



## Activity 1.6: Food for Thought: Climate Change and Trophic Cascades

**Grades 7 – 9**

**Description:** Students will read an article about the impact of melting ice on the Arctic food web. Students will diagram food webs with and without the effects of climate change, and will learn the concept of a “trophic cascade.”

**Total Time:** One to two class periods

**Materials:**

**Part 1**

- Copy of article or link to “Arctic Bears, the Melting Arctic’s Impact on Its Ecosystem”  
<http://www.pbs.org/wnet/nature/episodes/arctic-bears/the-melting-arctics-impact-on-its-ecosystem/780/>
- Copies of student handout “Climate Change and Arctic Ecosystems”
- White butcher paper
- Optional access to computer with internet
- Optional LCD projector to show preview arctic bear video PBS’s *Nature* “Arctic Bears”  
<http://www.pbs.org/wnet/nature/episodes/arctic-bears/introduction/778/>

### National Science Education Standards

**C4a** A population consists of all the individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

### AAAS Benchmarks

**5D/M4** All organisms, both land-based and aquatic, are interconnected by their need for food. This network of interconnections is referred to as a food web. The entire Earth can be considered a single global food web, and food webs can also be described for a particular environment. At the base of any food web are organisms that make their own food, followed by the animals that eat them, then the animals that eat those animals, and so forth.

**5E/H3** The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment. Continual input of energy from sunlight keeps the process going.

### Guiding Questions

- What is a trophic cascade?
- How can climate change set a trophic cascade in motion?

### Assessment

- Polar bear reading worksheet



## Background Information

Unit 1 has provided the students with an understanding of how food webs function under normal conditions. This lesson highlights how climate change can affect these systems in such ways as a “trophic cascade.” This is the “...effect of population change: in a food web, the cascading effect that a change in the size of one population in the web has on the populations below it.” (encarta.msn.com) Students with no prior knowledge of arctic (north pole) ecosystems may need help with a basic understanding of typical temperatures, organisms, and geographic location of the arctic region.

## Vocabulary

- **Trophic Level:** The position an organism occupies in a food chain. Trophic levels are often represented by numbers, starting at level 1 with primary producers such as plants. Further trophic levels are numbered subsequently according to how far the organism is along the food chain.

Level 1: Plants and algae make their own food and are called primary producers.

Level 2: Herbivores eat plants and are called primary consumers.

Level 3: Carnivores that eat herbivores are called secondary consumers.

Level 4: Carnivores that eat other carnivores are called tertiary consumers.

Level 5: Apex predators that have no predators are at the top of the food chain.

The path along the chain can form either a one-way flow, or a food "web." In real world ecosystems, there is more than one food chain for most organisms, since most organisms eat more than one kind of food or are eaten by more than one type of predator. Ecological communities with higher biodiversity form more complex trophic paths.

- **Keystone Species:** A species that exerts a large, stabilizing influence throughout an ecological community, despite its relatively small numerical abundance. Often, keystone species are the larger carnivores in an ecosystem. In a woodlands ecosystem, the wolf is a keystone species. Decreasing the wolf population may result in a trophic cascade.
- **Trophic Cascade:** The effects of a change in population or behaviors of one or more species in an ecosystem on the other species populations in that ecosystem. One example of a trophic cascade resulting from the loss of a keystone species is the extirpation of gray wolves (*Canis lupus*) from Yellowstone National Park. The long absence of wolves has resulted in a “cascade” of effects:
  - Large herbivores, such as elk or deer, increased in number, and foraging behavior changed significantly.
  - These animals over-browsed preferred plants, especially deciduous trees and shrubs like cottonwood, aspen, willow, and oaks, and spent more time in riparian areas.
  - As a consequence, “recruitment” of cottonwood and aspen (i.e., the growth of seedling/sprouts into tall saplings and trees) was drastically reduced, and uncommon plants became rare or were disappeared completely.
  - Long-term loss of streamside vegetation caused major changes in channel morphology and floodplain function.



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- Loss of berry-producing shrubs, and young aspens and cottonwoods, led to changes in the diversity and abundance—and sometimes the outright loss—of other species, including beaver, amphibians, and songbirds.
- The disappearance of top predators triggered an explosion of smaller “mesopredators,” such as coyotes, which led to further cascading effects.

Gray wolves were reintroduced in 1995, and were removed from the endangered species list in 2008.

### Procedure

1. Ask the students:

- What do you know about polar bears?
- In what region of the world do they live?
- Describe typical the characteristics of the Arctic region. Describe the temperature, flora, and fauna of the arctic region.
- How do you think the arctic region is relevant to you and climate change?

**Note:** It is a VERY common misconception that penguins and polar bears are found in the same region. However, polar bears live in the Arctic (North Pole), while penguins live in the Antarctic region (South Pole). It may help students to visualize that polar bears can be found in Alaska, Canada, and Russia, and penguins can be found in South Africa, Australia, and Argentina.

2. Distribute the student handout called “ Climate Change and Arctic Ecosystems.”
3. Give students five minutes to try the pre-reading activity alone and then go through it with the class.
4. You can introduce polar bears with a short five minute PBS production: *Nature* “Arctic Bears” <http://www.pbs.org/wnet/nature/episodes/arctic-bears/introduction/778/>
5. After showing the video, have students individually read “Arctic Bears: The Melting Arctic's Impact on Its Ecosystem” from *Nature* magazine. <http://www.pbs.org/wnet/nature/episodes/arctic-bears/the-melting-arctics-impact-on-its-ecosystem/780/>. If you have individual paper copies of the article for each student, have them circle the name of each organism that they read, ask them to begin to picture the food web of interacting arctic organisms. Also, ask the students to underline anything they find interesting, and to write a question mark next to any part of the article that is confusing.
6. After students read the article individually and fill in their handout, have students work together in groups of three or four to create a diagram of the food web that the polar bear is part of, and identify the impacts of changing climates on each component of the ecosystem. (They may want to look up photos of the other organisms in the food web.) They should also share and list interesting and key points of the article, vocabulary, and concepts that they do not understand.



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7. Closure: Small groups report out their findings from the article. Make a group list of findings on the board, and include a column for concepts of the article that students do not understand. Emphasize the final point that we all rely on healthy ecosystems to provide clean air, clean water, food, and oxygen.



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**Extensions:**

- Students could read local articles about animals outside of their habitat. This article can be compared and contrasted to the Arctic Bear article. “Cougar Shot in Chicago; Was 1,000 Miles from Home?” <http://news.nationalgeographic.com/news/2008/04/080417-cougar-shot.html>
- Show class the full video of arctic bear or just use snippets for introduction: PBS’s *Nature* “Arctic Bears” <http://www.pbs.org/wnet/nature/episodes/arctic-bears/introduction/778/>
- Evolution focus: <http://www.pbs.org/wnet/nature/episodes/arctic-bears/how-grizzlies-evolved-into-polar-bears/777/>
- *National Geographic* – “Strange Days on Planet Earth: The One Degree Factor” <http://www.pbs.org/strangedays/episodes/onedegreefactor/#>

**Useful Websites:**

- Local animal out of habitat article: <http://news.nationalgeographic.com/news/2008/04/080417-cougar-shot.html>
- Impact of arctic bear habitat: <http://www.pbs.org/wnet/nature/episodes/arctic-bears/the-melting-arctics-impact-on-its-ecosystem/780/>



Name \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

## Climate Change and Arctic Ecosystems

### Pre-Reading: Build a Food Chain

1. Three common organisms from the arctic are **lemmings** (a small rodent), different **mosses**, and the **arctic fox**. By listing the names and using arrows, try to put the organisms into a simple food chain. Label any trophic levels (producer, primary consumer, etc.) that you can.

### Post-Reading: read the online article and then answer the following questions

<http://www.pbs.org/wnet/nature/episodes/arctic-bears/the-melting-arctics-impact-on-its-ecosystem/780/>

2. What could happen to your food chain from #1 if the Arctic continues to warm rapidly? Draw a new food chain and give a written description of the changes that will occur.

3. Click on the video tab at the right of the website (or view the video with your instructor) “Video: Polar Bears Make a Difficult Decision”

<http://www.pbs.org/wnet/nature/episodes/arctic-bears/video-polar-bears-make-a-difficult-decision/782/>

- a. Explain the “choice” that the bears are making in the video.

- b. What is happening to polar bear populations?

