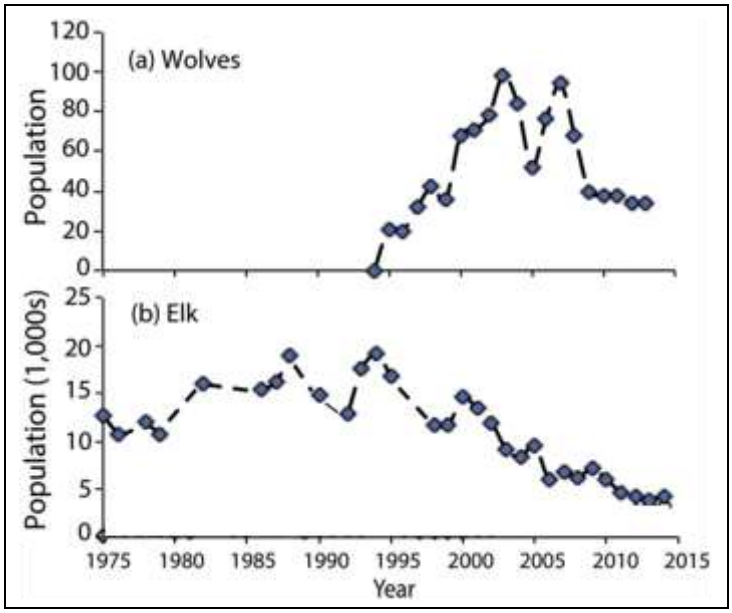
Food Webs – How did the elimination and return of wolves affect other populations in Yellowstone?[1]

Wolves in Yellowstone National Park

In the early twentieth century, humans eliminated wolves from Yellowstone. In the late twentieth century, humans brought wolves back to Yellowstone. You will learn how these changes in the wolf population affected the populations of other animals and plants in Yellowstone.

To begin, watch part of the "Ecosystems Video" (https://www.learner.org/series/the-habitable-planet-a-systems-approach-to-environmental-science/ecosystems/ecosystems-video/); begin at 13 minutes and 40 seconds (right when the video switches from a tropical ecosystem to Yellowstone) and end at 22 minutes (right after the researcher shows that tall willows escape browsing). An **ecosystem** includes the animals, plants and other organisms in an area and their physical environment.

These graphs summarize recent trends in the numbers of wolves and elk in the Northern Range in Yellowstone National Park.



1. Why did the number of elk decrease after 1995?

2a. What happened to the number of elk in Yellowstone after wolves were eliminated from Yellowstone in the early twentieth century?

2b. After wolves were eliminated from Yellowstone, willow growth decreased. What is a likely explanation for this trend in willow growth?

3a. Beavers use tall willows for food and building dams. Predict the change in the number of beavers when wolves were eliminated from Yellowstone. decreased ___ increased ___

3b. Explain your reasoning.

We will return to these questions after you have learned more during this activity.

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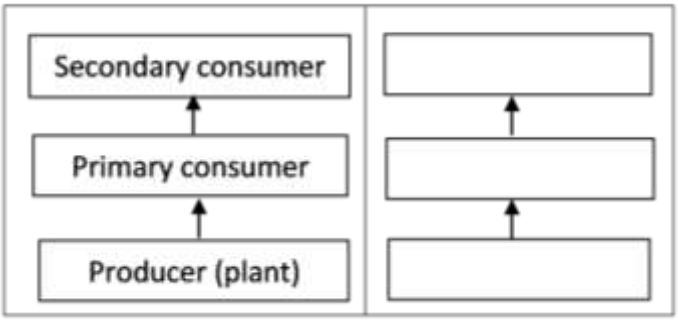
[1] By Drs. Ingrid Waldron and Lori Spindler, Dept Biology, University of Pennsylvania. © 2024. This Student Handout, an alternative version for students who are learning at home and do not have a printer, and the Teacher Preparation Notes with instructional suggestions and background information are available at https://serendipstudio.org/exchange/bioactivities/foodwebRR.

Food Chains and Food Webs

A **food chain** summarizes a sequence of trophic relationships. **Trophic** means eating or nutrition. As shown in this figure, producers (plants) are eaten by primary consumers (herbivores), and primary consumers are eaten by secondary consumers (predators).



4a. To show a specific food chain, write grass, rabbit and mountain lion in the appropriate blank boxes.

4b. Primary consumer and herbivore are different names for an animal that eats _____.

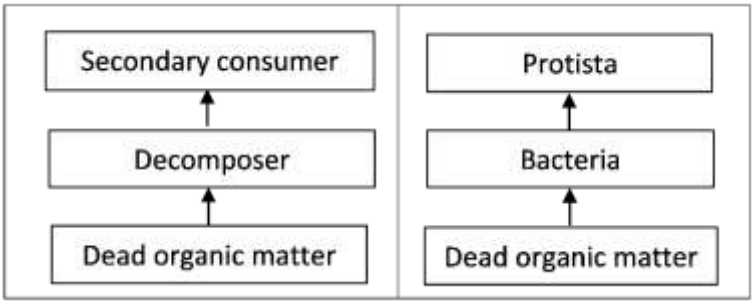
4c. Each arrow in a food chain points from an organism that _____ to an organism that _____ .

There is another type of food chain that doesn't begin with living plants. Think about a 100-year-old forest where the leaves have dropped from the trees each fall, dead branches have fallen, and animals have died each year. But, you won't see 100 years of dead stuff piled up on the ground in the forest.

5. What do you think has happened to all the dead stuff?

Decomposers get their nutrition from dead organic matter. Two major types of decomposers are bacteria and fungi (e.g. mushrooms). These bacteria and fungi secrete digestive enzymes into dead organic matter and absorb digested molecules. Thus, all the dead stuff is eventually digested.

The first flowchart on the right shows a food chain that begins with dead organic matter. The second flowchart shows an example of this type of food chain in Yellowstone.



6. If you visited Yellowstone, you might not notice this food chain. Why not?

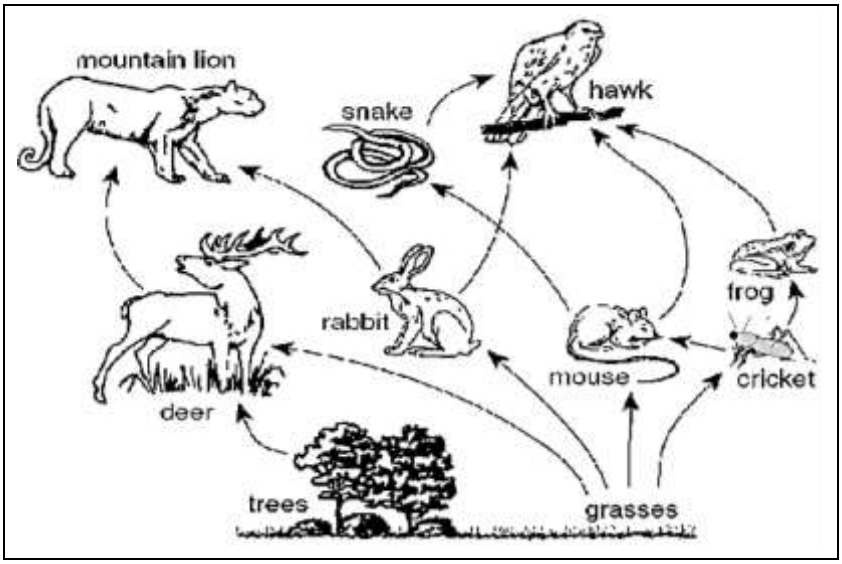
7. Match each item in the left list with the best match or matches from the right list.

Producer ___
Primary consumer ___ ___
Secondary consumer ___ ___
Decomposer ___

a. an animal that eats plants
b. an organism that consumes dead organic matter
c. an organism that eats primary consumers
d. an organism that eats producers
e. an organism that makes its own organic molecules from small inorganic molecules (e.g. uses photosynthesis to make sugars from CO_2 and H_2O)
f. includes some predators and Protista

In real biological communities, the trophic relationships are much more complex than a simple food chain. These more complex trophic relationships are summarized in a **food web**.

This figure shows a small part of a food web. Notice that the food web contains multiple food chains.



8. Use asterisks (*) to mark the organisms in one food chain in this food web.

Most of the organisms in this food web can be classified in one of these **trophic levels**:

- producers
- primary consumers
- secondary consumers.

However, not all organisms fit in a single trophic level. You may have heard of omnivores which eat both plants and animals. A more general category is a **trophic omnivore**, which is any animal that eats organisms from more than one trophic level.

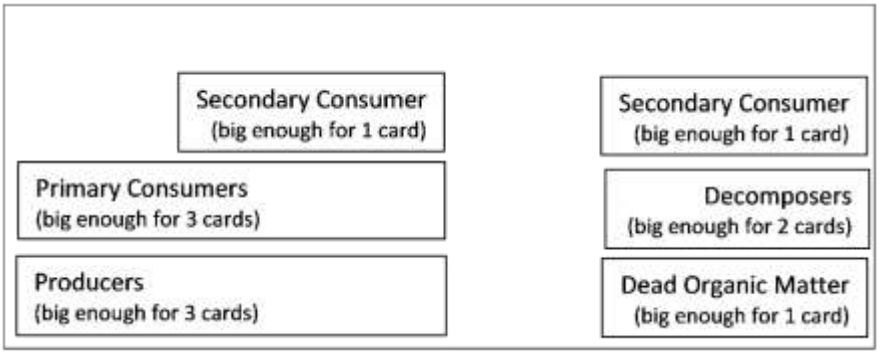
9. In the above figure, use one of the following symbols to label each type of organism.

P = Producer (There are 2 of them.)
PC = Primary Consumer (3)
SC = Secondary Consumer (2)
TO = Trophic Omnivore (3; any animal that eats trophic omnivores is a trophic omnivore.)

Trophic Relationships in Yellowstone

Pages 5-7 show the trophic relationships for each organism that will be included in your Yellowstone food web. To make your food web, complete each step in the procedure below and check the box before you begin the next step.

A. Your teacher will explain how to get a set of cards. You will need a surface that is approximately 45 cm (1.5 feet) wide and 60 cm (2 feet) tall for your food web. Draw and label the rectangles shown below on your lab table or on a large piece of paper. Leave space for trophic omnivores between and above the two sets of rectangles. ☐



B. Find the cards for the producers and dead organic matter in your Yellowstone deck. Put these cards in the appropriate rectangles. ☐

C. Find the cards for the primary consumers (which eat only producers) and the decomposers (which consume only dead organic matter). Put these cards in their rectangles. Draw an arrow to show each trophic relationship listed on the cards. ☐

D. Use the remaining cards to put the secondary consumers in their rectangles and the trophic omnivores in appropriate places outside the rectangles. (Remember that any animal that eats trophic omnivores is also a trophic omnivore.) Draw an arrow to show each trophic relationship. ☐

Your Yellowstone food web may look complex, but a complete Yellowstone food web would be much more complex. Here are some causes of this additional complexity.

- Many more types of organisms live in Yellowstone, including more than 1000 different kinds of plants and more than 1000 different kinds of insects.
- The trophic relationships are more complex than is shown in your food web. For example, when an elk is killed by a pack of wolves, the wolves eat much of the meat, but some of the rest is eaten by other animals such as bears, coyotes, eagles and ravens. After animals have finished eating, the remaining dead organic matter is consumed by decomposers.
- Some of the trophic relationships in your food web are much more important than others. For example, Yellowstone wolves eat many elk and few beavers.

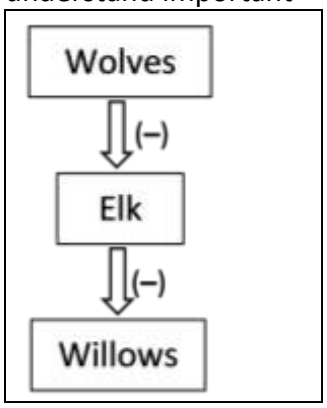
10a. To add a little of this complexity to your food web, make the arrow from elk to wolves fatter to represent the importance of this trophic relationship.

10b. Draw arrows from the producers and primary consumers to dead organic matter. These arrows will represent the general point that, every year, many plants and animals become dead organic matter.

11. Your teacher may suggest improvements for your food web. After you have made any suggested improvements, take a picture of your food web to submit to your teacher.

Even though your food web is incomplete, it can help you to predict and understand important ecological phenomena.

A **trophic cascade** occurs when a change in the size of a predator population has indirect effects on the size of another population in the ecosystem.



12. As shown in this figure, wolves reduce the number of elk, and elk reduce the number and size of willow shrubs. Show the indirect effect of wolves on the willow population with a curved arrow and (+) or (-) to indicate whether increases in the number of wolves result in increased or decreased willow growth.

13. After wolves were eliminated from Yellowstone, the number of beaver colonies decreased. What is a likely explanation? (Hint: Remember that beavers use tall willows for building dams and for food.)

23-28 cm

American Robins

Eat: Earthworms, beetles, other flowering plants

Eaten by: Snakes and birds of prey (not included in this food web)

2.1-2.4 m

Elk

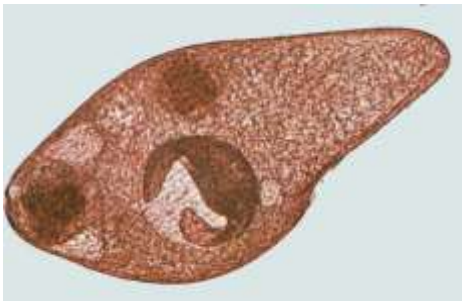
Eat: Grasses, willows, other flowering plants

Eaten by: Gray wolves, grizzly bears, coyotes

1.8-3.3 m

Grizzly Bears

Eat: Other flowering plants (including berries), elk



<1 mm

Protista

Eat: Bacteria

Eaten by: Nematodes

1-1.4 m

Coyotes

Eat: deer mice, elk

Eaten by: Gray wolves

1.4-2 m

Gray Wolves

Eat: Elk, coyotes, beavers

<80-400 cm

Willows

Eaten by: Elk, beavers

Grasses (including seeds)

Eaten by: Elk, deer mice

Dead Organic Matter

Consumed by: Bacteria, fungi, earthworms

Other flowering plants (including berries)

Eaten by: American robins, deer mice, elk, grizzly bears

58-99 cm (length, excluding tail)

Beavers

Eat: Willows

Eaten by: Gray wolves

8-10 cm (length, excluding tail)

Deer Mice

Eat: Grasses; other flowering plants

Eaten by: Coyotes

7-35 cm

Earthworms

Eat: Dead organic matter, fungi, bacteria

Eaten by: American robins

0.5-1 mm

Mites

Eat: Nematodes, fungi

Eaten by: Beetles

5-20 mm

Beetles

Eat: Mites

Eaten by: American robins

Fungi

Consume: Dead organic matter

Eaten by: Earthworms, mites, nematodes

2-6 µm

Bacteria

Consume: Dead organic matter

Eaten by: Protista, nematodes, earthworms

0.1-2.5 mm

Nematodes

Eat: Protista, fungi, bacteria

Eaten by: Mites