LESSON 10: I SPEAK FOR THE POLAR BEARS!

The Relationship Between Arctic Sea Ice and Polar Bear Habitat

PURPOSE/QUESTION

Students will use NASA satellite data to study changes in temperature and snow-ice coverage in the South Beaufort Sea, Alaska, correlate with USGS ground tracking of polar bears, and relate this to global change, sea ice changes, and polar bear migration.

GRADE LEVEL

9-12

TIME TO COMPLETE

1-2 – 50 minute time periods

STANDARDS

See appendix below-page 7

LEARNING OUTCOMES

- Students will analyze maps and time series data to understand changes.
- Students will construct data-based explanations and conclusions.
- Students will better understand global change through a local case study.
- Students will consider the impact of environmental changes on wildlife.
- Students will consider the impact of human activities on life and the Earth.

STUDENT OBJECTIVES

- Access and collect albedo, shortwave radiation, and snow-ice data.
- Analyze and compare the data sets to evaluate seasonal and geographic patterns, as well as long-term trends.
- Compute a linear regression of the data
- Draw conclusions from dataset evidence

TEACHER BACKGROUND

The polar regions of the Earth (Arctic and Antarctic) have some of the most extreme climates on Earth with temperatures usually well below freezing all year. The Arctic polar region is mainly sea ice floating upon the Arctic Ocean, whereas the Antarctic region is a continent with permafrost, glaciers and surrounding sea ice. Scientists expect and are observing that global warming due to the increase of greenhouse gases will first impact the polar regions and the expanse of sea ice. Even a few degrees increase in temperatures will cause sea ice to break away and float into warmer waters. The melting of sea ice not only will prompt climate and weather changes, but it will also impact the ecosystem in the Arctic. Local impacts are already being seen on polar bear habitat, diet and migration patterns. In this lesson, you will explore the changes in temperature and sea ice coverage in the South Beaufort Sea, north of Alaska. You will then consider how the changes you observe in the data may affect the migration of polar bears in the region.

PREREQUISITES

- Familiarity with locating places on maps using latitude and longitude
- Familiarity with understanding color palettes on maps and reading line plots

MATERIALS & TOOLS

- Computer with Internet Access
- Color printer (optional)
- CCC Tech Tips – found on pg. 4

VOCABULARY

- climate
- difference plot
- global warming
- greenhouse effect
- temperature
- trend

LESSON LINKS

- Polar Bear Background Information (NWF)
- Polar Bear Habitat and Population Distribution (Polar Bears International)
- Polar Bear Catching, Tagging, and Tracking Animation (WWF)
- Polar Bear Migration - Sea Ice Change Animation (USGS)
- Animation of sea ice extent, 1979–2009, in Google Earth (NSIDC)
- Summary of polar bear population status per 2010 (IUCN/SSC PBSG)

ESSENTIAL QUESTIONS-PART 1

1. What kind of habitat do polar bears prefer and why?
2. What months of the year are polar bears most dependent on sea ice?
3. What would be the consequences of significant melting of Arctic sea ice?

PROCEDURE PART 1 – Learn about polar bears!

Polar bears are a threatened species. Understanding their structure and function in a changing habitat is critical to understanding their plight and to finding solutions to sustain and increase their populations.

1. Examine the first three ***Lesson Links*** to learn about polar bears, their habitat and migration patterns.
2. Examine the map of polar bear habitat and population distribution found in the lesson links.
3. Be prepared to take part in a class discussion regarding what you have learned about polar bears and the Arctic climate.

ESSENTIAL QUESTIONS-PART 2

1. Which year has more snow-ice amount in the Arctic?
2. Based on the pattern of sea-ice melting in 2007, which populations of polar bear are at greater risk? Use the map of polar bear habitat and population distribution available in the lesson links above.

PROCEDURE PART 2 – Create maps of snow-ice coverage in Google Earth

1. Sea-ice reaches its annual minimum each September, after which sea ice begins to build up again. Map snow-ice coverage for September 1994 and September 2007.
   a. In the Live Access Server (Advanced Edition), click on the ***Choose Dataset*** button. Then choose ***Cryosphere > Monthly Snow/Ice Amount (ISCCP)***. A map will automatically appear.
   b. Select Date: ***September 1994***
   c. In order to better see the extent of sea ice, we will use Google Earth to display the data. Google Earth shows the data on a sphere that you can rotate to easily see the Arctic region. Click the button ***Google Earth*** button at the top.
   d. A new window will pop up. Choose the option to open the file in Google Earth. Examine the resulting map.
   e. Repeat the same process for September 2007.

ESSENTIAL QUESTIONS-PART 3

1. Using the line plots examine the seasonal oscillations of the variables. Do you see any trends in the line plots? Look especially for any trends in the annual minimum each year.

2. Are the trends at this location consistent with what you expected based on the snapshot maps you created in Part 2?

3. We could get a more complete understanding of the year-to-year variability by looking at the maps of sea-ice extent for each month. Examine the movie of annual sea-ice extent provided in the lesson links. Based on this movie, what kind of trends do you see for the habitat location you selected? For the Arctic as a whole?

4. Would you expect to see any impact on the habitat and migration of polar bears based on your conclusions?

5. Do you think there is a global change trend or just a local random variation? Why?

PROCEDURE PART 3 – Examine year-to-year variability and trends at a single location

1. Pick one of the polar bear populations you identified as being at greater risk in Part 2. Determine the latitude and longitude of a location within the habitat area that lies over water. Let's examine the year-to-year variability in snow-ice coverage at this location. This will help us learn whether the changes observed during the two years are part of a longer-term trend or whether we just happened to pick unusual years.

2. Plot Monthly Snow-Ice Percent Coverage Time Series
   a. Return to the browser window where you were working in My NASA Data.
   b. Under "LINE PLOTS", select: ***Time Series***
   c. Enter the latitude and longitude for the location you selected into the appropriate boxes just below the small grey map on the left of the screen.
   d. Set the time settings in ***Date Range*** to be ***Sep 1994*** to ***Sep 2007***.
   e. Click ***Update Plot*** and a time series plot will appear.
   f. Save or print the resulting plot.

WEBSITES FOR FURTHER LEARNING

- On Thin Ice: Already struggling with pollution, oil drilling and other threats, can polar bears survive global warming's devastating effects?
- March of the Polar Bears: Global Change, Sea Ice, and Wildlife Migration

STUDENT READING RESOURCES

- Polar Bear Could Get Endangered Species Status
- Sea Ice
- Will Polar Bears Survive?
- Climate Change and Polar Bear Count

ASSESSMENT TOOLS

- **Concept Quiz – found on pg. 10**
- **Essay – found on pg. 13**
- **Foldables®**
- **Student Reading and Science Notebook Assessment Tool – found in the folder for this lesson**

REFERENCES

Adapted from MND lesson plan contributed by Venugopal Bhat, Seattle, Washington

LESSON 10-APPENDIX

Tech Tips for Eco-Schools USA Climate Change Connections Curriculum

How do I import data into an Excel spreadsheet?

1. Access data from My NASA Data:
    a. Once you have all the parameters set for your desired data set (and have clicked "Update Plot" to have your preferences processed), click the "Show Values" button. A new window will pop up with a Table of Values.
    b. The first several lines of the Table will provide information that describes the data set, often called "metadata", such as the name of the variable, what subset of the data is included in the file, and what time range. Make sure to keep this metadata with the rest of the data when you copy it into Excel. This way you'll be able to easily keep track of which data you have!
2. Copy the data from the browser (note that these instructions are for Internet Explorer running on a PC, and may need to be modified for other platforms):
    a. In this new window, select all. You can do this by clicking anywhere in the window and then typing "Ctrl-A". Or you can right-click in the window, which will pop up a menu, and then choosing "Select All" from the options.
    b. Next, copy this data. Again there are two options. You can use the keyboard shortcuts, and type "Ctrl-C". Or you can right-click and choose "Copy" from the pop-up menu.
3. Paste the data into Excel:
    a. Now open your Excel worksheet and go to the tab where you want to put the raw data. Click in the A1 cell.
    b. Paste the data, either by typing "Ctrl-V", by clicking "Paste" (located at the left under the "Home" tab), or by right-clicking in the A1 cell and choosing "Paste".
4. Convert the data from text to columns:
    a. Now, we have the data in Excel, but we can't manipulate it very well because all the data for each row is lumped into one cell. We want to split out each data value into its own cell.
    b. Starting at the row where the column headers are located (probably around row 7), highlight the A column down to the end of the data.
    c. Click on the Data tab at the top of the window, and then choose the "Text to Columns" wizard (located a little to the right of center).
    d. A dialogue box will pop up to help you through the process.
    e. The first page of the wizard asks you to identify whether the data is "Delimited" or "Fixed width". In most cases, the My NASA Data data will be "Fixed Width", so select that option and click "Next".
    f. The next page of the wizard gives you a chance to check whether the column breaks make sense and to adjust them as necessary. Make any changes that are needed. Or, go back and switch to "Delimited" on page 1 if you notice that the columns are not lining up as you expected. Once you are satisfied with the columns, click "Next".
    g. The final page of the wizard allows you to designate what kind of data values are in each column and a destination for the data. For the purposes of the CCC curriculum, we'll just accept the defaults and click "Finish".
    h. Now your data should be in beautiful columns and the values should make sense. It's always a good idea to double check that nothing crazy happened!

My NASA Data isn't working! What should I do?

1. Double check that you entered everything correctly. Especially check that you have the right data set and that you have entered dates and latitude/longitude values within the range of available data. Usually the user interface will prevent you from entering invalid data ranges, but sometimes there are glitches.
2. Refresh the browser and/or restart the browser. Occasionally, a fresh start is the easiest way to clear out any mistakes or glitches.
3. Update your browser and/or JAVA. If you have older versions of the software, then you might find that some functionality is lost.
4. If you're still struggling, consider whether problem might be at the My NASA Data website. It might be a temporary problem, in which case taking a break and returning to the site at a later time could be a good choice. Or it could be a more significant problem, in which case you'll want to explore the "help" resources provided by My NASA Data (link in upper right hand corner of page).
5. Ask your Eco-Schools contact for help or email eco-schoolsusa@nwf.org!

How do I print or save a map or graph?

1. Use the "Print" button to generate a version of your map or graph that is suitable for saving or printing. Once you click on the "Print" button, a new window will pop up with your map or graph.
2. Print a map or graph by using the print option on your browser.
3. Save a map or graph in one of two ways:
    a. By choosing "Save as" in the browser. Use the defaults to save as a "Web Archive, single file (*.mht)".
    b. By right clicking and choosing "Save picture as…" Use the defaults to save as a *.png file.
4. When saving, make sure to give your new file a descriptive name and put it somewhere that you'll remember!

How do I find my latitude and longitude?

A number of sites help you find your latitude and longitude. For example:

1. http://itouchmap.com/latlong.html
2. http://www.findlatitudeandlongitude.com/

LESSON 10 - APPENDIX

WEB ADDRESSES FOR HYPERLINKS

PREREQUISITE KNOWLEDGE AND SKILLS

- **Latitude and longitude**
  http://itouchmap.com/latlong.html
- **Color palettes**
  http://geography.about.com/od/understandmaps/a/mapcolors.htm
- **Line plots**
  http://www.wtamu.edu/academic/anns/mps/math/mathlab/beg_algebra/beg_alg_tut9_bar.htm

VOCABULARY

- **Climate**
  http://mynasadata.larc.nasa.gov/science-glossary/?page_id=672?&letter=C
- **Difference plot**
  http://mynasadata.larc.nasa.gov/science-glossary/?page_id=672?&letter=D
- **Global warming**
  http://mynasadata.larc.nasa.gov/science-glossary/?page_id=672?&letter=G
- **Greenhouse effect**
  http://mynasadata.larc.nasa.gov/science-glossary/?page_id=672?&letter=G
- **Temperature**
  http://mynasadata.larc.nasa.gov/science-glossary/?page_id=672?&letter=T
- **Trend**
  http://mynasadata.larc.nasa.gov/science-glossary/?page_id=672?&letter=T

LEARNING LINKS

- **NWF – Polar Bear Background Information**
  http://www.nwf.org/Wildlife/Wildlife-Library/Mammals/Polar-Bear.aspx
- **PBI – Polar Bear Habitat and Population Distribution**
  http://www.polarbearsinternational.org/about-polar-bears/tracking/population-and-distribution
  WWF – Catching, Tagging, and Tracking animation
  http://wwf.panda.org/what_we_do/where_we_work/arctic/wildlife/polar_bear/tracker/
- **USGS – Polar Bear Migration – Sea Ice Changes animation**
  http://alaska.usgs.gov/science/biology/wandering_wildlife/ww_polarbear.swf
- **NSIDC – Animation of Sea Ice Extent 1979-2009 (Google Earth)**
  http://nsidc.org/images/arcticseaicenews/20091005_Figure6.mov
- **IUCN/SSC PBSG – Summary of Polar Bear Population Status per 2010**
  http://pbsg.npolar.no/en/status/status-table.html

WEBSITES FOR FURTHER LEARNING

- **On Thin Ice…An article about the plight of the polar bear related to the book by Richard Ellis.**
  http://www.nwf.org/News-and-Magazines/National-Wildlife/Animals/Archives/2007/On-Thin-Ice.aspx
- **March of the Polar Bear… - This is a lesson on the My NASA Data website if you have student who may be interested in doing some independent research.**
  http://mynasadata.larc.nasa.gov/preview_lesson.php?&passid=90

STUDENT READING RESOURCES

- **Polar Bears Could get Endangered Species Status**
  http://www.care2.com/greenliving/polar-bear-could-get-endangered-species-status.html
- **Sea Ice**
  http://earthobservatory.nasa.gov/Features/SeaIce/
- **Will Polar Bears Survive?**
  http://www.polarbearsinternational.org/polar-bears/will-polar-bears-survive
- **Climate Change and Polar Bear Counts**
  http://www.polarbearsinternational.org/polar-bears/climate-change#Changing%20Climate

LESSON 10-STANDARDS

National Science Education Standards

Unifying Concepts and Processes

- Systems, Order, and Organization
- Evidence, Models, and Explanations
- Change, Constancy, and Measurement
- Equilibrium

Standard A – Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Standard B – Physical Science

- Conservation of energy
- Interactions of energy and matter

Standard C – Life Science

- Interdependence of organisms
- Matter, energy, and organization in living systems

Standard D – Earth and Space Science

- Energy in the earth system
- Geochemical cycles

Standard E – Science and Technology

- Abilities of technological design
- Understandings about science and technology

Standard F – Science in Personal and Social Perspectives

- Natural resources
- Environmental quality
- Natural and human induced hazards
- Science and technology in local, national, and global challenges

Standard G – History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

National Education Technology Standards

N/A

National Council of Teachers of Mathematics

Measurement

- Understand measurable attributes

Process

- Connections
  - Recognize and apply mathematics in contexts outside of mathematics

Climate Literacy Principles

Principle 1: The sun is the primary source of energy for Earth's climate system.
Principle 2: Climate is regulated by interactions among components of the Earth system.
Principle 3: Life on Earth depends on, is shaped by, and affects climate.
Principle 4: Climate varies over space and time through both natural and man-made processes.
Principle 5: Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
Principle 6: Human activities are impacting the climate system.

Energy Literacy Principles

Principle 3: Biological Earth processes depend on energy flow through the earth system.
Principle 7: The energy choices made by individuals and societies affect quality of life.

LESSON 10-ESSENTIAL QUESTIONS ANSWER KEY

Essential Questions-1

1. What kind of habitat do polar bears prefer and why?
   [Polar bears primarily live on sea ice, near the ice edge, or on islands. These places allow the polar bears to hunt for seals, their favorite food.]

2. What months of the year are polar bears most dependent on sea ice?
   [Polar bears do most of their feeding during the summer and fall. They are most dependent on sea ice in the fall months, when they are trying to put on weight before hibernating for the winter.]

3. What would be the consequences of significant melting of Arctic sea ice?
   [As sea ice melts, polar bears will have to swim further to find food and habitat. This will lead to underweight bears and likely an increase in polar bear mortality.]

Essential Questions-2

1. Which year has more snow-ice amount in the Arctic?
   [1994]

2. Based on the pattern of sea-ice melting in 2007, which populations of polar bear are at greater risk? Use the map of polar bear habitat and population distribution available in the lesson links above. [Southern Beaufort Sea, Chukchi Sea, Laptev Sea, Kara Sea, …]

Essential Questions-3

1. Using the line plots examine the seasonal oscillations of the variables. Do you see any trends in the line plots? Look especially for any trends in the annual minimum each year.
   [Depends on location chosen. Most will show a decreasing trend, especially for the September minimum values.]

2. Are the trends at this location consistent with what you expected based on the snapshot maps you created in Part 2?
   [Depends on location chosen.]

3. We could get a more complete understanding of the year-to-year variability by looking at the maps of sea-ice extent for each month. Examine the movie of annual sea-ice extent provided in the lesson links. Based on this movie, what kind of trends do you see for the habitat location you selected? For the Arctic as a whole?
   [Depends on location chosen. Most all locations will show a decrease.]

4. Would you expect to see any impact on the habitat and migration of polar bears based on your conclusions?
   [Yes, I would expect that this decline in sea ice would have a major impact on polar bear habitat.]

5. Do you think there is a global change trend or just a local random variation? Why?
   [Looks like a global change trend because the impacts are so widespread.]

Name: _____ Date: _____

Science Concept Quiz
Lesson 10: I Speak for the Polar Bears!
The Relationship between Arctic Sea Ice and Polar Bear Habitat

As sea ice declines polar bear habitat also declines. Polar bears are a part of a delicate food chain and a larger food web of which powerful ramifications can occur if significantly disturbed. **Which statement is true based on your prior knowledge and work on lesson 10?**

algae → shrimp → arctic cod → ringed seals → polar bears

A. If the polar bears move to a new location to meet their basic needs then arctic cod population will increase.

B. If the shrimp population is taken out of the equation the arctic cod and ringed seal population will double.

C. If the ringed seals population has increased then a potential cause could be a decline in algae and shrimp populations.

D. If the arctic cod is taken out of the equation there will be a sharp decrease in the algae population and an increase in the shrimp population.

_____ points out of 20
I. Answer
A.○ B.○ C.○ D.○

_____ points out of 15
II. What is the main concept behind the question?
1. Polar bear habitat
2. Collecting evidence
3. Food chains
4. Making predictions

_____ points out of 25
III. Provide the reasoning for choosing your answer in part II.

_____points out of 40

IV. Why are the other responses in part I not the best answer choice?

1.

2.

3.

4.

Use the rest of this page if more room is needed to fully communicate your thoughts.

Teacher Answer Key

1. D

2. 3

3. Answers will vary. Knowledge of food chains and larger food webs will allow the questions to be answered successfully.

4. Answers will vary.

   A) Arctic cod populations will decrease not increase because the seal populations will more than likely increase since their main predator has moved on.

   B) Arctic cod relies on the shrimp as a major source of food, so its populations will not double but will probably decrease and if the cod populations decrease so will the seal populations.

   C) This is not the cause for the increase in the cod population. If this occurred there would be a decrease as each part of the food chain decreased in population size. A more likely cause for the increase in cod populations is that polar bear populations have declined.

   D) This is the correct answer. If arctic cod is taken out of the equation then algae will sharply decrease because there are so many more shrimp without cod predation and the shrimp's main source of food is the algae.

Student Name
Teacher/Class
Date

Lesson 10: I Speak for the Polar Bears!
The Relationship between Arctic Sea Ice and Polar Bear Habitat

Based on your analyses, collaborations, and writings provide evidence for understanding how Arctic sea ice has changed over a 13 year time period and how this has affected polar bear migration.

What Is the Expectation?

Accurate science relating to arctic sea ice and polar bear habitat

Evidence supporting your claims
Visual representations

Key vocabulary

Evidence of on grade level spelling and grammar usage