Teacher Guide
Climate Change and Arctic Ecosystems

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Activity Focus: Students analyze and interpret graphs and images involving climate change and the arctic ecosystem. Students create a brochure explaining arctic climate changes and how they can impact this system.

Major Concepts: Greenhouse gases (CO_2, methane, water vapor and nitrous oxides) may be increasing global warming. As a result of global warming, the arctic climate may be changing and affecting its ecosystem.

Objectives: After completing this activity, students will be able to:

- explain how greenhouse gases increase global warming which may create climate change
- define the arctic region
- explain the feedback loop of climate change and arctic sea ice
- compare temperatures and precipitation graphs of the arctic area and look for trends.
- explain differences in arctic sea ice area between 1979-2003 and correlate sea ice with polar bear populations.
- create a brochure explaining how arctic climate may be changing and affecting its ecosystem and how students can make an impact.

Materials and Preparation: You will need to prepare the following materials before conducting this activity.

- Copy the *Climate Change and Arctic Ecosystems* data interpretation and visualization activity (make 1 copy per student).
- Provide each student/group with 2 graph transparencies (cm^2 grid paper).
- Make a transparency or PowerPoint slide for each graph, map, and image.

Procedures: Students may work individually or as a group to complete the remaining aspects of the activity.

1. Introduce the activity by asking students to identify some of the factors that influence climates. How do these climatic factors affect the arctic region? Answer the "What I currently know and think" questions before starting the activity. You may want to discuss these as a class.

2. To complete the *Explore and Explain* portion of the activity, students will read some information about greenhouse gases and understand why the gases are of

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concern in climate change. Climate feedback loops are presented and questions follow. Figures 1 and 2 show temperature and precipitation for the arctic region. Students will need to look at the figures to try and understand the relationships between temperature and precipitation and climatic changes in the arctic.

3. For the *Extend* portion of the activity, two images are provided and the students need to figure out the percent of sea ice for 1979 and 2003. Teachers need to provide graph transparencies (2 for each individual/group) for the students to figure out the percents. Students will then predict when the sea ice will be completely gone. A video showing sea ice shrinking (http://video.google.com/videoplay?docid=3494554886799647252&q=arctic+sea+ice&total=77&start=0&num=10&so=0&type=search&plindex=2) will then be shown and students can compare answers to the video's prediction. Students will read about polar bears and their special adaptations for the arctic region. Students will figure out the percentage of population decrease for the Hudson Bay polar bear population. The relationship between polar sea ice and polar bear populations will be analyzed.
4. A brochure informing about arctic climate changes and the effect on the artic ecosystem will be made by the students. In the brochure, the students will have ways they can help protect this ecosystem. Teacher will need to provide paper for the brochures.

5. Have students reflect on their ideas by re-answering the engage questions writing their responses to the "What I now know and think" questions and have them reflect on their own thinking by completing the "how my ideas and thinking have changed" question. An extension of this activity would be *Project Wilds,* "Polar Bears in Phoenix?"

6. Collect student/group responses. Administer assessment item.

7. Optional Assessment- Have students read the following article on moose and wolf population in Isle Royale and then write a summary about climate change and Isle Royale ecosystem.
   www.admin.mtu.edu/urel/news/media_relations/544/

Assessments: The following assessments may be used as a pre/post activity assessment or as part of a module assessment.

- What is the arctic region?
- Why is the arctic region a special concern for climate change?
- What role does the sea ice play in arctic climates?
- What role does sea ice have in the polar bear's habitat?

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Quiz: The following quiz may be used as a post activity assessment.

How does global warming affect sea ice?

How does global warming affect the arctic region's climate?

What has happened to the sea ice since 1979?

A. Staying the same
B. Increasing
C. Decreasing
D. Increasing and decreasing in different areas.

The polar bear populations for the arctic region are:

A. Staying the same
B. Increasing
C. Decreasing
D. Increasing and decreasing in different areas.

Polar bear are dependent on what food source:_____

Bibliography

Greenhouse Gases
http://epa.gov/climatechange/kids/change.html

Climate Changes
http://www.ncdc.noaa.gov/oa/climate/research/2006/ann/ann06.html

Impacts of a Warming Arctic, Susan Joy Hassol
Cambridge University Press, 2004.

Arctic Temperature Graph
http://www.realclimate.org/index.php/archives/2005/01/senator-inhofe/

Sea Ice Images 1979 and 2003
http://earthobservatory.nasa.gov/Newsroom/NewImages/Images/Arctic

North Hemisphere Sea Ice Graph
http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.anom.jpg

Sea Ice Thickness
http://www.globalwarmingart.com/wiki/Image:Sea-ice_1950s-2050s_gif

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Polar bear adaptations
http://alaska.fws.gov/fisheries/mmm/polarbear/pdf/Polar_Bear_%20Status_Assessment.pdf

Project Wild, 1992, Council for Environmental Education

Polar bears in Hudson Bay
http://www.panda.org/about_wwf/where_we_work/europe/what_we_do/arctic/polar_bear/news/index.cfm?uNewsID=63980

Graph Paper
http://www.cdps.k12.ms.us/teacher_tools/math/1cmgrph.doc

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Appendix:

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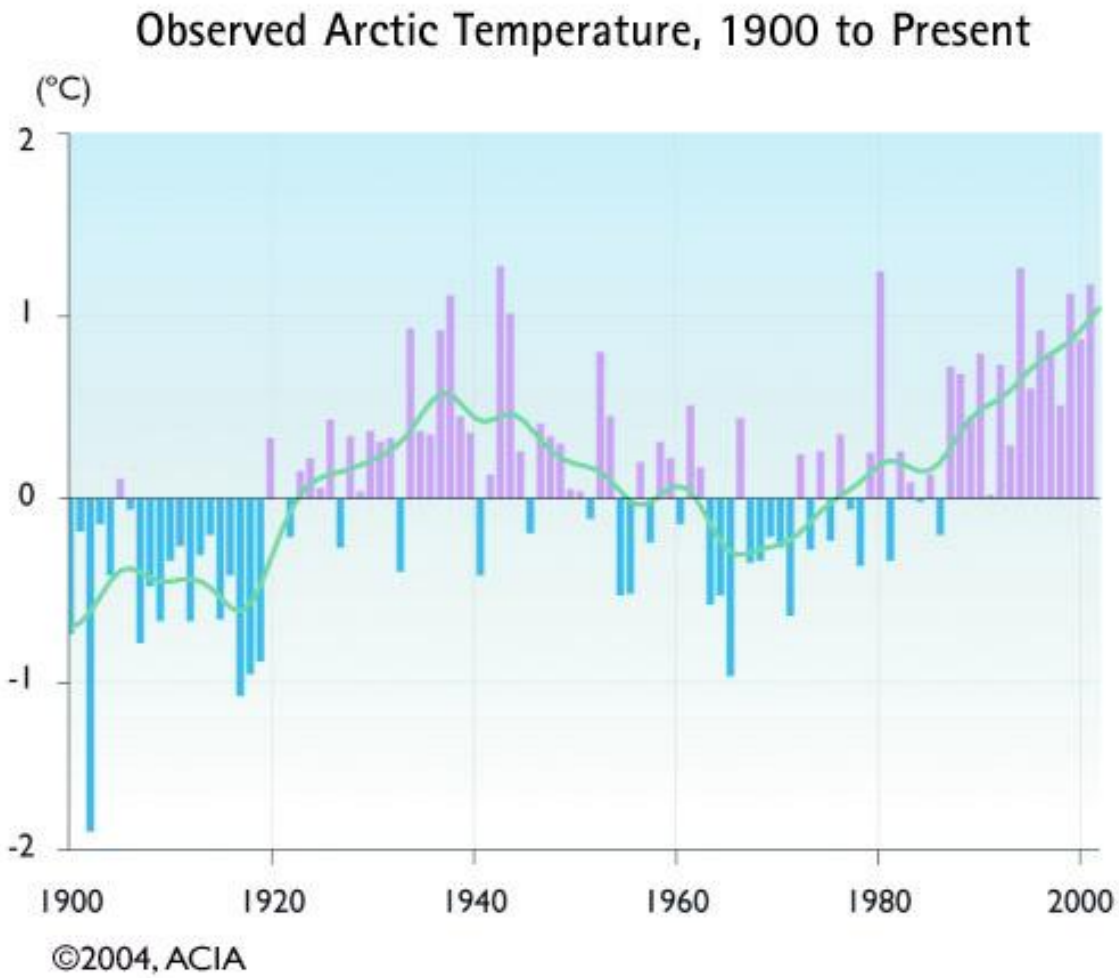

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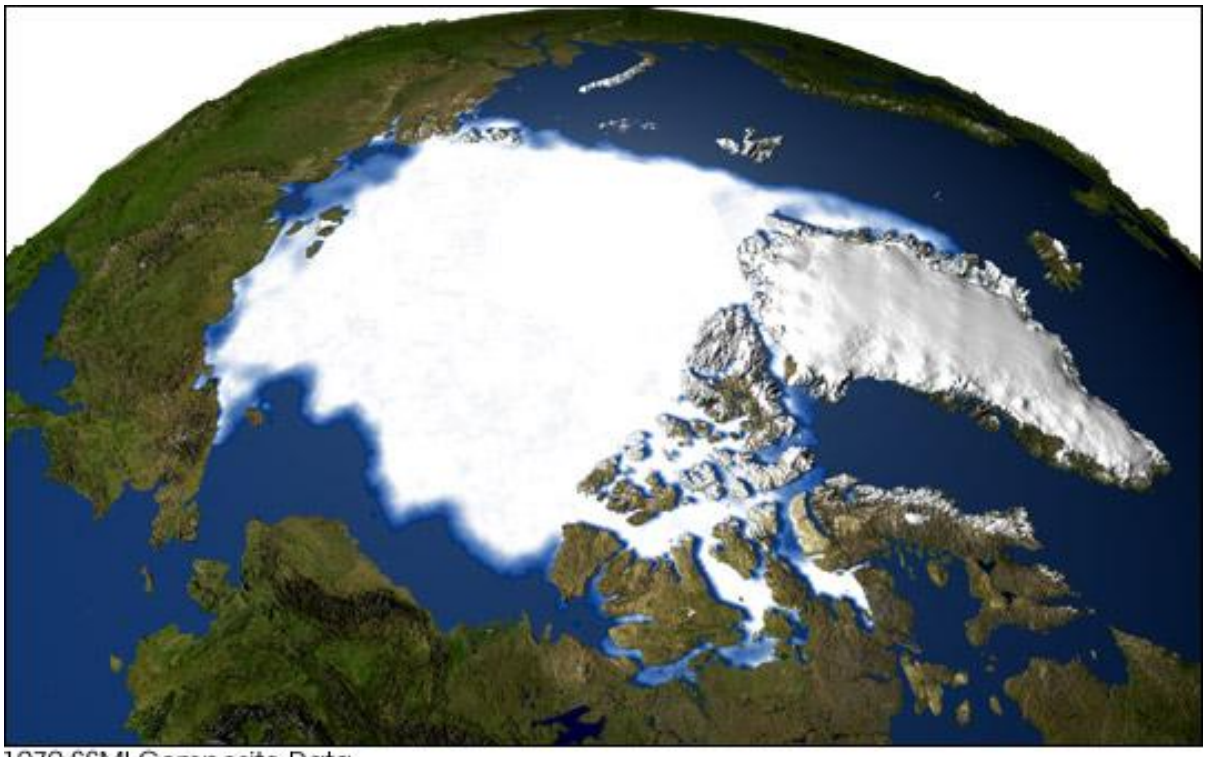
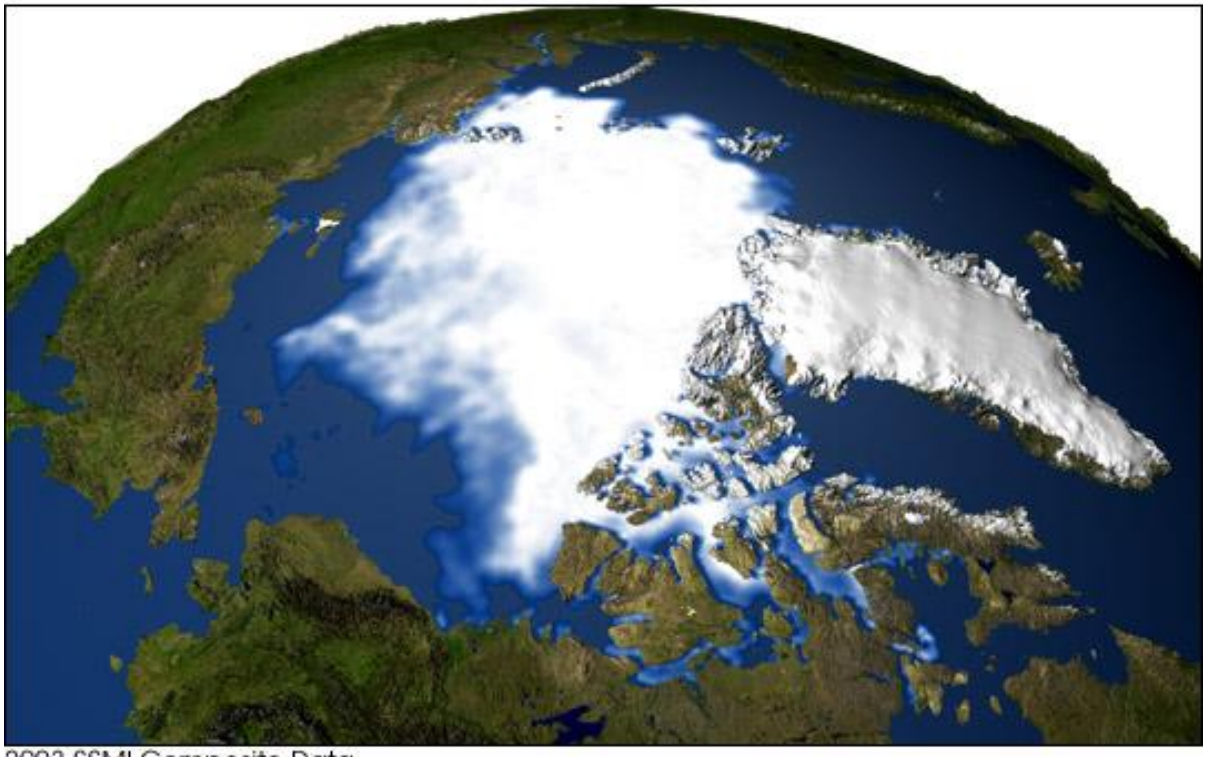


1979 SSMI Composite Data



2003 SSMI Composite Data

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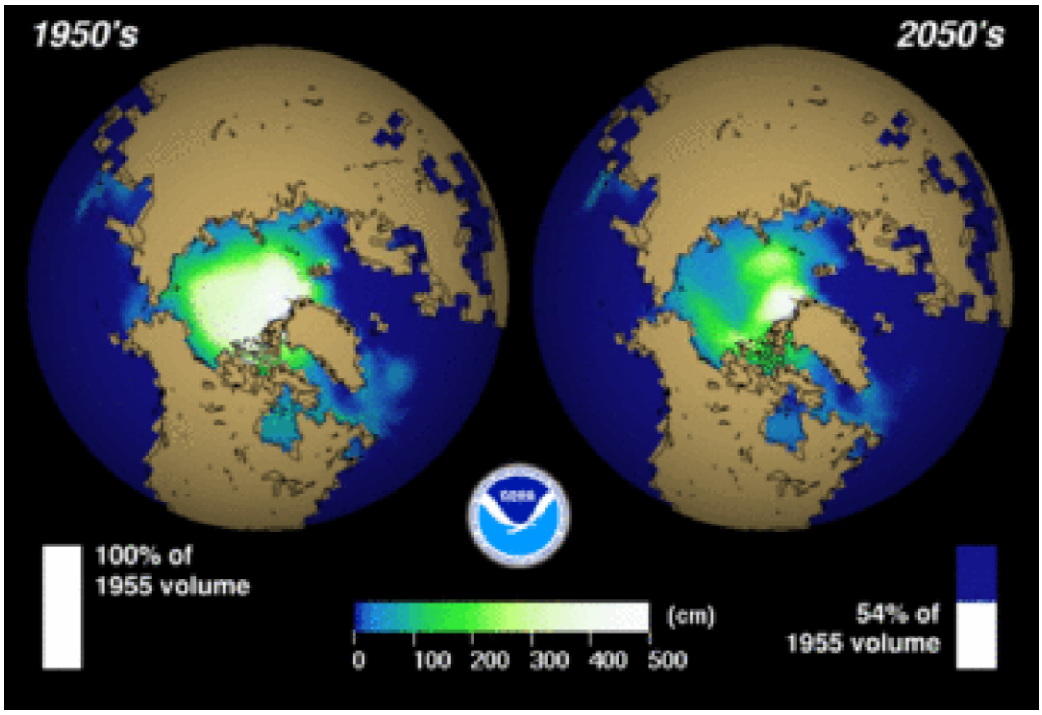

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Population	**Number** (Year of most recent estimate)	**Status**	**Current Trend**	**Estimated risk of decline** (Next 10 years)
S Beaufort Sea **SB**	1500 (2006)	Reduced	Declining	No estimate
N Beaufort Sea **NB**	1200 (1986)	Not reduced	Stable	No estimate
Viscount Melville **VB**	215 (1996)	Severely reduced	Increasing	Very low
Lancaster Sound **LS**	2541 (1998)	Not reduced	Stable	Higher
McClintock Channel **MC**	284 (2000)	Severely reduced	Increased	Very low
Gulf of Boothia **GB**	1523 (2000)	Not reduced	Stable	Lower
Foxe Basin **FB**	2300 (2004)	Not reduced	Stable	Lower
W Hudson Bay **WH**	935 (2004)	Reduced	Declining	Very High
S Hudson Bay **SH**	1000 (1988)	Not reduced	Stable	Lower*
Davis Strait **DS**	1650 (2004)	Data deficient	Data deficient	Lower
Baffin Bay **BB**	1546 (2004)	Reduced	Declining	Very High
Norwegian Bay **NW**	190 (1998)	Not reduced	Declining	Higher
Kane Basin **KB**	164 (1998)	Reduced	Declining	Very High
Chukchi Sea	2000 (1993)	Data deficient	Data deficient	No Estimate
Laptev Sea	800-1200 (1993)	Data deficient	Data deficient	No Estimate
East Greenland	unknown	Data deficient	Data deficient	No Estimate
Barents Sea	2997 (2004)	Data deficient	Data deficient	No Estimate
Kara Sea	unknown	Data deficient	Data deficient	No Estimate

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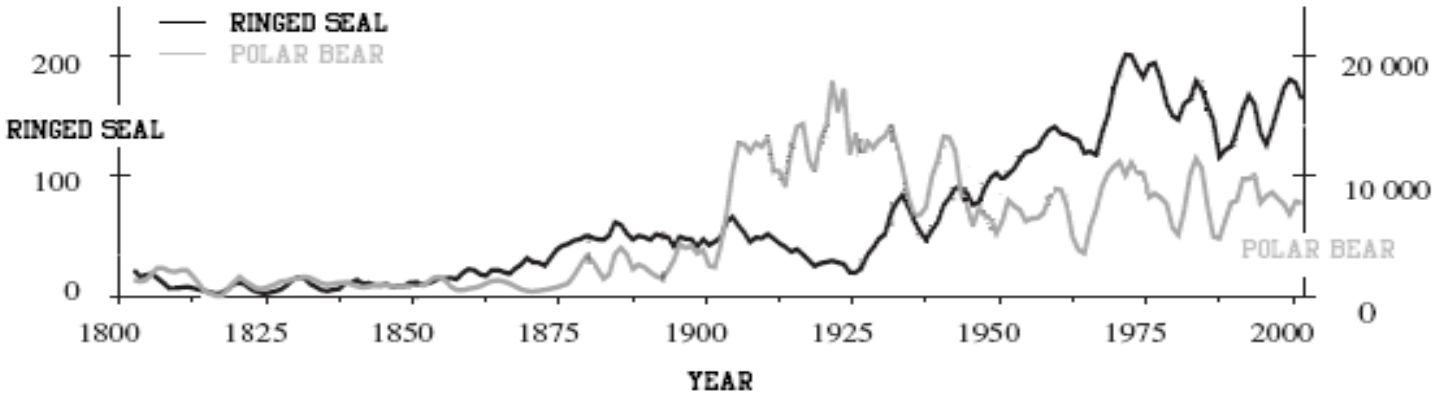

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