Food Web Dynamics

What is a common lake food web found in N.W. Montana and what ecological roles do the producers and consumers play in that ecosystem?

- **Grade Levels**
  6th-12th grade
- **Subject Areas**
  Life Science, Biology, Ecology and Environmental Science
- **Key Topics**
  Food chains, food webs, producers, consumers, plankton
- **Duration**
  Preparation Time: 30 min
  Activity Time: 2 x 50 min
- **Setting**
  Classroom (Groups of 2)
- **Skills**
  Organizing, Interpreting, Applying Information
- **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

SCIENCE & ENGINEERING PRACTICE(S):
Develop and Use Models

Overview

Students build a lake food web, learn how all organisms in the lake ecosystem are interconnected, and explain the roles phytoplankton and zooplankton play in the lake ecosystem as primary producers and consumers.

Objectives

Students will be able to:

- explain the structural differences between phytoplankton and zooplankton
- build a lake food web.
- describe the ecological roles of phytoplankton and zooplankton in the lake ecosystem.

Materials

Warm Up/Activity/Wrap Up

- Computer, projector, and student worksheets #1-9
- Teacher Resources #1-2
- Computer, chromebook, or tablet for students (1/pair)
- 2’ x 3’ Poster paper (1/pair)
- Scissors (1/pair)
- Rulers (1/pair)
- Color pencils or markers (1 set/pair)
- Glue/glue stick (1/pair)

Advanced Preparation

- Print the students worksheets #1-4 double-sided (1/student)
- Print the student worksheets #5-9 single-sided (1 set /pair)
- Arrange classroom so that the students can work in pairs.
- Gather colored pencils, markers, glue, and poster paper.
- Prior to class, pre-load the Teacher Resource pages on the computer so that they can be displayed in class over the projector.

Food Web Dynamics

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.

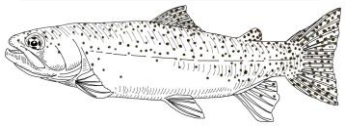
A ***food web*** is simply a collection of interwoven food chains that represent the flow of energy throughout the system. It is important to explain that the food chains and web in this lesson are a small representation of the larger web that exists in the natural environment.

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.

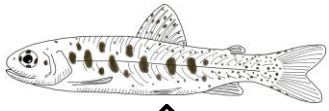
Aquatic invasive species (AIS) are non-native species that may cause environmental and/or economic harm to an ecosystem. Aquatic invasive species can often create physical and/or biological disturbances that have drastic impacts upon the entire ecosystem. Some AIS can create an ***ecological disturbance*** 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

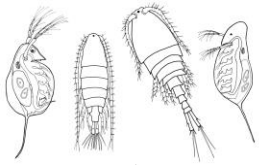
OSPREY
Quaternary Consumer



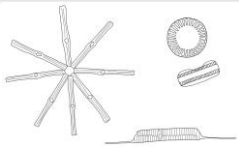
ADULT TROUT
Tertiary Consumer



JUVENILE TROUT
Secondary Consumer



ZOOPLANKTON
Primary Consumer

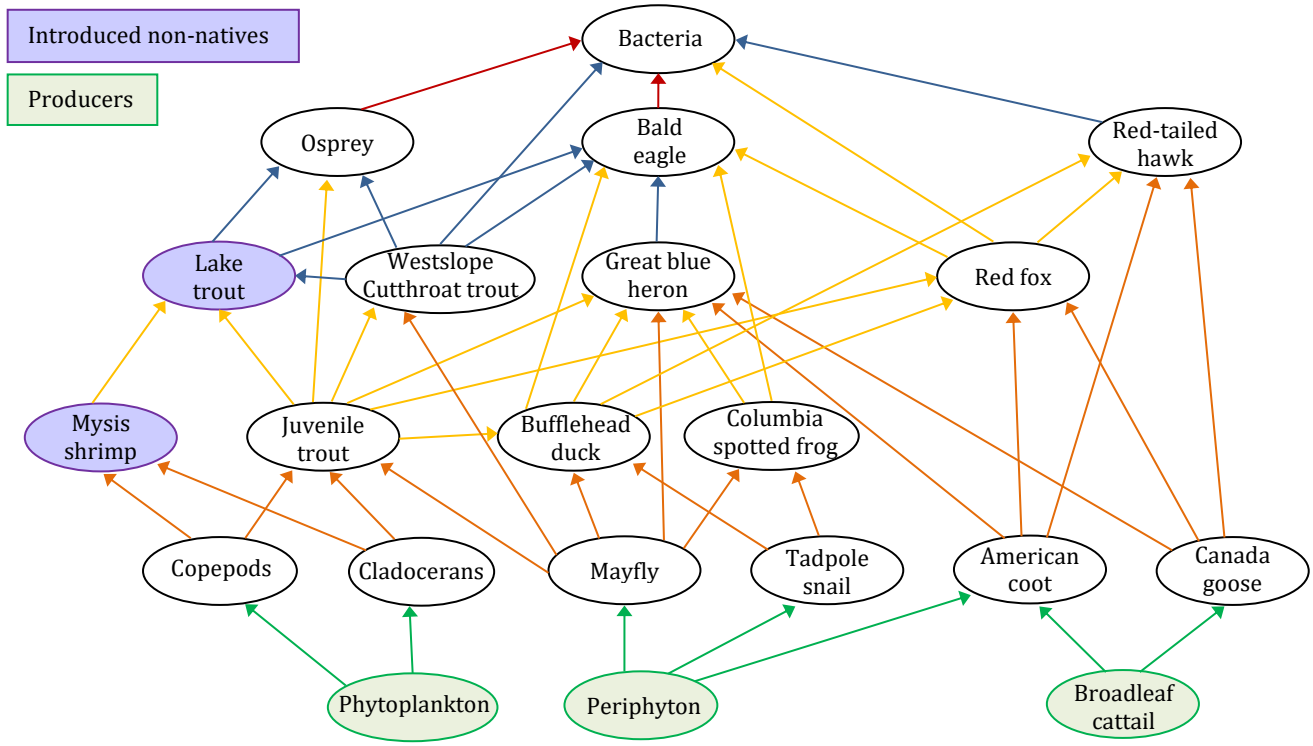


PHYTOPLANKTON
Primary Producer

Food Web Dynamics

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.

Lake Food Web in N.W. Montana:



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).
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.
Phytoplankton – A single-celled diatom (microscopic algae) that photosynthesizes and drifts with the currents in the lakes, streams, rivers, and wetlands.
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.
Zooplankton – A microscopic animal that drifts with the water that consumes phytoplankton to survive.

Procedure

◆ Warm Up (50 min.)

- Pass out the student worksheets #1-4 and display the provided photographs of the freshwater phytoplankton (diatoms) and zooplankton (see Teacher Resources #1-2).
- Students look closely at the two different types of plankton and Think-Pair-Share how they are similar and different.
  - *Answers may vary: They are both aquatic organisms made up of cells. The phytoplankton can photosynthesize to create food, whereas, the zooplankton must consume their food. They are both microscopic and they provide food for the larger organisms in the water. The zooplankton are animals that can reproduce, sense their surroundings, and respond to their environment.*
- Ask the students to use the provided computers/tablets to conduct research with their partner that will help them to complete the table on the worksheet. When they are finished with the table, they describe in their own words how the two types of plankton are similar and different on their worksheet.
- Discuss how these two organisms are key producers and consumers in the lake, pond, wetland, stream, and river ecosystems nearby and that they help to provide food for the entire system.
- Students read the top of the "Understanding a Food Chain" worksheet. Review the provided aquatic food chain and discuss how food chains represent a transfer of energy from one trophic level to another. The producers at the bottom of the food chains support all life above them, which is why there are typically more producers than consumers in any environment.
  - Students then write three more food chains (from any habitat) on their paper. Ask students to share.
- Pass out the color pencils. Read the top of the "Understanding a Food Web" worksheet with the students.
  - Students complete the key at the top of the diagram and then color in the arrows using the key. For example, all of the arrows coming up and out of the producers should represent the primary producers' energy that is flowing up to the primary consumers. They then color in the "herbivore" arrows and "carnivore" arrows.
  - Students then write ten more food chains from the diagram on their paper.

◆ Activity (35 min.)

- Pass out student worksheets #5-9, scissors glue, and markers to each group. Explain that they have 35 minutes to build the lake food web with their partner.
  - The students cut out the organisms and descriptions and then match them to each other correctly.
  - The students identify the producers in the web, build the food chains, reorganize the chains into a food web, and then ask the instructor to check the web.
  - The students then glue it down on the poster paper, draw the arrows moving up through the web, and lastly label the primary producers, primary/secondary/tertiary/quaternary consumers.

◆ Wrap Up (15 min.)

- After they build and label the web, they must summarize their understanding by completing the wrap up questions on the student worksheet #4.

Teacher Resources

Assessment Options

Have students:

- **complete the Food Web Dynamics worksheets** as described
- **build the Lake Food Web with a partner** to show how the aquatic organisms are interconnected.
- **summarize their understanding** by explaining what the food web represents and what roles the phytoplankton and zooplankton serve in the lake ecosystem.

Modifications

- Students may build the web in pairs or individually as appropriate.
- Simplify the food web by removing food chains from the web.
- Enlarge the food chain images and worksheets as needed.

Extensions

Students can:

- **observe phytoplankton and/or zooplankton** collected from a local water source using plankton nets.
  Supplies needed: zooplankton net (~64 mm), phytoplankton net (~20mm), sampling jars, microscopes, microscope slides for phytoplankton, microscope depression slides for zooplankton, cover slips, and disposable plastic pipettes.
- **design a cause and effect poster** about a specific ecological disturbance that could disrupt the lake 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.

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 Charles Lutz at Mission Valley Christian School for his contributions to 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: Harald Olsen (CC BY 2.0)

Mysis relicta is an aquatic non-native species that was intentionally introduced to some lakes in Montana. Since its introduction, it has drastically changed the food web by outcompeting the native zooplankton for food.

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Warm Up

Phytoplankton and zooplankton are organisms that drift with the water currents in oceans, lakes, rivers, streams, or wetlands. They can be found in salt, brackish, or fresh water around the world. These microscopic producers and consumers are essential to healthy marine and freshwater ecosystems.

First, look at the provided photographs of the phytoplankton and zooplankton. Next, use the internet to conduct research to complete the table below.

	Freshwater Phytoplankton	Freshwater Zooplankton
What is their physical shape and color?		
Do they have any appendages? If so, how do they use them?		
How do they move in the water?		
How do they acquire food?		
Who eats them?		
How do they reproduce?		
How do they protect themselves?		

How are the two types of plankton similar?

How are the two types of plankton different?

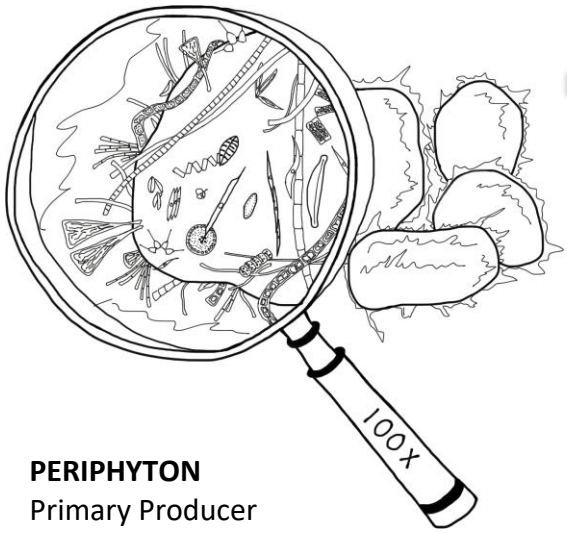
Understanding a Food Chain

Student Worksheet (2 of 9)

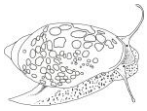
A **food chain diagram** represents the food energy that flows through an **ecosystem**. The sun provides energy for the **producers** (plants and algae) to make their own food through photosynthesis. The producers are the base of the food chain and are eaten by many organisms. The producers are called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

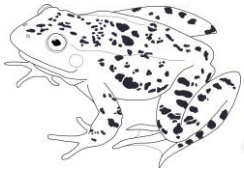
Below is a diagram of a food chain often found in the lakes, rivers, streams, and wetlands in Montana. Notice the arrows are pointed to the animal populations that are consuming the food.



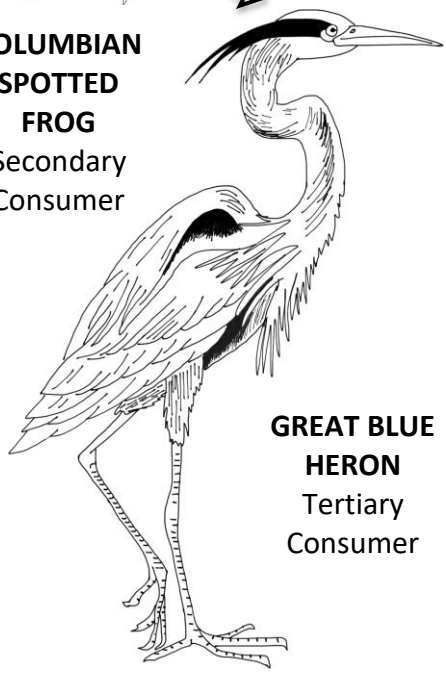
PERIPHYTON
Primary Producer
(The slimy green or brown stuff on rocks in the lake)



TADPOLE SNAIL
Primary Consumer



COLUMBIAN SPOTTED FROG
Secondary Consumer



GREAT BLUE HERON
Tertiary Consumer

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

1. _____

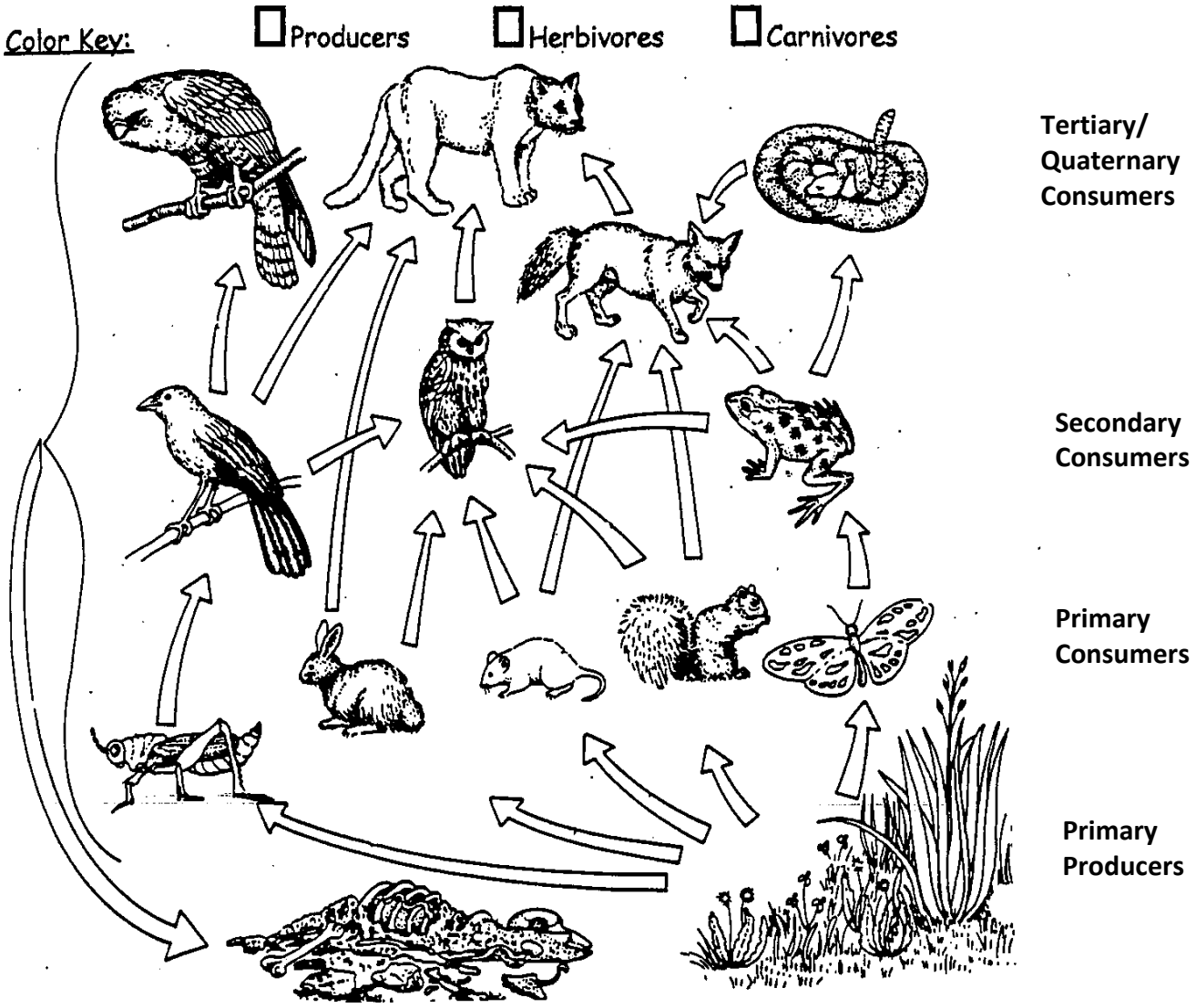
2. _____

3. _____

Understanding a Food Web

Student Worksheet (3 of 9)

Below is a diagram of a food web or a group of interlocking food chains that show the flow of energy through an ecosystem. First, select three colored pencil colors and color in the key below. Next, color the arrows flowing out of the primary producers with the producers color, color the arrows flowing out of the primary consumers with the herbivore color, and color the rest of the arrows as the carnivore color.



Identify find TEN food chains in this web. Food chains usually have at least four links and always start with a producer. Write your food chains below:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Activity: Build a Lake Food Web

Student Worksheet (4 of 9)

Use the provided directions to build a lake food web.

Wrap Up

After completing the lake food web, summarize your understanding by answering the questions below:

1. What does a food web represent? Be specific and use examples from the food web you built.

2. What role does the phytoplankton play in the lake ecosystem?

3. Why are phytoplankton important? *Hint…what do they give you?*

4. What role does zooplankton play in the lake ecosystem?

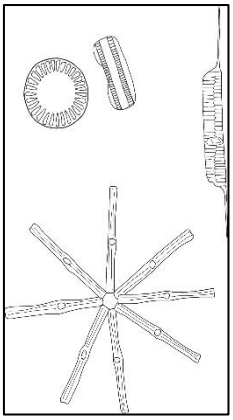
5. CAUSE AND EFFECT: Describe one ecological disturbance that could impact the lake food web and explain how it could potentially impact the ecosystem.

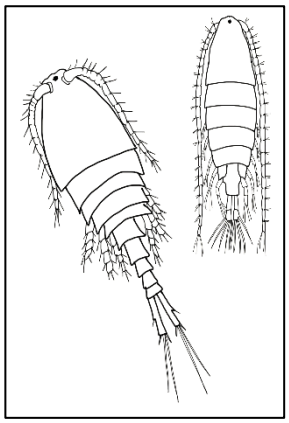
Name _____

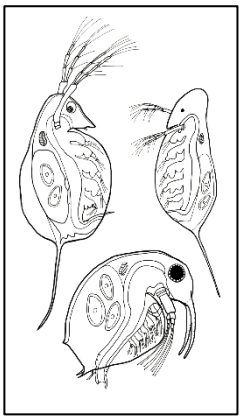
Build a Lake Food Web

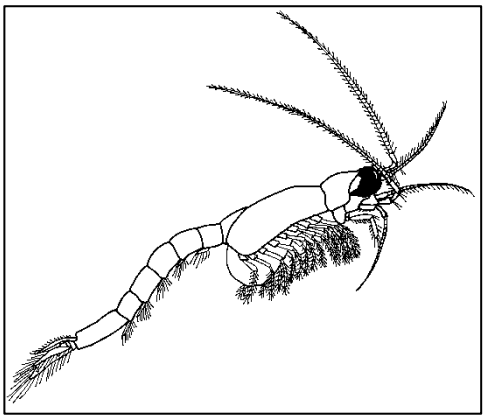
Student Worksheet (5 of 9)

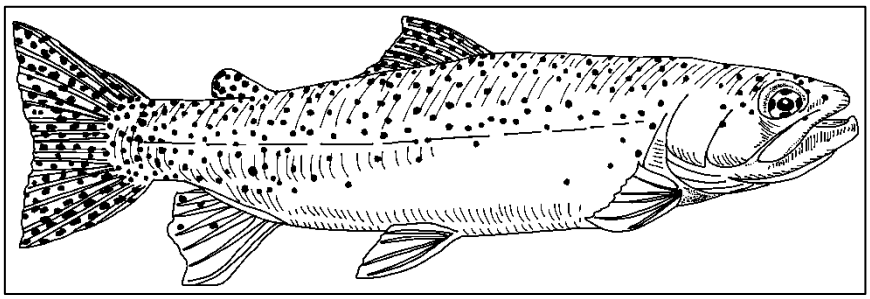
1. Cut out the organisms and descriptions. Match each organism with the description that fits.
2. Arrange the organisms on the poster to build a food web. Remember each food chain in the web should start with a producer. So place your producers at the bottom.
3. Ask your teacher to check your web BEFORE YOU GLUE it to the poster.
4. Glue the organisms and descriptions to the poster and use a marker to draw arrows between the organisms (the arrows should flow UP through the web).
5. Label whether each organism is a primary producer, primary consumer, secondary consumer, tertiary consumer, or quaternary consumer.

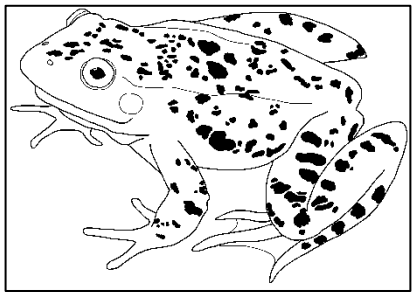


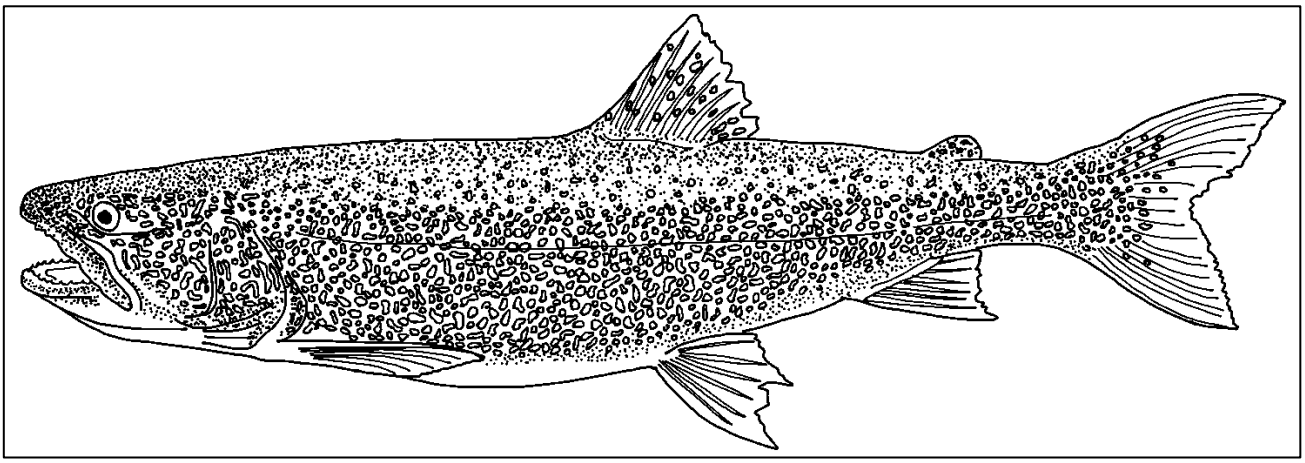




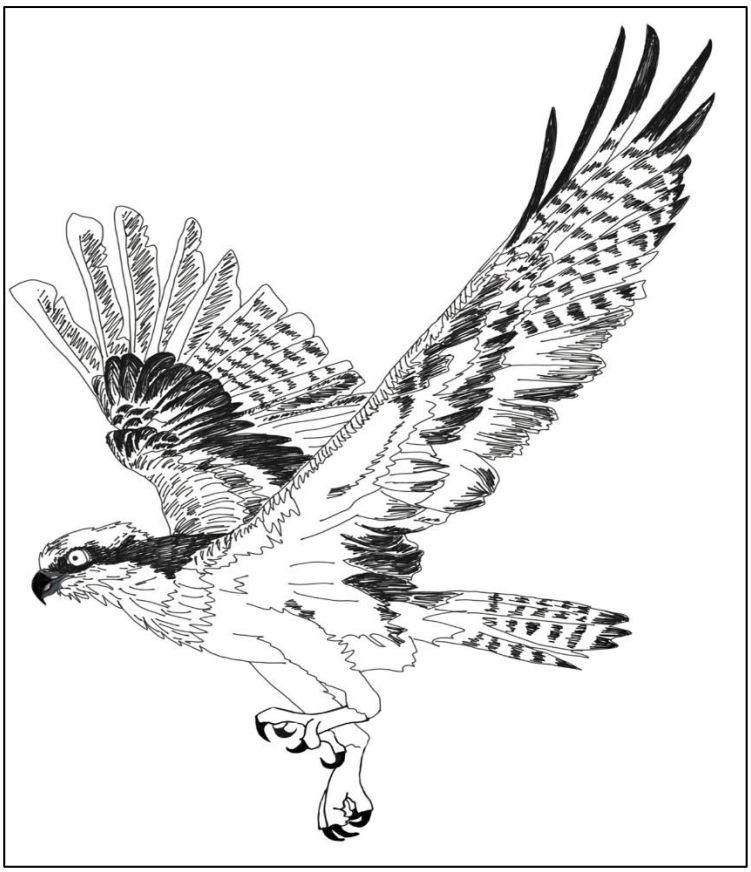


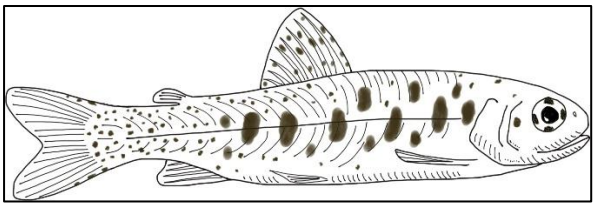


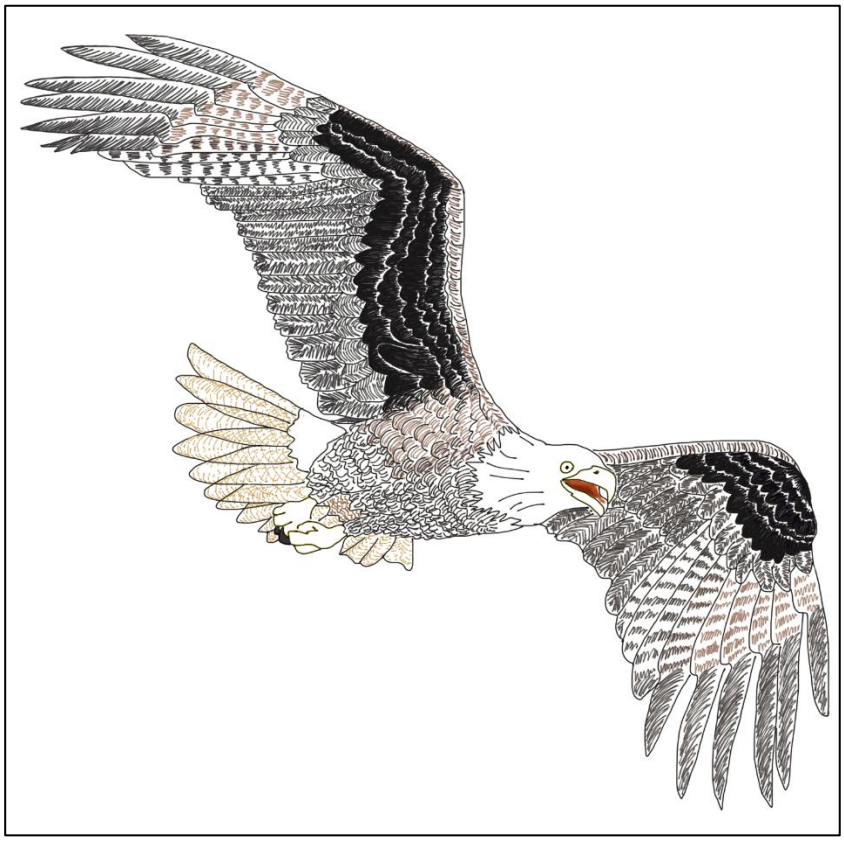


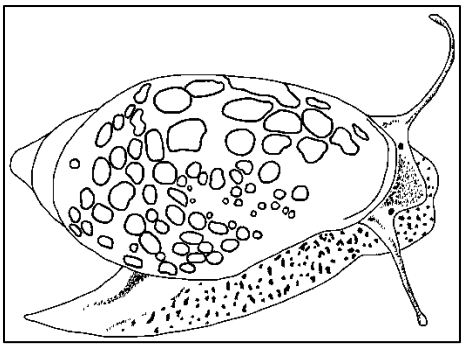


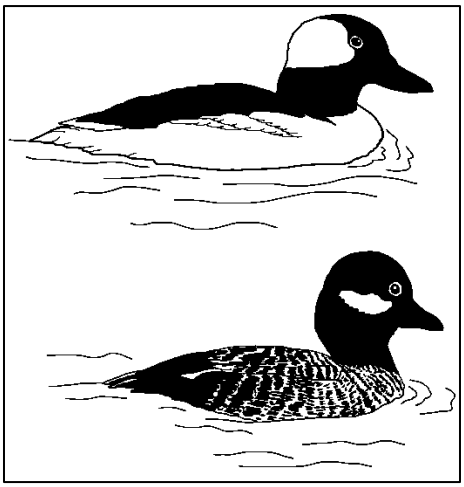
Build a Lake Food Web



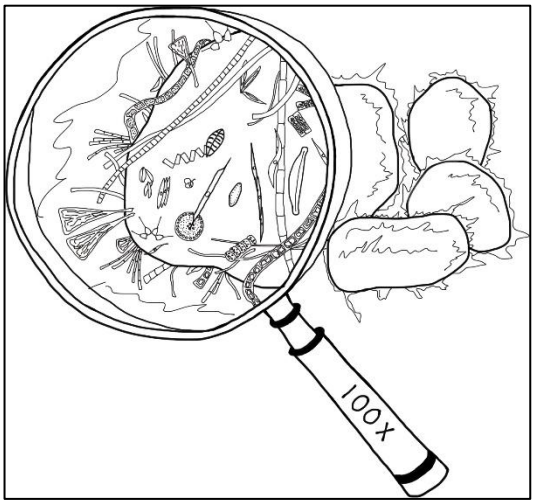


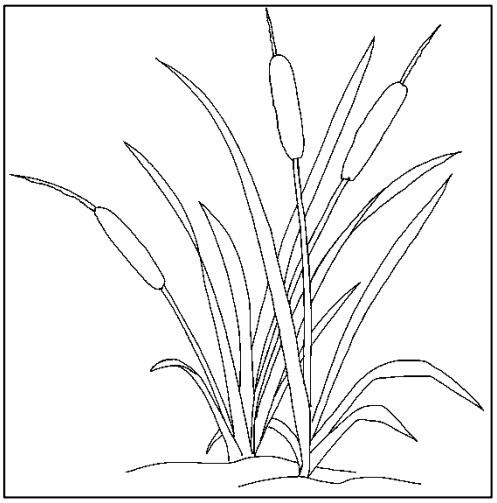


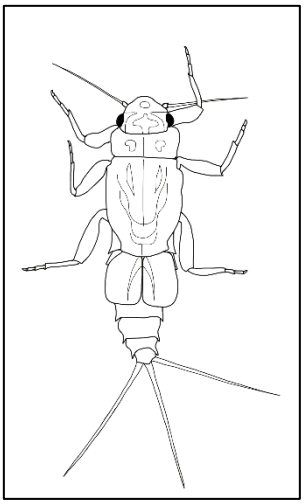


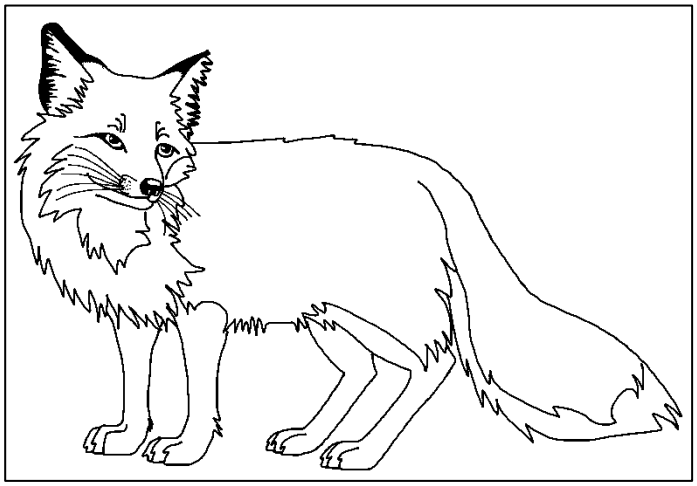


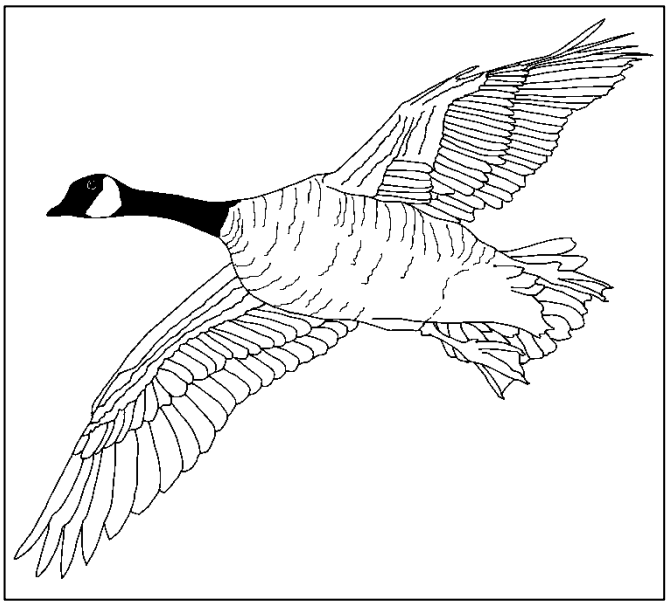
Build a Lake Food Web

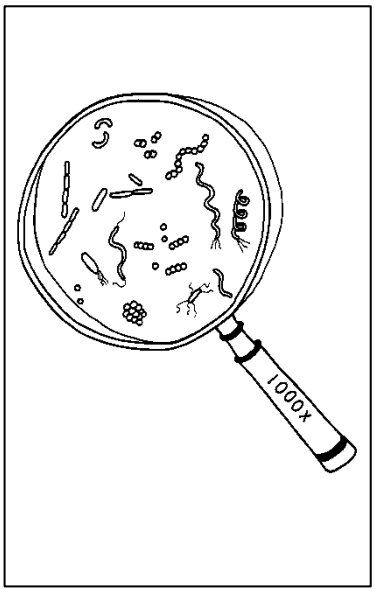


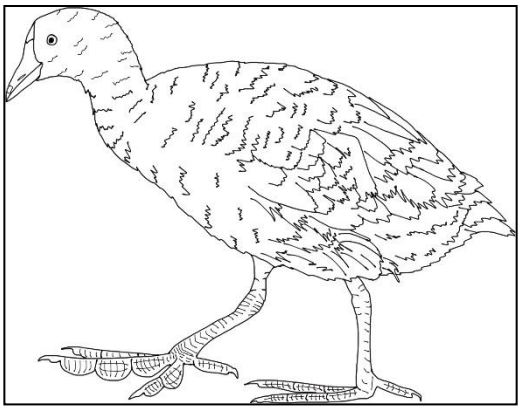












Build a Lake Food Web

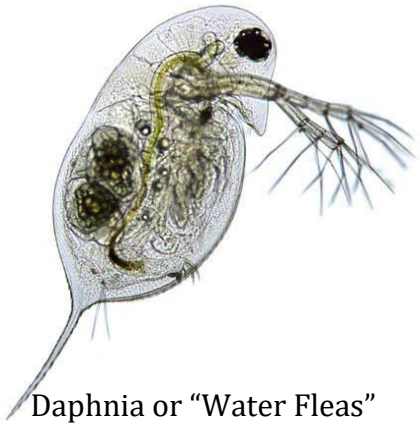
Phytoplankton I am a diatom (microscopic algae) that floats and drifts with the water currents. I use sunlight, water, and carbon dioxide to build sugar for myself through photosynthesis.	**Periphyton** I am the slimy microscopic algae that grows on the bottom of the lakes, streams, rivers and wetland areas. I use sunlight, water, and carbon dioxide to build sugar for myself through photosynthesis.
Broadleaf Cattail I grow in wetland areas. I provide nesting areas for many birds. I use sunlight, water, and carbon dioxide to build sugar for myself through photosynthesis.	**Tadpole Snail** I live along the bottom of fresh water lakes, ponds, streams, rivers, and wetland areas. I eat periphyton and decaying plants and animals found on rocks, sand, and wood.
Copepods - Zooplankton I am a small crustacean that lives in lakes, ponds streams, rivers, and wetland areas. You need to use a microscope to see me. I mostly eat phytoplankton and bacteria.	**Cladocerans - Zooplankton** I am often called a "water flea." I live in lakes, ponds, streams, rivers, and wetland areas. You need to use a microscope to see me. I mostly eat phytoplankton and bacteria.
Canada Goose I can be found near water, grassy fields, and grain fields. I eat grasses and sedges in the spring and summer. I eat cattail seeds, grain seeds and berries during the fall and winter.	**American Coot** I am a swimming bird found in large groups in lakes, ponds, and wetlands. I eat algae, pond lilies, duckweed, wild celery, eelgrass, sedges, hydrilla, cattail seeds and water milfoil.
Mayfly Larvae/Nymph I am an aquatic insect that usually lives along the bottom of lakes, streams, and rivers. I will soon turn into a flying adult mayfly. I eat periphyton off of rocks, sand, and wood.	**Juvenile Trout** I live in lakes, stream and rivers. I like to hide in the pools and side channels of rivers and streams. I eat aquatic insect larvae, baby fish, and small zooplankton.
Great Blue Heron I hunt along the shores of lakes, ponds, streams, rivers, and wetlands. I eat fish, frogs, turtles, young birds, bird eggs, snakes, insects and small mammals.	**Red-tailed Hawk** I hunt in open fields, grasslands, parks, and scrublands. I often look for food from high electrical poles. I eat mostly birds, small mammals, and snakes.

Build a Lake Food Web

Bufflehead Duck I dive for food in lakes, ponds, and wetland areas. I eat aquatic insect larvae, juvenile fish, crustaceans, snails, mussels, as well as, seeds from pondweed, bulrush, and slough grass.	**Columbia Spotted Frog** I live in lakes, ponds, wetlands, streams, and rivers. I often hide in aquatic plants to avoid predators. I eat snails, mussels, spiders, insect larvae, adult insects, & crustaceans.
Lake Trout I live in the cold, clear water of deep lakes and rivers. I eat large zooplankton, such as *Mysis* shrimp when I am young and other fish when I get bigger.	**Adult Westslope Cutthroat Trout** I live in the cold, clear water of lakes, streams, and rivers. I eat aquatic insects and smaller fish.
Bacteria I can be found in every habitat on Earth and on any living and/or non-living surface. I eat material from living and/or dead organisms.	**Red Fox** I live in a den or burrow in the ground in forested areas, mountains, and grasslands. I eat birds, fish, insects, small mammals, and fruits.
Osprey I hunt in fish-filled lakes, ponds, streams, rivers, and wetlands. I like to build my nest on high man-made structures. I dive into the water to catch fish.	**Bald Eagle** I nest in forested areas near large lakes and rivers. I often soar in the sky to search for my food. I eat fish, mammals, birds, frogs, snakes, lizards, and dead animals.
***Mysis* Shrimp** I live in deep, cold lakes. I hide in the deep water during the day and swim up to the surface to eat at night. I eat zooplankton.	

Teacher Resource (1 of 2)

Calanoid copepods

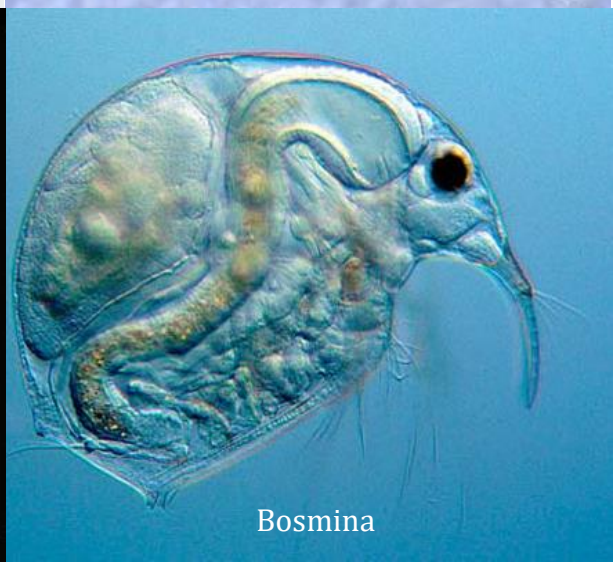


Daphnia or “Water Fleas”

Rotifer

Rotifer

Mysis shrimp



Bosmina