Levels of Organization in Ecosystems

Ecologists organize ecosystems into three major levels. These levels are: population, community, and ecosystem.

Population

A population is a group of individuals of the same species living and interacting in the same area at the same time. An example of a population of organisms is a grove of orange trees.

All of the orange trees that live in this grove belong to the same population.

Populations can be defined at different levels of size. A local population could occupy a very small habitat, such as a puddle, or a population could include every member of a species that occupies a large island. Because a population includes all of the members of a species that interact with one another, there is generally a boundary between populations. For example, most land-dwelling organisms cannot freely cross an ocean.

Community

A community includes all of the populations that live and interact in the same area. A community makes up an ecosystem's *biotic*, or living, factors. For example, all of the plants, animals, fungi, and microorganisms that co-exist inside of a forest make up a community. All of these organisms depend on one another for survival.

All of the organisms that interact with each other within this forest belong to the same community.

There are many types of interactions between organisms within a community. For example, *predator-prey* and*consumer-producer* interactions occur at this level. Competition and cooperation between different species are also part of community ecology.

Ecosystem

An ecosystem includes not only the interacting populations, or community of organisms; it also includes all of the *abiotic*, or nonliving parts of an ecosystem. Rocks, air, dirt, sunlight, water, weather, and even fire are abiotic factors.

An example of an ecosystem would include all of the living and nonliving factors that are inside a pond. The water in the pond, the algae and plants that grow in the water, the animals and bacteria that live in the water, the dirt and rocks on the bottom of the pond, and the sunlight that hits the water would all be considered a part of this ecosystem.

This pond ecosystem includes all of the biotic and abiotic components. This includes all of the interacting populations, as well as the water, minerals, and the amount of sunlight.

Ecosystems can vary greatly in size and conditions. The abiotic factors that make up an ecosystem determine what kinds of organisms can live there. For example, a desert ecosystem that is very hot and does not receive much water can only support certain kinds of organisms, such as cacti and lizards.

Organism Interactions

Organisms in an ecosystem can interact in many different ways. These interactions can be harmful or helpful to one or both of the organisms involved.

Symbiosis

Symbiosis is an interaction between individuals of different biological species. At least one of the organisms receives a benefit from the interaction. The other organism can either receive a benefit, be harmed, or not be affected in any way.
A symbiotic interaction involves a close relationship between the two organisms. In most cases these relationships have adapted over long periods of time, and at least one of the organisms has become so dependent on the relationship that it cannot survive outside of it.

There are three main kinds of symbiotic relationships: *commensalism*, *mutualism*, and *parasitism*.

Interaction	Species A	Species B
Commensalism	Receives benefit	Not affected
Mutualism	Receives benefit	Receives benefit
Parasitism	Receives benefit	Harmed

- **Commensalism—*In a commensalistic relationship, one organism benefits and the other is neither helped nor harmed.*** Often, the benefit that the organism receives is the ability to find food more easily or protection from other organisms. For example, large grazing herbivores, such as cattle and buffalo, stir up insects as they graze on grass in fields and pastures.Birds known as cattle egrets often follow behind the grazing herbivores and eat the insects. Since the cattle egret benefits by being able to find food easily and the grazing herbivores are not affected by the presence of the egrets, their interaction is an example of commensalism.

Cattle egrets follow behind large grazing herbivores and eat the insects that are stirred up. This is a form of*commensalism*.

Another common type of commensalism involves creating or finding shelter. Gopher tortoises are well-known for digging burrows underground. Tortoises generally use the shelter for a period of time and move on. Other animals, such as mice or rabbits, will use the abandoned shelters left by the

tortoises. The animal finding the burrow benefits from the work of the gopher tortoise, and the tortoise is not affected since it is no longer using it.

- **Mutualism—*Both organisms benefit in a mutualistic relationship.*** Animals and plants have developed a number of mutualistic relationships. Flowers and their pollinators are one of the most common examples of mutualism because many kinds of plants depend on insects, such as moths, bees, wasps, and beetles, to perform pollination in order to reproduce. Plants that rely on pollinators attract the pollinator by the shape, color, or smell of their flowers. As the pollinator feeds on the nectar or pollen from the flower, some of the pollen sticks to its legs and body. When the pollinator visits a second plant of the same species, the pollen from the first plant is transferred to the reproductive organs of the second plant, and pollination occurs. Both organisms receive a benefit from this interaction. The pollinator receives access to a food source and the plant is able to reproduce because of their relationship.

Bees receive nourishment from flowering plants, and plants are pollinated by the bees. Therefore, the relationship is *mutualism*.

In addition to pollinating plants, animals also help to spread seeds of plants. When animals feed on fruits, they carry the seeds farther away from the parent plant. By spreading them, it ensures that more of the seeds will land in a location that will support its growth. Animals do this by dropping seeds as they feed. Some plants have developed such a hard seed coat that the seeds must pass through the digestive system of an animal in order to germinate and grow. These plants depend on the animals that spread their seeds in order to continue the species.

- **Parasitism—*One organism benefits and the other is harmed in a parasitic relationship.*** The organism that receives a*benefit* is known as a **parasite**. The organism that is *harmed* by the relationship is known as the **host**.

The difference between a parasite and a predator is that a parasite generally does not kill its host. Instead, the parasite lives in or on the host for an extended period of time and continues to feed off of the host. In fact, most parasites are so dependent on the host that killing the host would not benefit the parasite. However, because parasites do harm their hosts, the hosts become more vulnerable to disease or predation by other organisms.

Parasites are usually smaller than the host species—but not always—and can live either inside or outside the body of their hosts. Common external parasites include fleas and mosquitoes which feed on the blood of their hosts. Internal parasites, such as tapeworms, live inside the body of their host and absorb nutrients from the host's body. In both cases, the parasite steals nutrients from the host, which harms the host. Parasites can be microbes, bacteria, viruses, plants, or animals.

This mosquito receives nourishment, while the human is harmed. This is an example of *parasitism*.

Image is courtesy of the CDC.

Competition

Organisms interact with others within the same population and with organisms from populations of different species.These interactions often reduce the chance of survival for some organisms. Resources in any environment are limited. There is only so much access to sunlight, food, water, shelter, and space.Therefore, plants and animals may have to *compete*, or struggle, to get resources for themselves. Many animals mark their territories with scents (smells) to try to keep other animals away. This helps make sure that the food, water, shelter, and possible mates in the animal's territory do not get taken by another animal. If one animal trespasses on the territory of another, a fight may start.

Animals compete for food, territory, and mates.

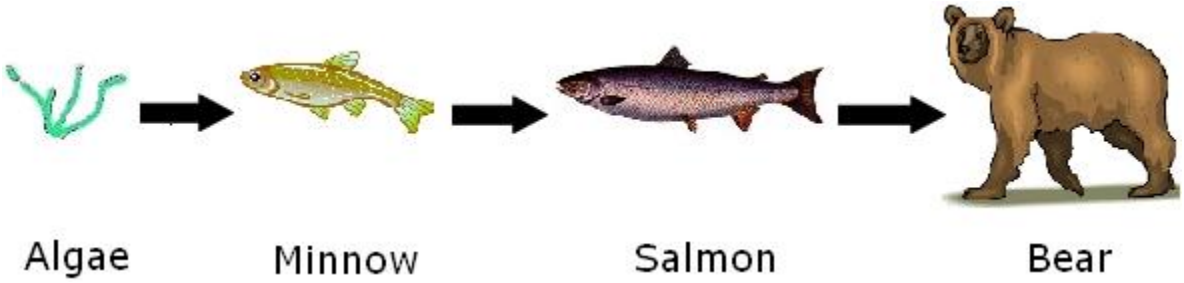
Trees in a forest compete for sunlight. As one tree grows taller, the shorter trees are shaded by it, and they receive less sunlight. The shorter trees may die as a result.

Energy Flow Through an Ecosystem

The ultimate source of energy for all ecosystems is the Sun. Only producers can convert solar energy into food energy. Therefore, all other organisms depend on producers for their energy needs.

Food Chains

A **food chain** describes the feeding relationships and energy flow between species within an ecosystem. **Producers** receive energy from the Sun and make food. Producers are the beginning of a food chain because all of the other organisms in the food chain depend on the food energy that is made by producers. The next organisms in the food chain are **primary consumers**, which eat producers. Next come **secondary consumers**, then tertiary consumers, and so forth until the top carnivore is reached. All organisms in the food chain are decomposed by decomposers.

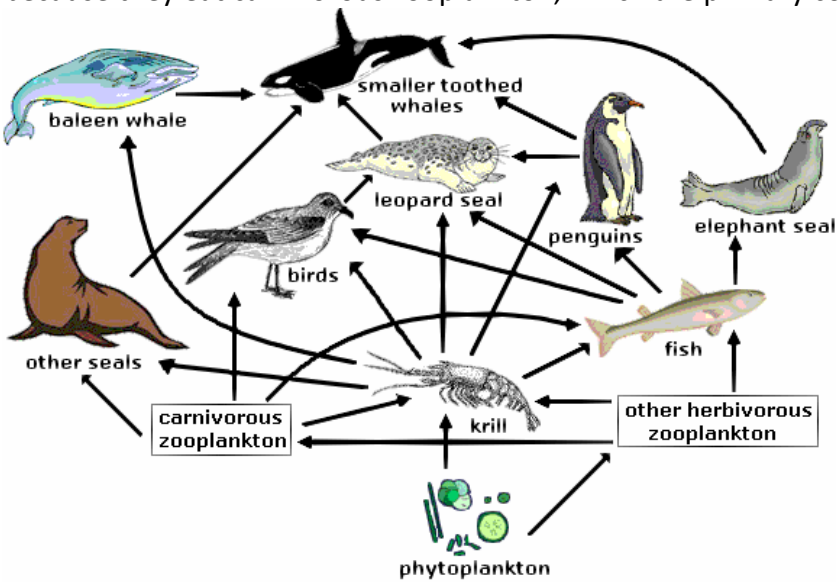


This food chain shows the flow of energy from a producer, algae, to the consumers in the ecosystem.Minnows are primary consumers, salmon are secondary consumers, and bears are tertiary consumers.

The arrows in a food chain or a food web represent the direction of energy flow. The arrow points from the organism that is being consumed to the organism that is receiving energy. For example, in the food chain above, the arrow points from the algae to the minnow. This means that the minnow is consuming the algae and receiving energy.

Food Webs

A **food web** is a group of interconnected food chains. Organisms within a food web can belong to more than one trophic level, or feeding level. For example, in the food web below, krill are both primary and secondary consumers. Krill are primary consumers because they eat phytoplankton, which are producers. Krill are also secondary consumers because they eat carnivorous zooplankton, which are primary consumers.



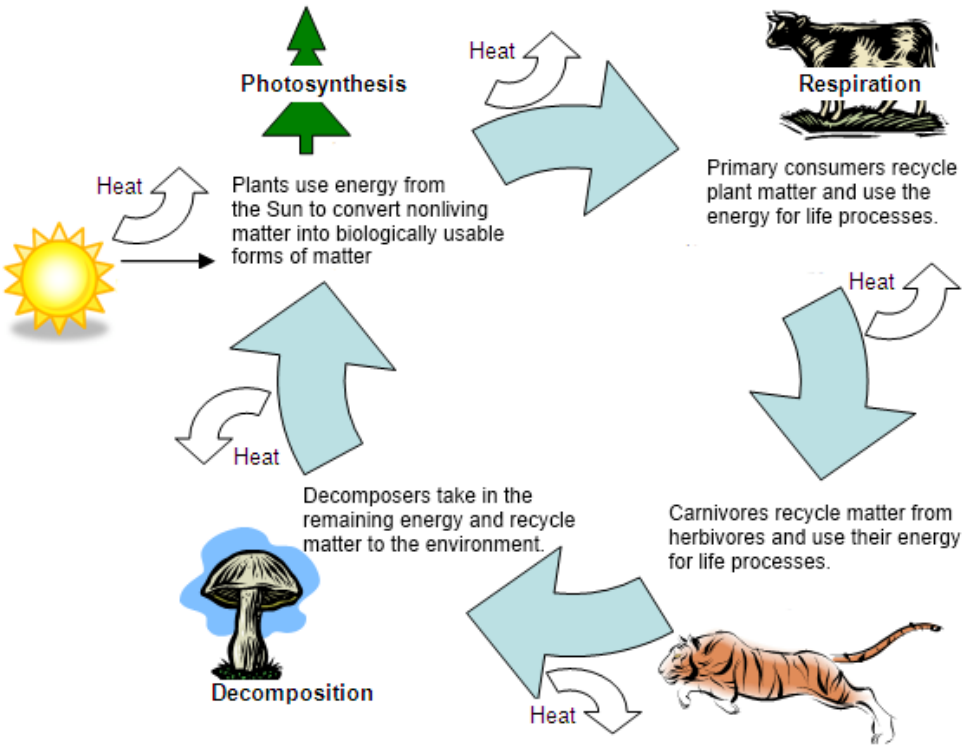
An Antarctic food web is shown in the picture above. Organisms in food webs can belong to more than one feeding level.

Conservation of Matter and Energy in Ecosystems

Ecosystems obey the laws of conservation of matter and energy.

Although matter may change forms as it cycles through an ecosystem, the amount of matter remains constant. Producers are able to convert nonliving matter—carbon dioxide and water—into a biologically usable form of matter. When consumers feed on producers, they also recycle the matter that composed the producers.

Decomposers break down animal wastes and the remains of dead plants and animals. Through this process, matter is converted back to water and nutrients, which are then returned to the soil and the atmosphere. This allows the cycle to continue.



Matter and energy are transferred from one organism to another in ecosystems.

Energy is also transformed as it flows through the system. The total amount of energy in the universe remains constant, but, unlike matter, energy is able to move freely into and out of the Earth system. Almost all of the energy entering ecosystems comes from the Sun. Producers are able to capture some of the Sun's energy during photosynthesis.

When consumers feed on producers, some of the producer's energy is transferred to the consumer. Energy is transferred in a similar fashion each time any consumer or decomposer feeds on any other organism. Organisms also use energy to perform life functions. For example, animals use energy to contract muscles during movement. This process transforms some energy into heat, which is transferred to the environment. Therefore, when that animal is later consumed, only some of its energy is transferred to the organism consuming it.

All of the energy that is captured by producers is eventually released and returned to the environment as heat.