THE KYOTO PROTOCOL;
A SENIOR CURRICULUM UNIT

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UNIT OUTLINE

8. Appendices:

Appendix 1 – Government response:

a - Housing and Commercial/Institutional Buildings
b - Large Industrial Emitters
c - International Emissions Reductions
d - What is a carbon sink?
e - What is a megatonne?
f - Covenants and Emissions Trading
g - Targeted Measures
h - Climate Change and Clean Air
i - Vehicles and Fuels
j - What are biofuels?
k - What are fuel cells?

Appendix 2 – Climate change and Ecosystems

(an optional activity for Science)

Appendix 3 – Global Warming: Early Warning Signs

(an optional activity)

Global Education Primer *

What is Global Education?

Global Education teaches students about the inter-connections between social justice, economic, environmental and political issues. Global Education can be brought into all subjects and levels of the curriculum.

See the home page of our web site at www.global-ed.org for more information.

What will students learn?

- To understand the connections between the world and its people.
- To understand human potential and equality across the globe.
- To look at the universe from different perspectives.
- To have an informed understanding of justice, human rights and responsibilities.
- To make our natural environment sustainable.

Why Teach Global Education?

- Students learn to be more tolerant, understanding and accepting of others.
- Students learn about developing countries and how to discuss development issues.
- Global Education increases greater understanding between cultures within a school environment.
- Students learn to be more socially responsible.
- Issues raised have links to many curriculum requirements.
- Students gain a positive outlook on making the world more peaceful.
  Global Education makes any curriculum more authentic and exciting..

*Adapted from CHF/Partners (www.partners.ca) Jan. 2003

CONNECTIONS TO THE GLOBAL EDUCATION STRANDS

The theme of the Kyoto is perfectly suited to a curriculum unit intended to help students gain a more global perspective of important world issues. Below is a table illustrating the connections between the four branches of Global Education and global warming.

PEACE & JUSTICE • we are all affected by the use of fossil fuels • conflicts are due to the competition for access to fossil fuels •are carbon credits fair? •territorial conflicts arise due to changing borders caused by increased sea levels •unequal development rates for LDCs experiencing global warming	**THE ENVIRONMENT** • burning of fossil fuels & green house gas emissions contribute to global warming, • links to other environmental disasters • impacts on natural habitat and wildlife • loss of bio-diversity due to climate change
HUMAN RIGHTS • basic human right of access to a clean supply of water and air and to clean soils and grounds • basic human right is to be surrounded by natural resources necessary to sustain life • human right to participate in a society that is developing in a manner consistent with the preservation and enhancement of life.	**SUSTAINABLE DEVELOPMENT** • dominance of multinationals over the extraction and supply of fossil fuels • need for alternative energy sources • opportunity for development of appropriate technology and alternative energy sources internationally (e.g. biogas, solar, wind, tidal power etc.) • development strategies for developing nations (situationally appropriate technologies)

Head, Heart and, Hand

A global education unit also, typically, does more than just present facts. It strives to involve students at three different levels.

HEAD: Intellectual
The "head" presents as many of the facts as possible, touching on all four of the aspects mentioned above. The student is also made aware of many other sources of information, which can be accessed via the Internet. These activities will try to help them assimilate this information, analyse it, practice some critical thinking, undertake research and share this information with fellow students.

HEART: Involvement of students:
The "heart" involves an examination of the basic human and moral values found within these issues. Without these activities, a critical analysis remains simply a cold, intellectual exercise, which will not help the students integrate and act upon the knowledge he/she has gained.

HAND: Action:
The "hand" involves searching for and examining possible solutions to the problems that students have learned about, and ways that we can work individually and collectively to reduce greenhouse gas emissions and meet the needs of the Kyoto Agreement. We need to help students develop a sense of empowerment as consumers and as potential future participants in the quest for social justice, peace and a healthy economy and environment. There are a number of solutions to global warming, which can be tackled individually, or together, and at the industrial, regional, national and international level.

CONNECTIONS TO THE ONTARIO CURRICULUM

Climate Change Unit

Ontario Curriculum: Overall Learning Expectations

Note: For the prepared climate change/global warming unit, only the "Overall Learning Expectations" have been included in the list below. It should be noted that within the Ontario Curriculum
Documents, there are several specific learning expectations that the unit meets as well.

Physical Geography: **Patterns, Processes and Interactions**,
Grade 11, University/College Preparation: (CGF3M)

Geographic Foundations: Space and Systems:

- explain the sources and nature of energy flows through the lithosphere, atmosphere, hydrosphere and biosphere.

Human-Environment Interactions:

- evaluate the impact of human life on natural systems;
- demonstrate an understanding of the importance of stewardship and sustainability as guiding principles for human use of the physical environment.

Global Connections:

- analyse local, regional, and global issues related to physical geography.

Understanding and Managing Change:

- analyse the causes and consequences of past and future climate change.

Methods of Geographic Inquiry:

- use geographic skills, methods, and technologies to gather, analyse and synthesize ideas and information;
- use a variety of methods and technologies to communicate the results of geographic inquiry and analysis effectively;
- describe careers related to physical geography.

Canadian and World Issues: **A Geographic Analysis**,
Grade 12, University Preparation (CGW4U)

Geographic Foundations: Space and Systems:

- explain the complex nature of the earth's natural and human systems;
- demonstrate an understanding of the cultural, economic, and political aspirations of selected groups and the effects of their actions on local, national, and global issues.

Human-Environment Interactions:

- analyse selected global trends and evaluate their effects on people and environments at the local, national, and global level;
- analyse geographic issues that arise from the impact of human activities on the environment in different regions of the world;
- evaluate approaches, policies, and principles relating to the protections and sustainability of the planet's life-support systems.

Global Connections:

- analyse instances of international cooperation and conflict and identify factors that contribute to each;
- identify the contributions made by a variety of individuals, organizations, and institutions to sustainable development strategies for the developing world, and evaluate their economic, environmental, and social impacts.

Understanding and Managing Change:

- analyse, forecast, and evaluate changes in the human use of the earth and its resources;
- evaluate the effectiveness of methods used by different organizations, governments, and industries to find short- and long-term solutions to geographic problems and issues at the local, national and global level.

Methods of Geographic Inquiry:

- use a variety of methods and technologies to communicate the results of geographic inquiry and analysis effectively;
- select and apply appropriate decision-making and problem-solving strategies to develop solutions for geographic problems and issues;
- conduct an independent inquiry that effectively applies geographic knowledge, skills, methods, and technologies to a selected local, national, or global geographic issue.

World Geography: Human Patterns and Interactions,
Grade 12 University Preparation (CGU4U)

Geographic Foundations: Space and Systems:

- explain the influence of social, political, cultural, and economic factors on human environments and activities.

Human-Environment Interactions:

- explain how humans have modified the natural environment.

Global Connections:

- evaluate the effects of the information revolution, technological progress, and global trade on world regions.

Methods of Geographic Inquiry:

- use forecasting, problem-solving, and decision-making models to develop solutions for geographic issues and problems.

The Environment and Resource Management,
Grade 12, University/College Preparation (CGR4M)/ Grade 12, Workplace Preparation (CGR4E)

Geographic Foundations: Space and Systems:

- analyse and explain relationships between the earth's major components: the lithosphere, atmosphere, hydrosphere, and biosphere.

Human-Environment Interactions:

- demonstrate an understanding of how humans are an integral part of an ecological system and of how human activity has short- and long-term effects on the natural environment;
- analyse and evaluate interrelationships between the environment, the economy, and society.

Understanding and Managing Change:

- evaluate the impact of economic, social, political, and technological change on natural environments;
- analyse the purpose and effects of current and evolving environmental legislation and regulations at the local, provincial, and national levels;
- evaluate a variety of ways to resolve environmental and resource management concerns on the local, regional and global scale.

Methods of Geographic Inquiry:

- use geographic skills, methods, and technologies to gather, analyse, and synthesize information on environmental andresource management issues and concerns;
- describe careers related to the environment and resource management.

The Kyoto Protocol

Source: Industry Canada

The Kyoto Protocol is an international agreement to address climate change by reducing greenhouse gas emissions, caused primarily by burning oil, gas and coal and by deforestation. The Protocol encourages countries around the world to move to more environmentally responsible ways of producing and using energy, in order to meet their targets for emission reductions.

The Kyoto Protocol was signed by 179 countries in Kyoto, Japan, in December 1997. The protocol commits 38 industrialized countries to cut their emissions of greenhouse gases between 2008 and 2012 to levels that are 5.2 per cent below 1990 levels.
The Parliament of Canada ratified the protocol on December 11, 2002.

1- The Greenhouse Effect

The "greenhouse effect" refers to the natural phenomenon that keeps the Earth in a temperature range that allows life to flourish. The sun's enormous energy warms the Earth's surface and its atmosphere. As this energy radiates back toward space as heat, a portion is absorbed by a delicate balance of heat-trapping gases in the atmosphere -- among them carbon dioxide and methane -- which creates an insulating layer. With the temperature control of the greenhouse effect, the Earth has an average surface temperature of 59°F (15°Celsius). Without it, its average surface temperature would be 0°F (-18°Celsius), a temperature so low, that the Earth would be frozen and could not sustain life.

"Global warming" refers to the rise in the Earth's temperature resulting from an increase in heat-trapping gases in the atmosphere.

2- Greenhouse Gases

How are greenhouse gases produced and what impact do they have on the environment? Greenhouse gases is a term used for gases (like carbon dioxide) which are mainly generated as a result of burning fossil fuels like coal, petrol and diesel.

While, the use of these fuels have helped industrialization enormously, it has caused a steady increase in levels of carbon rich gases and other pollutants. Scientists predict that higher levels of greenhouse gases will cause a significant warming of the earth by about one to five degrees celcius. This could cause potentially disastrous changes in the environment like violent storms, expanding deserts and melting ice caps, causing sea levels to rise and engulf coastal regions. According to one estimate, global warming could cause the world about $5 trillion. Developing countries are expected to be the hardest hit as they try to develop new industries to be able to compete with other and more industrialized nations.

The sources of greenhouse gases are varied and most of them occur naturally. However modern industry and our lifestyles have led to new sources of greenhouse gases, as well as to the emission of entirely new greenhouse gases. The most important greenhouse gases are listed in Appendix 1 below.

3- Global Warming

Weather and Climate

Weather is the state of the atmosphere at a given time and place, defined by variables such as temperature, moisture, wind, and barometric pressure. It is highly variable from day to day. By contrast, climate describes long-term weather patterns, with average temperatures and precipitation totals as well as typical occurrences of climatic extremes (such as normal dry periods or tropical storms) being used to characterize the climate for a particular region. This distinction is very important. Averages are always made up of numbers differing from the mean. Global warming is about the average going up. Over time this will make extreme colds become less likely.

The Intergovernmental Panel on Climate Change

In 1988 the United Nations Environment Programme and the World Meteorological Organization set up the Intergovernmental Panel on Climate Change (IPCC) to examine the most current scientific information on global warming and climate change. More than 2,500 of the world's leading climate scientists, economists, and risk experts from about 100 countries have contributed to the panel's most recent report, Climate Change 2001: The IPCC Third Assessment Report. These scientists reviewed all the published and peer-reviewed scientific information produced over the last few years to assess what is known about the global climate, why and how it changes, what it will mean for people and the environment, and what can be done about it.

The Third Assessment Report is the most comprehensive and up-to-date evaluation of global warming and serves as the basis for international climate negotiations.

The Intergovernmental Panel on Climate Change concluded in its Third Assessment Report, "An increasing body of observations gives a collective picture of a warming world and other changes in the climate system." The kinds of changes already observed that create this consistent picture include the following examples of observed climatic changes:

- Increase in global average surface temperature of about 1 degree Fahrenheit in the 20th century
- Decrease of snow cover, sea-ice ice extent and the retreat of mountain glaciers in the latter half of the 20th century
- Rise in global average sea level and the increase in ocean water temperatures
- Likely increase in average precipitation over the mid- and high-latitudes of the Northern Hemisphere, and over tropical land areas
- Increase in the frequency of extreme precipitation events in some regions of the world

As a result of an enormous scientific effort over the past 10-15 years to better understand the climate system and its relationship to human activities, there now is a growing consensus among mainstream scientists about the reality of global warming. As Dr. Robert Watson, then Chairman of the Intergovernmental Panel on Climate Change, said in 2001,

> " The overwhelming majority of scientific experts, whilst recognizing that scientific uncertainties exist, nonetheless believe that human-induced climate change is already occurring and that future change is inevitable."

This captures the conclusions of the most recent comprehensive assessment of the state of climate change science by the Intergovernmental Panel on Climate Change (IPCC).

The findings of the IPCC's Third Assessment Report ("Climate Change 2001") unequivocally paint a collective picture of a warming world. The report forms the authoritative new benchmark of what is known about climate change science and represents an unprecedented consensus among hundreds of climate change scientists from all over the world.

Scientists have concluded that human activities are contributing to global warming by adding large amounts of heat-trapping gases to the atmosphere. Our fossil fuel use is the main source of these gases.

Since pre-industrial times, the atmospheric concentration of carbon dioxide has increased by 31 percent. Over the same period, atmospheric methane has risen by 151 percent, mostly from agricultural activities like growing rice and raising cattle.

As the concentration of these gases grows, more heat is trapped by the atmosphere and less escapes back into space. This increase in trapped heat changes the climate, causing altered weather patterns that can bring unusually intense precipitation or dry spells and more extreme severe storms.

There is also clear recognition that certain activities are having a harmful effect on the environment and that the choices we make today can determine the health of our environment – not only for tomorrow or next year, but 100 years from now.

One of the most pressing environmental challenges is that of global warming. The international scientific community has concluded that the rapid increase in the concentration of greenhouse gas emissions in the atmosphere can be expected to increase the earth's surface temperature, change our climate, alter our environment and endanger our health.

Climate change involves the systematic change of the global atmosphere, which is inseparably linked to the oceans, the biosphere, and the world's water cycle, including its ice sheets and glaciers. Each of these components is immensely complex, incompletely understood, and linked -- via myriad feedback loops -- to each other. Changes in any one of these components can affect the functioning of any of the other systems. If understanding any part of this complex system weren't hard enough yet, add humans to the mix! Our activities have fundamentally affected not only the atmosphere, but each of the other systems as well.

Throughout the ten thousand year history of human civilization, weather patterns have remained relatively constant. Though floods, droughts, storms and other extreme weather events have always been a reality, they have been rare occurrences interrupting long periods of calm - sudden outbursts of violence marring a gentle rhythm.

Now, because of human induced climate change, that gentle rhythm is breaking up.

Implications for Canada

Climate change is happening. Its impact on ecosystems, economies and local weather has begun. In Canada we can expect climate change to bring an unprecedented warming of 0.2 degrees Celsius per decade. This may appear minor, but scientific analysis has shown that very profound changes will result from this steady rise in temperature.

Canadians should be warned that rising average temperatures do not simply mean balmier winters. Some regions will experience more extreme heat, while others may cool slightly. Flooding, drought, and intense summer heat could result. Scientists also say that violent storms

and other extreme weather events could result from the increased energy stored up in our warming atmosphere.

Because scientists expect that northern nations will be more affected by climate change than those closer to the equator, Canada is particularly vulnerable. We are already feeling the effects: increasing heat waves and related health problems, declining water levels in the Great Lakes, changes in fish migration and melting polar ice caps, as well as insect infestations in British Columbia's forests.

The sooner we act to reduce greenhouse gases, the gentler future impacts will be.

There are few things more fundamental to Canadians than the rich natural legacy we have inherited. Canadians understand the importance of the environment, both to the quality of life we enjoy and to our future economic progress.

The frequency of extreme weather events has increased steadily over the 20th century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. One in five Canadians was directly affected by a weather disaster between 1996 and 2000.

These disaster trends confirm the predictions of computer models: climate change will not simply produce a gradual rise in temperature, but an increase in the frequency and severity of extreme weather events.
We are ushering in a world of extremes.

Considering that in some regions people experience large daily temperature ranges (20-30°F), climate skeptics try to convince the public that global warming by a few degrees is nothing to worry about. This is another version of deliberately confusing weather and climate (see above). A small increase in the average temperature, however, obscures extremes and patterns of warming that are quite troubling: nighttime temperatures increase more than daily averages; there are already and will be more extreme heat but less extreme cold events; poleward latitudes warm more than other areas, etc. While the benefits of warming pointed out in the skeptics argument are certainly among the potential impacts of climate change, the potential negative impacts – such as heat-related illnesses and deaths, increased heat stress for crops, greater energy needs for cooling etc. -- are strategically omitted. Moreover, it bears emphasis that the difference in global average temperature between the last ice age and the present day is about 9°F! This puts the IPCC's projected range of climate change-related global average temperature increases of 2.5-10.4°F in an entirely different light.

After a decade of controversial reporting and public debate, some skepticism lingers in the public at large and is still rampant among industry groups and their proponents who fear adverse economic impacts from taking action on global warming. While their main tactic now is to dismiss potential solutions to the problem -- in particular the 1997 Kyoto Protocol to the UN Framework Convention on Climate Change -- climate skeptics continue to attack the science in order to undermine an essential and rational basis for cost-effective, sustainable action on this global problem.

In the IPCC's 2001 assessment of the scientific basis of climate change, the experts draw three important conclusions:

1-Climate change is underway.

2-Human activities do and will continue to alter the composition of the atmosphere.

The IPCC states, "emissions of greenhouse gases and aerosols due to human activities continue to alter the atmosphere in ways that are expected to affect the climate." Adding that trends of

greenhouse gas emissions from human activities point further upward, the scientists argue that significant emission reductions would be necessary to stabilize the climate.

3-Recent warming can be largely attributed to human causation. More strongly than ever, the IPCC states in its 2001 assessment, "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

4- The Impacts

> "All countries suffer from the impacts of climate change, including adverse effects on their agriculture, public health, food safety and the security of coastal communities, but developing countries are particularly vulnerable. A combination of poverty and a lack of technical capacity limits their ability to deal with the issue, increasing its impact on the global ecosystem. Moreover, developing countries are geographically more likely to be subject to more intense adverse effects of climate change."
> (CIDA web site)

a-The temperature

The Third Assessment Report from the Intergovernmental Panel on Climate Change projects that the Earth's average surface temperature will increase between 2.5 and 10.4°F or 1.4 to 5.8°C between 1990 and 2100 if no major efforts are undertaken to reduce the emissions of greenhouse gases (the "business-as-usual" scenario). This is significantly higher than what the Panel predicted in 1995 (1.8-6.3°F or 1.0-3.5°C), mostly because scientists expect a reduced cooling effect from tiny particles (aerosols) in the atmosphere.

Scientists predict that even if we stopped emitting heat-trapping gases immediately, the climate would not stabilize for many decades because the gases we have already released into the atmosphere will stay there for years or even centuries. So while the warming may be lower or at a slower rate than predicted if we reduce emissions significantly, global temperatures cannot quickly return to today's averages. And the faster and more the Earth warms, the greater are the chances for some irreversible climate changes.

An increase of a few degrees won't simply make for pleasantly warmer temperatures around the globe. Even a modest rise of 2° to 3°F or 1.1-1.7°C could have dramatic effects. In the last 10,000 years, the Earth's average temperature hasn't varied by more than 1.8°F or 1.0°C. Temperatures of only 5° to 9°F or cooler than those today prevailed at the end of the last Ice Age, in which much of North America was covered by up to 3,000 m of ice.

The 20th century was the warmest century of the last millennium; the 1990s were the warmest decade of the last century and the years 1999 and 2001 were the warmest years yet. This is well beyond the range of natural climate variability.

In Canada we are already feeling the effects of climate change, in the form of
• increasing number and intensity of heat waves and related health problems;
• declining water levels in the Great Lakes;
• changes in fish migration and melting of the polar ice cap;
• insect infestations in British Columbia's forests;
• hotter summers and higher levels of smog in major urban centres; and
• more extreme weather events such as droughts on the prairies, ice storms in eastern Canada, flooding in Manitoba and Quebec.

As climate change-related events such as these become more frequent, they will have an increasingly profound effect on our economy, our health and our quality of life.
Scientists predict that continued global warming on the order of 2.5-10.4 °F or 1 to 3.5 °C over the next 100 years (as projected in the IPCC's Third Assessment Report) is likely to result in:

- a rise in sea level between 3.5 and 34.6 in. or 15 to 95 cm leading to more coastal erosion, flooding during storms and permanent inundation.
- severe stress on many forests, wetlands, alpine regions, and other natural ecosystems.
- greater threats to human health as mosquitoes and other disease-carrying insects and rodents spread diseases over larger geographical regions
- disruption of agriculture in some parts of the world due to increased temperature, water stress and sea-level rise in low-lying areas such as Bangladesh, many small island states such as the Maldives or the Mississippi River delta.
- huge increase in incidents of drought and flooding - therefore widespread crop failures in countries with fragile agricultural systems, which will lead to increased famine. As a consequence, we may see an increase in migrations from those affected areas.

b-Health

Human health will be strongly impacted by climate change.
As climate change brings tropical weather to higher latitudes, tropical diseases - like the West Nile virus - will follow. Ecosystem disruption will make the outbreak of water-borne diseases more likely.
There may be a huge increase in infectious diseases particularly in tropical countries, as the range of malaria and dengue fever bearing mosquitoes increases in what were previously more temperate zones.
Increased droughts, especially in poorer countries, could reduce the supply of fresh water resulting in major threat to public health.
There may be more water pollution and tainted drinking water due to more flooding from erratic storms; particularly in overcrowded 3rd world cities with fragile sewer systems and inadequate infrastructures.

Air pollution, which is largely caused by fossil fuel use, is already a scourge on public health. Climate change will make smog more intense, and lead to still higher rates of asthma and heart disease.
The most devastating casualties will be among inhabitants of poor countries, where there is little infrastructure to deal with changing water tables and increased extreme weather. Among the world's least privileged, the potential for climate induced disaster is enormous.

According to the Government of Canada, air pollution prematurely kills at least 16,000 Canadians each year. Recent studies show that close to eight per cent of all non-traumatic mortality in Canadian cities is attributable to air pollution.
Burning fossil fuels is the main cause of both air pollution and climate change, and scientists believe that climate change will actually make air pollution an even greater health threat - unless fossil fuel emissions are drastically reduced.

c-The environment and biodiversity

Climate change is altering the patterns of life on the planet, and scientists have already blamed it for species extinctions, migrations and behaviour changes. Disproportionately large temperature rises in northern latitudes mean countries like Canada will experience some of the most serious impacts on biodiversity. See Species at Risk and Parks in Peril.

A changing climate forces plants and animals to migrate in order to survive. However, research has shown that most plant species are able to migrate at only one tenth of the speed required to keep up with human-induced climate change.

To make matters worse, human settlements and infrastructure have already subdivided ecosystem habitat into isolated patches. Climate change will make many of these patches uninhabitable for the species which live there, and they will be unable to escape.

Signs of climate stress are already apparent among wildlife:

Scientists view climate change as one of the causes of a dramatic drop in Pacific salmon populations along the west coast of North America. In 1999, scientists blamed global warming induced climate change for the disappearance of 20 Costa Rican frog species. British birds are laying their eggs earlier due to warmer springs in the last 20 years. Researchers worry this may affect survival, if food such as insects are not available when chicks hatch. In Europe, butterflies have shifted their boundaries north over the past 30 to 100 years, and rising temperatures are killing them at the southern extreme of their ranges.

Examples of observed physical and ecological changes:

- Thawing of permafrost
- Lengthening of the mid- and high-latitude growing season
- Poleward and upward shift of plant and animal ranges
- Declines of some plant and animal species
- Earlier flowering of trees
- Earlier emergence of insects
- Earlier egg-laying in birds

Global warming has also affected the prey of killer whales off the coast of Alaska. They now resort to hunting sea otters since sea lions and harbour seals are absent from their range. Scientists say the sea lions and seals have moved away because global warming has altered fish migration patterns. The loss of sea otters sets off a chain reaction that destroys kelp beds, an important habitat for many ocean species.
A receding Arctic icecap and earlier than normal breakup of sea ice has affected polar bears, which depend on sea ice to hunt seals. Recent studies showed polar bears in some regions were down a third in body weight. The latest generation of seals was also found to be much thinner than usual.
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Recent research has led scientists to predict that global warming could eliminate coral from most areas of the world by 2100. These abundant ecosystems are home to a fourth of all marine fish species. In 1998, record sea temperatures triggered the largest mass die-off of coral in modern times. The impact of global warming on Australia's Great Barrier Reef is expected to become severe by 2050.

d-Ground level ozone

Ground level ozone is the nasty cousin of stratospheric ozone. Whereas stratospheric ozone (the "ozone layer") protects plants and animals from ultraviolet radiation, ground level ozone is a primary ingredient of smog. Higher temperatures increase ground level ozone production - thus climate change will intensify urban smog.
Ozone is toxic at low concentrations and deadly at high concentrations. It bursts cell membranes in the lungs, and as cellular fluids build up, breathing becomes more rapid, shallow and painful. The elderly and children are especially vulnerable, and ozone can lead to lifelong damage as lungs stiffen and scar. Ozone also sensitizes the airways to irritants and other allergens. Elevated ozone levels mean more hospital admissions for asthma, respiratory disease and acute respiratory disorders.

e-Toxic Brew

Air pollution from burning fossil fuels produces many other compounds that hurt our health: carbon monoxide, nitrogen oxide, sulphur dioxide, volatile organic compounds, and small airborne particulates. They can cause impaired lung function, shortness of breath, wheezing, asthma attacks and premature death.
Air pollution is also the primary culprit behind rising levels of asthma. A recently published 10-year study of Southern California communities showed that children living in smoggy areas were three to four times more likely to develop asthma than those living in cleaner areas.
By reducing our use of coal, oil and natural gas, we can save thousands of lives and lessen the threat to human health of both climate change and air pollution.

Global warming and of stratospheric ozone depletion are two separate but related threats. Global warming and the greenhouse effect refer to the warming of the lower part of the atmosphere (also known as the troposphere) due to increasing concentrations of heat-trapping gases. By contrast, the ozone hole refers to the loss of ozone in the upper part of the atmosphere, the stratosphere. This is of serious concern because stratospheric ozone blocks incoming ultraviolet radiation from the sun, some of which is harmful to plants, animals and humans.

The two problems are related in a number of ways, including:

- Some human-made gases, called chlorofluorocarbons, trap heat *and* destroy the ozone layer. Currently, these gases are responsible for less than 10 percent of total atmospheric warming, far less than the contribution from the main greenhouse gas, carbon dioxide.

- The of stratospheric ozone layer traps heat, so if it gets destroyed, the upper atmosphere actually cools, thereby offsetting part of the warming effect of other heat-trapping gases. But that's no reason to rejoice: the cooling of the upper layers of the atmosphere can produce changes in the climate that affect weather patterns in the higher latitudes.

- And finally, trapping heat in the lower parts of the atmosphere allows less heat to escape into space and leads to cooling of the upper part of the atmosphere. The colder it gets, the greater the destruction of the protective ozone layer.

Reducing ozone-depleting gases is crucial to preventing further destruction of the ozone layer, but eliminating these gases alone will not solve the global warming problem. On the other hand, efforts to reduce all types of emissions to limit global warming will also be good for the recovery of the ozone layer.

Female caribou migrate in spring to small pockets of vegetation where they feed and raise their calves. But for the last 10 years, spring has come so early that by the time the caribou reached the coastal plain, their principal food plant had already gone to seed.

5- History and Contents of the Kyoto Protocol

The concept of sustainable development dates back a long way but it was at the UN Conference on Human Environment (Stockholm, 1972) that the international community met for the first time to consider global environment and development needs.

The 20th anniversary of Stockholm took place in 1992 in Rio de Janeiro. The UN Conference on Environment and Development, the "Earth Summit", agreed on Agenda 21 and the Rio Declaration.
The Summit brought environment and development issues firmly into the public arena. Along with the Rio Declaration and Agenda 21 it led to agreement on two legally binding conventions: Biological Diversity and the Framework Convention on Climate Change (FCCC)

In 1992, that approach was launched with more than 155 countries, including Canada, signing the United Nations Framework Convention on Climate Change (UNFCCC). Since then, a number of United Nations conferences have been held, including one in Kyoto, Japan in 1997.

The outcome of that conference was a Protocol to the UNFCCC. The Kyoto Protocol established legally binding targets for those industrialized countries that ratify the agreement and the timeframes within which those targets are to be met. Additional operational details were agreed to at subsequent meetings in Bonn, Germany and Marrakech, Morocco.
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The Protocol points us toward a future of lower greenhouse gas emissions, greater energy efficiency, sustainable growth, innovative technologies and cleaner air. At the same time, the Protocol represents only a first step – not the last word – on climate change. It will continue to evolve and, as it does so, we will take every opportunity to ensure that it is improved and strengthened.

Similarly, as we move forward we will work to extend the responsibilities under the Kyoto Protocol to an increasing number of countries. As a first step, however, the industrialized countries have the resources to play a leadership role in tackling this global challenge. Just as they have led on issues such as international agreements on trade, industrialized nations must also set the pace on environmental issues.
It is anticipated that in future rounds, major developing countries will assume emissions targets, moving us closer to a truly global response.

No one country, acting alone, can solve the problem of climate change, but by working together towards a common goal, the nations of the world can successfully address this challenge. That is why, in 1992, Canada supported the United Nations Framework Convention on Climate Change. Since then, the Government has announced its intention to ratify the Kyoto Protocol, which sets out specific targets for reducing greenhouse gas emissions.

The decision by the Bush administration in the United States not to ratify the Kyoto Protocol poses an important challenge from both a climate change and competitiveness perspective. The United States is the largest total emitter of greenhouse gases and the largest emitter per capita among industrialized countries.

Many individual states are already taking important steps to reduce greenhouse gas emissions. Oregon, Massachusetts and New Hampshire, for example, are regulating CO 2 emissions from power plants, including the use of offsets. The New England Governors, in conjunction with the Eastern Canadian Premiers, have committed to stabilizing greenhouse gases at 1990 levels by

2010 and to a 10 percent reduction by 2020. California recently passed legislation that allows the state to regulate the amount of greenhouse gases that are emitted by new automobiles and light trucks, beginning with the 2009 model year.

6- The Canadian Federal Government Response

The Government of Canada ratified the Kyoto Protocol in December, 2002, five years after ratifying the international agreement. Some political parties and business groups opposed the ratification.
To implement the Kyoto Protocol, the government has published a plan. Details of the plan are below.

Canadian households are already involved in protecting the environment: recycling, reducing and reusing. We now need to take the next step by improving the energy efficiency of our homes and making more informed choices when deciding what products and vehicles to buy.

Canada has negotiated international agreements on acid rain and to protect the ozone layer that have been successful and are models for the Kyoto and subsequent international treaties.

Canadian companies are also at the forefront, developing new fuels and new technologies and cutting their greenhouse gas emissions while improving their bottom lines.

The Plan sets out a three-step approach for achieving Canada's climate change objective of reducing annual greenhouse gas (GHG) emissions by 240 megatonnes (MT).

By necessity, the Plan will need to evolve over time. As new ideas emerge, new technologies are developed and better approaches suggested, we must be flexible enough to shift our resources from less effective actions to those with more potential to deliver emissions reductions.

- commits to new investments to increase the use of public transit and manage growth in vehicle use;
- sets the goal of increasing the amount of gasoline containing 10 percent ethanol blend to 35 percent of the market, in collaboration with the provinces and territories, and the amount of biodiesel production to 500 million litres; and
- proposes improved performance targets and best practices for all freight transport, and enhanced intermodal infrastructure (See Appendix 2)

Next Steps
The Government of Canada renews its commitment to working with the automotive manufacturers to develop a new fleet efficiency goal. Our objective is to improve fleet fuel efficiency by 25 percent by 2010 and to take additional steps to encourage consumer demand for more efficient vehicles. This plan proposes a further 2.8 MT reduction in emissions from vehicles and fuels through the following initiatives.
Consumer action on vehicle efficiency, including off-road vehicles (0.8 MT)

To assist consumers in making the best environmental choices, we will enhance public information programs. A new vehicle ranking system, similar to the ENERGY STAR® system currently used on consumer appliances, will be introduced, and could provide information on the "carbon burden" or life cycle carbon emissions from different vehicles. Targeted campaigns to reduce fuel use by improving vehicle maintenance and modifying driving practices will also be considered.
Significant reductions in emissions can also be achieved from off-road gasoline-powered products such as outboard motors and snowmobiles, as well as from diesel-fuelled commercial equipment such as farm tractors, logging equipment and construction machinery. This Plan proposes to promote more energy-efficient choices for emissions from consumer gasoline-

powered products and diesel-fuelled commercial equipment through voluntary agreements with manufacturers. Other measures, such as regulatory options, could also be considered, such as: increase target for ethanol blending to 35 percent of gasoline supply or develop a standard for a greenhouse gas free portion of gasoline (0.9 MT)

7- Future Solutions as offered in Canada:

KYOTO AND BEYOND

See full text of summary and full document at:

http://www.climateactionnetwork.ca/torriepdf.pdf	summary of report by Ralph Torrie
http://www.davidsuzuki.org/files/Kyoto_72.pdf	full report on Suzuki site
http://www.davidsuzuki.org/files/16pager.pdf	summary of the report

Contents of *Kyoto and Beyond* report:

a-The Low Emission Path to Innovation and Efficiency
b-Climate Change and the Case for a 50 Per Cent Reduction
c-Key policy principles that shaped the report's conclusions
d-Learning from the Canadian Experience
e-New primary energy in Canada
f-The residential sector
g-The commercial and institutional buildings sector
h-Passenger transportation
i-Freight Transportation
j-The Industrial sector
k-Non-energy emissions
l-The Fossil Fuel Industry
m-Electric Power

"The Kyoto Protocol is about responsibility. In this age where government fiscal responsibility is touted as a commandment, how can we not be environmentally responsible as well?
What we need now is to take advantage of Kyoto and meet our commitment in ways that will benefit all Canadians. It is time to accept our responsibility."

Dr. David Suzuki
September 2002

Ralph Torrie has been studying sustainable energy futures for 27 years. He served on the Royal Society of Canada's blue ribbon panel on greenhouse gas emission reductions, and is the co-inventor of environmental planning software used by over 300 municipalities and companies around the world.

The David Suzuki Foundation, an internationally recognized authority on climate-related issues, explores human impacts on the environment with an emphasis on finding solutions.

www.davidsuzuki.org
219–2211 West 4th Avenue
Vancouver, BC V6K 4S2
climateaction@davidsuzuki.org

CANet Canada is the national body of the international Climate Action Network. It is made up of more than 100 organizations across the country working to protect the environment from harmful human interference of the atmosphere resulting in climate change.

www.climateactionnetwork.ca
412–1 Nicholas Street
Ottawa, ON K1N 7B7
dcanet@magma.ca

CLASSROOM ACTIVITIES

SUGGESTED ICE-BREAKERS:

Introduction Icebreakers

Teacher Instructions

#1-Climate Change Bingo:

Have students move about the room getting the signature of students who can answer each bingo question. (They should also write down the answer.) The first student to complete the bingo wins. This short activity provides a good introduction to some of the issues of global warming. Teachers and students can debrief and discuss answers to the issues.

GLOBAL WARMING BINGO

Find someone who knows ...

the 4 major layers of the earth's atmosphere	what % of the earth's atmosphere is oxygen	the current concentration of carbon dioxide in the atmosphere	the term for storage reservoirs which absorb large amounts of carbon dioxide (e.g. forests, and plants)
the name of the currrent in the tropical pacific ocean that affects weather patterns (usually seems to occur in a 7-11 year cycle)	what a GCM is	the impact of global warming in Maldives and in Bangladesh	what cocalycaphores are
3 impacts of global warming in Canada	what carbon credits are	3 greenhouse gases	the 3 countries which have the highest square km of forests
3 impacts of global warming in developing countries	at least 5 ways to reduce fossil fuel consumption and conserve energy	someone who has been to Kyoto	how to explain the "greenhouse effect"

#2-Global Education Schematic:

Have students work in groups of 4 or 5 and using large sheets of paper, divide the paper into 4 sections according to the 4 strands of Global Education; Environment, Development, Human Rights, Peace and Justice (refer to schematic below).

Students will brainstorm how global warming, climate change and the Kyoto Agreement relates to those strands.

Students should then present their findings to the class.

Students' work can be posted around the room for the duration of the unit.

Here are some possible answers:

PEACE & JUSTICE	THE ENVIRONMENT
• we are all impacted upon by the use of fossil fuels • conflicts are due to the competition for access to fossil fuels •are carbon credits fair? •territorial conflicts due to changing borders due to increased sea levels •unequal development potential for LDCs	• burning of fossil fuels & green house gas emissions contribute to global warming, • this issue is related to other environmental issues such as desertification, drought, and severe storms… • impacts on natural habitat and wildlife • loss of bio-diversity due to climate change
HUMAN RIGHTS	**SUSTAINABLE DEVELOPMENT**
• basic human right is access to a clean supply of water and air and access to clean soils and grounds • basic human right is to be surrounded by natural resources necessary to sustain life • human right to be able to participate in a society that is developing in a manner consistent with the preservation and enhancement of life.	• dominance of multinationals over the extraction and supply of fossil fuels • need for alternative energy sources • opportunity for development of appropriate technology and alternative energy sources internationally (e.g. biogas, solar, wind, tidal power etc.) • development strategies for developing nations (situationally appropriate technologies)

SUGGESTED ACTIVITIES:

ACTIVITY #1

Climate Change Simulation:

Teacher Instructions:

1. The decision has been made to ratify the Kyoto Agreement. There is now a commitment to reduce greenhouse gas emissions in the future in Canada. We must devise a plan to implement the Kyoto Agreement.
2. Divide the class into teams. The teams must develop recommendations for reducing carbon dioxide emissions; they must come up with solutions to the greenhouse effect and global warming in their local area (e.g. incentives for alternative energy and forms of situationally appropriate alternative energy).
3. After discussing the problem in general terms, assign students a role from the list below and have each player present their initial position (this would enable natural alliances to occur).
4. Make a decision about the company's request for a mega-dam based on your recommendations above.
5. In their roles, hold a town hall meeting, and come to a consensus.
6. De-brief to understand how the decision was made and who had the power.

Note: a sketch map of the area will be included at a later date.

Players to include:

• Representative(s) from the company want to build a new mega-dam on a major salmon run river near the ocean to produce electric power. This company is a branch of a major oil producer, which wants to get into cleaner power, given the requirements of the Kyoto Agreement.
• Joe Public, who works in the city, but not for the plant
• Joe Plant, a unionized worker who works for SALECTRIC
• Energy Industry Lobbyist
• Representative(s) from a coalition of environmental groups
• Regional Health Officer
• A Rancher, who is located down-wind from the proposed dam site and whose land will be flooded by the dam reservoir.
• A provincial, environmental policy maker

The teacher may have fewer or more players depending on the number of pupils in his/her class

Role Descriptions:

Representative from SALELECTRIC metal plant:
You are a representative from the North American head office of SALELECTRIC Metal Company. Your company is very interested in building a plant in SalmonTown. You will employ 100 workers. You want to make a significant profit. You want to be on the leading edge on the business of alternative energy and "clean" mega-dams.

Joe Public:
You have concerns that SALELECTRIC is not going to abide by the Kyoto Agreement. You want to be sure that SALELECTRIC does not break any city bylaws and that indeed, it is advocating alternative energy. You also want to make sure that the city is going to benefit from SALELECTRIC's presence.

Joe Plant:
You are concerned that SALELECTRIC is going to lay off many workers because they are trained in oil production and mega dam building. You are worried that they are going to hire experts in alternative energy.

Energy Industry Lobbyist
You are going to argue that mega dams are an efficient way to produce power and that a mega dam can be built in accordance with the Kyoto Agreement. You will argue that mega dams are not major producers of global warming and thus are a good form of alternative energy.

Representative from a coalition of environmental groups
You are concerned that a mega dam is not the answer. It may meet the Kyoto Agreement, but there are other environmental issues associated with mega dams (e.g. large amounts of land flooded, mercury poisoning in the water, loss of fertile land, loss of fishing/spawning grounds etc.) You would like to see some other forms of alternative energy being used.

Regional Health Officer
You have serious concerns about SALECTRIC's presence in Salmon Town. Firstly, you are worried about the effects of flooding on the land. Naturally occurring mercury in the soil will be released into the reservoirs and flooded land. This means this mercury water will be used for irrigation and thus will cause mercury poisoning in crops. Also, this is a large fishing community; the fish will consume the mercury, and through biological magnification, humans will suffer from mercury poisoning. You would like to see some other forms of alternative energy being used which will reduce global warming and fossil fuel emissions. You, obviously, have concerns with the health effects of increased fossil fuel emissions and global warming.

A Rancher, who is located down wind from the proposed dam site and whose land will be flooded by the dam reservoir.You are enraged with SALELECTRIC's proposal. You would like to see other alternative energy projects as you will loose a lot of money with the proposed mega dam. Your fertile land will be flooded and your cattle will be forced to drink water from the reservoir possibly containing mercury.

A provincial, environmental policy maker
You want to make sure that the final project will meet the requirements of the Kyoto Agreement. You will want to ensure that the ecological footprint of this project is minimized.
You are not convinced a mega-dam is necessarily the best solution for meeting the energy demand and you would prefer to see other forms of energy being used.

ACTIVITY 2: Climate Change and the Developing World:
A Snapshot of Africa's Climatic Future

Climate change and international development experts have long warned that developing countries are at a much higher risk of being negatively effected by climate change than the developed countries of the world. Indeed, climate change presents developing countries with unique challenges because they lack the requisite financial resources to manage its impacts. However, it is difficult to at once summarize the challenges that climate change brings to all developing countries because two countries that share the same general economic disadvantages and characteristics may have entirely different economic compositions and experience entirely different natural impacts from the changing climate.

A "developing country" in North East Africa in an arid regional climate, with a highly rural population and an economy based largely in agriculture will face very different challenges from climate change than a country in South America with a more wet regional climate, a slightly more urban population, different agricultural exports and a greater economic dependency on tourism and manufacturing.

By the year 2030, climate change may have Sudan dealing with increases in droughts and famine and concerned about the security of its already worrisome food and water supplies, while Peru may be taking steps to prepare its coffee industry for decreased precipitation and increased temperatures and redrafting its tourism strategy in light of the risk of a malaria outbreak.

It is the very same global average surface temperature increase that affects both of these regional climates and both countries may have comparable economic characteristics, such as GDP per capita, but the impacts on their respective regional climates and societies will differ greatly.

What any two developing countries do share is the challenge of maintaining economic growth without creating societies that are based on fossil fuel use, thereby contributing further to the problem of high atmospheric GHG concentrations and ultimately, according to the IPCC, the warming trend that this world has experienced during the past century.

This section addresses the challenges that developing countries will face in dealing with climate change and gives special attention to Africa and it's constituent countries, many of which are among those least able to manage the natural and social impacts that this global problem is expected to produce. Within this massive and ecologically rich continent there is a range of potential impacts of climate change, many of which are unique to this particularly vulnerable region.

Africa and Climate Change

Africa is highly susceptible to the impacts of climate change despite producing a relatively small portion of the world's GHG emissions. A typical European country produces 50 to 100 times more GHG's per capita than a typical African country, while the United States produces 100 to 200 times more. It is only a small handful of African countries that produce most of the continent's GHG's; South Africa produces 42% and another 35.5 come from Egypt, Algeria and Nigeria combined.

An Already Volatile Climate

Most African countries are routinely affected by natural disasters such as drought, famine, disaster-related epidemics and flooding. These disasters take enormous human and economic tolls, and are expected to increase in frequency and intensity as the warming trend continues, combined with human factors such as land use changes and stresses on water resources.

Africa and the Kyoto Protocol

All but three African countries have ratified the United Nations Framework Convention on Climate Change and accepted the Kyoto Protocol as its mechanism for implementation. Those who have not (Angola, Somolia and Liberia) simply lack the governmental stability to participate in such international agreements. African countries stand to benefit greatly from the provisions in the Kyoto Protocol created to help developing countries create mitigation strategies, namely the Special Climate Change Fund and the Fund for the Least Developed Countries.

Within the Protocol are incentives that allow developed countries to offset their emissions by contributing to carbon-saving initiatives in developing nations such as forest conservation or carbon-saving tree planting programs. Funds will also be made available to develop infrastructure more capable of withstanding the impacts of climate change and mitigation projects such as flood defense systems.

Funds will also become available to help developing countries convert to cleaner technologies that would otherwise be inaccessible to most African nations, such as wind, and solar technologies as well as hydrogen fuel cell powered vehicles.

The Socio-Economic Story

Climate change presents the potential for an increase in humanitarian crises that African countries are not prepared to deal with. When considered in concert, the numerous potential natural effects of climate change and their social and economic impacts are beyond the manageability of any well developed region of the world, let alone a continent already dealing with existing humanitarian crises, an already volatile climate and lacking in the resources necessary to invest in prevention and mitigation.

The United Nations Environment Programme has published a web-based resource titled “Vital Climate Graphics”, a collection of slide images that communicate the problem of climate change. UNEP creates the following categories under which the numerous potential impacts of climate change can be understood:

Principle Natural Impacts

1. Temperature increase
2. Precipitation increases
3. Sea-level rise

1. Temperature Increase – the Intergovernmental Panel on Climate Change (IPCC) predicts a global average surface temperature increase of between 1 and 4.5 centigrade during the next century.

2. Precipitation Increase – while some regions may experience a reduction in precipitation, average global precipitation is expected to rise with temperature.

3. Sea-Level – the IPCC also predicts a global mean sea-level increase of between 13 and 94cm by the year 2100.

It is these main natural factors that are predicted to produce the following impacts on natural and human systems:

Potential Impacts (natural and human)	• Health • Agriculture • Forest • Water resources • Coastal areas • Species and natural areas

Human Health – There are obvious risks that higher temperatures present to human health, such as increases in heat and pollution related illnesses like heat stroke and respiratory diseases. But a slightly warmer world may also be more inviting to vector borne diseases and may broaden the range of diseases such as malaria. Issues of human health are especially pertinent to developing regions such as Africa, who lack the health infrastructure to carry out adequate prevention or treatment of these diseases.

Agriculture – Developing countries who depend on one or two agricultural products could face severe economic impacts from climate change. Uganda, for example, which relies heavily on exporting coffee for its economic sustenance, would experience a dramatic loss in land area suitable to grow coffee with a temperature increase of 2 degrees. Many regions within that country would be rendered too hot to grow coffee.

Forest – The warming trend may altogether move the range of certain plant species. In North America, for example, IPCC projections predict that deciduous trees may move northward toward higher altitudes, replacing coniferous trees and jeopardizing biological diversity.

Water Resources – Developing countries will face the greatest challenge in addressing the increasing scarcity of freshwater resources. Sub-Saharan Africa, which, as a region, has the least access to clean drinking water and sanitation in the world, is among the most vulnerable to water shortages.

Coastal Areas – Populated coastal regions as well as coastal ecosystems could be affected by rising sea-levels and increases in extreme weather phenomena. Although not in Africa, Bangladesh, one of the world's poorest nations, stands to experience the most severe impacts from sea-level rise. Storm surges have already caused damage in that country up to 100km inland. Imagining these events with a sea-level rise of 0.5 meters is difficult.

Species and Natural Areas - Experts warn that the warming trend and its effects will cause devastating species losses in many of the world's ecosystems, yet none can predict with certainty exactly how this will evolve. What we can be certain of is that species will face new challenges as their habitat is altered by human activity while it is being changed in ways as fundamental as average temperature and average precipitation**.**

In the web-resource mentioned above, "Vital climate Graphics", UNEP goes on to warn of other potential impacts of climate change:

- Desertification
- Deforestation
- Degradation of woodlands
- Cyclones
- Coastal erosion
- Loss of forest quality
- Coral bleaching
- Spread of malaria
- Reduced fresh-water availability
- Decreased food security

Classroom Activity

Teacher Instructions and Classroom Resources

http://www.unep.org/aeo/index.htm

http://www.climatehotmap.org

With the aid of UNEP's African Environmental Outlook web resource (section "A" – Atmosphere), and the "Global Warming: Early Warning Signs" web-based world map mentioned in Activity 3 of this module, students work in partners or small groups to produce a short paper to be accompanied by a brief in-class oral presentation which answers the following questions regarding a specific, assigned country in Africa. The presentation is to be delivered under the premise that the students are natives of their assigned country and are traveling the developed world to raise awareness of the challenges that they are facing in preparing for and mitigating the impacts of climate change. Student will be encouraged to pick a specific role or series of roles to play in the presentation and to attempt and offer the class personalized perspective based on those roles. Possible roles include rural farmer, government official, tourism businessperson, municipal politician, humanitarian worker, trade official, rural doctor, or city dwelling citizen.

1. What are the potential impacts of climate change specific to your country? Which impacts would be the most devastating to you, personally?
2. What are some of the early warning signs of climatic change in your country?
3. Has your country ratified the Kyoto protocol?
4. What action has the government of your country taken to prepare for climate change?
5. Is your country receiving assistance from other countries to deal with climate change?
6. What, if any, natural disasters have occurred in your country during the past 30 years?

7. Describe in general terms the climate of your country (average temperatures, rainfall, extreme weather phenomena, and so on. What might that description entail 20 to 30 years from now?
8. What policies would you like to see enacted to address this issue? What technologies might be needed to affect the required change?

The continent would be divided into regions or individual countries, depending on whether the class is divided into groups of two or more. Questions from classmates following each presentation would generate lively discussion, with each group attempting to maintain the outlook of their respective region and role.

(thanks to Chris Advansun for this activity)

ACTIVITY 3:

Opinion Paper: Using the materials provided, research the issues surrounding climate change/global warming and the Kyoto Agreement, and prepare a summative paper outlining the steps necessary for the implementation of the Agreement in

a) Canada,
b) the developing world, or
c) the international developed community.

Teachers: refer to the "Suggested Resources" in this document and you may use the Evaluation Rubric (below) to assess this project.

EVALUATION RUBRIC

Evaluation Rubric

Name:_____ Date: _____Evaluator: _____

Evaluation: K____A____TH____C____= /100 Levels
K____A____TH____C____

Categories and Criteria	Level 1	Level 2	Level 3	Level 4
Thinking and Inquiry Introduction	-Introduction touches on a few of the topics to be covered and lacks an indication of authors position	-Introduction gives brief overview of paper and states position of author on subject	-Introduction gives a clear overview of report contents and intent of report and position on issue by author	-Introduction is a concise abstract reflective of all issues to be addressed and intent of report and clearly indicates authors position on subject and rational for position
Analysis of Research Data	-lack analysis of research data -analysis that is present lacks clarity and synthesis -limited analysis of global warming and impact of Kyoto on Canadian Society	-Analysis of research data is limited, at the surface lacks depth -few conclusion drawn -conclusion drawn are only partial supported by evidence -Some analysis of global warming and impact of Kyoto on Canadian Society. -inclusion of who supports each position and why	-Clear analysis of research data -Conclusion are grounded in research -facts are distinguished from opinions - analysis of global warming and impact of Kyoto on Canadian Society -well developed discussion of each position and why they support that position	-Synthesis of research data to derive at clear and solid conclusions -All aspects of problematic research findings addressed -well developed positions on global warming and the Kyoto Accord -Concise discussion of who supports Kyoto and why, and if don't discussion of what they propose
Application: Report Body	-limited application of Earth Systems knowledge, few issues addressed -limited research skills applied -limited application of knowledge of impact on humans and animals	-some application of Earth System Knowledge but all issues not addressed -knowledge is somewhat applied to impact on humans and animals -some research skills are applied -report style is not as recommended, lacks organisation -some application of research skills	-application of Earth systems knowledge to topic -correct and appropriate research skills have been applied -correct format, headings, title page -grade appropriate research skills applied	-application of Earth's systems knowledge to topic and demonstrates knowledge of long term impacts on them and impact on humans and animals -report style in correct format, headings, title of report is original and reflective of issues and position on topic of author -advanced research skills applicable
Knowledge: Report Body	-limited use of correct geography terminology -limited demonstration of topic knowledge	-some use of geography terminology -some demonstration of topic knowledge -some positions explored and counter arguments	-correct use of geography terminology -competent knowledge of topic -all topics and questions explored and reported on	-correct use of geography terminology -complete exploration of issues and demonstration of topic knowledge beyond scope of assignment -all positions explored and

			-all positions explored and counter arguments	counter arguments are full developed an all aspects are addressed
Recommendations	-not developed, do not reflect the report issues -is a reiteration of introductory paragraph -is not backed up with research	-are somewhat developed, and touches on the report issues -is similar in wording and substance as the introductory paragraph -is supported with limited research	-is developed, reflects the research question and thesis -is based on the exploration of the topic and reflects research	- excellent application of the learning from the research data -extends the original premise of report -Introduces questions not raised in report outline. i.e. morality, ethics
Referencing and Citation	-less than two resources used -incorrect style for all entries in reference list -1 type of secondary source used -limited embedded citation	-number of resources one below minimum -incorrect style for some entries -2 type of secondary source used -limited embedded citation	-number of resources at minimum -correct style for all entries -3 types of secondary sources -embedded citation	-number of resources exceeds minimum reqirement -correct style for all entries -4 types of secondary sources used -used correct format for primary research -embedded citation
Communication Entire Report	-report is incomplete - style, grammar and spelling require work -poor and inappropriate language	-report meets minimum length -a few spelling and grammar errors -adequate language	-report meets minimum length -good grammar -clear and appropriate language	-report exceeds minimum length -exceptional grammar -clear, vivid, and appropriate language

(Activity suggested by Dianne Clipsham, Global Education Network)

SUGGESTED RESOURCES

Some of the following web sites* can be accessed through the Global Education Network web site at www.global-ed.org:

*Global Education Network consists of teachers, students, and members of the Community at large who believe that teaching and learning must integrate the interdependency of the social, economic, environmental, and political aspects of our world.

http://www.teachgeography.ca/physical/davidspencer/scrapbook/
http://www.web.net/~tendays/travelling.htm
http://www.ucsusa.org/warming/index.html

Environmental Groups

http://www.panda.org/home.htm

http://www.envirolink.org/

http://ds.dial.pipex.com/ritson/earth/index.htm
Earth Sciences section of WW&ES on-line journal, based in the USA.

Canadian Environmental Law Association The Canadian Environmental Law Association (CELA) is a non-profit, public interest organization to use existing laws to protect the environment and to advocate environmental law reforms. It is also a free legal advisory clinic for the public, and will act at hearings and in courts on behalf of citizens or citizens' groups who are otherwise unable to afford legal assistance.

Canadian Environmental Network was established to support, facilitate and advance the work of its member groups to protect the Earth and promote ecologically sound ways of life.

Climate Action Network – Canada (CANet) is made up of more than 100 organizations across Canada working to protect the environment from harmful human interference of the atmosphere resulting in climate change.

Green Communities Association are non-profit, community-based, multi-partner organizations that bring environmental solutions to homes, businesses, institutions, and communities

*Greenpeace is a non-profit organisation, with a presence in 40 countries across Europe, the Americas, Asia and the Pacific. As a global organization, Greenpeace focuses on the the most crucial worldwide threats to our planet's bio-diversity and environment.

*Pembina Institute for Appropriate Development The Pembina Institute is an independent, not-for-profit environmental policy research and education organization, founded in Drayton Valley, Alberta. The Institute's major policy research and education programs are in the areas of sustainable energy, climate change, environmental governance, ecological fiscal reform, sustainability indicators, and the environmental impacts of the energy industry.

*Sierra Club of Canada The Sierra Club has been active in Canada since 1969, working on matters of public policy and environmental awareness. We have local chapters and working groups in every region of the country. Check out the ten myths about the Kyoto Protocol, and Global Warming.

Saskatchewan Environmental Society The Saskatchewan Environmental Society is committed to maintaining the integrity of Saskatchewan's forests, farmlands and natural prairie landscapes; protecting the atmosphere, promoting energy conservation and development of renewable

resources; and building sustainable communities, responsible waste management, and enhancing water quality in our lakes and rivers.

*Suzuki Foundation Since 1990, the David Suzuki Foundation has worked to find ways for society to live in balance with the natural world that sustains us. Focusing on four program areas – oceans and sustainable fishing, forests and wild lands, climate change and clean energy, and the web of life, the Foundation uses science and education to promote solutions that help conserve nature.

West Coast Environmental Law Association West Coast Environmental Law empowers citizens to participate in forming policy for, and making decisions about, protecting our environment. From the local to international level, we support the right of the public to have a voice in how we share our earth. Since 1974, we have been providing free legal advice, advocacy, research and law reform services. And through our Environmental Dispute Resolution Fund, we have given away over $2,000,000 to hundreds of citizens' groups across BC to help them solve environmental problems in their own communities

The Green House Effect
http://www.scarborough.k12.me.us/middle/contribute/quest/weblesson.htm

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

Government links
Environment Canada
http://www.enviro.gc.ca
The Canadian International Development Agency (and the Canada Climate Change Development Fund-CCCDF)
http://www.acdi-cida.gc.ca

Kyoto Accord
http://www.unep.ch/iuc/submenu/begin/beginner.htm

http://www.worldwaterforum.org/themeWwf/en/themeListAll.do

Business Response to Global Warming
http://www.wri.org/wri/cpi/response/business.html
http://api-ec.api.org/newsplashpage/index.cfm
http://www.freedominion.ca/phpBB2/viewtopic.php?t=8008

Global Warming and Third World Countries
http://www.cru.uea.ac.uk:80/tiempo/floor0/briefing/briefing.htm

Global Warming and Plant Life-It's a Good Thing
http://www.purgit.com/co2ok.html

International
CAnet International The Climate Action Network (CAN) is a global network of over 287 Non-Governmental Organizations (NGOs) working to promote government and individual action to limit human-induced climate change to ecologically sustainable levels. CAN members work to achieve this goal through the coordination of information exchange and NGO strategy on international, regional and national climate issues.

Global Warming: Early Warning Signs (USA) Provides a map that illustrates the local consequences of global warming.

Solar energy

Solar Energy Society of Canada Inc. The Solar Energy Society of Canada Inc. will advance the awareness, understanding and use of solar energy in Canada.

EPA Global Warming Impacts –A good starting point for student research on climate change impacts on ecosystems. Reports are available by ecosystem type (coastal zone, forests, wetlands, etc.), by animal type (birds, fisheries), and by state.

http://www.epa.gov/globalwarming/impacts/
EPA Plant and Animal Impacts Bibliography – For in-depth research this site offers an extensive listing of scientific articles about the impacts of climate change on wildlife.
http://www.epa.gov/globalwarming/impacts/imp_blio.html

World Wildlife Fund Climate Change Campaign – This site is a gateway to several WWF online reports on the impacts of climate change on wildlife and protected areas. Of particular note for student research are the reports on bird migration and forests.
http://www.panda.org/climate/impacts.cfm

eNature Online Field Guides – A user-friendly site where students can see a picture and read about plant and animal species found in different habitats of North America (scroll down to the "Habitat Guides" section). Teachers can also create a classroom species list.
http://www.enature.com/.*Global Warming: Early Warning Signs Climate Change and Ecosystems* 26

Global Climate Change Online Resources – A comprehensive listing of online resources about global climate change, arranged by topic. Go to http://www.pacinst.org/cc_2.html to find specific resources about the impacts of climate change on biodiversity and ecosystems.
http://www.pacinst.org/ccresource.html

WebQuests

Global Warming – An inquiry based on WebQuest
http://olp.swlauriersb.qc.ca/webquest/globalwarming/index.html

Global Warming
http://students.itec.sfsu.edu/ITEC815/antaramian/

French/Francais

Ami-e-s de la terre La mission de l'A.T.Q. est de contribuer au développement d'une société écologiste soucieuse non seulement du respect de l'environnement naturel mais aussi de la promotion de certaines conditions d'existence de cette société.

Equiterre Équiterre est un organisme sans but lucratif voué à la promotion de choix écologiques et socialement équitables par l'action, l'éducation et la recherche dans une perspective intégrant la justice sociale, l'économie solidaire et la défense de l'environnement.

Réseau québécois des groupes écologistes Le Réseau québécois des groupes écologistes (RQGE) est un organisme sans but lucratif qui rallie les groupes écologistes du Québec.

Regroupement écologistes de Val D'Or et Environs Science for Peace

Union québécoise pour la conservation de la nature

GLOSSARY

Biofuels fuels made from biological products. Two examples are ethanol and biodiesel. Ethanol is a commercial alcohol that is made today from grain. It can also be made from cellulose fibres such as straw,

Carbon dioxide (CO2) Carbon dioxide comes from the decay of materials, respiration of plant and animal life and the natural and human-induced combustion of materials and fuels. It is removed from the atmosphere through photosynthesis and ocean absorption and by escaping into space.

An increasing amount of carbon dioxide is being released by the burning of fossil fuels (coal, oil, natural gas) for industrial purposes, transportation, and the heating/cooling of buildings, as well as by deforestation.

Data collected from polar ice cores show that concentrations of CO_2, which had been stable at about
280 parts per million by volume for the 10,000 years between the last ice age and the start of the 19 $_{th}$ century, have today increased by about 30 percent. If current trends in greenhouse gas emissions continue, by the end of this century their concentration in our atmosphere could be double what they had been prior
to the industrial revolution.

Carbon sink : any process that removes CO 2 from the atmosphere and stores it. Forests and agricultural soils can act as carbon sinks. Plants absorb CO 2 from the atmosphere through the process of photosynthesis. The CO 2 is stored in the plant tissue.

Climate describes long-term weather patterns, with **average** temperatures and precipitation totals as well as typical occurrences of climatic extremes (such as normal dry periods or tropical storms) being used to characterize the climate for a particular region.

Fuel cells generate electricity by a reaction that converts hydrogen and oxygen into electricity and heat. They are similar to a battery that can be recharged while power is being drawn from it. Instead of recharging using electricity, however, a fuel cell uses hydogen and oxygen.

Global warming : refers to the rise in the Earth's temperature resulting from an increase in heat-trapping gases in the atmosphere.

Greenhouse gases is a term used for gases (like carbon dioxide) which are mainly generated as a result of burning fossil fuels like coal, petrol and diesel.

Halocarbons: Halocarbons are human-produced chemical compounds containing members of the halogen family (bromine, chlorine, and fluorine) and carbon. They are some of the most effective heat trapping greenhouse gases of all. Halocarbons are typically involved in various industrial and home uses with chlorofluorocarbons (CFCs) being the most familiar.

Intergovernmental Panel on Climate Change (IPCC) set up in 1988 by the United Nations Environment Programme and the World Meteorological Organization to examine the most current scientific information on global warming and climate change.

Megatonne (MT) a unit of measure for greenhouse gas emissions. A megatonne is shorthand for one million tonnes. Each tonne equals one thousand kilograms.

Methane (CH4) Although there is less methane than carbon dioxide in the atmosphere, methane is a more effective heat-trapping gas. It comes from the decay of matter without the presence of oxygen. Primary sources include wetlands, rice paddies, animal digestive processes, fossil fuel extraction, and decaying garbage.

Nitrous oxide (N2O) Soils and oceans are the primary natural source of nitrous oxide. Humans contribute through soil cultivation and use of nitrogen fertilizers, nylon production, and the burning of organic material and fossil fuels.

Ozone (O3) Ozone exists naturally in the lower atmosphere in minute quantities. It also can be produced in the lower atmosphere from a reaction involving several human-produced pollutants and sunlight.

Water vapour: Water vapour come from natural respiration, transpiration, and evaporation. The amount of water vapour stored in the atmosphere increases as the Earth's surface temperature rises.

Weather is the state of the atmosphere at a given time and place, defined by variables such as temperature, moisture, wind, and barometric pressure. It is **highly variable** from day to day.

Appendix 1 Government of Canada Response:

Improved Performance Targets

a-Housing and Commercial/Institutional Buildings

Canadians have a tremendous opportunity to become more energy efficient and lower their home energy costs by taking a number of basic steps around their homes. The Plan will create the conditions for more informed choices and actions by:
• expanding cost-shared home energy audits for homeowners; and
• providing information to encourage consumers to purchase energy efficient appliances and equipment.

The Plan also proposes that governments work towards the following goals:
• energy efficient retrofits of 20 percent of the housing stock and 20 percent of the commercial/institutional building stock by 2010; and
• building all new homes to R2000 or equivalent standard by 2010 and all new commercial/ institutional buildings to a minimum of 25 percent above the Model National Energy Code by 2010.

b-Large Industrial Emitters

This Plan proposes a comprehensive approach to the large industrial emitters sectors. The three-pronged strategy, which is being developed in consultation with the provinces, territories and industry, involves:
• emissions targets established through covenants with a regulatory or financial backstop in consultation with industry, provinces, and territories;
• domestic emissions trading, with access to offsets and international permits; and
• cost-shared strategic investments in a number of
areas such as:
- renewable energy;
- clean coal demonstration projects; and
- a CO 2 pipeline.

c-International Emissions Reductions

The Plan builds on the efforts of Canadian businesses that are already active in the international emissions permit trading market. This will help developing countries chart a lower emissions path while creating profitable business opportunities for Canadian companies. To achieve this, the Government will:
• work with the private sector to establish a mechanism for efficient engagement in projects in developing countries; and
• consider the purchase of a minimum of 10 MT of international permits.

The Plan:
• proposes a personal goal for each Canadian to reduce emissions by an average of one tonne per
year by 2008-2012, supported by incentives, improved information and product availability;

A typical Canadian household with one mid-size car emits about 5,500 kg of CO 2 per year by driving about 20,000 kilometres.
* Canadians are buying larger and larger vehicles, with trucks, vans and sport utility vehicles now outselling cars. Although the fuel efficiency of engines has increased, the larger engines in current models neutralizes this effect.
* People in a typical Canadian household of four fly about 12,500 kilometres per year (taken

together) releasing about 3,100 kg of CO 2

* The typical Canadian household emits about 7,700 kg of CO 2 per year from energy used for home heating.The actual amount depends on the type of energy used (electricity, oil or gas) and on the province in which you live (some provinces produce electricity by burning greenhouse gas-intensive fossil fuels while others use nuclear or hydro power).

* For each square foot of housing we occupy, we contribute about 5.9 kg/year (depending on energy source and province) to the national greenhouse gas total.
* The use of appliances (such as fridge, stove, washer-dryer unit and dishwasher) in the typical Canadian home produces about 2,300 kg of CO 2 a year. Lighting emits about 700 kg of CO 2 per year and central air conditioning accounts for another 2,000 kg. In some homes, emissions from electricity use may approach or surpass emissions from space heating or driving!
* Heating water in the typical Canadian household emits about 2,500 kg of CO 2 per year, sixty per cent of it in taking showers and baths.
* The food eaten by a typical Canadian with a meat-based diet accounts for about 860 kg of CO 2 per year.
* Garbage typically accounts for about 1,500 kg CO 2 per year for a household of two adults and two children in Canada.
* True green power has no CO 2 emissions. Therefore every kWh supplied from green power displaces 0.5 kg CO 2 .

d-What is a carbon sink?

A "sink" is any process that removes CO 2 from the atmosphere and stores it. Forests and agricultural soils can act as carbon sinks. Plants absorb CO 2 from the atmosphere through the process of photosynthesis. The CO 2 is stored in the plant tissue. Agricultural soils can act as a sink when CO 2 removed from the atmosphere by crops is stored in the roots. When the plant dies, some proportion of the plant tissue remains in the soil and is transformed into soil organic matter.

e-What is a megatonne?

This document frequently uses the megatonne (MT) as a unit of measure for greenhouse gas emissions. A megatonne is shorthand for one million tonnes. Each tonne equals one thousand kilograms. What does this mean in everyday terms? The average Canadian is responsible for about 5.4 tonnes of greenhouse gas emissions every year. All references in this document are to annual emissions of greenhouse gases.

1 megatonne = 1,000,000 tonnes

1 tonne = 1000 kilograms

f-Covenants and Emissions Trading

Covenants and domestic emissions trading, as a market-based instrument, holds tremendous potential to minimize the cost of meeting Canada's climate change objectives by exploiting the efficiencies of markets while encouraging innovation and strategic investments.

Companies that emit greenhouse gases would meet their commitments either by reducing their emissions directly or by purchasing domestic offsets or international permits. The requirement for emitters to hold permits for their emissions creates an incentive for the use of lower-emissions technologies and energy sources.

Such an approach is already in use both in Canada and abroad to address a range of environmental issues.

Ontario, the United States, the United Kingdom and Denmark, for example, all have some form of trading system for air pollutants or greenhouse gas emissions. And the European Union is planning a union-wide greenhouse gas emissions trading system to be up andrunning by 2005. As will be discussed, the Plan outlines options for a domestic emissions trading system, linked to the international carbon market that will be created under the Kyoto Protocol. The Government of Canada will continue to work with industry, provinces, territories and stakeholders to clarify the architecture of a workable, efficient and effective domestic emissions trading system.

g-Targeted Measures

Targeted measures can include information (e.g.,labeling), incentives (e.g., production subsidies and cost-shared energy efficiency audits), regulations (e.g., energy efficiency standards) and tax measures (e.g., excise tax exemption for ethanol in gasoline). A number of tax initiatives are already in place to encourage the reduction of greenhouse gas emissions.
For example, accelerated depreciation is permitted for certain renewable technologies and the ethanol in gasoline is exempt from the federal excise tax and, in some provinces, from provincial fuel taxes.
The Government of Canada will continue to monitor and consult on climate change-related tax issues with a view to providing a fair, efficient and competitive tax system. In particular, we will assess the tax treatment of permits in a domestic emissions trading system.
In addition, one will consider investments in other specific program initiatives, such as incentives for retrofitting existing homes and expanding the CIPEC program for small and medium-sized enterprises.

h-Climate Change and Clean Air

Actions to reduce greenhouse gas emissions will also help achieve Canada's clean air goals. This includes reducing emissions of NOx and SO 2 from emitters like thermal electricity plants, refineries and pulp and paper mills, reducing traffic congestion in cities and reducing emissions from homes and buildings. Of the fossil fuels that are burned in Canada, coal has the highest levels of air pollutants and greenhouse gas emissions.

Under the Plan, one will be investing in the commercial-scale demonstration of cutting-edge clean coal technology. This technology will substantially reduce or eliminate greenhouse gas emissions as well as air pollutants such as particulates and mercury. By 2010, new coal-fired power plants should be as clean as natural gas.

In addition, one will be working with provinces and municipalities to increase the use of urban transit, which will decrease traffic congestion in our cities and help improve urban air quality.

These are just two examples of how taking action on climate change will help improve the health of Canadians, reduce the incidence of chronic bronchitis and asthma, and reduce health care costs.

i-Vehicles and Fuels
Actions Underway
The Motor Vehicle Fuel Efficiency Initiative in Action Plan 2000 targets a 25 percent improvement in new vehicle fleet fuel efficiency by 2010. This improvement is possible with existing technologies and technologies that are expected to become available in this decade. To that end, the Government of Canada will negotiate targets for the introduction of more fuel-efficient vehicles into the Canadian market with automotive manufacturers. Though federal legislation to enforce fuel efficiency standards does exist, it has not been proclaimed or brought into effect, because industry has, in the past, met or exceeded required standards voluntarily.

The Future Fuel Initiative will increase ethanol fuel use in vehicles from the current level of 240 million litres per year to 1 billion litres in 2010, enough ethanol to blend into 25 percent of Canada’s gasoline. This measure builds on the current federal and provincial excise tax exemptions on the ethanol portion of gasoline, as well as federal funding for research and development and the use of ethanol in the federal fleet.

j-What are biofuels?
Biofuels are fuels made from biological products. Two examples are ethanol and biodiesel. Ethanol is a commercial alcohol that is made today from grain. It can also be made from cellulose

fibres such as straw, but this is a new approach and is still under development. Taking all factors into account during its production and use, ethanol from grain has about 40 percent fewer GHG emissions than gasoline, and cellulosic ethanol has about 80 percent fewer emissions than gasoline. Ethanol can be blended up to 10 percent with gasoline and used in cars without modification. Biodiesel is a diesel fuel substitute that can be made from a variety of vegetable oils and animal fats (e.g., recycled cooking greases). It can be blended with diesel, resulting in lower GHG emissions.

The automotive industry, fuel providers, system integrators and many others have invested hundreds of millions of dollars in furthering research and development of fuel cell vehicles and other fuel cell and hydrogen technologies. Through Action Plan 2000, we are initiating four demonstration projects that will allow both government and industry to learn more about the kind of infrastructure that would be required to fuel these vehicles and further the development of the hydrogen economy in Canada.

k-What are fuel cells?

Fuel cells generate electricity by a reaction that converts hydrogen and oxygen into electricity and heat. They are similar to a battery that can be recharged while power is being drawn from it. Instead of recharging using electricity, however, a fuel cell uses hydogen and oxygen. One of its great appeals is that it generates electricity very efficiently and, depending on the source of hydrogen, with very little or no pollution

Source: Industry Canada

Appendix 2

Climate Change and Ecosystems (optional activity for science curriculum)

Overview

Students research the interdependencies among plants and animals in an ecosystem and explore how climate change might affect those interdependencies and the ecosystem as a whole.

Objectives

Students will:

1. Explore the complexity of ecosystem interdependencies ;
2. Explain how climate change could affect the components of an ecosystem;
3. Suggest ways to detect the impacts of climate change on ecosystems.

Prerequisite knowledge – Teacher

The geographic ranges of plant and animal species are affected by climatic factors such as temperature, precipitation, soil moisture, humidity, and wind. A shift in the magnitude or variability of these factors in a given location due to global climate change will likely impact the organisms living there.

Species sensitive to temperature may respond to a warmer climate by moving to cooler locations at higher latitudes or elevations. (Examples of plant and animal range shifts can be found on the map *Global Warming: Early Warning Signs*).

Factors other than climate may limit the extent to which organisms can shift their ranges.

Physical barriers such as mountain ranges or extensive human settlement may prevent some species from shifting to more suitable habitat. In the case of isolated mountain top species, there may be no new habitat at higher elevation to colonize. Even in cases where no barriers are present, other limiting factors such as nutrient or food availability, soil type, and the presence of adequate breeding sites may prevent a range shift.

In addition to the direct effects of temperature on organism physiology, projected climate changes under an enhanced greenhouse effect might change the availability of food, space, shelter, or water; upset the predator/prey balance of an ecosystem; increase susceptibility to pests/disease; change the frequency of natural hazards such as fires, droughts, and flooding. These effects might lead to local population declines or extinctions for some species.

Prerequisite knowledge – Student

Students should understand the concept of an ecosystem, including the relationship between abiotic and biotic factors and how a food chain works.

Students should know the physical/atmospheric measurements that are used to characterize a region's climate.

Materials

Regional nature guides; biology or environmental science textbooks

Computers with Internet access (desirable, but not necessary)

Global Warming: Early Warning Signs map. *Global Warming: Early Warning Signs*

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Procedure

ENGAGE

Using their prior knowledge only, ask students to answer the question: In what ways does climate affect plants and animals? Ask them to consider how latitude and altitude determine what types of species live in a region. Have students look at a world map of vegetation and evaluate how climate influences the distribution of plants. Ask students to identify the ways in which temperature affects the life cycle of animals (for example, migration, hibernation, breeding). Develop a list of climatic effects on plants and animals from student answers that can be used as a reference guide for student research.

EXPLORE

1. Have students use their knowledge of their part of the country to name the ecosystems found in nearby natural areas (such as lakes, wetlands, fields, forests, a river, or seashore). Have the class vote on one ecosystem to study in more detail.

Alternatively, if time and resources allow the teacher should pick an ecosystem that students can visit in one or two field trips to collect data.

2. Ask students to research as a class the basic components of the ecosystem they have chosen. Students should look for organisms in each category of *Producers, Herbivores, Omnivores, Carnivores*, and *Decomposers.* Nature guides, library books, and the Internet could all be sources of information for this exercise. The web sites of the Department of Environment or the local Environment Society would be good resources. If at all possible, take students on a field trip to collect data on the types of plants and animals found in the ecosystem. Students or the teacher can design a species observation sheet, and guidebooks can be used to assist with identifications in the field. Supplement the field observations with Internet or library research, especially for the larger mammals or nocturnal animals (A good online field guide can be found at eNature.com – see *Suggested Resources*).

3. After the class has finished their research, have each student create a web (using drawings or pictures, for example) of the basic components of the ecosystem showing interrelationships. The web should include physical factors such as the Sun, atmosphere, water, soil, and nutrients. At this point, students can begin to develop hypotheses concerning how climate change might affect the ecosystem. Ask each student to read the text on Plant and Animal Range Shifts from the *Global Warming: Early Warning Signs* map to learn some examples of how climate change affects organisms. Then have each student prepare a report to be presented orally to the class on how climate change could affect one of the plants or animals in the regional ecosystem. Give students some example questions to help them focus their research (See the example handout, "Guidelines for Students"). Students can also use the information generated by the class in the "ENGAGE" activity above.

4. Each student should present their research findings in the form of hypotheses concerning how the projected climate changes might affect their organism, and the reasoning behind the hypotheses. Tell the class that they will each be expected to write a summary essay in which they reflect on how the ecosystem as a whole might be different if the projected climate changes occur (see #5). In this way, each student will be responsible for understanding the material presented by other members of the class.

5. As a final exercise to hand-in, have each student prepare a description of the ecosystem as it is today, using a web for illustration, and a description of what each thinks the ecosystem might look like in 2100 if the projected climate changes occur, using a new web for illustration.

EXTEND

1. Ask students to make a list of the measurements that could be taken to try to detect the beginning signs of climate change in the ecosystem. Ask them to consider physical, biological, and chemical measurement possibilities. This exercise could be done as a class activity, or this could be included in the writing assignment in #5 above.

2. Have students research the possible effects of climate change on an ecosystem significantly different from the one they have just studied. Depending on your school location this might be a coastal system, coral reef, desert, or mountainous area. The World Wildlife Fund web site is a good source for information on climate change impacts in international protected areas. Ask students to compare and contrast the impacts in each of the two systems they have studied.

Standards Alignment

Student Activity Sheet: *CLIMATE CHANGE AND ECOSYSTEMS*

To evaluate how climate change due to an enhanced greenhouse effect might impact an ecosystem in your province. In a previous activity your class identified the major components of the ecosystem you have chosen to study. Because the organisms in the ecosystem function in a complex web of interdependencies, your class will need more information to evaluate how climate

change would affect the system has a whole. Your task as a member of the climate impacts evaluation team is to describe in detail how the projected climate changes could impact one species in the ecosystem. You will present your findings to the class, and use this information and that of your teammates to construct "before" and "after" pictures of the ecosystem, using both text and illustrations. In your research, try to consider all of the ways in which climate could impact your species, both directly and indirectly. The questions below will help you get started, but you may be able to identify other important relationships between your species and climate. Be creative!

My species is _____.

Its place in the food web is (circle one) *Producer, Herbivore, Carnivore, Omnivore, Decomposer.*

Illustrate the function of this species in the ecosystem by sketching interrelationships with other organisms:

Climate can affect a species directly, for example by constraining organisms to areas within their temperature tolerances, or indirectly by affecting food supply, availability of shelter, or other factors necessary for survival. In order to determine how climate change might affect a particular species, scientists must first try to understand all of the ways in which present climate influences that species. Research the life cycle, habits, and physiological needs of your species in order to identify the ways in which climate affects it today. Use the following questions as a guide to get you started. List other questions that you think are important in the space provided below..*Global Warming: Early Warning Signs*

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Life Cycle: What are the life stages of the species? When do changes from one stage to another take place? How is the species affected by the seasons? How does the species reproduce? When and how often does it breed?

Food: What are the nutritional needs of the species? What are its preferred foods? What are other food sources? What do the young eat? Is the food supply influenced by the seasons?

Shelter: Where does the species live in the ecosystem? Does it share this space with other species? What kind of shelter does it need for breeding/raising its young?

Predators/Disease: What species, if any, depend on this species for food (or parasitic/symbiotic relationships)? What diseases or pests affect this species? What conditions make the species susceptible to disease?

Competitors: What species compete with this species for food, shelter, or other needs? What if anything, maintains a balance among these competitors?

Other Important Factors:

Evaluating Climate Change Impacts:

Now that you have learned more about your species' life habits and needs, it's time to consider how global climate change might play a role in its future. Some scientific studies have suggested that climate change could change the distribution of species in an area because warmer temperatures would cause some species to shift their geographic ranges to cooler areas, either to higher latitudes or to higher elevations on mountain slopes. Other studies indicate that in areas where species are unable to move to accommodate changing climate conditions, for example, in places where their movement is blocked by large cities, population numbers could decline or local populations could become extinct. In fact, the impact of climate change on a species is likely to be complex because its survival is linked to many factors. You have identified some of the factors that are important to the survival of your species. Now look at the list of projected climate changes and evaluate how each of these changes might impact the species you studied. Use a table to characterize the impact as "little or no impact," "moderate impact," or "significant impact.".*Global Warming: Early Warning Signs*

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Climate Change Impact:(Little or None;Moderate; or Significant)

Nature of Impact:(examples: range shift north, earlier egg-laying, fewer breeding sites)

Higher Temps.

/More heat waves

1.

2.

3.
More heavy downpours
Change in drought frequency/severity
Heavier snowfalls
Change in flooding: frequency/severity
Change in fire: frequency/severity
Sea level rise
Polar Warming

Appendix 3: **Global Warming: Early Warning Signs**
Exploring Climate Change Impacts
Curriculum Guide

Developed by the Union of Concerned Scientists to accompany the 1999 world map "Global Warming: Early Warning Signs"
Adapted from: Global Warming: Early Warning Signs, which can be viewed on-line at http://www.climatehotmap.org/

About the Activities
These teaching materials are designed to accompany *Global Warming: Early Warning signs*, a science-based world map depicting the local and regional consequences of global climate change. The map was produced as a collaborative project by the Union of Concerned Scientists and several environmental organizations, and has been peer-reviewed by scientists.
It highlights events around the world in two broad categories: direct indicators of the observed long-term global warming trend ("fingerprints"), and events that are consistent with the projections for global climate change and are likely to become more frequent and widespread with continued warming .

Oral History Project: Climate Then and Now Oral History

Overview
Students interview older residents in the community about climate changes during their lifetime and compare the results to a climate change index that is based on historical temperature measurements.

Objectives
Students will:
1. Explore the factors that determine human perceptions of weather and climate;
2. Compile community survey results on local climate change;
3. Examine the historical record of climate change in their area;
4. Discuss the implications of human perceptions of local climate change on global climate change policy.

Prerequisite knowledge – Teacher
Weather is the state of the atmosphere at a specific time and place whereas climate is the average weather taken over a long time period for a given place or region.
Climate change is the long-term alteration in the average weather conditions for a particular location. To evaluate whether or not climate is changing, scientists study historical records of temperature and precipitation or the timing of weather-related events such as lake ice formation and ice-out, animal breeding or migration, and the length of the growing season.
The "Common Sense Climate Index" (http://www.giss.nasa.gov/data/update/csci/) has been proposed as a measure of whether an area has experienced a temperature change that should be noticeable to most people who have lived at that location for a few decades. A positive value for the index means that climate is warmer than average (The average value for the index is zero. It is based on the average value of the index for the period 1951 to 1980). The scientists who developed the index hypothesize that a persistent index value of +1 or greater represents a climatic warming noticeable to the people of a region.

Prerequisite knowledge – Student
Weather is the state of the atmosphere at a specific time and place whereas climate is the average weather taken over a long time period for a given place or region.
Climate change is the long-term alteration in the average weather conditions for a particular location.

Historical temperature and precipitation data are evaluated relative to a "normal," which is the average for a particular sub-period of time or the average of all the years of record.

Materials

Computers with Internet access
Survey form for interviews. *Global Warming: Early Warning Signs Oral History: Climate Then and Now* 10

Procedure

ENGAGE

Ask the class to characterize the climate of their region. They should consider such factors as the average temperature and precipitation, the magnitude of the temperature change from one season to another, the seasonal distribution of precipitation, the nature of the air masses that affect the climate, proximity to the ocean, large mountain ranges, or large lakes, etc. Then ask each student to list the ways in which this climate directly affects his or her life (for example, winter snow allows me to go skiing, mild climate lets me bike to school year-round, spring rain floods the soccer field). Next have the students make a judgment, based on their own observations, as to whether climate now is significantly different from when they were younger, and if so what was different about it. Have each student record their answer on a sheet of paper and then tally the results for the entire class.

Ask students to write a short essay discussing the results of the class survey. The essay should include a discussion of any similarities and differences among individual responses, in particular considering how different lifestyles affect how people

Perceive weather and climate and how their own lifestyle influenced their perception of climate change.

EXPLORE

1. Lead a class discussion about the reliability of the results of the class survey on climate change. In addition to lifestyle differences, students should recognize that the time frame over which people evaluate climate change influences the results. Ask the class how they might design a study to look more closely at human perceptions of climate change.

2. For a class project, students can interview older local residents to see if they have perceived any changes in climate during their lifetimes. They will then compare the results of the survey to climate change in their region as measured by the "Common Sense Climate Index." The tabulated results of the survey could eventually be written up as an article for the school or local newspaper, or as a presentation to a local radio or television station.

3. Divide the class into small groups to work on the design of the survey. The goal is to determine if people living in the area for a long time believe there has been a noticeable change in climate. Ask students to take into account the results from the ENGAGE activity (that is, students will need to include a question about the resident's lifestyle). When each group has finished a draft survey, bring the class back together to decide which questions should be included and how they will be presented. This could be done by class discussion. See the example "Climate Change Survey" provided below for key elements the class may wish to include.

4. Ask each student to interview two or three older residents, depending on the size of the community. If possible, students should interview people who have been in the area for at least three decades. Students should make it clear to the interviewees that their answers are completely anonymous, and students should not write the names of the residents anywhere on the data sheet.

5. Have students debrief in the classroom to share their experiences of how the interviewing went and to compile and analyze the group results. Depending on the survey design, the

class might want to create an overall continuum or some other chart of opinions—for example, "no change-----some change-----significant change-----very large change."

6. What were the results of the resident survey?
   Was there a clear opinion on change in climate or did answers differ from one resident to another? If they differed, were there any clear patterns relating the answers to the length of time the resident lived in the area, lifestyle, occupation, or other factors?
   What does the Climate Index say about climate change?
   Has climate been warming, cooling, fluctuating, or more or less consistent (both over the entire period of record, and for the period of record that corresponds to the lifetime of the interviewed residents)?
   According to the index, should the climate changes over the last few decades be noticeable to older residents (i.e. has the Climate Index been persistently greater than 1, or less than 1?)
   Do the results between the survey and the Climate Index agree? If they do agree can you say anything about the usefulness of the Climate Index, or do you still need more information?
   If they do not agree, can you suggest reasons for the disagreement (i.e. people's perceptions are not always consistent with reality, Climate Index is not a perfect measure of noticeable climate change, etc.)?

Putting it all together:
After students have completed all the exercises, have a final discussion on how perception of climate change might affect a person's position on climate change policy. For example, people who believe there has been a noticeable change in local climate might be more interested in supporting efforts to curtail greenhouse gas emissions. (This is, of course, only one of many possible factors that influence political position—encourage students to list other factors affecting opinions on climate change policy).

Climate Change Survey
1-How long have you lived in the area?
2-What is your occupation? Has your occupation changed?
3-How much time do you spend outdoors now? Did you spend more/less time outdoors in the past?
4-How much would you say your life today is affected by climate?
   Significantly/Somewhat/Not at all
5-How much was your life in the past affected by climate?
   Significantly/Somewhat/Not at all
6-How often do you follow weather forecasts?
7-Overall, would you say that climate has changed significantly during your lifetime? If so, how has it changed?
8-How would you respond to the following statements?
9-Compared to the past, today's summer temperatures are
   Much hotter/somewhat hotter/same/somewhat cooler/much cooler/not sure
10-Compared to the past, today's winter temperatures are
   Much colder/somewhat colder/same/somewhat warmer/much warmer/not sure
11-Compared to the past, the number of unusually hot days now is
   Much more/somewhat more/same/somewhat fewer/fewer/not sure
12-Compared to the past, the number of unusually cold days now is
   Much more/somewhat more/same/somewhat fewer/fewer/not sure
13-Compared to the past, our climate today is
   Much wetter/somewhat wetter/same/somewhat drier/much drier/not sure
14-Compared to the past, the first frost now occurs
   Much earlier/somewhat earlier/same time/somewhat later/much later/not sure
15-Compared to the past, bird migration in the spring now occurs

Much earlier/somewhat earlier/same time/somewhat later/much later/not sure

16-Compared to the past, ice breakup in spring now occurs

Much earlier/somewhat earlier/same time/somewhat later/much later/not sure

17-We have more heavy downpours now than in the past

Strongly agree/Agree/Disagree/Strongly disagree/not sure

18-We have more droughts now than in the past

Strongly agree/Agree/Disagree/Strongly disagree/not sure

19-We have more snow now compared to the past

Strongly agree/Agree/Disagree/Strongly disagree/not sure