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Integrated Science

Ecology Basics

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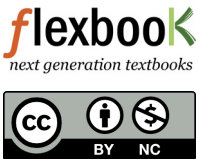

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Contents

CONCEPT 1 Introduction to Ecology

- Define ecology.
- Compare field studies to laboratory studies.
- Distinguish between abiotic and biotic factors.

Do organisms live in isolation?

No, organisms are not separated from their environment or from other organisms. They interact in many ways with their surroundings. For example, these deer may be drinking from this stream or eating nearby plants. Ecology is the study of these interactions. Scientists who study ecology are called ecologists.

Introduction to Ecology

Life Science can be studied at many different levels. You can study small things like cells. Or you can study big things like a group of animals. You can also study the **biosphere,** which is any area in which organisms live. The study of the biosphere is part of **ecology**, the study of how living organisms interact with each other and with their environment.

Research in Ecology

Ecology involves many different fields, including geology, soil science, geography, meteorology, genetics, chemistry, and physics. You can also divide ecology into the study of different organisms, such as animal ecology, plant ecology, insect ecology, and so on.

Ecologists also study biomes. A **biome** is a large community of plants and animals that live in the same place. For example, ecologists can study the biomes as diverse as the Arctic, the tropics, or the desert (**Figure** 1.1). They may want to know why different species live in different biomes. They may want to know what would make a particular biome or ecosystem stable. Can you think of other aspects of a biome or ecosystem that ecologists could study?

FIGURE 1.1
An example of a biome, the Atacama Desert, in Chile.

Organisms and Environments

All organisms have the ability to grow and reproduce. To grow and reproduce, organisms must get materials and energy from the environment. Plants obtain their energy from the sun through **photosynthesis**, whereas animals obtain their energy from other organisms. Either way, these plants and animals, as well as the bacteria and fungi, are constantly interacting with other species as well as the non-living parts of their ecosystem.

An organism's environment includes two types of factors:

1. **Abiotic factors** are the parts of the environment that are not living, such as sunlight, climate, soil, water, and air.
2. **Biotic factors** are the parts of the environment that are alive, or were alive and then died, such as plants, animals, and their remains. Biotic factors also include bacteria, fungi and protists.

Ecology studies the interactions between biotic factors, such as organisms like plants and animals, and abiotic factors. Abiotic factors include the oxygen that animals breathe, the carbon dioxide plants absorb, water that organisms need to survive, and sunlight plants need to make food.

Vocabulary

- **abiotic factor**: Aspect of the environment that is not a living organism, such as soil, water or air.
- **biome**: Large community of plants and animals distinguished by the dominant forms of animal and plant life and the climate.
- **biotic factor**: Components of the environment that are living, or were alive and then died, such as plants or animals.
- **biosphere**: Part of the planet and atmosphere with living organisms.
- **ecology**: Study of how living organisms interact with each other and with their environment.
- **photosynthesis**: Process by which specific organisms (including all plants) use the sun's energy to make their own food from carbon dioxide and water; process that converts the energy of the sun, or solar energy, into carbohydrates, a type of chemical energy.

Summary

- Ecology is the study of how living organisms interact with each other and with their environment.
- Abiotic factors are the parts of the environment that have never been alive, while biotic factors are the parts of the environment that are alive, or were alive and then died.

Practice

Use the resource below to answer the questions that follow.

- **A Study in Stream Ecology** at USGS http://gallery.usgs.gov/videos/449#.UKWeJId9KSo (6:57)

MEDIA

Click image to the left for use the URL below.

URL: http://www.ck12.org/flx/render/embeddedobject/117078

1. What are some of the abiotic factors that scientists monitor when dealing with stream ecosystems?
2. What are some of the biotic factors that scientists monitor when dealing with stream ecosystems?
3. What is a "benchmark" in ecology? Why are they essential?
4. How does water pollution seem to be affecting diversity in some streams?

Review

1. What do ecologists study?
2. In a forest, what are five biotic factors present? Five abiotic factors?
3. What is a biome? Give an example.

References

1. Courtesy of NASA. The Atacama Desert is an example of a biome. Public Domain

CHAPTER 2 Ecosystems & Interactions

Chapter Outline

2.1 Food Webs

- Distinguish a food chain from a food web.
- Be able to draw and interpret a food web.
- Summarize the roles of producers, herbivores, and carnivores in a food web.

How do the grasshopper and the grass interact?

Grasshoppers don't just hop on the grass. They also eat the grass. Other organisms also eat the grass, and some animals even eat the grasshopper. These interactions can be visualized by drawing a food web.

Food Webs

Energy must constantly flow through an ecosystem for the system to remain stable. What exactly does this mean? Essentially, it means that organisms must eat other organisms. **Food chains** (**Figure** 2.1) show the eating patterns in an ecosystem. Food energy flows from one organism to another. Arrows are used to show the feeding relationship between the animals. The arrow points from the organism being eaten to the organism that eats it. For example, an arrow from a plant to a grasshopper shows that the grasshopper eats the leaves. Energy and nutrients are moving from the plant to the grasshopper. Next, a bird might prey on the grasshopper, a snake may eat the bird, and then an owl might eat the snake. The food chain would be:

plant → grasshopper → bird → snake → owl.

A food chain cannot continue to go on and on. For example the food chain could not be:

plant → grasshopper → spider → frog → lizard → fox → hawk.

Food chains only have 4 or 5 total levels. Therefore, a chain has only 3 or 4 levels for energy transfer.

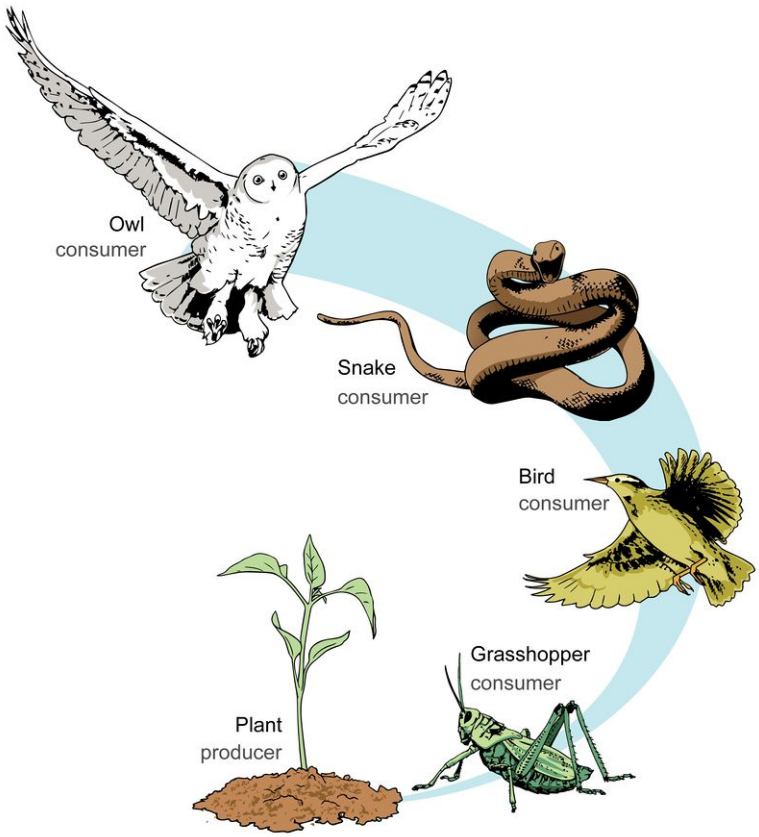

FIGURE 2.1

This food chain includes producers and consumers. How could you add decomposers to the food chain?

In an ocean ecosystem, one possible food chain might look like this: phytoplankton → krill → fish → shark. The **producers** are always at the beginning of the food chain, bringing energy into the ecosystem. Through photosynthesis, the producers create their own food in the form of glucose, but also create the food for the other organisms in the ecosystem. The **herbivores** come next, then the **carnivores**. When these **consumers** eat other organisms, they use the glucose in those organisms for energy. In this example, phytoplankton are eaten by krill, which are tiny, shrimp-like animals. The krill are eaten by fish, which are then eaten by sharks. Could **decomposers** be added to a food chain?

Each organism can eat and be eaten by many different types of organisms, so simple food chains are rare in nature. There are also many different species of fish and sharks. So a food chain cannot end with a shark; it must end with a distinct species of shark. A food chain does not contain the general category of "fish," it will contain specific species of fish. In ecosystems, there are many food chains.

Since feeding relationships are so complicated, we can combine food chains together to create a more accurate flow of energy within an ecosystem. A **food web** (**Figure** 2.2) shows the feeding relationships between many organisms in an ecosystem. If you expand our original example of a food chain, you could add deer that eat clover and foxes that hunt chipmunks. A food web shows many more arrows, but still shows the flow of energy. A complete food web may show hundreds of different feeding relationships.

Vocabulary

- **carnivore**: Organism that feeds on other animals.
- **consumer**: Organism that must consume other organisms to obtain food for energy.

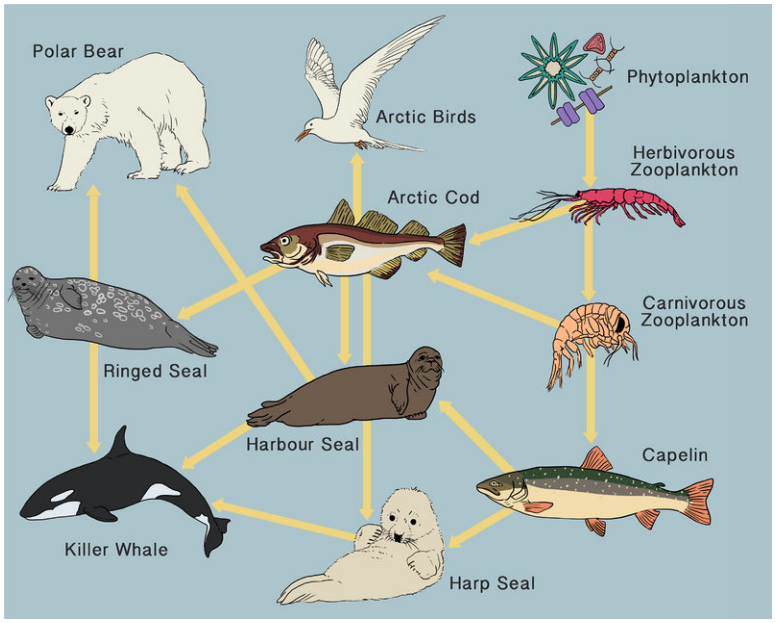

FIGURE 2.2
Food web in the Arctic Ocean.

- **decomposer**: Organism that obtains nutrients and energy by breaking down dead organisms and animal wastes.
- **food chain**: Diagram that shows feeding interactions in an ecosystem through a single pathway.
- **food web**: Diagram that shows feeding interactions between many organisms in an ecosystem through multiple intersecting pathways.
- **herbivore**: Animal that eats producers to obtain energy.
- **producer**: Organism that produces food for itself and other organisms.

Summary

- A food chain is a diagram that shows feeding interactions in an ecosystem through a single pathway.
- A food web is a diagram that shows feeding interactions between many organisms in an ecosystem through multiple intersecting pathways.

Practice

Watch the video at https://www.youtube.com/watch?v=0ZOvqYypOuo to help you answer the questions on your note worksheet.

Review

1. What is the difference between a food chain and a food web?
2. Food chains always begin with what type of organism? Why?
3. What is the herbivore in the following food chain: algae ->fish ->herons?

2.2 Habitat and Niche

- Define habitat and niche.
- Describe the roles of the habitat and niche in an ecosystem.

What is your niche at school?

Are you on the basketball team? Are you a cheerleader? Do you play an instrument in the band? Your niche would be your role or place in the school. What is your niche in your family and/or your community?

Organisms also each have their own niche in the ecosystem. Is an organism a producer or a consumer? How does the organism interact with other organisms? Is the organism involved in any symbiotic relationships?

Habitat and Niche

Niche

Each organism plays a particular role in its ecosystem. A **niche** is the role a species plays in the ecosystem. In other words, a niche is how an organism "makes a living." A niche will include the organism's role in the flow of energy through the ecosystem. This involves how the organism gets its energy, which usually has to do with what an organism eats, and how the organism passes that energy through the ecosystem, which has to do with what eats the organism. An organism's niche also includes how the organism interacts with other organisms, and its role in recycling nutrients.

Once a niche is left vacant, other organisms can fill that position. For example when the Tarpan, a small wild horse found mainly in southern Russia, became extinct in the early 1900s, its niche was filled by a small horse breed, the Konik (**Figure** 2.3). Often this occurs as a new species evolves to occupy the vacant niche.

FIGURE 2.3
The Konik horse.

A species' niche must be specific to that species; no two species can fill the same niche. They can have very similar niches, which can overlap, but there must be distinct differences between any two niches. When plants and animals are introduced, either intentionally or by accident, into a new environment, they can occupy the existing niches of native organisms. Sometimes new species out-compete native species, and the native species may go extinct. They can then become a serious pest. For example, kudzu, a Japanese vine, was planted in the southeastern United States in the 1870s to help control soil loss. Kudzu had no natural predators, so it was able to out-compete native species of vine and take over their niches (**Figure** 2.4).

Habitat

The **habitat** is the physical area where a species lives. Many factors are used to describe a habitat. The average amount of sunlight received each day, the range of annual temperatures, and average yearly rainfall can all describe a habitat. These and other **abiotic factors** will affect the kind of traits an organism must have in order to survive there. The temperature, the amount of rainfall, the type of soil and other abiotic factors all have a significant role in determining the plants that invade an area. The plants then determine the animals that come to eat the plants, and so on. A habitat should not be confused with an ecosystem: the habitat is the actual place of the ecosystem, whereas the ecosystem includes both the **biotic** and abiotic factors in the habitat.

FIGURE 2.4
Kudzu, a Japanese vine introduced intentionally to the southeastern United States, has out-competed the native vegetation.

FIGURE 2.5
Santa Cruz Island off the California coast has diverse habitats including a coastline with steep cliffs, coves, gigantic caves, and sandy beaches.

Habitat destruction means what it sounds like—an organism's habitat is destroyed. Habitat destruction can cause a population to decrease. If bad enough, it can also cause species to go extinct. Clearing large areas of land for housing developments or businesses can cause habitat destruction. Poor fire management, pest and weed invasion, and storm damage can also destroy habitats. National parks, nature reserves, and other protected areas all preserve habitats.

Vocabulary

- **abiotic factor**: Aspect of the environment that is not a living organism, such as soil, water, or air.
- **biotic factor**: Components of the environment that are living, or were alive and then died, such as plants or animals.
- **habitat** : Natural home or environment of an organism; the physical environment in which a species lives.

FIGURE 2.6

The above image shows wetland reeds, another type of habitat.

- **niche**: Role a species plays in the ecosystem.

Summary

- The role a species plays in the ecosystem is called its niche.
- A habitat is the physical environment in which a species lives.

Practice

Use the resource below to answer the questions that follow.

- **Competition, Predation, Symbiosis** at http://www.youtube.com/watch?v=D1aRSeT-mQE (3:20)

MEDIA

Click image to the left for use the URL below.
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1. How do you think rapid changes in the characteristics of habitats affect the niches of animals occupying that habitat?
2. Do you think rapid or gradual environmental changes have a greater potential to affect an organism's niche? Explain your answer.
3. On a very broad scale, how are the niches of a carnivore and an herbivore in the same geographic area similar? How do they differ?

Review

1. What is a niche?

2. Can two species share the same niche? Why or why not?
3. Name three factors that can be used to describe a habitat.
4. Distinguish between a habitat and an ecosystem.

2.3 Populations

Lesson Objectives

- Define population.
- Describe how births, deaths and migration affect population size.
- Explain how populations grow.
- Describe how limiting factors affect population growth.
- Describe growth of the human population.

Check Your Understanding

- What is ecology?
- How does an organism interact with its environment?

Vocabulary

- birth rate
- carrying capacity
- death rate
- dispersion
- emigration
- immigration
- limiting factor
- population growth rate

What is a Population?

A population is a group of organisms of the same species, all living in the same area and interacting with each other. Since they live together in one area, members of the same species reproduce together. Ecologists who study populations figure out how healthy or stable the populations are. They also look at how the populations interact with the environment.

First, ecologists will measure the size of the population. The population density is the number of individuals of the same species in a particular area. Ecologists also look at how individuals in a population are spread across an environment. How individuals are spaced within a population is called **dispersion**. Some species may be clumped or clustered (**Figure** 2.7) in an area. Others may be evenly spaced (**Figure** 2.8). Still others may be spaced randomly within an area.

Ecologists also study age and sex. The **birth rate** is the number of births per individual within a specific time period. The **death rate** is the number of deaths within a population during a specific time period. Knowing the birth and death rates of populations gives you information about a population's health. For example, when a population is made up of mostly young organisms, it means that the population is growing.

A population with equal birth and death rates will have equal numbers of individuals at each age level. A population with more individuals at or above an age when they can reproduce means that the number of individuals is decreasing

FIGURE 2.7

Individuals within this population of purple loosestrife plants are clumped because of the soil quality.

FIGURE 2.8

A population of cacti in the Sonoran Desert generally shows even dispersion due to competition for water.

in the population. This is because the organisms in this population cannot reproduce any more, so more children cannot be born, and then the population cannot grow.

Births, Deaths, and Migration

Births, deaths and migration all affect population growth. The **population growth rate** tells you if the number of individuals in a population is increasing or decreasing. Population growth rate depends on birth rate and on death rate. You can predict the growth rate by using the simple equation below:

growth rate = birth rate – death rate.

If the birth rate is larger than the death rate, then the population grows. If the death rate is larger than the birth rate, what will happen to the population? The population will go down. If the birth and death rates are equal, then the population will stay the same.

Factors that affect reproduction are:

1. Age at first reproduction.
2. How often an organisms reproduces.
3. The number of offspring.
4. Parental care.

5. How long an organisms is able to reproduce.
6. Death rate of offspring.

Organisms can use different strategies to increase their reproduction rate. Altricial organisms are helpless at birth and their parents give them a lot of care (**Figure** 2.9), while precocial organisms can take care of themselves at birth and do not require help from their parents (**Figure** 2.10). In order to reproduce as much as possible, they use very different strategies.

FIGURE 2.9

A hummingbird nest with young illustrates an altricial reproductive strategy, with a few small eggs, helpless and naked young, and intensive parental care.

FIGURE 2.10

The Canada goose shows a precocial reproductive strategy. It lays a large number of large eggs, producing well-developed young.

Migration

Migration is the movement of individual organisms into or out of a population. Migration affects population growth rate. There are two types of migration:

1. **Immigration** is the movement of individuals into a population from other areas. This increases the population growth rate.
2. **Emigration** is the movement of individuals out of a population. This decreases the population growth rate.

The earlier growth rate equation now looks like this:

growth rate = (birth rate + immigration rate) – (death rate + emigration rate)

One type of migration that you are probably familiar with is the migration of birds. Maybe you have heard that birds fly south for the winter. In the fall, birds fly thousands of miles to the south where is warmer. In the spring, they return to their homes. (**Figure** 2.11).

Monarch butterflies also migrate from Mexico to the northern U.S. in the summer and back to Mexico in the winter. These types of migrations move entire populations from one location to another.

FIGURE 2.11

A flock of barnacle geese fly in formation during the autumn migration in Finland.

Population Growth

If a population is given unlimited amounts of food, moisture, and oxygen, and other environmental factors, it will show a type of growth called exponential growth. Exponential growth means that as a population grows larger, the growth rate increases. This is shown as the J-shaped curve in **Figure** 2.12. You can see that the population grows slowly at first, but as time passes, growth occurs more and more rapidly.

In nature, organisms do not usually have ideal environments with unlimited food. In nature, there are limits. Sometimes, there will be a lot of food. Sometimes, a fire will wipe out all of the available nutrients. Sometimes a predator will kill many individuals in a population. How do you think these limits affect the way organisms grow?

Usually, populations first grow exponentially. But as populations increase, rates of growth slow down and slowly level off. This is shown as an S-shaped curve in **Figure** 2.12, and is called logistic growth. Why do you think occurs?

Limiting Factors

Limiting factors are things in the environment that can lower the population growth rate. Limiting factors include a

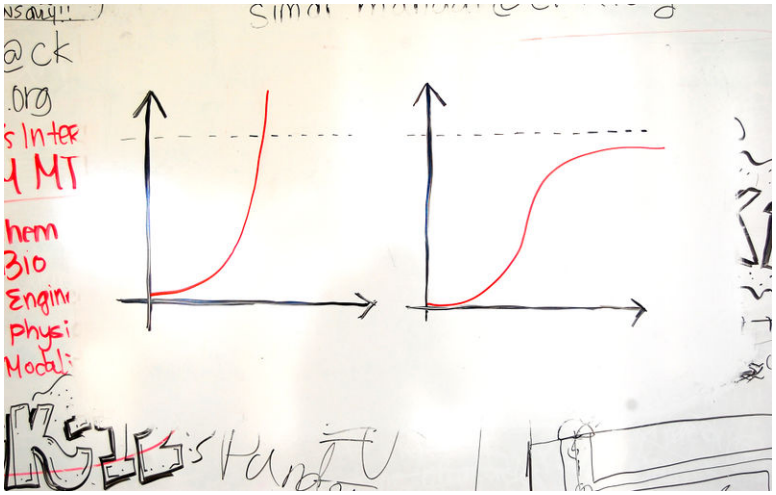


FIGURE 2.12

Growth of populations according to exponential (or J-curve) growth model (left) and logistic (or S-curve) growth model (right)

low food supply and lack of space. Limiting factors can lower birth rates, increase death rates, or lead to emigration.

When organisms face limiting factors, they show logistic type of growth (S-curve). Competition for resources like food and space cause the growth rate to stop increasing, so the population levels off. This flat line in growth is known as the carrying capacity. The **carrying capacity** is the maximum population size that can be supported in a particular area without destroying the habitat. Limiting factors determine what the carrying capacity is.

Food Supply as Limiting Factor

If there are 12 hamburgers at a lunch table and 24 people sit down at a lunch table, will everyone be able to eat? At first, maybe you will split hamburgers in half, but if more and more people keep coming to sit at the lunch table, you will not be able to feed everyone. This is what happens in nature. But in nature, organisms that cannot get food will die or find a new place to live.

In nature, when the population size is small, there is plenty of food for each individual. When there is plenty of food, organisms can reproduce, so the birth rate is high. As the population increases, the food supply decreases. When food decreases, organisms cannot reproduce as well, so the birth rates goes down. This will cause the population growth rate to decrease.

When the population decreases to a certain level where every individual can get enough food to eat, and the birth and death rates are stable, the population has reached its carrying capacity.

Other Limiting Factors

Other limiting factors include light, water, nutrients or minerals, oxygen, the ability of an ecosystem to recycle nutrients and/or waste, disease and/or parasites, temperature, space, and predation. Can you think of some other factors that limit populations?

Weather is also a limiting factor. For example, an individual *Agave americana* actually likes to grow when it is dry. Rainfall limits reproduction, which in turn limits growth rate. Can you think of some other factors like this?

Human activities can also limit the growth of populations. Such activities include use of pesticides, such as DDT, use of herbicides, and habitat destruction.

Lesson Summary

- A population is made of organisms belonging to the same species, all living in the same area and interacting with each other
- One measure of a population's health is the dispersion of individuals within a population
- The population growth rate shows how the population size changes per population member per unit of time.
- Birth rate, death rate, and migration affect population growth rate.
- In an ideal environment, populations show exponential growth. In nature, limiting factors cause logistic growth.

Review Questions

Recall

1. Name two ways ecologists know that a population is healthy.

2. Define Birth Rate.

3. Define Death Rate.

4. What is the equation that calculates growth rate in a population, include information on migration?

5. What are three factors that affect reproduction within a population?

Apply Concepts

6. How does a limiting factor such as food supply limit population size?

7. Give two examples of environmental crises that support the idea that our human population has already grown beyond the carrying capacity resulting in environmental degradation.

Critical Thinking

8. In the altricial reproductive strategy used by robins and hummingbirds, the birds hatch helpless and naked. Parents spend little energy in just a few small eggs. It is important these offspring survive because there are not very many of them. What strategies might parents use to make sure their young survive?

9. In human history, major advances in technology caused our population to increase rapidly. What do you think these major advances were?

Further Reading / Supplemental Links

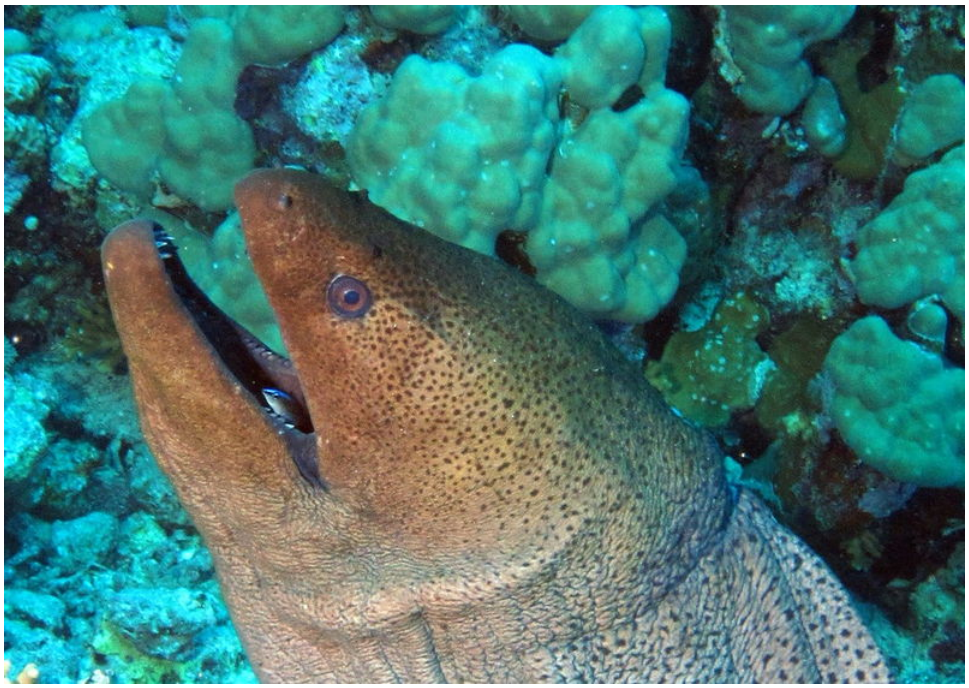
- http://www.brainpop.com/science/ourfragileenvironment/populationgrowth/preview.weml
- http://eelink.net/pages/EE+Activities+-+Population
- http://mathforum.org/t2t/faq/census.html

Points to Consider

- Now that you understand what makes up a population, what do you think makes up a community?
- You have learned about some of the factors that limit populations. What do you think are some interactions that affect the community?

2.4 Symbiosis

- Define symbiosis.
- Distinguish mutualism from commensalism and parasitism.
- Give examples of the different kinds of symbiosis.



Is this little fish about to become lunch?

Actually, this big fish is not opening his mouth to munch on that little fish. He is opening his mouth to get his teeth cleaned! This small fish eats dead skin and parasites from the body of the bigger fish. Both types of fish benefit from this relationship.

Symbiosis

Symbiosis describes a close and long-term relationship between different species. At least one species will benefit in a symbiotic relationship. These relationships are often necessary for the survival of one or both organisms. There are three types of symbiotic relationships: mutualism, communalism, and parasitism.

- **Mutualism** is a symbiotic relationship in which both species benefit.
- **Commensalism** is a symbiotic relationship in which one species benefits while the other is not affected.
- **Parasitism** is a symbiotic relationship in which the parasitic species benefits while the host species is harmed.

An example of a mutualistic relationship is between herbivores (plant-eaters) and the bacteria that live in their intestines. The bacteria get a place to live. Meanwhile, the bacteria help the herbivore digest food. Both species benefit, so this is a mutualistic relationship. The clownfish and the sea anemones also have a mutualistic relationship. The clownfish protects the anemone from anemone-eating fish, and the stinging tentacles of the anemone protect the clownfish from predators (**Figure** 2.13). Another example of this type of symbiotic relationship is the relationship

between the plover bird and the African crocodile. The tiny blackbird acts as a toothpick for the fierce crocodile, and helps by removing tiny morsels of food that are stuck between the crocodile's teeth. These food remains are the source of food for the bird. Another example is between the ostrich and the zebra. The ostrich always moves with the herd of zebras since it has a poor sense of hearing and smell, whereas the zebra has very sharp senses. The ostrich has a keen sense of sight, which the zebra lacks. Hence, these two species depend on each other to warn one another of any nearby imposing dangers.

Commensal relationships may involve an organism using another for transportation or housing. For example, spiders build their webs on trees. The spider gets to live in the tree, but the tree is unaffected. Other commensal relationships exist between cattle egrets and livestock. Cattle egrets are mostly found in meadows and grasslands are always seen near cattle, horses and other livestock. These birds feed on the insects that come out of the field due to the movement of the animals. They even eat ticks, fleas, and other insects off the back of animals. The relationship between tigers and golden jackals is also commensalism. The jackal alerts the tiger to a kill and feeds on the remains of the prey left by the tiger. This is not a mutualistic relationship as the tiger does not provide anything to the jackal.

Parasites may live either inside or on the surface of their host. An example of a parasite is a hookworm. Hookworms are roundworms that affect the small intestine and lungs of a host organism. They live inside of humans and cause them pain. However, the hookworms must live inside of a host in order to survive. Parasites may even kill the host they live on, but then they also kill their host organism, so this is rare. Parasites are found in animals, plants, and fungi. Hookworms are common in the moist tropic and subtropic regions. There is very little risk of getting a parasite in industrialized nations.

FIGURE 2.13

Clownfish in a sea anemone.

Vocabulary

- **commensalism**: Symbiotic relationship in which one species benefits while the other species is not affected.
- **mutualism**: Symbiotic relationship in which both species benefit.
- **parasite**: Organism that benefits in a symbiotic (parasitism) relationship in which one organism is harmed.
- **parasitism**: Symbiotic relationship in which one species benefits while the other species is harmed.
- **symbiosis**: Close and long-term interaction between different species.

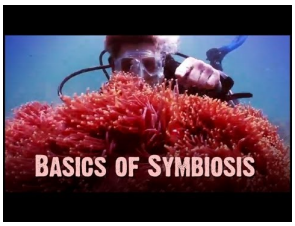
Summary

- Symbiosis describes a close and long-term interaction between different species.
- In a mutualism, both species benefit; in a commensalism, one species benefits while the other is not affected.
- In a parasitism, the parasitic species benefits, while the host species is harmed.

Practice

Use the resource below to answer the questions that follow.

- **Symbiosis: Mutualism, Commensalsim and Parasitism** at http://www.youtube.com/watch?v=zSmL2F1t81Q (5:17)



MEDIA

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1. What defines a symbiotic relationship?
2. Is the benefit gained by each individual in a mutualistic relationship equal?
3. What could a mutualistic relationship, in which one organism receives little benefit, also be called?
4. What type of relationship exists between the clown fish and the sea anemone?
5. What are the two explanations for where a clownfish's protective mucus comes from?

Review

1. What is symbiosis?
2. Distinguish between mutualism, commensalism, and parasitism.
3. Describe an example of a symbiotic relationship.
4. What's an example of a parasite?

2.5 References

1. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. This food chain includes both producers and consumers, but not decomposers. CC BY-NC 3.0
2. Laura Guerin. This food web displays some feeding relationships found in the Arctic Ocean. CC BY-NC 3.0
3. Flickr:Free Photo Fun. When the Tarpan horse breed became extinct, the Konik horse breed occupied its niche in the ecosystem. CC BY 2.0
4. Galen Parks Smith (Wikimedia: GSmith). The Kudzu is a species that has no natural predators and out-competed existing vines to take over their niches. CC BY 2.5
5. Courtesy of Shane Anderson, NOAA. Santa Cruz Island has a diverse set of habitats. Public Domain
6. Karen Roe. These wetland reeds represent a habitat. CC BY 2.0
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10. Courtesy of the U.S. Fish and Wildlife Service. http://commons.wikimedia.org/wiki/File:Branta_canadensis 1.jpg . Public Domain
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12. Laura Guerin; Robert Lopez. CK-12 Foundation . CC BY-NC 3.0
13. Samuel Chow. The clownfish and the sea anenome exist in a mutualistic relationship. CC BY 2.0

CONCEPT 3 Importance of Biodiversity

- Define biodiversity.
- Discuss the ecological and economic importance of biodiversity.
- Define and discuss biomimicry (bionics).

Why is preserving the rainforest important?

Preserving the rainforest is important for many reasons. But one reason conservation efforts have focused here is that the rainforest is home to more species of insects, amphibians, and birds than anywhere else on the planet. This wide diversity of life is called biodiversity.

Importance of Biodiversity

Biodiversity is a measurement of the amount of variation of the species in a given area. More specifically, biodiversity can be defined as the variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.

A place such as a coral reef has many different species of plants and animals. That means the coral reef is a ecosystem with high biodiversity (**Figure** 3.1). Because of its biodiversity, the rainforest shown above is an ecosystem with extreme importance. Why is biodiversity so important? In addition to maintaining the health and stability of the ecosystem, the diversity of life provides us with many benefits.

Extinction is a threat to biodiversity. Does it matter if we are losing thousands of species each year? The answer is yes. It matters even if we consider not only the direct benefits to humans, but also the benefits to the ecosystems. The health and survival of ecosystems is related to that ecosystem's biodiversity.

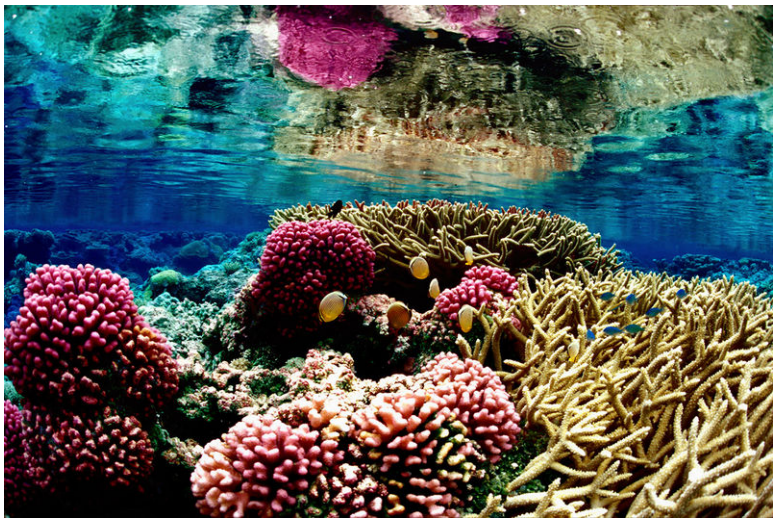


FIGURE 3.1

Coral reefs are one of the biomes with the highest biodiversity on Earth.

Economic Importance

Economically, there are many direct benefits of biodiversity. As many as 40,000 species of fungi, plants, and animals provide us with many varied types of clothing, shelter, medicines and other products. These include poisons, timber, fibers, fragrances, papers, silks, dyes, adhesives, rubber, resins, skins, furs, and more. According to one survey, 57% of the most important prescription drugs come from nature. Specifically, they come from bacteria, fungi, plants, and animals (**Figure** 3.2). But only a small amount of species with the ability to give us medicines have been explored. The loss of any species may mean the loss of new medicines, which will have a direct effect on human health.

FIGURE 3.2

Aspirin originally came from the bark of the white willow tree, pictured here.

Biodiversity and Technology

Nature has inspired many technologies in use today. **Bionics**, also known as biomimetics or biomimicry, uses organisms to inspire technology or engineering projects. By studying animals and their traits, we are able to gain

valuable information that we can put to use to help us. For example, rattlesnake heat-sensing pits helped inspire the development of infrared sensors. Zimbabwe's Eastgate Centre (**Figure** 3.3) was inspired by the air-conditioning efficiency of a termite mound (**Figure** 3.4).

FIGURE 3.3

Design of the Eastgate Centre (brown building), in Zimbabwe, which requires just 10% of the energy needed for a conventional building of the same size, was inspired by a biological design.

Ecological Importance

Biodiversity also has many benefits to ecosystems. High biodiversity makes ecosystems more stable. What can happen to an ecosystem if just one species goes extinct? What if that one species was a **producer** or **decomposer**? Would the loss of a producer have an effect on all the organisms that relied on that producer? If a decomposer vanishes, are there other decomposers to fill the void? Maybe the resulting species will adapt. Other species may fill in the **niche** left by the extinct species. But the extinction of one species could have a "domino" effect, resulting in the extinction of other species. This could greatly effect the stability of the whole ecosystem.

One important role of biodiversity is that it helps keep the nutrients, such as nitrogen, in the soil. For example, a diversity of organisms in the soil allows **nitrogen fixation** and nutrient recycling to happen. Biodiversity also allows plants to be pollinated by different types of insects. And of course, different species of fungi are necessary to recycle

FIGURE 3.4

The air-conditioning efficiency of this termite mound was the inspiration for the Eastgate Centre.

wastes from dead plants and animals. These are just a few of the many examples of how biodiversity is important for ecosystems.

Vocabulary

- **biodiversity**: Measurement of the amount of variation of the species in a given area.
- **bionics**: Use of organisms to inspire technology or engineering projects.
- **decomposer**: Organism that obtains nutrients and energy by breaking down dead organisms and animal wastes.
- **extinction**: Dying out of a species so that no members of the species exist anymore.
- **niche**: Role a species plays in the ecosystem.
- **nitrogen fixation**: Process of converting nitrogen gas in the air into nitrates in the soil.
- **producer**: Organism that produces food (glucose) for itself and other organisms.

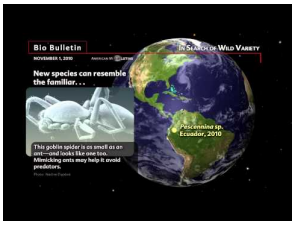
Summary

- Biodiversity is a measurement of the amount of variation of the species in a given area.
- Biodiversity is important because it directly benefits humans and ecosystems.

Practice

Use the resource below to answer the questions that follow.

- **In Search of Wild Variety** from American Museum of Natural History http://www.youtube.com/watch?v=Pbg_pGZv3CQ (1:52)



MEDIA

Click image to the left for use the URL below.

URL: http://www.ck12.org/flx/render/embeddedobject/57320

1. As of November 2010, about how many species have been identified on the Earth? How close do scientist feel this number is to the total number of species which exist?
2. In what kinds of locations are new species being found?
3. Can different species be identified by just looking at them? What techniques are scientists using to identify new species?

Review

1. What is biodiversity?
2. What does it mean if a place has high biodiversity?
3. What is an economic impact of biodiversity?
4. How does high biodiversity help the stability of an ecosystem?

References

1. USFWS Pacific. Coral reefs are one of the biomes with the highest biodiversity on Earth. CC BY 2.0
2. User:Willow/Wikimedia Commons. Aspirin is a medicine derived originally from nature. CC BY 2.5
3. Flickr:damien_farrell. Nature has also helped to inspire designs such as the Eastgate Centre. CC BY 2.0
4. Bengt Olof ÅRADSSON. The air-conditioning efficiency of this termite mound was the inspiration for the Eastgate Centre. CC BY 2.5

CONCEPT 4 Conservation

- Learn the value of conservation.
- Describe the three R's: reduce, reuse, recycle.

Can you make a difference?

Yes! You can conserve natural resources every day with every decision you make. Should you recycle that can? Yes! Should you buy a bottle of water or drink from the water fountain? Fountain! Should you walk or ride your bike to school or ask for a ride? Walk or ride your bike—it's good exercise too!

Conserving Natural Resources

How can we protect Earth's natural resources? One answer is **conservation**. This means saving resources. We need to save resources so some will be left for the future. We also need to protect resources from pollution and overuse.

When we conserve resources, we also cut down on the trash we produce. Americans throw out 340 million tons of trash each year. We throw out 2.5 million plastic bottles alone—every hour! Most of what we throw out ends up in landfills (**Figure** 4.1). In a landfill, all those plastic bottles take hundreds of years to break down. What are the problems caused by producing so much trash? Natural resources must be used to produce the materials. Land must be given over to dump the materials. If the materials are toxic, they may cause pollution.

The Three "R"s

You probably already know about the three "R"s. They stand for reduce, reuse, and recycle. The third "R"—recycle—has caught on in a big way. That's because it's easy. There are thousands of places to drop off items such as aluminum cans for recycling. Many cities allow you to just put your recycling in a special can and put it at the curb.

We haven't done as well with the first two "R"s—reducing and reusing. But they aren't always as easy as recycling. Recycling is better than making things from brand new materials. But it still takes some resources to turn recycled items into new ones. It takes no resources at all to reuse items or not buy them in the first place.

FIGURE 4.1
A bulldozer crushes a mountain of trash.

Reduce

Reducing resource use means just what it says—using fewer resources. There are lots of ways to reduce our use of resources.

- Buy durable goods. Choose items that are well made so they will last longer. You'll buy fewer items in the long run, so you'll save money as well as resources. That's a win-win!
- Repair rather than replace. Fix your bike rather than buying a new one. Sew on a button instead of buying a new shirt. You'll use fewer resources and save money.
- Buy only what you need. Don't buy a gallon of milk if you can only drink half of it before it spoils. Instead, buy a half gallon and drink all of it. You won't be wasting resources (or money!).
- Buy local. For example, buy local produce at a farmer's market, like the one pictured below (**Figure** 4.2). A lot of resources are saved by not shipping goods long distances. Products bought at farmer's markets use less packaging, too!

FIGURE 4.2
Buying locally grown produce at a farmer's market saves resources.

About a third of what we throw out is packaging. Try to buy items with the least amount of packaging. For example, buy bulk items instead of those that are individually wrapped. Also, try to select items with packaging that can be reused or recycled. This is called **precycling**. Pop cans and plastic water bottles, for example, are fairly easy to recycle. Some types of packaging are harder to recycle (**Figure** 4.3). If it can't be reused or recycled, it's a waste of resources.

- Many plastics: The recycling symbol on the bottom of plastic containers shows the type of plastic they contain. Numbers 1 and 2 are easier to recycle than higher numbers.

- Mixed materials: Packaging that contains more than one material may be hard to recycle. This carton is made mostly of cardboard. But it has plastic around the opening.

FIGURE 4.3

These types of packaging are hard to recycle. Could you reuse any of them?

Reuse

Reusing resources means using items again instead of throwing them away. A reused item can be used in the same way by someone else. Or it can be used in a new way. For example, Shana has a pair of jeans she has outgrown. She might give them to her younger sister to wear. Or she might use them to make something different for herself, say, a denim shoulder bag. Some other ideas for reusing resources are pictured below (**Figure** 4.4).

FIGURE 4.4

Do you reuse products, like these? Can you think of other ways to reuse resources?

Recycle

Many things can be recycled. The materials in them can be reused in new products. For example, plastic water bottles can be recycled. The recycled material can be made into t-shirts! Old phone books can also be recycled and

made into textbooks. When you shop for new products, look for those that are made of recycled materials (**Figure** 4.5). Even food scraps and lawn waste can be recycled. They can be composted and turned into humus for the garden.

FIGURE 4.5

This label shows that the product was made from recycled materials.

At most recycling centers, you can drop off metal cans, cardboard and paper products, glass containers, and plastic bottles. Recycling stations, like the one pictured below (**Figure** 4.6), are common. Curbside recycling usually takes these items too. Do you know how to recycle in your community? Contact your local solid waste authority to find out. If you don't already recycle, start today. It's a big way you can help the planet!

Summary

- Conservation is a very effective way to help us to have useful materials in the future.
- To conserve, follow the three R's: reduce, reuse, recycle.
- Reduce means to just use less.
- Reuse means to use something again, pass it on to someone who will, or change it so that it can be used in another way.

FIGURE 4.6
Are there recycling stations like this one where you live?

- Recycle means to have it recycled in your community. This is great; although, it does take energy.

Practice

Use the resource below to answer the questions that follow.

- http://www.energyhog.org/childrens.htm

Play the game to answer these questions.

1. What are energy hogs?
2. List 3 ways to save energy in the living room.
3. List 3 ways you can conserve energy in the kitchen.
4. List 2 ways to save water in the bathroom.
5. List 2 ways to conserve energy in the bedroom.
6. How can energy be conserved in the attic?

Review

1. Why is conservation a good thing?
2. What are the three R's? What do they mean?
3. Give an example of each of the three R's that you could do in your own life.

References

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