

Bringing Climate Change into the Classroom:

**A teaching module for use with Nova
Scotia's Grade 4 public school curriculum**



**A partnership between Dalhousie University and Nova Scotia Education
Supported by the Nova Scotia Department of Environment Climate Change Adaptation Fund**

OVERVIEW

LESSON	OBJECTIVES	MAIN ACTIVITIES	CURRICULUM OUTCOMES
1: Capturing Climate Change Through Art	<ul style="list-style-type: none"> *Think about/discuss roles of artists and how artists can communicate messages *Use art to explore student understanding of climate change 	<ul style="list-style-type: none"> *View artwork and discuss how art can be used to communicate environmental messages *Create art to reveal students' understanding of climate change – discuss their artwork 	<p>Visual Arts:</p> <ul style="list-style-type: none"> * share thoughts and ideas about artworks (Primary – 6, 4.2) * explore art as a way of expressing ideas and points of view (Primary – 6, 5.1) * demonstrate an awareness of the role of art and artists in their local and global communities (Primary – 6, 6.3)
2: What Causes Climate Change and How Can I Help?	<ul style="list-style-type: none"> *Introduction to greenhouse effect and human vs. natural causes of climate change *Students will begin thinking about how their actions, and those of their families, can contribute to creation of greenhouse gases 	<ul style="list-style-type: none"> *KWL chart as a way of summarizing students' prior knowledge and interests *Activity sheet exploring effects of volcanoes vs. humans on climate change *Introduction to carbon footprints and online carbon calculator activity 	<p>Science:</p> <ul style="list-style-type: none"> *identify their own and their families' impact on habitats and describe how personal actions help conserve habitats (108-3, 108-6) <p>Social Studies:</p> <ul style="list-style-type: none"> *examine the relationship between humans and the physical environment (4.3.3)
3. Warming Oceans and Sea Level Rise	<ul style="list-style-type: none"> *Introduction to adaptations to different environments and conditions – look at how polar bears are adapted to Arctic *Learn about sea level rise and identify areas in Nova Scotia that are vulnerable – discuss possible adaptations 	<ul style="list-style-type: none"> *Sea level experiment (sea ice vs. land-based ice) *Discuss polar bear adaptations and how polar bears may be affected to warming oceans and sea level rise *Read-aloud of news article <i>The Coast is Unclear</i> – discuss how people in NS may be affected by warming oceans and sea level rise 	<p>Science:</p> <ul style="list-style-type: none"> * compare the external features, behavioural patterns, and structural and/or behavioural adaptations for an animal to survive a particular habitat, real or imagined (204-3, 300-1, 300-2, 302-2) * predict how the removal of a plant or animal population affects the rest of the community and relate habitat loss to the endangerment or extinction of plants and animals (30-1, 301-2) <p>Social Studies:</p> <ul style="list-style-type: none"> * examine the relationship between humans and the physical environment (4.3.3)
4. What's in it for the Trees?	<ul style="list-style-type: none"> *Discuss adaptations that plants have to enable them to grow in different environments *Look at how climate change may affect growth and distribution of trees *Discuss spruce budworm and climate change connection 	<ul style="list-style-type: none"> *Identify adaptations of different plants *Play spruce budworm card game and learn about how climate change may affect the spread of this forest pest 	<p>Science:</p> <ul style="list-style-type: none"> *compare the external features, behavioural patterns, and structural and/or behavioural adaptations for an animal to survive a particular habitat, real or imagined (204-3, 300-1, 300-2, 302-2)

5. Farmers are Affected too: Climate Change and Soil Erosion

*Learn about ways that agriculture in Nova Scotia is/may be affected by climate change
*Look at different factors that cause soil erosion – make connections to climate change

*Carry out experiments to learn about how wind and water cause soil erosion
*Discuss ways that climate change can affect farmers and adaptations that are available for farmers

Science:

*demonstrate and record a variety of methods of weathering and erosion, including human impact on the landscape (108-3)
*describe how scientists’ knowledge of plant growth has led to agricultural and technological innovations and the impact on local and regional habitat issues (105-1, 108-6)

Social Studies:

*examine the relationship between humans and the physical environment (4.3.3)

6. Urban Areas & Climate Change

*Discuss differences between rural and urban areas, making connections to climate change (causes & impacts)
*Look at how different urban areas are affected by climate change, as well as possible adaptations

*Reading activity, looking at similarities/differences between Halifax and Toronto in terms of climate change
*Creative writing assignment, imagining future with changes and adaptations necessary as a result of climate change

Science:

*identify their own and their families’ impact on habitats and describe how personal actions help conserve habitats (108-3, 108-6)

Social Studies:

*examine the relationship between humans and the physical environment (4.3.3)

7. Climate Change Art Exhibition

*Reflect on previous 6 lessons and the information learned about climate change as well as the roles of artists
*Create climate change-inspired art and host a school art exhibition as a way of teaching younger students at the school about climate change

*Complete KWL chart from Lesson 1
*Create climate change art
*Plan and carryout art exhibition for younger students

Visual Arts:

*share thoughts and ideas about artworks (Primary – 6, 4.2)
*explore art as a way of expressing ideas and points of view (Primary – 6, 5.1)
*demonstrate an awareness of the role of art and artists in their local and global communities (Primary – 6, 6.3)

***Note: Applicable English Language Arts curriculum outcomes are not included as there are many opportunities for inclusion and individual teachers may integrate English Language Arts outcomes to suit their individual classes.**



CAPTURING CLIMATE CHANGE THROUGH ART

LESSON 1

Introduction:

Climate change is an issue that is explored by artists across the globe. Individual artists have become known for their efforts to capture climate change, including the effects of a changing climate, through their art (e.g., Canadian artists Linda Mackey and Franke James), and entire art exhibitions and festivals have also been dedicated to the cause of raising awareness of climate change. For example, the British Royal Academy of Arts featured an exhibition in 2009 called *Earth: Art of a changing world* that showcased different artistic representations of climate change and its known and potential impacts.

Objectives:

Through the process of creating their own artwork on climate change, and by looking at and discussing the artwork of their fellow classmates, as well as artists from both international and local communities, students will explore different ways that ideas and messages can be expressed through art. Students will discuss ways that artists can use their work to raise awareness of issues related to climate change and to encourage people to change attitudes and behaviours. Students will begin to start thinking about how they understand climate change, as well as ways that a changing climate may affect them personally.

Specific Curriculum Outcomes:

Students will be expected to...

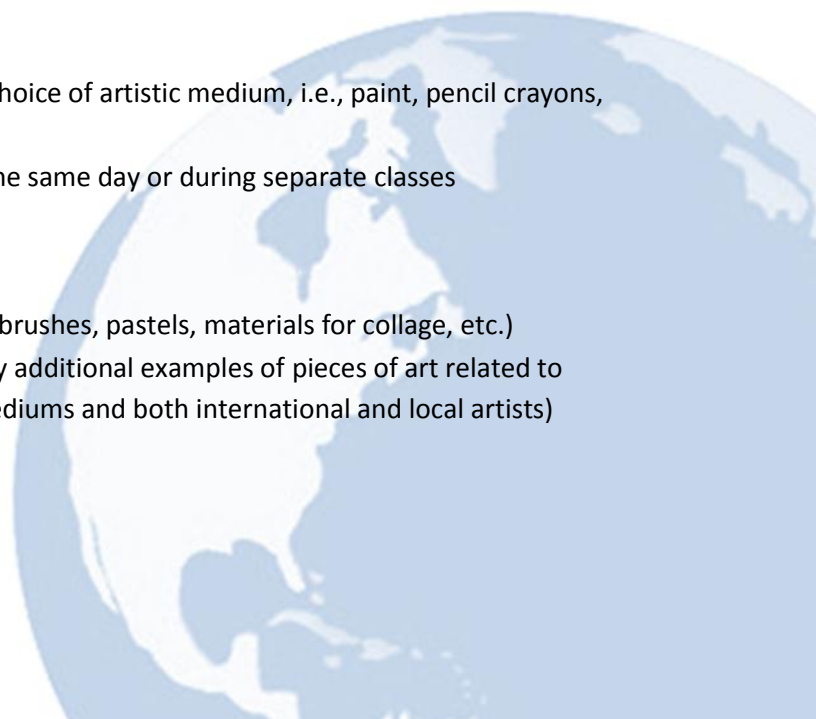
- share thoughts and ideas about artworks (Visual Arts: Primary – 6, 4.2)
- explore art as a way of expressing ideas and points of view (Visual Arts: Primary – 6, 5.1)
- demonstrate an awareness of the role of art and artists in their local and global communities (Visual Arts: Primary – 6, 6.3)

Time Frame:

- 1-2 hours (time will vary depending on the choice of artistic medium, i.e., paint, pencil crayons, pastels, etc.)
- Parts 1 and 2 may either be carried out on the same day or during separate classes

Materials Required:

- Paper and art supplies (e.g., paint and paint brushes, pastels, materials for collage, etc.)
- Teaching Resources 1.1 and 1.2, and possibly additional examples of pieces of art related to climate change (ideally, from a variety of mediums and both international and local artists)
- Journals or writing books



Part 1:

Activities:

1. Show students a piece of art that communicates an idea about an environmental theme (choose something other than climate change – e.g., can use Teaching Resource 1.1 illustrating an artist’s impression of pollution). Ask students to share their ideas about what the piece of art is depicting, how it makes them feel, what kinds of messages it might be conveying to its audience. Encourage students to think about ways that artists can use their work to communicate environmental messages to local and even global audiences (e.g., use of murals to communicate messages, art shows or exhibitions to raise awareness of issues, sell art to raise money for local adaptation projects, environmental organizations, etc.).
2. Once students have generated (with prompting, if necessary) ideas about ways that artists can help raise awareness of environmental issues and be part of solutions to environmental problems, ask students to raise their hands if they have heard of climate change.
3. Explain to students that they will be learning more about climate change together, but that they will first have a chance to share some of their current ideas about climate change through the creation of a piece of climate change-inspired artwork.
4. Explain to students that they are to produce a piece of artwork that conveys their their understanding of how climate change might affect them (or their families, community, local area, etc.). While students may be uncertain about what to focus on, advise them to do their best to try to capture what the words ‘climate change’ make them think of by depicting the impact (or impacts) of climate change that they are most concerned about. **Note: In order to avoid influencing students’ work, refrain as much as possible from giving students any suggestions about potential impacts they may wish to focus on.**
5. Once students have completed their artwork, have each student write a few sentences explaining what they have attempted to represent through their art (i.e., what impact have they depicted? Why are they particularly concerned about this impact?).

Part 2:

1. Explain to students that while creating a piece of artwork can be a good way for an artist to really think about and engage with a topic, it is also useful to look at and respond to art that is produced by others.
2. Remind students of the importance of being respectful when discussing the artwork of others, and challenge students to think of positive comments to share, and interesting questions to ask, when they look at different works of art.
3. Invite students to share their climate change-inspired art with the class. Have students explain their work, and invite positive comments, feedback, and questions from the class. Through this

activity, help students understand and appreciate why others may have approached this artistic assignment quite differently.

4. After students have had an opportunity to share their own work, invite students to look at and discuss an example of a piece of art related to climate change by a Canadian artist, Linda Mackey (Teaching Resource 1.2).
5. Have students share their thoughts about Linda Mackey's painting, *A Conversation*, in their journals or writing book (or piece of paper). Encourage students to discuss their reactions, what impact of climate change is depicted in the art, what kind of messages the artist may be communicating, how the art makes them feel, etc.

Assessment:

Students' artwork and their written explanations can be used to assess their ability to use art to express an idea about climate change. Students' contributions to classroom discussions can also be used to assess students' ability to respond to works of art and identify ways that artists can use their art in local and global communities.

Enrichment Opportunities:

Invite a local artist (ideally an artist interested in climate change or other environmental issues) to visit the classroom in order to discuss with students their work and the roles that artists can play in local and global communities.

References:

James, F. (2011). *Overview: Six tools for climate change art*. Retrieved online from http://www.frankejames.com/debate/?page_id=6012.

Mackey, L. (2011). Linda Mackey's homepage. Retrieved online from <http://www.lindamackeyartist.com/>.

Royal Academy of Arts. (2011). *Earth: Art of a changing world*. Retrieved from <http://www.royalacademy.org.uk/exhibitions/gsk-contemporary-season-2009/>.

Entity of Pollution



Used with permission of the artist, Sue Antlitz

A Conversation



Used with permission of the artist, Linda Mackey

WHAT CAUSES CLIMATE CHANGE AND HOW CAN I HELP?

Introduction:

Although natural forces contribute to climate change (e.g., volcanoes and variations in solar output), climate scientists, and the scientific community in general, largely agree that humans are also contributing to, and accelerating, global climate change. The scientific consensus is that: (1) the accumulation of greenhouse gases (e.g., carbon dioxide, methane, and chlorofluorocarbons (CFCs)) in the atmosphere is causing climate change, and (2) that human activity is responsible for the increasing rate of emissions of greenhouse gases into the atmosphere.

Objectives:

While students in Grade 4 will almost certainly have some level of familiarity with climate change, this lesson will encourage students to both share what they already know (or think they know!) about climate change, and also offer suggestions about what they would like to learn about climate change. Students will gain a better understanding of the greenhouse effect and what climate change is, and will be introduced to the difference between natural and human (anthropogenic) causes of climate change. Students will be encouraged to consider ways that they (and their families) contribute to increases in greenhouse gas emissions. Students will complete an online carbon calculator activity to encourage them to think about how they (and their families) could reduce their carbon footprints. By increasing students' understanding of human activities that result in emissions of greenhouse gases, students will begin to develop a sense of how they, and their families and larger communities, have the potential to contribute to greenhouse gas emissions and will begin to see a relationship between personal actions and climate change.

Specific Curriculum Outcomes:

Students will be expected to...

- identify their own and their families' impact on habitats and describe how personal actions help conserve habitats (Science, 108-3, 108-6)
- examine the relationship between humans and the physical environment (Social Studies, 4.3.3)

Materials:

- Chart paper for KWL chart
- Paper and markers (1 of each per group of 4-6 students)
- Teaching Resource 2.1 *Volcanoes vs. Humans: What, or Who, is Heating up the Planet?*
- Access to computers for online carbon footprint calculator activity

Activities:

Part 1:

1. Explain to students that they are going to be learning more about climate change. First, let students know that you are interested in hearing what students already know, and what questions students might have, about climate change. Divide students into small groups and encourage students to discuss climate change.
2. Instruct each group to designate someone to record their ideas. On one side of a piece of paper, the recorder will list everything the group already knows about climate change. On the other side, the recorder will write down suggestions from group members about questions they have and what they are interested in learning about climate change.
3. After students have had enough time to discuss and record their ideas in small groups, have groups share their ideas, recording the information generated from the small groups on a KWL (What I Know-What I Want to Know-What I Learned) chart displayed for the class to see.
4. Explain to students that an important place to start to learn more about climate change involves understanding how climate change works. Some of the groups may have mentioned greenhouse gases. If not, ask students if they have heard about greenhouse gases before. See if students can name any greenhouse gases (i.e., carbon dioxide, methane, nitrous oxide, water vapour, human-made aerosols, etc.).
5. Explain that these gases are called greenhouse gases because they produce what is called the greenhouse effect. Explain to students that the greenhouse effect is important because it allows the Earth to be warm enough to support life (without it, humans would not be able to survive!). Also, let students know that calling these gases greenhouse gases is actually a bit confusing, because they don't really behave in the same way that a greenhouse does. And the blanket analogy doesn't work that well either!
6. Explain to students that greenhouse gases in the atmosphere allow sunlight to pass through and reach the Earth's surface, warming the Earth. As the planet warms, it gives off heat energy that radiates toward space (have students think about what happens if they hold their hand over a hot object – it warms up because anything that is hot will give off heat). While some of this heat energy passes through the atmosphere and enters space, the greenhouse gases in the atmosphere cause some of the heat to be reflected back toward the Earth which causes additional heating. (Students might find it helpful to think of the Earth being heated by two fireplaces (although one is bigger and hotter, and therefore gives off more heat, than the other): the sun and the greenhouse gases in the atmosphere).
7. Introduce students to the idea of an 'enhanced' greenhouse effect (i.e., the fact that the greenhouse effect is getting stronger). Ask students what they think might happen when large

amounts of greenhouse gases build up in the atmosphere. Help students realize that while the greenhouse effect is natural (and necessary!), when large amounts of greenhouse gases are emitted into the atmosphere they cause more heat to be reflected back to the Earth, which can cause the Earth to slowly start to warm up. Using the fireplace analogy, you can ask students what would happen if you keep adding more wood to the fire? Answer: it gets hotter.

8. Tell students that while there are many different causes of climate change, they will be focusing on some of the ways that human activities cause an enhanced greenhouse effect. In particular, they will be learning more about human activities that release carbon dioxide, the greenhouse gas that makes the biggest contribution to climate change.
9. Have students work individually or with a partner to complete Teaching Resource 2.1, *Volcanoes vs. Humans: What, or Who, is Heating up the Planet?* in order to start thinking about different causes of climate change.
10. After students have had enough time to read the article and answer the questions, take up students' responses as a class. Have students suggest ways that they contribute to carbon dioxide emissions.

Part 2:

1. Introduce carbon footprints as a way that humans can think about how their activities and lifestyles contribute to emissions of carbon dioxide. Explain that carbon footprint calculators are popular tools that have been developed to help measure humans' contributions to carbon dioxide emissions. Explain that the idea of calculating carbon footprints isn't a perfect way of understanding how much carbon dioxide is released into the atmosphere as a result of our behaviours and lifestyle choices. However, it is a good way to at least start thinking about how different actions are associated with different levels of carbon dioxide emissions.
2. Explain to students that they will be going to a computer lab and will have a chance to calculate their own carbon footprints using an online calculator. Zero Footprint Youth Calculator (<http://www.meetthegreens.org/features/carbon-calculator.html>) is a good, child-friendly tool.
3. Take students to a lab and have students complete an online calculation of their carbon footprints. You may decide to work through the exercise as a class, or have students work at their own paces. Circulate to assist students, as needed.
4. Once students have had enough time to complete the activity, return to class and have students suggest ways they could reduce their carbon footprints. Optional: Encourage students to think about how their carbon footprints would compare to people in different parts of the world.

Assessment:

Students' contributions to classroom discussions and their completion of Teaching Resource 2.1 can be used to assess their understanding of different causes of climate change and in particular, ways that humans can contribute to climate change. A class discussion after the carbon calculator activity can be used to determine whether students are able to identify different actions/behaviours that result in carbon dioxide emissions, and therefore increase their carbon footprints.

Enrichment Opportunities:

Encourage interested students to try an online carbon calculator activity at home with their parents/family members. After they have completed the calculation, encourage them to come up with some practical ways that the family can reduce their carbon footprint.

References:

- Gerlach, T. (2011). Volcanic versus anthropogenic carbon dioxide. *Eos*, 92(24), 201-208.
- Hollingsworth, D., & Pressfield, J. (2011). *Human activities release more carbon dioxide than do volcanoes*. U.S. Geological Survey. Retrieved from <http://www.usgs.gov/newsom/article.asp?ID=2827&from=rss>.
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- U. S. Department of Energy. (2008). *How fossil fuels were formed*. Retrieved from http://www.fe.doe.gov/education/energylessons/coal/gen_howformed.html.
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- Weidema, Mikkel Thrane, M., Christensen, P., Schmidt, J., & Løkke, S. (2008). Carbon footprint: A catalyst for life cycle assessment? *Journal of Industrial Ecology*, 12(1), 3-6.

Volcanoes vs. Humans:

What, or Who, is Heating up the Planet??

Have you ever wondered what plays a bigger role in climate change, volcanic or human activity? If you answered yes, you are not alone! Scientists have also been interested in understanding how volcanoes and humans compare in terms of their impacts on climate change.

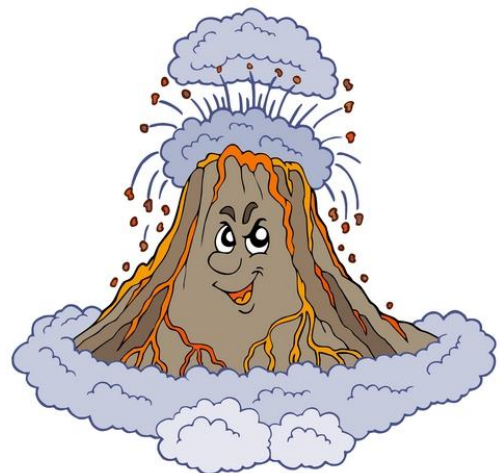
Keep reading to find out what scientists have discovered!

The Role of Volcanoes:

Volcanic eruptions may have an effect on climate. This is due to the fact that when a volcano erupts it can release huge amounts of volcanic gases and ash into the atmosphere. The two most important gases that are released from volcanoes are sulphur dioxide and carbon dioxide.

Large amounts of sulphur dioxide gas can actually cause the Earth to cool down. Many scientists think that major volcanic eruptions over the past century may have caused very small drops (much less than even one degree Celsius!) in the average temperatures on Earth. These changes in temperature didn't last long (maybe up to a few years), and they were so small that humans wouldn't have even noticed.

However, volcanoes can also cause the Earth to heat up. Volcanic eruptions release carbon dioxide, one of the most important greenhouse gases, into the atmosphere. Scientists know that carbon dioxide plays a big role in global warming and climate change. However, there have not been any volcanic eruptions large enough during our lifetimes to actually cause the Earth to heat up. Therefore, while scientists don't always agree on whether or not volcanoes ever released enough carbon dioxide to cause noticeable global warming, they do agree that the volcanoes around today are not heating up our planet.



The Role of Humans:

Scientists agree that humans are responsible for releasing greenhouse gases into the atmosphere. But how much are we releasing, and how big is the effect on climate change?

The four main greenhouse gases that are released because of human activity are carbon dioxide, methane, nitrous oxide, and halocarbons. Of these four, carbon dioxide has the biggest impact on climate change. You may be surprised to learn of the many different human activities that release carbon dioxide into the atmosphere and contribute to what is known as the 'enhanced' greenhouse effect. The biggest, and most important, way that humans release carbon dioxide is by burning what are known as fossil fuels. Most of us rely on fossil fuels all the time, in ways that many of us are not aware of. For example, transportation, heating and cooling our homes, and manufacturing many of the products that we use in our everyday lives requires the use of fossil fuels.

Over the last few hundred years, humans have been using a lot more fossil fuels. Just think of how many times you ride in a car (or bus, or truck) each week, and how many times you take a hot shower or bath. You may not know that these activities involve the use of fossil fuels. Even eating fruit shipped in from other countries, like pineapples and oranges, and buying products like new electronics, are ways of indirectly using fossil fuels. It shouldn't take long to start realizing that humans use fossil fuels all the time, and as a result, we put a lot of carbon dioxide into the atmosphere. However, burning fossil fuels is just one activity that we need to be concerned about. For example, cutting down forests is another activity that humans do that releases carbon dioxide into the atmosphere.

It turns out that humans release *a lot* more carbon dioxide than volcanoes! While humans around the world released a total of 35 gigatons of carbon dioxide into the atmosphere in 2010, volcanoes only release an average of less than one gigaton a year. Or, you can think of it this way: in less than a week, humans around the world cause more carbon dioxide to be released into the atmosphere than volcanoes release over an entire year. Clearly, human activity has a *much* bigger impact on climate change than modern day volcanic activity!

What are fossil fuels?

Fossil fuels are non-renewable sources of energy formed from the remains of prehistoric plants and animals. They are called non-renewable because they take a very long time to form. While scientists aren't sure exactly how long the process takes, they believe it takes at least hundreds of thousands of years! Humans burn fossil fuels in order to produce energy. When fossil fuels are burned, most of the energy that is stored in them is released into the atmosphere as carbon dioxide. Coal, oil, and gas are the fossil fuels that humans use most often.

Did you know that a gigaton is equal to one *billion* metric tons! And there are 1000 kilograms in one ton! That's huge!

Name: _____

Date: _____

Volcanoes vs. Humans: What, or Who, is Heating up the Planet??

So, what did you learn? Answer the following questions.

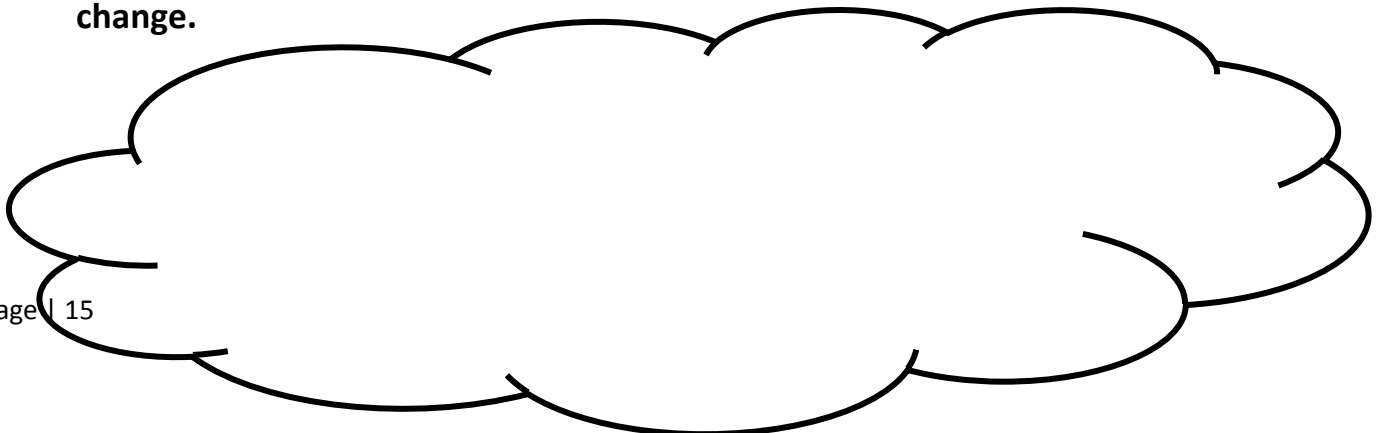
1. Which greenhouse gas can volcanoes release into the atmosphere?



2. Use the boxes to show what you learned about the roles that humans and volcanoes play in warming temperatures on Earth? Feel free to write notes and/or draw to help explain.

HUMANS	VOLCANOES

3. Fill the cloud with different human activities that contribute to climate change.



Introduction:

While average sea levels have been rising since the last ice age (~20,000 years ago), climate change is causing accelerated rates of sea level rise. As temperatures increase slowly, the melting of land-locked ice and land-based glaciers are contributing to sea level rise, as well as the thermal expansion of oceans (i.e., as oceans heat up, the warmer water expands). While sea level rise in itself has serious implications for coastal regions of Nova Scotia, higher sea levels can also contribute to more destructive and far-reaching surges. As more frequent and extreme storms are projected to be among the effects of climate change that will impact Nova Scotians, rising sea levels are clearly a concern for many people living in coastal regions of Nova Scotia.

Objectives:

By learning about sea level rise and the warming of oceans, students will gain a better understanding of some of the effects of climate change that are particularly important for coastal regions. Students will discuss how polar bears are adapted to living in Arctic environments, and will discuss how climate change is effecting polar bear populations. In addition to polar bears, students will begin to think about how humans are also affected by the warming of oceans and sea level rise. Students will identify areas that are most vulnerable to sea level rise (across the globe and in Nova Scotia) and will learn about some of the challenges faced by people living in coastal Nova Scotia, and ways that people in Nova Scotia can adapt to rising sea levels.

Specific Curriculum Outcomes:

Students will be expected to...

- compare the external features, behavioural patterns, and structural and/or behavioural adaptations for an animal to survive a particular habitat, real or imagined (Science, 204-3, 300-1, 300-2, 302-2)
- predict how the removal of a plant or animal population affects the rest of the community and relate habitat loss to the endangerment or extinction of plants and animals (Science, 30-1, 301-2)
- examine the relationship between humans and the physical environment (Social Studies, 4.3.3)

Materials:

- Teaching Resources 3.1 – 3.4
- Materials for sea level rise experiment (included on Teaching Resource 3.2): ice, water, containers, rulers, modelling clay or another material to create land mass
- Meter sticks

Time Frame:

- 1 hour

Activities:

1. Introduce students to the sea level experiment prepared in advance of class. Invite students to make predictions about what will happen when the ice melts in the two different scenarios (i.e., ice in water and ice on land). Ask for student volunteers to make connections to climate change.
2. Record students' ideas and tell class that they will check the results at the end of the lesson, after the ice has had a chance to melt.
3. Ask students what kinds of animals might be affected by warming oceans and rising sea levels. Invite students to share their ideas about ways that a warming habitat might affect its inhabitants.
4. Students will likely have thought of polar bears, the poster species for climate change. Encourage students to think about where polar bears live (marine Arctic environments) and how polar bears have special adaptations that allow them to live in this environment. Show students Teaching Resource 3.1, a picture of a polar bear, to help trigger ideas (e.g., why is white coat advantageous? (camouflage), black skin? (absorb sun and keep the bears warm- have students think about how hot black pavement gets on a sunny day) thick layer of fat? (help keep the bear warm and helps them float when swimming) rough pads on their feet? (help them walk on ice- have students think about whether of the difference between having boots with smooth soles and treads in the winter) etc.).
5. Ask students how loss of sea ice is affecting polar bears (polar bears use ice for hunting their prey, mainly seals, and with less ice they can experience difficulties finding enough food). Ask students how polar bears are coping with loss of sea ice (have to swim longer distances to find food, more interactions with humans as they are search for food, scientists have suggested that polar bears might be able to adapt to a changing climate if they start breeding with brown bears, etc.). What might happen if the climate keeps changing? (polar bears might eventually become extinct). What, and who, would be affected if polar bears went extinct? (seals and other animals that polar bears eat – their populations might increase, humans in the Arctic that hunt polar bears – lose a source of food and income, etc.).
6. Tell students that polar bears provide a good example of just how much a changing climate can affect an animal that is adapted to a particular habitat. But, polar bears are not the only ones that are affected by climate change. Ask students if they can think of anything else that would be affected? (Hopefully students suggest humans, prompt them if necessary).

7. Ask students to suggest what people would be most affected by sea level rise, one of the important effects of climate change (people living near coasts). Encourage students to suggest areas in Atlantic Canada and Nova Scotia that might be most affected. Show students Teaching Resource 3.3, the coastal sensitivity map, and explain how scientists look at different factors like soil and rock types, wave heights, and the coastal land formations to decide what areas might be most at risk to flooding, erosion (movement of soil), loss and/or movement of beaches, and damage to coastal dunes.
8. Explain to students that sea level rise is happening very slowly, but that over time, it can have very big effects. Ask for two student volunteers. Have one student show where 30 cm is on a meter stick. Explain that this is how much the sea level rose in Nova Scotia during the 20th century. Ask for the second student to show 70 cm on a meter stick. Then have the two students use two meter sticks to show 140cm. Explain that scientists project that by the end of the 21st century, the sea will rise between 70 – 140 cm in Nova Scotia.
9. Tell students that people living in different areas of Nova Scotia will be affected differently, and will have different ways of adapting to sea level rise.
10. Do a read-aloud of the article from the *Cape Breton Post*: The Coast is Unclear (July 25, 2011). Display a copy of the article (Teaching Resource 3.4) for the students to read (e.g., on overhead projector, printed and blown-up, etc.). Have students determine what kind of writing this is (newspaper article – how do they know? Name of newspaper, tagline, etc.) and highlight and define words that students are unfamiliar with (have student volunteers look up unfamiliar words in dictionary).
11. Have students identify what kinds of problems are described in the article, and have students suggest different ways of adapting to sea level rise that are mentioned in the article (e.g., moving homes and cottages further away from coast, planting shrubs and trees to protect coasts, placing boulders in the water to provide protection, and educating people about sea level rise and coastal erosion). See if students can think of any other ways of adapting to sea level rise that are not mentioned in the article.
12. Having learned about sea level rise and ocean warming and how they can affect both polar bears and humans, revisit the ice melting scenario to see which scenario resulted in sea level rise (the one with the ice cubes on the 'land'). Ask students what they can learn from this? What kind of ice melting will affect sea level rise? (Not icebergs and sea ice, but land-based glaciers, snow caps, ice sheets – the majority of global land ice is located in Antarctica and Greenland).
13. Remind students that luckily sea level rise is occurring very slowly (think back to the demonstration with the meter sticks) and that there are many ways that humans can adapt to increasing sea level and also many actions that humans can take to reduce the amount of greenhouse gases that are being emitted into the atmosphere.

Assessment:

Students' contributions to classroom discussions can be used to assess students' understanding of ways that polar bears are adapted to their environments, and what might happen if polar bears are removed from the environment. Students' contributions to the read-aloud activity can be used to assess students' understanding of how sea level rise may affect humans and ways that humans can adapt to rising sea levels.

References:

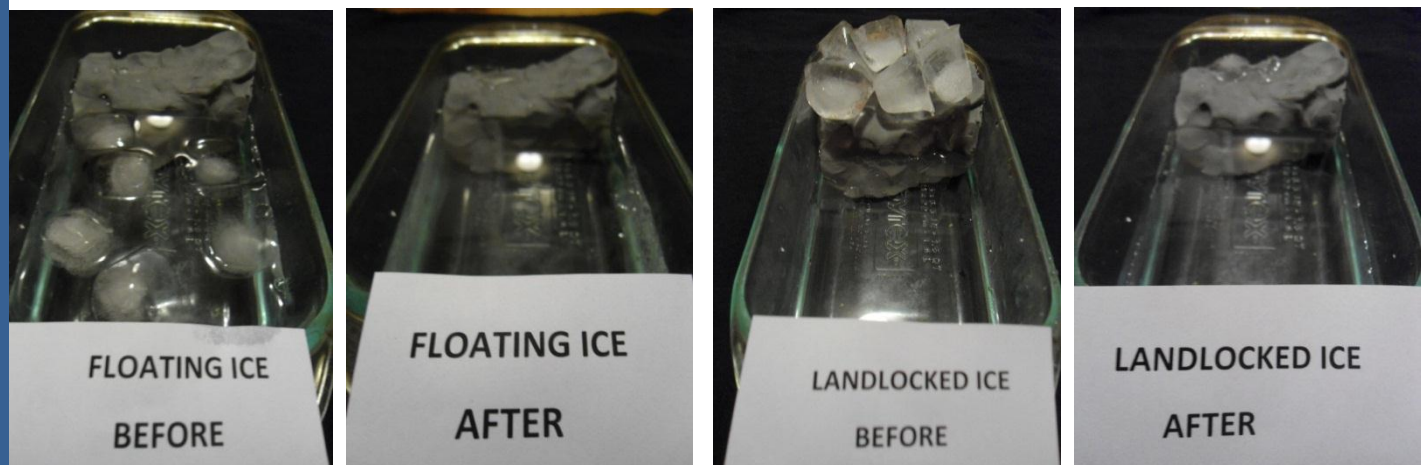
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Polar Bear Adaptations

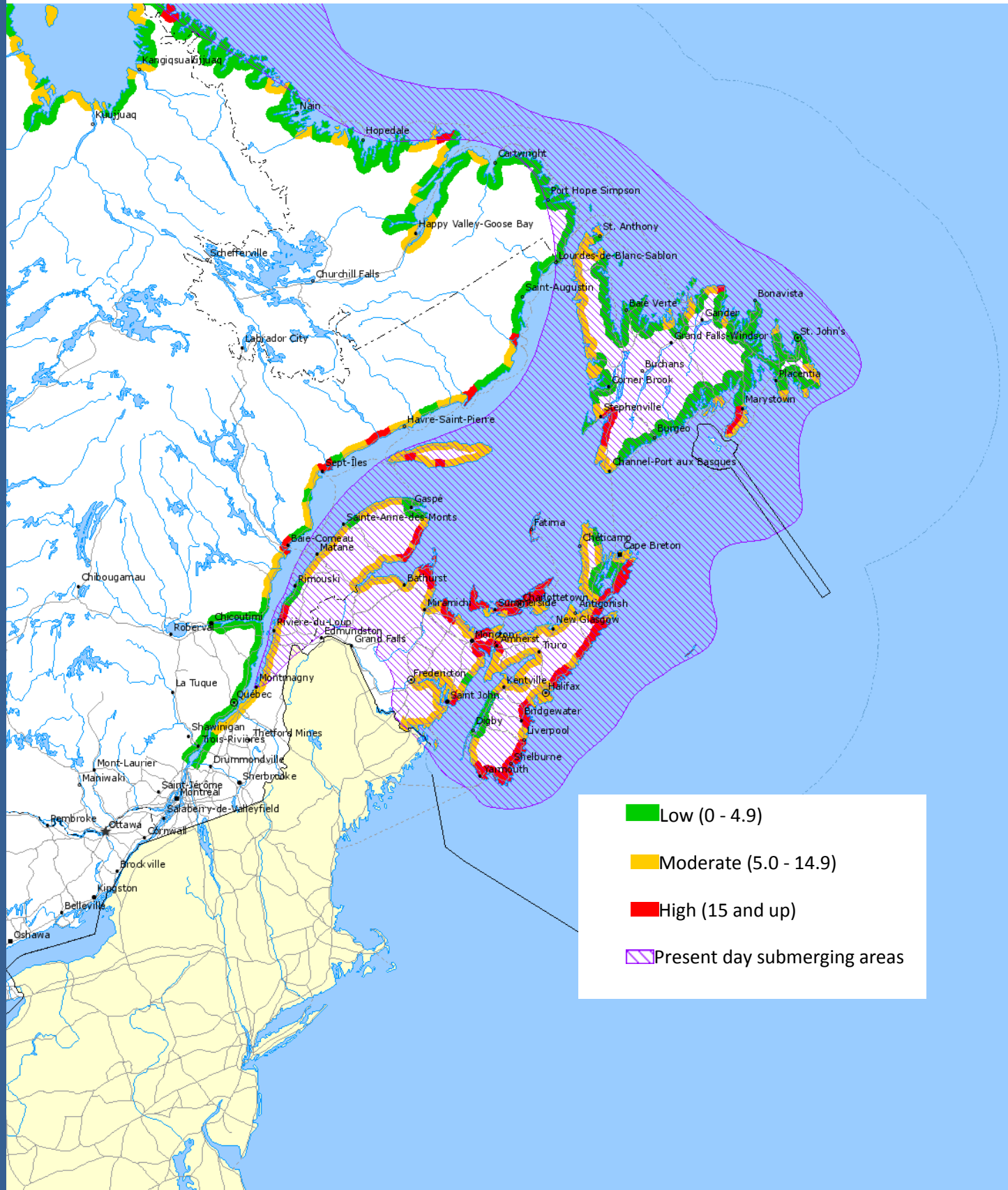


Sea Level Rise Activity

1. Prepare two containers similar to the ones illustrated below. Modelling clay was used for the demonstration; however, clay can be substituted with another material to create 'land.'
2. Put approximately the same amount of water in each container (if you use warm water, the ice will melt somewhat faster!).
3. Tell students that you will be placing the same amount of ice cubes in both containers; however, in one the ice will all be in the water, in the other, the ice will be entirely on the 'land.'
4. Have students predict what will happen to the water levels in both containers when the ice melts. Have them explain their reasoning.
5. Place ice cubes in the containers.
6. Have student volunteers measure the water levels in both containers. Record the results.
7. Once the ice has melted (you may allow student volunteers to use a hair dryer to speed up the process if they haven't melted by the end of class), have new volunteers measure the water again.
8. Discuss the results. What have they learned that can be applied to how sea level rise occurs as a result of climate change?



Coastal Sensitivity to Sea Level Rise



CAPE BRETON POST

Cape Breton's Only Daily Newspaper

The Coast is Unclear

Published on July 25, 2011

By Chris Shannon

Eroding shoreline forces man to move cottage.

LONG POINT — Coastal erosion along the Northumberland Strait in Inverness County has forced one part-time resident to move his cottage away from the cliff's edge, which has been slowly wearing away as the years go by.

Jim Guy, a retired political science professor at Cape Breton University, built a small summer home 16 years ago on two hectares of land in Long Point, near Judique.

Waves and pounding surf have worn away at the coast and the 10-metre high cliff the cottage sits on, Guy said in a recent interview.

"I decided because of the view and sound of the ocean ... to build it a little closer to the cliff, thinking it was going to last forever," he said.

In speaking with neighbours about their decisions in building far from the shoreline, Guy said he had to "bite the bullet" and moved his cottage



Jim Guy looks over the erosion along the bank of his cottage property in Long Point, near Judique, on Monday. Steve Wadden - Cape Breton Post

another 20 metres inland earlier this month.

A series of fierce fall storms in December further encouraged the move sooner rather than later.

"I lost an entire staircase down to the beach. It just tore it away."

The province's Climate Change Directorate is currently analyzing data from six communities on mainland Nova Scotia as part of a \$2.3-million project to collect specific information on climate change, such as changes in the sea level, increases in precipitation, flooding and infrastructure at risk.

The Atlantic Climate Adaptations Solutions project (www.atlanticadaptation.ca) is a partnership between the four Atlantic provinces, municipalities and Natural Resources Canada. The communities that are part of the three-year study are Chignecto Isthmus, Lunenburg, Minas Basin, Oxford, Yarmouth and the Halifax Regional Municipality.

Jason Hollett, acting executive director of the Climate Change Directorate, said erosion has been a particular problem for the shoreline along the Northumberland Strait.

“Anywhere along the shoreline that has the softer sandstone or rock (such as) the Northumberland area, it is particularly vulnerable because of the geological features of that area,” he said.

With 13,300 kilometres of coastline in the province, the intensity of coastal erosion is “very contextual” with one area experiencing major concerns but a shoreline two kilometers away facing little problem at all.

This situation makes developing a one-size-fits-all solution difficult, Hollett said.

“The shorelines are very dynamic in Nova Scotia and changes every season, and the winters are particularly harsh as well,” he said.

“A lot of people will drop boulders into the ocean as a way to harden the shoreline, which may work for their shoreline, or it may make the problem worse, or it may make the problem worse for their neighbours.”

There’s a greater chance of success in slowing down the effects of coastal erosion by planting shrubs, plants and trees to strengthen the shoreline.

A \$25,000 adaptation fund offered by the directorate is in its second year, and it’s awarded to municipalities, community groups and others wanting to do research and educate the community they live in on climate change. This year’s application deadline is Friday.

Hollett said a community group was given money last year to educate cottage owners on coastal erosion along the Northumberland Strait, and residents’ responses were included in a report to government.

Guy said now that his cottage has been moved, he can restart his renovation plans that initially began last fall.

“It was time to move it, and let’s see what happens here.”

People wanting to report coastal erosion or other effects of climate change can contact Climate Change Nova Scotia adaptation specialist Kyla Milne at 902-424-0786. More information is available at www.climatechange.gov.ns.ca

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WHAT'S IN IT FOR THE TREES?

Introduction:

With over three quarters of Nova Scotia forested, it is important to consider ways that the province's trees and forests are affected by climate change (e.g., changes in species' ranges, damage due to increased risk of forest fires and extreme weather events, threats from new pests, etc.). Furthermore, given that trees provide so many benefits to Nova Scotians (e.g., timber, jobs, habitat to support biodiversity, and oxygen to breathe), it is important to discuss adaptations that might be necessary to help ensure that the province continues to support large and healthy forests. Trees are also valuable as carbon 'sinks,' i.e., they are able to remove, and store, carbon dioxide from the atmosphere; therefore, trees can play an important role in helping to lower levels of atmospheric carbon dioxide.

Objectives:

Students will discuss how different trees and plants have adaptations that enable them to survive in particular climates and habitats. Students will be encouraged to consider ways that trees in Nova Scotia are, and will continue to be, affected by climate change. By comparing balsam fir and red oak, students will understand that not all species of trees will be affected in the same way (i.e., some might do better in Nova Scotia, while others might become less abundant). Students will also learn about how spruce budworm, a pest that has caused considerable damage to balsam fir in Nova Scotia, may also increase in numbers and spread to new areas as a result of climate change. A short game will help students see how climate change may affect spruce budworm numbers, and how forest managers can respond and try to control the spread of spruce budworm, and the damage they cause to trees in Nova Scotia.

Specific Curriculum Outcomes:

Students will be expected to...

- compare the external features, behavioural patterns, and structural and/or behavioural adaptations for an animal to survive a particular habitat, real or imagined (Science, 204-3, 300-1, 300-2, 302-2)

Materials:

- Teaching Resources 4.1 - Pictures of cactus, maple tree, spatial distributions of balsam fir and red oak
- Teaching Resource 4.5, instructions and game cards for spruce budworm game (One set of cards per group)
- Scissors

Time Frame:

- 1 hour



Activities:

1. Show students pictures of plants that have special adaptations to living in certain environments (Teacher Resources 4.1 and 4.2). Show students the picture of a cactus. Ask students what kind of habitat they might find a cactus in. Ask students what is unique about a cactus? What adaptations does it have that let it live in hot, dry environments. (Able to store water during periods of drought, spines to help protect cacti from birds and animals that want the water stored in the cacti and spines instead of leaves to minimize loss of water –plants lose through their leaves in a process called transpiration, waxy coating on the stems to help prevent water loss, etc.)
2. Show students the picture of maple tree. Ask what kinds of habitat they might find a maple tree in – invite students to share whether or not they have a maple tree growing near where they live. Have students share ideas about important differences between Nova Scotia and a desert or tropical region (e.g., 4 distinct seasons – relatively hot summers and cold winters). What adaptations does a maple tree to help it survive in places like Nova Scotia? (Answer: leaves that capture sunlight and make food for the tree during the summer but that are dropped in the winter to prevent loss of water, thick bark to protect the trees during cold months, etc.).
3. After discussing both the cactus and maple tree, have students suggest what they think are some of the most important aspects of a habitat that will determine whether or not a tree or plant can survive there? (Hopefully students will eventually come up with temperature and/or climate – prompt if necessary).
4. Remind students that they have looked at some of the ways that polar bears and people can be affected by climate change. Now they will be starting to think about ways that plants can be affected. Have students suggest ways that climate change might affect trees in Nova Scotia.
5. Explain to students that trees in Nova Scotia might be affected in a variety of ways as a result of climate change. For example, trees that do well in the warmer, southern parts of the province may be able to gradually grow further north and survive in habitats that had been too cold previously. Similarly, trees in colder, northern areas might not do as well with warmer temperatures. Climate change can also cause wetter winters, drier summers, more forest fires, storms and wind, and can result in new and/or increased pest invasions; all these changes can put additional stress on trees in Nova Scotia.
6. Researchers have carried out studies to try to project how the distribution of tree species might change in Nova Scotia as the climate continues to change. For instance, use balsam fir as an example to explain to students that this is a tree species that can currently survive almost anywhere in Nova Scotia, but that prefers cooler parts of the province, such as Cape Breton (suitable habitat is 99% of the province). Researchers have projected, however, that by 2040, less than half (46%) of Nova Scotia will be suitable habitat for balsam fir. By 2100, balsam fir might be able to survive in only 7% of the province (use Teaching Resource 4.3 to illustrate this).

7. Trees like red oak, however, might actually do better with a warming climate. In the case of red oak (Teaching Resource 4.4), it is expected to be able to increase its range across Nova Scotia by 2040, but is expected to decrease again somewhat as temperatures continue to rise until 2100 (however, researchers still project that it will be able to grow well in more parts of Nova Scotia than it currently does).
8. Explain to students that climate change is also creating additional problems for balsam fir in Nova Scotia.
9. Show students a picture of a spruce budworm. Ask if any students have heard of this insect. Have students share their ideas about what it is doing to forests in Nova Scotia (and across Canada). (Answer: Spruce budworms feed on the new growth on top 1/3 of softwood trees – they prefer balsam fir and also white spruce – and tend to kill trees within 3-4 years; scientists project that climate change will increase the range of spruce budworm and result in them moving further north to feed on and kill additional trees in Nova Scotia. Hot summers and periods of drought can result in outbreaks of spruce budworm; therefore, climate change is expected to result in more frequent and intense outbreaks).
10. Introduce spruce budworm game as a way for students to see how climate change and different forestry management measures can affect balsam fir in Nova Scotia. Explain the rules of the game to the class (also, provide each group with a copy of the instructions – Teaching Resource 4.5) and allow students to work in small groups (2-3 recommended) to play the game.
11. Once students have completed the game at least once, have students share some of their experiences with the game. Ask students to suggest why attempting to manage Nova Scotia's forests and control the spread of spruce budworm is a difficult job.

Assessment:

Students' contributions to classroom discussions can also be used to assess students' ability to understand how different plants have adaptations that allow them to live in unique environments.

Enrichment Opportunities:

Invite a forest manager or someone who works in the forestry industry in Nova Scotia (possibly a Christmas tree farmer) to visit the class and share additional information about how climate change may affect forests in Nova Scotia. Encourage them to share observations that they may have, and to discuss ways that the province and forestry industry can adapt to climate change.

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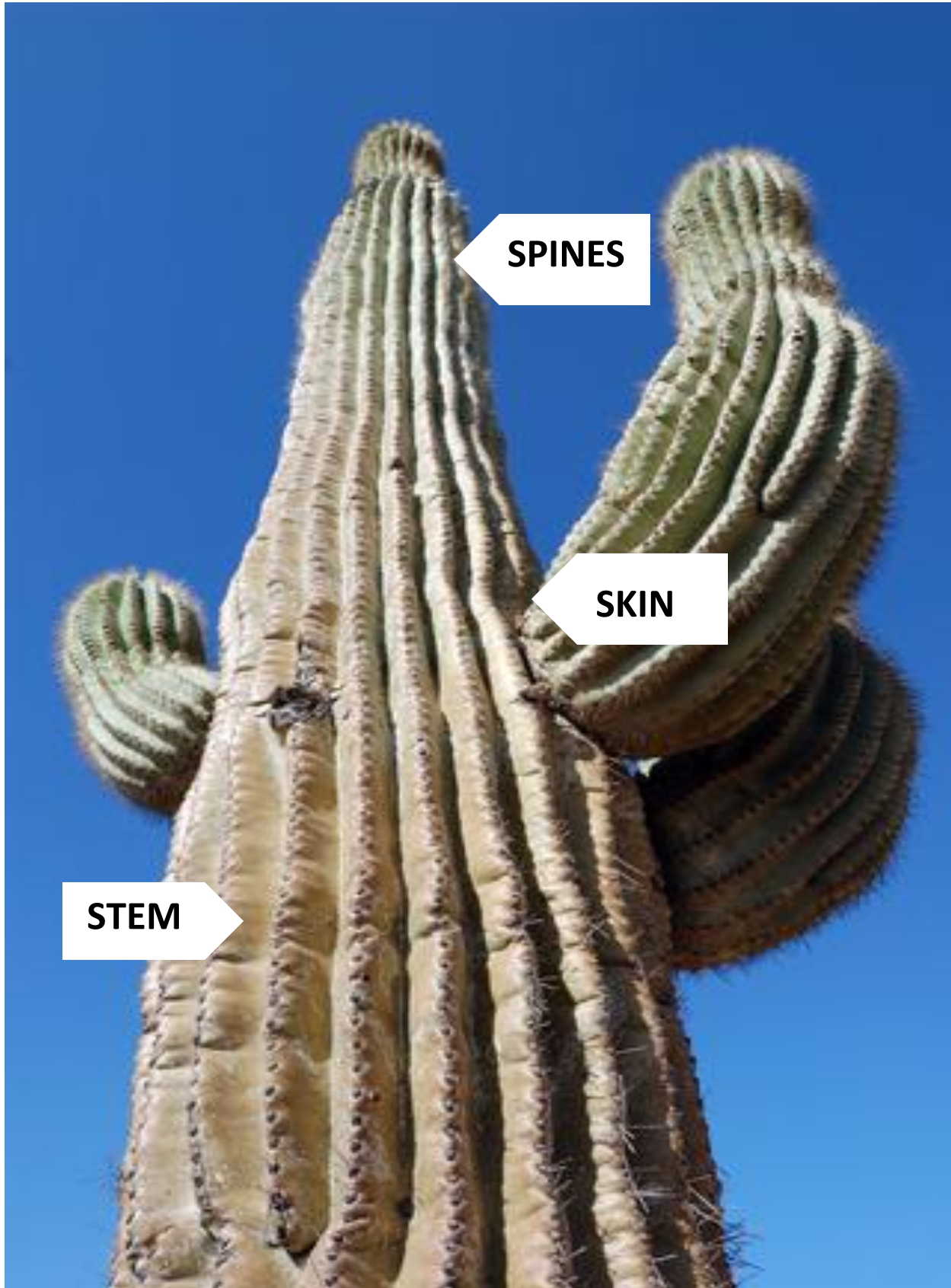
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Cactus Adaptations



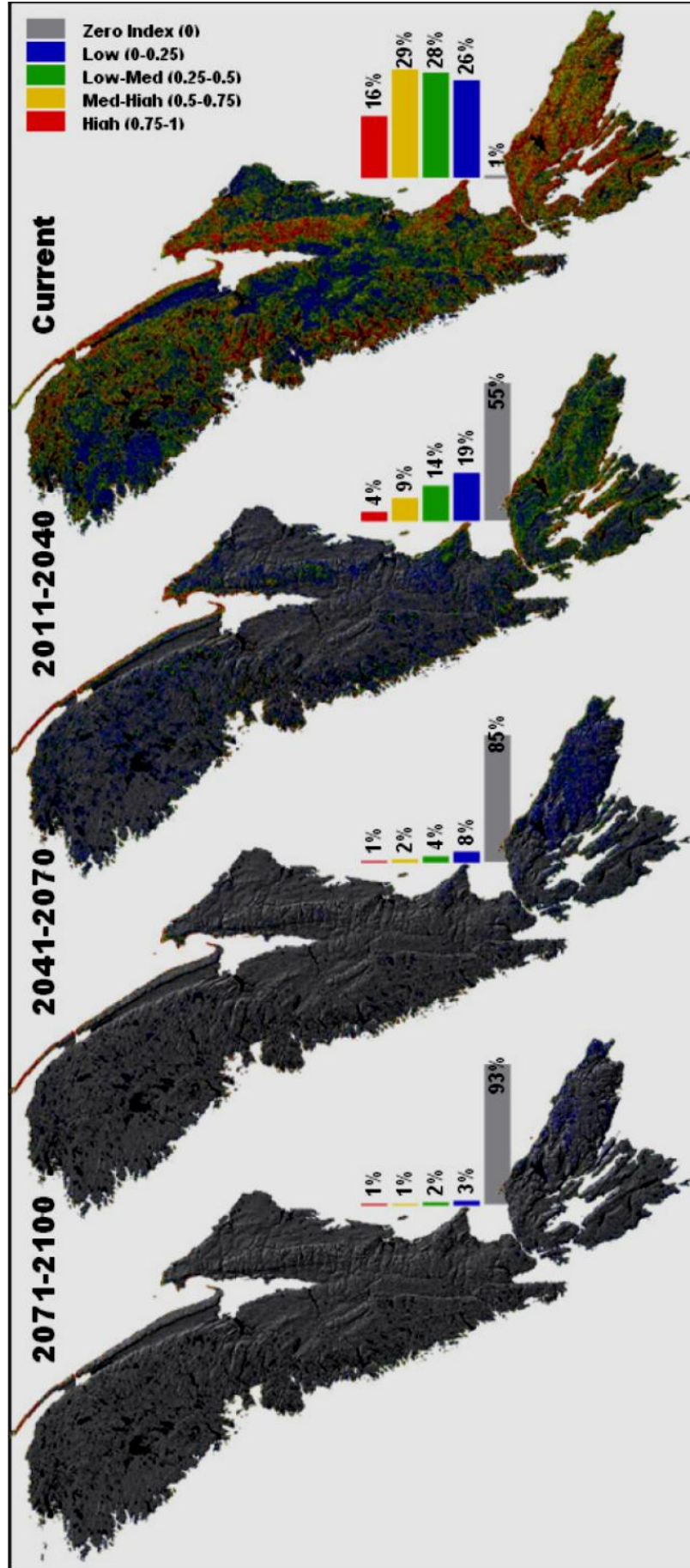
Maple Tree Adaptations



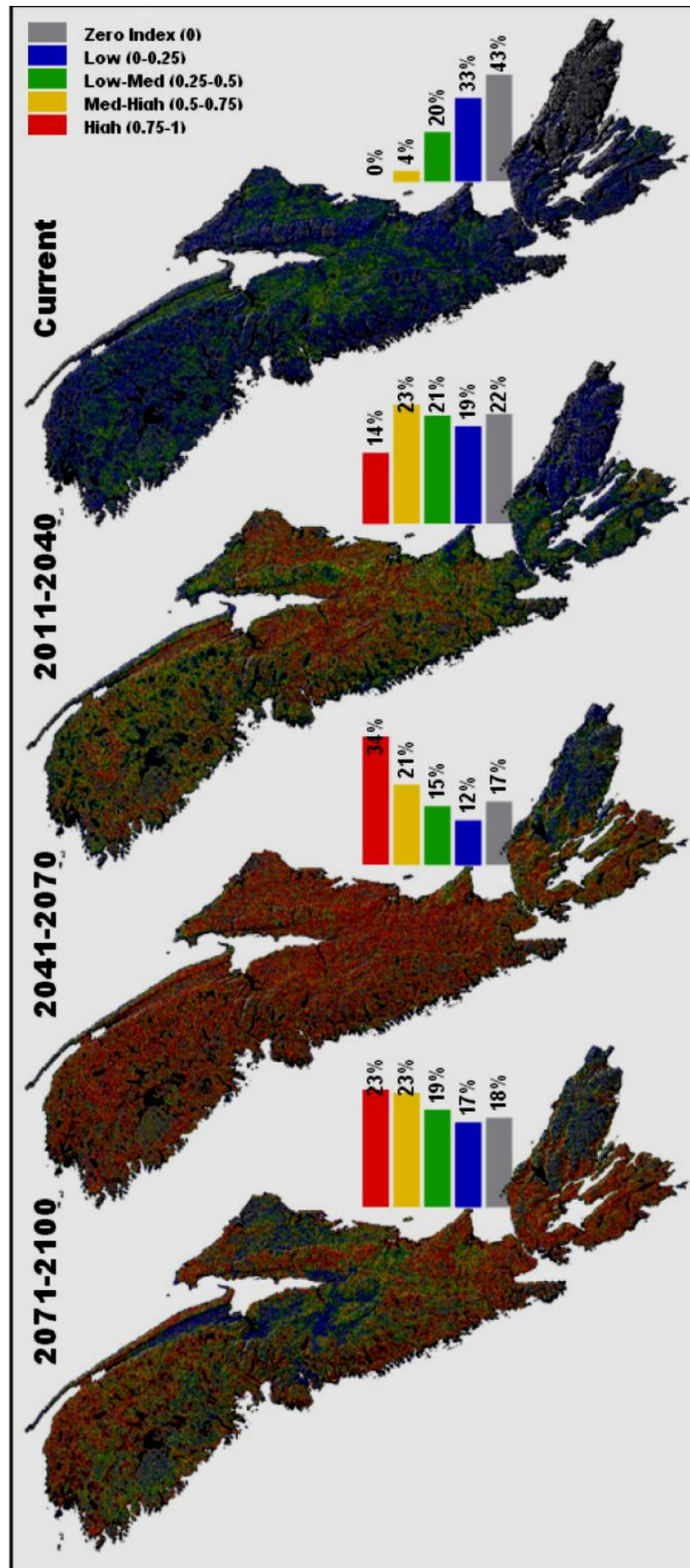
LEAVES

BARK

Potential Balsam Fir Distributions



Potential Red Oak Distributions



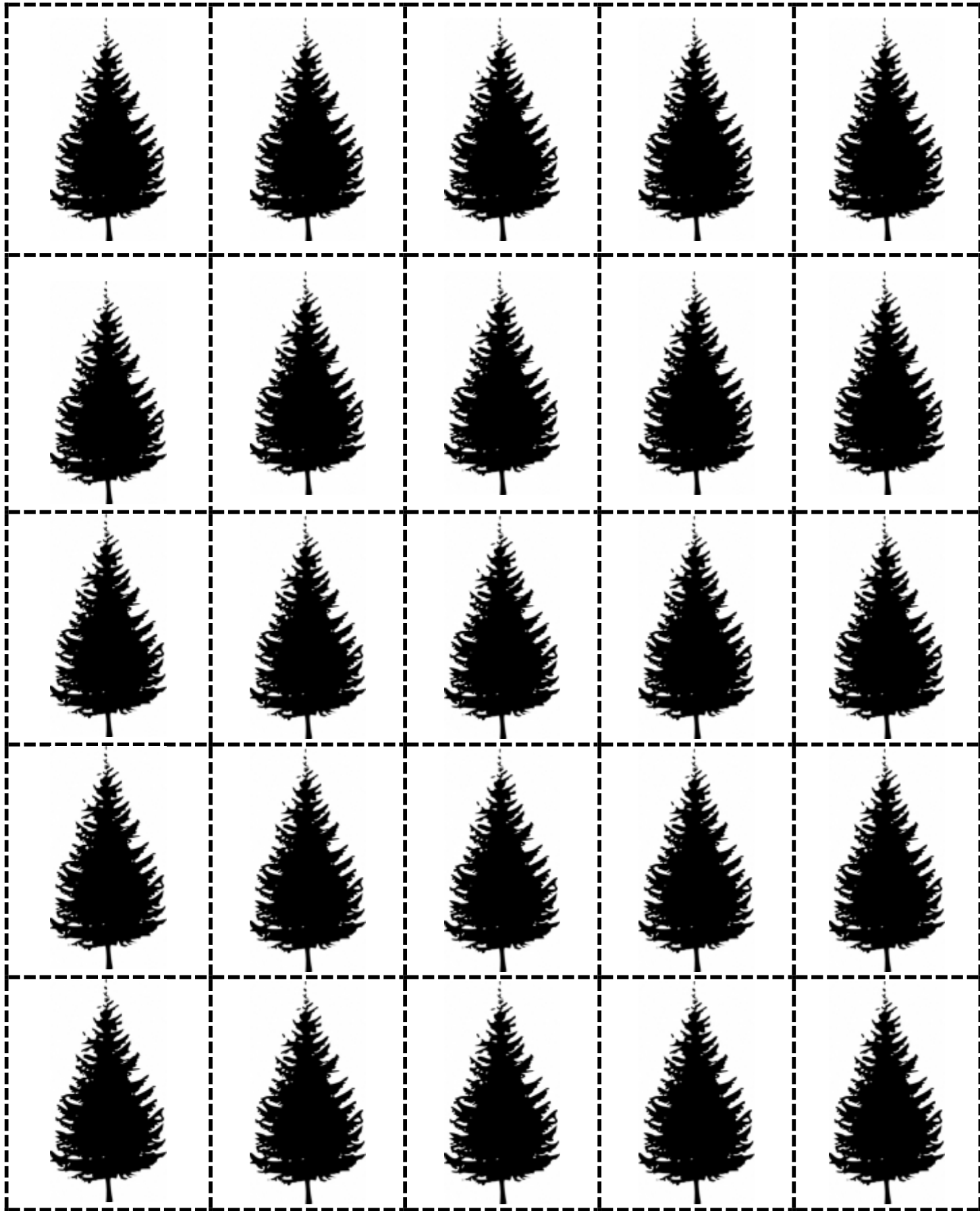


Spruce Budworm Game: Instructions

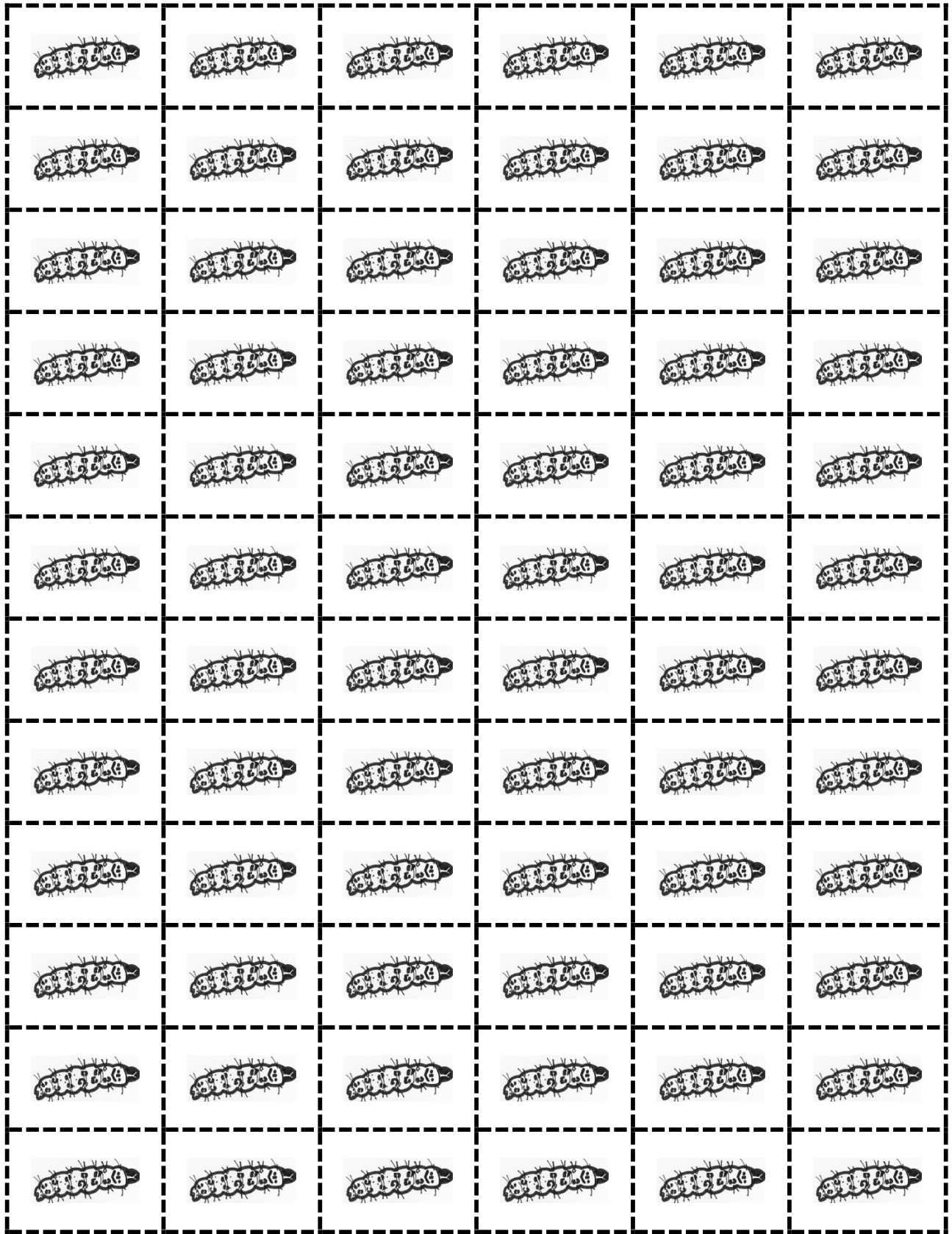


1. Choose one player to be the forestry manager. This person is responsible for all the balsam fir cards.
2. The other player will control the spruce budworm population.
3. The action cards (cards with instructions) should be placed in a pile, face down.
4. The forestry manager starts by placing 15 trees on the playing surface.
5. The spruce budworm player places 10 spruce budworms on trees in the forest. Note: Each tree can continue to live with up to 4 worms on it. It takes 5 spruce budworms on a tree to kill it. Once a tree has 5 worms on it, it is dead and removed from the game. The tree is returned to the forestry manager and the spruce budworms are returned to the spruce budworm player.
6. The forestry manager begins the game by choosing one of the action cards from the pile. Read and follow the directions.
7. At the beginning of the spruce budworm player's turn, the spruce budworm population multiplies. For each tree with 4 budworms, add an additional 2 budworms to the forest (e.g., if there are 3 trees with 4 worms on them, add 6 more budworms). For each tree with 3 worms on it, add 1 additional worm to the game). Once the new worms have been added, the spruce budworm player is to pick an action card from the pile and read and follow the directions.
8. Players take turns choosing an action card and following the directions. Remember, the spruce budworm player must multiply his/her worms at the START of EACH of his/her turns.
9. Continue the game until all the trees have died or until two turns have passed with no budworms in the forest.
10. If you have time, you can switch roles and play again, or start with either more or less trees at the beginning – your choice!





<p>Forest managers spray insecticide to control budworms. Remove 1 budworm from each infested tree.</p>	<p>Forest managers spray insecticide to control budworms. Remove 1 budworm from each infested tree.</p>
<p>Forest managers harvest some old (mature) trees to control spruce budworms. Remove up to 5 trees with three or more budworms on them. Remove budworms too!</p>	<p>Forest managers harvest some old (mature) trees to control spruce budworms. Remove up to 5 trees with three or more budworms on them. Remove budworms too!</p>
<p>Forest managers plant new trees to replace trees killed by spruce budworms. Add 2 trees.</p>	<p>Forest managers plant new trees to replace trees killed by spruce budworms. Add 2 trees.</p>
<p>Climate change results in a warmer than usual spring and summer and there is an outbreak of spruce budworms. Add 8 budworms.</p>	<p>Climate change results in a warmer than usual spring and summer and there is an outbreak of spruce budworms. Add 15 budworms.</p>
<p>Climate change allows spruce budworms to spread further north. Add 5 budworms.</p>	<p>Climate change allows spruce budworms to spread further north. Add 8 budworms.</p>
<p>An unusually cold winter kills many overwintering budworms. Remove two budworms from each infested tree.</p>	<p>An unusually cold winter kills some overwintering budworms. Remove one budworm from each infested tree.</p>
<p>Forest managers plant new trees to replace trees killed by spruce budworms. Add 2 trees.</p>	<p>Climate change results in a warmer than usual spring and summer and there is an outbreak of spruce budworms. Add 5 budworms.</p>
<p>Climate change does not result in a larger than normal population of spruce budworms this year. Add 2 budworms.</p>	<p>Climate change does not result in a larger than normal population of spruce budworms this year. Add 2 budworms.</p>



FARMERS ARE AFFECTED TOO: CLIMATE CHANGE AND SOIL EROSION

Introduction:

Climate change presents two important challenges for agricultural sectors: 1. Given that agricultural activities contribute to greenhouse gas emissions (e.g., methane and nitrous oxide as a result of manure from animal raising, and nitrous oxide from application of fertilizers), options must be explored for lowering greenhouse gas emissions, and 2. Ways for farmers to adapt to the effects of climate change on agricultural production must be investigated.

Objectives:

Students will review some of the impacts of climate change and will discuss ways that climate change is likely to affect crop production in Nova Scotia. Students will review coastal erosion and make predictions about how increases in heavy rainfall and wind storms can cause soil erosion for farmers. After conducting an experiment to gain a better understanding of how wind and water can cause soil erosion, students will discuss ways that farmers can try to protect their crops from soil erosion.

Specific Curriculum Outcomes:

Students will be expected to...

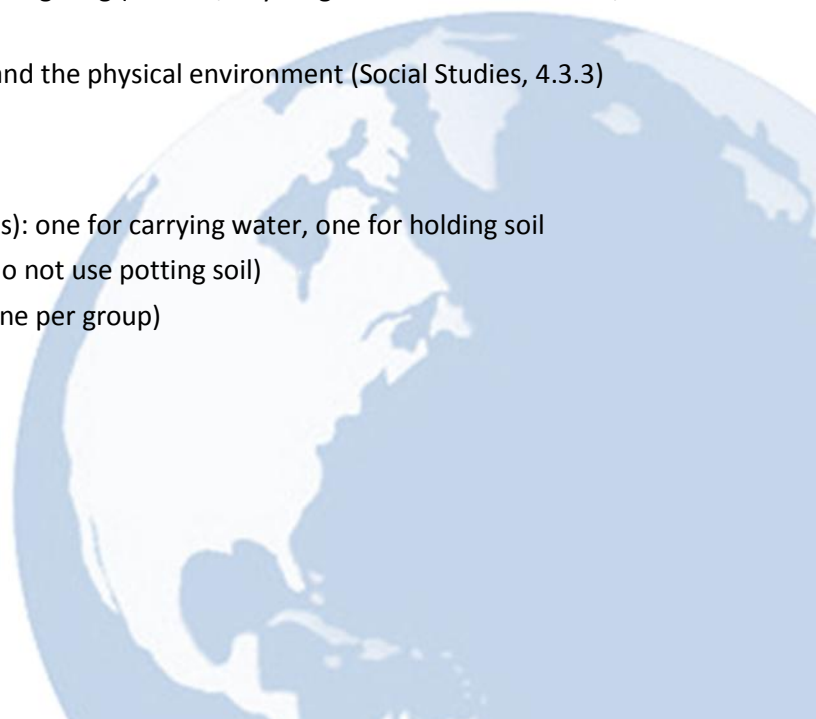
- demonstrate and record a variety of methods of weathering and erosion, including human impact on the landscape (Science, 108-3)
- describe how scientists' knowledge of plant growth has led to agricultural and technological innovations and the impact on local and regional habitat issues (Science, 105-1, 108-6)
- consider their own observations and ideas as well as those of others during investigation and before drawing conclusions (Science, Key Stage Curriculum Outcomes, 415)
- work collaboratively while exploring and investigating (Science, Key Stage Curriculum Outcomes, 418)
- examine the relationship between humans and the physical environment (Social Studies, 4.3.3)

Materials:

- Plastic containers (2 per group of ~4 students): one for carrying water, one for holding soil
- Bucket of dirt (sand can be substituted but do not use potting soil)
- Teaching Resource 5.1, observation sheet (one per group)

Time Frame:

- 45 min – 1 hour



Activities:

1. Review with students some of the general impacts of climate change that they have learned about so far, prompting students when necessary in order to generate a sizeable list (e.g., hotter temperatures, droughts, rising sea levels, increased pest infestations, erosion, more extreme weather events, etc.). Record students' ideas on the board.
2. Ask students to suggest ways (using the list to help them) that farmers growing crops in Nova Scotia might be affected by climate change (e.g., longer or shorter growing seasons, plants at risk from pests, drought causing plant loss, possibility to grow new species, etc.). Make sure to help students see that there will likely be positive and negative consequences for farmers.
3. If students did not come up with erosion as part of their list, add it now. Review with students what they know about erosion (e.g., rising sea levels causing soil in coastal areas to be washed away).
4. Explain to students that erosion doesn't only occur in coastal areas. Explain that erosion describes the natural processes that result in the movement of soil.
5. Ask students to suggest why farmers should be concerned about erosion of their soil. In other words, why is soil important for growing plants? What might happen if soil loss occurs?
6. Explain to students that climate change also results in more rain at times, and can result in more wind storms. Ask students how these might result in soil erosion for farmers?
7. Introduce the soil erosion experiment. Tell students that they will be going outside to do an activity to see what happens when wind and rain interact with soil. Explain that students will be working in small groups. Each group will have a plastic container (pie plates or other dishes would also work), a container of water, and an observation sheet and pencil. Note: this activity could also be done inside, but may involve more clean-up.
8. Explain to students that, as a group, they will decide what will happen to the dirt when they blow on it (simulating wind), and when they pour water on the dirt (simulating rain). Groups are to record their predictions (hypotheses) on their observation sheets (Teaching Resource 5.1).
9. Start with wind erosion. Pour some dirt into each of the groups' containers. Tell students to have someone in the group draw a before-picture. Tell students that they must all stand on the same side of the container, and can take turns blowing on the dirt one at a time. Have group discuss what happened and record their results, including an after-picture.
10. Repeat the activity for water erosion.

11. Call group together. Explain that they will be discussing what they found once they return to the classroom. However, if there is an area with grass or plants nearby, ask students what they think will happen if they blow on soil that has plants growing in it. What about if they pour water on it? Test students' predictions, if possible, having a couple of students blow on soil with plants or grass in it, and another student pour some water on the area. (Students should see that there is less soil movement).
12. Return to class to discuss their findings. Ask students why they think that having plants in the soil will cause less soil erosion, prompt them if necessary. (Plant cover helps shield the soil from the rain and wind and roots help hold soil in place).
13. Ask students what this means for farmers? How can farmers help prevent soil erosion? If students are having trouble coming up with ideas, help them think about how reducing the amount of bare, exposed soil and installing windbreaks (e.g., rows of trees or shrubs or artificial structures) are two ways that farmers can adapt to a changing climate and make their soil less vulnerable to erosion by wind and water. Restoring wetlands to store/slow water and reduced tillage (as opposed to ploughing) are additional adaptations that farmers may consider.

Assessment:

Groups' observation sheets can be used to assess students' comprehension of how wind and rain can cause soil erosion. Students' contributions to classroom discussions can also be used to assess students' ability to explain the difference between different kinds of soil erosion and to describe both why farmers might be concerned about soil erosion, and ways that they can help protect their crops from soil erosion.

Enrichment Opportunities:

Invite a local farmer, or someone involved in the agricultural industry, to visit the classroom and discuss additional ways that farms in Nova Scotia might be affected by climate change, and ways that farmers can adapt to climate change.

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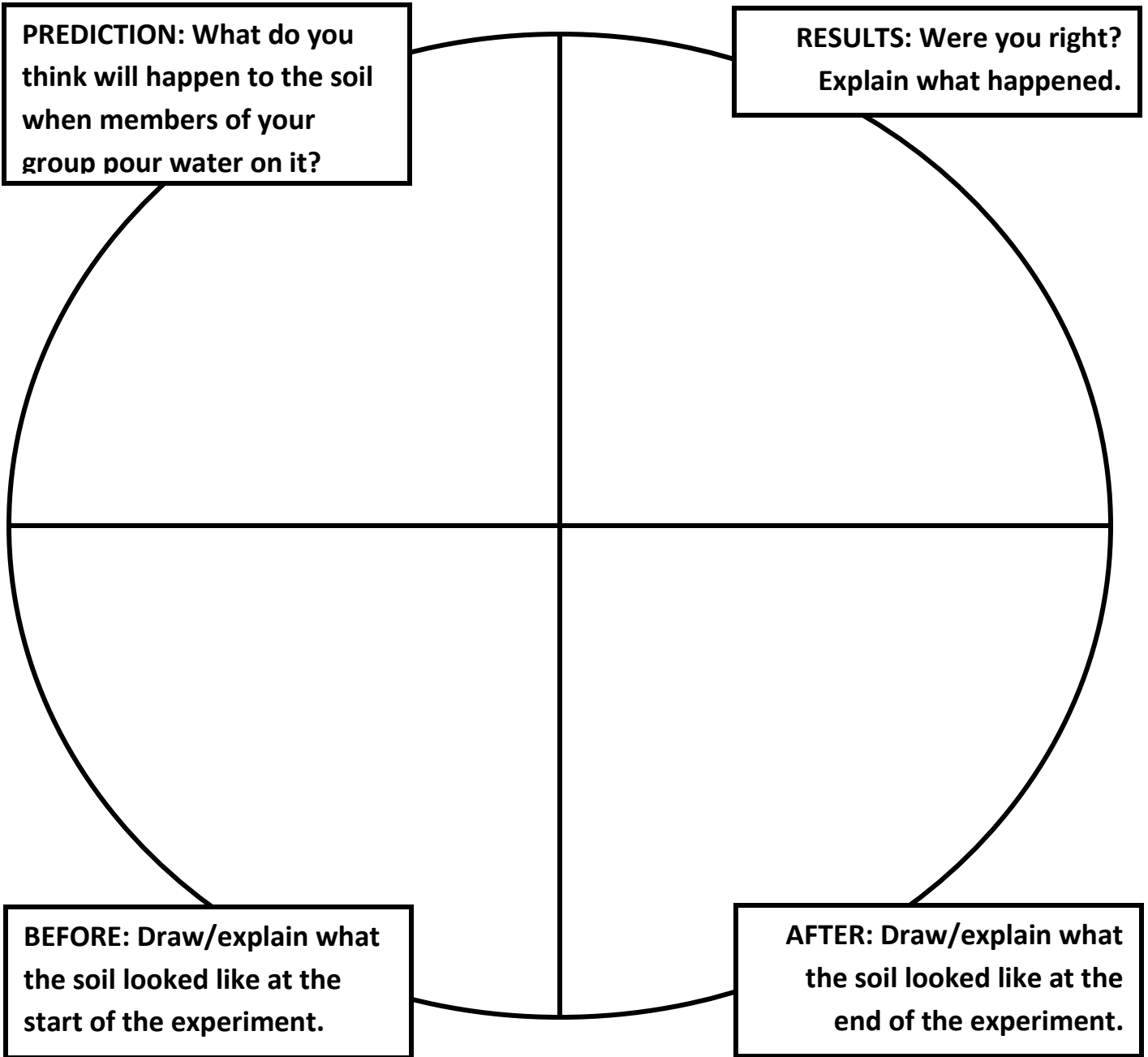
Soil Erosion: Group Observations

Names of group members:

Soil Scenario 1: What happens when you blow on soil? Use the spaces provided to record your ideas and explain how the soil changed.

<p>PREDICTION: What do you think will happen to the soil when members of your group blow on it?</p>	<p>RESULTS: Were you right? Explain what happened.</p>
<p>BEFORE: Draw/explain what the soil looked like at the start of the experiment.</p>	<p>AFTER: Draw/explain what the soil looked like at the end of the experiment.</p>
<p>What happens when you blow harder? What natural force does this remind you of?</p>	

Soil Scenario 2: What do you think will happen to the soil when members of your group pour water on it? Use the spaces provided to record your ideas and explain how the soil changed.



**What happens when you pour more water on it?
What happens when you pour water faster? What natural force does this remind you of?**

Introduction:

Only a small fraction of the surface of the Earth consists of urban areas (less than 3%), yet more than half of the global population is concentrated in urban centres. According to Statistics Canada's 2006 census, 56% of the population of Nova Scotia lives in urban areas. In some parts of the province the urban population is increasing as people move into Nova Scotia's urban areas. It is important to recognize that while urban areas are significant contributors to increasing levels of greenhouse gases (according to the United Nations, approximately 75% of global energy use occurs within cities), people living in urban areas, including urban planners and government members, must also consider measures that will allow the cities and their populations to adapt to climate change and reduce their vulnerability to the effects of a changing climate.

Objectives:

Students will discuss ways that cities are different from rural areas. Students will begin to think about how cities contribute to climate change, and also some of the ways that cities will be affected by climate change. By looking at Halifax and Toronto as case studies, students will learn about some of the different ways that cities in Canada are planning for climate change.

Specific Curriculum Outcomes:

Students will be expected to...

- identify their own and their families' impact on habitats and describe how personal actions help conserve habitats (Science, 108-3, 108-6)
- examine the relationship between humans and the physical environment (Social Studies, 4.3.3)

Materials:

- Teaching Resource 6.1 - 6.3

Time Frame:

- 1 hour

Activities:

1. Have students think of a large city they have visited (the city can be somewhere nearby, like Halifax, or anywhere else they may have travelled to, e.g., Toronto, Montreal, New York City, London, etc.). Allow students to share some of the cities they are thinking of (you may want to record the names on the board).



2. Invite students to share ideas about what made the city they are thinking about different from a location in the country. Record students' ideas (e.g., lots of people, big buildings, shopping centres, lots of traffic (cars), etc.).
3. Ask students to suggest ways that they think cities might contribute to climate change, and also be affected by climate change. Students should be able to recognize that cities use a lot of energy – i.e., burning of fossil fuels that contribute to increasing levels of greenhouse gases. Students may also come up with the idea that cities may be affected by sea level rise and increase of storms (if not, you may want to use Halifax as an example – given that Halifax is located by the ocean, ask students what this might mean for the city – encourage them to think back to earlier discussions on climate change).
4. Ask if students can think of any other major cities that are located near coasts? (e.g., Saint John, NB, Vancouver, BC, New Orleans, LA, Miami, FL, New York City, NY, etc.). Explain that there are many major cities located near coasts which will have to adapt to rising sea level and increased storm surges.
5. Explain to students that another issue for cities will be the rising temperatures. Explain to students that the temperatures in cities can actually be a few degrees warmer than outside of cities. This is called the 'urban heat island' effect.
6. Let students know that cities across the world have been coming up with plans for how they can reduce greenhouse gas emissions, and also how they can adapt to climate change.
7. Explain to students that they will complete an independent reading activity, looking at ways that two Canadian cities, Toronto and Halifax, have been responding to climate change.
8. Have students pair up for this activity. One student in each pair will read the Halifax handout, the other will read the Toronto handout.
9. Give students enough time to complete Teaching Resource 6.3, the *Tale of Two Cities* worksheet and creative writing activity.
10. Take up students' answers as a class. Invite student volunteers to share their pieces of creative writing with the class.
11. Finish by having students think back to the carbon footprint calculator activity from earlier in the unit. Remind students that while cities can try to make choices that will reduce their energy demands and result in fewer greenhouse gas emissions, individuals can also make a difference. Invite students to suggest one thing that they can do to lower their greenhouse gas emissions.

Assessment:

Students' contributions to classroom discussion can be used to assess their understanding of how their actions can contribute to increasing levels of greenhouse gases in the atmosphere. Students' written work on the *Tale of Two Cities* worksheet can be used to assess their understanding of different impacts of climate change and ways that cities can adapt to climate change.

Enrichment Opportunities:

Invite a member of the local city council to visit the classroom and discuss present (and future) impacts of climate change on the municipality. The guest should also be able to share information about ways that the municipality is adapting to (and plans to adapt to) climate change.

Have students choose a major city (provide examples of major cities in Canada and from the international community) and research how this city may be affected by climate change, and ways that the city may be adapting.

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A Look at Toronto:

Climate Change Impacts & Adaptations

Toronto is the capital of Ontario, and it is a big city. In fact, with a population of around two and a half million people, Toronto has more people than any other city in Canada. While there are a lot of people living in Toronto, there is also a large, and growing, number of people living in the areas surrounding Toronto. In fact, over five million people live in the Greater Toronto Area (GTA).

Although Toronto is not located near the ocean, it is close to a large body of water. The city is located on the northwest shore of Lake Ontario (the 8th largest freshwater lake in the world). While climate change causes oceans to rise, warmer temperatures can actually lower the level of lakes. This is because more water evaporates at higher temperatures.

With so many people and so much traffic, air quality is a concern for the city of Toronto. Unfortunately for people living in big cities, smog gets worse with hotter temperatures. Climate experts have also projected that Toronto will experience severe weather and storms more often as a result of climate change. Some of the changes will include hotter temperatures, heat waves, heavy rainfalls, flooding, and drought.

Did you know?

Smog is a type of air pollution that can affect our health. The air pollutants that make up smog mostly come from burning fossil fuels. While smog can occur anytime of the year, it is usually the worst during summer months.

City councilors and people living in Toronto have been concerned about climate change for years. In 2007, Toronto City Council adopted their Climate Change Action Plan. Another way that the city has been preparing for living with a changing climate is by creating a report called *Ahead of the Storm: Preparing Toronto for Climate Change*. This report describes ways that Toronto can adapt to climate change.

Toronto is trying to cut back the amount of greenhouse gases that it releases into the atmosphere. For example, by doing things like encouraging people to use

public transit more often and designing buildings that use less energy, Toronto hopes to reduce its greenhouse gas emissions.

However, the city of Toronto also recognizes that it is not enough to burn fewer fossil fuels. Toronto is also coming up with activities that will help the city prepare for living with climate change (these are called adaptations). Some of the adaptations that the city has come up with to help Toronto deal with climate change include:

- Planting more plants that can survive periods of drought
- Creating green roofs and using cool materials on the roofs of buildings that will reflect heat
- Planting more trees to provide shade and clean the air (Toronto hopes to eventually double the number of trees in the city)
- Warning people about extreme heat and offering emergency shelters where people can cool down during heat waves
- Creating health programs to deal with West Nile virus and Lyme disease (warmer and shorter winters can result in more mosquitoes and ticks, the insects that spread these illnesses)
- Improving sewer systems to help prevent flooding
- Educating people in Toronto about climate change and what they can do (e.g., information is available through Toronto's *Live Green Toronto* programs)

Did you know?

Green roofs are roofs that are specially designed to allow plants, and even trees, to grow on them. Green roofs are becoming more popular in Canada as people start to recognize that they can have a lot of benefits. For example, green roofs can lower energy usage, reduce the amount of stormwater runoff, and help lower temperatures. They can also make cities more beautiful by creating more green spaces.

These are just some of the many ways that the City of Toronto is trying to prepare for climate change.



A Look at Halifax:

Climate Change Impacts & Adaptations

Halifax is the capital of Nova Scotia, and the largest city in the province. With a population of nearly 300,000, it is also the biggest city in all of Atlantic Canada. Although Halifax is much smaller than some of Canada's biggest cities (e.g., Toronto and Vancouver), it is an important centre for business, education, industrial activity, manufacturing, and tourism.

Halifax is one of the major sea ports on the Atlantic Ocean, and Halifax Harbour is one of the largest natural harbours in the world. In fact, Halifax's location by the Atlantic Ocean is one of the reasons that some many people come to Halifax, whether they are drawn to the city to visit or do business.

However, the fact that Halifax is a coastal city is also one of the reasons that Halifax is vulnerable to climate change. Halifax's location also results in the city being hit by a lot of storms. Did you know that Nova Scotia tends to receive more storms than any other region in Canada?

Sea level rise and an increase in extreme weather events are two of the impacts of climate change that are the most important for the Halifax Regional Municipality (HRM) to deal with. With rising sea levels and more storms, Halifax will also be at risk of more coastal erosion and flooding. On top of that, experts have projected that Halifax will have warmer temperatures, more extreme summer heat, and even possible droughts.

Clearly, climate change can affect Halifax in many ways. Therefore, it should not be surprising that climate change has been called one of the most important issues facing the HRM today.

Did you know?

Droughts occur when there are long periods of unusually dry weather, with little or no rainfall. Droughts are more likely to occur when temperatures are hot. This is because the hot temperatures cause water to evaporate more quickly.

The Halifax Regional Municipality is already working on ways to reduce greenhouse gas emissions and also to prepare for a changing climate. For example, the HRM created *Climate SMART*, a plan that describes actions that the HRM and people in Halifax can take to help deal with climate change. These actions are also called adaptations.

Some of the adaptations that Halifax is working on to prepare for, and cope with, climate change include:

- Looking into options for designing buildings that are better able to survive intense storms and flooding
- Trying not to build in coastal areas and areas that have higher risks of flooding
- Educating people and businesses about climate change and actions that they can do to both lower greenhouse gas emissions and prepare themselves for climate change
- Planting more trees to provide shade and clean the air
- Putting more time and money toward research to get a better understanding of how climate change will affect coastal areas

Did you know?

A by-law has been approved in Halifax says that any new developments along Halifax's downtown waterfront must be a minimum of 2.5 metres above the ordinary high water mark. This by-law will help make sure that new buildings will be able to deal with rising sea levels. A by-law is a law or regulation that applies to a municipality.

While these are some of the many ways that Halifax is preparing for dealing with a changing climate, it is also important to remember that climate change may bring benefits for Halifax too. For example, warmer temperatures could be good for tourism! Remember, climate change can have both good and not-so-good impacts on Halifax.



Name: _____

Date: _____

A Tale of Two Cities:

Comparing Climate Change Impacts & Adaptations in Toronto & Halifax

Complete the boxes after you finish reading about your city. Answer the last question after you meet and discuss the readings with your partner.

The city I read about was: _____

In the boxes below, write down some of the ways that climate change can impact your city, and some of the actions that your city is doing to prepare for climate change.

IMPACTS	ADAPTATIONS

Name one climate change impact that Halifax and Toronto have in common, and one that is different:

COMMON

DIFFERENT

TORONTO:

HALIFAX:

Creative writing activity:



Imagine that it is 50 years in the future. Pretend that you are living in either Halifax or Toronto (pick one!). Describe some of the ways that climate change may have created changes to life in this city. Describe some of the things you think you might do to lower greenhouse gas emissions, and to help you live with the changing climate. You can be creative!

A large, empty rectangular box with rounded corners and a decorative scroll-like border on the top and bottom edges, intended for writing the creative response.

Introduction:

Art exhibitions and installation pieces have become popular ways of raising awareness of global climate change. From the 1.5 ton sculpture of a giant polar bear and cub that floated in the Thames, to EARTH, the global satellite art project launched by 350.org, to the many climate-change inspired art exhibitions around the globe, it is clear that artists have a special ability to capture the attention of the public and to spread messages, elicit feelings, and plant ideas.

Objectives:

As the culminating activity in the teaching module, the students will be creating another climate-changed inspired piece of art that will hopefully incorporate some of the new information and ideas that they have been exposed to during the previous six lessons. As the students learned about some of the roles that artists play in their communities during the first lesson, the students will now have an opportunity to put some of what they have learned to practice. Students will reflect on what they have learned and will create a piece of artwork that is meant to capture one of the ways that they might be affected by climate change. By planning and carrying out an art exhibition, students will have an opportunity to use their art to teach other students in their school about climate change.

Specific Curriculum Outcomes:

Students will be expected to...

- share thoughts and ideas about artworks (Visual Arts: Primary – 6, 4.2)
- explore art as a way of expressing ideas and points of view (Visual Arts: Primary – 6, 5.1)
- demonstrate an awareness of the role of art and artists in their local and global communities (Visual Arts: Primary – 6, 6.3)

Materials:

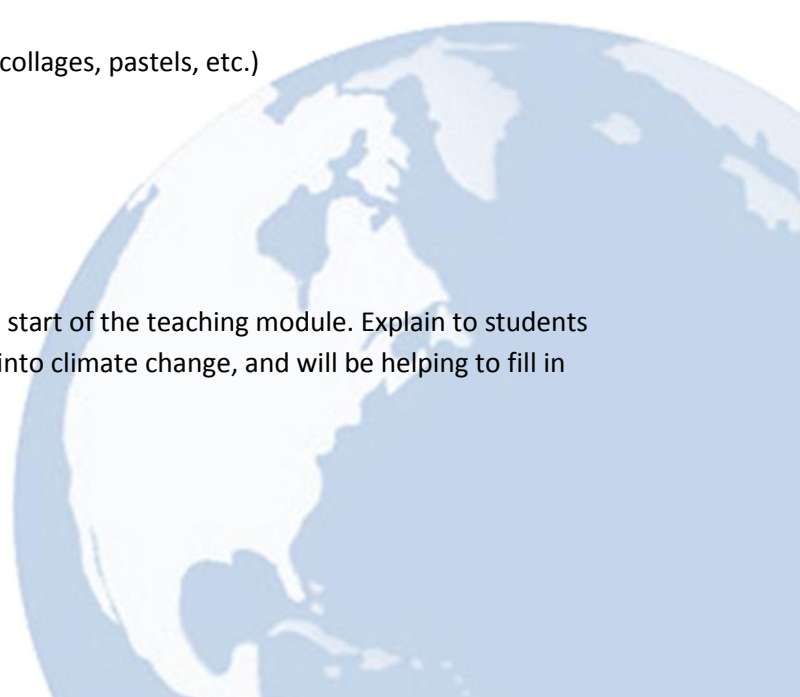
- Art supplies (e.g., paper, paints, materials for collages, pastels, etc.)

Time Frame:

- 1-2 hours

Activities:

1. Display the KWL chart that was created at the start of the teaching module. Explain to students that they are wrapping up their investigation into climate change, and will be helping to fill in the final column: What did I learn? (L).



2. Encourage students to think back over the past 6 lessons, and share some of the information that they learned about climate change. Record students' contributions.
3. Remind students about the first activity in the unit, i.e., how they created a piece of art to try to capture their understanding of climate change. Remind students of the different roles that artists can play in their communities.
4. Tell students that they will be creating another piece of art and they will be putting on a climate change-inspired art exhibition for younger students in the school. Explain to students that this will be an opportunity for them to play an important role in their school community. They will be using their art to get younger students thinking about climate change and to show students some of the different impacts of climate change.
5. Explain to students that they are to create a piece of art that captures the most important way that they think climate change might impact them, their family, their community, and/or the area in Nova Scotia where they live. Explain to students that while their art work may be similar to the original piece they created, it may also be very different given that they have learned about a variety of different impacts of climate change.
6. Emphasize to students the importance of taking their time to produce their best quality work as it will be part of an exhibition.
7. Allow students enough time to carefully complete their art. Instruct students to write one or two sentences describing that they have drawn. They may also decide to give their art a title.
8. After students have finished, have the class brainstorm possible names for their art exhibition. As a class, vote to select the best name. Go over the expectations of students during the exhibition. Explain to students that their work will be displayed on the walls (use of a gymnasium for the exhibition would be ideal), and they will be expected to stand by their art while the younger students walk around, look at the work, and ask the artists questions. Ideally, also allow the Grade 4 students a chance to admire their classmates' work and ask questions (e.g., split the class in half and have half stand by their art while the other half circulates and asks questions, then switch).
9. Back in the classroom, have students complete a reflection sheet.
10. Hold a class debriefing session after the art exhibition. Give students time to share reactions, comment on favourite pieces, address difficult questions raised by younger students, etc. Optional: Have refreshments as a part of a celebration of their work and accomplishments.

Assessment:

Students' artwork and their written explanations can be used to assess their ability to use art to express an idea about climate change. Students' contributions to classroom discussions can also be used to assess students' ability to recall information about climate change, comment on various works of work, and identify ways that artists can use their art in local and global communities.

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