Food Webs – Understanding What Happened When Wolves Returned to Yellowstone[1]

Wolves in Yellowstone National Park

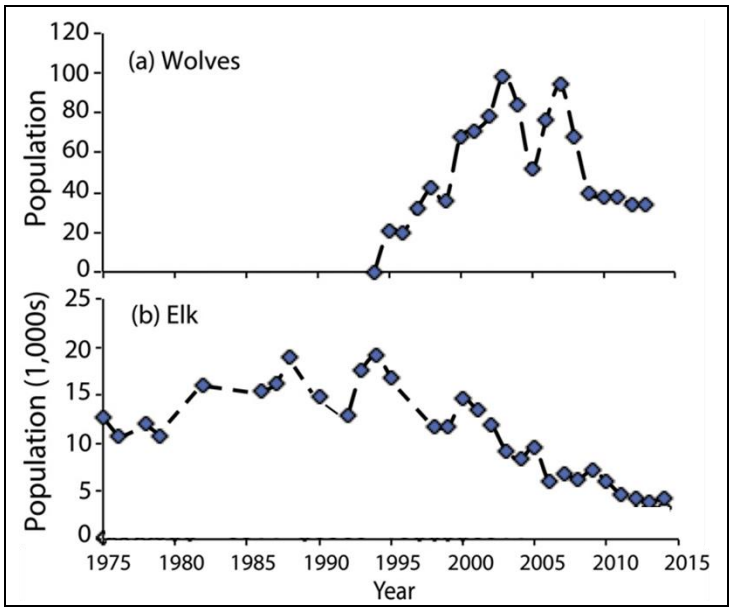
In the early twentieth century, humans eliminated wolves from Yellowstone. In the late twentieth century, humans brought wolves back to Yellowstone. How did these changes in the wolf population affect the other animals and plants in Yellowstone?

To begin to answer this question, watch the "Ecosystems Video" (https://www.learner.org/series/the-habitable-planet-a-systems-approach-to-environmental-science/ecosystems/ecosystems-video/), beginning at 13 minutes and 40 seconds and ending at 22 minutes and 37 seconds. 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.

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

1b. What happened to the bodies of the thousands of dead elk?



2. After 1995, willows grew taller in some parts of Yellowstone. What is one possible explanation for this trend?

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

3b. Explain your reasoning.

We will return to these questions after you have learned about food chains and food webs.

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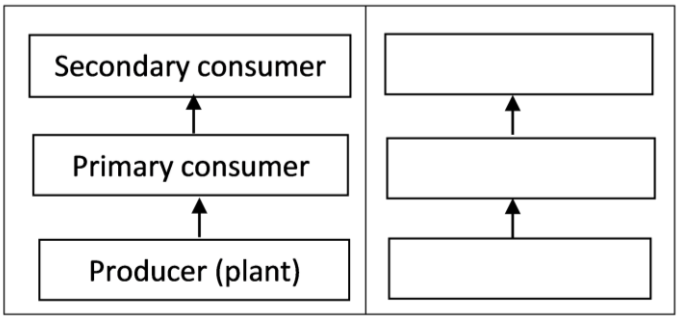
[1] By Drs. Ingrid Waldron and Lori Spindler, Dept Biology, University of Pennsylvania. © 2021. This Student Handout, an alternative Student Handout for students learning at home without a printer, and the Teacher Preparation Notes with instructional suggestions and background information are available at https://serendipstudio.org/sci_edu/waldron/#foodweb.

Food Chains and Food Webs

This figure shows a food chain. Secondary consumers eat primary consumers which eat producers (plants).

Notice that producers are shown at the bottom of the food chain. Each level above that eats organisms from the level below.



A **food chain** summarizes a sequence of trophic relationships, where **trophic** means eating or nutrition.

4. Write mountain lion, grass, and rabbit in the appropriate blank boxes to show a food chain.

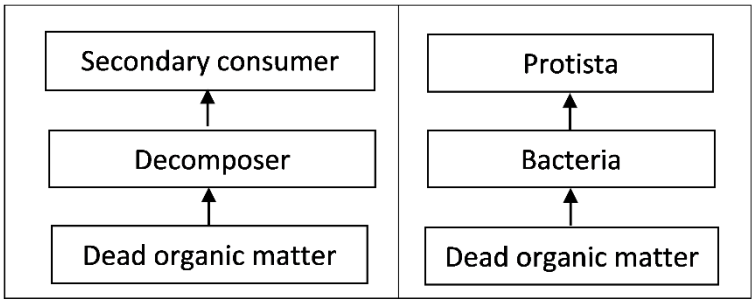
There is another type of food chain that doesn't begin with living plants.

5. 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. You won't see 100 years of dead stuff piled up on the ground in the forest. What has happened to all the dead stuff?

Decomposers get their nutrition from dead organic matter. Decomposers include bacteria and fungi (e.g. mushrooms) which secrete digestive enzymes and absorb digested molecules from the dead organic matter.

The first flowchart on the right shows a food chain with decomposers, and the second flowchart shows an example from Yellowstone.

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



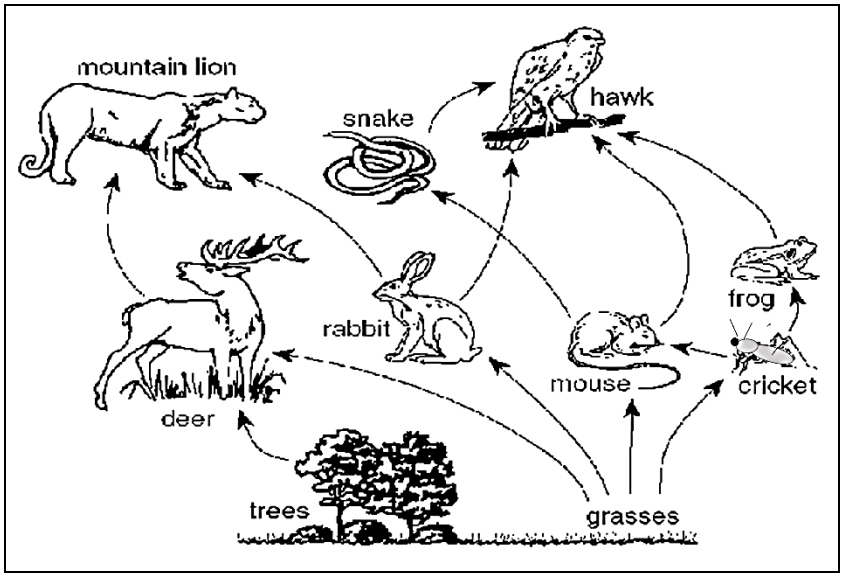
7. Match each item in the top list with the best match or matches from the bottom list.

Producer ___
Primary consumer ___ ___
Secondary consumer ___ ___

a. an animal that eats plants
b. an organism that consumes primary consumers
c. an organism that consumes producers
d. 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)
e. 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.

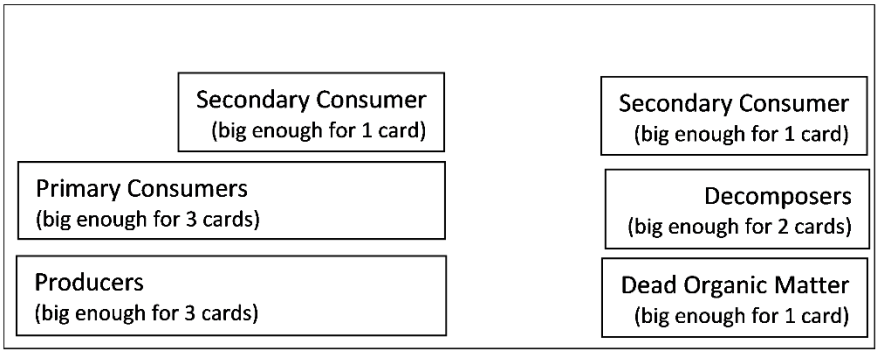
9. In the above figure, use one of the following symbols to label each type of organism.

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 or access an electronic equivalent. If you are using 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, on a large piece of paper, or on six smaller pieces 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. If you have your food web set up on a lab table or large piece of paper, draw an arrow to show each trophic relationship listed on the cards. Otherwise, you can represent each trophic relationship with an arrow on a strip of paper or with a piece of string. ☐

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.

- 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 other animals such as bears, coyotes and ravens eat some of the rest, and parts of the elk become dead organic matter which is consumed by decomposers.
- Some of the trophic relationships shown are much more important than others. For example, Yellowstone wolves eat many elk and few beavers.

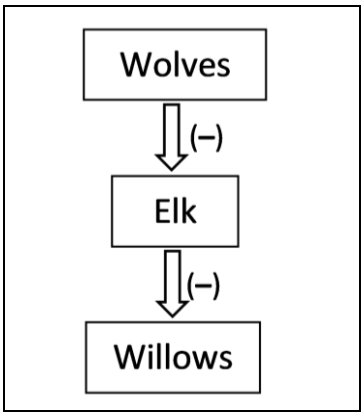
10a. Make the arrow from elk to wolves fatter to represent the importance of this trophic relationship.

10b. Draw arrows from the primary consumers and producers to dead organic matter. These arrows will represent the general point that all or parts of many plants and animals become dead organic matter which is consumed by decomposers.

11. Use teacher comments to improve your food web, and then take a picture of it to submit.

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 population of a predator not only affects its prey population, but also has indirect effects on another population in the ecosystem. In this flowchart, each arrow represents a negative effect of one population on the size of another population.



12. Add a curved arrow with a (+) to show the indirect effect of wolves on the willow population in this trophic cascade.

13. Explain how changes in the wolf population could produce the following trends in the number of beaver colonies.

- After wolves were <u>eliminated</u> from Yellowstone, the number of beaver colonies <u>decreased</u>.
- After wolves were <u>reintroduced</u> to Yellowstone, the number of beaver colonies <u>increased</u>.

(Hint: Beavers use tall willows for food and building dams.)

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

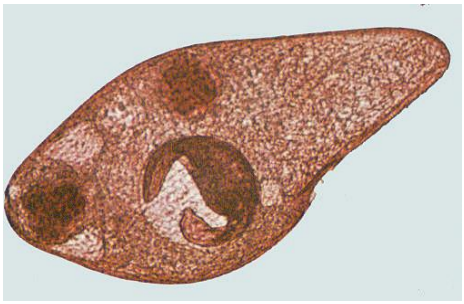
Eat: Grasses, willows, other flowering plants

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

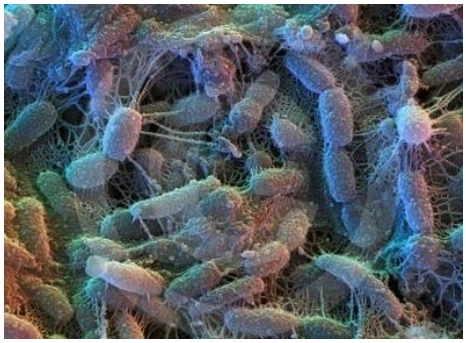
Eat: Mites

Eaten by: American robins

Fungi

Consume: Dead organic matter

Eaten by: Earthworms, mites, nematodes

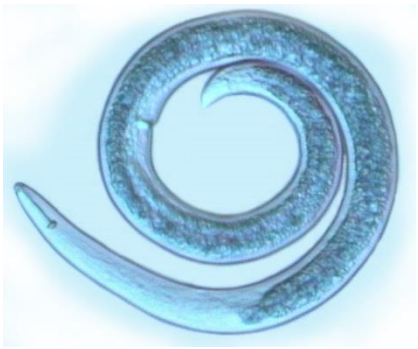


2-6 µm

Bacteria

Consume: Dead organic matter

Eaten by: Protista, nematodes, earthworms



0.1-2.5 mm

Nematodes

Eat: Protista, fungi, bacteria

Eaten by: Mites