Chapter 46

Ecosystems

The greatest thing in the world is not so much where we are, but in what direction we are moving.
Oliver Wendel Holmes

46-1 Ecology and Feeding Relationships

1. In your opinion, what is the most serious environmental problem we face in the United States?

Objective
You will be expected to define ecology, food chain, food web, producer, first order and second order consumer. Also be able to predict the effects upon a food web caused by changing one variable in the web.

What is Ecology
Ecology is a popular topic these days. The media regularly runs special news accounts about environmental problems. The Environmental Protection Agency is a relatively new governmental group. Ecological concerns are common topics of conversation and make frequent news headlines. Exactly what is ecology? Ecology is the study of the interactions of organisms with one another and their environments. For example, in studying a pond, an ecologist would determine which animals, plants and other organisms live in the pond. He or she would study the ways in which each organism depends upon other organisms for food. How organisms depend upon various physical and chemical requirements, such as minerals, oxygen, carbon dioxide and light would be examined. The effect of pollutants upon the organisms would also be studied.
Food Chains
When biologists study a specific area, it is important to know the diet of each animal interacting in that environment. One way of describing these feeding relationships is to describe them as food chains. A food chain describes which organism is eaten by which other organism.

The scene at the left shows a typical food chain. Grass is eaten by a rabbit. The rabbit is eaten by the owl. The relationship is also shown as follows:

Grass $\rightarrow$ Rabbit $\rightarrow$ Owl

The arrow always points to the animal doing the eating. The grass is known as the producer. All green plants are producers because they produce food. The rabbit is known as a first order consumer.

All first order consumers eat producers (plants and algae). The owl is a second order consumer. All second order consumers eat (consume) first order consumers. Third order consumers eat second order consumers.

2. What is ecology?

3. Define producer, first order consumer and second order consumer.

4. Diagram a food chain relationship for a deer, cougar and huckleberry bush. Identify the producer, first order consumer and second order consumer.

Food Webs
Food chains do not represent the complex interactions between organisms in an environment. The owl does not only eat rabbits. Rabbits eat other plants and other animals eat rabbits. A food web shows the interactions between a wide variety of organisms in an environment. Examine the following food web:
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46-2 Ecosystems

1. Describe some non-living factors that could affect the feeding relationships of the preceding owl food web.

   **Objective**

   You should be able to define and give examples of an ecosystem and biosphere. Be able to predict the effects of changing any one factor in an ecosystem.

   Food webs include only living organisms. There are many non-living factors that can affect the balance shown in food webs. Examples of some of these non-living factors are as follows: Amount of rain, temperature, amount of nutrients in the soil and pollutants. When studying the interrelationships in an environment, it is important to also know about these non-living factors. Biologists refer to the interaction of living and non-living factors in an environment as an ecosystem. Ecosystems usually have some type of natural boundary. Examples are: pond ecosystem, lake ecosystem, river ecosystem, island forest ecosystem, tidepool ecosystem and rotting log ecosystem.

   Ecosystems are, however, not usually isolated from one another. Organisms from one ecosystem can interact with those in a different ecosystem. The eagle in a forest ecosystem may take fish from the river ecosystem. The preceding owl food web is part of a forest and farm ecosystems. Non-living factors have an important influence upon the interactions within all ecosystems.

2. Hypothesize the effect a prolonged drought might have upon the owl's ecosystem.

3. What effect might the farmer's use of DDT have upon the owl's ecosystem? (DDT is known to weaken the shells of bird eggs usually resulting in the eggs' destruction before hatching.)

   Examine the following food web from a lake ecosystem:

   ![Diagram of a lake ecosystem food web]

   - Herons
   - Frogs
   - Turtles
   - Insects
   - Trout
   - Green Plants
   - Worms
   - Bass
   - Beaver

4. Name two first order consumers and two second order consumers in this lake ecosystem.
5. In the preceding food web, name two first order consumers and two second order consumer.

6. Diagram two new food chains in the above food web. Use the arrows and organism names method. Include at least three organisms in each food chain.

7. What does the snake eat? What does the fox eat?

Biologists can use a food web to study the effects of changing or introducing a variable in an environment. If three or four house cats were introduced into the environment described by the preceding food web, a biologist could predict how the interactions between organisms might be affected. Refer to the food web as you study the following predictions: It could be assumed that the cats would eat all the mice. Since mice are the only food for the snakes, the snakes would die. The owls would need to eat more rabbits and crows. The rabbit and crow populations would decrease. The foxes would only have rabbits to eat and they would be in scarce supply. This would decrease the fox population. The foxes could eat the cats. If all of the cats were destroyed, the area might return to normal. The important thing to remember is that changing one thing in an environment can affect most other organisms in the area since all living and non-living things are connected.

8. A logging company cut all large trees needed by owls. This resulted in the death and migration of the owls. Write a hypothesis that would predict the effect of this action upon the other organisms in this area.
5. Name a third order consumer.

Organisms in an ecosystem are involved in delicately balanced interactions with each other and their physical surroundings. Any factor that can cause death in one group of organisms will affect other organisms in the ecosystem. Apply this principle as you answer the next few questions.

6. Hypothesize what would happen to the trout population if fisherman caught most of the bass. Explain.

7. Hypothesize the effect of insecticide pollution upon organisms in the lake ecosystem. Which organisms would be most affected if a majority of the insects died?

8. Assume that acid rain causes the death of most worms. What effect will this have upon the turtle population in this environment? Explain.

The term **habitat** is often used to describe that part of an ecosystem where an organism lives. The soil is the primary **habitat** for the earthworm.

**The Biosphere**

The biosphere is another name for the earth and emphasizes the life zones on its surface. (Bio = life, sphere = earth) The biosphere is made up of all the earth's ecosystems combined. It includes both living and non-living factors. Certain conditions affect the entire biosphere. Any factor that can cause global warming or cooling can affect the entire biosphere. Removal of tropical rain forests affects global weather patterns and, therefore, can affect large portions of the biosphere. Our biosphere contains a finite supply of certain resources and living species. It must be preserved for present and future generations. We must reverse the trends of the past two centuries or the quality of life on the planet will continue to deteriorate. Only through understanding, commitment and sacrifice will this be accomplished.

**Experimental Design:**

9. If you were asked to create a sealed, ten foot glass biosphere cube to illustrate the principles of ecological balance, what organisms and conditions would you include in your model biosphere? Life in your model must be sustained for one year without outside interference.

**Biosphere II**

In the Arizona desert, an enclosed 2.5 acre self-supporting environment was constructed of steel and glass. Scientists call the earth biosphere I. They have named the Arizona enclosure **Biosphere II**. This $100,000,000.00 project was the largest totally sealed environment in the world at that time. It encompassed six geographical regions, each with different animals, plants and climates. Each region was known as a **biome**. There was a rain forest in a 75' high section. Another area contained a 35' deep ocean environment complete with a living coral reef and a beach repeatedly influenced by wave action. There was also a savanna region, a fresh water marsh, a salt water marsh
and a desert. More than 3,000 species of plants and animals were carefully selected to maintain the proper balance for biome food webs. Biosphere II duplicated all seasons with some regions dropping into the 30’s during winter. In the fall of 1991, eight scientists were sealed in the complex for a period of two years. They were to grow their own grain, fruits and vegetables as well as raise fish and animals. This project was considered only partially successful since significant numbers of organisms died in some biomes.

10. In Biosphere II there are no stored artificial sources of oxygen or carbon dioxide. From where would the plants and animals in Biosphere II get these necessary gases?