Antarctic Food Web

Overview

The western Antarctic Peninsula has become the fastest winter warming location on Earth. Air temperatures in Antarctica have increased dramatically within the past 50 years and have resulted in a significant decrease in the extent of sea-ice formed during the winter. This reduction in winter sea-ice has not only impacted the physics of the region but the biology as well. For instance, it has resulted in a reduction in the numbers of krill, tiny crustaceans, and an increase in the numbers of salps, small organisms that have been described as "bags of water."

Krill are more successful at times when there is more winter sea ice. The sea ice provides a refuge for krill and their larvae. It protects them from predators and provides them a food source in the form of larger ice algae, which grow in the small cracks on the bottom of the sea ice. Salps, on the other hand, prefer open water and warmer temperatures. They are also able to eat the smaller free floating algae that krill cannor. Thus, the reduction in sea ice as a result of climate change has led to a shift from krill dominated waters to those teeming with salps.

This transition from krill to salps could have devastating effects on the Antarctic food web. Krill are a major food source for many Antarctic predators, including seals, penguins, whales, fish, and birds. Meanwhile, salps are less nutritious than krill and are not the main source of prey for many organisms. As a result, the decrease in krill availability and increase in salps could cause a major disruption in the survival of upper level predators. In this activity, each group will be running a model of possible impacts to marine life as the amount of sea ice is reduced because of climate change.

Motivating Question: **How will the Antarctic food web change due to the melting of ice sheets? What will happen to the marine mammals like seals and whales?**

Materials

- ✓ Whiteboard or chart paper and a marker
- ✓ Antarctic Food Web (1/student or 1 enlarged)
- ✓ Before and After Figure (1/student) optional
- ✓ Game directions (1/group)
- ✓ Predator cards (1 set/group)
- ✓ Game boards (1 set/group)
- ✓ 6-8 copies of the krill, salps, ice algae, and free floating algae cards
- ✓ Hole punch
- ✓ Red and white construction paper
- ✓ Plastic sandwich bags (4/group)

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Activity Outline

Engage:	This activity will help the students convey their understanding about the organisms that are found in Antarctica and reveal previous conceptions about food webs. Also, it will provide the instructor with information on their background in this area.	10 minutes
Explore:	This activity seeks to introduce food webs. Students will explore how energy is transferred between trophic levels.	30 minutes
Make Sense:	This activity allows students to apply their understanding of how food webs and energy transfer work by applying it to changes in the Antarctic food web.	20 minutes
	Total:	60 minutes

Preparation (15 minutes)

1. Write the motivating question on the board or a large piece of paper:

   Q: How will the Antarctic food web change due to the melting of ice sheets? What will happen to the marine mammals like seals and whales?

2. Duplicate the game board and cards as follows:
   - Enough copies of the predator cards so that within each group (5 students) each student has a different predator card (penguin, seal, whale, petrel, and icefish)
   - Enough copies a game board so each group has all four rounds
   - 6-8 copies of the krill, salps, ice algae, and free floating algae cards
3. Make up enough copies of the Antarctic Food Web for each student in the class or post a copy so that it is visible to all students.
4. Make up bags of white and red (alternative colors can be used) hole punches so that each group has the following :
   Round 1 - 37 red punches (krill) and 10 white punches (salps)
   Round 2 – 27 red punches (krill) and 20 white punches (salps)
   Round 3 – 17 red punches (krill) and 30 white punches (salps)
   Round 4 – 10 red punches (krill) and 37 white punches (salps)

Instructor's Note

Each bag should be marked with its round #. The number of krill decreases as the amount of sea ice and ice algae decrease. Meanwhile, the number of salps increases. Pre-made bags allows the students to focus on the model rather than wasting time counting).

Engage (10 minutes)

1. **Think**: Review with students that all organisms need energy to live and grow. Ask them to consider that they are organisms, and therefore need energy. Start off by asking students to spend a few moments by themselves thinking about all their sources of energy

over the last 24 hours. What activities did they do today? If you like, have students jot down their thoughts in a notebook.

2. **Pair**: Ask students to turn to the person next to them and discuss where they think these sources of energy originally came from (think "beyond the supermarket"). Where do they think the sources of energy got their energy?

3. **Share**: Have a few pairs share their thoughts with the group. Record all their responses on flip-chart paper, but be careful not to correct or comment on the students' answers. Write the words below on the board, have students brainstorm examples of living things, and then list each student's response in the appropriate category
   Producers (plants)
   Consumers (Herbivores, Omnivores, Carnivores)
   Decomposers

4. Use the following questions to guide a discussion of how these groups of living things obtain their energy:

   Q: How do the producers get their energy? [Plants use the energy of the sun to produce food in their leaves through the process of photosynthesis.]

   Q: How do consumers get their energy? [Consumers eat plants and animals gaining their stored energy.]

   Q: What kinds of consumers are there and how do they get their energy? [Herbivores eat plants. Carnivores eat animals. Omnivores eat both plants and animals.]

   Q: How do the decomposers get their energy? [Decomposers break down dead animals and plants into their basic components.]

5. Distribute copies of the Antarctic food web and ask the students to look it over. Ask the students to identify the primary producers; herbivores, omnivores, and carnivores.

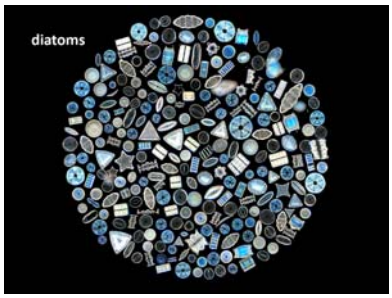
6. Provide the students with the krill, salps, ice algae, and free floating algae cards and discuss some or all of the following information:

- Krill depend on algal blooms underneath the ice for food during the winter (May to October). They cannot eat the small free floating algae because they are too tiny for them to catch.
- Salps, on the other hand, can eat the very small, free floating algae that live in the freshwater from melted ice.

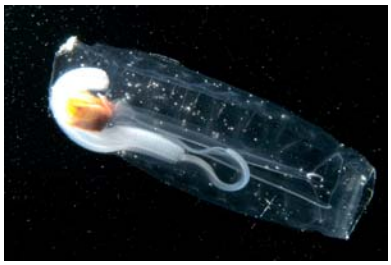
7. Point to the motivating question and ask:

   Q. How will the Antarctic food web change due to the melting of ice sheets? What will happen to the marine mammals like seals and whales?

   Again, have students share their ideas about the question with a partner and then with the table group. Finally, ask volunteers to share the ideas from their table group with the entire room. Tell them that we will now explore this question by collecting and analyzing data.



Marine Diatoms


Salp

Explore (20 minutes)

1. During this activity, each group will be running a model of possible impacts to marine life as the amount of sea ice is reduced because of climate change.
2. Distribute the "Before and After" handout and materials for the food web game.
3. Go over the following rules to the food web game.
   a. Each student should choose one consumer to become (Mackeral icefish, Humpback whale, Cape Petrel, Weddell seal, or Adelie penguin). They will remain that consumer for all rounds.
   b. Begin with the game board labeled Round 1 and empty the contents of Round 1 bag of krill and salps holes punches (dots) onto the board. The krill (red dots) should be placed beneath the ice sheet where the ice algae are located and the salps (white dots) should be placed in the open water where they feed on the free floating algae.
   c. You will begin each round by rolling the dice. The student with the highest number will go first, the next highest will go second, and so forth. (This order only lasts for this one round.)
   d. When it is your turn, you must take enough food so that you have energy to last to the next round. Your consumer card will


Antarctic Krill


Weddell Seal


Humpback Whale

provide information on what and how much you need to eat during each round. You must fulfill your food requirement. If you cannot fulfill these requirements during one round, then you haven't received enough energy. You are tired, but safe. However, if you cannot fulfill these requirements during the next round, you realize there isn't enough energy to survive in this place ~ so you decide to move to another area. You are no longer part of this ecosystem and no longer participate in the rounds.

e. When each player has had a turn during Round 1, place the krill and salps from that round back into the bag labeled Round 1.

f. Proceed to Round 2 using the Round 2 game board. Empty the contents of the krill and salps bag for Round 2 onto the board and separate them as you did for Round 1. Krill go under the ice and salps under the open water. In your journal, note any differences in the game boards and/or changes in the composition of krill and salps during Rounds 1 and 2.

g. Take turns rolling the dice again to see who eats first, second, third, etc. and then begin eating as you did for Round 1. Repeat steps d-g until the group has completed all 4 rounds.

4. Have the students draw in which consumers survived all four rounds of play on the "Before and After" handout. Alternatively, have them draw their own "Before" pictures as well as the "After".

Make Sense (20 minutes)

1. Ask one student to report out from each group. What happened as they ran through the model? Who survived, and who didn't?

2. Ask the students the following questions:

   Q: Were there any differences in the Antarctic environment between the rounds? If so, what were they? [Students should relay that there was less ice in each round and there were more salps and less krill during each round] Q: What happened to the consumers as the amount of krill decreased? Who was most affected? Least affected?

3. Return to the motivating question and ask the students:

Q: How will the Antarctic food web change due to the melting of ice sheets? What will happen to the marine mammals like seals and whales?

4. Depending on how the discussion on the motivating question went, provide the students with some or all of the following information:
   - The decrease in ice will impact the entire food web. As demonstrated by the energy transfer model, the loss of krill does not only impact the organisms that eat krill directly, but also those animals that eat the krill-eating animals.
   - As the amount of sea ice is reduced, there is a loss of algae that live within and under the ice, resulting in a decrease of krill. An increase in small algae that float in the freshwater from the melted ice results in more salps. Krill is significantly more nutritious than salps. Many organisms cannot substitute salps for krill.
   - The biological portion of the Antarctic ecosystem will change as animals either die or move to other locations in order to survive. Climate change is altering the ecosystem.
5. To reinforce all the above concepts, view **Act II: A small world after all**.

Video: *Act 2: A small world after all*, available at: *http://coseenow.net/antarctica*