Objective: 8.L.3.1

Chapter 5 • Lesson 17

The Organization of Ecosystems

Key Words • ecosystem • biotic factor • abiotic factor • habitat • niche • species • population • community • field study

Getting the Idea

How would you describe the area where you live? Do you live near the ocean? Do you live in the mountains? What kinds of trees grow where you live? Everything that surrounds you makes up your environment. All organisms live in and depend on their environments.

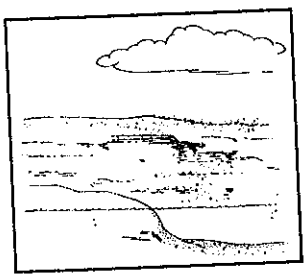
Biotic and Abiotic Factors

On Earth, all organisms are found in a zone called the biosphere. The biosphere includes Earth's land and water and the lowest part of the atmosphere. Living things can be found almost everywhere in the biosphere, including very hot or cold places and deep in the ocean.

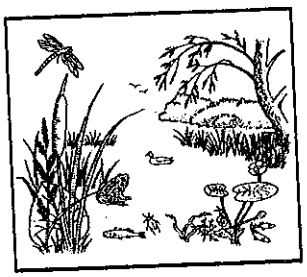
The biosphere is made up of smaller parts called ecosystems. An **ecosystem** includes all the living and nonliving parts of an environment as well as the interactions among them. Each ecosystem is an area where living and nonliving things interact. The living parts of an ecosystem are called **biotic factors**. The remains and wastes of organisms are also biotic factors. The nonliving parts of an ecosystem, such as light, temperature, weather, soil, and water, are its **abiotic factors**.

Abiotic factors help determine which organisms can live in an ecosystem. For example, abiotic factors such as soil type, temperature, and amount of sunlight determine which plants live in an area. All animals rely directly or indirectly on plants for food, and many animals also use plants for shelter. If an ecosystem cannot support certain types of plants, it will not support animals that depend on those plants.

Environment



Abiotic factors



Biotic factors

Each ecosystem contains different habitats. A **habitat** is the place where an organism lives. Its habitat supplies all the biotic and abiotic factors the organism needs to survive. Different organisms need different habitats. For example, a rotting log is a perfect habitat for insects, fungi, and worms. A sea star finds food and comfortable temperatures in shallow ocean water. Humans live in a wide variety of habitats. These habitats all supply the same basic needs of air, warmth, water, and food.

Organisms have different ways of feeding, reproducing, and defending themselves. How the organism acts within its ecosystem is called its **niche**. The niche can be thought of as the organism's role. Some animals eat other animals, and some eat only plants. Some plants grow in sunny spots, while others need shade. Worms and bacteria break down dead organisms for energy and recycle the nutrients into the ecosystem. Each of these roles in the ecosystem is part of an organism's niche.

Levels of Organization

The simplest level of organization in the living world is the organism. An organism is any living thing. Each organism is a member of a species. A **species** is a group of organisms that share most characteristics and can breed with one another. For example, all the white-tailed deer in North America belong to a species called *Odocoileus virginianus*.

The second level of organization is the population. All the organisms of a species that live in the same place at the same time make up a **population**. An example of a population is all the white-tailed deer living in a woodland area. Members of a population compete with each other for the resources they need for survival. White-tailed deer eat twigs, leaves, and grasses. When vegetation is scarce, a population of deer is likely to get smaller. If there is plenty of food, the population will grow.

A **community** is made up of all the populations that live in an area at the same time. A wetland community in North Carolina might include white-tailed deer, raccoons, black bears, turtles, snakes, fish, and many insects. It would also include all the grasses, shrubs, and trees living in the same area.

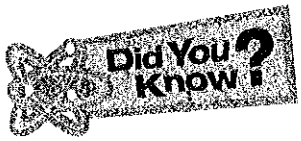
Populations in a community interact in many ways. For example, populations compete with each other for water, space, and other resources. You may have seen different species of birds competing for food at a bird feeder. Blue jays, sparrows, and chickadees try to get seeds from the feeder. Some species avoid competition by having a slightly different niche. Mourning doves avoid competition by eating seeds that have spilled on the ground. Cardinals often feed early in the morning or at dusk, when many other birds have stopped feeding. Competition is not limited to animal populations. Plant populations also compete for resources such as water, sunlight, and living space. You will learn more about competition among organisms in Lesson 20.

The next level of organization is the ecosystem. An ecosystem is made up of one or more communities and their nonliving environment. The parts of any ecosystem can be classified as either biotic factors or abiotic factors.

Ecosystems

There are many kinds of ecosystems, but they can be grouped into three main categories—terrestrial, freshwater, and marine. Terrestrial ecosystems are on land. These include forests, deserts, and grasslands. Freshwater ecosystems are in rivers, streams, lakes, and wetlands. Marine ecosystems are in oceans and other areas where the water is salty. You will learn more about marine ecosystems in Lesson 23.

North Carolina's main terrestrial ecosystems are forests. More than half of the state is covered by forests. In general, North Carolina's forest ecosystems can be described as temperate deciduous forest. A *temperate* region has a mild climate. *Deciduous trees* are those that lose their leaves in fall. Not all trees in North Carolina are deciduous. There are also many species of evergreen trees. Many of the same animals are found in all of North Carolina's forests. These include many species of birds. Forests are also home to white-tailed deer, foxes, coyotes, raccoons, chipmunks, squirrels, lizards, butterflies, and other insects.



The northern cardinal is the North Carolina state bird. This species is found in forests throughout the state.

Several rivers flow through North Carolina. Rivers are home to many species of fish, including largemouth bass, bluegill, black crappie, sunfish, and perch. Otters and alligators can be found in North Carolina's rivers. Algae and small plants grow in the water, and mosses and grasses grow along riverbanks. In some areas cypress trees also grow along the riverbanks. Some animals that do not live in a river affect its ecosystem because they feed on organisms in the river. Herons, kingfishers, and other wading birds stand in shallow water and catch fish to eat.

Focus on Inquiry

Scientists conduct many different kinds of investigations. Not all are conducted in a laboratory. A **field study** is a scientific investigation carried out in a natural setting. In a field study, scientists collect and record observations—information gathered with the senses. In the field, scientists use tools such as hand lenses to see small things and binoculars to see distant organisms.

In this activity, you will study a microhabitat and observe the organisms that live there. A microhabitat is a small, specialized habitat. Examples include a crack in a sidewalk or parking lot, the area under a rotting log, or the strip of grass between a road and a sidewalk.

Lesson Review

1. Which of the following is an abiotic factor in an ecosystem?

   A. bacteria

   B. air

   C. niche

   D. grass

2. Which of the following is a biotic factor in an ecosystem?

   A. water

   B. a large rock

   C. a rotting log

   D. temperature

3. What is a habitat?

   A. all the members of a community

   B. many different species living in the same place

   C. the role of an organism in its environment

   D. the place where an organism lives

4. Which of the following correctly lists the levels in an ecosystem from **largest** to **smallest**?

   A. ecosystem, community, population

   B. community, ecosystem, population

   C. population, ecosystem, community

   D. ecosystem, population, community

Chapter 6 • Lesson 21

Objective: 8.E.1.1

Earth's Water

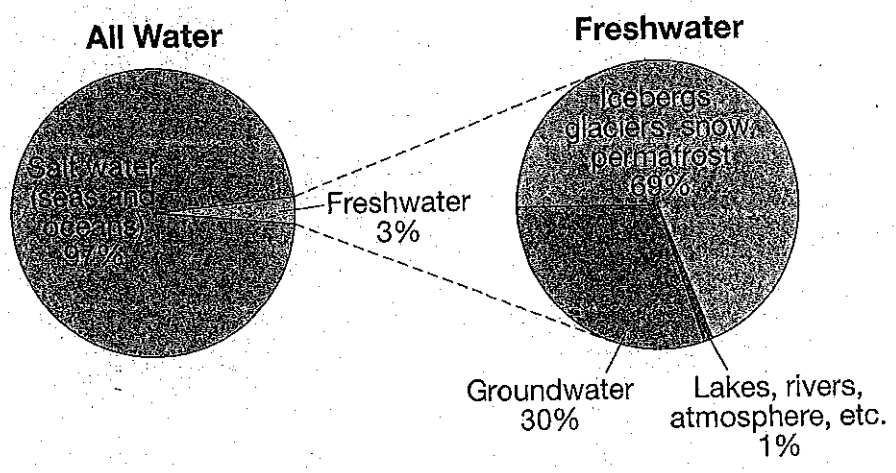
Key Words • hydrosphere • freshwater • groundwater • aquifer • watershed • estuary

Getting the Idea

Earth is a water planet. Water covers more than 70 percent of Earth's surface. The composition of all living things—people included—is more than 50 percent water. Living things on Earth need clean water to survive.

The Hydrosphere

The **hydrosphere** is made up of all the water found on, above, and under Earth's surface. Most of this water is liquid. About 97 percent of Earth's water is salt water found in the oceans. The remaining 3 percent is **freshwater**—water that is not salty. Water is found in the solid state in polar ice caps, glaciers, snow, and permafrost. Liquid water is found underground and in lakes, wetlands, and rivers. The atmosphere contains water vapor. Recall from Lesson 19 that water changes from one state to another as it circulates through the hydrosphere in the water cycle. The circle graphs below show where Earth's water is found.

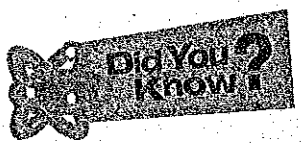


Most of Earth's freshwater is frozen in the polar ice caps. Ice covers nearly all of Antarctica and Greenland. Ice also covers most of the Arctic Ocean, near the North Pole. Glaciers contain large amounts of frozen water. A glacier is a mass of ice and snow that moves slowly over Earth's surface.

Nearly one-third of Earth's freshwater is **groundwater**, water located below Earth's surface. Groundwater collects as surface water moves down through soils and sediment to collect in spaces in underground rock. Groundwater moves through some layers of rock very slowly. It cannot flow at all through some rock layers.

An **aquifer** is a rock layer that collects and stores water. The freshwater we drink often comes from aquifers. People drill wells into aquifers to bring the water to the surface. As water is pumped out of an aquifer, more water moves into the aquifer. Aquifers are refilled slowly as water from the surface seeps down into the soil.

There are several aquifers in North Carolina. They form layers of groundwater separated by layers of rock that do not hold water. Some aquifers are near the surface of the land. Others can be as deep as 1000 meters below the surface.



Fifty-two percent of the people living in North Carolina get their drinking water from wells. Many homes have their own individual wells.

Water that collects above ground is surface water. Most of Earth's surface water is located in streams, rivers, lakes, and wetlands. A stream is a small body of flowing freshwater. A river is a large body of flowing freshwater, fed by other, smaller bodies of water. A lake is a large body of water surrounded by land. Lakes form in low areas where surface water collects. Wetlands are land areas that remain wet for all or part of the year. Wetlands act as natural sponges in an area. They collect and hold rainwater to prevent flooding. They also filter harmful chemicals out of water. Wetlands can improve the quality of water that will eventually become drinking water for communities.

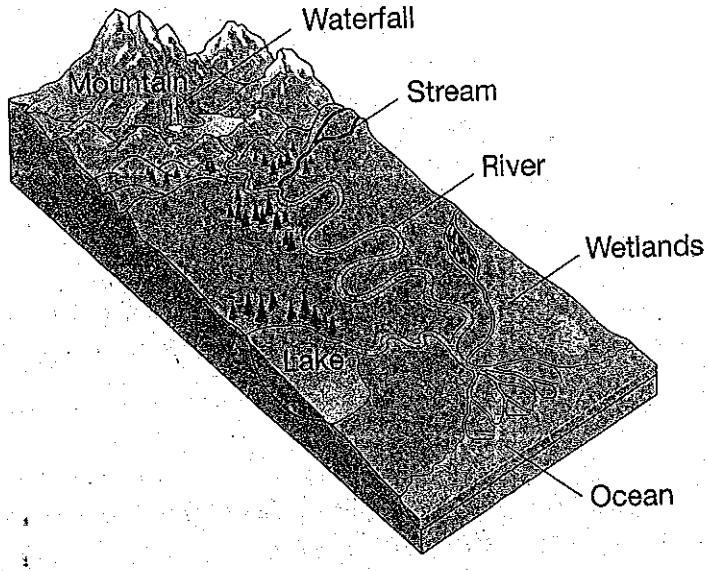
Surface water includes runoff. Recall that runoff is water that flows over the land without sinking into the ground. Runoff from rain and melted snow moves water and materials from one place to another. It can move soil, rocks, and seeds. It can also move harmful chemicals. Water is a solvent. You learned in Lesson 4 that a solvent can dissolve other substances. As runoff flows overland, it dissolves chemicals in fertilizers and other substances on the ground. The runoff then carries these substances into lakes and streams. You will also learn more about runoff in Lessons 24 and 25.

Watersheds

A **watershed** is an area of land that drains into a stream, river, lake, or other body of water. Watersheds can measure just one square kilometer or many thousands of square kilometers. Watersheds are separated from each other by higher land areas called divides. Mountain ridges make up many divides. For example, ridges of the Rocky Mountains form the famous Continental Divide.

Within a watershed, precipitation collects and finally drains into one body of water, such as a river, a lake, or the ocean. The water moves from higher to lower elevations, as gravity pulls the water downhill. Groundwater and surface water both contribute to the water in a watershed. The watershed shown below drains into the ocean.

Watershed Features



North Carolina's Water

Water reaches rivers by smaller streams, or tributaries. The large watershed that contains a river and its tributaries is sometimes called a river basin. North Carolina has 17 major river basins. The Neuse River Basin is one of four river basins that are completely within North Carolina. Other river basins extend into nearby states.

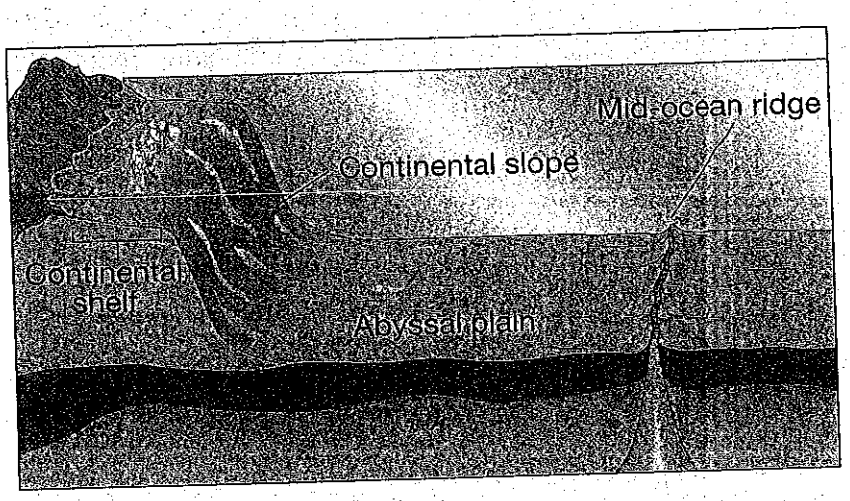
The Neuse River begins in Orange and Person counties. It flows 400 kilometers to its mouth at Pamlico Sound. Pamlico Sound is an **estuary**, a body of water in which freshwater from a river meets and mixes with salt water from the ocean. The sound's salt water comes from the Atlantic Ocean. The Neuse River Basin contributes freshwater to the sound but is not the only source. Freshwater from the Tar-Pamlico Basin also flows into Pamlico Sound.

Not all of North Carolina's freshwater drains into Pamlico Sound. The Cape Fear River drains directly into the Atlantic Ocean. Also, some freshwater is held in lakes. A natural lake is a low area of land where surface water runoff accumulates. Artificial lakes can be created by building a dam across a river. The largest natural lake in North Carolina is Lake Mattamuskeet. The largest artificial lake in North Carolina is Lake Norman.

The Arctic Ocean is the farthest north, lying over the North Pole. Much of the Arctic Ocean is covered with ice, especially when it is winter in the Northern Hemisphere. The Arctic Ocean is the shallowest of the oceans. The region of the ocean around Antarctica is called the Southern Ocean.

Ocean Floor

If you were in a submarine, you would see that the ocean floor contains many different kinds of features. These features include the continental shelf, continental slope, mid-ocean ridge, rift valleys, and trenches. Imagine traveling from the coast out to sea, along the ocean floor. You would first travel down the continental shelf. The continental shelf starts at the shore and slopes gently into the ocean. When the slope starts to get steeper, you have reached the continental slope. The continental slope goes from the edge of the continental shelf to the flatter part of the deep ocean floor.



Most of the ocean floor is a huge, dark, flat region known as the abyssal plain. The abyssal plain is covered with mud and the remains of animals that lived in the ocean. Although much of the ocean floor is flat, the ocean floor has some of the most dramatic features on Earth. One such feature is an ocean trench. An ocean trench is a large, V-shaped valley. Mid-ocean ridges are underwater mountain ranges. The mountains of the mid-ocean ridges can have peaks that rise 2500 meters. Some even reach above the surface of the ocean water, forming islands.

Ocean Composition

Although the ocean contains huge amounts of water, that water is not drinkable because it is salty. The ocean is fed by freshwater sources such as rivers and streams, so why is it salty? The primary reason is that surface water washes over rocks containing salts such as sodium chloride. Sodium chloride is common table salt. As water flows over the rocks, the water picks up some of the salt and carries it into the oceans. When ocean water evaporates, it leaves this salt behind. Over millions of years, this process has made the ocean salty. Underwater volcanoes also add salt to the ocean.

Salinity is the saltiness of a body of water. The salinity of ocean water can vary from place to place, but it is usually about 3.5 percent. In other words, about 3.5 percent of ocean water is made up of dissolved salts. Salinity may be less than 3.5 percent in areas where a large river releases a lot of freshwater into the ocean. Salinity is higher than 3.5 percent in areas where there is more evaporation. When water evaporates from the ocean, it leaves the salt behind. The remaining solution then has a higher salt content.

Ocean Resources

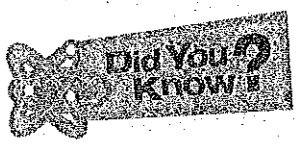
For centuries, people have used the ocean as a source of food. Commercial fishing is an important industry in North Carolina. Ocean waters off the North Carolina shore yield many species of fish, including swordfish, tuna, and flounder. Other species include shrimp, crabs, oysters, and scallops.

Food resources in the ocean are threatened by human activities. Recall that **pollution** is the release of an unwanted substance into the environment. Oil spills and chemicals that wash into the sea from rivers can kill organisms in the sea. Overfishing, the taking of too many fish, also threatens these ocean resources. If too many fish are taken out of the ocean, there will not be enough fish left to reproduce, and the populations will decrease. Fisheries, areas where fish are caught, must be monitored to make sure that too many fish are not taken from the ocean.

The ocean is a source of mineral resources. Two important resources are oil and natural gas. Large deposits of oil and natural gas have been found under the ocean floor. Offshore wells drill through the ocean floor to remove these resources. Magnesium is a metal that can be extracted from seawater.

The Ocean and the Water Cycle

Recall from Lesson 19 that the water cycle is the continuous movement of water between Earth's surface and its atmosphere. The ocean is huge, and large amounts of water evaporate from it every day. This water enters the atmosphere, and winds carry some of the water over land. Eventually, the water condenses and falls to the ground as precipitation.



More than 80 percent of the water that evaporates from Earth's surface comes from the ocean.

Discussion Question

Manganese is a valuable element used in producing steel. Potato-sized rocks containing large amounts of manganese cover the ocean's abyssal plain. However, this source of manganese is not widely used. Why do you think this is the case?

Lesson Review

1. An ocean basin is
   - **A.** a continuous body of water that covers 70% of Earth's surface.
   - **B.** a deep trench along the floor of the ocean.
   - **C.** a part of Earth's surface covered by ocean water.
   - **D.** the layer of the ocean closest to the surface.

2. How is the deep ocean floor different from the shallow parts of the ocean floor near land?
   - **A.** The deep ocean floor is flatter than the parts of the ocean floor near land.
   - **B.** The deep ocean floor is steeper than the parts of the ocean floor near land.
   - **C.** The deep ocean floor receives more light than shallower parts of the ocean.
   - **D.** The deep ocean floor is not covered with mud.

3. What is the source of most of the salt in the ocean?
   - **A.** human activities
   - **B.** rocks on land
   - **C.** fish
   - **D.** wind

4. Which of these is **not** a threat to living ocean resources?
   - **A.** overfishing
   - **B.** oil spills
   - **C.** evaporation
   - **D.** pollution

Objectives: 8.E.1.2; 8.E.1.3

Chapter 6 • Lesson 23

Marine Ecosystems and Estuaries

Key Words • marine • upwelling • chemosynthesis • estuary

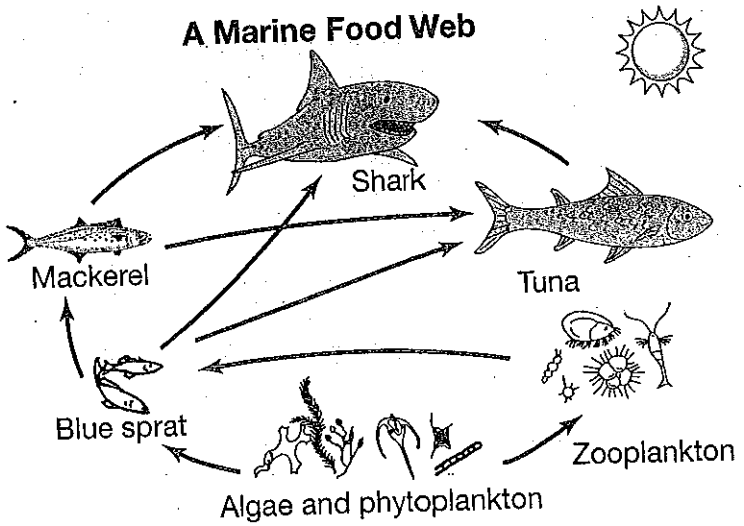
Getting the Idea

Almost half of the known species of organisms live in the ocean. Because so much of the ocean has not yet been explored, that amount could be even greater. Different kinds of organisms live in different parts of the ocean.

The Ocean's Producers

Producers in **marine**, or ocean, environments are important to all life on Earth. The main producers in the ocean are algae and other microscopic organisms called phytoplankton. These producers live in the upper region of the ocean. There, they receive enough light to perform photosynthesis. Light is absorbed as it passes through water, so sunlight does not reach deeper levels of the ocean.

In the ocean, as on land, energy flows directly or indirectly from producers to consumers. The food web below shows the role of producers in a marine ecosystem. The food web includes zooplankton, microscopic organisms that feed on producers.



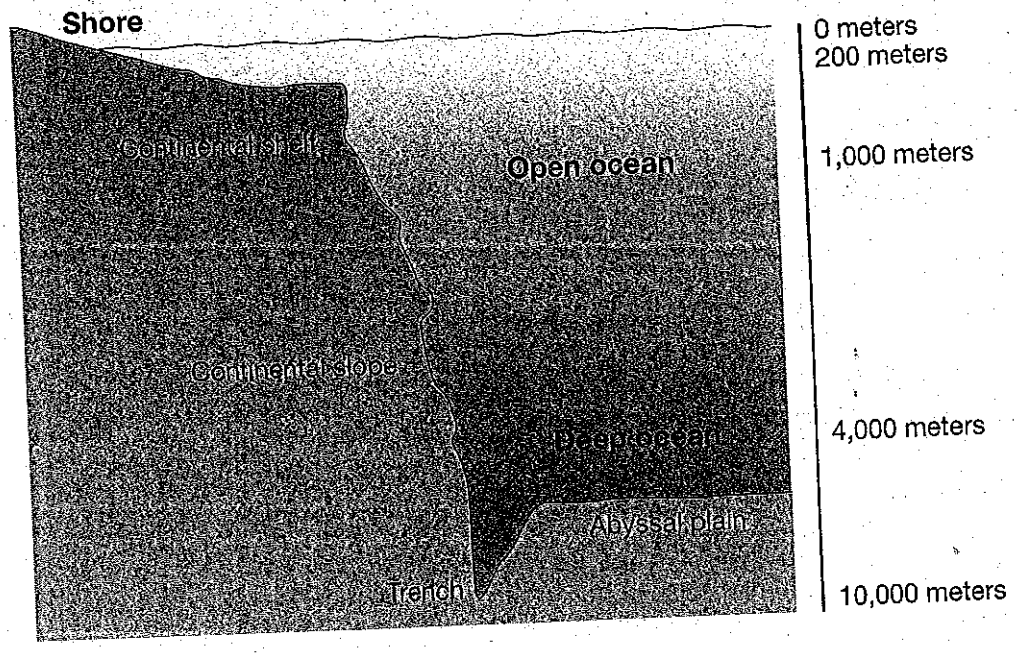
Recall that when producers perform photosynthesis, they release oxygen. Much of the oxygen that algae and phytoplankton produce is used by marine organisms. Some of it enters Earth's atmosphere, where it is used by organisms on land.

Populations of producers in the ocean can be affected by ocean currents called upwellings. An **upwelling** carries cold water from deep in the ocean up the surface. This water is rich in nutrients that have collected deep in the ocean. Producers at the surface use the nutrients, and their populations increase. As a result, populations of consumers grow too. Parts of the ocean where upwellings occur can support large populations of fish and other organisms.

Marine Ecosystems

The ocean can be divided into three major ecosystems. The *shore* ecosystem is found where the ocean meets the land. The *deep ocean* ecosystem includes the deepest layers of the ocean. The *open ocean* is away from the shore and above the deep ocean.

Major Ocean Ecosystems



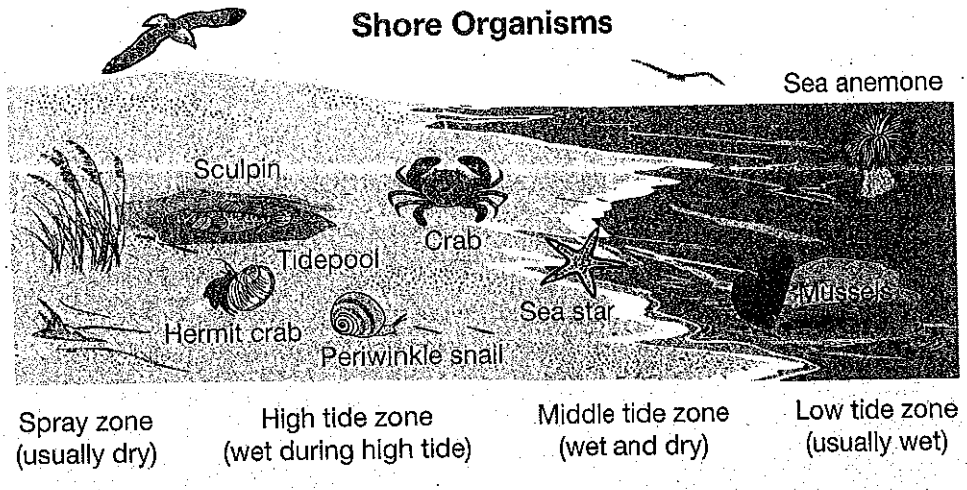
The Shore

The part of the ocean nearest the land is the *shore*. Because the water is shallow, light reaches the bottom of the ocean in this ecosystem. The shore is affected greatly by motion of the water. Waves constantly move the mud and sand in this area around, so few plants live in the water here. Tides rise and fall, changing the depth of the water. At low tide, some areas are exposed to the air.

Some marine animals, such as snails and crabs, can move with the changing tides. Animals such as mussels are attached to rocks or other surfaces. If they are exposed to air at low tide, they close their shells tightly to keep from drying out. Clams dig into wet sand and close their shells tightly. Marine worms also dig into the sand.

During high tide, water fills shallow depressions. As the tide goes out, these depressions remain filled, forming tide pools. Many different organisms can be found in tide pools. They include algae, limpets, and sea urchins.

Shorebirds such as gulls and sandpipers rely on this ecosystem for food. They follow the waves, feeding on organisms that are exposed when a wave moves out.



The Open Ocean

The *open ocean* includes a vast area of the ocean and contains a variety of organisms. Conditions in different parts of the open ocean vary because of several factors. One of these is depth. In the open ocean, sunlight can reach depths of up to 200 meters. Water above this depth is warmed by the sun and supports a large population of producers. Many types of fish and marine mammals live in this upper region of the open ocean.

Some consumers can live below the area where light is bright enough for photosynthesis. Water at this depth is cooler, and the pressure is greater. Organisms in this part of the ocean include some kinds of jellyfish, fish, and squid. These organisms feed on nutrients that drift down from above. They may also rise closer to the surface to feed. Some large consumers, such as whales, which live in the upper part of the ocean, can dive down to feed on animals in the deeper, dark part of the ocean.

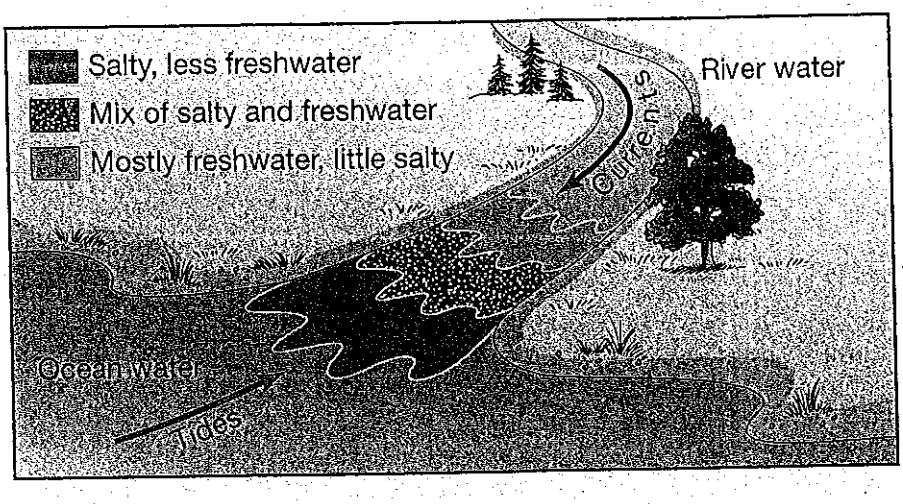
The Deep Ocean

The deepest layers of the ocean are thousands of meters below the ocean's surface. At these depths, there is no light, so photosynthesis is not possible. The pressure is very great and the water is cold. But there is life at these great depths. Openings in the ocean floor called thermal vents release heat, creating areas of warmth. Small ecosystems form around these vents. The ecosystems rely on microorganisms that make their own food. These autotrophs do not use sunlight, as in photosynthesis. Instead, they use the energy stored in chemical bonds. This process is called **chemosynthesis**. Microorganisms around deep-ocean vents provide energy for giant tubeworms, clams, and other life forms.

Estuaries

Recall that an **estuary** is a body of water in which freshwater from a river meets and mixes with salt water from the ocean. Estuaries come in all shapes and sizes and go by many different names. They may be known as inlets, bays, harbors, lagoons, or sounds. Examples include Boston Harbor, Chesapeake Bay, Pamlico Sound, and Albemarle Sound.

In an estuary, freshwater flows downstream in a river. Rising tides push ocean water into the river. At high tide, the saltwater is farther upstream. At low tide, the saltwater is pushed farther downstream by the river water. As a result, the depth and salinity of water in an area change during the day as the tide rises and falls. Organisms in estuaries can tolerate these changes in their environment.



Estuaries are often protected from ocean waves by land features. These features include barrier islands, reefs, or sand spits. The calm waters of an estuary are rich in dissolved oxygen, nutrients, and minerals supplied by the river water. Sea grasses and marsh grasses grow in and along the edge of the water. Grasses and other plants in an estuary provide food and shelter for many organisms. Fish, shrimp, crabs, clams, and other shellfish live well in these conditions. Estuaries are nurseries for many animals, including some ocean animals that swim into estuaries to breed.

Discussion Question

Pamlico Sound is very popular with people who like to fish. Why do you think it is a good place to fish?

Lesson Review

1. Which are the main producers in the ocean?
   - **A.** algae and other microscopic organisms
   - **B.** seaweed growing on the ocean floor
   - **C.** sea grasses growing on the ocean floor
   - **D.** microorganisms living near vents in the ocean floor

2. Which region of the sea is affected by changes in the tides?
   - **A.** open ocean
   - **B.** deep ocean
   - **C.** shore
   - **D.** open ocean and shore

3. Producers in the upper part of the ocean get nutrients from
   - **A.** their roots, which grow into the ocean floor.
   - **B.** materials brought to the surface by upwellings.
   - **C.** dead organisms floating in the water.
   - **D.** river water that washes out to the ocean.

4. How are estuaries different from lakes or the ocean?
   - **A.** Estuaries contain only salt water.
   - **B.** Estuaries contain only freshwater.
   - **C.** Estuaries contain both salt water and freshwater.
   - **D.** Estuaries are not bodies of water.

Objective: 8.E.1.4

Water Pollution

Key Words • stewardship • pollutant • point-source pollution • non-point-source pollution • algal bloom

Getting the Idea

All organisms including humans need water to carry out their life processes. Many organisms also make their homes in water environments. Because water is so important to life on Earth, it is essential to protect Earth's water resources and use them wisely. Unfortunately, people have not always done this. Following practices that protect Earth's resources is called **stewardship**. In this lesson and in Lesson 25, you will learn about ways humans have damaged water systems. You will also learn about ways humans are working to improve the quality of water in these water systems.

Pollution

For a long time, people assumed that there would always be a supply of clean water to drink. People thought that chemicals and wastes could be dumped into bodies of water and would wash out to sea where they would not cause any problems. We now know that this is not true.

Recall that pollution is the release of an unwanted substance into the environment. Many human activities can release such substances into water. A **pollutant** is any substance that can harm the environment. Pollutants include toxic chemicals, human and animal wastes, and fertilizers and pesticides. These pollutants run off the land and into rivers, lakes, and the ocean. All these pollutants can reduce water quality and damage ecosystems. Cleaning up water systems can be difficult and expensive. Working to prevent pollution is the best and least expensive way to protect Earth's waters.

Sources of Water Pollution

Water pollutants can come from many different sources. Sometimes it is possible to find out where a pollutant comes from. Pollution that comes from a single site is called **point-source pollution**. Oil spilling from a supertanker into an ocean or river is an example of point-source pollution. A drainpipe spilling waste into a river is another example. More examples of point-source pollution of ground and surface water systems are listed in the chart on the next page.

Sometimes the source of a pollutant is not easy to identify. Pollution that comes from many places or an unidentified source is called **non–point-source pollution**. In North Carolina, non–point-source pollution in rivers often comes from farmland. Fertilizers, pesticides, and animal wastes are carried into water systems by runoff.

Another source of non–point-source pollution is rain. Acid rain makes bodies of water acidic, which can kill fish in the water. Rain can carry pollutants —including lead and sulfur— from the air to the ground. From there the pollutants enter groundwater and surface water systems. Heavy rains can also cause sewer systems to overflow. This overflow pollutes water systems with pesticides, fertilizers, plastic debris, raw sewage, and oil.

Sources of Water Pollution

Point-Source Pollution	Non-Point-Source Pollution
■ Damaged sewer pipes or systems	■ Chemical runoff from agricultural fields, golf courses, and lawns
■ Release of raw sewage from wastewater treatment plants	■ Waste runoff from feedlots
■ Leaking underground oil tanks	■ Soil from farms
■ Release of chemicals from paper mills or other industries into streams	■ Sand, grit, oil, and gasoline from city and suburban streets
■ Release of dishwater or sewage from homes directly into water systems	■ Salts from irrigation of farm fields
■ Release of heated water from power plants or factories into streams	■ Mercury pollution from coal-burning power plants
	■ Acid rain

Pollution that enters rivers eventually flows to the ocean. Other forms of pollution enter the ocean directly. Garbage is a form of pollution that affects oceans. The United States has laws that limit what can be disposed of into the sea, but many other countries dispose of large amounts of trash in the oceans. Some of the garbage, such as paper and food waste, will decay over time. However, plastics in garbage are a large problem because they do not decay. Ocean currents flow all around the world. Trash dumped in the ocean in one place gets carried to places all around the world. Plastics float around the world, carried by ocean currents.

Nutrients and Water Pollution

Plants get nutrients they need from soil. People add nutrient-rich fertilizers to soil in order to promote plant growth. Some farms use huge amounts of fertilizers, and people often spread fertilizers on their lawns. Runoff carries fertilizers into water systems, and eventually this fertilizer reaches the ocean. Animal and human wastes, if not properly managed, can also release excess nutrients into water systems.

Two kinds of nutrients found in fertilizer are phosphates and nitrates. Phosphates contain phosphorous, and nitrates contain nitrogen. Too much of these nutrients in water ecosystems may cause an extremely rapid growth of algae, called an **algal bloom**. Algal blooms harm water systems. Algal blooms cause the water to become cloudy. They block light from reaching plants farther down in the water.

Some algae that cause blooms give off substances that harm other organisms. These substances can kill fish and other animals. The microscopic organism *Pfiesteria* is a type of alga that can reproduce quickly in the warm, nutrient-rich waters of estuaries. It produces a chemical that poisons fish. The chemical is also harmful to humans who breathe or touch it. People may become dizzy, get headaches, or develop sores on their skin from *Pfiesteria* poisoning. *Pfiesteria* blooms have occurred in the estuaries of North Carolina and other eastern states.

Excess nutrients in water can also lead to low oxygen levels in the water. When algae and other aquatic plants grow in large numbers, they run out of resources and begin to die. As decomposers break down the remains of these organisms, they use up much of the oxygen in the water. When less oxygen is available to fish, they are more likely to get sick. Lack of oxygen can also kill fish and other aquatic organisms.

A similar process has produced low-oxygen dead zones in oceans. Dead algae can sink deep in the ocean, below levels where light can reach. Without light, photosynthesis cannot take place. So when the dead algae decay in these deep regions of the ocean, the oxygen that is used up does not get replaced easily. The lack of oxygen results in a region where few organisms live—a dead zone.

Pollution of Groundwater

When it rains, water runs along the surface of the land. It may pick up chemicals such as fertilizers or road salts. Some of this water seeps into the soil and enters the groundwater. It brings the pollutants it contains along with it. Once the pollutants reach an aquifer, they can move a long distance underground. When people dig wells into the aquifer, they may find that their water source is polluted.

Local Water Issues

As you will learn in Lesson 25, many laws have been passed to reduce water pollution. Many of these laws focus on water released from farms and factories. But they are not the only sources of pollutants. Individuals can also reduce or eliminate sources of water pollution. People can reduce their use of fertilizers and pesticides on lawns to prevent chemicals from running into local streams and lakes. People can sweep up sand and sediment from streets or sidewalks to keep these materials out of storm drains. Homeowners can make sure that their wastewater pipes do not empty directly into a lake or stream. Car and truck owners can keep their vehicles in good working order and make sure they do not leak oil, gas, or other fluids. Everyone can play a role in protecting water systems.

Discussion Question

Many people enjoy spending time on sailboats and motorboats. How can these people avoid contributing to water pollution?

Lesson Review

1. An example of non–point-source pollution is

   A. wastewater from a leaking pipe.

   B. fertilizer runoff from lawns.

   C. oil from a leaking underground tank.

   D. chemicals released from a paper mill.

2. A clear example of point-source pollution is

   A. trash floating in ocean water.

   B. feedlot wastes in a river.

   C. oil spilling from a supertanker.

   D. salts from irrigation.

3. What is a possible effect of high nutrient levels in water systems?

   A. algal blooms

   B. fewer algae

   C. healthier fish

   D. hotter water

4. Which of the following occurs when algae decompose in the ocean?

   A. Decomposers at the ocean's surface remove oxygen from the air.

   B. Decomposers add oxygen to the ocean water.

   C. The ocean water releases excess oxygen into the air.

   D. Decomposers remove oxygen from the ocean water.

Objectives: 8.E.1.3; 8.E.1.4

Chapter 6 • Lesson 25

Monitoring Water Quality

Key Words • pH • turbidity • salinity • bioindicator

Getting the Idea

Water is a precious resource that must be managed and protected. Federal and state governments have set water quality standards to keep water clean and safe. Wastewater must be treated to keep pollutants out of aquatic ecosystems and drinking water.

Water Regulations

Many laws have been passed to protect water quality in the United States. The Clean Water Act was passed in 1972. This law focuses on protecting surface waters, such as lakes and rivers. The main goals of this law are "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." To improve water quality, the Clean Water Act helps pay for wastewater treatment plants.

The Environmental Protection Agency (EPA) sets and enforces quality standards for wastewater that is released by industry and local governments. The EPA and other agencies have also set up educational programs to help reduce non–point-source pollution, such as chemicals in runoff.

Regulations have also been established to ensure safe drinking water. The Safe Drinking Water Act was passed in 1974. This law gives the EPA the power to set standards for the quality of drinking water. The EPA also sets the standards for the tests used to evaluate the quality of drinking water.

Other laws protect ocean waters. The U.S. Marine Protection, Research, and Sanctuaries Act was passed in 1972. It regulates the dumping of substances that can damage human health or marine ecosystems. A later law outlawed dumping sewage from towns and cities into the ocean.

The 1990 Oil Pollution Act requires all oil tankers operating in U.S. waters to have double hulls by 2015. Double hulls reduce the risk of an oil spill in case of a tanker accident. This law was passed after the *Exxon Valdez* spilled 260,000 barrels of crude oil in Alaska in 1989, damaging marine and shoreline ecosystems.

Water Quality

Scientists monitor, or check on, water quality. They measure and test water in field studies, with tools such as thermometers and water meters. Scientists also collect water samples and analyze them in laboratories. Scientists use a variety of indicators to determine the health of a water source. Indicators include the amounts of substances dissolved in the water, the temperature of the water, and the kinds of organisms that live in a body of water.

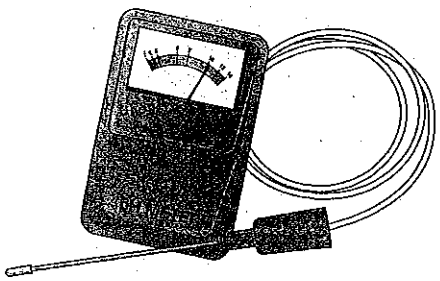
Many factors affect the quality of water, in both freshwater systems and the ocean. Seasonal changes in temperature affect the amount of oxygen in the water. Weather can affect water quality. Heavy rains may wash soil into lakes and rivers, turning them a muddy brown. In rivers and streams, the depth of the water and how fast it flows can also affect water quality. Human activities have big effects on the quality of water. Adding certain chemicals to a water system can change the numbers and kinds of algae in the water. This, in turn, affects the numbers and kinds of animals that live in the water.

Physical Indicators

Physical indicators are related to the physical properties of water. Two physical indicators are dissolved oxygen and temperature. Organisms that live in water habitats get oxygen from the water in which they live. This oxygen is dissolved in the water.

Dissolved oxygen is related to water temperature. Colder water can hold more dissolved oxygen than warmer water. As water temperature increases, the amount of dissolved oxygen decreases. A healthy water source has medium to cool temperatures and high dissolved oxygen levels. A water source with high temperatures or low dissolved oxygen levels is unhealthy. Water organisms become stressed under such conditions. Stressed organisms are more likely to become sick. For example, fish kills can happen when dissolved oxygen is low and water temperatures are high. A fish kill is an event in which large numbers of fish die.

Another physical indicator of water quality is **pH**, a measure of how acidic or how basic a liquid is. The pH scale of measurement is numbered from 0 to 14. A liquid with a pH of 7 is considered neutral. A water source with a pH that is too high or too low is unhealthy. The ocean has a slightly basic (8.0 to 9.0) pH, which is healthy for marine organisms. Water may become too acidic (low pH) from acid rain. Water may become too basic (high pH) if too many algae grow in it.



Turbidity is a measure of how clear water is, or how many solid particles are in the water. A water source with high turbidity, or cloudy water, is unhealthy. Soil that enters water in runoff can increase turbidity. After heavy rains, the water in streams may become turbid. As the soil particles settle to the bottom or are carried downstream, the water becomes clear again. Rapid growth of algae also causes high turbidity. High turbidity may keep plants and algae from getting enough sunlight to make food. High turbidity can also clog the gills of fish.

A healthy water source is clear. However, not all clear water sources are healthy. If a lake becomes extremely acidic due to acid rain, no organisms can live in the water. Such a lake will look very clear, but it is not a healthy water system.

Chemical Indicators

Chemical indicators are related to the chemical properties of water. Recall that high levels of nitrates or phosphates can be unhealthy, leading to algal blooms. It is difficult to deal with these pollutants because they often come from non-point sources. Substances such as arsenic, mercury, sulfur, and lead have been released from factories. Factories are point sources. Once the source is identified, steps can be taken to stop the release of the pollutant.

Salinity is another chemical indicator. Recall that **salinity** is the saltiness of water. The salinity of ocean water can vary from place to place, but it is usually about 3.5 percent. Freshwater may have a small amount of salt, but it should be less than a tenth of a percent. The salinity of freshwater systems may increase in the winter due to runoff from salts spread on roads to melt ice. In an estuary, salinity varies. Closer to the ocean, salinity is nearly as high as that of seawater. Farther up the river or bay, salinity decreases.

Biological Indicators

Biological indicators, or **bioindicators**, are organisms used to monitor the health of an ecosystem. Some organisms can survive only under specific conditions. For example, trout are fish that require a lot of oxygen. The presence of trout in water can show that a water source is healthy and has plenty of oxygen.

A wide diversity, or variety, of organisms also indicates clean water. Many kinds of insect larvae—immature forms of insects—develop in streams and ponds. Insect larvae may be found swimming in water or living under rocks in the water. Clean water will contain many species of insect larvae. Larvae of mayflies, caddis flies, and stoneflies live in clean water. If the water is polluted, these insects cannot survive. When diversity is reduced, there is less competition among species for resources. This helps the populations of species that can survive in polluted water. For example, blackfly larvae can live in water that is too polluted for many species. So a large number of blackfly larvae indicates polluted water.

Standards for Analyzing Results

Scientists also monitor water quality by comparing their results to certain values, called standards. These standards may be set by each state or by the U.S. government. If water samples do not meet standards, scientists try to find and fix the problem.

Monitoring water quality can help scientists identify pollutants and their sources. If nitrates are high or dissolved oxygen is low, fertilizers in runoff may be the problem. If pH is too low, acid rain or mine waste may be polluting the water. High temperatures may be caused by industries releasing warm water into streams. Finding a source of pollution is the first step in improving water quality.

Focus on Inquiry

You can monitor the quality of the water in your school and at home. Obtain some paper for testing pH. Put a sample of tap water in a small plastic cup. Use the paper to test the water's pH. Dip the paper in the water. Compare the color of your wet pH paper with the color chart provided with the paper. Record the pH of your sample in the data table below. Test two other samples of tap water in the same way, and record the values. Testing several samples will make your data more reliable. Finally, calculate and record the average pH of the water.

pH Data for Tap Water

Sample	pH
Sample 1	
Sample 2	
Sample 3	
Average	

Is your water acidic or basic? (To help you decide, use the description of pH on page 146.) Explain your answer.

_____

_____

The Environmental Protection Agency recommends that the pH of drinking water be between 6.5 and 8.5. Does the pH of your water fall in this range? _____

_____

Lesson Review

1. For what types of water does the Clean Water Act set water quality standards?

   A. ocean waters

   B. groundwater

   C. all U.S. waters

   D. surface waters

2. Which of the following are indicators of a healthy water source?

   A. high nitrates, high pH, and low temperature

   B. low temperature, high dissolved oxygen, and neutral pH

   C. low pH, high nitrates, and low dissolved oxygen

   D. high turbidity, high dissolved oxygen, and high temperature

3. Scientists tested water at a sampling site in the Neuss River watershed. They found that dissolved oxygen dropped to its lowest level during July. What is the most likely cause of the low dissolved oxygen data for July?

   A. high pH

   B. low turbidity

   C. high temperatures

   D. low salinity

4. Under which conditions are large numbers of fish in a lake most likely to die?

   A. right after a storm with heavy rainfall

   B. when the water's dissolved oxygen is high and temperatures are lower than average

   C. when the water's dissolved oxygen is low and temperatures are higher than average

   D. when the water's turbidity is low and temperatures are in the average range