WONDERS OF THE ARCTIC

EDUCATOR GUIDE

SCIENCE NORTH SCIENCE NORD

GIANT SCREEN FILMS

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The Arctic has always been a place of mystery, myth and fascination.

The Inuit and their predecessors adapted and thrived for thousands of years in what is arguably the harshest environment on earth. Today, the Arctic is the focus of intense research. Instead of seeking to conquer the north, scientist pioneers are searching for answers to some troubling questions about the impacts of human activities around the world on this fragile and largely uninhabited frontier.

The giant screen film, *Wonders of the Arctic*, centers on our ongoing mission to explore and come to terms with the Arctic, and the compelling stories of our many forays into this captivating place will be interwoven to create a unifying message about the state of the Arctic today. Underlying all these tales is the crucial role that ice plays in the northern environment and the changes that are quickly overtaking the people and animals who have adapted to this land of ice and snow.

This Education Guide to the *Wonders of the Arctic* film is a tool for educators to explore the many fascinating aspects of the Arctic.

This guide provides background information on Arctic geography, wildlife and the ice, descriptions of participatory activities, as well as references and other resources. The guide may be used to prepare the students for the film, as a follow up to the viewing, or to simply stimulate exploration of themes not covered within the film. The suggested activities can be adapted to various grade levels and complement other studies in science, biology, geography, and history.

What is the Arctic?

The Arctic can be defined in many different ways — by geography, by climate, and by territory.

- The Arctic is the region north of the Arctic Circle, at 66 degrees, 32 minutes North (66° 33'N).
- A climate is considered an Arctic climate if the mean temperature of the warmest summer month is below 50°F (10°C).
- The Arctic is a region that has continuous and discontinuous permafrost, which is permanently frozen soil.
- **The circumpolar Arctic covers a huge area, almost equal in size to the entire North American continent!**
- The Arctic is comprised of both land and ocean. It is the northernmost areas of the eight countries that border the Arctic Ocean — United States (Alaska), Canada, Russia, Finland, Norway, Sweden, Denmark (Greenland), and Iceland.

Key features of the Arctic:

- The Arctic experiences 24 hours of daylight in the summer months (July and August) and 24 hours of darkness in the winter months (November through February). The darkest time of the year at the North Pole is December 21,the Winter Solstice. The sun rises again at the North Pole on March 21, the Spring Equinox. On the Fall Equinox, September 21, the sun sinks below the horizon, leaving the North Pole in twilight and then full darkness.
- The Arctic is a dry region. The further North you go, the drier it is. The high Arctic is often described as a polar desert. The annual precipitation in the Arctic is less than 19.5 inches (500 mm).
- Permafrost is permanently frozen ground and is found throughout the Arctic. The thickness of the permafrost varies from 6 to 3200 feet (2-1000 m)! Normally, only the uppermost 3 feet (1 m) of 'active layer' thaws during the summer.
- The Arctic Ocean is the smallest of the world's five oceans. It features an enormous permanent ice pack of 3 million square miles (8 million square kilometers). During the summer, open seas surround the permanent ice pack around the North Pole. In winter, this frozen area nearly doubles in size and stretches to the surrounding continents. The ice in the Arctic Ocean is dynamic, meaning it moves, breaks up, and changes form.
- Arctic life is dependent on either of two ecosystems: (1) the terrestrial ecosystem of which caribou, musk ox, fox, lemmings, and wolves are a part, and (2) the marine ecosystem of which polar bears, whales, krill and seabirds are a part.

Arctic Wildlife

As seen in *Wonders of the Arctic*, this region is home to a fascinating and diverse group of animals, adapted to survive and succeed in land, ice and ocean habitats. Arctic wildlife species are a part of one of two major ecosystems — terrestrial and marine.

The animals that live on land such as musk oxen, caribou, foxes, wolves, and lemmings depend solely on a terrestrial ecosystem. Contrary to popular belief, few animals hibernate through the long Arctic winter. In the high Arctic, there is very little snow to insulate or protect a hibernating animal. To survive the Arctic winter, the animals have developed unique adaptations, such as changing fur color and sophisticated heat exchange systems. The collared lemming is fed upon by foxes, wolves and many predatory birds. These small rodents change from their drab brown summer coats to a winter 'morph' that looks like a totally different animal. The lemming's coat turns white in winter, it develops a hump over its front shoulders, and its front claws develop two hooks for each of its three toes. These adaptive claws are used for digging through frozen ground in order to feed on plants.

Marine animals, such as polar bears and whales, depend solely on the marine ecosystem. Polar bears travel thousands of kilometers each year on the sea ice in search of their favorite meal, ringed seals. Their white fur camouflages them and keeps them warm, as does the 4 inch (10 cm) layer of blubber under their skin.

Walruses, like polar bears, are only found in the cold waters of the Northern Hemisphere. The male walrus is the largest, weighing up to 4100 lbs (1900 kg). Walruses feed primarily on mollusks, diving to depths of 300 feet (90 m), sometimes staying under water for as long as 30 minutes.

Many species of whales are found in Arctic waters. In the winter, most of these whales migrate further south, away from the encroaching sea ice. There are three whale species that are true Arctic whales — the bowhead, the narwhal, and the beluga. These animals spend winter and summer in the Arctic Ocean, swimming to areas known as polynyas, which are areas of open water surrounded by sea ice.

Climate Change and the Arctic

The poles are the barometers of climate change for the planet. They are the first places to experience the impacts of climate change. Scientists have documented that glaciers at the poles are melting at a faster rate than they were just decades ago. Sea ice over the polar oceans is becoming thinner from year to year.

The impacts of thinning sea ice and disappearing sea ice are emerging in numerous ways. For example, polar bears in the Arctic who normally spend nine months of the year traveling on sea ice in search of seals, are being forced to spend three to four weeks less time hunting. The polar bear's sea ice hunting platform is melting earlier in the spring and forming later in the fall. As a result, the bears have a longer fasting period in the Arctic summer. Research is showing that adult bears are smaller than they were 20 years ago, and that females are having fewer cubs.

Humans are also feeling the effects of rapid change. In the Arctic, Inuit people who hunt for seals on sea ice are finding the sea ice less predictable and more dangerous to travel on during certain times of year. Traveling on ice roads in the Arctic is a popular method of moving vast amounts of goods during winter, and a much cheaper method of transportation than having to bring products in by air. However, a warming climate is making certain ice roads very dangerous due to thin ice conditions. Melting permafrost is also destabilizing the ground beneath buildings and roads.

Wonders of the Arctic Featured Researchers

Ilkoo Angutikjuak and **Shari Fox Gearheard** are both featured in the Wonders of the Arctic film. They work together for the benefit of the Arctic, each bringing their own set of expertise. Together, they form a holistic research approach, as unique as the Arctic itself.

Ilkoo Angutikjuak was born in October, 1942 and grew up in the Sam Ford Fjord area north of Kangiqtugaapik (Clyde River) Nunavut. He has spent his life on the land and sea ice, providing for his family and gaining a deep knowledge about the environment and animals. Ilkoo is a respected Elder and hunter. He is also a Canadian Ranger, accomplished carver and artist, deep sea fisherman, professional guide, traditional knowledge and skills instructor, researcher, expert on Inuit weather forecasting, former language specialist at the local school, and a former cameraman for the Inuit Broadcasting Corporation. Ilkoo and his wife Kalluk live in Clyde River with their children and grandchildren.

Shari Fox Gearheard was born and grew up in southern Ontario. She is a research scientist with the National Snow and Ice Data Center, University of Colorado, based in Clyde River. Since 1995, Shari has worked on environmental projects that bring together Inuit knowledge and science. In 2013, she and her collaborators published a book entitled, *The Meaning of Ice: People and Sea Ice in Three Arctic Communities*, which celebrates Arctic sea ice as it is seen and experienced by the Inuit, Iñupiat, and Inughuit people. Her work has been featured in *Science and Natural History*, and she has been a contributing author for major reports such as the *Arctic Human Development Report II* and the *Arctic Climate Impact Assessment (ACIA)*. Shari lives in Clyde River with her husband Jake and their 21 Inuit sled dogs.

Resources

- https://www.itk.ca

Activity 1: Arctic Geography

Activity Description

Students familiarize themselves with Arctic geography by locating and identifying the latitude of the Equator, their hometown, the Arctic Circle and all the countries within the Arctic region.

Background Information

The film *Wonders of the Arctic* explores the unique geography of the Arctic region. The Arctic region begins north of the Arctic Circle.

The Arctic Circle is one of the five major circles of latitude that mark maps of the Earth. The Equator is also a circle of latitude that marks 0°, and is found right in the middle of our planet. The Arctic Circle is found at 66° 33'44' (or 66.5622°) north of the equator.

There are eight different countries that have land north of the Arctic Circle including Canada, the United States of America (Alaska), Russia, Norway, Sweden, Finland, Iceland and Denmark (Greenland).

The Arctic Circle is the southernmost latitude in the Northern Hemisphere at which the sun can be above or below the horizon continuously for 24 hours. The sun stays above the horizon for 24 hours on the June Solstice and below the horizon for 24 hours on the December Solstice. These events happen exactly once a year on these days. North of the Arctic Circle, the numbers of days of 24-hour light or 24-hour darkness increases with latitude.

Materials

- World map (Worksheet 1)
- Arctic map (Worksheet 2)
- Globe
- Colored pencils, markers or crayons
- Pencils and erasers
- Ruler

Procedure

1. Hand out a copy of the world map (Worksheet 1) to each student.
2. Identify the equator and color it red using a colored pencil, marker, or crayon.
3. Identify the Arctic Circle and color it blue.
4. Identify where your city/town is located on the map. Mark the location with a green "X".
5. Using your ruler, draw a green line going through your city or town that is parallel to the Equator and Arctic Circle to show where the latitude is located.
6. Discuss latitudes and mark the degrees of latitude for each line. The Equator is 0° and the Arctic Circle is 66° 33'. Research at what latitude your city or town is located.
7. The Arctic is the region of the Earth that is north of the Arctic Circle. It consists of a variety of landscapes including land, ice, and ocean.
8. Hand out a copy of the Arctic map (Worksheet 2). Using the globe, show the perspective of the map given to them.
9. As a class, locate each country that lies within the Arctic Circle.
10. Color and label the countries on your map.

Extensions/Adaptations:

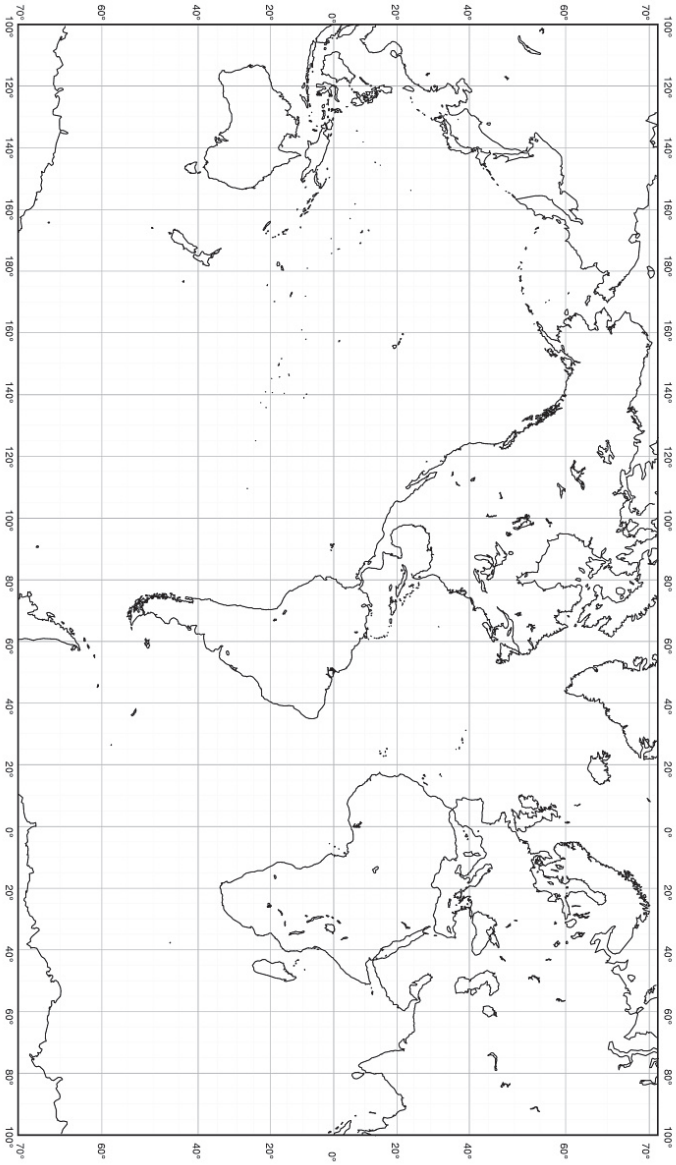
- Compare the Arctic environment to your own by comparing latitude, average temperature, hours of daylight on the summer and winter solstices, landscape, native plants and animals, population etc.
- Using a map of North America, locate different Arctic communities.

Resources:

http://www.worldatlas.com/aatlas/latitude_and_longitude_finder.htm

A great website to help locate the latitude of your city or town.

Worksheet 1: Arctic Geography



World Map

Worksheet 2: Arctic Geography

Credit: http://www.grida.no/graphicslib/detail/arctic-map-political_1547. Hugo Ahlenius, UNEP/GRID-Arendal)

Activity 2: Life in the Arctic

Activity Description

Students formulate and share opinions on what life is like in the Arctic while demonstrating research skills by compiling information from a wide variety of print and electronic resources.

Background Information

The *Wonders of the Arctic* film explores the connection between people and their Arctic home. People have lived in the circumpolar Arctic for thousands of years. Indigenous people have lived in the North American Arctic for at least 4000 years.

Over centuries these people have survived and flourished under some of the harshest conditions on Earth. Today, more than four million people live in the circumpolar Arctic, with the indigenous population ranging from 80 percent in Greenland to 15 percent in Arctic Norway, and as little as 3 percent in Arctic Russia.

Arctic people include the Inuit in Canada, Greenland, Alaska, and Russia, the Na'Dene in Canada and Alaska, the Aluets and Athabaskans in Alaska, the Saami in Scandinavia, and the Chukchi, Nenets, and many more in Russia.

Current issues such as natural resource development and climate change are altering the way of life of Arctic peoples and are certain to have an impact on the environment and their future. Despite tremendous pressures, many Arctic communities are still closely linked to the native wildlife and local resources.

Materials

- Paper
- Writing tools
- Computers with Internet connection
- Library books
- Internet resources

Procedure

1. Introduce the research project as a way for students to take what they learn and teach others about Life in the Arctic.
2. Students can work individually or in groups for their research project.
3. Brainstorm ideas of what you think life is like in the Arctic for Indigenous populations, like the Inuit or Inupiat.
4. Write down your predictions.
5. Research and write a paper about Indigenous culture in the Arctic.
6. Discuss Indigenous culture in the Arctic with your students. What did they learn? Did their research confirm or dispute their original predictions?

Resources

- https://www.itk.ca
- http://www.arctic-council.org/
- http://www.arcticpeoples.org/
- http://www.mnh.si.edu/arctic/index.html

Activity 3: Weather and Climate

Activity Description

Students track and graph local temperatures and Arctic temperatures and compare their results, observing daily weather cycles. Using historic data, students graph climate data from different years at an Arctic location and compare the data over time.

Background Information

The *Wonders of the Arctic* film examines the effect of a changing climate on the landscape, wildlife and people of the Arctic. Understanding weather and climate patterns are essential for understanding these changes that are occurring.

Weather is a mix of events that we see every day in our atmosphere including temperature, precipitation and humidity. Weather changes every day, week, month and season.

Climate is the average weather taken over a period of many years. Climate differs from region to region around the world and is influenced by a variety of factors including the amount of sunlight an area receives, landscape, proximity to an ocean, and altitude. Weather changes every day, whereas climate changes over years, decades, and centuries.

The climate on Earth has always been changing, but the change the planet is experiencing currently is much faster then it has ever been. The climate of our planet is warming, with the greatest changes occurring in the Polar Regions, especially the Arctic.

Materials

- Outdoor thermometer
- Paper
- Pencils
- Graph paper
- Historic Climate Data for Eureka, Nunavut Canada (see appendix).

Procedure

1. Place thermometer outdoors in a location that is accessible to the class. For a minimum of five days (more days will give a better data set), record outdoor temperatures in the morning and again in late afternoon.
2. Using Internet weather websites or apps, choose a location in the Arctic to track temperature data. Record daily temperatures for same time in morning and afternoon as your school data. See Appendix for links to weather websites.
3. Draw a line graph that shows date and time along the horizontal axis and temperature on the vertical axis. Plot the date and time of each temperature recording for both the school and Arctic data. Use two different colors to designate the different locations.
4. Compare daily temperature cycles with the class. When are temperatures the highest and lowest? What's the greatest difference in temperatures? How is the temperature in the Arctic different than that of your school?
5. Using the historic average temperature data from Eureka, Nunavut Canada, draw a graph with years on the horizontal axis and average temperature on the vertical axis. Plot the data points.
6. Discuss with the class any trends that they see on their graphs and ask questions about why the think any changes may be happening.

Extensions/Adaptations

- Create and draw a thermometer to show the differences between Celsius and Fahrenheit temperatures. Mark on the thermometer the temperature where water freezes.
- Find historic climate data for your region. How has it changed?
- Use Microsoft Excel or other similar computer-graphing program to graph historic climate data. Add a *trendline* and discuss the results.

Resources

- **The Difference Between Weather and Climate Videos**
  https://www.youtube.com/watch?v=Hoirv3OhLmc
  https://www.demonstrate.com/watch?v=uEs6WBNTrDE
- **The Difference Between Weather and Climate**
  http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html
- **Daily Weather Data for Alaska US**
  http://pafg.arh.noaa.gov
- **Daily Weather Data for Nunavut Canada**
  http://weather.gc.ca/forecast/canada/index_e.html?id=NU
- **Daily Weather Information for Barrow, Alaska US**
  http://pafg.arh.noaa.gov/Obs/obHistory.php?site=PABR&hrs=12
- **Daily Weather Information for Resolute, Nunavut Canada**
  http://weather.gc.ca/city/pages/nu-27_metric_e.html

Appendix: Historic Average Yearly Temperature for Eureka, Nunavut Canada

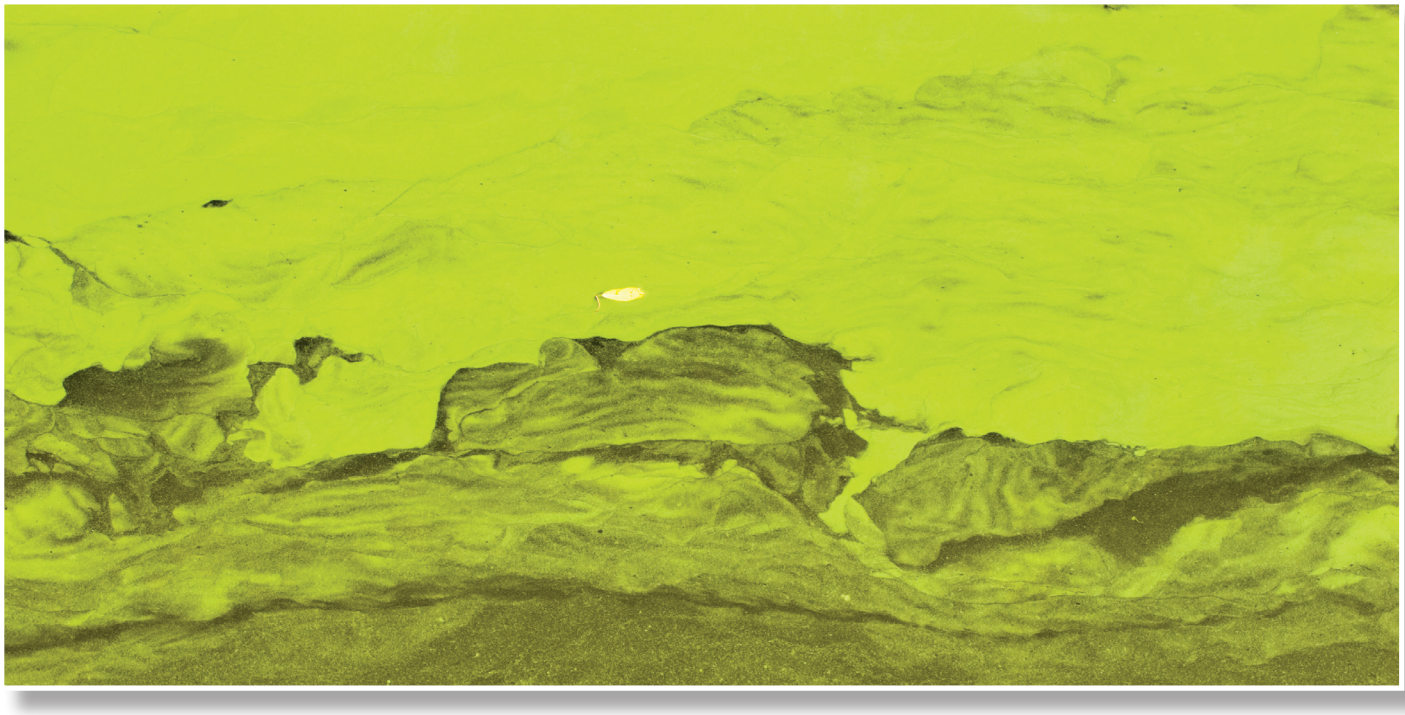
Year	Average Yearly Temperature °C	Average Yearly Temperature °F
1948	-16.7	1.9
1949	-16.2	2.8
1950	-16.2	2.8
1951	-15.9	3.4
1952	-15.0	5.0
1953	-16.4	2.5
1954	-15.4	4.3
1955	-16.5	2.3
1956	-17.3	0.9
1957	-17.0	1.4
1958	-14.5	5.9
1959	-15.8	3.6
1960	-14.7	5.5
1961	-16.9	1.6
1962	-14.6	5.7
1963	-15.8	3.6
1964	-16.8	1.8
1965	-15.2	4.6
1966	-16.9	1.6
1967	-15.7	3.7
1968	-16.4	2.5
1969	-16.1	3.0
1970	-16.8	1.8
1971	-16.9	1.6
1972	-18.6	-1.5
1973	-16.9	1.6
1974	-18.0	-0.4
1975	-17.3	0.9
1976	-17.3	0.9
1977	-16.5	2.3
1978	-16.0	3.2
1979	-18.3	-0.9
1980	-16.3	2.7
1981	-14.0	6.8
1982	-17.2	1.0
1983	-16.0	3.2
1984	-18.0	-0.4

1985	-16.6	2.1
1986	-17.5	0.5
1987	-17.8	0.0
1988	-14.1	6.6
1989	-17.5	0.5
1990	-16.0	3.2
1991	-15.3	4.5
1992	-17.4	0.7
1993	-15.5	4.1
1994	-14.8	5.4
1995	-14.9	5.2
1996	-15.3	4.5
1997	-16.0	3.2
1998	-13.7	7.3
1999	-16.5	2.3
2000	-15.6	3.9
2001	-15.3	4.5
2002	-14.4	6.1
2003	-14.5	5.9
2004	-16.1	3.0
2005	-13.9	7.0
2006	-13.3	8.1
2007	-14.3	6.3
2008	-14.9	5.2
2009	-14.5	5.9
2010	-12.5	9.5
2011	-13.7	7.3
2012	-14.1	6.6

Activity 4: Algae Bloom

Activity Description

Students learn the importance of algae in the Arctic food chain through a hands-on activity that demonstrates the conditions needed for optimum growth.



Background Information

Plankton, animal species, and various environmental factors shape the unique Arctic Ocean's ecosystem and complex food web. The *Wonders of the Arctic* film explores the importance of ice algae that grows on the undersurface of Arctic ice. Phytoplankton and algae are *primary producers* or *autotrophs* and form the base of the Arctic's food chain. These microscopic organisms rely on the sun's rays that penetrate through the thick Arctic ice to make their own nutrients.

During this activity, lawn fertilizer or a phosphate product is used. Phosphorus is an important nutrient for algae and is required for cell growth. It is used to store and transfer the organism's energy.

Algae blooms are found under the Arctic ice, in warmer oceans and freshwater ecosystems. A bloom signifies a heavy growth of algae in a body of water. Initially, a bloom can be beneficial to the animals in the ecosystem because the algae produce oxygen as a waste material. However, if the algae bloom is too large, it can harm the plants in the ecosystem, as they would compete for space and carbon dioxide. Eventually, the algae die off in large quantities and take up oxygen in order to decompose. At this point, the algae are detrimental to both the plants and animals living in the ecosystem.

Materials

- 4 beakers or glass containers (2 cups or 500 mL capacity)
- Area that receives sunlight for several hours a day
- Measuring spoon (1/4 teaspoon)
- Elastics
- Cheesecloth
- Aluminum foil
- Water from a natural source (non-treated water)
- Lawn fertilizer or any phosphate product (not necessary)
- Worksheet 4

Procedure:

1. Students can work in pairs. Provide four beakers or glass containers for each group.
2. Label the beakers as follows:
3. + Sun, + Nutrients
4. + Sun, - Nutrients
5. - Sun, + Nutrients
6. - Sun, - Nutrients (this is your control)
7. Add one cup (250 mL) of the non-treated water to each beaker.
8. Add a ¼ teaspoon of lawn fertilizer or phosphate product to each container labeled *+ Nutrients*.
9. Completely cover each container labeled - *Sun* with aluminum foil so that light cannot penetrate the container.
10. Cover the beakers labeled *+ Sun* with cheesecloth secured with an elastic to prevent additional particles from entering the system.
11. Set the beakers in the sunlight, and make daily observations on your Worksheet 4.
12. Draw conclusions on which container will have the most algae growth and which will have the least growth. Justify your predictions.
13. Repeat the activity with other sources of water such as lake or marsh.
14. Answer the following questions. Under what conditions did algae grow? Under what conditions did the algae grow best? Under what conditions was there no growth? What do the results of this experiment tell us about the needs of algae in the Arctic Ocean?

Extensions/Adaptations:

- Keep track of algal density with cell counts in addition to color detection. Use microscopes, slides and cover slips to do cell counts of the cultures over time and create graphs of cell density (determined from your counts) over time.
- Have students research news articles about algae blooms in the Arctic and why this could be a concern for scientists

Resources:

- http://www.scientificamerican.com/article.cfm?id=thinning-arctic-ice-allows-plankton-bloom

Worksheet 4: Algal Bloom

Algal Bloom Observation table:

Day 1

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Day 2

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Day 3

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Day 4

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Day 5

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Day 6

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Day 7

Container	Color	Smell	Clarity (How clear is the sample?)	Other Observations
+ Sun, + Nutrients				
+ Sun, - Nutrients				
- Sun, + Nutrients				
- Sun, - Nutrients				

Activity 5: Measuring Albedo

Activity Description

Students create an apparatus to measure how heat plays a role in warming up the air in the environment. They learn how gases behave when they warm up and cool down, and what effect colors in the environment play on the rate of heating and cooling.

Background Information

The Earth gets its energy from the sun. This type of energy is called solar radiation. The Earth absorbs some of the sun's radiation, while the rest of it gets reflected back to space. The ability of the Earth's surface to reflect light is known as albedo. Albedo is measured using a scale from 0–1. A black surface has no reflective power and has an albedo of 0, while a perfectly white surface reflects all of the light and has an albedo of 1.

In the environment, fresh snow has the highest albedo of approximately 0.9. That means that it reflects about 90% of the incoming radiation. If the snow is dirty or melting, the albedo is much less. On the other hand, water in the environment has an albedo of approximately 0.08, meaning it only reflects 8% of incoming radiation and absorbs the rest.

The *Wonders of the Arctic* film examines changes in Arctic ice. As the temperature rises in Arctic climates, the sea ice melts. Since the ice reflects most of the radiation and the water absorbs radiation, a cycle begins to occur. This cycle is called a negative feedback loop. This means that as the temperature rises and more ice melts, the temperature of the water also increases as more radiation is absorbed. This melts even more sea ice and continues to increase the temperature of the water. This loop continuously amplifies the increase in air temperature to have an increased effect on sea ice melting.

Water, air and ice all behave differently when they are exposed to different temperatures. One is a solid, one a liquid and the other a gas. When you heat up a substance, the particles become excited and move away from each other, causing them to take up more space. When you cool them the opposite generally happens. The particles move closer to one another, becoming denser and therefore taking up less space. Water is a unique substance in this sense. It follows the same rules until it is frozen. Once frozen, solid water actually expands and becomes less dense (this is why ice floats). For the purpose of this activity, it is important to note how gases behave when they are heated and cooled.

Materials

- 2 mason jars
- 1 white balloon
- 1 black balloon
- 1 black sheet of paper
- 1 white sheet of paper
- 2 straws
- Tape
- Ruler
- Heat lamp (if conducting experiment indoors)

Procedure

1. Take the two balloons and cut off the ends.
2. Place the balloons over the mouth of the mason jar so they are tight.
3. Wrap one mason jar with black paper and the other mason jar with white paper. Be sure to cover the whole jar leaving the top of the balloon uncovered.
4. Tape one straw horizontally to the middle of the balloon on each apparatus. This apparatus is known as a barometer.
5. Place the ruler beside the tip of the straw and record the initial measurement where the barometer begins.
6. Place the two barometers outside in the sun, or set up heat lamp and place the two jars evenly in the light from the lamp.
7. Take measurements over the next hour at 5 minutes, 15 minutes, 30 minutes and 1 hour. Record where the tip of the straw reaches on the ruler at each time interval.
8. To get the total measurement of which balloon moved the most, subtract the two measurements from each other.
9. Which balloon moves the most or is the quickest to fill up?

Resources

- http://www.esa.int/Our_Activities/Observing_the_Earth/Reflecting_on_Earth_s_albedo
- http://www.climatedata.info/Forcing/Forcing/albedo.html

Activity 6: Arctic Food Chains

Activity Description

Students explore an Arctic food chain and examine how changes in population of each part of that food chain can affect the populations of other species.

Background Information

The Arctic environment appears to be one of the harshest places on Earth with extreme cold temperatures and periods of 24-hour sunlight and 24-hour darkness. Despite these harsh conditions, the Arctic Ocean is teeming with life.

The Arctic Ocean ecosystem is comprised of many different species of algae, plankton, and animals that all fit into a unique and complex food web. Each species has a unique role to play within the web of life and each species relies on others for survival.

Ice algae and phytoplankton are the foundations of this food web and use the sun for photosynthesis to make sugars for food. All other Arctic Ocean species depend on these algae to sustain life. Ice algae are a mixture of many different species of algae that live under and within the sea ice. Phytoplankton are microscopic organisms that live near the surface of the ocean to get sunlight for photosynthesis.

Zooplankton is composed of small animals that can be microscopic in size to a few inches (centimeters) or even feet (meters) long! Some of the most abundant types of zooplankton are copepods — small teardrop-shaped crustaceans with long antennae and, in most species, only one eye. Another abundant type is krill — small shrimp-life crustaceans that are a big part of the diet of fish and baleen whales. Zooplankton can feed on smaller zooplankton, phytoplankton or detritus.

Arctic cod are silver in color and grow up to 12 inches (30 cm) long. They are one of the few fish that thrive in the cold Arctic water temperatures and have developed an adaptation of antifreeze proteins in their blood. This fish is a key component of Arctic food webs and is a food of narwhals, belugas, seals, and seabirds. Cod consume plankton like copepods and krill.

Bearded seals are one of the five seal species that live in the Arctic. Bearded seals reach about 6.9–8.9 feet (2.1–2.7 m) in length and weigh between 442–948 lbs (200–430 kg). They have square-shaped front flippers and thick whiskers on their muzzle. They feed on squid and fish like the Arctic cod and are predated upon by polar bears.

Polar bears are a carnivorous bear found mostly within the Arctic circle. Polar bears mainly feed on seals, hunting at the seal's breathing holes. A bear will patiently wait by a breathing hole; when the seal emerges, the polar bear reaches into the hole with its front paw and drags the seal onto the ice. Polar bears are at the top of the food chain.

Materials

- Food Chain (Worksheet 5)
- Pencils
- Erasers

Procedure

1. Explain to students that they are going to be exploring an Arctic food chain. Each organism in the food chain depends on the other.
2. What organism is at the bottom of the food chain? How does this organism make its food? What organism is at the top of the food chain? What does it eat?
3. Draw arrows pointing up, symbolizing an INCREASE in population, or arrows pointing down symbolizing a DECREASE in population beside each organism depending on the scenario.
4. Discuss with the students each of the scenarios and what that would mean for the different populations of organisms.
5. Scenario 1: Climate change causes the ice to melt earlier in the year, not allowing polar bears access to food and polar bear population decreases.
6. Scenario 2: Increase in commercial fishing of Arctic cod causes an Arctic cod population decrease.
7. Scenario 3: Less sea ice results in increased oil exploration and ship transportation, which results in an oil spill. What may happen to each species?

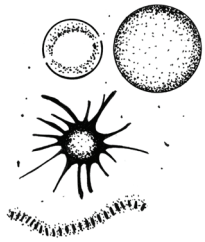
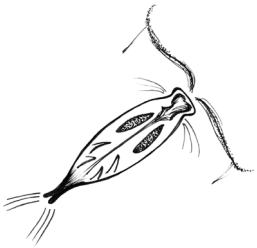
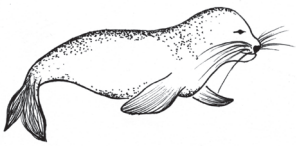
Extensions/Adaptations

- Complete research projects on each part of the food chain.

Resources

- http://polardiscovery.whoi.edu/arctic/ecosystem.html

Worksheet 5: Arctic Ocean Food Chain Handout

	Environmental Scenarios		
	Ice melts earlier in year	Increase of commercial fishing of cod	Oil Spill
			
			
			
			
			

Activity 7: Polar Bear Bioaccumulation

Activity Description

Students learn how toxic substances like mercury can accumulate in individual organisms through bioaccumulation and are concentrated in top predators like polar bears through biomagnification.

Background Information

There are many threats to Arctic wildlife as explored in the film *Wonders of the Arctic*. While polar bears are threatened with changing ice conditions, they also face other threats such as accumulation of harmful pollutants.

Bioaccumulation is the increase in concentration of a substance in living organisms as they take in contaminated air, water, or food.

As one larger animal eats many smaller animals, the level of contamination concentrates in the body of the larger animal. The results move up with the food chain with the highest concentrations of contaminants accumulating in the largest predators.

Polar bears in the Arctic have shown to have high concentrations of mercury in their fat, livers and hair. Mercury acts as a nerve toxin and the main health concern is its effect on the brain, particularly in the growing fetus and the young. Mercury can also damage reproduction in mammals and birds. In fish, its effects include a decreased sense of smell, damage to the gills, blindness, and more.

Bioaccumulation is a problem in the north because of higher concentrations of toxic pollution. It is especially problematic in that many Arctic animals have more fat on their bodies to help keep warm and mercury accumulates in fatty tissue.

Materials

- Colored armbands: 2 white, 5 blue, 18 red.
- Paper bags or small containers
- 20 White paper dots per student
- 10 colored paper dots per student

Procedure

1. Divide the class into three different groups. In a class of 26 students, there would be two polar bears, six seals, and 18 fish. You need about three times as many fish than seals and three times as many seals as polar bears.
2. Give each student an armband to indicate the animal they represent. White is for polar bears, blue for seals and red for fish.
3. Hand each "fish" a small paper bag or other small container. This container represents the stomach of whichever animal is holding it.
4. With the student's eyes closed, distribute the white and colored paper dots around a large open space. A gymnasium, playing field, or a cleared classroom would work.
5. Give the students their instructions. The fish are the first to go looking for food. The seals and polar bears are to sit quietly on the sidelines watching the fish. The seals and polar bears are predators and they must wait for the right moment to catch their prey. At a given signal, the fish are allowed to enter the area and collect as much food (white and colored dots) to put in their stomachs (paper bags). Give the fish 30 seconds to collect food and then ask them to stop.
6. The seals are now allowed to hunt the fish. The polar bears are still on the sidelines waiting until they are allowed to hunt the seals. Give the seals up to 60 seconds to hunt the fish. Any fish that is tagged or touched by the seal must give its bag of food to the seal and then sit on the sidelines.
7. Now is the time for the polar bears to hunt the seals. The same rules follow. Any seals still alive may hunt for fish, and the fish are still searching for food. If a polar bear tags a seal, the polar bear gets the food bag and the seal goes to the sideline. Let play run from 15 – 60 seconds depending on the size of your play area.
8. When finished, ask the students to come together, bringing their food bags with them. Which students still have food bags? Ask the polar bears to empty their food bags. Count the total number of white pieces and the total number of colored pieces. Count how many each surviving seal and each surviving fish has of each color.
9. Inform the students that there is a toxin in their environment where the polar bears, seals and fish live. It's called mercury.
10. Which animal has the most colored pieces? Why?

Extensions/Adaptations

- Have students describe each animal as a carnivore, herbivore, detritivore, or primary producer.

Resources

- http://www.nbcnews.com/id/42917670#.UpjpfKUZq5c
- http://sciencebitz.com/Keynotes/Artic_ecosystem_case_study.pdf

Activity 8: School Yard Whales

Activity Description

Students measure and draw the length of four Arctic whales and compare the size of each whale to every day objects.

Background Information

Four species of whales call the Arctic home: bowheads, belugas, narwhals and orcas. The researchers in the *Wonders of the Arctic* film study whale tissue to learn about their environment and health.

Bowheads are the second largest whale in the world by weight. They weigh between 150,000–200,000 lbs (75,000–100,000 kg) and 35–40 feet (13–14 m) long. They have an amazing lifespan with estimates of over 150 years old! They are baleen whales and have baleen plates instead of teeth for filtering food out of the ocean. Bowhead whales have extremely long baleen plates, up to 14 feet (4.2m), and feed almost exclusively on zooplankton like krill.

Bowheads live in the Arctic Ocean and throughout high latitudes in the Northern Hemisphere. They overwinter at the southernmost edge of the pack ice and move further north as the ice begins to break up in the spring.

Belugas are small toothed whales. Beluga whales live in the Arctic or sub-Arctic. They inhabit the Arctic Ocean and its adjoining seas and in certain times of year, can inhabit some large rivers. They are generally found in shallow coastal water. Males average 11.2–15.1 feet (3.4 – 4.6 m) long and weigh about 3,307 lbs (1,500 kg). Females average 9.8–13.1 feet (3 – 4 m) and weigh about 2,998 lbs (1,360 kg). Belugas use echolocation to navigate and find food. They use their fatty melon to focus ultrasonic sounds through the water and receive echoes of that sound from surrounding objects and prey.

Narwhals are small toothed whales and are the only whale to overwinter in the dense Arctic pack ice, taking advantage of openings in the ice to breathe. Male narwhals have a characteristic single tooth or tusk that gives them the nickname "unicorn of the sea". This specialized tooth is not used for eating, but can actually detect changes in temperature, barometric pressure and water composition to help them navigate around Arctic ice. Males, at an average length of 13.5 feet (4.1 m), are slightly larger than females, at an average of 11.5 feet (3.5 m). Typical adult body weight can range from 1,800 to 3,500 lbs (800 – 1,600 kg). A male narwhal's tusk can be 4.9–10.1 feet (1.5–3.1 m) long.

Orcas (killer whales) are a mid-sized toothed whale. They are easily recognized by their distinct black and white patterns. Orcas are between 23 to 32 ft (7 to 9.7 m) and weigh up to 11,900 lbs (5,400 kg). Orcas are found in all of the world's oceans, including the Arctic Ocean. Scientists are discovering increased numbers of orcas in the Arctic as global warming causes changes in Arctic ice. This change could pose a threat to other populations of Arctic whales.

Materials

- School playground
- Sidewalk chalk
- Measuring tape (surveyor's tape ideal)
- Camera (optional)

Procedure

1. Research the four different Arctic whales and their body lengths.
2. In the schoolyard, divide into several groups (depending on space available) and measure and label each of whales according to their length.
3. Which is the longest whale? Which is the shortest?
4. Estimate how many students in your class would it take to equal the length of the whale.
5. Take pictures to compare their own body lengths with that of the whale. Students can line up on the ground, hold hands.
6. Back in the classroom, find the length of common objects: pencil, baseball bat, car, school bus, etc.
   Have students calculate the length of each whale using the numbers of common objects.

Extensions/Adaptations

- Create paper-mâché models of the different whales, or other art projects like a mobile that show the differences in the whale sizes.

Resources

- http://oceansnorth.org/narwhal-belugas-and-bowhead
- http://blog.wwf.ca/blog/2013/09/13/moving-killer-whales-arctic/

Activity 9: Try a Blubber Glove!

Activity Description

Students experiment with a blubber glove to see how fat is an effective insulate for Arctic animals.

Background Information

Many animals seen in the *Wonders of the Arctic* film have blubber to help keep them warm in the harsh, cold Arctic climate. Blubber is a thick layer of fat found on mammals, especially whales, seals, sea lions and polar bears. A key feature of mammals is the ability to thermoregulate (maintain a constant body temperature). For most mammals, hair and perspiration do the trick, but for humans, clothing and controlled environments substitute. Loss of body heat resulting in hypothermia can easily kill a mammal.

Body heat is lost through conduction in water and convection in air. To control this heat loss, whales, seals and polar bears have a layer of fat (blubber) to insulate from the cold and to help store energy from their food.

Materials

- Freezer lock bags (3 bags per blubber glove), size 9 inches x 7 inches
- 1 pound (500 g) of lard or © Crisco per bag
- Duct tape and clear duct tape
- Plastic tub for water
- Ice cubes
- Thermometer for measuring water temperature

Procedure: Making the Blubber Glove

We recommend making the gloves prior to this activity. Older students working in small groups can make 1 glove per group.

1. Lay two freezer bags side by side, with the sides touching.
2. Using clear duct tape, join the two touching sides.
3. Fill each bag with a ½ pound (250 g) of lard and spread evenly through the bags.
4. Seal the tops.
5. Fold over one bag onto the other.
6. Using clear duct tape, join the two sides and the bottom. You now have 2 bags joined together on three sides and open at the top.
7. Slip these two joined blubber bags into a third freezer bag.
8. Duct tape the top of the outside bag to the top of the 2 lard-filled bags, making sure you leave the center open.
9. You now have a 'blubber glove'!

Procedure

1. Explain that we are going to see first-hand how effective blubber can be.
2. Fill a plastic, tabletop tub with 5 inches (12 cm) of water and several trays of ice cubes. After a few minutes the water should be quite cold.
3. Put the thermometer into the water. Record the water temperature.
4. Take out your 'blubber glove' and place one hand inside it. With the other hand hold the edge of the glove so it does not slip off your hand and into the water.
5. Dip the glove with your hand inside into the water, making sure the water level does not go above the glove.
6. Wiggle your fingers inside the glove. Did your fingers feel the cold?
7. After 10 seconds, take the hand that was inside the glove out of the glove and immediately place it in the water.
8. What is your reaction?
9. Answer the following questions. Do you feel the difference? Absolutely, the water will feel very cold against the skin. Why do you think the blubber helps your hand stay warm? It insulates your hand from the cold. Why is it difficult to feel the cold water through the 'blubber' in the glove? The blubber is a barrier and keeps the heat in.

Extensions/Adaptations

- What is the thickness of blubber among different Arctic animals? Compare bowhead whales to walruses, and polar bears to seals.

References

- http://www.seaworld.org/infobooks/PolarBears/pbadaptations.html

Activity 10: Thick-billed Murre

Activity Description

Students compare the Arctic bird the thick-billed murre to that of a more familiar Antarctic bird, the emperor penguin. Students discover the similarities and differences between these two birds, their lifecycles and the ecosystems where they live.

Background Information


Photo: USFWS

A common bird of the far northern oceans, the thick-billed murre (Uria lomvia) is found in Arctic waters all across the globe and featured in the *Wonders of the Arctic* film. It remains up to the limits of pack ice in winter, using its wings to swim underwater to find its fish and invertebrate prey. The thick-billed murre is a member of the auk family and are the birds with black on the head, neck, back and wings with white under parts. Adult murres weigh about 2 pounds (1 kg) and are about 12 inches (30 cm) tall.

Murres are not good fliers or walkers, but are very good swimmers. They have smaller wings for the size of their bodies and so in order to take off from the water, they need to flap really fast and will often use the waves to help them lift off into the air. Murres use their wings to help propel them in the air and through the water.

The emperor penguin (Aptenodytes forsteri) is the tallest and heaviest of all living penguin species. Emperor penguins are only found in the Antarctic, with all species of penguins found only in the Southern Hemisphere. Emperor penguins cannot fly and the wings are different and flattened into flippers for swimming and diving.

Materials

- Paper
- Writing tools
- Computers with Internet connection
- Library books
- Internet resources
- Worksheet 6

Procedure

Introduce the research project as a way for students to learn a new animal, while comparing that animal to one they are already familiar with.

Students can work individually of in groups for their research project.

1. Brainstorm with students what they know about penguins.
2. Brainstorm with students what they know about murres.
3. Write down all of the students' knowledge and understanding of each of the birds.
4. Research and compare and contrast each bird.
5. Students may do this in a chart or report format.

Resources

- http://www.hww.ca/en/species/birds/murres.html
- http://www.livescience.com/34555-why-penguins-quit-flying.html

Worksheet 6: Thick-billed Murre

	Thick-billed Murres	Emperor Penguins
Physical Characteristics		
Geographic Range		
Habitat		
Diet		
Migration		
Communication		
Behavior		
Lifespan		
Reproduction		
Conservation Status		

Activity 11: Everyone Can Help: Get to Know an Endangered and Threatened Species

Activity Description

Students research a local endangered and threatened species of their choice and present their findings as a poster, brochure, booklet, song, dance, play, news report, morning announcement, or hall display.

Background Information

Many animals in the Arctic are threatened due to the melting ice sheets or from over hunting. Endangered and threatened species are not only found in the Arctic. They are found all over the world, including the United States, Canada and Europe. There are even endangered and threatened species in your local ecosystems!

Every successful conservation effort has relied on support and action from people. When it comes to the protection of wildlife, particularly endangered and threatened species, an understanding of individual organisms is very important.

This activity helps students gain a better understanding of local endangered and threatened species that interest them. Students present their research findings to the class, school, parents, community, or with whomever they decide to share.

Materials

- Internet resources
- "Protect Endangered and Threatened Species" Worksheet 7
- Paper
- Writing tools
- Computers with Internet connection
- Library books

Procedure

Introduce the research project as a way for the students to take what they've learned and teach others about how to protect Arctic endangered and threatened species.

Students can work individually or in pairs.

1. Research and choose an Arctic endangered and threatened species to study.
2. Complete the "Protect Endangered and Threatened Species" worksheet.
3. Research your information using the Internet and library books.
4. Create a product based on the research. Present the findings by making a poster, brochure, booklet, song, play, news report, morning announcement, or hall display. Your final product should include all of the items researched from the worksheet.

Extensions/Adaptations

Encourage your students to take part in your school's morning announcements, bulletin boards, and newsletters by teaching others how to protect endangered and threatened species.

Students can present their projects in character as if they are a researcher, television news reporter, or a teacher. They can also present as if they are the animal talking about itself.

Students may complete their projects online and present them using PowerPoint. They can also upload their projects to a school website.

Resources

- **Species at Risk – Canada**

  http://www.registrelep.gc.ca/default_f.cfm

- **U.S. Fish & Wildlife Service – Endangered Species**

  http://www.fws.gov/endangered/

- **Endangered Species**

  http://www.earthsendangered.com

Worksheet 7: Everyone Can Help: Get to Know an Endangered and Threatened Species

Group Members:

Species:

Status (extirpated, endangered, threatened, or special concern):

1. If your species is an animal, what does it eat? If your species is a plant, how does it obtain food?
2. Is your species a carnivore, herbivore, omnivore, or producer?
3. What type of habitat does your species need to survive?
4. Where can your species be found?
5. What kind of shelter does your species need?
6. What 'habitat components' does your species require to survive? (For example: rocks, logs, trees, mud, sand, etc.)
7. What natural and/or human factors have caused your species to become at risk?
8. What can people do to protect your species?

Activity 12: Ice Maps

Activity Description

Students get a better understanding in the changes of the Arctic ice over the last 14 years by creating their very own animated flipbook.

Background Information

The main theme of *Wonders of the Arctic* is the changes occurring in the Arctic due to changes in the sea ice. The Arctic ice pack, or Arctic ice cap, is a large area of pack ice formed from seawater of the Arctic Ocean. The Arctic ice packs significantly change in size and thickness during seasonal changes throughout the year. Although the Arctic ice changes seasonally, there is a trend that indicates that the northern cap is shrinking at rate of about 3 percent per decade.

In spring and summer, when melting occurs, the margins of the sea ice retreat. In September 2007, the Arctic Sea ice melted early, and rapidly fell to record low levels. This was the first time in recorded history that the Northwest Passage opened to ships without the need of icebreakers. In 2008, the Arctic Sea ice melted and both the Northwest Passage and the Northeast Passage were ice-free. This was the first time that both passages were open at the same time.

September 16, 2012 marks a new record low for Arctic sea ice.

Materials

- Arctic ice pack images printed on card stock (Worksheet 8)
- Scissors
- Stapler and staples

Procedure

Hand out printed copies of the Arctic ice pack images to students (Worksheet 8). Students can chose if they want to animate the September or March series of ice maps.

1. Cut out the images and stack them according to date (older to newer). Make sure to leave a white boarder at the top or side of the ice maps when cutting them.
2. Staple the images together on the white boarder.
3. Flip through the pages quickly to animate the melting ice in the Arctic.

Extensions/Adaptations

- Research existing animations of the melting Arctic ice pack.
- Draw your own ice maps to create a digital flipbook showing the melting Arctic ice.
- Create a collage with satellite images of the Arctic.

Resources

- http://nsidc.org/arcticseaicenews/

Worksheet 8: Ice Maps