

It's All Interconnected

Summary

Students will:

- Understand ecological systems
- Provide experiences to assist citizens to increase their sensitivity and stewardship for the environment
- Understand cause-and-effect relationships

Setting

Classroom

Objectives

Students will:

1. Define "food web."
2. Explain energy transfer in the food web.
3. List factors that cause species extinction.
4. Explain the roles of predators and prey.
5. Appreciate the benefits of biological diversity.

Materials

Activity 1:

3-by-5-inch cards for name tags and habitat situation change

Activity 2:

- one plastic bucket, jug, or milk carton
- three corks

Activity 3:

- sticks to serve as plot markers
- one piece of paper per student
- one pen per student

Activity 4:

- pictures of organisms (producers, consumers, and decomposers)
- wire (or wooden dowels or straws)
- strong thread

- one pair of scissors per student or group
- glue (optional)

Activity 5:

one piece of paper and pencil per student (or one calculator per student)

Activity 6:

one [Pyramid Climb Handout](#) per student

Background

"All things are interconnected."

A diverse environment is a healthy environment. The more species of plants and animals (biodiversity) that an ecosystem contains, the more unlikely it is that the ecosystem will be disrupted by the removal of one of those species. Unfortunately, many of our activities have reduced the diversity of both plants and animals. Scientists estimate that we are losing at least one species per day! Although some species have become extinct due to "natural causes," the majority of extinctions are due to human activities. Some of these activities and the percentage of extinctions caused by each are:

habitat alteration	30%	pest control	7%
commercial hunting	21%	subsistence food hunting	6%
competition with introduced species	16%	captured to serve as pets	5%
sport hunting	12%	superstitious beliefs	2%
		pollution	1%

No one really knows how deeply the loss of one species affects our entire environment. But we do know that the extinction of a species is final. It is a mistake that can never be truly measured or corrected.

Biodiversity produces a stable, healthy environment. For example, if a pine forest with only one species of tree contracts a disease, the entire forest may be wiped out. This would not happen if the forest included more than one species, since others would probably be resistant to the disease.

Since wild animals are usually more sensitive than humans to problems in their natural environment, the disappearance of wildlife in an area is an indicator that something is wrong. The problem may be a serious disruption in a natural cycle or food chain that will eventually affect humans. Because of this, wildlife is a barometer indicating to us the health of our environment.

When something disrupts the food chain at the bottom, it is magnified at each succeeding level. When it reaches the top, the disturbance appears as a major environmental disruption. This makes raptors and other predators at the top of the food chain especially vulnerable when the chain becomes unbalanced. For example, the pesticide DDT was once widely used. Insects, fish, and small mammals absorbed the chemical as it washed into the water and food systems. Eagles and other birds then accumulated toxic levels as they consumed the poisoned prey. This resulted in high rates of weakened eggshells, inability to reproduce, and death by pesticide poisoning. The bald eagle, brown pelican, and peregrine falcon were placed on the endangered species list because of their severe population depletions. Because of this environmental barometer, people have begun to realize the potential danger to humans and are trying to find safer pesticides.

It is crucial that we understand the interconnectedness of our ecosystems. Damage to one ecosystem reaches much further than its own boundaries. For example, the lives of migratory birds clearly demonstrate the interconnections between North and South America. When habitats are destroyed in the Southern hemisphere, it shows up in the Northern hemisphere when fewer birds migrate north in the spring. And these surviving birds may also find that their northern nesting grounds have been invaded by shopping malls and housing developments. In certain areas, nesting migrant songbirds have declined 70 percent during the last 35 years and some species have completely disappeared from areas where they used to thrive.

Loss of habitat is the greatest threat to wildlife today. Urban sprawl, new highways, housing developments, agricultural development, etc., all decrease the natural habitats available for birds and wildlife. These habitats that remain each have their individual limit, called carrying capacity. Carrying capacity is the limit to the number of animals that an area can support, and varies depending upon the species present and seasonal weather changes. Once the carrying capacity is reached, any new animals born or migrating into the population must compete with the established animals for food, water, and shelter (limiting factors.) The losers must move somewhere else or die. If there is no other habitat available close by, these surplus animals are doomed. (See Figure 1, below.) The only way to increase carrying capacity is to increase the size of the habitat or improve its quality.

Figure 1 - [Bucket Diagram](#)

Every ecosystem interacts with all other members of the system. For example, earthworms aerate the soil; deer droppings fertilize the soil and promote grass growth; grasses hold moisture in the soil, prevent erosion, and provide food for deer and other wildlife. Grass seeds feed mice and many other rodents, which in turn, are food for the hawk flying overhead. So the earthworm, grass, deer, mouse, hawk, and all other the other living organisms in the ecosystem are intricately woven together in a delicate "web of life."

Energy is one of the basic requirements for life. The ultimate source of energy for all living things is the sun. Green plants convert and store energy from the sun through the

process of photosynthesis. Since they create their own food, plants are called **producers**. Creatures that do not make their own energy are called **consumers**. They depend upon other organisms for their energy source. An animal that eats plants is called a **primary consumer** or an **herbivore**. An animal that eats other animals is called a **secondary consumer** if it eats herbivores or a **tertiary consumer** if it eats other consumers. Consumers that eat other animals are **carnivores**, and an animal that eats both plants and animals is called an **omnivore**. This sequence of eating and being eaten that extends from sunlight and plants throughout a long series of plant and meat eating animals is called a **food chain**. At the end of food chains are found the **decomposers**. These bacteria, insects, worms, etc., break down the dead material and return it to the soil.

An example of a food chain is...grass...is eaten by ...a grasshopper...which is eaten by ...a lizard...which is eaten by ...a fox...which dies and is consumed by worms, insects, and bacteria.

A **food web** provides a more realistic picture of what actually happens in an ecosystem. A food web is a complex network of many overlapping and interconnected food chains. It more accurately describes the energy transfers involved in the processes of life and death.

It is important to understand that at each step of the food chain, there is a transfer of both energy and materials. This transfer is often diagramed as a **food pyramid** or biomass pyramid, with each level being higher and smaller than the one below. Energy transfer within the food chain is only about 10 percent efficient, with 90 percent of the energy being lost with each additional transfer. So at each pyramid level, more pounds of food are required to support the next higher level. As a general rule, 100 pounds of plants could support 10 pounds of herbivores, which in turn could support one pound of carnivore.

An important factor of this pyramid is that the higher the level in the food chain, the fewer consumers can be supported. Predators, such as raptors, wolves, etc. (including humans!) get their energy third- or fourth-hand, so they need to eat a lot to get enough energy. They are said to be at the top of the food chain, and are actually the most vulnerable of all consumers since they are totally dependent upon the lower levels for their survival.

Procedure

1. Habitat Change Game

This game demonstrates how changes in habitat alter kinds or numbers of animals in an area.

To play, divide the classroom into areas of grassland, forests, and lakes. Designate three areas of each habitat type. For instance, you will have Forest A, Forest B, and Forest C. Draw a map of the location of these areas on the chalkboard or overhead projector. Students will role-play the animals that live in the habitat

areas. For instance, some of the students can be largemouth bass or striped bass living in lakes, some can be trout or smallmouth bass living in streams. The forests can "house" deer, squirrels, and boreal owls. Coyotes and rabbits can live in the grassland areas.

To begin the activity, each student will make his animal's name tag and go to the appropriate habitat area. Regardless of the number of students present in an area at the start of the game, this will be the maximum number of animals this area can support throughout the game (the habitat's carrying capacity). Record this number on a master sheet. The teacher will draw a habitat card and read the habitat change situations. The situation on the card will affect one of the three areas of a habitat type A, B, or C. For instance, the card chosen might involve Forest A (Situation 2.) After the card has been read, all of the animals in this area must move to one of the other forest areas. The teacher will check the master sheet and see how many animals that area can hold. If the number exceeds the maximum established at the beginning of the game, the extra students will have to "die," i.e., return to their seats.

This will bring about the logical discussion of overcrowding and habitat loss. If the next habitat card chosen involves Forest C, students can migrate back to Forest A. The teacher then checks the numbers of animals in both A and C. If the game continues long enough, most of the animals will be eliminated because of habitat destruction or modification. Assess for students' feelings. How did they feel when they lost their homes? How did they feel when people's "progress" destroyed their habitats? Discuss possible solutions that are actually workable.

Suggested habitat change situations:

- Grassland A has been plowed up and planted to Bermuda grass pasture for cattle.
- Forest A has been pushed down to make way for a housing development.
- Sewage from nearby cities has been carried into Lake A.
- Forest B has been cut down for lumber for houses, furniture, paper, etc.
- A highway will be constructed through Forest C and Grassland C.
- A state park is being built near Lake B. There has been clearing for picnic tables, camping areas, and parking areas.
- A golf course is being built on an area of Grassland B.
- A farmer has decided to plow up Grassland C in order to grow crops.
- Silt was carried from farming and construction projects and eventually filled up Lake C.

(Adapted from *Critters and Concepts: A Teaching Guide to Oklahoma Wildlife*, Oklahoma Dept. of Wildlife Conservation)

2. There's A Hole in the Bucket!

This activity demonstrates how the number of animals in an area is determined by the availability of food, water, and shelter, and how these limiting factors affect the carrying capacity of the ecosystem.

Take a plastic bucket, jug, or milk carton, and make three holes in one side, progressing toward the top. Label each of these holes with "Water" on the bottom, "Food" in the middle, and "Shelter" on the top. Tell the students that the amount of water the bucket will hold is the carrying capacity for wildlife. The holes in the side of the bucket represent limiting factors. Pour water into the bucket until it begins to run out the first hole. In this example, water is the limiting factor for wildlife. The carrying capacity for wildlife is the amount of water below the first hole, and no matter how much water you pour in, the amount the bucket will hold is limited by this hole. Discuss. Plug up the bottom hole. This represents the fact that water is no longer limited. Now pour water into the bucket again. Now what becomes the limiting factor? (Food.) Plug the food hole and pour more water into the bucket until it reaches carrying capacity. Shelter is now the limiting factor. Plug the shelter hole and add more water. Discuss the wildlife habitat in your area and the capacity to carry a certain number of each kind of animal suited to live there. What happens to wildlife if a construction project suddenly removes its shelter? Pull the plug in the hole marked "shelter." Continue this discussion and demonstrate the effects of further changes in the habitat.

(Adapted from *Critters and Concepts: A Teaching Guide to Oklahoma Wildlife*, Oklahoma Dept. of Wildlife Conservation)

3. Observations of Population Numbers

This activity illustrates the relationships between producers and consumers in a natural ecosystem.

Select a natural area where you have seen animals, birds, and plants, and not many people. This may be in your backyard, a park, a wooded lot, a riverbank, a marsh, etc. Step off an area 10 yards square and place a marker at each corner. Draw the major features of your plot, such as rocks, trees, a wall, water, etc. Identify every living organism that you can find within your square and divide them into one of these categories: producer, consumer, decomposer. How many different kinds of producers, consumers, and decomposers can you find? Can you actually see any decomposers? If not, how can you tell that they are present? Is there evidence of other creatures that come into your plot but are not there now? Draw a food pyramid that describes the producers and consumers in your plot. Now choose a one-square-yard area of your plot and count all the individual producers and consumers that you can find. Among the consumers, how many are

herbivores, carnivores, or omnivores? What can you determine about their feeding relationships and interdependency?

(Adapted from Links of Life: The Housatonic and You. Gretchen Kingsley, Patricia Mahnensmith, and Dana McArdle. Schooner, Inc.)

4. Food Mobile

This activity illustrates the relationships between primary producers and consumers within a food chain. Students work individually or in small groups to construct a mobile representing a simple food chain (pyramid) based upon their understanding of food pyramids and the ecosystem. They will need to understand that the bottom of the mobile represents the sun.

Gather pictures of various organisms from magazines, etc. Examples of consumers are: birds of prey, wolves, coyotes, lions, raccoons, many fish, humans, etc. Examples of producers are algae, grass, berries, etc. Examples of decomposers include bacteria, insects, and worms. Primary, secondary, and tertiary consumers should all be included in the pyramid, based on information included in the background section of this lesson. After the mobiles are completed and displayed, discuss some of the following questions:

- Where in the mobiles are the meat-eaters? Where are the vegetarians?
- What is the relationship between the type of animal or plant and its position in the mobiles?
- Where are the primary producers in each mobile? What happens when you remove one? Several? How does the result compare with what happens when you remove one or more producers?
- What is the final consumer in each mobile? What other organisms could be at the top of the pyramid?
- Does a disturbance at certain levels of a mobile result in greater change than disturbances at other levels? Explain this.
- How does the complexity of a mobile affect its susceptibility to change? How can this be explained?
- What implications does what you have observed in this exercise have for ecosystem management and preservation, particularly in relation to biological diversity?

(Adapted from Project Learning Tree Activity Guide: Grades 7-12, the American Forest Council, 1988)

5. Energy Transfer

This activity helps students understand how living things exchange energy and matter with each other and practices the use of ratios.

Lead the class in a discussion about energy transfer in the food chain using the information provided in the Background section of this lesson plan. Draw the pyramid as shown below (see Figure 2). Explain that only about 10 percent of the solar energy striking the earth's surface is incorporated into plant tissues and only about 10 percent of the plants' stored energy is used by primary consumers. Energy continues to be lost as you ascend through the first- and second-level carnivores.

Figure 2 -[Energy Transfer Pyramid](#)

Write the following problems on the board and ask the students to solve them.

- According to the pyramid, what is the ratio of third-order consumers to producers? (1/1000)
- What is the ratio of first-order consumers to third-order consumers? (100/1)
- If 100 minnows eat 1,000 algae plants, how many bass will they provide with energy? (10)
- If 1,000 grasshoppers weigh three grams each, how many grams of energy will they supply to a frog? (300 grams)
- If a rabbit and a ground squirrel each supplied the same amount of energy to a coyote and it took 600 of both to supply energy for one year to 1 coyote, how many of either rabbits or ground squirrels would it take to supply energy for 4 coyotes for 1 year? ($600 \times 4 = 2,400$)

6. Pyramid Climb

This activity demonstrates how living things exchange energy and matter with each other.

Begin the activity with a discussion of the food pyramid. Use information provided in the Background section of this lesson plan to explain the food pyramid and energy-loss concepts. Distribute copies of the pyramid handout (see figure 3). Scramble the lists below and copy them onto the blackboard. The students must unscramble the lists and use these words to fill in the ladder rungs with the correct producers and consumers. Several combinations will be possible if the "extra" words are included; however, only one or two combinations can be correctly completed to include tertiary consumers. Additional organisms may be added to the lists to create additional or more complex combinations.

Figure 3 -[Pyramid Climb Handout](#)

Producer and consumer list:

Lake or Stream	Prairie	Forest
Algae	leaves	leaves
Minnnows	grasshopper	beetles
Bass	quail	raccoon
man	man	man
Extras:		
snake	coyote	deer
water insect	sunflower	berries

The class will start by unscrambling the same list, the prairie. After completing this pyramid, discuss the correct producer-consumer order. Then complete the other two ladders and discuss the possible combinations and relationships.

(Adapted from Critters and Concepts: A Teaching Guide to Oklahoma Wildlife, Oklahoma Dept. of Wildlife)

Wrap-up/conclusion

Discussion:

- Why are there more plants than herbivores, and more herbivores than carnivores?
- What would happen to a prairie food web if the grass suddenly disappeared? What would happen if the decomposers disappeared?
- Could there be a food chain without plant eaters or meat eaters? (Yes. Animals are not essential to a food chain, but plants and decomposers are.)
- Why are there so few species at the top of the pyramid?
- How could toxins from polluted water move through the food chain to affect humans?
- What are some alternatives for preserving habitats? How does this help maintain biological diversity?

Extensions

1. Stage a classroom debate. Search local and national newspapers for decision cases and controversies regarding habitat preservation and other environmental issues for topics to debate. An example is a debate between a lumber company owner who wants to spray a forest to combat insects versus the owner of a salmon cannery who insists that the pesticide runoff would kill the salmon and the local fishing industry.

2. Have students each select an endangered species and present a report describing the length of time endangered, the factors that led to endangerment, past and present range,

past and present population, and outlook for survival. Are there any common patterns or trends that can be observed among the endangered species? Are there any practical actions that citizens can take to assist in the preservation of species?

3. Have the students create a hypothetical animal or plant with characteristics that would make it vulnerable to extinction. How do the traits of this species compare with those of any real animals or plants? What changes would enable this species to better resist extinction?

4. Make an environmental barometer to indicate the quality of your school environment as a habitat for wildlife. Show seasonal changes in the barometer's readings. Are there ways in which your school grounds could become a habitat for a wider variety of species?

5. Write congressional representatives, senators, state legislators, the president, and other influential people, requesting that they protect both the rain forest and local habitats. Ask them to support legislation that will protect programs and international trade agreements that do not lead to forest destruction and to support efforts that share our knowledge about sustainable agriculture. Tell them that you support legislation that promotes biodiversity and fights tropical deforestation.

To write your state representative:

The Honorable (representative's name)
U.S. House of Representatives
Washington, D.C. 20515

To write your senator:

The Honorable (senator's name)
U.S. Senate
Washington, D.C. 20515

6. Show the film *The Lorax*, which is based on a Dr. Seuss book with the same title. Discuss the meaning. It is available for purchase or rent in 16mm film or video format from: Phoenix Films, 468 Park Ave. S, New York, NY 10016. 800-221-1274.

Activism Kits

- **Activist Kit.** Contains information on congress and the environment. National Wildlife Federation, 1400 17th Street, NW, Washington, D.C. 20036.
- **Audubon Activist ToolKit.** Materials for getting involved to protect wetlands, Alaskan wildlife refuges, and ancient forests (\$6). Audubon Activist, Box K, National Audubon Society, 950 Third Avenue, New York, NY 10022.
- **Earth Day and Beyond.** A student organizers' manual (\$5) and "Rainforest Awareness Week Packet" (\$4). Creating Our Future, 1640 Francisco Street, Berkeley, CA 94703.

- **Who Says You Can't Change the World?** A student action guide written for young people by young people (\$3.95). Youth for Environmental Sanity, 706 Frederick Street, Santa Cruz, CA 95062-2205. (408) 459-9344.
- **Ecosystems.** A simple kit containing adequate information to get across essential facts and still maintain interest. Contains a biome map of North America, a short description accompanied by a colored picture of each biome. Also includes descriptions of food chains and carbon, nitrogen, and water cycles using acetate overlays, as well as food-chain exercises for students to complete. National Audubon Society, 950 Third Ave., New York, NY 10022. Grades 4-6.

Book Resources

- *Chains, Webs & Pyramids: The Flow of Energy in Nature.* Laurence Pringle, Crowell, 1975. Explains the methods and models, such as food chains, food webs, and ecological and energy pyramids, with which scientists identify and examine the flow of energy from living thing to living thing. Grades 4-6.
- *How to Make the World a Better Place.* Jeffrey Hollender, William Morrow, New York, 1990.
- *The Infinite Web.* Robert Silverberg, Dial Press, New York, 1977. A collection of science fiction stories focusing on ecology and how all life is interrelated, as well as what happens when the delicate balance of nature is altered or upset.
- *Understanding Ecology.* Elizabeth T. Billington, Frederick Warne and Company, New York, 1971. The roles of living things in nature help explain ecosystems, food chains, communities, etc. Glossary. 88 pages.

Activity Guides

- Project Learning Tree (Grades 7-12). American Forest Council, 1250 Connecticut Avenue NW, Washington, D.C. 20036.
- Project WILD and Aquatic Project WILD. Western Association of Fish and Wildlife Agencies and the Western Regional Environmental Education Council, Inc., 5430 Grosvenor Lane, Bethesda, MD 20814, 301-493-5447.

Videos

- Diversity Endangered. Video on biodiversity. Global Tomorrow Coalition for Education Services, 25422 Trabuco Road, #105-440, El Toro, CA 92630 (\$10 deposit, \$5 refundable).
- Our Threatened Heritage. (1987) 18-minute video on the disappearance of the rain forest. National Wildlife Federation, International Programs, 1412 16th Street NW, Washington, D.C. 20036. 202-637-3776.
- The Vanishing Forest: The Crisis of Tropical Deforestation. Filmstrip, audiotape, and guide on the importance of rainforests and reasons for their conservation. Contrasts temperate and tropical forests and explores forest dynamics. Knowledge Unlimited, P.O. Box 52, Madison, WI 53701. 800-356-2303.

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