Impact of a Changing Climate on the Pacific Walrus

Region: Polar / Subpolar

Grade Level(s): 5-8

Time Required: 2 – 3 class periods

Focus Question(s):

- How will long term climate changes impact Pacific walrus populations?
- What role does ice play in the food web, physical conditions of the environment, and the life habits of the walrus?

Learning Objectives:

- Students will develop an understanding of the impact of loss of sea ice on walrus populations.
- Students will develop an understanding of and model the northern Bering Sea food web and impacts on the ecosystem when the food web is altered.
- Students will develop an understanding of the importance of collecting population data and of why it is difficult to make policy decisions without these data.
- Students will develop an understanding of the cultural impacts of policy decisions concerning marine mammals like the Pacific walrus in order to protect their populations.

Activity 1: Bering Sea Food Web

Materials:

- White paper (preferably large pieces of bulletin board paper or poster board) enough for groups of 2-3 students to each have a sheet
- Pencils, color pencils, crayons, markers
- Scissors
- Glue sticks
- Tape
- Ball of yarn, roll of string, or twine – preferably a bright color

Background Knowledge:

- See Polar/Sub-polar Eco-region case study and internet resources on Bering Sea ecology.

Procedures/Instructional Strategies:

1. Review with students the concept of food webs and possible impacts on other populations of plants and animals when any part of the food web – be it a producer or consumer – is removed.
    - Use a food web from your local area as an example. See also steps 5 and 6, below.
    - Help provide students with a sense of place by using a map to locate the northern Bering Sea and point out its physical geology and climate conditions.

2. As a class, create a list of the members of the food web in the northern Bering Sea. The teacher may have students do research to generate the list or, for time-saving purposes, provide the list for the students. The list should include, but is not limited to the following:
    - Algae
    - Zooplankton
    - Phytoplankton
    - Copepods
    - Shrimp
    - Clams
    - Mussels
    - Hermit crabs
    - Snow crabs
    - Brittle stars (ophiuroids)
    - Sea stars (formerly starfish)
    - Predatory marine snails
    - Algae-eating marine snails
    - Sculpin (a wide-mouthed bottom feeding fish)
    - Worms (benthic infauna that live in the mud)
    - Cod, Pollock, herring, flounder, and other fish
    - Ice seals (bearded, ringed, ribbon, spotted)
    - Walrus
    - Toothed whales (killer, beluga, etc.)
    - Baleen whales (grey, bowhead, etc.)
    - Polar bear
    - Diving ducks (eider)
    - Other birds (flumar, cormorant, petrel, gull, kittiwake, tern, auk, puffin, murre, etc.)
    - Humans

3. Place students in groups of two or three. Have groups use the white paper to draw the northern Bering Sea food web. They should show or identify trophic levels, predator/prey relationships, and demonstrate the interconnectivity between the members. Students can draw the animals themselves, look for pictures in magazines, or use the internet to print and cut pictures to paste onto the paper.

4. Display student work on classroom or hallway walls and invite students to constructively compare the attributes of each group's food web.

5. Write (or have students write) the names of the members of the food web, using large letters, on index cards and tape them to their chest or shoulder. Move to a large open area either by spreading the class out to the perimeters of the classroom, going outside or to the gym, and have students spread into a circle. Have the student labeled algae to hold on to one end of the ball of yarn and toss the ball to the next member of the food web that eats algae, like clams. Then clams should still hold on to the yarn and toss the ball to the next food web member that would eat them or be eaten by them. The predator/prey relationship can be demonstrated both ways. The goal is to create a spider web of the yarn.

6. After the web is created, have students think of scenarios that might cause one or more of the members to disappear and then have that student drop their piece of the web and let students observe and reflect as a group on the impact that collapsed part of the web has on other members that are connected to it. Example: If the clams were unable to tolerate warmer temperatures of the sea water and their populations were to decline, the student labeled clams would drop their hold of the yarn in the web and the effect would be to see a large section of the web collapse because several other organisms depend on clams as a food source.

7. Have students complete the "Northern Bering Sea Food Web" sheet.

Extensions:

- Have students research and write a report, make a brochure, create a poster, etc. on any of the animals in the northern Bering Sea food web and give a presentation to the class. Include habitat, scientific name, behavior, adaptations to living in a cold environment, gestation, etc.

- Have students follow a Polar TREC teacher's web journal as they travel with a team of scientists through the Bering Sea and the Arctic Ocean. Depending on the grade level, the teacher can use scaffold reading techniques and model reading by reading the journals to the class out loud as they are updated on the web. The teachers often report on what the scientists are studying and often include pictures of the animals they encounter, the scientists, and themselves in this eco region. http://www.polartrec.com/

Activity 2: Walrus Population Graphing Exercise (more advanced)

Materials:

- Graph Paper
- Pencil

Background Knowledge:

- Because Pacific walrus populations are spread over large areas in the Bering Sea and Arctic Ocean, scientists have had to rely on airplanes to conduct aerial surveys of walrus populations. Long term data from walrus populations is sparse and inconsistent. Survey methods and methods of population estimates have varied widely over the years, but the use of satellite technology in helping with population estimates is beginning to prove promising. So, even without a large amount of long-term data for comparisons, scientists believe they are beginning to collect reliable evidence that walrus populations are in decline. It is well documented that sea ice cover, and thus walrus habitat, has been significantly reduced in the last few decades due to rising sea surface temperatures. Also, reports from researchers working in the Bering Sea over the last several years have included anecdotal evidence of stranded walrus calves sitting on the ice edge without their mothers for extended periods of time. This anecdotal evidence includes accounts of under-weight walrus calves and female walruses. See article on stranded walrus calves here: http://www.whoi.edu/oceanus/viewArticle.do?id=13087 For more information, research other Internet resources on Bering Sea ecology.

Procedures/Instructional Strategies:

1. Review the life habits and habitat requirements of walruses with the class. Discuss how limitations on habitat, space, food source, environmental stresses, and hunting/poaching can affect seasonal populations of a herd. The teacher should guide the discussion toward loss of sea ice as a loss of habitat and a limitation to food source access.

2. Discuss potential ways to protect walruses if the population is in decline. Students may mention putting the walrus on the Federal Endangered Species List and making laws against hunting them or doing anything to harm them. They may also mention reducing global warming so that the remaining ice might be prevented from disappearing. This is a great opportunity to introduce discussion topics like the federal process to put a species on the endangered or threatened list, subsistence hunting and the culture of native human populations, and ways to reduce greenhouse gas emissions or otherwise mitigate global warming.

3. Policy makers usually need evidence that tells them that the population is decreasing before they enact laws to protect a species. Ask students the following questions:
    a. What kind of data do we need to study walrus populations?
    b. How do we know if walrus populations are in decline?
    c. How could we draw a picture to illustrate whether walrus populations are in decline or on the rise?

4. Review the concept of graphing with students including types of graphs, independent and dependent variables, scale, and the purpose and usefulness of graphs.

5. Use the following data table to graph the Pacific walrus population. Have the students complete the "Walrus Population Graphing Exercise" sheet. Depending on grade and ability level, the teacher may want to assist in setting up the x and y axes.

6. NOTES: This is a great opportunity for a class discussion on the appropriate type of graph to use and how to set up the time scale.
    a. A line graph would show change in the population over time.
    b. A line of best fit graph would show population trend.
    c. Graphs produced using a larger time scale might show a much more pronounced trend while graphs using a smaller scale might show a less apparent trend in population growth/decline. Notice in the table that the references for the data are all different. Each research team used a slightly different method of estimating the walrus populations. A class discussion can be facilitated and/or a research project by students conducted to determine what evidence the Endangered Species Act requires of the U.S. Fish and Wildlife Service in order to put an animal (in this case the walrus) on the Threatened and Endangered Species List. The discussion can include questions about validity and reliability of data, population trends analysis, federal "acts" and how they are actually carried out. The discussion can be carried through experimental design as well.

Pacific Walrus Population Data Table

Aerial survey estimates of the Pacific walrus population, 1975 – 1990.

Year	Population Estimate	References
1975	221,350	Estes and Gilbert 1978, Estes and Gol'tsev 1984
1980	246,360	Johnson *et al*. 1982, Fedoseev 1984
1985	234,020	Gilbert 1986, 1989, Fedoseev and Razlivalov 1986
1990	201,039	Gilbert *et al*. 1992

[Source: U.S. Fish & Wildlife Service, Marine Mammals Management. Stock Assessment Reports. Pacific Walrus (*Odobenus rosmarus divergens*): Alaska Stock. Revised 12 July 2002. Anchorage, Alaska.]

Extensions:

- Have students research the Federal Endangered Species Act and the process and qualifications for adding or removing a species to or from the list.
- Have students research subsistence hunters and how culture and available resources become a factor when determining how to protect an animal that certain human populations depend on for survival.
- Have students read more about current population sampling techniques that include using satellite thermal imagery. NASA, Ames Research Center, NASA Ice Images Aid Study of Pacific Walrus Arctic Habitats: http://www.nasa.gov/centers/ames/research/2006/walrus.html

Extensions:

- On Google Earth, note the areas along the Bering Sea where populations of subsistence hunters are located.
- Compare the geomorphology of the entire Bering Sea. Notice there are two main ocean zones and compare/contrast the communities that dominate each.
- Study algae as an extremeophile. How is algae able to live on the underside of the ice?
- Class debate: Determine possible strategies for subsistence hunter populations in the Bering Sea to deal with climate change? What will they do when there is no more ice to bring them walrus, seals, and grey whales? Who should decide?

National Science Education Standards Addressed (Content Standards 5-8):

Life Science:

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Earth and Space Science:

- Structure of the earth system

Physical Science:

- Properties and changes of properties in matter
- Transfer of energy

Name:
Date:
Class:

Northern Bering Sea Food Web
Student Assessment Sheet

Answer the following questions in complete sentences unless otherwise stated. You may use a separate sheet of paper.

1. Which member(s) of the northern Bering Sea food web are the producers? How does this compare with the food web where you live?

2. Which members of the northern Bering Sea food web are the primary consumers? What do they eat and where do they live?

3. Which members of the northern Bering Sea food web are the secondary consumers? What do they eat and where do they live?

4. Which members of the northern Bering Sea food web are the tertiary consumers? What do they eat and where do they live?

5. Which members of the northern Bering Sea food web help break down organic matter (or aid in decomposition)? What do they eat and where do they live?

6. Choose and describe a predator/prey relationship in the northern Bering Sea food web.

7. Sea ice is disappearing at an alarming rate due to climate change. Describe the possible impacts through the food web beginning with the algae and ending with humans.

Northern Bering Sea Food Web
ANSWER KEY

Students should have answered the following questions in complete sentences. A separate sheet may be used. All answers may vary to some degree.

1. Which member(s) of the northern Bering Sea food web are the producers? How does this compare with the food web where you live?
    a. Algae that grows on the edges and underneath the sea ice and phytoplankton that floats in the water. Answers may vary depending on location.

2. Which members of the northern Bering Sea food web are the primary consumers? What do they eat and where do they live?
    a. Primary consumers include clams and mussels that filter the algae out of the water. They live on the bottom of the Bering Sea on the shallow continental shelf.

3. Which members of the northern Bering Sea food web are the secondary consumers? What do they eat and where do they live?
    a. Secondary consumers include diving ducks such as eiders and walruses who both eat clams. They both live on the surface of the Bering Sea. The eiders float on top of the water while walruses live on the ice.

4. Which members of the northern Bering Sea food web are the tertiary consumers? What do they eat and where do they live?
    a. Tertiary consumers include humans and polar bears. Native subsistence hunters depend on hunting for food. They live on land in coastal communities that are often surrounded by ice during certain periods of the year. Polar bears live on the ice and land.

5. Which members of the northern Bering Sea food web are decomposers? What do they eat and where do they live?
    a. Decomposers include hermit crabs and worms that feed on detritus in or on top of the mud at the bottom of the Bering Sea.

6. Choose and describe a predator/prey relationship in the northern Bering Sea food web.
    a. Answers may vary.

7. Sea ice is disappearing at an alarming rate due to climate change. Describe the possible impacts through the food web beginning with the algae and ending with humans.
    a. The algae mainly depends on the sea ice as a substrate to grow on near the surface of the sea so that it can receive the sunlight it needs to photosynthesize. Without the sea ice, this producer and base of the food web is reduced. The effects of this reduced food source ripple through the food web. If there is not enough food for the organisms, then their populations will be reduced due to the limited food source. Eventually, as the populations of marine mammals are reduced, then the native communities of humans that feed on them will have to

look for another food source or they will not survive. Students should provide more detail on a path through the food web.

Name:
Date:
Class:

Walrus Population Graphing Exercise
Student Assessment Sheet

Use the following data table to graph the Pacific walrus population estimates on a separate sheet of graph paper. Be sure to title your graph and label your axes correctly. Check with your teacher about what type of graph you should use and how you should determine your scale. When you are finished, answer the questions below in complete sentences unless otherwise stated. You may use a separate sheet to answer the questions.

Pacific Walrus Population Data Table
Aerial survey estimates of the Pacific walrus population, 1975 – 1990.

Year	Population Estimate	References
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[Source: U.S. Fish & Wildlife Service, Marine Mammals Management. Stock Assessment Reports, Pacific Walrus (*Odobenus rosmarus divergens*): Alaska Stock. Revised 12 July 2002. Anchorage, Alaska.]

Questions:

1. What type of graph did you use and why?

2. Which axis contains your independent variable? Explain.

3. Which axis contains your dependent variable? Explain.

4. Compare the scale you used on your graph and the way your graph turned out to a classmates' graph who used a different scale. How are they different and how are they the same? Do they both indicate the same overall picture about the walrus population.

5. Notice that the data for each year was collected by different researchers during different studies. Explain how this might affect the data. Does it seem to make the data more or less credible?

Walrus Population Graphing Exercise
ANSWER KEY

Use the following data table to graph the Pacific walrus population estimates on a separate sheet of graph paper. Be sure to title your graph and label your axes correctly. Check with your teacher about what type of graph you should use and how you should determine your scale. When you are finished, answer the questions below in complete sentences unless otherwise stated. You may use a separate sheet to answer the questions.

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Questions:

1. What type of graph did you use and why?
   a. Line graph to show change in population over time.
   b. Line of best fit shows population trend to extrapolate.

2. Which axis contains your independent variable? Explain.
   c. The x axis should contain the independent variable, years, because that is what determines the population estimate.

3. Which axis contains your dependent variable? Explain.
   d. The y axis should contain the number of walruses. The number of walruses depends on or is determined by the year.

4. Compare the scale you used on your graph and the way your graph turned out to a classmates' graph who used a different scale. How are they different and how are they the same? Do they both indicate the same overall picture about the walrus population.
   e. Answers may vary.

5. Notice that the data for each year was collected by different researchers during different studies. Explain how this might affect the data. Does it seem to make the data more or less credible?
   f. Answers may vary, but essentially, it is difficult to determine if this data is useful for determining a trend in the walrus populations because each of the studies was done differently and therefore may have been inconsistent with each other in a variety of ways.