



Lesson Plan

Polar Bears & Ice



In a Nutshell:

Through discussion, reading, and activities, students learn about the Arctic food chain, polar bears, and the devastating impact that the melting ice will have on them. Using what they have learned, they take action – writing a letter to a local political representative explaining what they have learned and requesting positive action.



Goal:

To give students a proper scientific understanding of the threat that global warming poses to polar bears, and everyone who lives in the Arctic.



Background Learning:

Teachers should be familiar with the basic science of climate change and its anticipated impacts as reviewed in:

- High School Backgrounder #1: Climate Change: What's the Big Deal?
- High School Backgrounder #2: The Greenhouse Effect

If this is the only lesson you are doing on climate change, **students** should read:

- High School Backgrounder #1: Climate Change: What's the Big Deal?

Grade Level: Grades 6–2

Subjects: Social Studies, Sciences, Geography, Northern Studies, English Language Arts, Inuuqatigiit

Enrichment: Visual arts, Sciences, Mathematics, English Language Arts, Geography, Inuuqatigiit

Time: Two hours

Setting: Classroom

Materials: Map of the Arctic (optional – see Introduction to Lesson Plan for sources), poster or chart paper for drawing food chain diagrams, Teacher Handout: Arctic Questions, copies of three student handouts

Skills: Analysis, discussion, small group work, problem solving, inference, predicting, concept development

Key Vocabulary: Food chain, global warming



Learning Outcomes:

Visit the website and click on the icon for your territory to review the learning outcomes that are addressed by this lesson.



Nunavut



NWT



Yukon



Introduction to Lesson Plan:

This lesson helps students to grasp the consequences of melting Arctic ice, particularly for polar bears. The students work their way through a series of three student handouts, each followed by discussion. This lesson should be extended over two classroom periods to allow enough time for reading, discussion and activities. Before the lesson, you will need to print out copies of the handouts, and a copy of the Arctic Ocean Map (<http://maps.grida.no/arctic/> or <http://www.worldatlas.com/webimage/countrys/polar/arctic.htm>)



Activity:

- 1. Step 1: The Arctic Ocean** (Use Teacher Handout: Arctic Questions (Step 1)) – Introduce basic concepts of the world’s Arctic region (location, size, peoples and animals that live there, weather, etc.). You may want to select some question from Step 1 of the Teacher Handout: Arctic Questions, located in the Handout section. It may also be useful to download and print a map of the Arctic. (<http://maps.grida.no/arctic/> <http://www.worldatlas.com/webimage/countrys/polar/arctic.htm>)
- 2. Step 2: The Arctic Marine Food Chain** (Use Teacher Handout: Arctic Questions, Step 2), Student Handout: The Arctic Marine Food Chain) – Introduce the Arctic marine food chain. (See some questions in Teacher Handout: Arctic Questions, Step 2). Ask the students to form small groups (two to four students). Give each group a copy of Student





Handout: The Arctic Marine Food Chain. Ask them to read it and follow the activity instructions at the bottom. (Assure them that artistic details don't matter; the drawing just needs to show that they have the main idea of a food chain.) At the end of five minutes, ask each group to post their food chain diagrams on the wall.

3. Step 3: The Life of the Polar Bear (Use Student Handout: The Life of a Polar Bear) – Ask: What do we know about the polar bear? Pass around copies of Student Handout: The Life of a Polar Bear (one for each student). Ask each of the groups to read the sheet (or have students take turns reading to the whole class), and then create three questions, as outlined on the bottom of the sheet. When the groups have finished, go through each in turn, allowing them to pose one question to the class. Make sure the students understand the annual rhythms of the polar bears, both on and off the ice, and how they have very little food to eat once they leave the ice.

4. Step 4: The Melting Arctic Ice (Use Teacher Handout: Arctic Questions, Step 4), Student Handout: The Melting Arctic Ice) – Give each student a copy of the Student Handout: The Melting Arctic Ice. Either have all students read the whole handout, or assign each group a different section of the handout to read and teach to the class (Sections: The Melting of the Arctic Summer Sea Ice Width (Extent)/ The Melting of the Arctic Summer Sea Ice Depth (Thickness)/ The Impact on the Polar Bears). When students have finished their reading, lead a discussion on the handout. (See suggested questions in the Teacher Handout: Arctic Questions, Step 4.)

5. Step 5: Reflection and Action – To help your students deal with their responses to this data, give them time to express their feelings. Ask your students to spend one minute thinking about what they have learned. Invite them to share their thoughts or feelings with the rest of the class, then to write a short letter to a political representative, which they can also post on the student web-exchange, asking them what steps they are taking to save the polar bear, to slow the melting ice, and to stop global climate change:



- Prime Minister of Canada, Langevin Block, 80 Wellington St, Ottawa, Ontario K1A
- Premier of Nunavut, PO Box 2410 Iqaluit, Nunavut X0A 0H0
- Premier of Yukon, Box 2703, Whitehorse, Yukon Y1A 2C6
- Premier of North West Territories, PO Box 1320, Yellowknife, NT X1A 2L9



Handouts:

Visit the website and click on the icon for the complete set of handouts that support this lesson:

- Teacher Handout: Arctic Questions
- Student Handout: The Arctic Marine Food Chain
- Student Handout: The Life of the Polar Bear
- Student Handout: The Melting Arctic Ice



Student Web-Exchange:

Post the letters to politicians. For other posting options, see Enrichment Ideas. Visit the website and click on the icon for information on how to post material.



Evaluation:

Ask each student to write down the five most important things they learnt during the class, and to share them with the class. As repetitions begin, ask students to share anything that has not been already mentioned.



Enrichment Ideas:

Visual Arts, Biology

Marine Food Chain: Research and draw a poster on the Arctic marine food chain. Include information about what each animal needs, and how the climate chain may affect the food chain.



More Information:

Arctic Species:
<http://collections.ic.gc.ca/arctic/species/species.htm>

Polar Bears, Shrinking Ice:
<http://collections.ic.gc.ca/arctic/species/polarbea.htm>

Arctic is Warming Eight times faster:
www.cananet.au/canarycalls/issue5.html

Climate Change and the Melting Arctic Sea Ice (Greenpeace Report, 1999)
<http://archive.greenpeace.org/climate/arctic99/reports/sealce3.html>

Dramatic thinning of the sea-ice:
www.tmgnow.com/repository/global/ice_thinning.htm Also
www.agu.org/sci_soc/prll/prll9935.html

International Association for Bear Research and Management:
<http://bearbiology.org>

Photographs:
www.arctic.noaa.gov/gallery_polarbear.html &
www.polarbearsalive.org/gallery.php

Polar Bears International:
www.polarbearsalive.org



Mathematics

Graphing the Ice: Create three graphs, showing the trend of the melting ice according to the data in the Student Handout #3: The Melting Arctic Ice. Extend the graphs forward into the future, to see when the sea-ice disappears.

English Language Arts

Creating Student Links: Write a letter to other northern students, sharing thoughts, ideas, and concerns. (If you live in Arctic, you might have first-hand experiences to share, too). Post this letter on the Student Web Exchange.

Biology

Phytoplankton (for students in Arctic ocean communities): Gather phytoplankton and zooplankton from the ocean, and examine them under a microscope. Research the conditions required by phytoplankton and zooplankton, and where they fit into the Arctic food chain. Discuss how climate change may affect their survival.

Inuuqatigiit, Geography, Science

Gathering Local Knowledge: Form pairs, and arrange to talk to your elders after school about the sea-ice, and what they remember from the past. What are their experiences with polar bears? How does the melting ice affect their traditional hunting? Take notes, so that you can share their experiences with your schoolmates.

English Language Arts

A Future Without Polar Bears: Write a letter to your future grandchildren, telling them what you think and feel about living in a world that may not have any more polar bears. Send it to the local paper to see if they will publish it.



More Information (continued):

Polar Bears Adventure Learning Program:
www.polarbearsalive.org/story031505_1.php

Polar Sea Ice Could be Gone by End of Century:
www.commondreams.org/headlines03/0310-07.htm

Population Status Review with map and survey data:
<http://pbsg.npolar.no/pop-maps.htm>

Polar bear denning maps:
www.absc.usgs.gov/research/programs/mammals.htm/polar

Recently Warming of Arctic (2003) (Multi-media story):
www.gsfc.nasa.gov/topstory/2003/1023esuice.html#addinfo

Sea Ice Chart, 1900–2000:
www.arctic.noaa.gov/images/ice_extent.gif

The Shrinking Polar Bears:
www.tv.cbc.ca/national/pgminfo/warming/bears.html

What has been happening to polar bears in recent decades?:
www.arctic.noaa.gov/essay_schliebe.html



About the Author:

My name is Guy Dauncey. I live with my wife and various animals on a small organic plant nursery, just outside Victoria, on Vancouver Island.

I work as an author and consultant in the fields of global climate change, sustainable energy policy, green buildings, and green communities. I am author of the book *Stormy Weather: 101 Solutions to Global Climate Change* (New Society Publishers, 2001, \$27.95), and a frequent public speaker and workshop leader.

In 2001, I helped draft the Whitehorse Declaration on Northern Climate Change at the Circumpolar Climate Change Summit. I have yet to travel north of Whitehorse, but I have been following the impact of global climate change on the Arctic for many years, with growing concern.

My website is www.earthfuture.com.





Teacher Handout

Arctic Questions

Step 1: The Arctic Ocean

First, what do we know about the Arctic Ocean?

- *Where is it?*
- *How big is it?* (13 million square kilometres)
- *What does most of it consist of?* (Water and ice)
- For sub-Arctic residents: *Who has seen the Arctic Ocean?*
- *What is the North Pole?* (The geographical north pole is the top of the Earth's axis, around which the stars appear to revolve. The magnetic north pole is the northern end of the Earth's magnetic field)
- *How many countries border the Arctic?* (Eight – Canada, USA, Russia, Finland, Norway, Sweden, Iceland, Greenland)

Weather

- *What is the weather like in the Arctic?* (As warm as +18°C in summer, down to –56°C in winter).
- *How many hours of sunshine are there in the Arctic summer?* (Up to 24 hours)
- *How many hours of sunshine are there in the Arctic winter?* (As few as 0 hours)
- *What happens to the sea during the winter?* (It freezes up from shore to shore)
- *What happens to the sea during the summer?* (The ice melts in more southern areas)



Step 2: The Arctic Marine Food Chain

- *How many creatures can you name, that live in or on the Arctic ocean?* (Polar bears, musk ox, caribou, Arctic hares, Arctic fox, gulls, loons, terns, geese, seaducks, shorebirds, ringed seals, walrus, sea lions, beluga whales, bowhead whale, humpback whale, sperm whale, killer whale, narwhals, Arctic cod, char, salmon, capelin, herring, halibut, shellfish, crustaceans, zooplankton, copepods, amphipods, and krill, phytoplankton, diatoms, blue-green algae.) See <http://collections.ic.gc.ca/arctic/species/species.htm>
- *What is a food chain?* (Who eats who – e.g. bears eat big fish, big fish eat small fish, small fish eat small ocean creatures called zooplankton; zooplankton eat small ocean organisms called phytoplankton; phytoplankton eat algae; algae live off energy from the sun, the water, and nutrients in the water.)
- *Why is the Arctic food chain so fragile?* (If one link, such as the Arctic Char, goes extinct, the whole food chain can collapse, because there aren't so many replacement foods as in more temperate climates.)
- *What is the biggest animal in the Arctic, at the top of the food chain?* (Polar bear)
- *What is the smallest creature, or organism, at the bottom of the food chain?* (Algae)

Step 4: The Melting Arctic Ice

- *Why is the ice melting?* (Global warming is causing Arctic temperatures to rise very rapidly)
- *Can you describe the difference between the ice extent and the ice thickness?* (Width versus depth)
- *Which is melting the fastest – the extent, or the thickness of the ice?* (The thickness – it has lost 40% of its thickness over the past 30 years)
- *What do scientists think will happen to the summer ice, if the melting continues?* (It could melt away entirely by 2030–2050)
- *What do scientists think will happen to the year-round ice, if the melting continues?* (It could melt away entirely by 2100)
- *How old will you be when the summer ice disappears entirely?* (A 15-year old in 2005 will be 40–60 years old in 2030–2050)
- *When the sea-ice melts, does it raise the level of the sea?* (No)
- *How old will you be when the year-round ice disappears entirely, if global warming continues to increase?* (A 15-year old in 2005 will be 110 years old in 2110)
- *How old will your children be?* (Maybe 70 years old)
- *How many kilograms does a polar bear lose in weight, for each week earlier that the ice melts in the spring?* (10 kg)



- *What do the polar bears do, if there is no ice?* (Hang out on the land, and become hungry)
- *What will happen to the ringed seals, if there is no ice?* (They will find it really hard to raise their young in safety)
- *What will happen to the diatoms and algae, if there is no ice?* (They will be unable to grow, and will lose most of their populations)
- *What will happen to the Arctic marine food chain, if there is no ice?* (It will undergo an enormous shake-up, as some species disappear and new species move into the warmer waters)
- *How do you think the melting ice is affecting people in Inuit communities, who live next to the ocean?* (It is changing their hunting habits. There is more fishing from boats, less hunting from the ice, and less opportunity for snowmobiles to travel over the ice and snow - on both land and water)
- For Inuit communities: *How is the melting ice affecting you?*
- *Why is the warming of the Arctic happening?* (Because of global climate change, which is happening because our enormous planetary use of fossil fuels is releasing unprecedented quantities of carbon into the atmosphere, creating carbon dioxide, which traps the sun's heat.)



Student Handout

Student Handout #1

The Arctic Marine Food Chain

A food chain shows how living things need each other for food. A green plant is usually found at the bottom of a food chain. The plant uses energy from the sun to carry on a process called photosynthesis. This allows the plant to produce its own food. This plant is called a producer. The producer is eaten by an animal, which in turn is eaten by another animal.

Since most animals eat more than one type of food, they might be able to feed from more than one food chain. However, in the Arctic food system, there aren't a lot of different species that can be substituted.

Polar bears
(at the top of the food chain)

eat

Ringed seals, walrus, sea lions, beluga whales, and narwhals

which eat

Arctic cod, char, salmon, capelin, herring, and halibut

which eat

Small fish, shellfish, crustaceans and other invertebrates

which eat

Zooplankton, small crustaceans, copepods, amphipods, and krill

which eat

Phytoplankton

which eat

blue-green algae

which absorb

Icy water, sunlight and ocean nutrients
(at the bottom of the food chain)



5-Minute Arctic Food Chain Activity

1. Look at this food chain.
What is the biggest animal in the Arctic, at the top of the food chain?
What is the smallest organism (the producer) at the bottom of the food chain?
2. Using the poster paper given to you by your teacher, quickly draw a picture or diagram of this food chain. You probably don't know what all of these animals look like. Don't worry! Just do your best to give a sense of how the Arctic food chain works.



Student Handout

Student Handout #2

The Life of a Polar Bear

Read this information carefully. When you have finished reading, you will be asked (along with the rest of your group) to make up three questions to test how well the rest of your class understands the life of a polar bear. Keep this in mind as you go through the information.

Where do polar bears live?

Polar bears range throughout the circumpolar north, where they hunt seals at open leads in the Arctic sea-ice. Scientists estimate that there are about 22,000 bears in the Arctic. They live on Wrangel Island and in western Alaska, along the Alaska coast, in Canada's Beaufort Sea, in James Bay and Hudson Bay, among Canada's many Arctic islands, in Greenland, in Russia's Spitzbergen-Franz Josef Land, and along the coast of Siberia. Sixty percent of the world's polar bears live in Canada. There are no polar bears in the Antarctic – just penguins. There are no penguins in the Arctic.

How big are polar bears?

The largest adult male polar bears can grow up to three metres tall, and weigh up to 770 kilograms. Their average weight is 350–650 kg.

The largest adult female polar bears can grow up to two and a half metres tall, and weigh up to 320 kilograms. Their average weight is 150-250 kg.

How do polar bears keep warm?

Polar bears have adapted to survive in the Arctic, where winter temperatures can plunge to -45°C . Two layers of fur and a layer of blubber up to 11.5 cm thick provide such good insulation that they experience almost no heat loss. They have more problems with overheating than with cold, and they quickly overheat when they try to run. They live for 15 to 18 years.

What do polar bears eat?

The bear's favourite hunting ground is on the Arctic sea-ice, where they hunt for ringed seals and bearded seals, (and sometimes for walrus) throughout the long dark winter. They capture the seals by lying in wait by one of their breathing holes. When the seal rises for air, the bear yanks it from the water.



What do polar bears do in the spring?

The bears eat most of their year's food between late April and mid-July, when the ringed seal pups are abundant. They stalk the seals when they're basking on the ice, crawling slowly forward when a seal is sleeping, and pouncing when it is about 20 feet away, before it can escape back into the sea. They also crash through the snow dens where the ringed seals raise their young and eat the pups. During this time, studies in the Hudson Bay area show that they increase their body-weight by 10 kg a week. They need all the food they can get to keep their bodies warm in the year ahead, and to ensure success in having cubs.

What do polar bears do in the summer?

In July, when the ice melts, they retreat to the land. Since global warming is raising the temperature in the Arctic, the sea-ice is melting earlier. With each week earlier that it melts, the bears have less chance to feed, and come ashore 10 kg lighter. During the summer they mostly go without food, surviving on a diet of eat birds, bird eggs, kelp, and even beached whales. In areas of the Arctic where the ice is not melting so fast (Ellesmere Island, northern Greenland), the bears will remain on the ice all summer long.

What do polar bears do in the fall and winter?

In the fall, the rising temperatures affect them again. The longer the delay before the sea ice returns, the hungrier polar bears become. Biologists believe that starvation is the leading cause of death for subadult bears. As soon as the ice returns, they start hunting again and spend the whole winter out on the ice. Polar bears have been known to swim more than 60 miles without rest, in search of food. They are skilled divers, with excellent underwater vision. Where there is an abundance of ice and seals, they have a smaller range.

When do polar bears have their cubs?

A female bear usually has two cubs. After feeding heavily in August and September, she digs a den in a snowdrift along a mountain slope. The cubs are born in November or December. They are blind, toothless, and covered with short, soft fur. They grow rapidly, thanks to all the calories in their mother's milk, which has a fat content of roughly 31%. They remain in the den until March or April, when they come out to hunt on the ice. The cubs generally stay with their mother until they are two and a half years old. Six out of ten cubs die in their first year, as a result of starvation, predation or accidents.

The polar bear is threatened not only by global warming, but also by hunting and by the accumulation of toxic industrial chemicals in the food chain.



Polar Bear Questions

Create 3 questions to test the polar bear knowledge of others in your class.

1.

2.

3.



Student Handout

Student Handout #3

The Melting Arctic Ice

The Arctic Ocean is one and a half times the size of Canada (13 million versus 9 million sq. km). In winter, the entire ocean freezes, and the ice stretches from Canada to Russia. In summer, when the temperature rises above 0°C, the ice melts around the southern edges.

The Arctic Warming

Since 1900, air temperatures in the Arctic have increased by 5°C, due to global climate change. Satellite data from NASA in 2003 showed that the rate of surface warming between 1981 and 2001 was eight times the warming of the previous 100 years. Some areas are warming by two and a half percent per decade. When measuring the Arctic melting, it is important to distinguish between the loss of width (or extent) and the loss of depth. It is also important to distinguish between the melting of the summer ice, and the year-round ice.

As the Arctic ice melts, there will be no impact on global sea levels, since the ice is already in the sea. Imagine taking a container of water, freezing it, and then thawing it. The water level will be the same, before and after. The concern about steady sea level rise comes from the expansion of water, as it warms. The concern about dramatic global sea level rise comes from the melting of land-based ice in Greenland and the Antarctic.

The Melting of the Arctic Summer Sea Ice Width (Extent)

The width of the Arctic sea ice is monitored by aerial photography, and by satellite. Between 1978 and 1996, it shrank by three percent per decade. The year-round ice is declining at a rate of nine percent per decade. If this continues, it will melt entirely by 2100. In 2002, there was the least summer ice ever on record. Scientists use computer modelling to see what may happen in the future. The US Geophysical Fluid Dynamics Laboratory computer model shows that the Arctic sea ice extent will fall by 20% by 2050.



If the CO₂ in the atmosphere continues to rise, by 2125 the ice-free period will increase from 8.5 to 21.5 weeks. Studies show that for each week earlier that the ice breaks up, the polar bears lose 10 kg in weight, because they have less time to hunt on the ice. If half of the additional ice-free time comes in the early summer, the bears will lose 65 kg in weight.

In 1991, when the volcano Mount Pinatubo in the Philippines blew its top, it sent up so much dust that there was a temporary cooling of the whole planet. The following summer, the ice on Hudson Bay melted almost a month later. The polar bears had a whole extra month in which to hunt, and when they finally came ashore they were bigger, heavier, and their cubs survived better. The dust soon settled, however, and the rising temperatures continued. By 2002, polar bear field workers in Churchill, Manitoba, on the Hudson Bay, were reporting that the bears were skinnier and smaller, and the big 650 to 900 kg bears were no longer around.

Ian Stirling, a researcher with the Canadian Wildlife Service of Environment Canada, says that since 1980, the average weight of the female bears has dropped by up to 15%, and the average rate of reproduction has fallen from one cub to 0.87 cubs a year (a 13% fall).

The Melting of the Arctic Summer Sea Ice Depth (Thickness)

The thickness of the ice is much harder to monitor. It can be done using sonar from a submarine, or by creating elastic gravity waves from the surface, vibrations that can be used to measure the thickness of the ice. Each test gives a reading for only one spot. Now imagine doing this in an area much larger than Canada!

When the cold war ended and the US submarine data was declassified, a research team from the University of Washington in Seattle compared the data from three autumn cruises by the USS *Pargo* in 1993, the USS *Pogy* in 1996, and the USS *Archerfish* in 1997 with older data from 1958-1976. At 29 sites, they found that the average depth of the ice had thinned by 1.3 metres, a loss of 40%. If this rate of thinning continues, the summer ice will melt entirely by 2050.

In September 2003, a Chinese team found that the average thickness of the Arctic ice had fallen to 2.7 metres, from a previous average of more than 4.6 metres in the 1980s. This is a 42% rate of decrease in 20 years. Based on this more recent data, the summer ice could melt entirely by 2030.



The Impact on Polar Bears

The loss of the ice will have several major impacts on polar bears, and on the marine food chain:

- With each week earlier that the sea-ice melts in spring, the bears lose 10 kg of weight.
- With each week later that the sea-ice freezes in fall, the bears lose more weight.
- As the ice breaks up into ice floes, the bears have to swim farther between the floes to hunt the ringed seals, burning up more energy.
- With each week earlier that the sea-ice melts, the seals have less opportunity to raise their pups.
- When precipitation falls as rain instead of snow, the dens that the ringed seals build on the sea ice can collapse, revealing the pups to the bears.
- The diatoms and algae that form the bottom of the food chain flourish at the edges of the sea-ice, where the sunlight and the water interact with the ice. As the summer sea-ice disappears, there may be fewer diatoms and algae, causing a weakening of the whole Arctic marine food chain.
- If all the Arctic ice disappears by 2100, which the computer models are predicting, the polar bears will have no ability to hunt for seals at all. Without any ice, the ringed seals and walrus will be forced to risk having their pups on land, and to live around the shores. This might provide a continued food source for the polar bears.