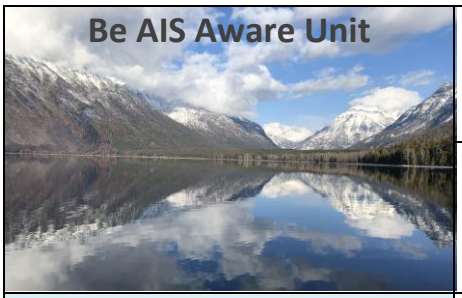


Food Web Challenge

Do you ever wonder how non-native aquatic invasive species can impact an aquatic food web?

Grade Level
Middle School

Subject Areas
Life Science, Environmental Science, Ecology, and Human Impacts

Key Topics
Ecosystems, food chains/webs, producers, consumers, and aquatic invasive species

Duration
Preparation Time: 30 min
Activity Time: 60 min

Setting
Classroom (Groups of 3-4)

Skills
Organizing; Interpreting; Applying

Standards
NGSS & MT Science Std.:
MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
CORE IDEA(S):
LS2.B: Cycle of Matter and Energy transfer in Ecosystems
CROSSCUTTING CONCEPT(S):
Energy and Matter
Cause and Effect
SCIENCE & ENGINEERING PRACTICE(S):
Develop and Use Models

Overview
Students complete a lake food web challenge, learn how all organisms in the lake ecosystem are interconnected, and explain how aquatic invasive species can impact the food web.

Objectives
Students will be able to:
- build a lake food web.
- explain how aquatic invasive species impact the lake food web.
- demonstrate how an ecological disturbance can occur in an ecosystem.

Materials
Warm Up
- Computer, projector
- Student worksheets #1-2 (double-sided)

Activity
- Laminated or printed food web cards (1 full set/group; included in AIS teaching trunk)
- Scissors or paper cutter
- Color pencils or markers (1 set/group)
- Glue/glue stick (1/group)
- 2’ x 3’ Poster paper (1/group)

Wrap Up
- 4” x 6” lined index card or 8 ½” x 11” wide-ruled paper (1/group)
- Alternatively, students may create a video using a Chromebook/tablet

Advanced Preparation
- Laminated cards are included with the teaching materials. If you prefer to glue the cards down, print and pre-cut the food web cards from the template.
- Arrange classroom so that the students can work in groups of 3-4.
- Gather colored pencils, markers, glue, and poster paper.
- Prior to class, pre-load the Food Web Challenge presentation found on the associated thumb drive or on our website: https://flbs.umt.edu/newflbs/k12teachingmaterial

Food Web Challenge

Background

An ***ecosystem*** is a community of organisms that all share a particular habitat and interact with each other as they work to survive. These organisms are often organized into different trophic levels based upon how they acquire their food energy. ***Producers*** are organisms that can create their own food from inorganic (non-living) chemicals in the environment. Phytoplankton are microscopic algae found in lakes, rivers, streams, wetlands, and oceans. Plankton is derived from planktos, which means "to wander or drift." Therefore, phytoplankton are producers often found drifting where there is abundant light for photosynthesis. Phytoplankton use sunlight to convert water and carbon dioxide into sugar and oxygen through photosynthesis. This oxygen and sugar is then used to make chemical energy needed for survival. In contrast, ***consumers*** are organisms that cannot make their own food. These organisms must find and consume their food from their surrounding environment. Zooplankton are examples of primary consumers that eat phytoplankton as they drift through the water.

A ***food chain diagram*** is a visual representation of the flow of food energy through an ecosystem. Typical food chains start with a producer and are composed of at least three types of organisms. For example, when zooplankton eat phytoplankton, the energy from the phytoplankton goes into the zooplankton. Likewise, when young trout eat zooplankton the energy from the zooplankton and the phytoplankton collectively goes into the juvenile trout population. This food energy is further passed on when larger organisms such as adult trout, osprey, or bald eagles eat the juvenile trout. It is important to remember that even though we simplify a food chain diagram by depicting one individual organism, in reality this organism represents a population of that organism in a specific ecosystem.

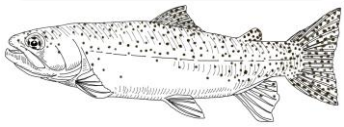
A ***food web*** is simply a collection of interwoven food chains that represent the flow of energy throughout the system. It is important to explain that the food chains and web in this lesson are a small representation of the larger web that exists in the natural environment.

Since producers are the base or foundation to every food chain within an ecosystem, there are typically more producers than consumers in any given habitat. Freshwater lakes in Northwestern Montana are often filled with a variety of phytoplankton, periphyton (slimy algae on rocks or other surfaces), submerged vegetation, emergent aquatic plants (i.e. water lilies), and wetland plants that border the lake. These producers support a wide variety of animal life in and around the lake. The animals in the lake ecosystem can either be found in the lake or around the lake. For example, there are many different types of waterfowl (e.g., ducks, geese) and raptors (e.g., osprey, eagles, hawks) that find their food in, on top of, or near the lake.

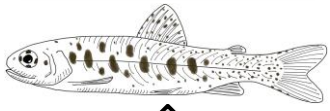
Aquatic invasive species (AIS) are non-native species that may cause environmental and/or economic harm to an ecosystem. Aquatic invasive species can often create physical and/or biological disturbances that have drastic impacts upon the entire ecosystem. Some AIS can create an ***ecological disturbance*** that impacts established food chains within an ecosystem. The story of *Mysis relicta*, a freshwater shrimp, and its impact in Flathead Lake is a well-documented example.

Common Lake Food Chain in N.W. Montana

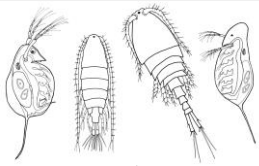
OSPREY
Quaternary Consumer



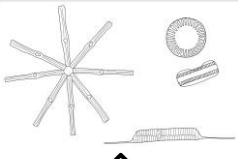
ADULT TROUT
Tertiary Consumer



JUVENILE TROUT
Secondary Consumer



ZOOPLANKTON
Primary Consumer

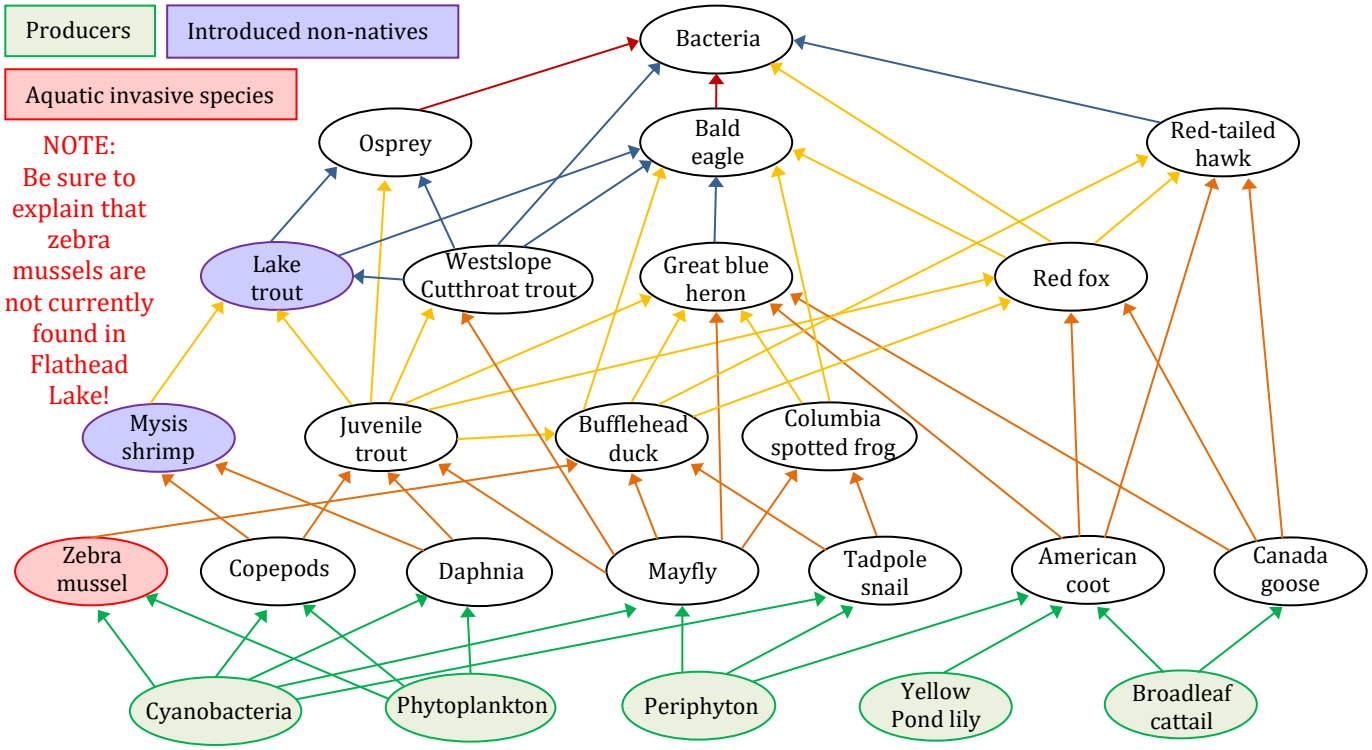


PHYTOPLANKTON
Primary Producer

Food Web Challenge

Mysis shrimp were intentionally introduced into lakes in Northwest Montana with the goal of providing Kokanee salmon populations with a new source of food. These shrimp eventually found their way into Flathead Lake. Unfortunately, Kokanee are sight feeders that hunt in the surface waters of the lake; whereas, *Mysis* shrimp hide in the dark, deep waters during the day and only come up at night to feed on zooplankton. These shrimp quickly began to eat the smaller zooplankton (copepods and *Daphnia sp*.) that was the Kokanee's primary food source. In addition, the non-native lake trout found in Flathead Lake began to eat the shrimp, to get bigger, and to prey upon the Kokanee salmon. Due to a decrease in food and an increase in predators, the Kokanee salmon populations immediately collapsed. Subsequently, the bald eagle populations that depended upon these fish as a source of food also declined. The introduction of the shrimp caused a dramatic ecological disturbance and altered the Flathead Lake food web. Since invasive zebra and quagga mussels eat the phytoplankton at the base of our aquatic ecosystems, their introduction could cause a more devastating ecological disturbance than the shrimp.

Potential Flathead Lake food web in N.W. Montana if zebra mussels are introduced:



Vocabulary

Carnivore – A consumer that only eats other animals.
Consumer – An organism that eats or consumes other organisms to survive.
Decomposer – A consumer such as a fungi or bacteria that chemically breaks down organic matter.
Detritivore – A consumer that orally feeds on detritus (dead or decomposing organic matter).
Ecological disturbance – An event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment.
Ecosystem – A community of organisms and the non-living environment they inhabit.
Food Chain – A series of organisms linked together by the transfer of food energy from one population of organisms to another population of organisms.
Food Web – A series of interlocking and independent food chains found in an ecosystem.
Herbivore – A consumer that only eats photosynthetic plants and/or algae.
Omnivore – A consumer that eats both plants/algae and animals.
Producer – An organism that can use light or chemical energy to produce its own food from inorganic (non-living) substances (ex. plant, algae, or cyanobacteria) typically via photosynthesis.

Food Web Challenge

Procedure

◆ Warm Up (20 min.)

- Turn on the projector, display the Food Web Challenge slide show, and pass out the student worksheets.
- Draw the following chart on the board:

Plants	Animals

- Slide #2: Conduct a 30-second brainstorm and have the students write down what they think all plants need to survive. Ask 4-5 students to share their answers and post the answers in the chart on the board.
- Slide #3: Conduct a 30-second brainstorm and have the students write down what they think all animals need to survive. Ask 4-5 students to share their answers and post the answers in the chart on the board.
  - *Review that all plants and animals need water, energy/food, oxygen, a space to live, and the ability to respond to their environment. While the sun serves as a critical source of energy for plants, plants themselves help to directly or indirectly feed animals in each ecosystem.*
- Slide #4: Students record one observation they have about the ecosystem on their worksheet. Ask 1-2 students to share their observations to the class.
- Slide #5: Ask students to record the most abundant type of organism they see in the ecosystem (plants).
- Slide #6: Students examine the biomass diagram and identify/record the group of organisms that has the most biomass globally (plants).
- Slide #7: Students look at the calculated percent of biomass for each group.
  - *Review that 82% of all biomass on Earth is made up of plants, 17% is bacteria/fungi/protists/archaea, which are mostly microscopic, and 0.3% is composed of animals.*
- Slide #8: Students record one SPECIFIC reason why they think plants are the most abundant.
  - *Plants are the foundation of all ecosystems and so we need more of them to support all life.*
- Slides #9-14: Briefly, review the difference between producers and consumers. The organisms on these slides are all found in the Tundra ecosystem.
- Slide #15: Review what a food chain is.
- Slide #16. Read the top of "Understanding a Food Chain" worksheet and review the provided chain.
  - Students then write one more food chain (from any habitat) on their paper. Ask students to share.
  - Conduct a 30-second brainstorm and have the students list all the ways the food chain in the example could be negatively impacted or disrupted.
  - *Answers may vary: flood, introduced species, aquatic invasive species, too many nutrients to the lake (ex. eutrophication causes algal blooms that are then eaten by bacteria in the water, which leads to low oxygen conditions in the lake), drought, pollution, etc.*
- Slide #18: Use the provided tundra food web to review what a food web is.
- Slides #19-20: Explain what an ecological disturbance is and how *Mysis* shrimp caused a local disturbance.

◆ Activity (25 min.)

- Pass out the glue/tape, markers, and one food web card set to each group. Display the food web challenge directions (slide #21) and explain that they have 25 minutes to complete the food web challenge.
- Students identify the producers in the web, build the food chains, organize the chains to build the food web, have the instructor check the web before they can glue or tape it down, and lastly draw the arrows moving up through the web. ***Note – if using laminated cards, see recommended modifications on the next page.***

◆ Wrap Up (15 min.)

- After they build and label the web, they must label the zebra mussel card as an aquatic invasive species.
- Students write a paragraph (or create a video) that explains how this species could impact the lake food web and possibly cause an ecological disturbance. Students must identify the organisms that would be directly impacted by predation or a loss of food.

Teacher Resources

Assessment Options

Have students:

- **write a paragraph or create a video clip** that summarizes how the invasive mussels would impact the lake food web.
- **conduct a think aloud with a partner** to explain how energy flows through an ecosystem and how invasive species can disrupt the food web.
- **conduct research** to learn about a different aquatic or terrestrial habitat, build a food web for that habitat, and identify an invasive species that could potentially disturb the ecosystem.
- **design a cause and effect poster** about a specific ecological disturbance.

Modifications

- If the students have already learned about food chains/webs, shorten the warm up activity to review the concepts as needed.
- If using the provided laminated cards, students may arrange them on the poster, trace the cards, and write the organism names in the boxes. This will allow the cards to be used for multiple periods in one day.
- Simplify the food web by removing food chains from the web.
- Enlarge the food chain cards and worksheets as needed.

Extensions

Students can:

- **add in another aquatic invasive species** to the food web activity to predict how the new organism could impact the food web.
- **research traditional Native American uses** for organisms found in the lake food web and how those practices have been impacted by the introduction of non-native fish and other aquatic invasive species.
- **create a short story** from the perspective of an organism in an ecosystem that has been invaded by an aquatic invasive species.

Books

Elton, C. S. (2000). *The Ecology of Invasion by Animals and Plants* (new ed.). Chicago, IL: University of Chicago Press.

Lockwood, J. L., Hoopes, M. F., & Marchetti, M. P. (2013). *Invasion Ecology* (2nd ed). West Sussex, UK: John Wiley & Sons, Ltd.

Online Resources

Montana Field Guide: http://fieldguide.mt.gov/

Montana Science Partnership food web and trophic levels website contains information about aquatic macroinvertebrates found in Montana streams: http://www.sciencepartners.info/module-8-macroinvertebrates/insect-feeding-food-webs/food-webs-trophic-levels/

Acknowledgements

All food web images were illustrated by Holly Church. Many thanks to teachers from Bigfork, Somers, Polson, and Whitefish who provided feedback on this lesson.

Photo credit: Michael Palmer (CC BY-SA 4.0)

Adult mayflies often emerge in lakes and streams during the spring and fall. These aquatic insects serve as an important food source for native fish.

Photo credit: Great Lakes Environmental Research Laboratory (public domain)

Zebra Mussels are an aquatic invasive species that filter-feeds on phytoplankton. It can attach to surfaces, reproduce quickly, and spread through planktonic larvae.

Photo credit: Harald Olsen (CC BY 2.0)

Mysis relicta is an aquatic invasive species that was intentionally introduced to some lakes in Montana.

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Food Web Challenge

Name _____

Warm Up

Student Worksheet (1 of 2)

As you view the provided presentation answer the following questions.

30-second brainstorm…What do all plants need to survive?

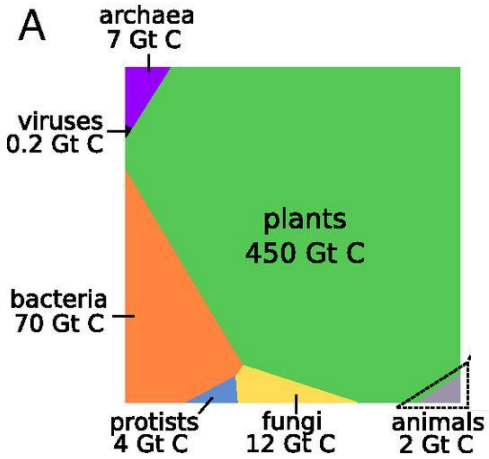
30-second brainstorm…What do all animals need to survive?

Record ONE observation you have about the Northwest Montana ecosystem.

What is the most abundant type of organism that you see in this ecosystem? _____

Examine the diagram below, which group of organisms has the MOST biomass worldwide? _____

Global Partitioning of Biomass



1 gigaton (Gt) = 1,000,000,000,000,000 grams or 10^{15} grams **1 gram =** Bar-On et al. (2018), PNAS

Why do you think that is? Provide one <u>specific</u> reason.

Food Web Challenge

Name _____

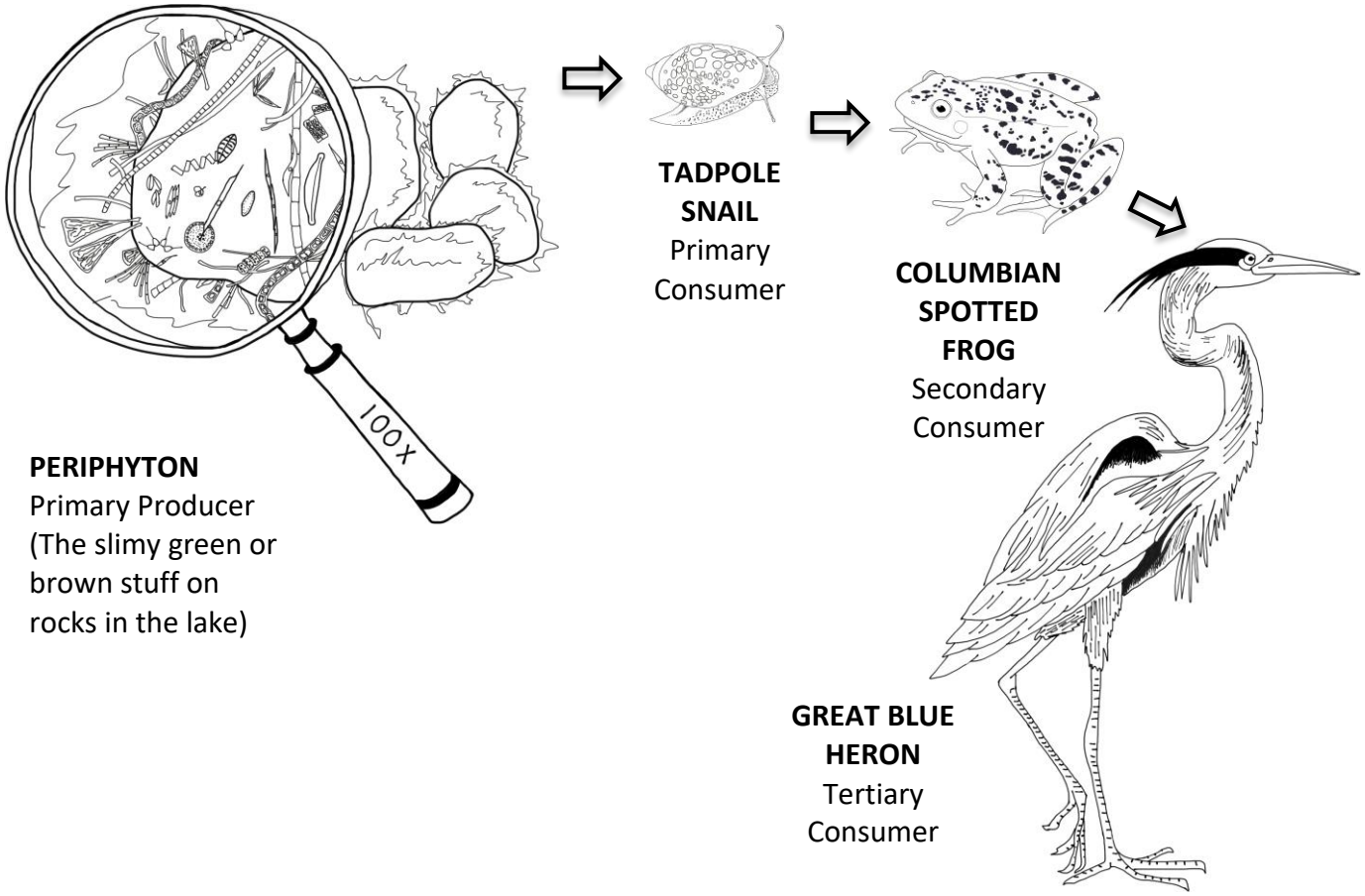
Understanding a Food Chain

Student Worksheet (2 of 2)

A **food chain diagram** represents the food energy that flows through an **ecosystem**. The sun provides energy for the **producers** (plants and algae) to make their own food through photosynthesis. The producers are the base of the food chain and are eaten by many organisms. The producers are called **primary producers** because they make the initial sugar that the entire food web depends upon.

A **consumer** is an organism that cannot make its own food. **Herbivores** are **primary consumers** that eat plants. **Omnivores** are both primary consumers that eat plants and secondary consumers that eat animals. **Carnivores** are typically secondary, tertiary, or quaternary consumers that only eat other animals.

Below is a diagram of a food chain often found in the lakes, rivers, streams, and wetlands in Montana. Notice the arrows are pointed to the animal populations that are consuming the food.



PERIPHYTON
Primary Producer
(The slimy green or brown stuff on rocks in the lake)

Brainstorm and write ONE more food chain below. Remember, all food chains start with a producer and usually have at least THREE types of organisms.

30-second brainstorm…List all of the ways the food chain above could be negatively impacted or disrupted?