

## Task 2. Forestry Management and Climate Change

**Purpose:** To outline and recommend good forestry strategies for a local forest to help maintain the carbon budget, reduce global climate change and support the Kyoto Protocol.

**Scenario:** A local forest provides timber for a pulp mill and softwood lumber for construction. The old growth forest was harvested in the 1800s, mostly for white pine. Spruce and balsam have been cut for pulp, but the construction boom in Southern Ontario has increased the value of logs that can be transported to that market for building construction. Local residents are concerned that cutting too much timber will reduce the value of the forest and hurt local ecosystems, which are also valuable for tourism. Some people are also concerned that increased cutting will contribute to climate change. The Ministry of Natural Resources requires that forest managers be certified for ISO 14001 Standards.

Several people in the area (environmental activist, forester, forest manager, municipal official) have been asked to outline and recommend good forestry practices that will

help maintain the carbon budget, slow global climate change and help meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

**Student Task:** Students will choose (or be assigned) one of the following roles: environmental activist, forester, forest manager, municipal official. Using this assumed perspective, they will complete a report that outlines how the practices they have described affect the value of the forest and the environment in terms of a specific ecosystem and the global climate.

The report is to explain how each choice connects to slowing climate change, thus helping to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions. A copy of rough work and a list of sources should be included to support the recommendations made. The report should answer the following questions:

- What are good forestry practices?
- How does the chosen method of harvesting and regrowth affect global climate?
- How do these practices reduce the environmental impact on local ecosystems?

### Resources:

Several student worksheets/ resources support the task:

- ▶ Appendix 2.1 *Checklist of Preparation-Forestry Management and Climate Change* helps the student keep track of the information and skills they need to prepare for the assignment;
- ▶ Appendix 1.2 *Summary of the Kyoto Protocol* (see page 18) to provide an overview of the Protocol and its goals;
- ▶ Appendix 2.2 *Student Task and Expectations-Forestry Management and Climate Change* outlines the task and identifies the expectations covered.

Teacher resources have been developed:

- ▶ Strand-by-strand Focus Questions to organize ideas and lessons to support the task;
- ▶ Appendix 2.3 *Evaluation Rubric for Report*.

## Expectations

(Note: examples in square brackets are additions tailored for this resource.)

BY1.06P	describe how different ecosystems respond differently to short-term stresses and long-term changes	CH2.09P	represent simple chemical reactions using word equations, balanced chemical equations, and, where appropriate, molecular models
BY2.04P	through investigations and applications of basic concepts select and integrate information from various sources, including electronic, print, and community resources, to answer the question chosen	CH3.01P	use scientific nomenclature to identify common consumer products [e.g., common waste products formed by different kinds of technology, such as a chainsaw]
BY2.05P	through investigations and applications of basic concepts, analyse the data and information gathered to clarify aspects of the concern or issue	CH3.03P	relate chemical reactions to familiar processes encountered in everyday life [e.g., identify the waste products created by the operation of different kinds of technology – gasoline vs. diesel vs. an alternative fuel source]
BY2.06P	through investigations and applications of basic concepts, communicate the results of the investigation using a variety of oral, written, and graphic formats	ES1.02P	describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks
BY3.01P	assess the impact of technological change on an ecosystem [e.g., forest harvesting and transportation technology]	ES1.03P	describe and illustrate the factors affecting heat transfer within the water cycle in the atmosphere [e.g., the role of forests as carbon sinks and the release of carbon with a forest fire]
BY3.03P	identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, Ministry of Natural Resources and ISO 14001 for forestry management]		

ES1.06P	describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents [e.g., the global impact of increased energy in the atmosphere]	ES3.01P	identify the impact of climate change on economic, social, and environmental conditions [e.g., what are future considerations for forestry?]
ES1.07P	describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems [e.g., how does climate change explain current severe weather, such as droughts?]	PH3.01P	perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation
ES2.01P	through investigations and applications of basic concepts, identify factors that affect the development, severity, and movement of local weather systems [e.g., what forestry activities affect severe weather?]	PH3.02P	investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation

## Prior Learning Required for this Task

*The task requires that the student have a basic understanding of one of the main goals of the Kyoto Protocol which Canada has ratified – to reduce greenhouse gas emissions (to 6% below 1990 levels by the 2008-2012 period). This is the context within which the research, analysis and application is pursued. See Appendix 1.2 (page 18) for a one-page student summary of the Kyoto Protocol.*

*The Ontario EcoSchools multimedia presentation The Science of Climate Change has been designed specifically for Grade 10 Science (see Resources for ordering information).*

### Fundamental Skills

#### ▸ *Read and Analyse*

Students need to be able to read material and identify/classify key ideas:

**Problem**

**Processes**

**Factors**

**Effects**

**Costs**

**Benefits**

Concept mapping activities or other graphic organizers that help students find and classify information would provide practice.

#### ▸ *Research*

Students need to be able to find information on forest management practices. This may include map-reading skills. From this material, students need to identify how different strategies affect Canada's carbon budget and various ecosystems that are part of or near the forest. Activities that support this require students to find and interpret information. *As students learn about ecosystems in the Biology strand they should work with resources that will be available for this summative task.*

#### ▸ *Systems Analysis*

Students need to be able to identify parts of a system and connections between or among systems. In particular, students need to be able to identify human choices that act as inputs to the forest, affecting not only local ecosystems, but also the potential for future human activities in the area and the long-term yield of forest products.

## Science Background

See “How Approved Textbooks Link to Learning about Climate Change” (pages 45-48) for a strand-by-strand list of climate change topics in Science textbooks.

▶ ***Biology: EcoSystems and Human Activity***

Textbooks often present a generic ecosystem for describing the parts and processes of such a system. Students need to identify specific elements in a specific ecosystem to complete the summative task effectively. Succession to a climax forest provides an opportunity to discuss a number of different ecosystems that could be found near a managed forest. Student research and analysis of a specific ecosystem helps develop skills that will be required for this summative task.

▶ ***Chemistry: Chemical Reactions and Their Practical Applications***

Using experiments they can do, or using research skills, students can identify chemical products of various combustion reactions, forest fires and vehicular combustion (gasoline and diesel). Combustion produces CO<sub>2</sub> and also ash that can affect local ecosystems.

▶ ***Earth and Space Science: Weather Systems***

Textbooks often present generic weather information. Students need to be familiar with how to find normal weather patterns for a region that contains an ecosystem of interest. Researching information about weather conditions that increase or decrease the risk of forest fires would be a useful practice for this summative task. Students can also use predictions of future climatic conditions to generalize about the future of forests in different parts of Canada, especially areas in the West.

▶ ***Physics: Motion and Its Applications***

Wood products can be transported in various ways, but trucks are used more frequently at all sites. This requires that roads be built into relatively remote areas. Truck exhaust is a source of heat, and many different chemical products. Students may want to find out how many trucks are required to carry enough logs to make the wood products in a community of single family dwellings. This data can then be used to make generalizations about how much forest is used and the amount of GHGs generated by transporting these products.

## Focus Questions – Climate Change Connections

These strand-by-strand questions are provided to suggest ways to organize ideas as you plan your lessons with the culminating task in mind.

### Biology: EcoSystems and Human Activity

#### Focus Questions

- What are the sources and sinks for carbon in a forest and in the world?
- What roles do forests play in the global carbon budget?
- How does the role of a forest change as it ages or is cut for timber?
- How do forest fires affect the carbon budget?
- What is the impact of forest fires on an ecosystem?
- How does ash affect an ecosystem?
- How are different forests harvested?
- What technological changes have affected cutting and removing timber from a forest?
- What are the impacts of different forestry practices?
- What is meant by “sustainable forestry”?
- How do specific forestry practices link to climate change concerns outlined in the Kyoto Protocol?

#### Climate Change Connections

- ▶ Any model of the carbon cycle for an ecosystem can act as a model for a *carbon budget* for the planet. This accounting framework measures carbon stocks and fluxes (inputs and outputs) by identifying carbon sources and sinks. A balance of sources and sinks means that global levels remain the same. Activity that disturbs this balance can then be identified.
- ▶ Forests play a role in the carbon budget. As sinks, a growing forest sequesters CO<sub>2</sub> from the atmosphere. Harvesting forests reduces this activity, but can lead to renewed growth and hence renewed sequestering. Forest fires both deforest the environment and increase CO<sub>2</sub> levels in the atmosphere.
- ▶ Have students consider the role of diversity in an ecosystem. Look specifically at how changing forestry and transportation technologies can affect the ecosystem’s ability to respond to stress, such as forest harvesting or fire. These considerations can then act as a foundation for a broader exploration of sustainability and practices that are consistent with sustainable forests. Link this discussion to the carbon budget model presented above for a better understanding of climate change issues and the goals of the Kyoto Protocol in relation to choices that people make.

## Chemistry: Chemical Reactions and Their Practical Applications

### Focus Questions

- What are the chemical reactions that make up a forest fire?
- How do the products of a forest fire affect an ecosystem?
- What are other chemical reactions that produce greenhouse gases?
- What are other products of other combustion reactions that contribute greenhouse gases to the atmosphere?
- What are other effects on the local environment?
- Which forestry practices produce fewer greenhouse gases?

### Climate Change Connections

- ▶ Forest fires are an example of combustion reactions that form greenhouse gases. Burning fuels for transportation or other technologies can produce greenhouse gases and acid compounds that affect ecosystems. As the concentration of greenhouse gases increases, the impact of these gases on ecosystems and global climate patterns is more severe. The chemistry learned here can be used for later learning about weather and climate patterns.
- ▶ Use specific greenhouse gases and other carbon compounds to reinforce students' understanding of the components of the carbon cycle.
- ▶ Making consumer choices with the environment in mind can be explored. Forestry methods that reduce CO<sub>2</sub> emissions are “green” *practices*. Goods produced through using energy and materials more efficiently are “green” *products*.
- ▶ Forestry methods can be ranked in terms of CO<sub>2</sub> output; some methods are “greener” than others.

## Earth and Space Science: Weather Systems

### Focus Questions

- How does changing the concentration of CO<sub>2</sub> in the atmosphere affect the amount of energy in the atmosphere?
- How does more heat in the atmosphere lead to changes in flow that lead to changing climate?
- How will climate change affect the productivity of forests in Ontario?
- How do forests contribute to reducing the energy imbalance in the atmosphere by removing atmospheric carbon?
- What are the patterns of forest fires?
- How might the change in the distribution of forest fires caused by climate change affect the pattern of forest fires?
- Which forestry practices increase/decrease fire risks?
- How can fire risk be reduced?

## Climate Change Connections

- ▶ Changes to the atmosphere caused by greenhouse gases affect the balance of energy input and energy output for the planet. This is called the global radiation balance. Changing this balance changes the transfer of energy through wind patterns and ocean current patterns. Climate change is a consequence of these energy changes.
- ▶ Heat transfer is studied in terms of changes in the hydrosphere, where heat transfer takes place and where the consequences develop. Deforestation removes heat sinks and affects the water cycle.
- ▶ Forest composition is related to climate (boreal or mixed deciduous). If global climate changes, the distribution and survival of some forests will change. Such changes will also affect fire patterns. Consider the consequences of shifting wind patterns and ocean current patterns. This is like climate modeling.

## Physics: Motion and Its Application

### Focus Questions

What are the traditional methods of cutting and removing timber from a forest?

How has harvesting technology and transportation technology changed?

How do these new technologies affect forestry practices?

How do different technologies contribute more/less to CO<sub>2</sub> production?

How does satellite technology help track the movement and spread of forest fires?

## Climate Change Connections

- ▶ Compare the CO<sub>2</sub> emissions for different means of transporting wood out of a forest and for different harvesting technologies.
- ▶ Current transportation generally uses fossil fuels, which produce CO<sub>2</sub> and other chemical products.
- ▶ Recent changes in transportation and harvesting technology affect the speed of harvesting an area, and may affect the biodiversity of the area, which could then affect the area's ability for further growth.
- ▶ Satellite technology can be used to track physical conditions and fire patterns.

## Resources

### Textbooks

See “How Approved Textbooks Link to Learning about Climate Change” (pages 45-48) for a strand-by-strand list of climate change topics in Science textbooks.

### Websites

#### *Carbon budget*

[http://www.nrcan.gc.ca/cfs-scf/science/brochure\\_carbon\\_budget/carbon\\_e.html](http://www.nrcan.gc.ca/cfs-scf/science/brochure_carbon_budget/carbon_e.html)

This page explains the carbon budget model and makes specific references to forests and the cycling of carbon in forests at different stages.

<http://www.climatechangesolutions.com/english/science/budget.htm>

Simple explanation of model with sample values.

<http://geochange.er.usgs.gov/pub/carbon/fs97137/>

This is a very useful site that puts the idea of the carbon budget in the climate change context, with specific reference to the Mississippi Valley.

#### *Forests and Forestry*

[http://www.glfc.forestry.ca/science/research/ecolecos\\_e.html](http://www.glfc.forestry.ca/science/research/ecolecos_e.html)

This site has very specific ecosystem information, with a special view towards forests.

<http://ontariosforests.mnr.gov.on.ca/>

The Ontario government’s main page about forestry with many links.

<http://www.algomaforest.com/>

Algoma forestry information.

<http://www.algonquinforestry.on.ca/>

Algonquin forestry information.

<http://www.ene.gov.on.ca/envision/news/2003/070401.htm>

The Ontario government identifies criteria for forest management.

[http://www.nofc.forestry.ca/climate/en/factsheets/factsheets\\_e.html](http://www.nofc.forestry.ca/climate/en/factsheets/factsheets_e.html)

This Environment Canada site links to pages about climate change, carbon budget and a variety of forest types.

[http://www.nofc.forestry.ca/climate/en/factsheets/factsheet9\\_e.html](http://www.nofc.forestry.ca/climate/en/factsheets/factsheet9_e.html)

This site from Environment Canada specifically considers forest fires in the boreal forest.

### *Vehicle Exhaust*

<http://www.osha.gov/SLTC/dieselexhaust/chemical.html>

A good list of many components of diesel exhaust. Each chemical listed links to a chemical sampling information page.

<http://www.nrdc.org/air/transportation/ebd/chap2.asp>

Good site with health risks outlined and specific chemical products listed.

### *Weather*

<http://www.ontarioweather.com/summer/forestfire.asp>

These links may not be active at certain times of the year.

<http://www.spruce.ca/PPG/fire/index.htm>

This site has photos of forest fires.

<http://www.fire.uni-freiburg.de/current/Canada.htm>

National fire monitoring and early warning.

### *Transportation*

<http://www.eia.doe.gov/oiaf/1605/gg96rpt/chap2.html>

This site shows that CO<sub>2</sub> emissions from transportation produces about one-third of USA carbon emissions.

<http://www.niwa.cri.nz/ncces/co2calc/>

This New Zealand Residential CO<sub>2</sub> Calculator site allows students to calculate the amount of CO<sub>2</sub> produced by cars using gas or diesel, when distance (in km) is used.

## Appendix 2.1 *Checklist of Preparation - Forestry Management and Climate Change*

As you work through the course of study, remember to use the checklist periodically to track the key ideas and skills you are acquiring as you prepare for the final assignment.

### Checklist of Preparation

#### I can

- identify biotic and abiotic factors in an ecosystem
- research information about an ecosystem and forest management
- describe how forests change over time
- find and interpret data about ecosystems
- ask questions about the impact of chemical processes on the environment
- identify the products of forest fires
- identify the products of vehicle exhaust
- describe how weather can affect conditions for forest fires
- identify how climate change may affect forest fires in the future
- determine how different transportation choices produce more or less CO<sub>2</sub>

## Appendix 2.2 *Student Task and Expectations:* *Forestry Management and Climate Change*

**Purpose:** To outline and recommend good forestry strategies for a local forest to help maintain the carbon budget, reduce global climate change and support the Kyoto Protocol.

**Scenario:** A local forest provides timber for a pulp mill and softwood lumber for construction. The old growth forest was harvested in the 1800s, mostly for white pine. Spruce and balsam have been cut for pulp, but the construction boom in Southern Ontario has increased the value of logs that can be transported to that market for building construction. Local residents are concerned that cutting too much timber will reduce the value of the forest and hurt local ecosystems, which are also valuable for tourism. Some people are also concerned that increased cutting will contribute to climate change. The Ministry of Natural Resources requires that forest managers be certified for ISO 14001 Standards.

Several people in the area (environmental activist, forester, forest manager, municipal official) have been asked to outline and recommend good forestry practices that will help maintain the carbon budget, slow global climate change and help meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

**Student Task:** You will choose (or be assigned) one of the following roles: environmental activist, forester, forest manager, municipal official. Using this assumed perspective, you will complete a report that outlines good forestry practices, and describe how they affect the value of the forest and the environment in terms of a specific ecosystem and the global climate.

The report is to explain how each choice connects to slowing climate change, thus helping to meet the goal of the Kyoto Protocol to reduce greenhouse gas emissions. A copy of your rough work and a list of sources should be included to support the recommendations made. Your report should answer these questions:

- a) What are good forestry practices?
- b) How do these practices reduce the environmental impact on local ecosystems?
- c) How does this management strategy affect global climate?

**Expectations:** Use this list of expectations, along with Appendix 2.1 *Checklist of Preparation* to help you complete your assignment:

- describe how different ecosystems respond differently to short-term stresses and long-term changes
- through investigations and applications of basic concepts select and integrate information from various sources, including electronic, print, and community resources, to answer the question chosen
- through investigations and applications of basic concepts, analyse the data and information gathered to clarify aspects of the concern or issue
- through investigations and applications of basic concepts, communicate the results of the investigation using a variety of oral, written, and graphic formats
- assess the impact of technological change on an ecosystem [e.g., forest harvesting and transportation technology]

- ▶ identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, Ministry of Natural Resources and ISO 14001 for forestry management]
- ▶ represent simple chemical reactions using word equations, balanced chemical equations, and, where appropriate, molecular models
- ▶ use scientific nomenclature to identify common consumer products [e.g., common waste products formed by different kinds of technology, such as a chainsaw]
- ▶ relate chemical reactions to familiar processes encountered in everyday life [e.g., identify the waste products created by the operation of different kinds of technology – gasoline vs. diesel vs. an alternative fuel source]
- ▶ describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks
- ▶ describe and illustrate the factors affecting heat transfer within the water cycle in the atmosphere [e.g., the role of forests as carbon sinks and the release of carbon with a forest fire]
- ▶ describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents [e.g., the global impact of increased energy in the atmosphere]
- ▶ describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems [e.g., how does climate change explain current severe weather, such as droughts?]
- ▶ through investigations and applications of basic concepts, identify factors that affect the development, severity, and movement of local weather systems [e.g., what forestry activities affect severe weather?]
- ▶ identify the impact of climate change on economic, social, and environmental conditions [e.g., what are future considerations for forestry?]
- ▶ perform a cost-benefit analysis, including environmental and safety factors, of technologies which have enabled us to attain ever-faster speeds on land and water and in the air, and of alternative modes of transportation
- ▶ investigate the benefits and risks to the community and the individual of alternatives to motor-vehicle transportation

## Appendix 2.3 *Evaluation Rubric for Report*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts	Concepts are simple, with gaps.	Concepts are mostly simple and complete.	Ideas are developed with some depth.	Concepts are complete and developed with insight.
K/U Facts and terms used accurately and connect to concepts presented.	Facts and terms are presented with limited accuracy and loosely connect to the concepts presented.	Facts and terms used accurately and appropriately for the concepts presented.	Facts and terms are used accurately and they connect and support concepts presented.	Facts and terms effectively support the ideas presented so that the concepts are understood more easily.
K/U Transfer of concepts to new contexts	Transfers simple concepts to new context	Transfers simple concepts to new contexts with some effectiveness	Transfers both simple and complex concepts to new contexts effectively	Transfers complex concepts to new contexts effectively
I Analysis and interpretation of data	Limited analysis and interpretation of data	Moderate analysis and interpretation of data	Considerable analysis and interpretation of data	Thorough analysis and interpretation of data
C Accurate use of scientific terminology, symbols, conventions and SI units	Limited accuracy of scientific terminology, symbols, conventions and SI units	Moderate accuracy of scientific terminology, symbols, conventions, and SI units	Considerable accuracy of scientific terminology, symbols, conventions, and SI units	A high degree of accuracy of scientific terminology, symbols, conventions, and SI units
C Use of report form	Limited command of the report form	Moderate command of the report form	Considerable command of the report form	Extensive command of the report form
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Analysis of social and economic issues	Analyses forest practice in terms of simple social and economic issues.	Analyses forest practice in terms of some social and economic issues.	Analyses forest practice in terms of various social and economic issues.	Analyses forest practice in terms of complex social and economic issues.
MC Assessment of impacts of science and technology on the environment	Identifies and assesses how specific forest practice affects the area of interest.	Explains and assesses how specific forest practice affects the area of interest.	Explains and assesses how key forest practices affect the area of interest.	Explains and assesses the impact of varied forest practices on the area of interest.
MC Proposing courses of practical action in relation to identified problems	Extends analyses of problems into courses of practical action with limited effectiveness	Extends analyses of problems into courses of practical action with moderate effectiveness	Extends analyses of problems into courses of practical action with considerable effectiveness	Extends analyses of problems into courses of practical action with a high degree of effectiveness