestration
- developing strategies to increase the amount of trees planted on marginal agricultural lands
- generating energy through the combustion of wood by-products and forest biomass
- role of wetlands in managing climate change

For more information, contact the Ontario Forest Research Institute or visit Ontario's Forests web site at http://ontariosforests.mnr.gov.on.ca

Forest Fires and Climate Change

Activity Info

Level: junior/intermediate
Subjects: science, ecology, art
Duration: one class
Group: class and individual
Setting: classroom
Preparation: news sources or Internet, art materials

Summary

Students will look at the relationships between forest fires, the formation and health of the forest, weather and climate change.

Learning Outcomes

Students will:

- recognize that fire occurs naturally and affects the health and formation of forests
- look at how weather conditions affect forest fires and from this, older students will investigate the possible effects of climate change on forest fires
- depict, through art, some of the changes fire brings about in a forest

Since 1980 Canada has lost an average of 2.4 million hectares of forest to fires each year, a 140 per cent increase over the previous 30 years.

Background

Forest fires, the health of Canada's forests, and climate change are all closely related.

- Canada's forests, in many regions rely on fire. Despite the devastating effects that fires can have, as a natural process fire ***does not*** destroy a forest but rejuvinates it. Fires remove dead trees and litter from the forest floor, release nutrients to help new growth, and allow new plant and wildlife species to move in. In some forests, the seeds of trees such as jack pine and lodgepole pine, will not be released from their cones unless exposed to fire.
- Climate change may lead to more forest fires due to warmer and drier weather, and increases in lightning storms (a natural cause of fires).
- Canada's forests play an important role in helping to reduce the amount of carbon in the atmosphere and, by doing this, reduce carbon dioxide, one of the main greenhouse gases.
- Changes in the frequency of fires will change the carbon cycle and increase the release of CO_2 to the atmosphere.

Although research is conducted on all of Canada's forests, the boreal (taiga) forest which occupies much of the northern hemisphere plays an important role in climate change. As part of these studies, the International Geosphere-Biosphere Program has established permanent study areas in North America, Europe and Asia with researchers from the CFS and many other organizations participating. Some of the many questions that they are seeking to answer include:

- What are the past and present fire and weather patterns?
- How much carbon is lost during and after a fire due to direct burning and subsequent decay?
- After a fire, when does a forest turn from a source of carbon back into a carbon sink?
- How will this affect the overall global climate budget?
- How will fires and climate change affect the forest and its distribution?

Answering these questions will help scientists in many ways. Understanding historical climate/fire relationships will provide insight when projecting future patterns under a warming climate, and in understanding the ways fires might develop and behave on a large scale. On a smaller scale, understanding future fire patterns may help in making local forest management decisions and in planning for human safety in communities near high-risk areas.

When doing your research, check out the following web sites:

- www.msc-smc.ec.gc.ca/ccrm/bulletin
- http://nofc.cfs.nrcan.gc.ca/science/research/climate_change_e.php (click on: downloads — climate change — facts sheets)

1. As a class, discuss the causes of forest fires, for example: campfires, sparks from trains, cigarettes thrown from cars and lightning.

2. Ask the students to look at news or Internet sources for information about recent or past forest fires, and long term fire and weather records.

- Can the students detect any changes or trends in the records?
- Do they see a relationship between the long term fire records and the long term weather records?
- Do the reports of individual fires include information about the weather conditions or type of season leading up to the fire, such as a dry spring?
- How did the individual fires start? Did weather conditions affect the cause of the fire, the fighting of the fire, or its spread?

3. Based on this research and the students' observations, what are some of the ways weather affects forests? For older students you may wish to link this to some of the projected impacts of climate change outlined on pages 6 and 7.

4. Use a class discussion to help children understand that fire is a natural process with both positive and negative effects on the forest, and that many of our attitudes about fire are based on how it affects humans (loss of timber, damage to homes and communities, risk to human life, loss of life). This activity's Background information, and various other teaching resources such as the ones listed below, can help you.

5. Students can create a drawing or a class mural showing the different ways a forest changes after a fire. A few ideas to get you started:

- squirrels and owls nest in old, large trees that are often left standing after a fire
- many young tree seedlings grow up quickly after a fire, nourished by the newly released nutrients
- deer eat the tender young shoots of trees and bushes that sprout after a fire.

Forest Fire Resources for Educators:

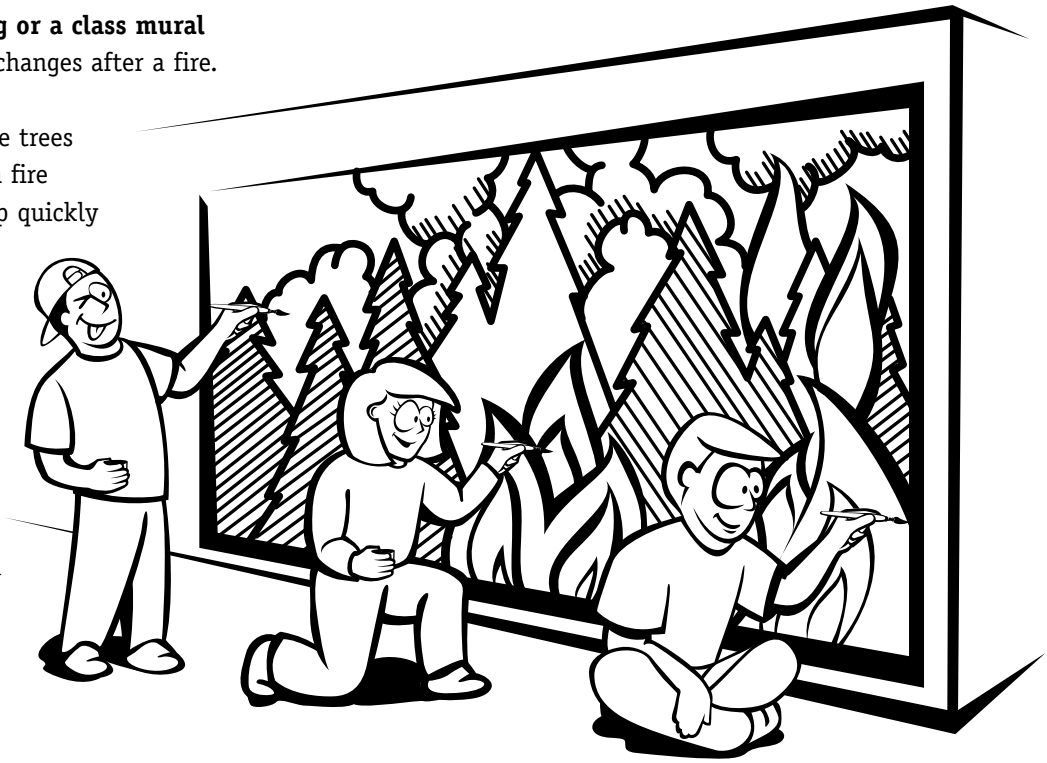
Forest Fires: Handle with Care! National Forest Week Teaching Kit, Canadian Forestry Association, 1999.

Focus on Fire: A Forest Fire Education Supplement for Teachers and Resource Educators, Ontario Ministry of Natural Resources/Ontario Forestry Association, 1998.

Lightning is a natural cause of forest fires. Both lightning and thunder are the result of electrical discharges given off by the reaction of the positive and negative charges found in rain clouds. These charges build up static electricity that can react between clouds or between clouds and the ground.

You can demonstrate static electricity by rubbing a ping pong ball on a piece of wool. Use the ball to pick up small bits of paper or to attract someone's hair. Students may want to experiment with combs or balloons. If you darken the classroom you may be able to see the sparks jumping between objects.

Researchers are studying the charcoal found in lake sediments throughout Canada's boreal forest to understand the relationship between climate and fire since the last Ice Age, 10,000 years ago.



THE NATURAL ROLE OF FIRE

Recent research suggests that nature's own forest management plan, which makes use of fire, insects and disease, flooding and wind damage, is the best model for conserving biodiversity in the forest.

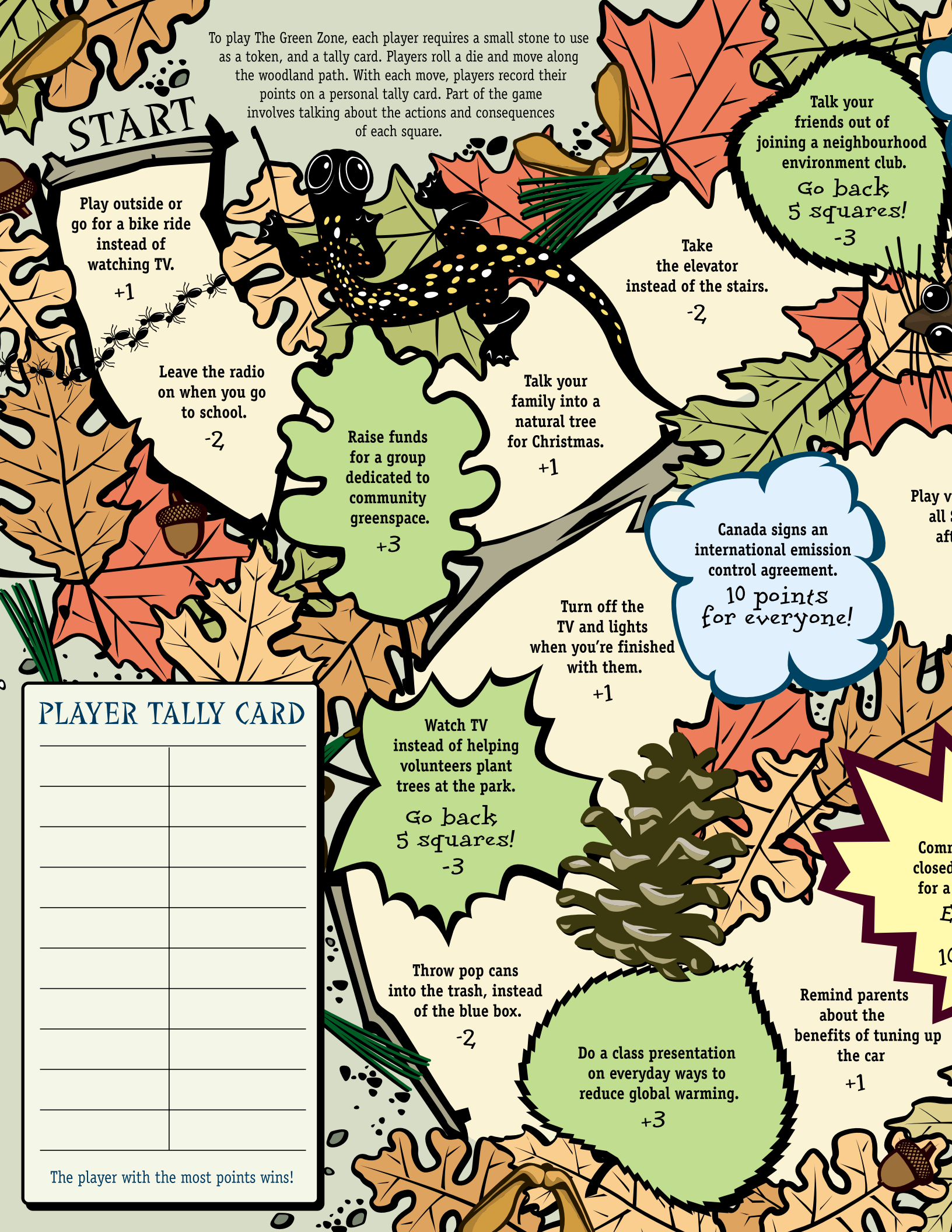
Partners in the 2.75 million hectare Foothills Model Forest in western Alberta are aware that wildfires have always played a role in the forest. They set out to map the pattern of natural disturbances to use as a guide for planning forest harvesting, prescribed burns and other management strategies. This multi-year project includes research in selected locations and on different scales.

The forest company, Weldwood Canada Ltd., is using the research results to ensure that harvesting and reforestation emulate natural disturbances as much as possible. Weldwood has initiated an experiment to study the ecological, economic and cultural impacts of larger harvest areas. As well, Jasper National Park is using this same research to determine the intensity, location, range and size of its prescribed burns to conserve biodiversity and reduce the potential for catastrophic wildfires.

Additional research is being conducted to study the needs of the 284 land-based wildlife species to ensure that the range of habitat they require, from young forests to mature forests, is maintained.

MODEL FOREST NETWORK
RÉSEAU DE FORÊTS MODÈLES

The Native people of the Canadian Arctic say they are now experiencing natural events previously unknown in their oral history — thunder and lightning. Electrical storms in the high Arctic are among the evidence of climate change being reported in a new study by the International Institute for Sustainable Development.


START
To play The Green Zone, each player requires a small stone to use as a token, and a tally card. Players roll a die and move along the woodland path. With each move, players record their points on a personal tally card. Part of the game involves talking about the actions and consequences of each square.
Play outside or go for a bike ride instead of watching TV.
+1
Leave the radio on when you go to school.
-2
Raise funds for a group dedicated to community greenspace.
+3
Talk your family into a natural tree for Christmas.
+1
Take the elevator instead of the stairs.
-2
Talk your friends out of joining a neighbourhood environment club.
Go back 5 squares!
-3
Canada signs an international emission control agreement.
10 points for everyone!
Turn off the TV and lights when you're finished with them.
+1
Watch TV instead of helping volunteers plant trees at the park.
Go back 5 squares!
-3
Throw pop cans into the trash, instead of the blue box.
-2
Do a class presentation on everyday ways to reduce global warming.
+3
Remind parents about the benefits of tuning up the car
+1
PLAYER TALLY CARD
The player with the most points wins!


THE GREEN ZONE
Local industry announces emission reduction.
10 points for everyone!
Put on a sweater instead of turning up the heat.
+1
Help host environment day at your neighbourhood park.
+3
ideo games Saturday ternoon.
-2
Ask your neighbourhood store to stock items with less packaging.
+3
Bring a litterless lunch to school.
+1
Say no to an opportunity to help green your school playground.
Go back 5 squares!
-3
Choose a fresh fruit snack instead of a processed, packaged treat.
+1
On International Walk to School Day, 75 per cent of your school participates.
10 points for everyone!
nunity park is l to make room new building.
veryone loses 0 points!
Beg a drive to a friend's house two blocks away.
-2
A smog alert is announced in your community.
Everyone loses 10 points!
Walk everywhere you go for an entire day.
+1
FINISH

Shrinking Our Ecological Footprint

Activity Info

Level: junior to senior
Subjects: environmental studies, citizenship, art, language
Duration: one or two classes
Group Size: class
Setting: classroom
Preparation: copies of **The Green Zone** gameboard for younger grades (see page 20)

Summary

Students will look at the impacts that they as individuals, and we as Canadians, have on the environment. They will explore ways to reduce their impacts.

Learning Outcomes

Working at a level appropriate to your class, students will:

- explore our impacts on the environment
- identify ways to change one or more of these impacts
- make the commitment to change at least one way they impact the environment

Background

Nature provides all the resources that we use to live. If we use more resources than we replace, or if we produce more waste than nature can take care of, we throw our natural systems out of balance.

The concept of an ecological footprint is a relatively new way of expressing this human impact on the environment. Basically it looks at the resources we consume and at the waste we generate. It then expresses this relationship as the amount of land required exclusively to produce the resources consumed and waste generated by a population. These calculations include only the available biologically productive land and water. This means non-productive land, such as deserts, and areas given over to cities and other human uses, are not included in the tally.

1. Reflect on our impact on the environment. As a class, discuss the different ways we, as individuals, each affect the environment around us. What do we need to survive (air, water, shelter, each other)? What wastes do we produce (when we eat and breathe, to keep us warm or to cool us, to get places, to ship our goods)? What extras do we expect from our world (trendy clothes, convenience products, holidays, snowmobiles, motor boats)?

Remember to keep this discussion appropriate to the grade level and to balance it with positive statements. For example, remind students that while humans place demands on the planet, we also celebrate nature through music and art.

2. Based on the discussion in part 1, complete the chart on page 23 itemizing **Resources We Use and Waste We Produce** and identifying **Ways We Can Improve**.

FOR OLDER STUDENTS

Older students may also want to look into the actual impact of each change. For example, walking to school for one month will mean x km less driving and save y litres of gas. Saving y litres of gas will save z litres of our air (burning one litre of gas requires 8,000 litres of air). Discuss the pros and cons of each change.

3. Explore ways we can change the way we live in order to reduce our ecological footprint. Play the **The Green Zone** game on pages 20 and 21. The game is designed to provide students with a fun activity that will help them understand the environmental implications of actions and events. By rolling a single die, players move around the board, gaining and losing green points based on the action/event-consequence in the squares they land on.

FOR OLDER STUDENTS

Challenge older or advanced students by having them earn bonus points if they can explain the science behind the action/event-consequence.

4. Doing it! Making a commitment. Ask the students to think about one thing that they could reasonably do over the coming month to help the environment. Ask them to design their own pledge form to support this commitment. They might want to include a drawing or description of how this change will help.

Name _____ Date _____

Shrinking Our Ecological Footprint

Resources We Use and Waste We Produce	Ways We Can Improve

Canadians and Our Gigantic Ecological Footprint!

- Researchers estimate that on Earth, there are currently only 2.2 hectares of productive land available per person to provide all the resources, waste assimilation and life support services we need.
- A Canadian uses 9.4 hectares to support his/her lifestyle, which is 4.3 times our fair share. If everyone on Earth lived at this level we would need four more Earth-sized planets to sustain us.
- By 2020 the Canadian figure is projected to grow to near 13.8 hectares. Our growing demand for fossil energy to run our cars, heat and cool our homes and businesses, is responsible for two-thirds of this growth.

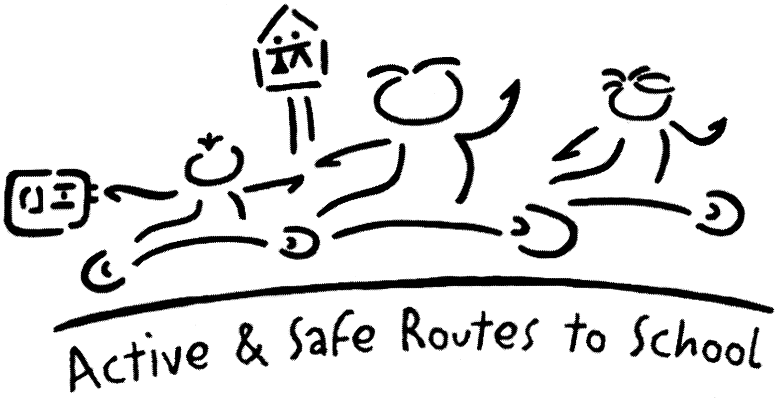
Top 10 Ecological Footprints

1.	United Arab Emirates	16.4
2.	USA	12.2
3.	Singapore	10.3
4.	Kuwait	10.3
5.	New Zealand	9.5
6.	Canada	9.4
7.	Denmark	9.4
8.	Australia	9.1
9.	Ireland	8.7
10.	Finland	8.4

Facts to think about:

- Some countries have a limited land area but a large population.
- Some countries have limited biologically productive land (desert countries).
- Some countries have a high standard of living including high energy use, high consumerism, and high waste production.

Scary Note: These countries and many others exceed the sustainable limit.



International Walk to School Day: Tuesday, October 2, 2001

Last year students from 846 schools across Canada joined others from around the world for the First International Walk to School Day. With their parents or friends they walked, ran, bicycled, skated or used other non-polluting, active means of getting around to promote safety, health, physical activity and concern for the environment.

There are nearly 5.5 million students in Canada. Think of the difference that even one Walk to School Day would make if everyone took part.

Register today and receive your kit for the International Walk to School Day 2001 by visiting www.goforgreen.ca/asrts

If your school is in Ontario or British Columbia, please contact the following Go for Green partners:

ONTARIO

www.greenestcity.org

BRITISH COLUMBIA

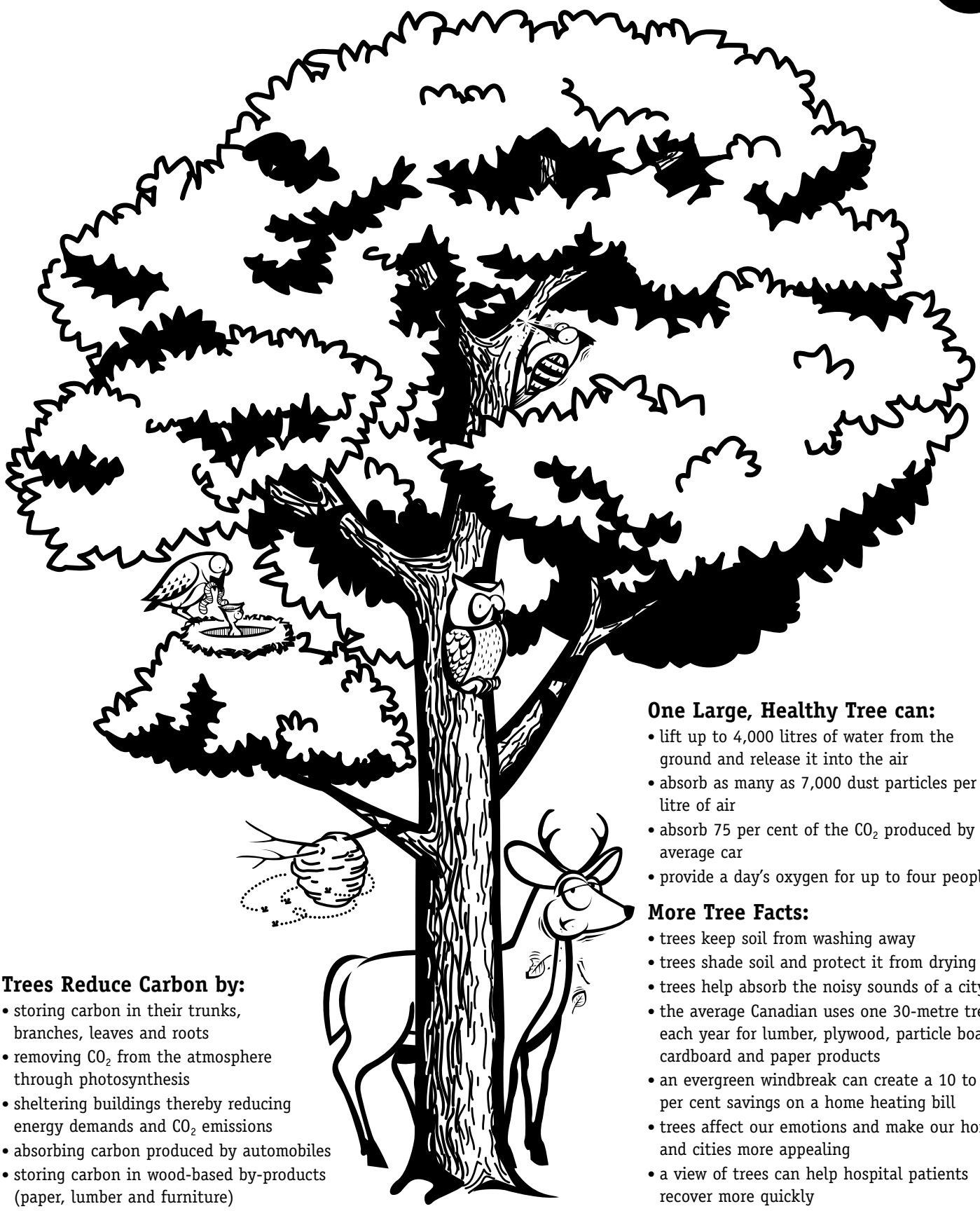
www.waytogo.icbc.bc.ca

Go *for* Green

The Active Living & Environment Program

Name _____ Date _____

How Trees Help the Planet



Trees Reduce Carbon by:

- storing carbon in their trunks, branches, leaves and roots
- removing CO_2 from the atmosphere through photosynthesis
- sheltering buildings thereby reducing energy demands and CO_2 emissions
- absorbing carbon produced by automobiles
- storing carbon in wood-based by-products (paper, lumber and furniture)

One Large, Healthy Tree can:

- lift up to 4,000 litres of water from the ground and release it into the air
- absorb as many as 7,000 dust particles per litre of air
- absorb 75 per cent of the CO_2 produced by the average car
- provide a day's oxygen for up to four people

More Tree Facts:

- trees keep soil from washing away
- trees shade soil and protect it from drying out
- trees help absorb the noisy sounds of a city
- the average Canadian uses one 30-metre tree each year for lumber, plywood, particle board, cardboard and paper products
- an evergreen windbreak can create a 10 to 15 per cent savings on a home heating bill
- trees affect our emotions and make our homes and cities more appealing
- a view of trees can help hospital patients recover more quickly

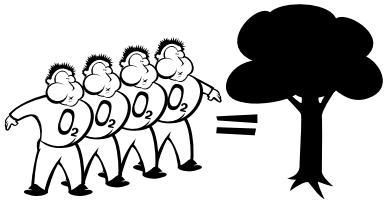
Can you find five additional ways that this tree is helping our planet?

See answers on page 39.

Name _____ Date _____

Trees Can Do It: Just Do the Math!

1. One large tree can provide a day's oxygen for up to four people. How many trees are needed to provide one day's oxygen for your entire class? How about your entire school?



2. Evergreen trees planted in a row create a windbreak. A windbreak can reduce home heating costs by 10 to 15 per cent. If you planted a windbreak that would provide a 10 per cent saving, you would save $120 on a heating bill of $1,200 per year.

a) How much would your final bill be?

b) How much money would you save over five years?

c) What other benefits would that windbreak provide?

3. You need about 500 full-sized trees to absorb the carbon dioxide produced by a typical car driven 20,000 km per year. Estimate how many kilometres your family drives per year. Don't forget to include the mileage on all vehicles used at both home and work. How many full-sized trees does your family need to absorb the carbon dioxide produced by your vehicle(s) in one year?

4. One hectare (2.5 acres) of Christmas trees produces enough oxygen to support 45 people. Christmas trees are harvested when they are 10 years old. This means that a Christmas tree farm cuts only 10 per cent of its crop each year, leaving another 90 per cent growing.

a) If a farmer has 80 hectares (200 acres) of trees, how many hectares (acres) of trees does he need to replant after each harvest?

b) The remaining trees can meet the oxygen needs of how many people?

c) Why is there a difference between this information and the information given in #1.
Hint: Think about the different tree types.

5. Each day a full-sized tree can absorb nearly 75 per cent of the carbon produced by the average, well-maintained car. How many trees are needed to absorb the daily carbon from 75 automobiles?

See answers on page 39.

Greenspace in Our Communities

Activity Info

Level: junior/intermediate
Subjects: geography, environmental science
Duration: field trip and/or research time, plus one class
Group: small groups or individuals
Setting: outdoors and in classroom
Preparation: base map of community/ study area; coloured pencils or markers

Summary

Students will look at, identify and map different land uses within their own community. They will look at the role and cumulative value of different types of greenspace.

Learning Outcomes

Students will:
- identify and map the different types of land use in their neighbourhood
- estimate the percentages of land set aside for different uses and compare it with their own observations
- discuss options for protecting or increasing urban greenspaces
- look at the urban forest and the roles that trees play in cities, especially with respect to climate change

Background

Despite our vast expanses of land and open space, more Canadians live in cities than in rural areas. In fact, almost 80 per cent of our population live in towns and cities. There are benefits to urban life: more job opportunities, better access to schools, hospitals and recreational facilities, and more conveniences all round. But unless we plan and work carefully, cities can become places of pavement and cement with few greenspaces.

Fortunately, most modern day Canadian towns and cities have land use plans that reflect the need for greenspace and the protection of natural areas within the urban landscape.

A city's greenspace includes the **urban forest**: the sum of trees lining the streets and greenspace corridors, plus those that grow in yards, parks, ravines and woodlots. We have only recently started to recognize the value of the urban forest and its contribution to the health of cities.

Trees provide oxygen, protect soil, filter water, provide food and habitat for wildlife and give humans pleasure, but they also play an important role in dealing with a number of climate change issues. The **How Trees Help the Planet** Activity Sheet on page 25, outlines many related benefits. Most of these factors become even more significant in an urban environment, especially in light of the increased levels of pollution and heat associated with climate change, for example:

- Cities are heat islands. They are usually 5 to 9 C warmer than surrounding areas. Trees help cool cities by shading streets and parking lots, and cooling urban streams and drains for the fish and wildlife that live there.
- Trees tie up the carbon produced by vehicles and various urban energy demands. Carbon dioxide is a greenhouse gas that contributes significantly to global warming. According to Tree Plan Canada, researchers estimate that an urban tree can save five to ten times more overall carbon than a rural tree.
- Pollution is concentrated in cities. Trees tie up many air pollutants and a single tree can absorb as many as 7,000 dust particles per litre of air. In addition to being a climate benefit, this factor can improve the health of urban dwellers who suffer from asthma and other respiratory diseases.
- Trees shelter buildings thereby reducing energy demands for winter heating and summer air-conditioning. This means reduced energy use and lower greenhouse gas emissions.
- Trees are shown to have social benefits in crowded cities. They absorb noise, screen unsightly views, provide privacy and can significantly increase property values. Studies show that hospital patients who can view trees from their window recover more quickly than those who don't, and some police officers believe that trees and landscaping instill community pride and help reduce crime.

1. As a class, discuss the different ways land is used in your neighbourhood. For example, your community may include a built up area of residences including homes, apartments and townhouses, and businesses such as factories, stores, malls, hotels. It will also include areas for vehicles (roads, highways, parking lots). Most communities include some greenspace. Ask your students to decide as a group what they would classify as greenspace.
- Does the land have to be in a natural state?
- Does it have to have trees?
- Is there a size limit?
- What about parks, golf courses, playgrounds, gardens and similar areas?
- Can it provide a home for wildlife or a natural space for people?

2. Set out the geographic area you want the students to study. For younger students you may wish to include the school and one or two blocks in the immediate vicinity. Older students may wish to look at a larger scale. As a class, estimate how much of your study area is given over to buildings, to vehicles, to greenspace and to other features. You will compare this later with your findings.

3. Ask the students to walk the study area and make a sketch map showing areas occupied by the following:

- **buildings**: homes, schools, stores, factories
- **vehicle-use**: paved roads, highways, parking lots
- **greenspace**: as defined by the students (ask them to include an estimate of per cent or number of trees in this greenspace)
- **other features**: streams, rivers, extensive barren or abandoned land, areas under development

Students should try as much as possible to draw these features to scale and they should record any special observations.

4. Back in the classroom, ask the students to refine their maps and to colour in the three major land uses. Colour the buildings grey, vehicle-use red and greenspace light green, using a darker shade to highlight the per cent of (or individual) trees. They should also mark any other significant features. Make sure they label the map with a scale and create a legend to define any symbols they use.

5. Based on their maps, observations and greenspace criteria from step 1, discuss the following points:

- What portion is greenspace?
- How much of this area includes trees?
- How do people use the greenspaces?
- How are the greenspaces used by wildlife?
- Were there many signs of wildlife in these areas?
- Is there any water, such as a creek, pond or ditch, to provide water for birds and animals?
- Are there areas that could be changed over to greenspace or where the greenspace might be improved by planting trees and shrubs? There may be locations along riverbanks, on abandoned roads or building lots, around parking lots, industries or factories, or in the school yard (see "Greening Your School Grounds" page 29).

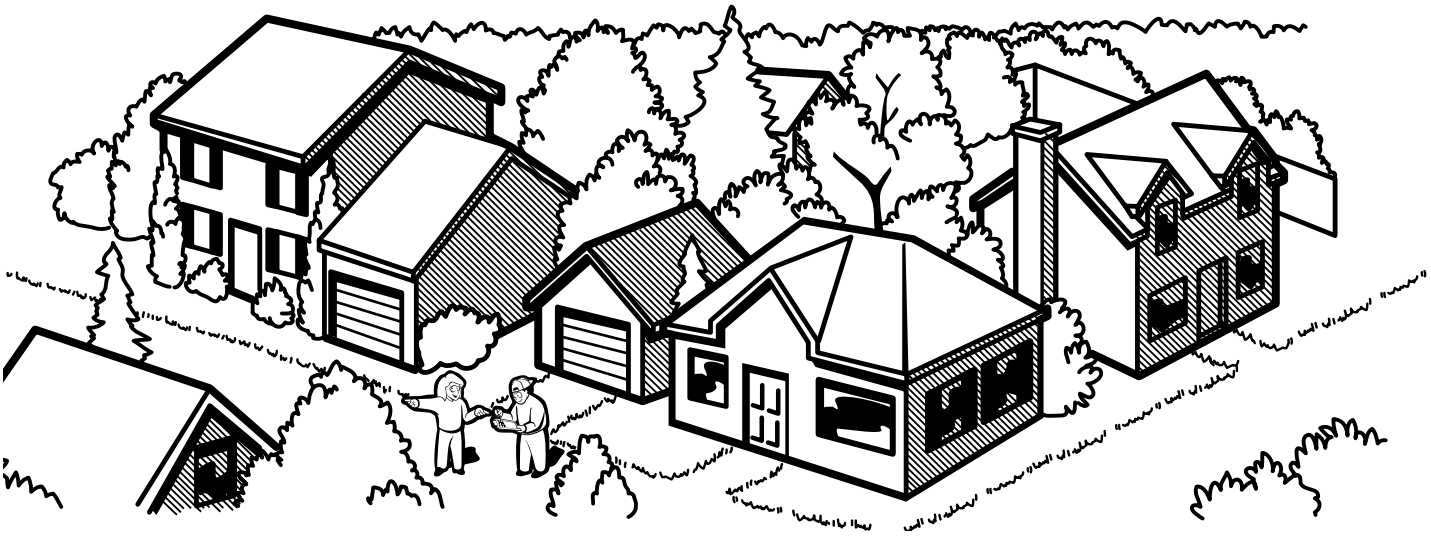
FOR OLDER STUDENTS

It has been said that North American cities are not designed for people but for their vehicles. Do students believe this is a valid statement based on this activity and their knowledge of their home town? In light of their mapping exercise, this discussion and what we know about climate change, what plans would they make to improve our cities? Ask the students to develop a series of recommendations to improve their communities.

Studying Land Use

One of the big challenges that urban planners, forest managers and others face is trying to find a way of identifying, classifying and expressing the different types of natural areas and land uses that exist. While researchers and planners can look at a new subdivision development or at an individual woodlot on a micro level, they know that these places do not exist in isolation. Indeed, all land-use needs to be considered as part of a bigger picture.

To do this, many organizations use a system of ecological land classification (ELC), to categorize the very complex relationships that exist in nature. To create these specific definitions or categories, researchers study the soil, water, rocks, trees, plants and local climate conditions of an area. Then they name or classify the category, often choosing a plant community which best describes the site. For example, naming an area "silver maple swamp" means it has a predominance of silver maple trees, as well as a specific set of soils, plants and wildlife known for their water storage properties.



Greening Your School Grounds

"The best time to plant a tree was twenty years ago. The second best time is now."
— Anonymous

Background

Schools across Canada are involved in projects to change their school yards in order to make them more environmentally friendly and create exciting learning spaces. Fortunately, there are many groups across Canada that have experience with school yard naturalization projects and that are actively involved in helping schools to accomplish their goals. Some of these organizations are listed on page 30. You and your students can learn from them and benefit from their experiences.

Benefits

Greening your school grounds can:

- create a place to learn about the environment as a complex interconnected series of relationships
- offer hands-on learning opportunities in all areas of the curriculum
- provide a diversity of play experiences and increase opportunities for creative play
- develop a sense of school and community ownership and belonging
- help reduce school ground violence among students
- produce an ecologically and aesthetically improved landscape
- create a chemical-free landscape
- be a model for environmental rehabilitation and community building
- demonstrate the role of trees in climate change and help address some of its effects:
  - provide shade from harmful UV radiation
  - cool or replace heat-generating parking lots and paved areas
  - shelter buildings to reduce heating and cooling costs
  - reduce emissions of greenhouse gases

Information and photos provided by the Tree Canada Foundation.

1. Check for support and spread the news. Check with your school principal to make sure you have the school's support. Your principal can also help you deal with red tape and acquiring any special permission you may need to proceed. Then, spread the news! Invite students, parents, teachers and the neighbourhood to get involved.

2. Create a planning group. Your task goes beyond planting some grass and a few trees. You will be planning, designing, raising funds and asking local businesses to provide services. If you want to succeed you will need several managers — the movers and shakers who will sustain these efforts over the long term. And, if your project is going to take place over several years, you will want to be sure to keep the door open for new people to get involved and keep the momentum going.

3. Survey the grounds. Look at the physical features of your school grounds and acquire a site plan from the school board or archives. You will need to determine what areas are available for your project and which features should be incorporated (parking areas, sports fields) or avoided (buried telephone and gas lines, water pipes).

4. Identify your school needs. Each project is different and reflects the needs and desires of the school community. What do you want to achieve? What do the students want? You might want to get some ideas from projects that have been successfully completed by other groups.

5. Create a concept. Prepare a landscape plan with the students and teachers to ensure that the results are a team effort and that everyone learns from the process. Are there artists in the group? They might want to create sketches of how the new space will look. Assign someone to look at the resources you require, the costs and possible sources.

6. Break your landscape plan into phases or steps. Using your plan, divide the project into smaller phases or steps. Start small and each accomplishment will be rewarding for everyone. A new landscape won't happen overnight. It is likely to take three to five years or more to create the environment you want.

7. Action plan: Let's do it! Prepare an action plan including timelines and responsibilities and start organizing the resources.

8. Measure the difference and celebrate your success. Make sure you record your progress through photos, video or other means. Spread news of your efforts through the local media. And celebrate! Plan a special ceremony, a ribbon-cutting party, a fresh-air community open house, a school picnic, or a recognition ceremony for donors, sponsors and other community members who helped out.

Students at École Secondaire Franco Supérieur in Thunder Bay launched a **Greening School Grounds** project at their school during the summer of 2000 as part of the city's Forest Capital of Canada celebration. Greening School Grounds is one of Tree Canada's national tree planting programs. This is an excellent example of how students can learn to take personal responsibility for the environment they live in.
www.borealforest.org

before

after

Tree Canada Foundation actively promotes the planting and care of trees in urban and rural environments and sponsors a "Greening School Grounds" program. They can help you plan your project, provide funding and fundraising guidance, and provide ideas on how to use the landscape as part of the curriculum. Tree Canada has resource staff across Canada who are willing to assist in greening your school community. www.treecanada.ca

Tree Canada Reboisons le Canada

Evergreen is dedicated to 'bringing nature back to our cities' through education and community action projects. Through its Learning Grounds program, Evergreen has helped over 1,100 schools across Canada undertake naturalization projects. Evergreen offers national grants, practical guidebooks and videos, regional workshops, an interactive web site with an on-line registry of successful projects, and staff who can offer practical advice.
www.evergreen.ca

TOYOTA | EVERGREEN
LEARNING GROUNDS

Canadian Wildlife Federation sponsors National Wildlife Week and is one of Canada's largest environmental organizations. CWF has many resources dealing with naturalization of backyards and various other landscapes.
www.cwf-fcf.org

Green Teacher has published a book called *Greening School Grounds, Creating Habitats for Learning*. This 120-page book is an excellent tool to promote hands-on, interdisciplinary learning about the environment through projects that benefit schools and increase greenspace and biodiversity in communities.
www.greenteacher.com

The Seasons of a Forest

Activity Info

Level: junior
Subjects: art, language arts, science, ecology
Duration: one class
Group: divide class into four groups
Setting: classroom; optional field trip
Preparation: art materials including four mural-size pieces of paper or newsprint; pastels, tissue paper, paint, fabric, etc.

Summary

Students will look at the forest through the different seasons.

Learning Outcomes

Students will:
- recognize and depict the diversity of life in their local forest
- look at the way the forest changes through the different seasons

Background

Forests are more than just trees. They include hundreds of different kinds of shrubs, vines, flowers, mosses, fungi, birds, animals and insects. They may also include areas of rock, exposed soil, creeks, marshes and lakes.

Forests vary region to region. A forest in the mountains of British Columbia contains many different types of trees, plants, and animals compared to a forest in northern Saskatchewan, southern Ontario or Nova Scotia.

1. OPTIONAL: If you have easy access to a nearby forest or woodlot, take your class for a tour. Ask the students to look at the different features of the forest. What do the trees look like? Do they keep their leaves year-round or do they drop them in the fall? Are there any flowers in bloom? What covers the ground (grasses, mosses, leaf litter, rock)? Do you see any birds and animals, or signs of them in the forest?

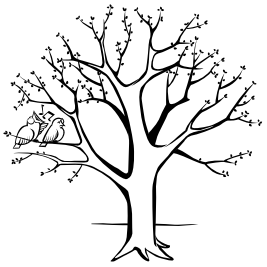
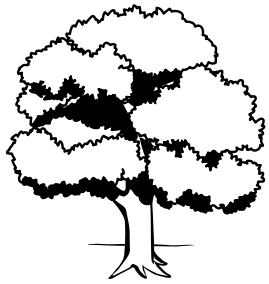
2. In the classroom, discuss your visit to the forest or draw on the students' own experiences to discuss the forests or woodlands in your area. Who lives in the forest (squirrels, birds, deer, foxes)? How do they use the forest (for a nest or den, for food)?

3. Discuss what the forest would be like at different times of the year. Use **The Seasons of a Forest** activity sheet (page 32) to make a list of words and phrases to describe the forest and its inhabitants during each season. What would you feel? What would the weather be like? What sounds would you hear?

4. Divide the class into four groups and ask each group to create a mural of one of the four seasons in the forest.

Name _____ Date _____

The Seasons of a Forest

Write descriptive words and phrases, weather and sounds for each season. What do you feel?	
 **spring**	
 **summer**	
 **fall**	
 **winter**	

The Carbon Cycle and Canada's Forests

Activity Info

Level: junior to senior
Subject: science, chemistry, biology and ecology
Duration: one or two classes
Group: class and individual
Setting: classroom; optional trip to woodland or forest
Preparation: copy **The Carbon Cycle** (see page 35) for each student; research local forest ecology

Summary

Students will explore the nature of the carbon cycle and its relationship to different processes within the forest. They will come to understand the dynamic nature of forests in storing and releasing carbon. They will look at their local forest, and come to understand its role in natural processes, particularly the carbon cycle.

Learning Outcomes

Students will:

- discuss carbon and the carbon cycle
- gain an understanding of why carbon is a concern in global warming and look at the evidence that proves this natural cycle is out of balance
- look at the life cycle of the forest and forest succession, and at the different processes in the forest to learn which store and which release carbon
- discuss the role of Canada's forests in acting as carbon sinks

Background

If we look at how nature operates without the influence of humans, we see what appears to be a series of perfect systems. These systems or cycles provide the basic needs of all life. When they are in balance, what is **waste** at one stage becomes a **resource** at another.

Carbon Cycle

Carbon atoms form the basis of all plant, animal and human life. The atmosphere contains only .03% carbon dioxide. At first glance, it might appear that we will run out of carbon. But if we look at the fact that life has existed on Earth for over three billion years we realize that something else is going on. Carbon is constantly being recycled through the environment.

The carbon atoms that we find in plants and animals come from the air, water and from rocks such as limestone. During photosynthesis, plants convert this carbon into a form usable by animals, including humans. Animals also release carbon atoms back into the atmosphere through the process of respiration.

Carbon Dioxide

One of the biggest concerns around global warming is the increase of carbon in the atmosphere. Levels of carbon dioxide, a greenhouse gas, have increased by over 30 per cent since 1700. This suggests that the carbon cycle is seriously out of balance. A big source of this carbon is the burning of fossil fuels (gas, coal, oil and wood). Fossil fuels are derived from living organisms that release carbon when they decay or are burned.

Forest Cycle

Forests grow, age and change their makeup over time in a process known as **succession**. In its early stage a forest is made up of many small plants that establish themselves quickly and grow rapidly. These plants create soil and, if the conditions are right, are in turn replaced by shrubs and other woody plants. Tree species eventually move in but even these may be replaced by other kinds of trees as the forest evolves and matures.

The forest grows rapidly when it is young, and eventually develops to full maturity when it becomes a **climax forest**, a stage where little growth or change occurs. While some types of forests may remain in this mature state for very long periods of time, forests eventually succumb to insects, decay, fire, wind damage, and other natural forces. To keep the forest cycle alive, mature trees fall to the ground, rot, and form the soil and nutrients needed to sustain the next generation.

Formula for Photosynthesis:

$$6\,CO_2 + 12\,H_2 = C_6H_{12}O_6 + 6\,O_2 + 6\,H_2O$$

1. Using the illustsration on page 35, discuss the carbon cycle with your class. Compare it to other cycles, for example the natural water, oxygen and nitrogen cycles, or industrial recycling processes (paper or metal). Your students may be aware or some of these cycles, but you may need to introduce them to others.

2. Using the formula for photosynthesis, ask your students to define how a forest absorbs carbon.

- What are the three substances created when carbon dioxide and hydrogen react with each other during photosynthesis? (*answer: sugars, oxygen and water*)
- Using this equation, what other cycles are also involved? (*answer: water cycle, oxygen cycle*)

3. Ask your students to research what it means when a cycle or system is in balance.

- Are there signs that the Earth's carbon cycle may be out of balance?
- Where does this extra carbon come from?

There are several examples in this booklet that they can study.

4. Discuss forest succession with the students using your local forest and forest species as an example. If you need help you may want to contact a local Model Forest, your provincial forestry association, or a provincial department or ministry of natural resources or forestry.

5. Ask the students to describe forest succession using their local forest as an example.

If at all possible, visit a local woodland or nearby forest. Ask your students to study the forest closely in relation to the carbon cycle, and to record their findings. For example:

- Identify trees of different ages.
- Are there many seedlings?
- How thick is the understorey of plants and shrubs growing under the taller trees?
- What is the forest floor composed of? Is there a lot of litter such as dead leaves, twigs, branches?
- Are there signs of the buildup of organic, carbon-storing matter?
- Does this forest appear to store a small or large quantity of carbon? Many forests will vary as you move through them. Some tree species will have very little undergrowth, while other parts of the forest will be very dense.

Mystery of the Missing Carbon #1

Each year the burning of fossil fuels releases about seven billion metric tonnes of carbon into the atmosphere. Scientists have been able to determine that three billion tonnes remain in the atmosphere and another two billion are absorbed by oceans. But what about the remaining two billion tonnes? If this carbon were not being absorbed somewhere, the levels of CO_2 would be rising even more dramatically then they are already. Scientists assume that plants absorb this missing carbon but they are not sure where this is happening and how much is being taken in.

BOREAS (see pages 6 and 10) is only one of many initiatives attempting to solve this scientific quandary. It studies the Earth's carbon cycle to gain a better understanding of global warming.

Mystery of the Missing Carbon #2

In 1999 Canada's 36 recycling mills used 1.6 million tonnes (about 13.5 times the weight of the CN Tower) of old newspapers to produce newsprint and packaging materials. More newspapers are recycled each year at Canadian mills than Canadians read. How can this be?

A. Canadians don't read their papers, they only use them to line bird cages and kitty litter boxes.

B. Canadians have been hoarding newspapers for decades and are only now putting them into their recycling bins.

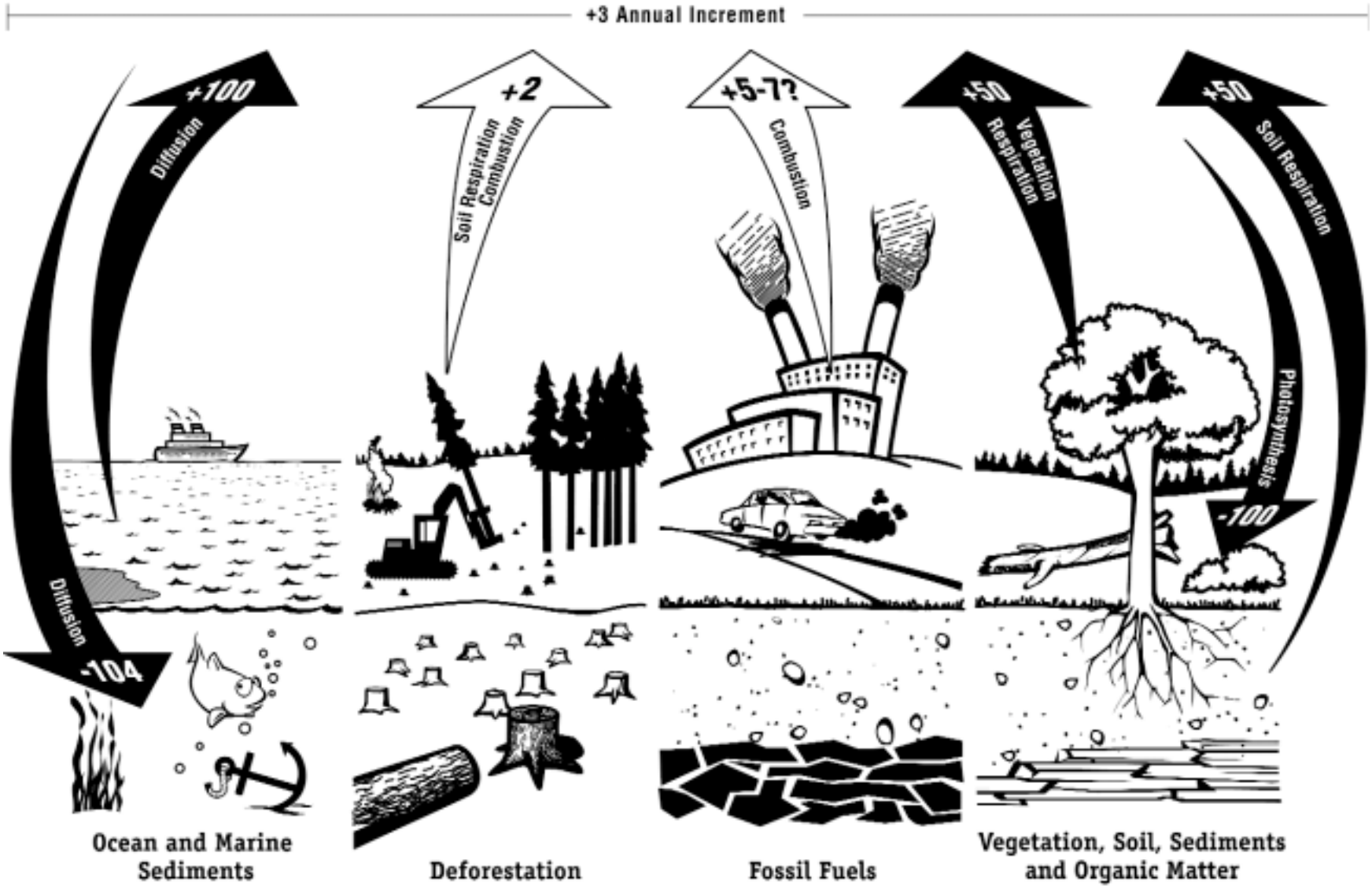
C. Canadian mills recycle not only Canadian newspapers but American newspapers.

See answer on page 39.

The Carbon Cycle

The carbon cycle is a natural process involving the transfer of carbon atoms to and from the atmosphere. The numbers in this illustration represent billions of metric tonnes. Scientists believe that the natural balance in this cycle has been altered by human activities such as the burning of fossil fuels and deforestation. Carbon is building up in the atmosphere as a greenhouse gas (CO_2), which is contributing to global climate change.

Forests play an important role in the carbon cycle, storing carbon in vegetation and soils, and in taking CO_2 out of the atmosphere through photosynthesis. It is important to note here that deforestation in this illustration means converting forested lands to other uses such as agriculture. This does not include managing forests through sustainable harvest and regeneration. Canada is a world leader in sustainable forest management.



Dealing with Climate Change: A Planetary Debate

Activity Info

Level: senior
Subjects: human geography, science, politics, global education
Duration: several class periods plus research time
Group: three to four; class
Setting: classroom
Preparation: Internet or library access

Summary

Students will research international organizations and their roles in dealing with global issues. Then, through role-playing and debate, they will look at some of the issues that negotiators face in trying to reach an international agreement addressing climate change.

Learning Outcomes

Students will:

- research various international organizations that deal with global issues
- explore the complexity of dealing with global issues
- through research, role-playing and debate, gain an understanding of the diverse issues facing negotiators working on international climate change agreements including:
  - credits for forests as carbon sinks and forest fire prevention
  - issues of fairness and global equity
  - economic and political issues

In 1987, Canada, along with 23 other nations, signed the Montreal Protocol on Substances that Deplete the Ozone Layer. This treaty is designed to reduce the use of ozone-depleting chemicals (CFCs and halons) and through this to prevent global environmental and health problems from reaching the crisis stage.

The Protocol continues to be updated and now more that 175 parties have implemented measures to reduce the emission of ozone depleting substances.

Background

Recently, a number of international efforts have been undertaken to address climate change. In 1997, representatives from 160 countries met in Kyôto, Japan to negotiate an agreement aimed at reducing world-wide emissions of greenhouse gases. In signing the **Kyôto Protocol**, 38 industrialized nations agreed to reduce emissions of six greenhouse gases. The United States, the European Union, Canada and others agreed that by 2012 their emissions would be about five per cent below the level of 1990 emissions.

The goal of the Sixth International Conference on Climate Change held in The Hague, Netherlands, November 2000, was to prepare a blueprint for cutting emissions of greenhouse gases and complete the agreement reached in Kyôto. More than 10,000 delegates attended but they faced great challenges. In the end, the talks were declared unsuccessful, with environmental groups and others blaming the United States, Canada, Japan and Australia for their failure. Another set of talks is scheduled for May 2001.

So, what went wrong?

"…humanity is for the first time instituting a genuine instrument of global governance … By acting together, by building this unprecedented instrument, the first component of an authentic global governance, we are working for dialogue and peace. We are demonstrating our capacity to assert control over our fate in a spirit of solidarity, to organize our collective sovereignty over this planet, our common heritage."

—Jacques Chirac, President of France, The Hague, November 2000

The challenges in negotiating an international agreement of this magnitude are enormous. Based on history, negotiators in The Hague and those participating in future workshops will continue to struggle with these issues.

Sovereignty and Politics

The issues that affect climate change do not respect national borders. Each nation, and its politicians, have their own priorities and concerns about other governments directing their future. Can the world negotiate effectively with the rich, energy producing/consuming countries in North America and Europe, and convince them to make the dramatic economic and lifestyle changes required?

Public Will

Does the public perceive climate change as a serious enough threat to deal with it? Where does it fit with the other challenges different countries face such as war and civil conflict, food supply, human rights? And, even in countries with few of these concerns, are people willing to make the necessary personal changes? What will it take to create this change in our public will?

Conflicting Evidence

Scientific and public opinion seem to be coming together and most agree that human activities contribute significantly to climate change and that climate change is a serious threat. Many nay-sayers have changed their views, but there are still conflicting opinions. In the December 2000 issue of *Nature* magazine, Canadian researcher Jan Veizer, challenged basic assumptions regarding global warming, saying that greenhouse gases may not drive climate change but simply amplify change set off by other factors. His research of 500 million years of geological records also appears to show that CO_2 increases were not always accompanied by planetary warming but by a drop in average temperature.

Points to Consider

Crediting Forests as Carbon Sinks

- Forest-rich nations such as Canada, could count our vast woodlands against our emissions-reduction commitments, while nations without forest resources or the climate to support forests, could not.
- So far, researchers have only made basic guesses as to how much carbon dioxide forests absorb, where they absorb it, and under what conditions.
- Forests probably absorb less carbon as they reach maturity. Would this mean that we need to designate forests as new or old?
- Some countries might want to count any forested area (seedlings, immature trees, stunted trees growing in inhospitable conditions). Would this be fair?
- Companies in industrial nations would like to be able to plant trees in developing countries and count these against their energy use at home.
- As the planet warms, a point is reached where the forests stop absorbing carbon and start releasing it. One study indicated that within 50 years the warmer temperatures would speed up the decomposition of organic matter in soil in the temperate forests. Based on this model, by the end of this century the forests might be responsible for an additional 2 C increase in the Earth's temperature. Another study indicates the increase could be as much as 5 C.

Reducing Energy Use

- Politicians don't want to raise the price of oil, gas or coal, or to make gas less available. Soaring gas prices in the fall of 2000 brought about a public demand for governments to act. In the United States, the government tapped the Strategic Petroleum Reserve to keep pump prices down.
- Credits should go to industrial countries that repair existing, or develop new, sources of power for developing nations.

Selling the Deal

- Politicians want a fair deal for their interests at home and they want to be re-elected.
- The United States delegation was adamant that it couldn't sell a strong climate change treaty at home.

Other proposals suggest that credits be given for:
- active forest management to prevent forest fires
- alternative energy sources (solar, wind, nuclear)
- agricultural lands as carbon sinks
- tillage methods that increase carbon stored in the soil as humus

1. Divide the class into groups and conduct a research project.

a) Ask each group to research one of the following international organizations:

- United Nations
- World Trade Organization
- World Bank
- UNESCO: United Nations Educational, Scientific and Cultural Organization
- International Institute for Sustainable Development
- International Model Forests
- IUCN: International Union for the Conservation of Nature

For each organization:

- describe the organization, its mandate and the issues it deals with
- list the participating countries
- outline some of the challenges or threats the organization faces, and its strengths and weaknesses
- provide brief examples of some of its successes and failures and, if possible, the reasons for these

Students should list their research sources to allow for a discussion of reliability and bias.

b) Ask each group to make a 10-minute presentation to the class summarizing their organization. This may take more than one class. Wrap up with a discussion about the role these international organizations play in our modern world, the types of problems they attempt to solve, and the challenges they face.

2. Conduct a class debate: Negotiating for Climate Change. Divide the students into working groups of three to four people. Assign each group a role to research and present from page 38. One person will act as spokesperson for the group but the others should play a key role as advisors and researchers. You may want to point out to the students that this mirrors the manner in which such discussions are normally conducted, with a minister or other person of authority speaking but drawing on the resources and expertise that others provide. Ask one student to act as a moderator to keep speakers to their allotted time and on track.

After sufficient research time, each speaker will be given three to five minutes to present a prepared statement on their position and a condition they would like met before signing an agreement on climate change. After all have spoken, the floor will be open for questions. Before speaking, each person should identify themselves and their affiliation. For example, "I am an advisor to the Minister of Energy addressing nuclear energy issues." Presenters may also ask questions. All questions should be clear and to the point.

If time permits, you may wish to allow each speaker one to three minutes to restate his or her point or to make a rebuttal of someone else's argument. If you choose to do this, give the groups time to debrief and to help their speaker construct the key points to back his or her statement.

Forest Minister, Forest-Rich Industrial Country

Your country has vast tracts of forest but you are a high consumer of fossil fuels. These forests are well managed, there is evidence that they store carbon, and you have an active program to prevent forest fires. You believe that you should be given credit for the important role these forests play in climate change.

Economist, Forest-Poor Industrial Country

Your country depends on its energy-consuming industries to drive its economy. You know that under the agreement you will be required to continue to reduce or limit your energy use. Your country is densely populated and what land you have is used for intensive agriculture, not forestry. Is it fair that others can gain credit for their forests allowing them to continue to use energy at their current level? Will this make their industries more globally competitive?

Energy Minister, Developing Country

You are seeking financial and political support to help your country develop nuclear energy. There are many pros and cons about nuclear energy but one of its benefits is that is does not produce CO_2. You don't have the resources to pay for it alone and you believe that, since it benefits the planet, other countries should help build it.

Hint: Heating a Canadian home for one year produces different amounts of CO_2 depending upon the energy source: wood: (12 tons), oil (11 tons), natural gas (seven tons), hydroelectricity and nuclear (zero tons).

Energy Official, Industrial Nation

You are responsible for providing energy to millions of people and you do so using a variety of sources including hydroelectric, nuclear and coal. You know that these energy demands will continue to grow. You would like to look at a variety of options including credit for supporting tree planting at home and in other countries of the world.

Politician, Industrial Country

Your country produces oil and is a high consumer of fossil fuels. You have had citizen protests at home demanding that you keep fuel prices low. You enjoy being a politician and want to be elected next term.

Government Official, Developing Country

Your small tropical country is working to improve the well being of its citizens. You agree that substances like CFCs and methyl bromide (used in agriculture) may contribute to global warming. But, you also recognize their value in providing much-needed refrigeration and in protecting food supply. You see a significant inequity in countries that have used these substances for years asking you not to use them, especially if alternatives do not exist.

Environmentalist, Industrial Nation

Your country is a serious contributor to the causes of climate change and you know that dramatic changes are needed in your policies at home. However, you also know that if these climate change talks fail completely it may take years before a similar process can be implemented.

Agriculturalist, Industrial Nation

There has been a great deal of discussion at these talks about credits for forests as carbon sinks. However, huge tracts of land in your country are given over to agriculture. Carbon is tied up in humus-rich soil and by the use of certain tillage methods. You believe that a method must be developed to credit countries with vast agriculture lands for their role in storing carbon.

As part of The Hague conference 118 young people between 12 and 18 years old from 61 different countries took part in a two-day Youth Conference. Afterwards, they issued a declaration which included a plea that:

"All of us, young and old, wherever we are, have the responsibility to reduce the negative effects of climate change. In addressing climate change we call on our adults and leaders to stop politicking and dwelling on petty differences.... The causes and the solutions of climate change are known. Now is the time to stop talking and to start acting."

— Youth Conference, 6th International Conference on Climate Change
The Hague, 19 November 2000

Glossary

atmosphere: *the mass of air surrounding the Earth like a blanket. It contains all the gases such as oxygen and carbon dioxide that living things need to survive.*

biomass: *the total mass of living organisms (plants, fungus, animals) per unit of area.*

carbon dioxide: *a gas found in our atmosphere that has one molecule of carbon and two molecules of oxygen.*

carbon reservoir: *a place where carbon is stored, for example in the deposits of underground fossil fuels (oil, gas, coal).*

carbon sink: *a place where carbon is accummulating or increasing.*

climate: *the average (typically 30 years) weather, including seasonal extremes and variations, that occurs either locally, regionally or globally.*

climate change: *the overall change in weather patterns — temperature, precipitation, wind, etc.*

colonizers: *plant species capable of moving into an area and beginning the process of succession.*

combustion: *burning, any chemical process accompanied by the emission of heat and light, typically by combination with oxygen.*

decomposition: *the process that biological materials (plant, animal) go through, breaking up (disintegrating, rotting) into component parts or elements.*

deforestation: *the removal of forests, the conversion of forested land to other uses, such as agriculture.*

diffusion: *the molecular mixing of one substance into another.*

ecosystem: *a complex community of organisms and the environment they live in. This includes all animals, insects, fungi, plants, bacteria, soil, air, water, rocks and people. For example, a forest ecosystem.*

environmental processes: *natural processes that keep the Earth healthy, much like the natural processes of our bodies (breathing, blood circulation). For example, the carbon cycle and the water cycle are environmental processes. By interfering with these processes, we can affect the health of the planet.*

evaporation: *the process which changes a substance from liquid to vapour or gas, the way water evaporates into the air.*

fossil fuels: *carbon based remains of organic matter that have been geologically transformed into coal, oil and natural gas. Combustion of these substances releases large amounts of energy. Currently, humans are using fossil fuels to supply much of their energy needs.*

forest succession: *the gradual process through which plant communities (especially trees) establish, live, grow old, and die, leaving space and nutrients for new growth.*

global warming (global cooling): *refers to a change in the global average surface temperature*

greenhouse effect: *the role that various gases in the Earth's atmosphere play in insulating and warming the Earth's surface.*

greenhouse gases: *carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and water vapour (H_2O); found naturally in the Earth's atmosphere, which trap the heat of the sun.*

green space (greenspace): *natural or human-created vegetated areas including forests, parks, woodlands, etc.*

land use plan: *a plan designed to designate land for various purposes (e.g. industrial, low-density residential, high-density residential, commercial, agriculture, forestry, recreation, parks, protected areas)*

ozone: *a highly reactive bluish coloured gas containing three molecules of oxygen. It is created from oxygen when electrical charges from lightning or machinery spark and cause a reaction. High amounts of ozone exist at ground level, but in the upper atmosphere the ozone layer blocks harmful ultraviolet radiation.*

ozone depletion (thinning ozone layer): *the loss of ozone from the upper layers of the Earth's atmosphere.*

photosynthesis: *the process that occurs in plants in the presence of sunlight converting carbon dioxide into sugars, water and oxygen*

respiration: *the process of CO_2 release in plants*

sink: *see carbon sink*

succession: *see forest succession*

urban forest: *the sum of trees lining streets and in yards, parks, ravines, woodlots and greenspace corridors*

UVA, UVB: *two of three types of ultraviolet radiation produced by the sun*

UVC: *ultraviolet radiation produced by the sun but does not reach the Earth's surface; helps form the ozone layer by providing energy to break apart oxygen atoms allowing them to recombine with whole oxygen molecules to form ozone*

weather: *temperature, snowfall and rainfall, winds and clouds, that change from day to day and season to season in a particular location*

Quiz Answers

How Trees Help the Planet
page 25

1. Birds nest in trees
2. Birds and animals eat the seeds or berries of trees.
3. Woodpeckers eat the insects that live in trees.
4. Insects lay their eggs on trees.
5. Deer feed on the branches of some species of trees.

Just Do the Math!
page 26

1. # of students in class x 4

2a) $1,080

2b) 600

3. total # km x .025 (500 trees divided by 20,000 km)

4a) 72 hectares (180 acres)

4b) 3,240

4c) Trees in #1 are large, mature trees. In #4 they are younger and include seedlings and very small trees.

5. 100 trees

Mystery of the Missing Carbon #2
page 34

The answer is C. In fact, this is part of a cycle. Trucks carry newsprint into the US where it is used to print newspapers and then the used paper is returned here for recycling.

Other Internet Links

Canadian Centre for Climate Modelling and Analysis
http://www.cccma.bc.ec.gc.ca/eng_index.shtml

Climate Change Solutions
www.climatechangesolutions.com

CSIRO Division of Atmospheric Research (Australia)
www.dar.csiro.au/

Natural Resources Canada
www.NRCan.gc.ca

Natural Resources Canada, Adaptation to Climate Change
http://sts.gsc.nrcan.gc.ca/adaptation/

NOAA Climate Monitoring and Diagnostics Laboratory
www.cmdl.noaa.gov

NOAA El Niño Theme Page
www.pmel.noaa.gov/toga-tao/el-nino/nino-home.html

Ontario Christmas Tree Growers
www.christmastrees.on.ca

Pembina Institute for Appropriate Development
www.pembina.org

University of Victoria, Climate Modelling Group
http://climate.uvic.ca/

United Nations Framework Convention on Climate Change
www.unfccc.de/

US EPA Global Warming Site
http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

US NOAA-CIRES Climate Diagnostics Center
www.cdc.noaa.gov/

CFA Programs www.canadianforestry.com

Envirothon

Envirothon is an international environmental education program for secondary school students. In Canada, Envirothon is a Canadian Forestry Association program, delivered in partnership with the provincial forestry associations across the county. Envirothon is delivered through local schools with the assistance of sponsoring organizations and individuals.

Envirothon has three components:

- School-based learning, guided by a set of expectations and key references.
- Workshops and field trips led by local professionals.
- Regional, provincial and international team competitions, including an outdoor component and group presentations.

Envirothon is important to CFA because it allows us to reach secondary school students and raise their level of knowledge on environmental issues and ecological sustainability principles.

For more information on Envirothon contact the CFA in Ottawa or the provincial forestry association in your province. There is a list of contacts for those associations on the inside front cover of this teaching kit.

Photos: International Envirothon Competition 2000, Nova Scotia

National Forest Week

The CFA has been the sponsoring agency for National Forest Week in Canada for over 70 years. National Forest Week allows the CFA to work with partners across the country to raise awareness of forest issues.

The CFA and the provincial forestry associations work together to set a theme for the week. The theme then becomes the focus for a series of educational and public information campaigns and activities across Canada.

The federal and provincial governments, forest industry, regional and community organizations, and educational institutions take part in National Forest Week activities.

National Fire Education Program

Fire remains an important element of the CFA's public education program. The CFA is Smokey Bear's home in Canada. Smokey has been carrying the flag for forest fire prevention since 1940, and his message is as important now as it has ever been. A large number of forest fires are still caused by human carelessness.

CFA's Smokey Bear program allows us to get that important forest fire prevention message out to school children, but it also provides an opportunity to talk about the critical and positive role of fire in some forests ecosystems.

The CFA distributes a large and very popular selection of promotional items under the Smokey Bear program. Contact our Ottawa Office for information.

Forest Capital of Canada

Each year, the Canadian Forestry Association designates one community in Canada as the Forest Capital of Canada. The Forest Capital community then becomes the focal point for a series of forest education and public information activities, programs and events.

The Forest Capital of Canada program allows the CFA to bring municipalities, industry, and community organizations together to build understanding of forest issues at the local level. It also allows communities to highlight and celebrate their rich forest heritage on a national level.

Partners in Forest Education

Environment Canada / Environnement Canada

Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts

Ontario

Model Forest Network / Réseau de forêts modèles

National Forest Strategy Coalition / Coalition pour la stratégie nationale sur les forêts

Alberta Environment

Weldwood

StoraEnso

Tembec

TD Bank Financial Group

The Royal Canadian Geographical Society / La Société géographique royale du Canada

Weyerhaeuser
The future is growing™

Tree Canada Reboisons le Canada

Herb Shaw & Sons Ltd.
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Established 1847

CCGE CCEG
Canadian Council for Geographic Education
Conseil canadien de l'enseignement de la géographie

Forest Products Association of Canada / Association des produits forestiers du Canada

John Deere

Ducks Unlimited Canada

LP
LP is a trademark of Louisiana-Pacific Corporation

Bank of Montreal

The Canadian Forestry Association gratefully acknowledges these organizations for their assistance in the development of the Canada's Forests Teaching Kit.

Canadian Forestry Association

since 1900

The CFA is Canada's
oldest conservation organization,
with a rich legacy
of public education and advocacy,
promoting the wise use
of Canadian forest resources.
