Arctic Food Webs

ACTIVITY TIME

40-50 minutes

LEARNING OUTCOMES

- Discuss roles of primary producers and consumers in a food web.
- Describe food web interactions specific to the arctic sea ice.
- Illustrate an arctic marine food web.

OVERVIEW

In this activity students work in groups to develop an arctic marine food web. Groups then move through the classroom viewing each others' food webs and adding their own information.

FLOW

1. Watch video & explore Interactive Food Web.
2. Brainstorm a list of marine arctic organisms.
3. Student groups create food webs.
4. Graffiti activity with food webs.
5. Interpretation of student food webs.
6. Discussion questions.

CONTENTS

STUDENT OVERVIEW

WHY?

Food webs help us understand the interconnected nature of ecosystems. They help us understand human's place in ecosystems.

WHAT?

- The organisms that live in a sea ice ecosystem.
- The predator and prey relationships between these species.

HOW?

- Watch a video showing numerous sea ice organisms
- Learn the Inuktitut names and Inuit knowledge species
- In groups, choose a species to focus on
- Create a food web
- Talk about your findings and make connections

IMAGE 1 Narwal swim through a lead in the sea ice.

BACKGROUND

"Cree and Inuit observe and respect a natural order of relationships connecting the largest animals to the smallest organisms. For instance, in the open-water season, Inuit dispose of sea mammal carcasses so the shrimp have the food they need and can, in turn, support the many fish, birds, and sea mammals that eat them." (McDonald, M. A et al.[1])
In the winter, sea ice is a very important physical or **abiotic** component of the arctic **ecosystem** it impacts all of the wildlife surrounding it.

The marine arctic **food web**, like all other food webs, is made up of **primary producers**, consumers and **decomposers**.

IMAGE 2 Phytoplankton, a type of marine algae, gives the water its green colour.

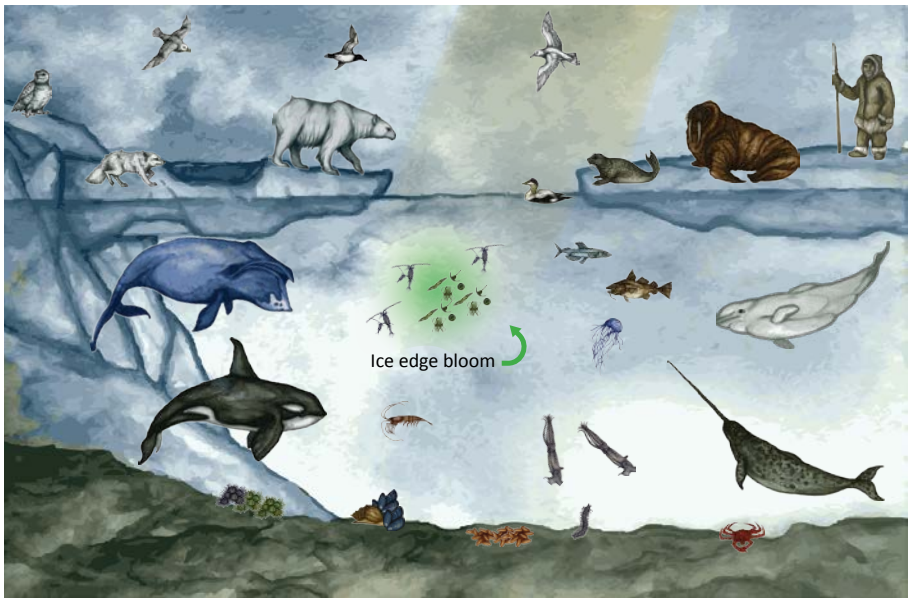


FIGURE 1 When sea ice melts in spring, sunlight reaches phytoplankton at the ice edge and causes it to bloom, forming the base of the marine Arctic food web.

VOCABULARY

Abiotic: Non-living elements of an ecosystem, such as weather and climate.

Decomposers: Organisms that break down and recycle waste and dead organisms.

Ecosystem: A community of organisms that interact with each other and their environment.

Food web: A diagram that depicts energy transfer between organisms in an area.

Herbivore: An organism that only eats plants.

Pelagic: Relating to the open ocean.

Photosynthesis: The process of turning the sun's energy into sugar as done by plants.

Phytoplankton: Microscopic algae that convert sunlight into energy. Phytoplankton are important primary producers in marine food webs.

Primary production: The conversion of energy from sunlight into organic compounds, such as sugars.

Primary producers: Organisms such as plants and algae that make their own food by converting energy from the sun into organic compounds like sugars.

Trophic level: The position of an organism in a food web, based on its distance from primary production.

Zooplankton: Primary consumers in marine food webs. Small animals that graze on phytoplankton.

PRODUCERS

On land and in the ocean, producers are plants that convert energy from the sun into sugars through **photosynthesis**. In the ocean, these plants are seaweeds, sea grasses and microscopic algae called **phytoplankton**. In open-water, or **pelagic**, ecosystems phytoplankton form the base, or first **trophic level** of the marine food web.

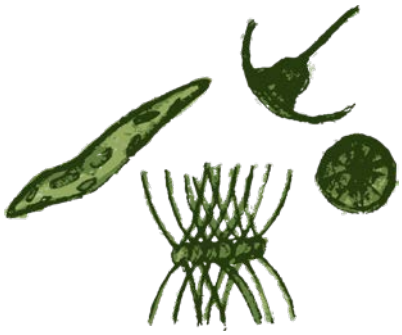


IMAGE 3 Phytoplankton

One unusual feature of marine arctic food webs is that **primary production** can only occur during a very short period of the year. Short winter days mean there is little or no sunlight to support photosynthesis. Even as the days grow longer, thick sea ice and snow cover prevent sunlight from reaching phytoplankton in the water column. Spring blooms of phytoplankton often occur first at the ice edge.

CONSUMERS

Consumers include **herbivores** that feed on producers, predators that feed on herbivores, and predators that eat other predators.

Primary Consumers

Marine arctic food web herbivores eat phytoplankton. These herbivores are commonly called **zooplankton** and include pelagic crustaceans like copepods.

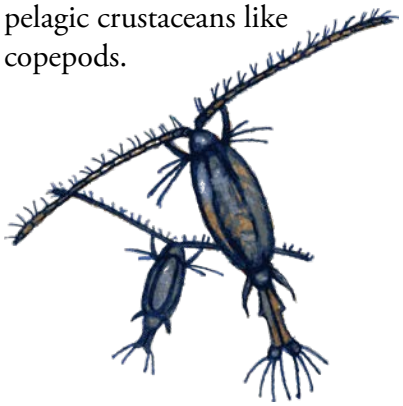


IMAGE 4 Copepods.

Secondary Consumers

Secondary consumers can include organisms from multiple trophic levels from small krill and prawn, which generally eat zooplankton, to larger species like cod and eiders, which eat these smaller species and each other. Even simple food webs can have many trophic levels.

IMAGE 5 Ringed seal.

Top Consumers

The highest trophic level includes apex predators that are at the top of the food chain. Orcas and polar bears are two iconic examples of important apex predators in the arctic.

IMAGE 6 Polar bear.

DECOMPOSERS

Decomposers are another important group in every ecosystem, because they break down organic materials and make nutrients available to other organisms. However, they do not fit into a specific trophic level because they eat dead matter from all levels and deliver the last step in various organic matter and nutrient cycles.

IMAGE 7 Marine bacteria

Understanding the roles of different groups of organisms is integral to understanding how ecosystems work and how we are a part of them. One way we do this is by creating food web diagrams. Food web diagrams are simplified depictions of some of the relationships in an ecosystem.

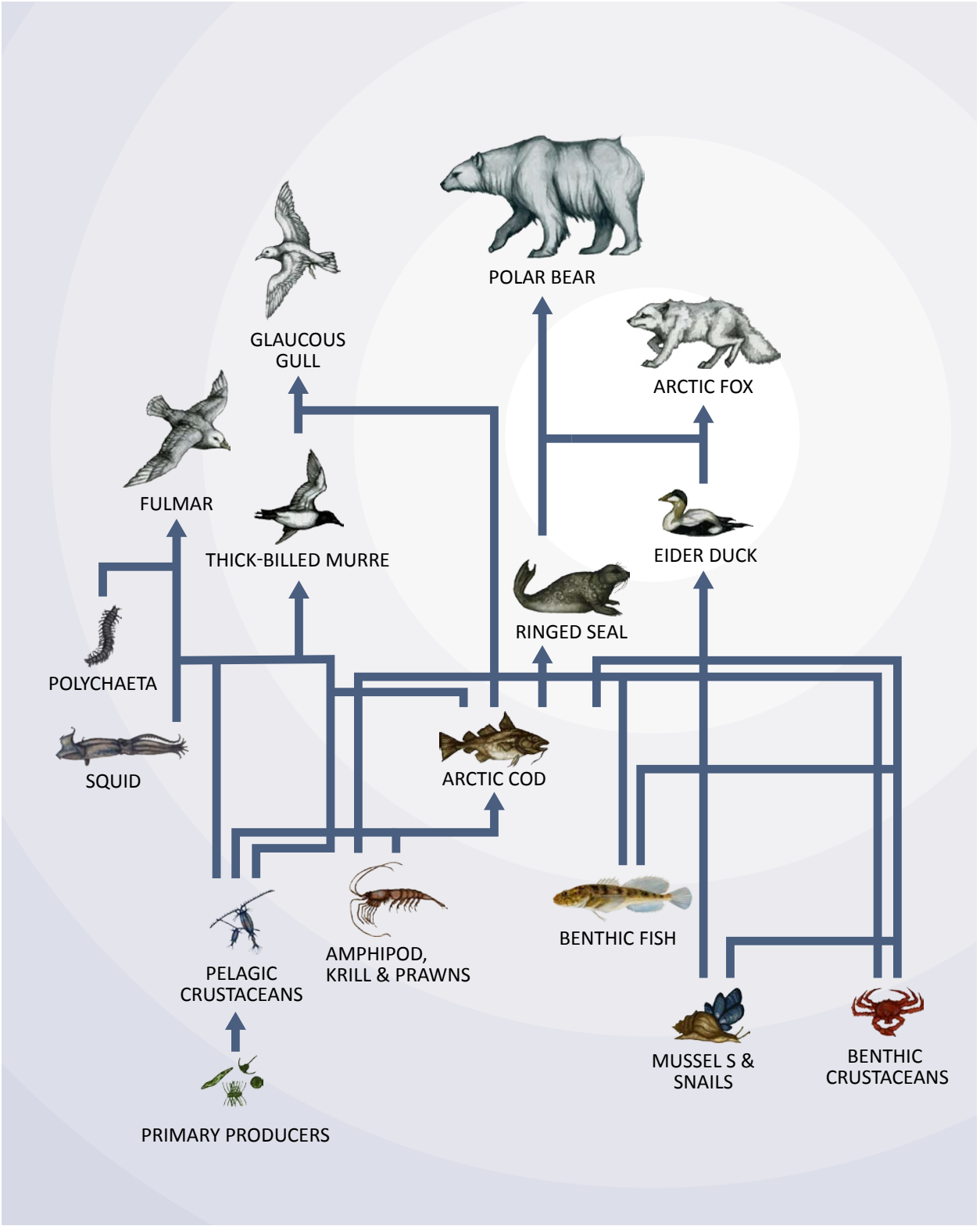


FIGURE 2 A simplified arctic coastal food web.

PREPARATION

MATERIALS

- Chart paper
- Colored markers

RESOURCES

Sea Ice Ecology video
A short video-montage showing many different Arctic creatures. See majestic narwhals swimming along a crack in the ice and the mighty walrus basking on the sea ice.
https://arcticeider.com/links/afw03

Interactive Food Web & Wildlife Profiles
Access profiles of arctic marine wildlife and use the interactive food web to visualize connections between species.
https://arcticeider.com/links/afw04

Food Web Sorter SMART Notebook Activity
Smart Notebook file that can be used to explain basic trophic levels. Students can come up to the board and drag the creature icons to the correct location.
https://arcticeider.com/links/afw1

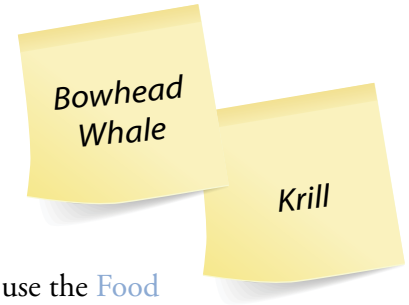
IMAGE 8 A snowy owl looks for dinner.

IMAGE 9 White in the winter, arctic fox turn brown in the summer to match their surroundings.

PROCEDURE

1. Watch the Sea Ice Ecology video (pg. 6) to introduce/review the wide variety of wildlife that live in arctic marine ecosystems.
2. Optional: work with the Culture or Inuktitut teacher in your school to teach students Traditional knowledge about the species shown in the video.

   - What is the local Inuktitut term for each creature? – Interactive Food Web (pg. 6)
   - Which species are harvested in your community? Where? How?
   - Share traditional stories about these species.
   - How have their diets changed in recent memory?



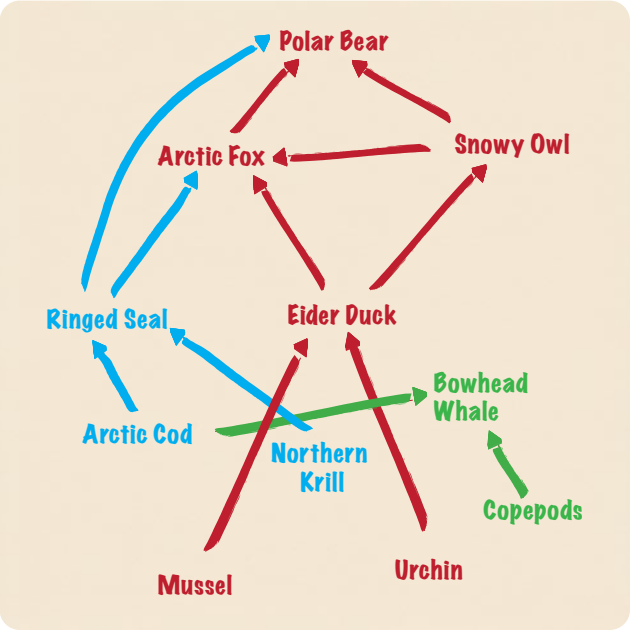
3. Brainstorm a list of marine organisms found in the Arctic by asking students to write creatures' names on the board. Then form 2 teams and alternate writing organisms until they can't think of anymore.
4. Read the Background section together as a class and optionally use the Food Web Sorter (pg. 6) activity to classify organisms into different categories.
5. Load the Interactive Food Web (pg. 6) and compare it to your class's list of species. Add any missing species and discuss how arrows in a food web follow the flow of energy rather than representing who eats whom.
6. Divide the class into small groups (3-4 students). Ask each group to choose a focus species from the board around which they will centre their food web. Have groups alternate between creatures that live in different spheres to ensure that a diversity of species are chosen. Suggested focus species include:

   A. Phytoplankton
   B. Zooplankton
   C. Mussels
   D. Arctic Cod
   E. Thick-billed Murre
   F. Common Eider
   G. Bowhead Whale
   H. Capelin
   I. Northern Fulmar
   J. Ringed Seal
   K. Polar Bear

7. Give each group a large sheet of chart paper and a marker (different colour for each group) to create their food web. Each group's food web should start with their focus species and expand outwards.
8. Allow time for the students to discuss what they saw in the video, the interactive food web and what they wrote on the board.
9. After 8-12 minutes, students leave their charts at their table and rotate to another group taking with them their group-specific coloured marker.
10. Instruct students to add their own ideas and connections in their group's colour.

11. The students will move through all the food web charts on your signal until they are back at their own. Give them 2 - 5 minutes at each chart and the same back at their own to make any additions. This is a short period of time but they are not meant to cover everything - they should be making additions and connections to their focus animals, which they have discussed in much further detail while making their own chart.
12. Once the groups are done rotating, have students put up all the charts on one wall so that they can be compared. Ask student to compare how the charts are similar? How do they differ?
13. Ask the students to add bacteria into their food webs. Have the groups discuss where the bacteria should be added and their connections.

Bacteria are found in the water column. They are eaten by protists (ciliates and microflagellates), other microorganisms found in the water column, which are then eaten by zooplankton. The bacteria are an important part of the carbon cycle as many bacteria take up inorganic carbon and convert it to organic carbon which can be used by other organisms that are consumers. Bacteria are also important decomposers, breaking down plant and animal tissue and returning nutrients to the environment. Some types of bacteria are found in the digestive systems of animals where they help digest some foods. In fact, bacteria are found just about anywhere you could imagine and they play many very important roles in ecosystems.



14. Use the Discussion Questions, in small groups or as a class, to recap the most important aspects of food webs. In particular, make sure students understand what primary producers and primary consumers are and which organisms in their food webs fill these roles. Refer back to the Food Web Sorter activity if needed.

DISCUSSION QUESTIONS

1. Where do all of the creatures in the food web ultimately get their energy from?

   The sun.

2. Why are primary producers so important in the arctic marine food web? Indicate the primary producers on your food web.

   Primary producers store light energy from the sun in chemical compounds which can be used by other organisms as energy sources. Only primary producers are capable of doing this – all other organisms ultimately rely on primary producers. Thus, primary producers are important not only in arctic food webs, but in every ecosystem in the world. In the oceans, most primary producers are phytoplankton (microscopic algae). They are particularly important in the Arctic Ocean, as other types of marine primary producers, such as seaweeds and sea grasses, are uncommon.

3. What is the role of polynyas in the arctic food web?

   Polynyas are areas of open water in sea ice. They are biological hot spots, because water there is some of the first to receive sunlight in spring, and therefore the first place where the primary producers begin to grow. This in turn attracts other animals in the food web.

4. Put humans on your food web, what do you notice and what allows humans to be different than all the other animals?

   Humans exist at the top of the food web and have connections to nearly everything in it. We hunt polar bears, seals, whales and birds. We catch fish, collect mussels and urchins to eat. We even harvest algae. Dried kelp is used in sushi, and other algae can be a protein substitute for various diets. Human ingenuity has allowed us to make tools and develop processing methods in order to eat nearly everything in the food web.

5. How would the extinction of one of the species on your food web affect the other species?

   The extinction or decline of one species would have direct effects on the predators and prey of that species. For example, if Arctic cod went extinct, numbers of zooplankton might increase because Arctic cod would not be feeding on them anymore, but Thick-billed murre populations might decrease, as Arctic cod are an important prey item for them. There are also many possible indirect effects – if there were no more cod, and zooplankton numbers increased, then the zooplankton might eat more phytoplankton than before. If there were no cod for murres to feed on, then they could possibly begin eating more capelin than they did previously. Indirect effects are difficult to predict, as there are many uncertainties, especially in more complex food webs.

6. Why is it important for food webs to have many different connections?

   Food webs with lots of different connections are often more resilient. The decline or loss of one species can sometimes be compensated for by other species in the food web, so that the strength of indirect effects is moderated. For example, if Thick-billed murres feed on both Arctic cod and capelin, if the cod is scarce in one year, murres can rely more on capelin.

7. What would be the downside of having a very simplified food web?

In a very simplified food web, the decline or loss of one species can have a very large impact on a food web. If a predator feeds only on one prey species, it will be very strongly affected if its prey declines or disappears.

8. Which animals in your food web are hunted in your community? Which ones have you tried?

Answers will vary.

IMAGE 10 Orcas trapped in a polynya. If they don't escape soon, the polynya will close and they will run out of air. (D & A Weetaluktuk)

IMAGE 11 A school of capelin crowds the ocean.

EXTENSIONS

The food webs developed in this activity can be used in several other lesson plans in this educational package. Based on the food webs that were created by the class, each student could make their own version that they can add to throughout future activities. To make it easy, photocopy or scan each student's original food web and then file it somewhere safe. Students can then make additions to their food web on the copies, using a different one for each lesson plan. After several versions of the food webs have been developed, students could then compare these to their original food webs.

SOURCES

1 McDonald, M. A., Arragutainaq, L., & Novalinga, Z. (1997). Voices from the bay: Traditional ecological knowledge of Inuit and Cree in the Hudson Bay bioregion. Ottawa, Ont.: Canadian Arctic Resources Committee.

Watercolour artwork by S. Desroches and M. Gordon.

All photos by Joel Heath unless otherwise noted.

ATTRIBUTION

PRIMARY

- Rian Dickson

CONTRIBUTORS

- Simone DesRoches
- Karl Hardin
- Joel Heath
- Sharina Kennedy
- Jackie Kidd
- Jennifer Provencher
- Misha Warbanski
- Evan Warner