Climate Change and the Arctic

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Learning Objectives

Students will...

- Examine their knowledge and beliefs about the topic of climate change in the Arctic.
- Identify patterns and trends in Arctic sea ice from maps and satellite imagery.
- Make predictions about the future extent of sea ice changes in the Arctic.
- Create illustrated haikus to represent their predictions for the future.

Time required

Two 60 – 90 minute periods

Suggested Grade level

Secondary (Grades 9-12)

Materials

- Map: Sea Ice Change in the Arctic
- Passage from *Polar Imperative* (Appendix A)
- Arctic Climate Change Timeline (Appendix B)
- Climate Change Continuum Activity Sheet (Appendix C)
- Satellite imagery
- Access to the internet to examine and explore:
  - NASA Earth Observatory: World of Change, Arctic Sea Ice http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice.php
    Image pairs show Arctic sea ice concentration for the month of September (left) and the following March (right) for a time series beginning in September 1999 and ending in March 2013.
  - National Snow and Ice Center: Satellite Observations of Arctic Change http://nsidc.org/soac/sea-ice.html#seaice
    The maps and bar graphs show how the Arctic Ocean sea ice cover for different years and months compares to averages from 1979 to 2012. The maps show spatial patterns of the differences (anomalies) of sea ice concentration for each year

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Introduction

Climate Change Continuum Activity (inspired by *Classroom Strategies for Interactive Learning, Anticipation Guides* in Buehl, 2014, pp.60-61)

Project the Climate Change Continuum Activity Sheet or provide copies as individual handouts. Students first complete the activity individually and then share their thinking with a partner or small group. As each statement is discussed, have students provide justification for their decision; ask them to talk about their thinking and share their insights and knowledge. Next, call-on students to contribute thoughts and information in a whole-class discussion.

Share the passage from *Polar Imperative* and the Arctic Climate Change Timeline with the class (read aloud, read it together, or ask students to read it individually). After students have completed the reading, have them return to the statements in the Climate Change Continuum Activity to determine how they have changed their thinking. With a partner or in a small group, have them locate the information from the text that supports or rejects each statement. Edit the activity sheet by rewriting any statement to make it consistent with the information from *Polar Imperative*.

Inform students that they are going to move from textual analysis of information to visual information about climate change in the Arctic. They will identify patterns and trends in Arctic sea ice extent from maps and satellite imagery and make predictions about the future extent of sea ice changes in the Arctic.

Development

Project the Sea Ice Change in the Arctic map for the class to examine. (If students have completed the introductory lesson in this resource package, they will already be familiar with the map.) Ask students to identify patterns and trends in sea ice change from the map. Explore satellite imagery from the same period of time from the NASA Earth Observatory and/or the National Snow and Ice Center and examine patterns and trends. Does the information correspond with the data on the map? Are there any discrepancies? What are the strengths/limitations of this type of information vs. textual information?

Based on this evidence, ask students to make predictions about the future extent of sea ice changes and the possible impact of climate change in the Arctic. Tell them that they will transform their prediction into an illustrated haiku to make a creative connection to their thinking.

Conclusion

Show students examples of the beautifully illustrated climate change haikus published by Gregory C. Johnson that represent the findings of the IPCC in 2013. Several haikus feature the Arctic environment. Briefly discuss the impact of these haikus compared to the scientific report of the same findings. Ask students to create their own illustrated haiku, using information from the lesson as their inspiration. (Project/distribute the Haiku template if required.) The haikus could be shared in a gallery at school or on a website.

and month.

- Climate Change haikus published by Gregory C. Johnson that represent the findings of the IPCC in 2013: https://www.wmo.int/youth/sites/default/files/field/media/library/full_ipcc_haiku_slides_opt.pdf
- Haiku template: http://www.readwritethink.org/files/resources/lesson_images/lesson1072/haiku_pattern.pdf

Set-up:

Read the passage from *Polar Imperative* to understand the context of this lesson in relation to the topic of Arctic sovereignty. Consult the Sea Ice Change in the Arctic Map, Timeline and the Glossary to equip yourself with the spatial relationships, facts and vocabulary used in the lesson. Make copies of the Climate Change Continuum Activity Sheet, *Polar Imperative* passage, Timeline and Haiku template as necessary. Preview the satellite imagery websites and the Climate Change haikus.

Optional: Many educators are finding the practice of 'front-loading' and 'flipped' teaching to be very effective as a way to make the most of class time together. This could be attempted with this lesson by making the passage from *Polar Imperative*, Map, Timeline and Glossary available to students before the lesson activities. They would be responsible for reading and reviewing the material and come to class ready to participate in activities and discussions.

Links to Canadian National Standards for Geography

Essential element 5: Environment and Society

- Global effects of human modification of the physical environment
- Global effects on the human environment by changes in the physical environment
- Environmental issues

Extend your geographic thinking

- Expedition Arctic (see the Collections gallery for more information about natural treasures of the Arctic to inspire haikus...)
  http://www.expeditionarctic.ca/site/les_collections-collection/
- National Film Board of Canada: Meltdown
  https://www.nfb.ca/film/meltdown
  In this short animation, a polar bear must try his luck finding a job in the big city when the last of his Arctic ice environment disappears. It's hard fitting into the human world, however, so this bear finds a more creative solution to his predicament.

Appendix A: Passage from *Polar Imperative*

The most distinguishing characteristic of the Arctic is its climate – fiercely cold in the winter and surprisingly temperate during summer. On occasion the Subarctic is subject to even colder temperatures as it lacks the warming effect of the Arctic Ocean. Contrary to what one might expect, snowfall is heavier in the Subarctic, with depths decreasing as one moves northward to the windswept High Arctic, where the sun sits closest to the horizon, never setting in summer and never rising in winter. The long daylight hours in spring and summer have a profound effect on the environment, bringing the energy needed to sustain animal and plant life without melting the frozen ground. In this manner, ice and snow have shaped the northern landscape, with changes occurring only in times of dramatic temperature change. The Great Ice Age and the Little Ice Age are two examples; the current warming trend is yet another (Grant, 2010, p.7).

From a historical perspective, major climate change frequently acted as a catalyst for shifts in authority or possession (of the Arctic). Not only did a warming trend initiate arrival of the first inhabitants of the Arctic and a cooling period led to their demise, but changes in temperature continued to influence commercial interest in the region's resources. With few exceptions, warming spells prompted stiffer competition, cooling periods a decline. The latest warming trend is again inciting increased competition because of easier access to the resources and lower shipping costs through the northern sea routes, rather than by way of the Panama or Suez Canal. As a result, there is growing support from European and Asian countries to have the Northwest Passage and Northern Sea Route declared international straits, as opposed to internal waters claimed by Canada and Russia (Grant, 2010, pp.398-399).

Former ICC president Sheila Watt-Cloutier has repeatedly warned that the warming trend experienced in the Arctic is akin to "a canary in a mine shaft," a harbinger of more dire consequences elsewhere in the world. The rationale for this statement rests in scientific evidence that the melting sea ice and especially the glacier ice on Greenland's icecap will eventually raise sea levels throughout the world; others are more cautious in their predictions. Although to date climate change has not had nearly the same negative effects on temperate regions, scientific climate modelling suggests that global warming will increase incrementally over the next century, possible with devastating consequences for the poorer developing countries. The debate still rages as to how high the temperature will rise globally and how soon.

The ecological balance of the Arctic is under threat, the most publicized concern being the polar bears' ability to adapt. A more imminent worry is the arrival of southern predators, such as killer whales now sighted in Foxe Basin, which pose a threat to existing marine life. Humpback whales have been observed far north of their normal habitat, in one instance in an area for future offshore oil rigs (Grant, 2010, pp.409-410).

Appendix B: Arctic Climate Change Timeline

55 million years ago	Peak warming trend when the Arctic Ocean was much hotter. Habitats of freshwater plants and animals existed due to the closure of the straits between Arctic waters and the Atlantic and Pacific Oceans. (p.26) Fossils found include prehistoric marine animals such as the champsosaur, titaaliks, and freshwater Asian turtle. (p.27)
800,000-450,000 years ago	Fossilized tree trunks have been found on Axel Heiberg Island dating back to this era. Ice core samples from Greenland show evidence of moths, butterflies, beetles and spiders, as well as the pollen and needles of spruce, pine and a species of yew.(p.27)
450,000 years ago	Temperatures fell low enough in the Arctic to create the ice cover that exists today. (p.26)
125,000 **years ago**	Last warming period, when the temperature was estimated to be only five degrees Celsius warmer than at present. Ice cover remained during this final warming period. (p.27)
80,000 to 20,000 years ago	A period of intense cold, known as the Great Ice Age, left a thick covering of glacial ice across much of what is now known as Canada and the northern U.S.
1275 to 1850	Little Ice Age sees a period of gradual cooling which affected growth of the North Atlantic pack ice as early as 1250 AD and, at minimum, cooling by 1850 AD.
1990s	Amid economic prosperity came the realization that the world might be encountering a sustained warming trend that could prove irreversible unless there was coordinated global action to mitigate unnatural causes. (p.406)
2000s	Warnings emerge from the scientific community about the unusual acceleration of Arctic temperatures, in part caused by release of increasing amounts of carbon dioxide and other greenhouse gases into the atmosphere. New discoveries of oil and gas, diamonds and minerals, coincide with a rapidly escalating warming of the Arctic climate and melting of the land and sea ice. (p.406) Yup'ik Eskimos on Alaska's west coast suffered severe erosion caused by flooding, the village of Newtok was abandoned and its 340 residents relocated to higher ground nine miles away. (p.409)
2008	Russian scientists were forced to request emergency evacuation from their research station on a drifting ice flow. Although they had used similar floes annually for over fifty years, this time their ice island had melted to a small fraction of its original size a full six weeks before their planned departure. (p.410)
2009	NASA satellite observations showed further decrease in permanent sea ice, with first-year ice amounting to 70% of the total compared to 40-50% in the 1980s and 1990s. Summer melt of first-year ice posed problems for shipping because the new open water has yet to be charted.

FROM: POLAR IMPERATIVE, BY SHELAGH GRANT

Appendix C: Climate Change Continuum Activity Sheet

Read the following statements about climate and climate change in the Arctic. Consider what you know or have heard about each statement. Mark your opinion with an X on the continuum based on how strongly you agree or disagree with each of the statements below.

A) Characteristics of the Arctic Climate:

It is fiercely cold in winter and summer.

Strongly Agree ---------- **Strongly Disagree**

Snowfall in the Arctic is heavy.

Strongly Agree ---------- **Strongly Disagree**

The Arctic experiences very little daylight, even in summer.

Strongly Agree ---------- **Strongly Disagree**

Historically, the northern landscape is known for its constant state of flux.

Strongly Agree ---------- **Strongly Disagree**

B) Contemporary Climate Change issues

The latest warming trend in the Arctic is creating increased competition for resources.

Strongly Agree ---------- **Strongly Disagree**

Melting sea ice from the Arctic will not impact human communities.

Strongly Agree ---------- **Strongly Disagree**

Killer whales in the Arctic pose a threat to marine life in the region.

Strongly Agree ---------- **Strongly Disagree**

Sea Ice Change in the Arctic