Community Ecology

PLANTS, ANIMALS, and other organisms occupy the same geographic areas in nature. These organisms interact with one another. It is easy to see and understand some interactions, such as a fox preying on a hare. Many interactions, including the decay of organic matter, are much less noticeable.

Objective:

Explain aspects of community ecology.

Key Terms:

abiotic factors
autotroph
biotic factors
biotic potential
carrying capacity
deceleration phase
decomposers
ecosystem
exponential growth curve
exponential growth phase
heterotroph
lag phase
limiting factor
logistic growth curve
population
primary consumers
primary producers
producers
secondary consumers
stable equilibrium phase
tertiary consumers
trophic level

The Community of Organisms

A community is all the species or populations living together in a given area. Community ecology is the study of how different species inhabiting the same geographic region interact. Community ecologists examine factors that influence biodiversity, community structure, and the distribution and abundance of species. Organisms in a community function in different ways and are classified based on their function within the community.

ENERGY FLOW IN AN ECOSYSTEM

An **ecosystem**, or ecological system, consists of an array of living and nonliving things that interact with each other in a definable space. An ecosystem may be as small as a puddle of water or as large as the planet Earth. Every ecosystem, no matter how small or large, is affected by the type and quantity of resources and by the movement of energy through the ecosystem.

Ecosystems consist of abiotic and biotic factors. **Abiotic factors** are the nonliving things within an ecosystem. Examples of abiotic factors are water, soil, and sunlight. **Biotic factors** are the living things within an ecosystem. Biotic factors, such as plants and animals, rely on abiotic factors to live.

Energy Flow

A fundamental characteristic of every ecosystem is the energy flow, or energy transfer, within it. For an energy transfer system to work, it must have the following three types of organisms: producers, consumers, and decomposers.

Producers are the autotrophic organisms that make their own food through the conversion of sunlight into chemical energy via the process of photosynthesis. Producers, such as plants or algae, can be referred to as autotrophic. An **autotroph** is an organism that produces its own food.

Consumers are heterotrophic. A **heterotroph** is an organism that must consume food to gain energy. Animals are considered consumers because they feed on plants and other animals.

Decomposers are heterotrophic organisms that break down organic materials. Fungi, such as molds and mushrooms, and bacteria are examples of decomposers. Decomposers secrete enzymes that cause the decomposition of organic materials, which are the remains of plants and animals.

FIGURE 1. Grass and trees are autotrophs, and the elk is a heterotroph.

Trophic Levels

A **trophic level** is composed of the organisms that feed at a particular link in a food chain. Primary producers, primary consumers, secondary consumers, and tertiary consumers are examples of trophic levels. **Primary producers** are plants that capture the sun's energy through photosynthesis. Energy flow begins with primary producers. **Primary consumers** are heterotrophs whose main food source is from the primary producers. A grasshopper is an example of a primary consumer since it feeds on plants. **Secondary consumers** are heterotrophs whose main food source is from the primary consumers. A sparrow is an example of a secondary consumer since it eats grasshoppers. **Tertiary consumers** are heterotrophs whose main food source is from the secondary consumers. A fox is an example of a tertiary consumer since it is known to eat sparrows.

The flow of energy within an ecosystem results in large losses between successive trophic levels. As a rule of thumb, only about 10 percent of the energy in one trophic level will be available to the next trophic level. For example, if within an ecosystem, the primary consumers consume 1,000 kg of plant material, approximately 100 kg will be converted to animal tissue in the primary consumer trophic level. Only 10 kg will be converted in the sec-

FIGURE 2. A wolf preying on a rabbit is an example of a secondary consumer eating a primary consumer.

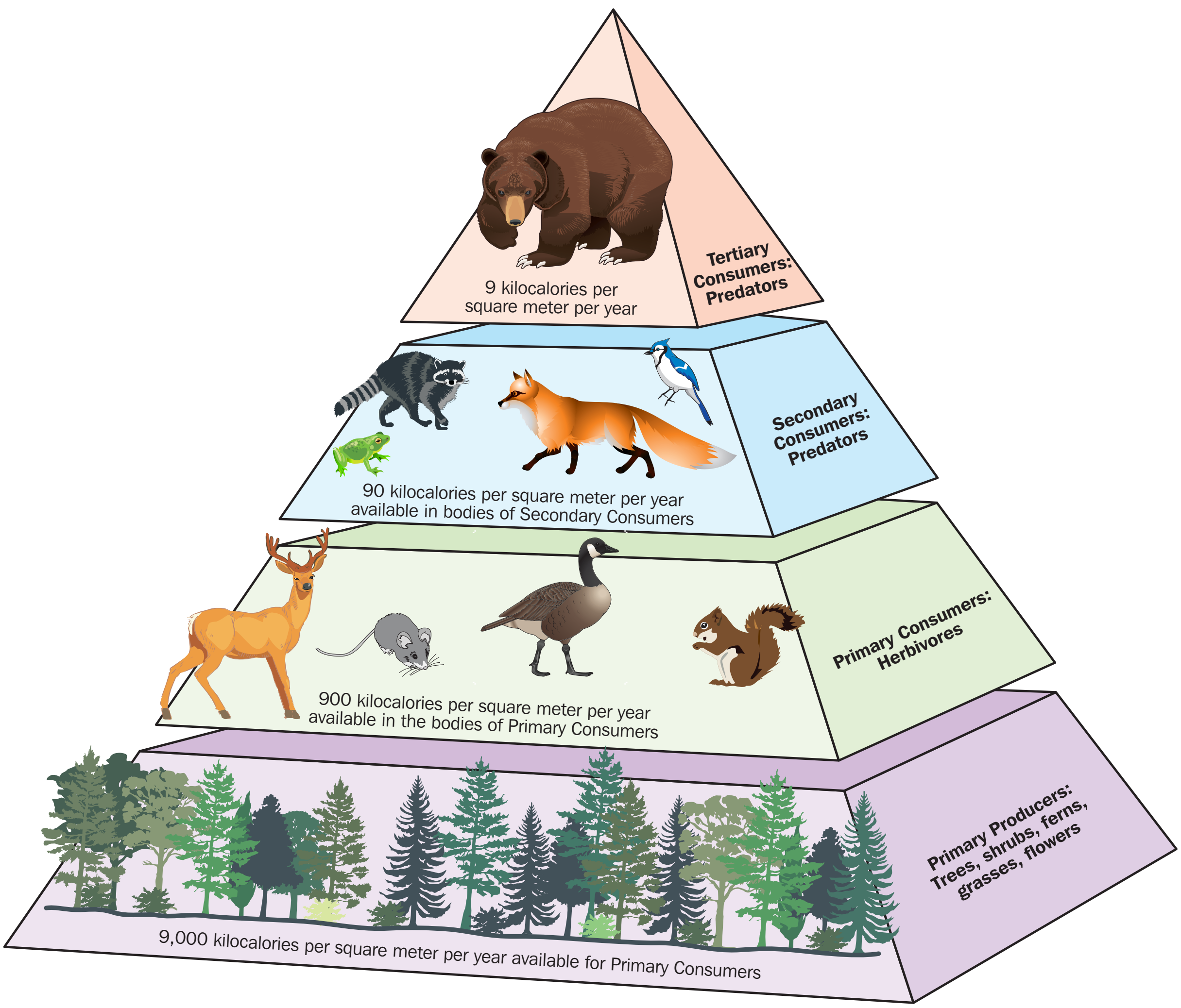

FIGURE 3. A pyramid of biomass.

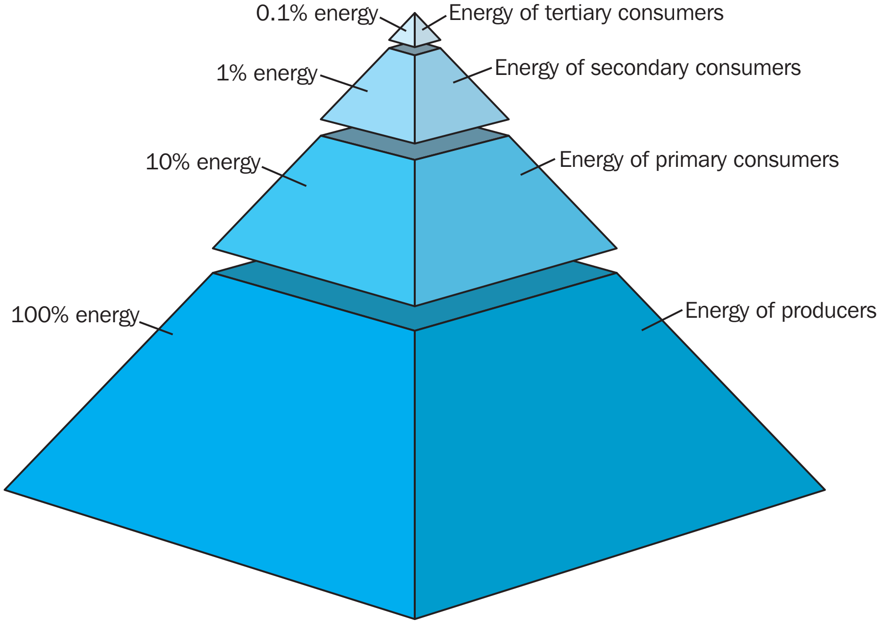

FIGURE 4. A pyramid of energy.

ondary consumer trophic level, and only 1 kg will be converted in the tertiary consumer tropic level. Few carnivores can be supported in a food web because carnivores are found in the upper trophic levels.

POPULATIONS

A **population** is a group of individuals of the same species living in the same geographic region. A population may consist of animals, plants, or microorganisms. Population ecology is the study of a group of organisms, how many there are, and why numbers rise or fall.

A population will show exponential, or unrestricted, growth when available resources exceed the number of individuals able to exploit them. A population will demonstrate logistic, or restricted, growth when any essential resource is in short supply. An essential resource that is in short supply is a **limiting factor** on population growth. Food is an example of a potential limiting factor on population growth.

Exponential Growth

The **exponential growth curve**, or the J-curve, occurs when there is no limit to population size. The exponential growth curve has two phases: the lag phase and the exponential growth phase. During the **lag phase**, growth is slow because the population is small. During the **exponential growth phase**, growth is accelerating. During exponential growth, a population is enjoying what is known as its biotic potential. **Biotic potential** is the maximum population growth that occurs under ideal conditions, such as an adequate food supply, adequate space, and no problems associated with pests or predators.

FURTHER EXPLORATION...

ONLINE CONNECTION: The Rule of 70

An understanding of exponential growth is essential when discussing population growth. An important concept of exponential growth is that the growth will occur in proportion to what is already present. For example, if a grizzly bear population of 100 grew at an annual rate of 7 percent, after 10 years the population will have doubled to 200. In another 10 years, the population will have doubled again to 400.

The Rule of 70 is used to determine the doubling time of a quantity growing at a given annual percentage rate. Dividing the percentage of growth into 70 will reveal the approximate number of years required for the population to double. For example, if the grizzly bear population was growing at an annual rate of 3.5 percent, divide 70 by 3.5. The answer is that it would take 20 years for the population to double. If the annual rate was 14 percent, the doubling time would be 5 years.

Read more about the Rule of 70 at http://www.ecofuture.org/pop/facts/exponential70.html.

TABLE 1. Some Doubling Times for the Rule of 70

Growth Rate (% per year)	Doubling Time in Years
0.1	700
0.5	140
1	70
2	35
3	23
4	18
5	14
6	12
7	10
10	7

Logistic Growth

The **logistic growth curve**, or the S-curve, shows the effects of a limiting factor. The logistic growth curve has four phases: the lag phase, the exponential growth phase, the deceleration phase, and the stable equilibrium phase. The first two phases are identical to the corresponding phases in the exponential growth curve. The **deceleration phase** shows growth slowing, likely as a result of a limiting factor. Eventually a population will stabilize at a fairly constant size; this is known as the **stable equilibrium phase**. At this point the population is at carrying capacity.

Carrying Capacity

Carrying capacity is the maximum number of individuals of a given species that the environment can support without causing damage to the ecosystem. If the population of animals goes beyond the carrying capacity, the wildlife is in danger of becoming overcrowded, potentially leading to unbalance of the ecosystem. If the population is not reduced, permanent damage to the ecosystem can result. In addition, overcrowded populations will lead to health issues, such as malnutrition, and eventually animal die-off will occur. Overcrowding increases the likelihood of illness and increases the amount of waste produced. If space is a limiting factor, waste may become a risk to animal health as well.

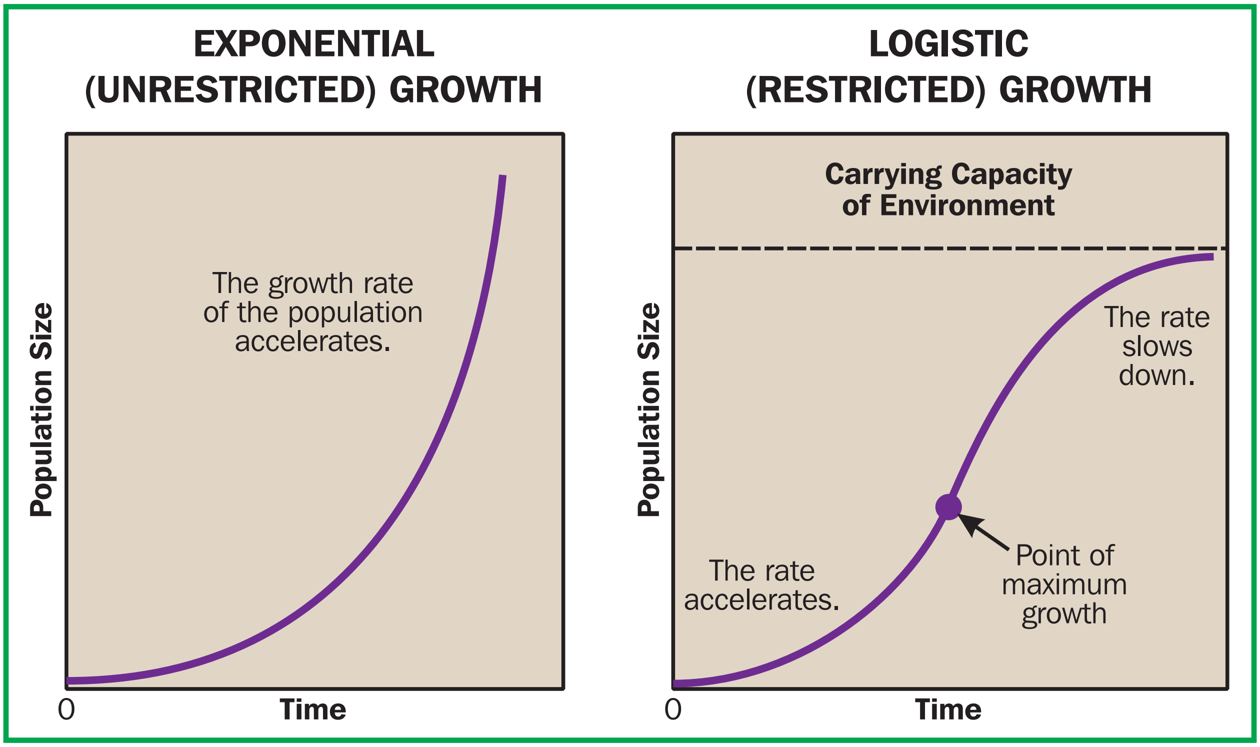

FIGURE 5. Growth curves.

Summary:

Community ecology is the study of how different species inhabiting the same geographic region interact. An ecosystem consists of an array of living and nonliving things that interact with each other in a definable space. A fundamental characteristic of every ecosystem is energy flow. Energy transfers through producers, consumers, and decomposers.

A trophic level is composed of the organisms that feed at a particular link in a food chain. Primary producers, primary consumers, secondary consumers, and tertiary consumers are examples of trophic levels. The flow of energy results in large losses between successive trophic levels.

A population is a group of individuals of the same species living in the same geographic region. A population will show exponential growth when available resources exceed the number of individuals able to exploit them. A population will demonstrate logistic growth when any essential resource is in short supply.

Checking Your Knowledge:

1. What is community ecology?
2. How does energy flow through an ecosystem?
3. What are trophic levels?
4. How do exponential growth and logistic growth compare?
5. What is the significance of carrying capacity?

Expanding Your Knowledge:

Visit a natural area near you, and conduct a study of the ecological community. If necessary, refer to a variety of resources to identify the principal producers and consumers in the area. Answer questions, such as the following: Are the populations stable, declining, or growing? What environmental conditions impact the community of species?

Web Links:

Community Ecology

http://mansfield.osu.edu/~sabedon/campbl53.htm

Competition, Predation, and Symbiosis

http://www.youtube.com/watch?v=D1aRSeT-mQE

Population Ecology Basic Concepts

http://www.biology-questions-and-answers.com/population-ecology.html

Agricultural Career Profiles

http://www.mycaert.com/career-profiles