



## Climate Change Posters Curriculum



## TABLE OF CONTENTS

Introduction .....	i
Curriculum Links .....	ii
Application to Senior 2 Science Weather Dynamics .....	1
Climate Change in Canada. ....	6
Climate Change in Canada Key. ....	8
Degrees of Variation: Climate Change in Nunavut.....	10
Degrees of Variation: Climate Change in Nunavut Key .....	14
The Tides of Change: Climate Change in Atlantic Ocean .....	18
The Tides of Change: Climate Change in Atlantic Ocean Key. ....	23
A Change in the Wind: Climate Change in Quebec. ....	28
A Change in the Wind: Climate Change in Quebec Key.....	33
Weathering the Changes: Climate Change in Ontario.....	38
Weathering the Changes: Climate Change in Ontario Key.....	44
Temperature Rising: Climate Change in Southwestern BC.....	49
Temperature Rising: Climate Change in Southwestern BC Key.....	54
The Winds of Change: Climate Change in the Prairie Provinces .....	59
The Winds of Change: Climate Change in the Prairie Provinces Key .....	66
Taking the Chill Off: Climate Change in the Yukon and Northwest Territories.....	72
Taking the Chill Off: Climate Change in the Yukon and Northwest Territories Key .....	76

## **ACKNOWLEDGEMENTS**

Natural Resources Canada – A Teacher’s Resource for the Climate Change Poster Series is intended to supplement the current resources available on this series and is available on the Web site <http://adaptation.nrcan.gc.ca/posters/>.

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## **PREFACE**

Starting in 1999, the Climate Change Action Fund (CCAF) sponsored the development of a series of regional posters on the general science and regional impacts of climate change. Led, or co-led, by Natural Resources Canada (NRCan), the development of these posters was done in close collaboration with provincial and territorial counterparts and stakeholders. NRCan is grateful to its partners who have participated in the development of this curriculum resource. This guide and associated activities is intended to accompany the poster series, with the material found in this guide coming directly from the posters.

## **INTRODUCTION**

The Teacher’s Resource for the Climate Change Poster Series is intended to provide a full range of questions and activity suggestions for the complete set of the 7 Climate Change posters. Teachers may choose to follow the suggested framework and work extensively with the full poster series while some may choose to study and work with only the poster(s) that appear to fit with the region that they live and study in. The overall goals of the resource are to: increase student’s knowledge of climate change, demonstrate the complexity of this environmental phenomenon and improve students’ critical thinking skills while evaluating these complex issues. The Climate Change Poster Series resource enhances several skill areas including critical thinking, evaluation, analysis, application, discussion, questioning, public speaking and reporting.

The Teacher’s Resource has been primarily aligned to meet various curriculum outcomes of S2 science across the country. (See Curriculum Links section for details.)

**Natural Resources Canada – Climate Change Posters Curriculum Resource**  
**Provincial Curriculum Outcome Links S2 / Grade 10 / Other Senior Science**

<b>Lesson: NRCan Climate Change Posters</b>	<b>British Columbia/ Yukon</b>	<b>Alberta</b>	<b>Saskatchewan</b>	<b>Manitoba</b>	<b>Ontario</b>	<b>Quebec/ Nunavut</b>	<b>Atlantic Provinces</b>	<b>Pan- Canadian</b>
<p>1. Degrees of Variation: Climate Change in Nunavut</p> <p>2. The Tides of Change: Climate Change in Atlantic Canada</p> <p>3. A Change in the Wind: Climate Change in Quebec</p> <p>4. Weathering the Changes: Climate Change in Ontario</p> <p>5. Temperature Rising: Climate Change in Southwestern British Columbia</p> <p>6. The Winds of Change: Climate Change in the Prairie Provinces</p> <p>7. Taking the Chill Off: Climate Change in the Yukon &amp; Northwest Territories</p>	<p><b>Grade 11</b> Earth Science, Atmospheric Science</p>	<p><b>Science 10</b> Unit 1: Energy From the Sun 1,2,3</p> <p>Unit 2: Changes in Living Systems 1,4</p> <p>Unit 4: Energy and the Environment 1,2</p>	<p><b>Science 10</b> Core Unit A: Earth / Environmental Science</p> <p>Factors A-1,2,4,5,6 B-2,8,10,11, 12,13,15,16 C2-10, 12-15, D-1-11 F-3-7</p> <p><b>Biology 20</b> 1.9,1.10 2.5,2.9,2.11 6.3</p>	<p><b>Science 20 F</b> Cluster 4: Weather Dynamics S2-4-01 S2-4-02 S2-4-07 S2-4-08</p> <p>Cluster O: Skills &amp; Attitudes S2-0-2a,b,c S2-0-5b S2-0-6a,b S2-0-7e S2-0-8c S2-0-9a,d,e</p>	<p><b>Grade 9</b> Earth and Space Science The Sustainability of Ecosystems</p> <p><b>Grade 10</b> Ecosystems and Human Activity Weather Systems</p> <p><b>Grade 11</b> Environmental Science</p>	<p><b>Secondary School Physical Science Course</b> Terminal objective 1.0: To describe the main characteristics of the Earth's atmosphere.</p> <p>Terminal objective 1.2: To describe the various phase changes of water vapour.</p> <p>Terminal objective 1.3: To explain the direct effect of the wind on air circulation and weather systems.</p>	<p><b>Science 10</b> Weather Dynamics 114-6 115-2,6 116-1 117-6,10 118-2,7</p> <p>212-1 213-2,3,6,7 214-3,10,11 215-5</p> <p>331-1,2,3,4,5</p> <p><b>Sustainability Issues in an Ecosystem</b> 213-7 214-3</p> <p>318-1,4 331-6</p>	<p><b>Grade 10 – 12</b> 115-2,6,7 116-3,4,5 117-1,8 118- 1,2,3,8,9,10</p> <p>214-5,7,8,9,10, 15,17,18 215-1,4,6,7</p> <p>330-4,5,6,8 331-1,2,3,4,6,7 332-1,2,3,7</p>

*Atlantic Provinces and Pan-Canadian Curricula Numbering: \* STSE: 1\_\_\_, SKILLS: 2\_\_\_, KNOWLEDGE: 3\_\_\_. \*STSE – Science, Technology, Society and the Environment*

## **Natural Resources Canada: 7 Regional Climate Change Posters** **Application to Senior 2 Science Weather Dynamics**

In the **Manitoba Senior 2 Science Weather Dynamics** cluster we examine the relationships that control weather and climate. Our Earth's global energy budget is reviewed through water and heat transfer, along with severe weather phenomena. We gather and analyze meteorological data related to a severe weather event, and explore the social, economic, and environmental impact of the event. We also investigate the topic of climate change with reference to both natural events and human activities, and look at the long-term potential consequences of climate change.

### **Learning Outcomes:**

1. Illustrate the composition and organization of the hydrosphere and the atmosphere, examining salt water, fresh water, polar ice caps/glaciers, troposphere and the stratosphere.
2. Outline factors influencing the Earth's radiation budget: solar radiation, cloud cover, surface reflectance (albedo), absorption, and latitude.
3. Explain effects of heat transfer within the atmosphere and hydrosphere on the development and movement of wind and ocean currents. This will include the Coriolis effect/convection, prevailing westerlies, jet streams, and El Niño.
4. Explain the formation and dynamics of severe weather phenomena such as thunderstorms, tornadoes, blizzards, hurricanes, etc.
5. Analyze and interpret collected meteorological data such as meteorological maps and satellite imagery related to a severe weather event.
6. Discuss the social, economic, and environmental impacts of a recent severe weather event.
7. Describe evidence that climate change occurs naturally and can be influenced by human activities.
8. Discuss potential consequences of climate change. E.g. Agricultural shifts, extreme weather events, changes in biodiversity.

### **The 7 Climate Change posters available are titled:**

1. Degrees of Variation: Climate Change in Nunavut
2. The Tides of Change: Climate Change in Atlantic Canada
3. A Change in the Wind: Climate Change in Quebec
4. Weathering the Changes: Climate Change in Ontario
5. Temperature Rising: Climate Change in South Western British Columbia
6. The Winds of Change: Climate Change in the Prairie Provinces
7. Taking the Chill Off: Climate Change in the Yukon & Northwest Territories

*The posters are available from the Geological Survey of Canada:*

1. 601 Booth Street, Ottawa, Ontario K1A 0E8
2. 3303-33<sup>rd</sup> Street NW, Calgary, Alberta T2L 2A7
3. 101-605 Robson Street, Vancouver, B.C. V63 5T3

*Or by calling:*

1. 1-800-622-6232 (allow 4 – 6 weeks delivery)
2. 1-888-252-4301

*Or order on-line:*

1. [http://climatechange.gc.ca/english/teachers/poster\\_order.asp](http://climatechange.gc.ca/english/teachers/poster_order.asp)

*Explore the following website to view the posters, and to get more information on climate change:*

1. <http://adaptation.nrcan.gc.ca/posters/>

*Ordering the posters, and having them laminated will allow you to use this resource in your classroom many times. Another option is to photocopy the poster into manageable 8.5 x 11" sheets for access in booklet form.*

*The posters carry much of the necessary information, and capacity to address the Manitoba Senior 2 Science Weather Dynamics unit, particularly outcomes 7 and 8. They also focus on most of the topics within outcomes 1 through 6, making this a fantastic resource for senior 2 science teachers in Manitoba.*

### **Suggestions for Activation:**

*Introduction to the topic of climate change, its potential impacts, and interest in the posters can be facilitated with a variety of activation activities:*

1. *Videos: A number of videos to prompt interest in the topic are available:*
  - a. What's Up With the Weather? Nova, 2 hours. Original broadcast April 18, 2000. \$19.95 U.S.
  - b. Warnings from the Ice. Nova, 1 hour. Original broadcast April 21, 1998. \$19.95 U.S.
  - c. Chasing El Niño. Nova, 1 hour. Original broadcast Oct. 13, 1998. \$19.95 U.S.
  - d. Einstein Revealed. Nova, 2 hours. Original broadcast Oct. 1, 1996. \$19.95 U.S.
  - e. Planet Earth: The Climate Puzzle. WQED Pittsburgh, PA. Metropolitan Pittsburgh Public Broadcasting, Inc., 1986.
2. *Articles: Ongoing research and reports on climate change offer numerous articles to prompt student inquiry. Suggestions include:*

- a. Suzuki, David. "Let Kyoto take wing: Ottawa signed the accord. Now, let it keep its promise with budget incentives for a green, 21<sup>st</sup> century economy, says environmentalist DAVID SUZUKI." Globe and Mail. 17 Mar 2004. A19.
- b. Stipp, David. "The Pentagon's Weather Nightmare: The climate could change radically, and fast. That would be the mother of all national security issues." Fortune, 9 Feb 2004. Time, Inc. Vol. 149, i3, p100.
- c. Jaccard, Marc. "Cool your jets: Let the market fight emissions: Forget about Kyoto. Here's a better way." Globe and Mail. 31 Mar 2004. A19.

Assigned reading for individual students or groups, with the task of reporting main points may facilitate a discussion on climate change to set the stage for work on the NRC regional posters.

### **Suggestions for Instruction:**

*Student groups of 3 are ideal to provide enough elbowroom to work on the posters. If desired, two groups of 3 can operate on one poster at a given time.*

1. The first page of each worksheet (one for each region) can provide a good introduction to the posters. Student groups have 10 minutes at each poster to complete the 3 Trivia, and "Did You Know" true and false questions, switching posters when the "bell rings". *Time: ~70 minutes.*
2. The second, and subsequent pages of each poster's worksheet have bold, underlined titles corresponding to a particular section of each poster – students will quickly identify this, but teacher direction at activity start will help provide focus.
3. Several strategies for completing the 7 worksheets include:
  - a. Assigned groups work on one poster at a time, completing one worksheet per group. *Time: ~7 hours*
  - b. One or two groups are assigned to one poster to complete the worksheet. Heads are then numbered, and a jigsaw is used so students can share the information from their poster with other groups. *Time: ~4 - 5 hours.*
  - c. Each student is assigned a portion of each worksheet to gather information from all posters. Groups then meet to collate the information onto one worksheet. *Time: ~4- 5 hours*

### **Suggestions for Assessment/Evaluation:**

1. Evaluation of poster worksheets (individual or group).
2. Final, summarizing worksheet: "Climate Change in Canada":
  - a. Students work in original groups, or (using numbered heads, a deck of cards, the alphabet, etc.) with newly assigned groups on this final worksheet. Student groups can present the results of their concluding discussions, and answers with the class. *Time: 1 - 2 hours.*

- b. Alternatively, students can work on this as an independent assignment, using the information they have collected from the larger group activity. This evaluation tool can also be divided into sections, with individuals or with student groups assigned particular sections.
- c. Individual assessment with this piece within a time-limited classroom evaluation setting may also prove useful.

**Suggestions for Follow-up Activities/Supplemental Materials:**

Climate Binder/ Video: Creating a Climate of Change. Society, Environment and Energy Development Studies (SEEDS) Foundation. David Lunn, 2002.

- *7 modules and supporting video*

Web sites:

1. <http://www.pbs.org/wgbh/nova/teachers> Nova Teachers provides access to the videos listed above, in addition to excellent resources accessible under the following headings:
  - *Program Overview*
  - *Viewing Ideas*
  - *Classroom Activity* (some excellent student handouts included)
  - *Ideas from Teachers*
  - *Related Nova Resources*
  - *Interactive for Students*
2. <http://www.climatechangecanada.org> Temperature Rising. Poster and activities, related links on poster 5, British Columbia.
3. <http://www.weatheroffice.ec.gc.ca> Canadian weather and climate data.
4. [http://climate.weatheroffice.ec.gc.ca/Welcome\\_e.html](http://climate.weatheroffice.ec.gc.ca/Welcome_e.html) National Climate Data and Information Archive.
5. <http://ehp.niehs.nih.gov/topic/climatetop.html> Environmental Health Perspectives Online. Climate change impacts on human health explored.

Articles:

1. "With or without Kyoto, Canada needs a plan." Editorial. Globe & Mail. 4 Dec 2003. A24.
2. Chase, Steven and Tuck, Simon. "Ottawa looks at big outlays for clean gas." Globe & Mail. 13 May 2003. A1.
3. Pearce, Fred. "Kyoto changes may drive deforestation." New Scientist. 22 Mar 2003. Vol 177, i2387, p15(1).
4. "Is Kyoto Dead?" The Economist. 6 Dec 2003. Vol 369, i8353, p73US.



5. "Climate Change's Impacts on Wildlife." National Wildlife. June – July 2002.
6. "Climate Change Impacts on Agriculture." Environment. March 2000. Vol 42, i2, p3.
7. Regush, Nicholas. "Microbes on the March." Canadian Geographic. September/October 2000. p62 – 29.
8. Marchese, John. "Forecast: Hazy." Discover. June 2001. p45 – 51.
9. "Greenhouse Effect, R.I.P." Discover. August 2001. p17 – 18.
10. Zimmer, Carl. "The El Niño Factor." Discover. January 1999. p98 – 106.
11. Hayden, Thomas. "What's Up With the Weather?" Newsweek. 31 Jan 2000.
12. Wood, Chris. "Wild Weather." Macleans. 25 Jan 1999.
13. Nash, Madeleine. "Will We Control the Weather?" Time. 10 Apr 2000. p72 – 74.

For Winnipeg Teachers:

1. Fort Whyte Centre: Weather and Climate Change Lab
  - [http://www.fortwhyte.org/fwSchool\\_Programs.html](http://www.fortwhyte.org/fwSchool_Programs.html)
  - 4 - 5 hour interactive program
  - \$8.00 per student (10 – 75 students)
2. Environment Canada Weather Office Tour: 4<sup>th</sup> Floor Via Rail Station
  - Prairie warnings are generated from data at this site
  - Allow approx. 1 hour per trip (30 - 40 min. in training room followed by tour/questions), with 9:30 a.m. arrival time at the earliest.
  - 20 - 30 students maximum
  - Contact: Jay Anderson, Meteorologist, 984-7923
  - <http://www.weatheroffice.ec.gc.ca>
3. Environmental Speakers Bureau:
  - Senior 2 "Wild Weather" presentation (1 hour)
  - Contact: Mary Melnychuk, 925-3777 (Mary is a former high school teacher)
  - 30 students maximum

## Climate Change in Canada

Use the information you collected from the 7 regional posters on climate change in Canada to answer the following questions:

1. In comparing percentages provided on incoming solar radiation on the 7 posters, you may have noticed that different values were assigned to the following:
  - a) % of incoming solar radiation absorbed by the atmosphere
  - b) % ...reflected by the atmosphere
  - c) % ...absorbed by the Earth's surface
  - d) % ...reflected by the Earth's surface

Why do you think these values differ amongst the various regions?

2. After examining all of the posters, which region in Canada do you think will **suffer** the most by climate change? Provide 3 reasons to back up your answer.

\_\_\_\_\_:

a)

b)

c)

3. After examining all of the posters, which region in Canada do you think will **benefit** the most by climate change? Provide 3 reasons to back up your answer.

\_\_\_\_\_:

a)

b)

c)

4. Predict how climate change will impact human population (numbers of people) in these 7 regions. Give a reason for your prediction.

a) Nunavut:

b) Atlantic Canada:

c) Quebec:

d) Ontario:

e) The Prairie Provinces:

f) South Western B.C.:

g) Yukon and Northwest Territories:

5. What is the message that Natural Resources Canada is trying to deliver with the production of these posters?

6. After studying the information on these posters, what can YOU do as a Canadian citizen to help reduce the effects humans have on climate change?

a)

b)

c)

## Climate Change in Canada

Use the information you collected from the 7 regional posters on climate change in Canada to answer the following questions:

1. In comparing percentages provided on incoming solar radiation on the 7 posters, you may have noticed that different values were assigned to the following:
  - a) % of incoming solar radiation absorbed by the atmosphere
  - b) % ...reflected by the atmosphere
  - c) % ...absorbed by the Earth's surface
  - d) % ...reflected by the Earth's surface

Why do you think these values differ amongst the various regions? (2)

**The 7 regions offer very different landscapes and land cover, impacting these percentages. While icy regions sport a higher albedo, thus reflecting more incoming solar radiation, regions with greater forest cover or bodies of water will absorb more.**

2. After examining all of the posters, which region in Canada do you think will **suffer** the most by climate change? Provide 3 reasons to back up your answer. (3)

\_\_\_\_\_:

a)

b)

c)

3. After examining all of the posters, which region in Canada do you think will **benefit** the most by climate change? Provide 3 reasons to back up your answer. (3)

\_\_\_\_\_:

a)

b)

c)

4. Predict how climate change will impact human population (numbers of people) in these 7 regions. Give a reason for your prediction. (7)

a) Nunavut:

b) Atlantic Canada:

c) Quebec:

d) Ontario:

e) The Prairie Provinces:

f) South Western B.C.:

g) Yukon and Northwest Territories:

5. What is the message that Natural Resources Canada is trying to deliver with the production of these posters? (2)

**Climate change is a phenomenon that has occurred throughout Earth's history. Evidence from many sources exists to support this. We have a concern however that we are influencing climate change with the recent introduction of certain human activities (i.e. burning of fossil fuels). Awareness, coupled with caution is needed to carry us into a healthy and ecologically sustainable future.**

6. After studying the information on these posters, what can YOU do as a Canadian citizen to help reduce the effects humans have on climate change? (3)

a)

b)

c)

***Degrees of Variation:  
Climate Change in Nunavut***

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. What Nunavut town has 3 “Q’s” in its name?
  
2. What is a “thermosyphon”?
  
3. What colour are the ptarmigans?

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version.

- \_\_\_ About 2/3 of Canada’s CO<sub>2</sub> and NO<sub>x</sub> emissions come from transportation.
- \_\_\_ Every litre of gas used in your vehicle produces almost 1 kg of CO<sub>2</sub>.
- \_\_\_ Human activity is responsible for emitting 30 million tons of methane each year.
- \_\_\_ Greenhouse gas molecules have life spans of months or even years.
- \_\_\_ Climate models predict the greatest warming will occur in southern Ontario.
- \_\_\_ If the Greenland Ice Sheet melts, it contains enough ice to raise the global sea level by 6 – 7 metres.
- \_\_\_ Polynyas are areas of open water surrounded by sea ice.
- \_\_\_ In the Arctic, ocean temperature varies only a few degrees (-2 to +3°C).
- \_\_\_ Burning garbage is a major source of ozone emissions.
- \_\_\_ The average temperature of Earth without the Earth’s natural greenhouse effect would be zero degrees Celsius.

**Climate Change - The Basics:**

1. Locate the box with the sun in it, and record the following information:  
 \_\_\_\_ % of incoming solar radiation reflected back to space.  
 \_\_\_\_ % of incoming solar radiation absorbed by the atmosphere.  
 \_\_\_\_ % of incoming solar radiation absorbed by the earth's surface.
2. Predict the effects that melting of polar ice caps would have on these percentages (in 1 above).
3. What human-induced factors contribute to climate change?
4. What greenhouse gas is most closely linked to human activities?
5. What is the current concentration (parts per million by volume) of CO<sub>2</sub> in our atmosphere?

**Climate Has Always Changed:**

Examine the ice core data from the last 12 000 years:

1. Has most of the last 12 000 years in Nunavut been above or below present normal temperatures?
2. Estimate what percentage of the last 12 000 years has had above/below present normal temperatures:  
 ~ \_\_\_\_ % above normal temperatures  
 ~ \_\_\_\_ % below normal temperatures
3. Estimate what percentage of the last 150 000 was spent below present normal temperatures.
4. What was the eastern high arctic average summer temperature in the year you were born?

**The Current Conditions:**

1. Was the global ground surface temperature in the year 1500 warmer or cooler than today? By how many degrees?

2. Using the graph, comment on any trends in frequency of intense winter storms in the northern hemisphere.

### **Climate Projections:**

1. What is the projected intermediate estimate for CO<sub>2</sub> concentration (ppm by volume) for the year 2100?
2. What technology was necessary for us to develop GCMs (general circulation models) of the Earth's climate?
3. How accurate are these models?

### **Glaciers and Sea-Level Rise:**

1. From the map showing sensitivity to sea level rise, which province's Hudson Bay coastline is the least vulnerable (i.e. has the lowest sensitivity to sea-level rise), Manitoba, Ontario or Quebec? (Circle the right answer)
2. Which Ice Cap in the Arctic is beginning to show a trend toward more summer melt?

### **Of Ice and Men:**

1. What traditional northern activities depend on sea ice?
2. What emergency occurred in early June 1997?
3. Predict how the opening of the "Northwest Passage" would:
  - a) create social change:
  - b) increase environmental hazards:
  - c) raise sovereignty issues:

### **Life at Sea:**

1. What do scientists predict will happen to the range of many marine species as climate changes?
2. What animals require strong sea ice to breed, nurse pups and rest?



3. How will Inuit hunters be affected as animals shift their range in response to climate change?
4. According to the News North, when it gets too warm, what do the animals do?

**Northern Landscapes:**

1. What is found beneath the ground surface in nearly all of Nunavut?
2. How will people be affected if the permafrost thaws?

**Life on the Land:**

1. How will the herbivores' food supply in the north be affected by climate change?
2. What small mammal pictured may be threatened by CO<sub>2</sub> trapped under the snow?
3. What is expected to happen to the range of plant species in the north?
4. How will warming affect birds in the region?

**The Challenge:**

1. How does Canada rank globally for CO<sub>2</sub> emissions?
2. What is the world average CO<sub>2</sub> emission (tonnes/year)?
3. Examining residential emissions of CO<sub>2</sub>, what activity is responsible for 53% of these emissions? \_\_\_\_\_ Propose ways to decrease this output, from this source:
4. How might human health be affected by GHGs (greenhouse gases)?
5. Did any of the information on this poster alarm you in any way? If so, how?

**Degrees of Variation:**  
**Climate Change in Nunavut**

Group Members: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (bonus)

1. What Nunavut town has 3 “Q’s” in its name?  
**Qikiqtarjuaq**
2. What is a “thermosyphon”?  
**A device put into the ground to remove heat from the ground and dissipate it to the air, which prevents the permafrost from melting.**
3. What colour are the ptarmigans?  
**White (birds)**

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version. (10)

- \_\_\_ About ~~2/3~~ of Canada’s CO<sub>2</sub> and NO<sub>x</sub> emissions come from transportation. **F, 1/3**
- \_\_\_ Every litre of gas used in your vehicle produces almost 4 kg of CO<sub>2</sub>. **F, 2.5**
- \_\_\_ Human activity is responsible for emitting 30 million tons of methane each year. **T**
- \_\_\_ Greenhouse gas molecules have life spans of ~~months~~ or even ~~years~~.  
**F, decades, centuries**
- \_\_\_ Climate models predict the greatest warming will occur in ~~southern Ontario~~.  
**F, arctic regions**
- \_\_\_ If the Greenland Ice Sheet melts, it contains enough ice to raise the global sea level by 6 – 7 metres. **T**
- \_\_\_ Polynyas are areas of open water surrounded by sea ice. **T**
- \_\_\_ In the Arctic, ocean temperature varies only a few degrees (-2 to +3°C). **T**
- \_\_\_ Burning garbage is a major source of ~~ozone~~ emissions. **F, greenhouse gas**
- \_\_\_ The average temperature of Earth without the Earth’s natural greenhouse effect would be ~~zero~~ degrees Celsius. **F, -18**

**Climate Change - The Basics:**

1. Locate the box with the sun in it, and record the following information: (3)
  - 31 %** of incoming solar radiation reflected back to space.
  - 23 %** of incoming solar radiation absorbed by the atmosphere.
  - 46 %** of incoming solar radiation absorbed by the earth's surface.
2. Predict the effects that melting of polar ice caps would have on these percentages (in 1 above). (1)
  - Less reflected, more absorbed.**
3. What human-induced factors contribute to climate change? (2)
  - Enhanced GH effect and atmospheric aerosols; land use change.**
4. What greenhouse gas is most closely linked to human activities? (1)
  - CO<sub>2</sub>**
5. What is the current concentration (parts per million by volume) of CO<sub>2</sub> in our atmosphere? (1)
  - ~360 ppm**

**Climate Has Always Changed:**

Examine the ice core data from the last 12 000 years:

1. Has most of the last 12 000 years in Nunavut been above or below present normal temperatures? (1) **Above**
2. Estimate what percentage of the last 12 000 years has had above/below present normal temperatures: (2)
  - ~ **75 - 80%** above normal temperatures
  - ~ **20 - 25%** below normal temperatures
3. Estimate what percentage of the last 150 000 was spent below present normal temperatures. (1) **~80%**
4. What was the eastern high arctic average summer temperature in the year you were born? (1) **(0.5 – 3°C)**

**The Current Conditions:**

1. Was the global ground surface temperature in the year 1500 warmer or cooler than today? By how many degrees? (1) **1°C cooler**
2. Using the graph, comment on any trends in frequency of intense winter storms in the northern hemisphere. (2) **Increasing, with regular fluctuations.**

**Climate Projections:**

1. What is the projected intermediate estimate for CO<sub>2</sub> concentration (ppm by volume) for the year 2100? (1) **~650 ppm**
2. What technology was necessary for us to develop GCMs (general circulation models) of the Earth's climate? (1) **Computers**
3. How accurate are these models? (1)  
**Not very, since there are many variables to climate that we don't fully understand.**

**Glaciers and Sea-Level Rise:**

1. From the map showing sensitivity to sea level rise, which province's Hudson Bay coastline is the least vulnerable (i.e. has the lowest sensitivity to sea-level rise), Manitoba, Ontario or **Quebec**? (Circle the right answer) (1)
2. Which Ice Cap in the Arctic is beginning to show a trend toward more summer melt? (1) **South Melville Ice Cap**

**Of Ice and Men:**

1. What traditional northern activities depend on sea ice? (2)  
**Travel, hunting, fishing**
2. What emergency occurred in early June 1997? (1)  
**Students were left drifting on an ice floe for 6 days!**
3. Predict how the opening of the "Northwest Passage" would: (3)
  - a) Create social change: **What was once a relatively isolated social community/cultural landscape would be open to significant impacts.**
  - b) Increase environmental hazards: **With increased travel, comes increased risk associated with tankers/spills, etc.**
  - c) Raise sovereignty issues: **The Canadian OEEZ boundary might be threatened, particularly with the effect of melting polar ice recreating newly defined political boundaries.**

**Life at Sea:**

1. What do scientists predict will happen to the range of many marine species as climate changes? (1) **Northward shift**
2. What animals require strong sea ice to breed, nurse pups and rest? (1) **Walrus and bearded seals**

- How will Inuit hunters be affected as animals shift their range in response to climate change? (2) **Forced to change their hunting regimes**
- According to the News North, when it gets too warm, what do the animals do? (1)  
**Go to cooler areas.**

### **Northern Landscapes:**

- What is found beneath the ground surface in nearly all of Nunavut? (1)  
**Permafrost**
- How will people be affected if the permafrost thaws? (3)  
**Infrastructure suffers greatly: roads, runways, sewage, water supply, underground mines collapse, etc. Open pit mining benefits.**

### **Life on the Land:**

- How will the herbivores' food supply in the north be affected by climate change? (2)  
**Improved with increased plant growth.**
- What small mammal pictured may be threatened by CO<sub>2</sub> trapped under the snow? (1)  
**Lemming**
- What is expected to happen to the range of plant species in the north? (1)  
**Expand northward**
- How will warming affect birds in the region? (2)  
**Positive impacts on northern birds, negative on southern.**

### **The Challenge:**

- How does Canada rank globally for CO<sub>2</sub> emissions? (1) **2<sup>nd</sup>!**
- What is the world average CO<sub>2</sub> emission (tonnes/year)? (1) **3.9 tonnes/year**
- Examining residential emissions of CO<sub>2</sub>, what activity is responsible for 53% of these emissions? **Transportation** Propose ways to decrease this output, from this source: (3)  
**Carpool, public transit...**
- How might human health be affected by GHGs (greenhouse gases)? (2)  
**Food/water quality, infectious diseases**
- Did any of the information on this poster alarm you in any way? If so, how? (1)

***The Tides of Change:  
Climate Change in Atlantic Canada***

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. What province is Saint John located?
2. What is meant by the term “blowdown”?
3. What “distinguishing” features does a Harlequin Duck have?

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version.

- \_\_\_ Cod travelled northwards between 1900 and 1920, but after 1930 they retreated southwards.
- \_\_\_ Changes in water temperature affect only a few species in the marine food web.
- \_\_\_ A 20 – 30% reduction in present global emissions of CO<sub>2</sub> would be required to stabilize atmospheric CO<sub>2</sub> concentrations at current levels.
- \_\_\_ Canada’s emission reduction target under the Kyoto Protocol is 3%.
- \_\_\_ 100% of Atlantic Canada’s fog comes from outside the region.
- \_\_\_ Venus has an atmosphere of 75% CO<sub>2</sub>.
- \_\_\_ The climate between 1000 and 1200 A.D. was very similar to today’s.
- \_\_\_ The “Little Ice Age” began in the 1200’s and ended in the 1500’s.
- \_\_\_ Temperatures on Venus reach 430 °C.
- \_\_\_ Canada has about 4% of the world’s population, but produces 2% of global CO<sub>2</sub> emissions.

**Is Climate Changing?**

1. What is happening to most of the world's glaciers?
2. What is the IPCC?
3. Examine the Temperature Change maps. In what general areas do you see shading corresponding to the greatest temperature change?

**Climate Has Always Changed:**

1. How can climate be described over the past 10 000 years?
2. Answer the question in the 

<b>Green box</b>
------------------

**The Greenhouse Effect:**

1. What are "the big three" GHGs (greenhouse gases)?
  - a)
  - b)
  - c)
2. Describe the projected rise in atmospheric CO<sub>2</sub> concentrations from the graph.
3. According to the solar energy budget, what portion of the earth absorbs as much radiation as it reflects?

**The Air We Breathe:**

1. What human activities contribute to smog?
2. Examine the triangle  $\Delta$ , and predict the impact on health care costs if fossil fuel burning is reduced. Explain.
3. What activity is responsible for 26% of GHG emissions in Canada?

**Freshwater Issues:**

1. Examining the 2 graphs pertaining to the Saint John River, what correlation exists between the number of mild days in January and peak daily flow?
2. Answer the “?” on hydro-electric power.

**Forests in Peril?**

1. How do air-filled stems in hardwoods cause their demise?
2. Why might the Gypsy moth threaten Canadian forests if warming continues?

**Down on the Farm:**

1. Make a list of pros and cons for farmers if global warming continues?

**Pros****Cons**

2. What is the greatest concern for agriculture in Atlantic Canada?

**Changing Ecosystems:**

1. Examining the 2 maps, comment on what a doubling of atmospheric CO<sub>2</sub> would do to the area, or amount of land in Canada occupied by:
  - a) Tundra?
  - b) Grasslands?
  - c) Temperate regions?
2. How will Atlantic Canada’s biomes change if this is accurate?
3. Predict what this shift in ground cover will mean for the biodiversity (plant and animal life) in Atlantic Canada?



**How do we Measure up?**

1. List the 3 levels of government involved in addressing climate change:
  - a)
  - b)
  - c)
2. How many tonnes of CO<sub>2</sub> are YOU responsible for emitting each year as a Canadian citizen?
3. As Canadians we emit a little more than twice as much CO<sub>2</sub> per capita than citizens of \_\_\_\_\_.
4. What country comes a close second to the U.S., who leads in global CO<sub>2</sub> emissions?
5. In Atlantic Canada, rank the following activities according to GHG emissions:
  - \_\_\_\_\_ Transportation
  - \_\_\_\_\_ Residential
  - \_\_\_\_\_ Industrial
  - \_\_\_\_\_ Electricity Generation

**The Ocean:**

1. What 2 ocean currents meet in the Canadian Atlantic region?
  - a)
  - b)
2. Compare the speeds of the 2 currents:
  - a)
  - b)
3. How large would cod caught in waters with bottom temperatures of 6°C compare to those caught in warmer or cooler waters?
4. What factors need to be considered when predicting average future fish stocks?

**Rising Sea Level and Vanishing Coasts:**

1. What is the projected tidal water level (m) for the year 2100? How does this compare to today?
2. What specific types of coastal areas will be most affected by sea-level rise?

**Storm Surges and Coastal Flooding:**

1. What is a storm surge?
2. What P.E.I. city was flooded by a storm surge January 21, 2000?
3. Answer the “?” regarding protection.

**Sea Ice and Icebergs:**

1. What will happen to sea ice with global warming?
2. What is predicted to happen to the southern limit of iceberg travel?
3. When did the Titanic sink?
4. Answer the “?” regarding icebergs.

***Bonus Question:*** *What is the spelling/grammatical error in this frame?*

**Let's Meet the Challenge:**

1. How can YOU help to reduce greenhouse gases?
2. Brainstorm in your group, and list ideas to reduce our GHG emissions in Canada:

***The Tides of Change:  
Climate Change in Atlantic Canada***

Group Members: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (bonus)

1. What province is Saint John located?  
**New Brunswick**
2. What is meant by the term “blowdown”?  
**A lot of trees felled in a storm**
3. What “distinguishing” features does a Harlequin Duck have?  
**White stripes/markings**

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version. (10)

- \_\_\_ Cod travelled northwards between 1900 and 1920, but after 1930 they retreated southwards. **T**
- \_\_\_ Changes in water temperature affect ~~only a few~~ species in the marine food web.  
**F, all**
- \_\_\_ A ~~20—30%~~ reduction in present global emissions of CO<sub>2</sub> would be required to stabilize atmospheric CO<sub>2</sub> concentrations at current levels. **F, 50 – 60%**
- \_\_\_ Canada’s emission reduction target under the Kyoto Protocol is ~~3%~~. **F, 6%**
- \_\_\_ ~~100%~~ of Atlantic Canada’s fog comes from outside the region. **F, 75%**
- \_\_\_ Venus has an atmosphere of ~~75%~~ CO<sub>2</sub>. **F, 98%**
- \_\_\_ The climate between 1000 and 1200 A.D. was very similar to today’s. **T**
- \_\_\_ The “Little Ice Age” began in the 1200’s and ended in the ~~1500’s~~. **F, 1800’s**
- \_\_\_ Temperatures on Venus reach 430 °C. **T**
- \_\_\_ Canada has about ~~4%~~ of the world’s population, but produces 2% of global CO<sub>2</sub> emissions. **F, 0.5% of population**

**Is Climate Changing?**

1. What is happening to most of the world's glaciers? (1)  
**Shrinking**
2. What is the IPCC? (1)  
**Intergovernmental Panel on Climate Change**
3. Examine the Temperature Change maps. In what general areas do you see shading corresponding to the greatest temperature change? (1)  
**The poles**

**Climate Has Always Changed:**

1. How can climate be described over the past 10 000 years? (1)  
**Stable**
2. Answer the question in the Green box (1)  
**Examine long-term records**

**The Greenhouse Effect:**

1. What are "the big three" GHGs (greenhouse gases)? (3)
  - a) **CO<sub>2</sub>**
  - b) **CH<sub>4</sub>**
  - c) **N<sub>2</sub>O**
2. Describe the projected rise in atmospheric CO<sub>2</sub> concentrations from the graph. (1)  
**Quite extreme**
3. According to the solar energy budget, what portion of the earth absorbs as much radiation as it reflects? (1)  
**The atmosphere – reflects 25% incoming, absorbs 25% incoming.**

**The Air We Breathe:**

1. What human activities contribute to smog? (1)  
**Burning fossil fuels**
2. Examine the triangle Δ, and predict the impact on health care costs if fossil fuel burning is reduced. Explain. (1)  
**Reduced...**
3. What activity is responsible for 26% of GHG emissions in Canada? (1)  
**Transportation**

**Freshwater Issues:**

1. Examining the 2 graphs pertaining to the Saint John River, what correlation exists between the number of mild days in January and peak daily flow? (1)  
**Positive correlation**
2. Answer the “?” on hydro-electric power. (1)  
**Increased water flow = more power; reduced water flow with increased evaporation = less power.**

**Forests in Peril?**

1. How do air-filled stems in hardwoods cause their demise? (1)  
**Prevent water flow**
2. Why might the Gypsy moth threaten Canadian forests if warming continues? (1)  
**Large numbers are a threat to trees, and since the moths die at temperatures below -9°C, warming may not allow enough deaths.**

**Down on the Farm:**

1. Make a list of pros and cons for farmers if global warming continues? (2)

**Pros**

- longer growing season; higher yields
- less loss from winter kill
- fall harvesting easier
- vineyards more common

**Cons**

- drought; increased irrigation \$
- increased winter insect pests
- more generations of summer pests

2. What is the greatest concern for agriculture in Atlantic Canada? (1)  
**Trend toward more severe weather events**

**Changing Ecosystems:**

1. Examining the 2 maps, comment on what a doubling of atmospheric CO<sub>2</sub> would do to the area, or amount of land in Canada occupied by: (3)
  - a) Tundra? **Reduce by ~ 1/3**
  - b) Grasslands? **Reduced to ~1/2**
  - c) Temperate regions? **Increased ~ 3 to 4 times the area**
2. How will Atlantic Canada's biomes change if this is accurate? (2)
  - **The temperate forest zone will extend northward in Atlantic Canada**
  - **The existing soil conditions and life cycles will limit rates of forest migration.**
  - **Existing forests will undergo significant disruption before a new equilibrium is established.**

3. Predict what this shift in ground cover will mean for the biodiversity (plant and animal life) in Atlantic Canada? (1) **Many changes...**

**How do we Measure up?**

1. List the 3 levels of government involved in addressing climate change: (3)
  - a) **Federal**
  - b) **Provincial**
  - c) **Municipal/Regional**
2. How many tonnes of CO<sub>2</sub> are YOU responsible for emitting each year as a Canadian citizen? (1)  
**21.4 tonnes/year**
3. As Canadians we emit a little more than twice as much CO<sub>2</sub> per capita than citizens of **Japan**. (1)
4. What country comes a close second to the U.S., who leads in global CO<sub>2</sub> emissions? (1) **Australia**
5. In Atlantic Canada, rank the following activities according to GHG emissions: (2)
  - 2** Transportation
  - 4** Residential
  - 3** Industrial
  - 1** Electricity Generation

**The Ocean:**

1. What 2 ocean currents meet in the Canadian Atlantic region? (1)
  - a) **Labrador**
  - b) **Gulf Stream**
2. Compare the speeds of the 2 currents: (1)
  - a) **Labrador – 1 km/h**
  - b) **Gulf Stream – 15 km/h**
3. How large would cod caught in waters with bottom temperatures of 6°C compare to those caught in warmer or cooler waters? (1)  
**Average**
4. What factors need to be considered when predicting average future fish stocks? (2)  
**Fishing/quotas, habitat change/food supply, change in predators...**

**Rising Sea Level and Vanishing Coasts:**

1. What is the projected tidal water level (m) for the year 2100? How does this compare to today? (1)  
**2.0 m, .6 - .7 m over today's 1.3 – 1.4 m**

2. What specific types of coastal areas will be most affected by sea-level rise? (1)  
**Salt marshes, lagoons, etc.**

**Storm Surges and Coastal Flooding:**

4. What is a storm surge? (1)  
**A rise in water level on the coast (from a storm)**
5. What P.E.I. city was flooded by a storm surge January 21, 2000? (1)  
**Charlottetown**
6. Answer the “?” regarding protection. (1)  
**Dykes, seawalls, etc.**

**Sea Ice and Icebergs:**

1. What will happen to sea ice with global warming? (1)  
**It will become thinner, and less extensive**
2. What is predicted to happen to the southern limit of iceberg travel? (1)  
**Move northward**
3. When did the Titanic sink? (1) **1912**
4. Answer the “?” regarding icebergs. (1)  
**Because the salt does not freeze with the water, and is left behind in the water.**

***Bonus Question:*** What is the spelling error in this frame? **effect → affect**

**Let's Meet the Challenge:**

1. How can YOU help to reduce greenhouse gases? (1)  
**Public transit, car pool, bike, walk...**
2. Brainstorm in your group, and list ideas to reduce our GHG emissions in Canada: (1)

## **A Change in the Wind: Climate Change in Quebec**

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. Approximately how far apart (km) are Montreal and Quebec City?
2. When did an ice storm hit Quebec, leaving half the population without power?
3. Can you see anything in the landfill that could have been recycled? If so, what?

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version.

- \_\_\_ The two warmest years on record are 1988 and 1989.
- \_\_\_ ¼ of greenhouse gas emissions in Quebec are the direct result of human activities.
- \_\_\_ Flooding costs \$10 - \$15 million annually in Quebec.
- \_\_\_ Montreal is frequently hit by severe weather events.
- \_\_\_ Methane, CH<sub>4</sub> can retain 10 times more heat than CO<sub>2</sub>.
- \_\_\_ Zebra mussels have significantly altered Quebec’s ecosystem.
- \_\_\_ The average car emits over 2 times its weight in CO<sub>2</sub> every year.
- \_\_\_ Northern regions are likely to be most affected by a projected warmer climate.
- \_\_\_ Caribou herds will increase with a warmer climate.
- \_\_\_ The Earth’s heating more rapidly than it has at any other time during the past 1000 years.



### **What is Climate Change?**

1. What is the average temperature at the Earth's surface? \_\_\_\_\_
2. What would it be without greenhouse gases? \_\_\_\_\_
3. Which of the GHGs has increased in concentration the most since the Industrial Revolution? \_\_\_\_\_
4. Record the percentages of incoming solar radiation:
  - a) absorbed by the atmosphere: \_\_\_\_\_%
  - b) absorbed by the Earth's surface: \_\_\_\_\_%
  - c) reflected by the atmosphere: \_\_\_\_\_%
  - d) reflected by the Earth's surface: \_\_\_\_\_%

### **A Climate in Constant Flux:**

1. When have 10 of Quebec's warmest years of the century occurred?
2. When did the Little Ice Age occur?
3. What computer models are used to predict future climatic conditions?
4. Viewing the global map, what areas are projected to have the greatest temperature change in the next half century?
5. How do the 3 graphs depict the projected temperature change by the year 2100?

### **Our Health:**

1. What is the most direct health risk from warming climates?
2. Will warming increase or decrease the amount of smog?
3. Of the 4 indirect impacts on human health, decide which one will likely affect you the most. Explain.

### **Extreme Weather – What are the Risks?**

1. List examples of severe, or extreme weather events that may increase with global warming.
2. How could climate change affect the condition of our roads in Montreal?
3. Brainstorm in your group to generate a list of how more extreme weather events will impact humans.

**Could a Warmer Climate Mean a Shortage of Water?**

1. How will the projected climate change alter precipitation patterns?
2. What might be the effects of droughts and reduced groundwater, as a result of climate change, on humans?
3. When groundwater changes due to changes in precipitation, how does it affect fish?

**The St. Lawrence has its Ups and Downs:**

1. Fill in details of the St. Lawrence River:
  - a) Distance of flow: \_\_\_\_\_
  - b) Length of shoreline: \_\_\_\_\_
  - c) The 3 sections are: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
2. Why is there a concern for biodiversity/life along shorelines as the freshwater reach changes?
3. Describe what the coastal erosion at Rivière à Claude looks like?
4. What is the one and only potentially positive effect of rising sea level in the gulf?
5. What is meant by the term “riparian”?

**A Dynamic Forest:**

1. What will happen to the tree line in Quebec?
2. Describe the southern Quebec forest from the picture.
3. How are the following expected to be altered with global warming?
  - a) Precipitation?
  - b) Forest fires?

4. Compare the 2 maps:
- What 2 new ecoclimates may be found in Quebec with a climate of double CO<sub>2</sub> levels?  
 \_\_\_\_\_  
 \_\_\_\_\_
  - What ecoclimate might disappear in this region?

**What about the Far North?**

- How has the permafrost been affected by climate warming?
- What specific impacts to northern communities will occur if the permafrost melts?
- What tree dominates in the northern forest?
- How will tree growth be affected by climate warming?

**Wildlife Acclimates:**

- Use the poster to describe how 3 particular species might be affected by a change in climate:
  - \_\_\_\_\_:
  - \_\_\_\_\_:
  - \_\_\_\_\_:

**Our Farms:**

- How will grain crops be affected by climate warming?
- What will happen to the range of fruit and vegetable production in Quebec?

3. What is the maple syrup industry sensitive to?
4. Discuss the possible "+" and "-" effects to Quebec's agriculture from the poster, and decide whether the net result will be more of a positive or negative one. Explain your decision.

**Emissions – How Do We Measure Up?**

1. Rank the following activities by their GHG (greenhouse gas) emissions:

- \_\_\_\_\_ Residential
- \_\_\_\_\_ Electricity
- \_\_\_\_\_ Waste
- \_\_\_\_\_ Transportation
- \_\_\_\_\_ Agriculture
- \_\_\_\_\_ Industry

2. What gas is released from buried garbage?
3. What does "hydraulically generated" mean?

**We Can All Help:**

1. What is the "must do" to counter the effects of climate change?
2. Read the 6 ideas provided for energy reduction, and create a list of at least 3 more energy-saving tips that YOU can work on:
  - a)
  - b)
  - c)

**A Change in the Wind:**  
**Climate Change in Quebec**

Group Members: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (bonus)

1. Approximately how far apart (km) are Montreal and Quebec City?  
**~250 km**
2. When did an ice storm hit Quebec, leaving half the population without power?  
**January 1998**
3. Can you see anything in the landfill that could have been recycled? If so, what?  
**Yes! Milk carton, pop can**

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version. (10)

- \_\_\_ The two warmest years on record are ~~1988~~ and ~~1989~~. **F, 1998 and 1999**
- \_\_\_ ~~1/4~~ of greenhouse gas emissions in Quebec are the direct result of human activities. **F, 1/3**
- \_\_\_ Flooding costs \$10 - \$15 million annually in Quebec. **T**
- \_\_\_ Montreal is frequently hit by severe weather events. **T**
- \_\_\_ Methane, CH<sub>4</sub> can retain ~~40~~ times more heat than CO<sub>2</sub>. **F, 21**
- \_\_\_ Zebra mussels have significantly altered Quebec’s ecosystem. **T**
- \_\_\_ The average car emits over ~~2~~ times its weight in CO<sub>2</sub> every year. **F, 3x**
- \_\_\_ Northern regions are likely to be most affected by a projected warmer climate. **T**
- \_\_\_ Caribou herds will ~~increase~~ with a warmer climate. **F, decrease**
- \_\_\_ The Earth’s heating more rapidly than it has at any other time during the past ~~4000~~ years. **F, 10 000**

### **What is Climate Change?**

1. What is the average temperature at the Earth's surface? (.5) **15°C**
2. What would it be without greenhouse gases? (.5) **-18°C**
3. Which of the GHGs has increased in concentration the most since the Industrial Revolution? (1) **CH<sub>4</sub>, increased by 145%**
4. Record the percentages of incoming solar radiation: (2)
  - a) absorbed by the atmosphere: **23%**
  - b) absorbed by the Earth's surface: **46%**
  - c) reflected by the atmosphere: **25%**
  - d) reflected by the Earth's surface: **6%**

### **A Climate in Constant Flux:**

1. When have 10 of Quebec's warmest years of the century occurred? (1)  
**Since the 1980s**
2. When did the Little Ice Age occur? (1)  
**~1400 – 1850 AD**
3. What computer models are used to predict future climatic conditions? (1)  
**GCMs**
4. Viewing the global map, what areas are projected to have the greatest temperature change in the next half century? (1)  
**Polar/northern regions**
5. How do the 3 graphs depict the projected temperature change by the year 2100? (1)  
**Drastically increasing**

### **Our Health:**

1. What is the most direct health risk from warming climates? (1)  
**Heat stress**
2. Will warming increase or decrease the amount of smog? (1)  
**Increase**
3. Of the 4 indirect impacts on human health, decide which one will likely affect you the most. Explain. (1)

### **Extreme Weather – What are the Risks?**

1. List examples of severe, or extreme weather events that may increase with global warming. (1)  
**Flooding, ice storms, winds, rain, hail**
2. How could climate change affect the condition of our roads in Montreal? (1)  
**Increased winter warm spells and thawing produce potholes**
3. Brainstorm in your group to generate a list of how more extreme weather events will impact humans. (1)

### **Could a Warmer Climate Mean a Shortage of Water?**

1. How will the projected climate change alter precipitation patterns? (1)  
**Less frequent, but heavier precipitation**
2. What might be the effects of droughts and reduced groundwater, as a result of climate change, on humans? (1)  
**Less water for consumption, agriculture, recreation; storm sewers overloaded.**
3. When groundwater changes due to changes in precipitation, how does it affect fish? (1)  
**Groundwater is typically cool/cold, and it cools rivers that it enters. If this is altered, fish habitats will be affected.**

### **The St. Lawrence has its Ups and Downs:**

1. Fill in details of the St. Lawrence River: (3)
  - a) Distance of flow: **1500 km**
  - b) Length of shoreline: **4200 km**
  - c) The 3 sections are: **freshwater reach  
estuary  
gulf**
2. Why is there a concern for biodiversity/life along shorelines as the freshwater reach changes? (1)  
**Habitat changes**
3. Describe what the coastal erosion at Rivière à Claude looks like? (1)  
**(Road falling into sea)**
4. What is the one and only potentially positive effect of rising sea level in the gulf? (1)  
**Possibility of accommodating larger ships**
5. What is meant by the term “riparian”? (1)  
**Associated with rivers**

**A Dynamic Forest:**

1. What will happen to the tree line in Quebec? (1)  
**Increase northwards**
2. Describe the southern Quebec forest from the picture. (1)  
**Lush, conifers**
3. How are the following expected to be altered with global warming?
  - a) Precipitation? (1) **Increase**
  - b) Forest fires? (1) **Decrease**
4. Compare the 2 maps:
  - a) What 2 new ecoclimates may be found in Quebec with a climate of double CO<sub>2</sub> levels? (1) **Moderate temperate  
Hudson plain**
  - b) What ecoclimate might disappear in this region? (1)  
**Subarctic**

**What about the Far North?**

1. How has the permafrost been affected by climate warming? (1)  
**Increased temperature in this layer has led to melting**
2. What specific impacts to northern communities will occur if the permafrost melts? (1)  
**Infrastructure – landing strips, roads, etc.**
3. What tree dominates in the northern forest? (1)  
**Black spruce**
4. How will tree growth be affected by climate warming? (1)  
**Improved in size and shape**

**Wildlife Acclimates:**

1. Use the poster to describe how 3 particular species might be affected by a change in climate: (3)
  - a) \_\_\_\_\_:
  - b) \_\_\_\_\_
  - c) \_\_\_\_\_:



**Our Farms:**

1. How will grain crops be affected by climate warming? (1)  
**They will benefit**
2. What will happen to the range of fruit and vegetable production in Quebec? (1)  
**Move northward**
3. What is the maple syrup industry sensitive to? (1)  
**Freeze and thaw**
4. Discuss the possible "+" and "-" effects to Quebec's agriculture from the poster, and decide whether the net result will be more of a positive or negative one. Explain your decision. (1)

**Emissions – How Do We Measure Up?**

1. Rank the following activities by their GHG (greenhouse gas) emissions: (2)
  - 3** Residential
  - 6** Electricity
  - 5** Waste
  - 1** Transportation
  - 4** Agriculture
  - 2** Industry
2. What gas is released from buried garbage? (1) **CH<sub>4</sub>**
3. What does "hydraulically generated" mean? (1) **By water**

**We Can All Help:**

1. What is the "must do" to counter the effects of climate change? (1)  
**Consume less energy**
2. Read the 6 ideas provided for energy reduction, and create a list of at least 3 more energy-saving tips that YOU can work on: (3)
  - a)
  - b)
  - c)

**Weathering the Changes:  
Climate Change in Ontario**

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. Approximately how many kilometres separate Ottawa from Toronto?
2. What insect vector (carries and spreads disease) is diagrammed on the poster?
3. What is a “walking school bus”?

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version.

- \_\_\_ Canada’s per capita water use is the fifth highest in the world.
- \_\_\_ Every litre of gasoline you use in your car produces almost 1 kg of CO<sub>2</sub>.
- \_\_\_ “Jackrabbit” starts consume about 25% more fuel than if you accelerate gradually.
- \_\_\_ Cold-water fish species such as lake trout, may disappear from southern Ontario as their habitat changes.
- \_\_\_ Every year in Ontario, about 1000 forest fires destroy over 290 000 hectares of forest.
- \_\_\_ Using cold water to wash and rinse our clothes saves up to 225 kg of CO<sub>2</sub> per year.
- \_\_\_ Replacing one frequently used regular light bulb with an energy efficient compact fluorescent bulb will save 100 kg of CO<sub>2</sub> per year.
- \_\_\_ 1/3 of the CO<sub>2</sub> emissions generated from human activities comes from transportation.
- \_\_\_ The Great Lakes region is home to 25% of Canada’s industries.
- \_\_\_ Venus has an atmosphere that is 98% CO<sub>2</sub>, with temperatures around 200 °C.

**The Climate System – A Balancing Act:**

1. What 5 elements balance our climate? \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_,  
\_\_\_\_\_.
2. Examining the graph showing global temperature change over 10 000 years, when was the greatest change recorded?
3. When did the Little Ice Age take place?
4. What is the projected temperature change by the year 2100?
5. What was the Toronto area like ~20 000 years ago?
6. Record the following percentages of incoming solar radiation:  
\_\_\_\_\_% absorbed by atmosphere  
\_\_\_\_\_% reflected by atmosphere  
\_\_\_\_\_% absorbed by Earth's surface  
\_\_\_\_\_% reflected by Earth's surface
7. Without greenhouse gases in our atmosphere, what would our planet be like?
8. What are "the big 3" GHGs?  
a) \_\_\_\_\_  
b) \_\_\_\_\_  
c) \_\_\_\_\_
9. Which GHG is produced by landfills and wetlands?
10. What information can ice cores provide?

**Future Climate:**

1. What is the current concentration of CO<sub>2</sub> in our atmosphere?
2. Extrapolating from the graph, when will you expect the amount of CO<sub>2</sub> in our atmosphere to double today's levels?
3. What is predicted to happen along with climate warming in Ontario?
4. What is a GCM?
5. Examining the global map, what regions are expected to have the most significant temperature changes?

**Where We Live:**

1. Discuss in your group how YOU will be affected by a warmer climate. Describe several ways.
2. Are storms such as thunderstorms expected to become more or less severe with climate warming?
3. What might have changed (other than climate) that may have contributed to an increase in the number of climate-related disasters?
4. How many households in total lost power in the January 1998 ice storm?
5. Calculate the costs of the ice storm from the transmission tower and wooden utility pole damage.

**Our Health:**

1. What climate factors affect our health?
2. How many more hot days over 35°C in southern Ontario are expected (compared to today), by the middle of the next century?
3. How do certain microclimates, such as those found in cities, differ from the surrounding region?
4. What impact will warmer daytime temperatures have on smog?
5. What gas is mapped by concentration in southern Ontario?
6. Around which 2 Great Lakes is the concentration of this gas (from question 5 above) the highest?
7. Would an outdoor summer job in the Lake Erie area be desirable? Why or why not?

**Our Water:**

1. What looks strange in the Macey's Bay picture of May 15, 2000?
2. What concerns arise when water supplies are warmer?
3. List all of the water movements/exchanges outlined in the hydrological cycle:
4. Lower water levels will decrease shipping costs. True or False?
5. Typically, how much more water does the average household use for flushing toilets than for drinking and kitchen use?

**Our Farms:**

1. Make a list of the pros and cons of climate warming for farmers in Ontario:

**Pros**

**Cons**

2. In reviewing these lists, do you think the farmers will benefit, or suffer economically?

**Our Forests:**

1. Pretend you are a pine tree in Ontario. Write a short story of how you will be affected by climate change.

“Hi. I am \_\_\_\_\_, a pine tree in Ontario....”

**Our Natural Heritage:**

1. What 3 nutrients are exchanged between air, plants, and animals in any ecosystem, as diagrammed?

a)

b)

c)

2. Write “W” for warm-water fish, or “C” for cold-water fish beside each fish below:

\_\_\_\_\_ lake trout

\_\_\_\_\_ black bass

\_\_\_\_\_ white perch

\_\_\_\_\_ sunfish

\_\_\_\_\_ lake whitefish

\_\_\_\_\_ white bass

3. What is the problem with large populations of snow geese?

**How Do We Measure Up?**

1. Rank these countries (1 – 9) by 1995 CO<sub>2</sub> emissions:

Canada \_\_\_\_\_

U.K. \_\_\_\_\_

Japan \_\_\_\_\_

Italy \_\_\_\_\_

China \_\_\_\_\_

Germany \_\_\_\_\_

India \_\_\_\_\_

Russia \_\_\_\_\_

U.S. \_\_\_\_\_

2. Look at the house and car. Can one family make changes that can make a difference? Explain.

**Where Do We Go From Here?**

1. How many nations originally negotiated the Kyoto Protocol?
2. Are we capable of changing for the future as a nation of individuals? Brainstorm with your group to generate ideas of what students in your school could do to “meet the challenge” (i.e. the walking carpool)

**Weathering the Changes:  
Climate Change in Ontario**

Group Members: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (bonus)

1. Approximately how many kilometres separate Ottawa from Toronto?  
**~350 km**
2. What insect vector (carries and spreads disease) is diagrammed on the poster?  
**mosquito**
3. What is a “walking school bus”?  
**A program for parents walking kids to school**

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version. (10)

- \_\_\_ Canada’s per capita water use is the ~~fifth~~ highest in the world. **F, 2nd**
- \_\_\_ Every litre of gasoline you use in your car produces almost 4 kg of CO<sub>2</sub>. **F, 2.5**
- \_\_\_ “Jackrabbit” starts consume about ~~25%~~ more fuel than if you accelerate gradually. **F, 50%**
- \_\_\_ Cold-water fish species such as lake trout, may disappear from southern Ontario as their habitat changes. **T**
- \_\_\_ Every year in Ontario, about ~~1000~~ forest fires destroy over 290 000 hectares of forest. **F, 1500**
- \_\_\_ Using cold water to wash and rinse our clothes saves up to 225 kg of CO<sub>2</sub> per year. **T**
- \_\_\_ Replacing one frequently used regular light bulb with an energy efficient compact fluorescent bulb will save 100 kg of CO<sub>2</sub> per year. **T**
- \_\_\_ 1/3 of the CO<sub>2</sub> emissions generated from human activities comes from transportation. **T**
- \_\_\_ The Great Lakes region is home to ~~25%~~ of Canada’s industries. **F, 45%**
- \_\_\_ Venus has an atmosphere that is ~~98%~~ CO<sub>2</sub>, with temperatures around ~~200~~ °C. **F, 430°C**



**The Climate System – A Balancing Act:**

1. What 5 elements balance our climate? (2.5) **Sun, atmosphere, oceans, precipitation/water, land.**
2. Examining the graph showing global temperature change over 10 000 years, when was the greatest change recorded? (1) **Recently, and ~4000 BC**
3. When did the Little Ice Age take place? (.5) **~1200 – 1850**
4. What is the projected temperature change by the year 2100? (1) **Over 4°C**
5. What was the Toronto area like ~20 000 years ago? (1) **Under 900 m of ice!**
6. Record the following percentages of incoming solar radiation: (2)  
**23%** absorbed by atmosphere  
**25%** reflected by atmosphere  
**46%** absorbed by Earth's surface  
**6%** reflected by Earth's surface
7. Without greenhouse gases in our atmosphere, what would our planet be like? (1)  
**33°C colder**
8. What are “the big 3” GHGs? (1.5)  
a) **CO<sub>2</sub>**  
b) **CH<sub>4</sub>**  
c) **N<sub>2</sub>O**
9. Which GHG is produced by landfills and wetlands? (1) **CH<sub>4</sub>**
10. What information can ice cores provide? (1) **The gases, and thus temperatures going back tens of thousands of years.**

**Future Climate:**

1. What is the current concentration of CO<sub>2</sub> in our atmosphere? (1) **~360 ppm**
2. Extrapolating from the graph, when will you expect the amount of CO<sub>2</sub> in our atmosphere to double today's levels? (1) **~2060 - 2070**
3. What is predicted to happen along with climate warming in Ontario? (1) **The frequency and severity of extreme weather events may increase.**
4. What is a GCM? (1) **Global Climate Model is a computer simulation for predicting future climate.**
5. Examining the global map, what regions are expected to have the most significant temperature changes? (1) **Poles**

**Where We Live:**

1. Discuss in your group how YOU will be affected by a warmer climate. Describe several ways. (1)
2. Are storms such as thunderstorms expected to become more or less severe with climate warming? (1) **More**
3. What might have changed (other than the climate) that may have contributed to an increase in the number of climate-related disasters? (1) **Populations more concentrated, building design (e.g. high rises, etc.)**
4. How many households in total lost power in the January 1998 ice storm? (1)  
**~1 million**
5. Calculate the costs of the ice storm from the transmission tower and wooden utility pole damage. (1.5)  
 **$(130 \times 100\,000) + (30\,000 \times 3000) = 91\,300\,000$ , or  $9.13 \times 10^7$**

**Our Health:**

1. What climate factors affect our health? (1)  
**Temperature, humidity, pressure**
2. How many more hot days over 35°C in southern Ontario are expected (compared to today), by the middle of the next century? (1) **By 36 (from 10 to 46)**
3. How do certain microclimates, such as those found in cities, differ from the surrounding region? (1) **Warmer – pavement / buildings absorb heat.**
4. What impact will warmer daytime temperatures have on smog? (1)  
**Increase it**
5. What gas is mapped by concentration in southern Ontario? (1) **Ozone**
6. Around which 2 Great Lakes is the concentration of this gas (from question 5 above) the highest? (1) **Erie, Michigan**
7. Would an outdoor summer job in the Lake Erie area be desirable? Why or why not? (1) **Potential lung damage**

**Our Water:**

1. What looks strange in the Macey's Bay picture of May 15, 2000? (1)  
**Docks, no water**
2. What concerns arise when water supplies are warmer? (1)  
**Water quality – microbes and algal blooms**

3. List all of the water movements/exchanges outlined in the hydrological cycle:  
(2)  
**Evaporation, transpiration, condensation, precipitation, surface runoff, groundwater flow, stream flow.**
4. Lower water levels will decrease shipping costs. (.5) True or **False**?
5. Typically, how much more water does the average household use for flushing toilets than for drinking and kitchen use? (1)  
**3x**

**Our Farms:**

1. Make a list of the pros and cons of climate warming for farmers in Ontario: (2)

<u>Pros</u>	<u>Cons</u>
- longer growing season	- more irrigation required
- increased yield of certain crops	- winter crop damage
- the potential for growing specialty fruits and vegetables	

2. In reviewing these lists, do you think the farmers will benefit, or suffer economically?  
(1)

**Our Forests:**

1. Pretend you are a pine tree in Ontario. Write a short story of how you will be affected by climate change. (2)

“Hi. I am \_\_\_\_\_, a pine tree in Ontario....”

**Our Natural Heritage:**

1. What 3 nutrients are exchanged between air, plants, and animals in any ecosystem, as diagrammed? (1.5)
- O<sub>2</sub>**
  - CO<sub>2</sub>**
  - H<sub>2</sub>O**
2. Write “W” for warm-water fish, or “C” for cold-water fish beside each fish below: (2)
- C** lake trout
  - W** black bass
  - W** white perch
  - W** sunfish
  - C** lake whitefish
  - W** white bass

3. What is the problem with large populations of snow geese? (1)  
**Their spring feeding frenzy destroys marshes**

**How Do We Measure Up?**

1. Rank these countries (1 – 9) by 1995 CO<sub>2</sub> emissions: (2)

Canada	<b>2</b>	Italy	<b>7</b>	India	<b>9</b>
U.K.	<b>5</b>	China	<b>8</b>	Russia	<b>3</b>
Japan	<b>6</b>	Germany	<b>4</b>	U.S.	<b>1</b>

2. Look at the house and car. Can one family make changes that can make a difference? Explain. (1)

**Where Do We Go From Here?**

1. How many nations originally negotiated the Kyoto Protocol? (1)  
**160**
2. Are we capable of changing for the future as a nation of individuals? Brainstorm with your group to generate ideas of what students in your school could do to “meet the challenge” (i.e. the walking carpool) (1)

***Temperature Rising:  
Climate Change in Southwestern British Columbia***

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. What animals are diagrammed as methane producers?
2. How thick was the glacier on top of Vancouver 16 000 years ago?
3. What monster is said to inhabit Okanagan Lake?

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version.

\_\_\_ Hydroelectric reservoirs supply 50% of B.C.’s electrical needs.

\_\_\_ Canada has about 4% of the world’s population, but produces 2% of global CO<sub>2</sub> emissions.

\_\_\_ The cost of fighting B.C.’s forest fires during the 1998 summer was \$120 million.

\_\_\_ The 1980’s was the warmest decade of the last century.

\_\_\_ 9000 years ago, average temperatures in southern B.C. were 1 – 2 °C warmer than today.

\_\_\_ The 1948 Fraser River Flood cost an estimated \$100 million.

\_\_\_ Mackerel may eat young salmon.

\_\_\_ On average, each person uses over 100 L of water at home every day.

\_\_\_ Motor vehicle exhaust is the source of nearly 30% of the greenhouse gas emissions in the lower Fraser Valley.

\_\_\_ The atmosphere of Venus is 75% CO<sub>2</sub>.

### **Is Climate Changing?**

1. How does weather differ from climate?
2. How do glaciers behave when climate changes?
3. By how much is the global temperature expected to rise above 1980 levels by the year 2100?
4. Where does the global map indicate the most significant temperature changes will occur?

### **Climate Has Always Changed:**

1. What kind of biodiversity would you expect to have inhabited the Vancouver area 16 000 years ago?
2. Examine the global temperature change over 10 000 years. What seems to be the trend toward the year 2100?
3. When did the Little Ice Age occur?
4. Do you think extrapolating the graph from 1998 shows a probable increase? Why or why not?

### **Why is Climate Changing Now?**

1. Record the following information on incoming solar radiation:
  - \_\_\_\_\_ % absorbed by atmosphere
  - \_\_\_\_\_ % reflected by atmosphere
  - \_\_\_\_\_ % absorbed by Earth's surface
  - \_\_\_\_\_ % reflected by Earth's surface
2. Summarize the carbon balance diagram.
3. What turning point saw additions of CO<sub>2</sub> to the atmosphere overtake removals?

4. Aside from water vapour, what are “the big three” GHGs?
  - a)
  - b)
  - c)
5. What are the causes of the rapid build-up of CO<sub>2</sub> in our atmosphere?
6. Examine the graph on atmospheric CO<sub>2</sub> concentrations.
  - a) How many ppm CO<sub>2</sub> are currently in our atmosphere?
  - b) What is the projected concentration for the year 2050?

**The Air We Breathe:**

1. What gets trapped in the Fraser Valley?
2. What will happen to the number of “bad air” days as climate warms?

**Coastal Floods and Failing Ships:**

1. Wetter and stormier winters are predicted for coastal B.C. Predict what impact this might have on the skiing industry in B.C.
2. Are slopes more or less at risk with wetter winters? Explain.

**Rising Seas:**

1. As climate warms, what will happen to glaciers?
2. What areas are most vulnerable to rising sea levels?
3. Answer the “?” regarding restricting development along shorelines.
4. Explain what is meant by “coastal squeeze”.

**Salmon in Hot Water:**

1. Why might tuna and mackerel replace salmon stocks in southern B.C.?
2. How might a reduction in salmon affect B.C.'s economy?
3. Create a "**human** stress-o-meter" to temperature, similar to the one for salmon.

**Low-Water Blues:**

1. What industry will largely be affected by changes in river flow with climate warming?
2. How much more water is used in an average home for showers than for baths?
3. What units are river flows reported in?
4. What date typically sees the Similkameen River's highest flow rate?
5. Explain what is meant by "evapotranspiration".
6. As evapotranspiration increases, what happens to the summer watertable?

**Forests in Transition:**

1. Answer the "?" in the centre of this frame.
2. Approximately how far is Kamloops from Hope, B.C.?
3. Which of these 2 regions (Kamloops/Hope) do you think will be more affected by climate warming, and why?
4. What impact will climate warming have on the B.C. forest industry and economy?



**Down on the Farm:**

1. Explain why the impacts of warming will have “mixed blessings” for the interior?
2. How will climate warming affect impacts on crops by pests?
3. If you were a greenhouse owner, how would your expenses shift throughout the year from present day?
4. What do you think the overall impact will be to the average B.C. farmer’s income?

**How Do We Measure Up?**

1. Rank the following regions by their per capita CO<sub>2</sub> emissions:

Canada	_____	Latin America	_____	India	_____
U.S.S.R.	_____	China	_____	Africa	_____
Japan	_____	Australia	_____	U.S.	_____

2. Approximately how many citizens of India have the same impact as one Canadian in CO<sub>2</sub> emissions? \_\_\_\_\_
3. Out of individual household CO<sub>2</sub> emissions, what % does automobile use put out?
- 4.
5. What activities contribute to 75% of CO<sub>2</sub> emissions that are not individually produced?

**Let’s Meet the Challenge:**

1. What did Margaret Mead say?
2. What does she mean?
3. Generate a list from group members, outlining what we as individuals can do to help reduce our personal impact on climate change:

**Temperature Rising:  
Climate Change in Southwestern British Columbia**

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (bonus)

1. What animals are diagrammed as methane producers?  
**Sheep and cattle**
2. How thick was the glacier on top of Vancouver 16 000 years ago?  
**1.5 km**
3. What monster is said to inhabit Okanagan Lake?  
**Ogopogo**

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version. (10)

- \_\_\_ Hydroelectric reservoirs supply ~~50%~~ of B.C.’s electrical needs. **F, 90%**
- \_\_\_ Canada has about ~~4%~~ of the world’s population, but produces 2% of global CO<sub>2</sub> emissions. **F, 0.5% population**
- \_\_\_ The cost of fighting B.C.’s forest fires during the 1998 summer was \$120 million. **T**
- \_\_\_ The ~~1980’s~~ was the warmest decade of the last century. **F, 1990’s**
- \_\_\_ 9000 years ago, average temperatures in southern B.C. were 1 – 2 °C warmer than today. **T**
- \_\_\_ The 1948 Fraser River Flood cost an estimated ~~\$400~~-million. **F, \$200**
- \_\_\_ Mackerel may eat young salmon. **T**
- \_\_\_ On average, each person uses over ~~400~~ L of water at home every day. **F, 300**
- \_\_\_ Motor vehicle exhaust is the source of nearly 30% of the greenhouse gas emissions in the lower Fraser Valley. **T**
- \_\_\_ The atmosphere of Venus is ~~75%~~ CO<sub>2</sub>. **F, 98%**

**Is Climate Changing?**

1. How does weather differ from climate? (1)  
**Daily vs. extended conditions**
2. How do glaciers behave when climate changes? (1)  
**Expand when cools/shrink when warms**
3. By how much is the global temperature expected to rise above 1980 levels by the year 2100? (1)  
**~ 4.5 - 5°C**
4. Where does the global map indicate the most significant temperature changes will occur? (1)  
**The poles**

**Climate Has Always Changed:**

1. What kind of biodiversity would you expect to have inhabited the Vancouver area 16 000 years ago? (1)  
**Very little, it was covered with ice!**
2. Examine the global temperature change over 10 000 years. What seems to be the trend toward the year 2100? (1)  
**Warming**
3. When did the Little Ice Age occur? (1) **~1300 until late 1800's**
4. Do you think extrapolating the graph from 1998 shows a probable increase? Why or why not? (1)

**Why is Climate Changing Now?**

1. Record the following information on incoming solar radiation: (2)
  - 25%** absorbed by atmosphere
  - 25%** reflected by atmosphere
  - 47%** absorbed by Earth's surface
  - 3%** reflected by Earth's surface
2. Summarize the carbon balance diagram. (2)  
**Carbon transfers between the hydrosphere, lithosphere and atmosphere.**
3. What turning point saw additions of CO<sub>2</sub> to the atmosphere overtake removals? (1)  
**Industrial Revolution**

4. Aside from water vapour, what are “the big three” GHGs? (1)
  - a) **CO<sub>2</sub>**
  - b) **CH<sub>4</sub>**
  - c) **N<sub>2</sub>O**
  
5. What are the causes of the rapid build-up of CO<sub>2</sub> in our atmosphere? (1)  
**Human activities: burning fossil fuels, deforestation, agricultural practices.**
  
6. Examine the graph on atmospheric CO<sub>2</sub> concentrations.
  - a) How many ppm CO<sub>2</sub> are currently in our atmosphere? (1) **~360 ppm**
  
  - b) What is the projected concentration for the year 2050? (1) **~480 ppm**

**The Air We Breathe:**

1. What gets trapped in the Fraser Valley? (.5) **Smog**
  
2. What will happen to the number of “bad air” days as climate warms? (1)  
**Increase**

**Coastal Floods and Failing Ships:**

1. Wetter and stormier winters are predicted for coastal B.C. Predict what impact this might have on the skiing industry in B.C. (1)  
**Positive and negative impacts.**
  
2. Are slopes more or less at risk with wetter winters? Explain. (1)  
**More at risk, due to the reduced stability of the slopes.**

**Rising Seas:**

1. As climate warms, what will happen to glaciers? (1)  
**Melt → increased seawater**
  
2. What areas are most vulnerable to rising sea levels? (1)  
**Deltas, tidal marshes, low-lying coastal areas**
  
3. Answer the “?” regarding restricting development along shorelines. (1)  
**Opinion....restrictions might save property if sea levels rise.**
  
4. Explain what is meant by “coastal squeeze”. (1)  
**Loss of coastal land, and “squeeze” on developed cities and their dykes.**

**Salmon in Hot Water:**

1. Why might tuna and mackerel replace salmon stocks in southern B.C.? (1)  
**They live in warmer waters, while salmon are a cooler water fish.**

2. How might a reduction in salmon affect B.C.'s economy? (1)  
**Huge impact!**
3. Create a "human stress-o-meter" to temperature, similar to the one for salmon. (2)
- |                         |              |                         |
|-------------------------|--------------|-------------------------|
| <b>Air temperature:</b> | <b>↑45°C</b> | <b>Extreme stress</b>   |
|                         | <b>↑40°C</b> | <b>Very high stress</b> |
|                         | <b>↑35°C</b> | <b>High stress</b>      |
|                         | <b>↑30°C</b> | <b>Uncomfortable</b>    |
|                         | <b>↑25°C</b> | <b>Comfortable</b>      |
|                         | <b>↑20°C</b> | <b>Comfortable</b>      |

**Low-Water Blues:**

1. What industry will largely be affected by changes in river flow with climate warming?  
(1) **Hydroelectric power generation**
2. How much more water is used in an average home for showers than for baths? (1)  
**19% compared to 2%; ~10 times more**
3. What units are river flows reported in? (.5) **m<sup>3</sup>/s**
4. What date typically sees the Similkameen River's highest flow rate? (1)  
**~May 20**
5. Explain what is meant by "evapotranspiration". (1)  
**Evaporation from plant surfaces/leaves.**
6. As evapotranspiration increases, what happens to the summer water table? (1)  
**Decreases**

**Forests in Transition:**

1. Answer the "?" in the centre of this frame. (1)  
**They will suffer....poor growth, increased fire risks, etc.**
2. Approximately how far is Kamloops from Hope, B.C.? (1) **~100 km**
3. Which of these 2 regions (Kamloops/Hope) do you think will be more affected by climate warming, and why? (1)  
**Kamloops – grassland and scattered pine**  
**Hope - forest**  
**Opinion question....forest**
4. What impact will climate warming have on the B.C. forest industry and economy? (1)  
**Improved growth and yield? Loss due to increased fire?**

**Down on the Farm:**

1. Explain why the impacts of warming will have “mixed blessings” for the interior? (1)  
**Better growing conditions vs. increased drought**
2. How will climate warming affect impacts on crops by pests? (1)  
**It will increase the impact pests have.**
3. If you were a greenhouse owner, how would your expenses shift throughout the year from present day? (1)  
**Lowered winter heating costs; increased summer cooling costs.**
4. What do you think the overall impact will be to the average B.C. farmer’s income? (1)  
**Opinion...increased yields vs. impacts of drought**

**How Do We Measure Up?**

1. Rank the following regions by their per capita CO<sub>2</sub> emissions: (2)

Canada	<b>2</b>	Latin America	<b>6</b>	India	<b>9</b>
U.S.S.R.	<b>4</b>	China	<b>7</b>	Africa	<b>8</b>
Japan	<b>5</b>	Australia	<b>3</b>	U.S.	<b>1</b>
2. Approximately how many citizens of India have the same impact as one Canadian in CO<sub>2</sub> emissions? (1) **India ~0.25 tonnes/year**  
**Canada ~4.75 tonnes/year → ~19**
3. Out of individual household CO<sub>2</sub> emissions, what % does automobile use put out? (1) **45%**
4. What activities contribute to 75% of CO<sub>2</sub> emissions that are not individually produced? (1)  
**Transportation, electricity generation, fossil fuel production, agriculture, community and industrial waste, other industry.**

**Let’s Meet the Challenge:**

1. What did Margaret Mead say? (1)  
**“Never doubt that a small group of committed peoples can change the world. Indeed, it is the only thing that has.”**
2. What does she mean? (1)  
**Open...a small number of individuals in developed countries (on a global ratio) have impacted our world enormously.**
3. Generate a list from group members, outlining what we as individuals can do to help reduce our personal impact on climate change: (1)

***The Winds of Change:  
Climate Change in the Prairie Provinces***

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. When was most of Canada covered with ice?
2. What is the current land cover around Uranium City?
3. What landmark is seen in the picture of a city?

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version.

- \_\_\_ Nearly 40% of Albertans live in either Calgary or Edmonton.
- \_\_\_ Almost half of the population of Saskatchewan lives in rural areas.
- \_\_\_ About 10% of Regina relies on groundwater for its water supply.
- \_\_\_ There are more than 5000 glaciers in the eastern Rockies.
- \_\_\_ The 1980’s were the warmest decade of that century.
- \_\_\_ Most forest fires in Canada are caused by careless campers.
- \_\_\_ The hottest temperature ever recorded in Canada was 45 °C on July 5, 1997.
- \_\_\_ The most expensive weather-related disasters are tornadoes.
- \_\_\_ Every litre of gas used in your car produces about 5 kg of CO<sub>2</sub>.
- \_\_\_ The Calgary hailstorm of 1991 lasted for 15 minutes!

### **Climates Do Change:**

1. When was the last time most of Canada was covered with ice?
2. Examine the 3 graphs:
  - a) Graph 1: What does the graph depict climate to have been like in:
    1. 8000 BC?
    2. 4000 BC?
    3. The last 500 years?
  - b) Graph 2:
    1. What does the graph show for several hundred years before 1980?
    2. What happened to the Rockies during this period of time?
  - c) Graph 3:
    1. Describe what has happened to Earth's average temperature since 1980.
    2. What is the projected temperature rise for the year 2100?
    3. Do you think this is a realistic projection? Why or why not?
3. Examine the map showing projected summer temperatures for 2080 – 2100. By how much will temperatures in North America have increased from the 1975 – 1995 time period?
4. What might happen to temperatures south of Greenland and eastward off the Canadian Atlantic coastline?

### **Why is the Climate Changing Now?**

1. Record the following information on incoming solar radiation:

\_\_\_\_\_% absorbed by atmosphere  
 \_\_\_\_\_% reflected by atmosphere  
 \_\_\_\_\_% absorbed by Earth's surface  
 \_\_\_\_\_% reflected by Earth's surface



2. What are the 2 most important greenhouse gases? \_\_\_\_\_ & \_\_\_\_\_.
3. If there were no GHGs, what would not be possible on Earth?
4. Examine the graph showing atmospheric CO<sub>2</sub> concentrations, and describe what occurred after the Industrial Revolution.
5. What specific human activities are responsible for the rapid build-up of CO<sub>2</sub> in our atmosphere?
6. Summarize how the carbon cycle maintains balance on Earth by listing all factors involved in the capture and release of this element.
7. Where is most of Earth's carbon stored?
8. How many billion tonnes of carbon are stored in fossil fuels?
9. What are the "big three" GHGs we're concerned about?
  - a)
  - b)
  - c)

### **How Are Climates Changing in the Prairies?**

1. Despite the warming trend depicted in the Prairie temperature graph, what is also apparent on a year-to-year basis?
2. By how much has the yearly average temperature increased over the last 50 years?
3. What province is particularly susceptible to drought?
4. What will this mean to farmers there?

**Melting Glaciers:**

1. What will be affected by retreating glaciers?
2. Examining the graph for glacier-fed stream flow, when is the peak time for glacial melt runoff?
3. What fish may already have been impacted by a reduction in glacial-derived flows?

**Water Resources:**

1. Check off all of the following that **apply** to groundwater:
  - A good alternative source of water throughout the prairies
  - Provides an unlimited source of water
  - Is a renewable resource
  - Can become contaminated, and not safe for use
  - Is used for irrigation on the prairies
  - Provides many residences with all of their water needs
2. Examine the diagram showing Calgary. If you were to develop a management/conservation program for this city's water supply, what would you take into consideration?

**Changing Vegetation:**

1. Looking at the 2 maps of prairie vegetation, present and future, what is projected to happen to the percentage ground cover of:
  - a) Grasslands?
  - b) Aspen parkland?
  - c) Boreal forest?
  - d) Foothills forest?
  - e) Subarctic?

2. Write a short story describing what might happen to you if you were a tree in a prairie forest.

“Hi. I am \_\_\_\_\_.....”

3. Comment on the usefulness of satellite images for detecting forest fires.

**Rivers in Flux:**

1. Will all rivers be affected in the same way as climate warms?
2. Of the 4 types of rivers listed, which one will have an impact on Winnipeg, and how might we be affected?
3. Answer the following regarding the Red River Flood of 1997:
  - a) The cost?
  - b) Number of military personnel?
  - c) How many people evacuated?
  - d) What kind of protection saved most towns south of Winnipeg?
  - e) What did Morris, Manitoba look like?
  - f) How were members of your group affected by the flood?
4. Examine the graph.
  - a) How many years from the period 1892 – 1945 had flows over 2000 m<sup>3</sup>/s?
  - b) \_\_\_\_\_ from 1945 – 1999 had flows over 2000 m<sup>3</sup>/s? \_\_\_\_\_
  - c) Predict what a graph showing the next 50 years might show, explaining your prediction.

**Extreme Weather:**

1. What are the specific extreme weather events that cause death and destruction on the prairies?
  
2. Rank your list in question 1 above in order of the risks to the citizens of Winnipeg.
  
3. Examine the graph showing costs of weather-related disasters. How do the last 20 years appear different out of the last 70 depicted?
  
4. What do you think the effect of this trend will be on insurance rates/premiums?
  
5. Have you personally been affected by extreme weather? If so, how?

**How Do We Measure Up?**

1. From the graph, rank the following nations (1 – 9) according to their CO<sub>2</sub> emissions:

Canada	_____	U.K.	_____	India	_____
Russia	_____	China	_____	Italy	_____
Japan	_____	Germany	_____	U.S.	_____

2. How many citizens of India output CO<sub>2</sub> equivalent to a single Canadian? \_\_\_\_\_
  
3. What activity is responsible for the greatest output from individual residences?
  
4. What activities produce the 75% of GHGs not produced by residences?

**Life in the North:**

1. What animals are vulnerable to changes in sea ice, and why are the females particularly vulnerable?
  
2. What is permafrost?
  
3. What will be affected if the permafrost melts with a warming climate?

4. Examine the 2 prairie maps.
  - a) Currently, approximately what percentage of the prairies has some permafrost?
  - b) Approximately what percentage does the future map depict?

**Life in the Prairies:**

1. How might a person living in a prairie city be affected as climate warms?
  
2. How might a person living in a farming community be affected as climate warms?

**Let's Meet the Challenge:**

1. Pretend your group is the Federal department responsible for deciding what will be done on the prairies to address climate change issues. Make a list, from higher to lower priority, of what you will do to initiate changes (i.e. YOU decide the future).

**The Winds of Change:**  
**Climate Change in the Prairie Provinces**

Group Members: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (bonus)

1. When was most of Canada covered with ice?  
**At the peak of the last ice age ~16 000 years ago**
2. What is the current land cover around Uranium City?  
**Evergreen needleleaf forest**
3. What landmark is seen in the picture of a city?  
**Calgary tower**

**Did You Know?** Use the pieces of information under this heading (“Did You Know?”) on the poster to answer the following true/false (T or F) questions. If the statement is false, cross out the incorrect word or number value, and write in the correct version. (10)

- \_\_\_ Nearly 40% of Albertans live in either Calgary or Edmonton. **F, 60%**
- \_\_\_ Almost half of the population of Saskatchewan lives in rural areas. **T**
- \_\_\_ About 10% of Regina relies on groundwater for its water supply. **T**
- \_\_\_ There are more than ~~5000~~ glaciers in the eastern Rockies. **F, 1300**
- \_\_\_ The ~~1980's~~ were the warmest decade of that century. **F, 1990's**
- \_\_\_ Most forest fires in Canada are caused by ~~careless campers~~. **F, lightning strikes**
- \_\_\_ The hottest temperature ever recorded in Canada was 45 °C on July 5, ~~1997~~. **F, 1937**
- \_\_\_ The most expensive weather-related disasters are ~~tornadoes~~. **F, droughts**
- \_\_\_ Every litre of gas used in your car produces about ~~5 kg~~ of CO<sub>2</sub>. **F, 2.5 kg**
- \_\_\_ The Calgary hailstorm of 1991 lasted for ~~45~~ minutes! **F, 30!**

### **Climates Do Change:**

1. When was the last time most of Canada was covered with ice? (1)  
**At the peak of the last ice age, ~16 000 years ago.**
  
2. Examine the 3 graphs:
  - a) Graph 1: What does the graph depict climate to have been like in: (1.5)
    1. 8000 BC?  
**Temps ~ 4°C below average, and today**
    2. 4000 BC?  
**~ 2°C above average temps over the past 10 000 years**
    3. The last 500 years?  
**Little ice age – below average temps for the last 10 000 years**
  
  - b) Graph 2:
    1. What does the graph show for several hundred years before 1980? (.5)  
**Cooler than average temps – Little Ice Age**
  
    2. What happened to the Rockies during this period of time? (.5)  
**The glaciers expanded**
  
  - c) Graph 3:
    1. Describe what has happened to Earth's average temperature since 1980. (1)  
**It has risen considerably (~ 0.6°C)**
  
    2. What is the projected temperature rise for the year 2100? (.5)  
**Close to 5°C**
  
    3. Do you think this is a realistic projection? Why or why not? (.5)
  
3. Examine the map showing projected summer temperatures for 2080 – 2100. By how much will temperatures in North America have increased from the 1975 – 1995 time period? (1)  
**~ 3 - 5°C, depending on the location**
  
4. What might happen to temperatures south of Greenland and eastward off the Canadian Atlantic coastline? (1)  
**May drop up to 4 - 5°C**

### **Why is the Climate Changing Now?**

1. Record the following information on incoming solar radiation: (2)

**23%** absorbed by atmosphere  
**25%** reflected by atmosphere  
**46%** absorbed by Earth's surface  
**6%** reflected by Earth's surface

2. What are the 2 most important greenhouse gases? (.5) **H<sub>2</sub>O & CO<sub>2</sub>**
3. If there were no GHGs, what would not be possible on Earth? (1) **Life**
4. Examine the graph showing atmospheric CO<sub>2</sub> concentrations, and describe what occurred after the Industrial Revolution. (1)  
**Rise from ~280 ppm to >360 ppm by the year 2000**
5. What specific human activities are responsible for the rapid build-up of CO<sub>2</sub> in our atmosphere? (1)  
**Burning fossil fuels, deforestation, and agricultural practices.**
6. Summarize how the carbon cycle maintains balance on Earth by listing all factors involved in the capture and release of this element. (2)  
**Plants – photosynthesis, biota – respiration, deforestation, burning fossil fuels, atmosphere/lithosphere/hydrosphere transfers...**
7. Where is most of Earth's carbon stored? (1) **75 000 000 billion tonnes in ROCKS!**
8. How many billion tonnes of carbon are stored in fossil fuels? (.5) **5 000 billion**
9. What are the "big three" GHGs we're concerned about? (1)
  - a) **CO<sub>2</sub>**
  - b) **CH<sub>4</sub>**
  - c) **N<sub>2</sub>O**

### **How Are Climates Changing in the Prairies?**

1. Despite the warming trend depicted in the Prairie temperature graph, what is also apparent on a year-to-year basis? (1)  
**Fluctuations above and below average temperatures**
2. By how much has the yearly average temperature increased over the last 50 years?  
(1) **~ 1.2°C**
3. What province is particularly susceptible to drought? (.5) **Saskatchewan**
4. What will this mean to farmers there? (1)  
**Open...decreased yield, increased erosion, and increased irrigation...**

### **Melting Glaciers:**

1. What will be affected by retreating glaciers? (1)  
**Downstream water flows, wildlife habitats, hydroelectric production.**
2. Examining the graph for glacier-fed stream flow, when is the peak time for glacial melt runoff? (.5) **June / July**



3. What fish may already have been impacted by a reduction in glacial-derived flows?  
(.5) **Bull trout**

**Water Resources:**

1. Check off all of the following that **apply** to groundwater: (1)
- A good alternative source of water throughout the prairies
  - Provides an unlimited source of water
  - Is a renewable resource
  - Can become contaminated, and not safe for use
  - Is used for irrigation on the prairies
  - Provides many residences with all of their water needs
2. Examine the diagram showing Calgary. If you were to develop a management/conservation program for this city's water supply, what would you take into consideration? (1)  
**Glaciers/melt, population growth, increased evaporation...**

**Changing Vegetation:**

1. Looking at the 2 maps of prairie vegetation, present and future, what is projected to happen to the percentage ground cover of: (1.5)
- |                      |   |
|----------------------|---|
| a) Grasslands?       | <b>Increase by ~2x, extending northward</b>   |
| b) Aspen parkland?   | <b>Increase by ~2x, extending northward</b>   |
| c) Boreal forest?    | <b>Increase by ~2x, extending northward</b>   |
| d) Foothills forest? | <b>Not much change</b>                        |
| e) Subarctic?        | <b>Almost disappears (~1/7 original area)</b> |
2. Write a short story describing what might happen to you if you were a tree in a prairie forest. (1.5)
- “Hi. I am \_\_\_\_\_.....”
3. Comment on the usefulness of satellite images for detecting forest fires. (.5)  
**Extremely useful!**

**Rivers in Flux:**

1. Will all rivers be affected in the same way as climate warms? (1)  
**No. It depends on their location and source**
2. Of the 4 types of rivers listed, which one will have an impact on Winnipeg, and how might we be affected? (1)  
**Prairie-source rivers will experience lower, but more variable flows, and larger extreme flows.**

3. Answer the following regarding the Red River Flood of 1997: (2)
- The cost? **> \$800 million**
  - Number of military personnel? **7000**
  - How many people evacuated? **25 500**
  - What kind of protection saved most towns south of Winnipeg? **Ring-dikes**
  - What did Morris, Manitoba look like? **An island**
  - How were members of your group affected by the flood?
4. Examine the graph.
- How many years from the period 1892 – 1945 had flows over 2000 m<sup>3</sup>/s? (.5)  
**2**
  - How many years from 1945 – 1999 had flows over 2000 m<sup>3</sup>/s? (.5) **11**
  - Predict what a graph showing the next 50 years might show, explaining your prediction. (1)

### **Extreme Weather:**

- What are the specific extreme weather events that cause death and destruction on the prairies? (1)  
**Thunderstorms, tornadoes, hailstorms, heat waves.**
- Rank your list in question 1 above in order of the risks to the citizens of Winnipeg. (1) **Open.... Depending on criteria chosen - economic risk might put hailstorms first, while heat waves might cause more risk to lives.**
- Examine the graph showing costs of weather-related disasters. How do the last 20 years appear different out of the last 70 depicted? (1)  
**Much higher costs, and more frequent large costs.**
- What do you think the effect of this trend will be on insurance rates/premiums? (.5)  
**Up!**
- Have you personally been affected by extreme weather? If so, how? (.5)

### **How Do We Measure Up?**

- From the graph, rank the following nations (1 – 9) according to their CO<sub>2</sub> emissions: (2)

Canada	<b>2</b>	U.K.	<b>5</b>	India	<b>9</b>
Russia	<b>3</b>	China	<b>8</b>	Italy	<b>7</b>
Japan	<b>6</b>	Germany	<b>4</b>	U.S.	<b>1</b>

- How many citizens of India output CO<sub>2</sub> equivalent to a single Canadian? (1)

3. What activity is responsible for the greatest output from individual residences? (.5)  
**Transportation - 53%**
4. What activities produce the 75% of GHGs not produced by residences? (1)  
**Industry, agriculture, transportation, electricity generation, fossil fuel production, waste.**

**Life in the North:**

1. What animals are vulnerable to changes in sea ice, and why are the females particularly vulnerable? (1)  
**Polar bears. Females will have less time on the ice in spring to feed on seals.**
2. What is permafrost? (1)  
**Frozen ground that remains below 0°C all year.**
3. What will be affected if the permafrost melts with a warming climate? (1)  
**Infrastructure – buildings, railways, roadways, pipelines, etc.**
4. Examine the 2 prairie maps.
  - a) Currently, approximately what percentage of the prairies has some permafrost? (.5) ~**50%**
  - b) Approximately what percentage does the future map depict? (.5) ~ **5 – 10%**

**Life in the Prairies:**

1. How might a person living in a prairie city be affected as climate warms? (1)  
**More enjoyable temperatures, more severe weather events, decreased air quality, higher air-conditioning costs, lower heating costs, new insects/diseases, increased grocery prices...**
2. How might a person living in a farming community be affected as climate warms? (1)  
**Higher / lower yields, irrigation demands, crop type change, increased losses from severe weather...**

**Let's Meet the Challenge:**

1. Pretend your group is the Federal department responsible for deciding what will be done on the prairies to address climate change issues. Make a list, from higher to lower priority, of what you will do to initiate changes (i.e. YOU decide the future). (1)

***Taking the Chill Off:  
Climate Change in the Yukon & Northwest Territories***

Group Members: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following:

1. Describe the permafrost in the Whitehorse region.
2. Who took the picture of the polar bear on the poster?
3. What bird is depicted in the NRC icon?

**How Has Climate Changed?**

1. Examine the graph showing temperature change over the last 10 000 years.
  - a) How many times has the temperature been above average during this time?
  - b) Around what year in time did we see the longest period of above average temperatures?
2. In Inuvik, how were temperatures of the Little Ice Age collected/derived?
3. Describe the “Mean Annual Temperature” in Inuvik graph.

**Why Does the Climate Change?**

1. What 3 events can alter climate significantly?
  - 
  - 
  -

**What is the Greenhouse Effect?**

1. What 2 gases mentioned absorb heat energy in the atmosphere? Do you know of any others?
2. What activity contributes to extra CO<sub>2</sub> in our atmosphere?
3. What does the graph showing CO<sub>2</sub> concentrations display for the last 200 years?
4. What is the current day concentration (parts per million by volume) of CO<sub>2</sub> in our atmosphere?

**Permafrost and Climate Change:**

1. What might happen to the permafrost if climate warms?
2. How will people be affected by thawing permafrost?
3. Which of the 3 areas measured for summer thaw showed the most significant change in 1998?

**A Greener North:**

1. What will happen to the treeline with climate change?
2. What may happen to insect distribution as climate warms?
3. What new types of vegetative cover will be found in the Yukon and Northwest Territories as climate warms?

**A Tougher Life for Caribou?**

1. What insect might increasingly harass caribou with warmer temperatures?
2. What might happen to the reproduction rate of caribou if climate warms?
3. How might caribou changes have an impact on the people in the region?

**Fire and Ice:**

1. Will the risk of forest fires increase or decrease in the north with expected climate changes?
2. List 3 effects of excessive thawing of ice:
  - a)
  - b)
  - c)

**Rivers and Lakes:**

1. What tool/device was utilized to collect the pictures showing the Old Crow Flats in 1990 and 1994?
2. Which “group” of fish may not be able to adjust to warmer waters?

**Impacts of Climate Change in the Beaufort Sea Region:**

1. What specific types of communities are at significant risk with climate warming?
2. During what years did Tuktoyaktuk experience severe storms?
3. Examine the air photo taken of Tuktoyaktuk from 1947. What do the green and black lines show has happened over the last 50+ years?
4. What has been proposed, and somewhat implemented since 1976?

**Sea Ice and Marine Mammals:**

1. What phenomenon extended the melt season in 1997 – 1998?
2. What animal do polar bears heavily rely on for food?
3. Describe the general trend of ice concentration in the area over time, comparing the 30-Year Median graph to that of September 1998.
4. Why do seals suffer when ice melts quicker than usual?

**How Are N.W.T. and Yukon Responding to Climate Change?**

1. How many tonnes of CO<sub>2</sub> did Canada produce in 1995? Convert this to scientific notation.
2. Even though emissions from the region itself are small, do global emissions affect this region with larger impacts?
3. What are some alternatives to diesel fuel generators?
4. What can YOU do to reduce greenhouse gas emissions, save energy and money, OTHER THAN what is listed?!

**Taking the Chill Off:  
Climate Change in the Yukon & Northwest Territories**

Group Members: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Trivia Challenge:** Search the entire poster to find answers for the following: (3)

1. Describe the permafrost in the Whitehorse region. **Sporadic**
2. Who took the picture of the polar bear on the poster? **Ian Stirling**
3. What bird is depicted in the NRC icon? **Canada Goose**

**How Has Climate Changed?**

1. Examine the graph showing temperature change over the last 10 000 years.
  - a) How many times has the temperature been above average during this time? (1)  
**4 or 5**
  - b) Around what year in time did we see the longest period of above average temperatures? (1) ~ **4000 BC**
2. In Inuvik, how were temperatures of the Little Ice Age collected/derived? (1)  
**From tree rings (Dendrochronology)**
3. Describe the “Mean Annual Temperature in Inuvik” graph. (1)  
**Significant peaks and dips, with temperatures noticeably increasing since ~1975.**

**Why Does the Climate Change?**

1. What 3 events can alter climate significantly? (3)
  - **Changes in Earth’s position relative to the sun**
  - **Major volcanic eruptions**
  - **Changes in circulation and temperature of oceans (e.g. El Niño)**



### **What is the Greenhouse Effect?**

1. What 2 gases mentioned absorb heat energy in the atmosphere? Do you know of any others? (2)  
**CO<sub>2</sub> and water vapour**
2. What activity contributes to extra CO<sub>2</sub> in our atmosphere? (1)  
**Burning fossil fuels**
3. What does the graph showing CO<sub>2</sub> concentrations display for the last 200 years? (1)  
**Large increases!**
4. What is the current day concentration (parts per million by volume) of CO<sub>2</sub> in our atmosphere? (1)  
**360 ppm**

### **Permafrost and Climate Change:**

1. What might happen to the permafrost if climate warms? (1)  
**Melt/ become thinner/ perhaps disappear**
2. How will people be affected by thawing permafrost? (2)  
**Infrastructure, travel, etc.**
3. Which of the 3 areas measured for summer thaw showed the most significant change in 1998? (1) **Beaufort Coast**

### **A Greener North:**

1. What will happen to the treeline with climate change? (1)  
**It will shift northward**
2. What may happen to insect distribution as climate warms? (1)  
**Migrate northward, having a potentially adverse effect on plants and animals.**
3. What new types of vegetative cover will be found in the Yukon and Northwest Territories as climate warms? (2)  
**Temperate and grassland**

### **A Tougher Life for Caribou?**

1. What insect might increasingly harass caribou with warmer temperatures? (1)  
**Mosquito**
2. What might happen to the reproduction rate of caribou if climate warms? (1)  
**Decline due to decreased health, less feeding/nutrition.**

3. How might caribou changes have an impact on the people in the region? (1)  
**They rely on caribou for food, and also for the maintenance of traditional lifestyles. A breakdown of the traditional food supply will force adoption of other dietary sources (adverse health effects have already impacted this population as a result e.g. diabetes).**

**Fire and Ice:**

1. Will the risk of forest fires increase or decrease in the north with expected climate changes? (1) **Increase**
2. List 3 effects of excessive thawing of ice: (3)
  - a) **Deeper and larger landslides.**
  - b) **Increased sediment load along riverbanks, which could affect fisheries and destroy spawning beds.**
  - c) **Landslide dams created, affecting transportation routes.**

**Rivers and Lakes:**

1. What tool/device was utilized to collect the pictures showing the Old Crow Flats in 1990 and 1994? (1) **Satellite (imagery)**
2. Which “group” of fish may not be able to adjust to warmer waters? (1)  
**Cold water species such as Arctic Char.**

**Impacts of Climate Change in the Beaufort Sea Region:**

1. What specific types of communities are at significant risk with climate warming? (1)  
**Coastal**
2. During what years did Tuktoyaktuk experience severe storms? (1)  
**1944, 1970, 1993, 2000**
3. Examine the air photo taken of Tuktoyaktuk from 1947. What do the green and black lines show has happened over the last 50+ years? (2)  
**Significant loss of shoreline**
4. What has been proposed, and somewhat implemented since 1976? (1)  
**Shoreline protection measures**

**Sea Ice and Marine Mammals:**

1. What phenomenon extended the melt season in 1997 – 1998? (1) **El Niño**
2. What animal do polar bears heavily rely on for food? (1) **Seals**

3. Describe the general trend of ice concentration in the area over time, comparing the 30-Year Median graph to that of September 1998. (2)  
**Definitely decreasing!**
4. Why do seals suffer when ice melts quicker than usual? (2)  
**Mothers depend on stable ice for lairs, so that a successful 6-week nursing period can take place. If the ice melts, the seal pups are weaned prematurely, forcing them to fend for themselves at too young an age.**

**How Are N.W.T. and Yukon Responding to Climate Change?**

1. How many tonnes of CO<sub>2</sub> did Canada produce in 1995? Convert this to scientific notation. (2)     **619 000 000 tonnes = 6.19 x 10<sup>8</sup> tonnes**
2. Even though emissions from the region itself are small, do global emissions affect this region with larger impacts? (1) **Yes!!**
3. What are some alternatives to diesel fuel generators? (2)  
**Solar panels and walls, photovoltaics, waste heat recovery, wind turbines.**
4. What can YOU do to reduce greenhouse gas emissions, save energy and money, OTHER THAN what is listed?! (2)  
**Car pool, minimize air conditioner use, etc...**