The Mysterious Dead Zone

Every summer, millions of fish are killed in an area in the Gulf of Mexico called a hypoxia region. Hypoxia is a condition that occurs when there is an unusually low level of oxygen in the water. The area is often referred to as the "dead zone" because almost every fish and crustacean in the area dies. In 1995, this zone covered more than 18,000 km², and almost 1 million fish were killed in a single week. Why does this happen? Can it be stopped?

Scientists think the excess nitrogen and phosphate is from animal waste and runoff from farms and developments. The pollution may also be caused in part by the overfertilization of crops. The extra fertilizer runs into the rivers, which empty into the Gulf Coast.

Ecosystem Models Suggest Solutions

All along the Gulf Coast, marine scientists and Earth scientists are trying to find methods to reduce or eliminate the "dead zone." They have made physical and computer models of the Mississippi River ecosystem that have accurately predicted the data that has since been collected. The scientists have changed the models to see what happens. For example, wetlands are one of nature’s best filters. They take up a lot of the chemicals present in water. Scientists predict that adding wetlands to the Mississippi River watershed could reduce the chemicals reaching the Gulf of Mexico. Although scientific models support this hypothesis, they also indicate that adding wetlands to the Mississippi River watershed would not be enough to completely prevent the "dead zone."

Find Some Solutions

- The Gulf of Mexico is not the only place that suffers from a hypoxia region. Research other bodies of water to find out how widespread the problem is. Have scientists found ways to reduce or eliminate the hypoxia regions elsewhere? How could this information be used to improve the situation in the Gulf of Mexico?
A flurry of orange fish swim through the sun-dappled crevices of a tropical coral reef. All around them other life exists—sea fans, eels, anemones, and living corals. Could this scene exist anywhere else? It could... if the place was underwater in a warm climate close to the shore. In this chapter, you will learn how the nonliving environment affects organisms and how they are adapted to where they live.
A MINI-ECOSYSTEM

In this activity, you will build and observe a miniature ecosystem.

Procedure

1. Place a layer of gravel in the bottom of a large widemouth jar or 2 L bottle with the top cut off. Add a layer of soil.

2. Add a variety of small plants that require similar growing conditions. Choose plants that will not grow too quickly.

3. Spray water inside the jar to moisten the soil.

4. Cover the jar, and place it in indirect light. Describe the appearance of your ecosystem in your ScienceLog.

5. Observe your mini-ecosystem every week. Spray it with water to keep the soil moist. Record all of your observations.

Analysis

6. List all of the nonliving factors in the ecosystem you have created.

7. How is your mini-ecosystem similar to a real ecosystem? How is it different?
Land Ecosystems

Imagine that you are planning a camping trip. You go to a travel agency, where you find a virtual-reality machine that can let you experience different places before you go. You put on the virtual-reality gear, and suddenly you are transported. At first your eyes hurt from the bright sunlight. The wind that hits your face is very hot and very dry. As your eyes grow accustomed to the light, you see a large cactus to your right and some small, bushy plants in the distance. A startled jack rabbit runs across the dry, dusty ground. A lizard basks on a rock. Where are you?

You may not be able to pinpoint your exact location, but you probably realize that you are in a desert. That’s because most deserts are hot and dry. These abiotic, or nonliving, factors influence the types of plants and animals that live in the area.

The Earth’s Biomes

A desert is one of Earth’s biomes. A biome is a geographic area characterized by certain types of plant and animal communities. A biome contains a number of smaller but related ecosystems. For example, a tropical rain forest is a biome that contains river ecosystems, treetop ecosystems, forest-floor ecosystems, and many others. A biome is not a specific place. For example, a desert biome does not refer to a particular desert. A desert biome refers to any and all desert ecosystems on Earth. The major biomes of Earth are shown in Figure 1.
Forests

Forest biomes develop where there is enough rain and where the temperature is not too hot in the summer or too cold in the winter. There are three main types of forest biomes—temperate deciduous forests, coniferous forests, and tropical rain forests. The type of forest that develops depends on the area's temperature and rainfall.

Temperate Deciduous Forests  In the autumn, have you seen leaves that change colors and fall from trees? If so, you have seen trees that are deciduous, which comes from a Latin word meaning "to fall off." By losing their leaves in the fall, deciduous trees are able to conserve water during the winter. Figure 2 shows a temperate deciduous forest. Most of these forests contain several different species of trees. Temperate deciduous forests also support a variety of animals, such as bears and woodpeckers.

Figure 2  In a temperate deciduous forest, mammals, birds, and reptiles thrive on the abundance of leaves, seeds, nuts, and insects.

Grasses, herbs, ferns, and mosses are scattered across the forest floor. Most of the flowering plants bloom, and produce seeds in early spring, before the trees grow new leaves.

Temperate Deciduous Forest
Average Yearly Rainfall
75–125 cm (29.5–49 in.)

Average Temperatures
Summer: 28°C (82.4°F)
Winter: 6°C (42.8°F)

In forests, plant growth occurs in layers. The leafy tops of the trees reach high above the forest floor, where they receive full sunlight.

Beneath the tree layer, woody shrubs and bushes catch the light that filters through the trees.
**Coniferous Forest**

**Average Yearly Rainfall**
35–75 cm (14–29.5 in.)

**Average Temperatures**
Summer: 14°C (57.2°F)
Winter: −10°C (14°F)

---

**Coniferous Forests** Coniferous forests do not change very much from summer to winter. They are found in areas with long, cold winters. These forests consist mainly of *evergreen* trees, which are trees that don’t lose their leaves and stay green all year. Most of these trees are *conifers*, which means that they produce seeds in cones. You have probably seen a pine cone. Pine trees are common conifers.

Most conifers can also be identified by their compact, needlelike leaves. These leaves, or needles, have a thick waxy coating that prevents them from drying out and being damaged during winter.

*Figure 3* shows a coniferous forest and some of the animals that live there. Notice that not many large plants grow beneath the conifers, partly because very little light reaches the ground.
Tropical Rain Forests  The tropical rain forest has more biological diversity than any other biome on the planet; that is, it contains more species than any other biome. As many as 100 species of trees may live in an area about one-fourth the size of a football field. Although some animals live on the ground, the treetops, or canopy, are the preferred living site. A huge variety of animals live in the canopy. If you counted the birds in the canopy of a rain forest, you would find up to 1,400 species! Figure 4 shows some of the diversity of the tropical rain forest biome.

Most of the nutrients in a tropical rain forest biome are in the vegetation. The topsoil is actually very thin and poor in nutrients. Farmers who cut down the forest to grow crops must move their crops to freshly cleared land after about 2 years.

Figure 4  A Tropical Rain Forest Biome

- Trees of various heights form a continuous green roof, called the canopy, that may extend 60 m above the forest floor.
- Woody vines climb the tree trunks to reach sunlight.
- Little light reaches the ground. Low-growing plants of the rain forest don’t require a lot of light.
Grasslands

Plains, steppes, savannas, prairies, pampas—these are names for regions where grasses are the major type of vegetation. Grasslands are found between forests and deserts. They exist on every continent. Most grasslands are flat or have gently rolling hills.

Temperate Grasslands  Temperate grassland vegetation is mainly grasses mixed with a variety of flowering plants. There are few trees because fires prevent the growth of most slow-growing plants. The world’s temperate grasslands support small, seed-eating mammals, such as prairie dogs and mice, and large herbivores, such as the bison of North America, shown in Figure 5.

![Bison roaming in a grassland](image)

Figure 5  Bison roamed the temperate grasslands in great herds before they were hunted nearly to extinction.

Savanna  The savanna is a tropical grassland with scattered clumps of trees. During the dry season, the grasses die back, but the deep roots survive even through months of drought. During the wet season, the savanna may receive as much as 150 cm of rain. The savannas of Africa are inhabited by the most abundant and diverse groups of large herbivores in the world, like those shown in Figure 6. These include elephants, giraffes, zebras, gazelles, and wildebeests.

![Carnivores in a savanna](image)

Figure 6  Carnivores, such as lions and leopards, prey on herbivores, such as these zebras and wildebeests. Hyenas and vultures usually “clean up” after the carnivores.
Deserts

Deserts are hot, dry regions that support a variety of plants and animals. In a desert, most of the water that falls to the ground evaporates. Organisms have evolved in specialized ways to survive extreme temperatures with very little water. For example, plants grow far apart to reduce competition for the limited water supply. Some plants have shallow, widespread roots that absorb water quickly during a storm, while others may have very deep roots that reach ground water.

Animals also have adaptations for survival in the desert. Most are active only at night, when temperatures are cooler. Tortoises eat the flowers or leaves of plants and store the water under their shells for months. Figure 7 shows how some desert plants and animals survive in the heat with little water.

**Figure 7** There are many well-adapted residents of the desert biome.

- **Desert**
  - **Average Yearly Rainfall**
    - Less than 25 cm (10 in.)
  - **Average Temperatures**
    - Summer: 38°C (100°F)
    - Winter: 7°C (45°F)
**Tundra**

In the far north and on the tops of high mountains, the climate is so cold that no trees can grow. A biome called the *tundra* is found there.

**Arctic Tundra** The major feature of the arctic tundra is permafrost. During the short growing season, only the surface of the soil thaws. The soil below the surface, the *permafrost*, stays frozen all the time. Even though there is little rainfall, water is not in short supply. That's because the permafrost prevents the rain that does fall from draining, and the surface soil stays wet and soggy. Lakes and ponds are common.

The layer of unfrozen soil above the permafrost is too shallow for deep-rooted plants to survive. Grasses, sedges, rushes, and small woody shrubs are common. A layer of mosses and lichens grows beneath these plants on the surface of the ground. Tundra animals, like the one shown in **Figure 8**, include large mammals such as caribous, musk oxen, and wolves, as well as smaller animals, such as lemmings, shrews, and hares. Migratory birds are abundant in summer.

**Alpine Tundra** Another tundra biome is found above the tree line of very high mountains. These areas, called alpine tundra, receive a lot of sunlight and precipitation, mostly in the form of snow.

---

**SECTION REVIEW**

1. How is the climate of temperate grasslands different from that of savannas?

2. Describe three ways that plants and animals are adapted to the desert climate.

3. Where are most of the nutrients in a tropical rain forest?

4. **Applying Concepts** Could arctic tundra accurately be called a frozen desert? Why or why not?
Marine Ecosystems

They cover almost three-quarters of Earth’s surface and contain almost 97 percent of Earth’s water supply. The largest animals on Earth inhabit them, along with billions of microscopic creatures, shown in Figure 9. Their habitats range from dark, cold, high-pressure depths to warm sandy beaches; from icy polar waters to rocky coastlines. They are oceans and seas. Wherever these salty waters are found, marine ecosystems are found. A marine ecosystem is one that is based on salty water. This abiotic factor has a strong influence on the ecosystems of oceans and seas.

Abiotic Factors Rule

Like terrestrial biomes, marine biomes are shaped by abiotic factors. These include temperature, the amount of sunlight penetrating the water, the distance from land, and the depth of the water. These abiotic factors are used to define certain areas of the ocean. As with terrestrial biomes, marine biomes occur all over Earth and can contain many ecosystems.

Sunny Waters  Water absorbs light, so sunlight can penetrate only about 200 m below the ocean’s surface, even in the clearest water. As you know, most producers use photosynthesis to make their own food. Because photosynthesis requires light, most producers are found only where light penetrates. The most abundant producers in the ocean are called phytoplankton. Phytoplankton are microscopic photosynthetic organisms that float near the surface of the water. Using the energy of sunlight, these organisms make their own food just as plants that live on land do. Zooplankton are the consumers that feed on the phytoplankton. They are small animals that, along with phytoplankton, form the base of the oceans’ feeding relationships.
**Wonderful Watery Biomes**

Unique and beautiful biomes exist in every part of oceans and seas. These biomes are home to many unusually adapted organisms. The major ocean areas and some of the organisms that live in them are shown below in Figure 10.

**A The Intertidal Zone** The intertidal zone is the area where the ocean meets the land. This area is above water part of the day, when the tide is out, and is often battered by waves. Mud flats, rocky shores, and sandy beaches are all in the intertidal area.

**B The Neritic Zone** Moving seaward, the water becomes gradually deeper toward the edge of the continental shelf. Water in this area is generally less than 200 m deep and usually receives a lot of sunlight. Diverse and colorful coral reefs exist in the waters over the continental shelf, where the water is warm, clear, and sunny.

---

**Figure 10** The life in a particular area depends on how much light the area receives, how far the area is from land, and how far the area is beneath the surface.

**A** Sea grasses, periwinkle snails, and herons are common in a mud flat intertidal area. You will find sea stars and anemones on the rocky shores, while clams, crabs, and the shells of snails and conchs are common on the sandy beaches.

**B** Although phytoplankton are the major producers in this area, seaweeds are common too. Animals, such as sea turtles and dolphins, live in the area over the continental shelf. Corals, sponges, and colorful fish contribute to the vivid seascape.
The Oceanic Zone  Past the continental shelf, the sea floor drops sharply. This is the deep water of the open ocean. To a depth of about 200 m, phytoplankton are the producers. At greater depths, no light penetrates, so most organisms obtain energy by consuming organic material that falls from the surface.

The Benthic Zone  The benthic zone is the sea floor. It extends from the upper edge of the intertidal zone to the bottom of the deepest ocean waters. Organisms that live on the deep-sea floor obtain food mostly by consuming material that filters from above. Some bacteria are chemosynthetic, which means they use chemicals in the water near thermal vents to make food. A thermal vent is a place on the ocean floor where heat escapes through a crack in the Earth’s crust.

Organisms such as bacteria, worms, and sea urchins thrive on the deep-sea floor.

Many unusual animals are adapted for the darkness and high pressures of great ocean depths. Here you will see whales, squids, and fishes that glow in very deep, dark water.
A Closer Look

Marine environments provide most of the water for Earth’s rainfall through evaporation and precipitation. Ocean temperatures and currents have major effects on world climates and wind patterns. Humans harvest enormous amounts of food from the oceans and dump enormous amounts of waste into them. Let’s take a closer look at some of the special environments that thrive in the ocean.

Coral Reefs In some sunny tropical waters, the sea floor contains coral reefs. Corals live in a close relationship with single-celled algae. The algae produce organic nutrients through photosynthesis. This provides food for the coral. The coral provide a place in the sun for the algae to live. The foundation of the reef is formed from coral skeletons that have built up over thousands of years. Coral reefs, like the one in Figure 11, are home to many marine species, including a large variety of brightly colored fish and organisms such as sponges and sea urchins.

The Sargasso Sea In the middle of the Atlantic Ocean is a large ecosystem with no land boundaries. It is called the Sargasso Sea. Sargassum is a type of algae usually found attached to rocks on the shores of North America, but it forms huge floating rafts in the Sargasso Sea. Animals adapted to this environment live among the algae. Most of the animals are the same color as the Sargassum. Some even look like it! Why do you think this is so? Can you find a fish in Figure 12?

Self-Check

1. List three factors that characterize marine biomes.
2. Describe one way organisms obtain energy at great depths in the open ocean.

(See page 168 to check your answers.)
**Polar Ice** The Arctic Ocean and the open waters surrounding Antarctica make up a very unusual marine biome—one that includes ice!

The icy waters are rich in nutrients from the surrounding landmasses. These nutrients support large populations of plankton. The plankton in turn support a great diversity of fish, birds, and mammals, as shown in **Figure 13**.

**Estuaries** An area where fresh water from streams and rivers spills into the ocean is called an **estuary**. The fresh water constantly mixes with the salt water of the sea. The amount of salt in an estuary changes frequently. When the tide rises, the salt content of the water rises. When the tide recedes, the water becomes fresher. The fresh water that spills into an estuary is rich in nutrients that are carried by water running off the land. Because estuaries are so nutrient-rich, they support large numbers of plankton, which provide food for many larger animals.

**Intertidal Areas** Intertidal areas include mudflats, sandy beaches, and rocky shores. Mud flats are home to many worms and crabs and the shorebirds that feed on them. Sandy beaches are also home to worms, clams, crabs, and plankton that live among the sand grains.

On rocky shores, organisms either have tough holdfists or are able to cement themselves to a rock to avoid being swept away by crashing waves. **Figure 14** shows some of these animals.

**Figure 14** Sea stars can wedge themselves under a rock to keep from being washed out to sea.

---

**SECTION REVIEW**

1. Explain how a coral reef is both living and dead.
2. Why do estuaries support such an abundance of life?
3. **Analyzing Relationships** Explain how the amount of light an area receives determines the kinds of organisms that live in the open ocean.
Freshwater Ecosystems

A mountain brook bubbles over rocks down a mountainside. A mighty river thunders through a canyon. A small pond teems with life. A lake tosses boats during a heavy storm. A dense swamp echoes with the sounds of frogs and birds.

What do all of these places have in common? They are freshwater ecosystems. Like other ecosystems, freshwater ecosystems are characterized by abiotic factors, primarily the speed at which the water is moving.

Water on the Move

Brooks, streams, and rivers are ecosystems based on moving water. The water may begin flowing from melting ice or snow. Or it may come from a spring, where water flows up to the surface of the Earth. Each trickle or stream of water that joins a larger trickle or stream is a tributary.

Fast-Moving Water  As more tributaries join a stream, the stream becomes larger and wider, forming a river. Aquatic plants line the edge of the river. Fishes live in the open waters. In the mud at the bottom, burrowers, such as freshwater clams and mussels, make their home.

Organisms that live in moving water require special adaptations to avoid being swept away with the current. Producers, such as algae and moss, cling to rocks. Consumers, such as insect larvae, live under rocks in the shallow water. Some consumers, such as tadpoles, use suction disks to hold themselves to rocks.

Slowing Down  As a river grows wider and slower, it may meander back and forth across the landscape. Organic material and sediment may be deposited on the bottom, building deltas. Dragonflies, water striders, and other invertebrates live in and on slow-moving water. Eventually, the moving water empties into a lake or an ocean. Figure 15 shows how a river can grow from melted snow.

Figure 15  This figure shows the features of a typical river. Where is the water moving rapidly? Where is it moving slowly?
Still Waters

Ponds and lakes have different ecosystems than streams and rivers have. Lake Superior, the largest lake in the world, has more in common with a small beaver pond than with a river. Figure 16 shows a cross section of a typical lake. In looking at this illustration, you will notice that the lake has been divided into three zones. As you read on, you will learn about these zones and the ecosystems they contain.

Where Water Meets Land Look at Figure 16 again, and locate the littoral zone. It is the zone closest to the edge of the land. This zone has many inhabitants. Plants that grow in the water closest to the shore include cattails and rushes. Farther from the shore are floating leaf plants, such as water lilies. Still farther out are submerged pond weeds that grow beneath the surface of the water.

The plants of the littoral zone provide a home for small animals, such as snails, small arthropods, and insect larvae. Clams, worms, and other organisms burrow in the mud. Frogs, salamanders, water turtles, various kinds of fishes, and water snakes also live in this area.

Life at the Top Look again at Figure 16. This time locate the open-water zone. This zone extends from the littoral zone across the top of the water. The open-water zone only goes as deep as light can reach. This is the habitat of bass, blue gills, lake trout, and other fish. Phytoplankton are the most abundant photosynthetic organisms in the open-water zone of a lake.

Life at the Bottom Now look at Figure 16 and find the deep-water zone. This zone is below the open-water zone, where no light reaches. Catfish, carp, worms, insect larvae, crustaceans, fungi, and bacteria live here. These organisms feed on dead organic material that falls down from above.

Figure 16 Freshwater ecosystems are characterized by abiotic factors that determine which organisms live there.
A Trip to Lake Superior
Suppose you are a life scientist who specializes in the plants that live in and near Lake Superior. You are preparing for a yearlong expedition to Thunder Bay, on the Canadian shore of Lake Superior.

You will stay “in the wild.” Based on what you have learned about ecosystems, answer the following questions: How will you live while you are there? What will you bring along? What problems will you encounter? How will you overcome them?

Wetlands
A wetland is an area of land where the water level is near or above the surface of the ground for most of the year. Wetlands support a variety of plant and animal life. They also play an important role in flood control. During heavy rains or spring snow melt, wetlands soak up large amounts of water. The water in wetlands also seeps into the ground, replenishing underground water supplies.

Marshes A marsh is a treeless wetland ecosystem where plants such as cattails and rushes grow. A freshwater marsh is shown in Figure 17. Freshwater marshes are found in shallow waters along the shores of lakes, ponds, rivers, and streams. The plants in a marsh vary depending on the depth of the water and the location of the marsh. Grasses, reeds, bulrushes, and wild rice are common marsh plants. Muskrats, turtles, frogs, and red-wing blackbirds can be found living in marshes.

Figure 17  Turtles find a lot of places to escape from predators in a freshwater marsh. Many species raise their young in these protected areas.
Swamps  A swamp is a wetland ecosystem where trees and vines grow. Swamps occur in low-lying areas and beside slow-moving rivers. Most swamps are flooded only part of the year, depending on the rainfall. Trees may include willows, bald cypresses, water tupelos, oaks, and elms. Vines such as poison ivy grow up trees, and Spanish moss hangs from the branches. Water lilies and other lake plants may grow in open-water areas. Swamps, like the one in Figure 18, provide a home for a variety of fish, snakes, and birds.

From Lake to Forest
How can a lake or pond, like the one in Figure 19, disappear? Water entering a standing body of water usually carries nutrients and sediment along with it. These materials then settle to the bottom. Dead leaves from overhanging trees and decaying plant and animal life also settle to the bottom. Gradually, the pond or lake fills in. Plants grow in the newly filled areas, closer and closer toward the center. With time, the standing body of water becomes a marsh. Eventually, the marsh turns into a forest.

Figure 19  Eventually decaying organic matter, along with sediment in the runoff from land, will fill in this pond.

SECTION REVIEW

1. Describe some adaptations of organisms that live in moving water.

2. Compare the littoral zone with the open-water zone of a pond.

3. How is a swamp different from a marsh?

4. Analyzing Concepts  The center of a pond is 10 m deep. Near the shore it is 0–1 m deep. Describe the types of organisms that might live in each zone.
Too Much of a Good Thing?

Plants require nutrients, such as phosphates and nitrates. Phosphates are often found in detergents. Nitrates are often found in animal wastes and fertilizers. When large amounts of these nutrients enter rivers and lakes, algae and plant life grow rapidly and then die off. Microorganisms that decompose the dead matter use up oxygen in the water, killing fish and other animals. In this activity, you will observe the effect of fertilizers on organisms that live in pond water.

Procedure

1. Use a wax pencil to label one jar “Control,” the second jar “Fertilizer,” and the third jar “Excess Fertilizer.”

2. Pour 750 mL of distilled water in each of the jars. Read the label on the fertilizer container to determine the recommended amount of fertilizer. To the Fertilizer jar, add the amount of fertilizer recommended for 750 mL of water. To the Excess Fertilizer jar, add 10 times the recommended amount. Stir the contents of each jar to dissolve the fertilizer.

3. Obtain a sample of pond water. Stir it gently but thoroughly to make sure that the organisms in it are evenly distributed. Pour 100 mL of pond water into each of the three jars.

4. Observe a drop of pond water from each jar under the microscope. Draw at least four of the organisms. Determine whether the organisms you see are algae, which are usually green, or consumers, which are usually able to move. Describe the number and type of organisms in the pond water.

Materials

- wax pencil
- 1 qt (or 1 L) jars (3)
- 2.25 L of distilled water
- fertilizer
- graduated cylinder
- stirring rod
- 300 mL of pond water containing living organisms
- eyedropper
- microscope
- microscope slides with coverslips
- plastic wrap
- protective gloves

Common Pond-Water Organisms

- *Volvox* (producer)
- *Spirogyra* (producer)
- *Daphnia* (consumer)
- *Vorticella* (consumer)
Cover each jar loosely with plastic wrap. Place the jars near a sunny window, but do not place them in direct sunlight.

Based on your understanding of how ponds and lakes eventually fill up to become dry land, make a prediction about how the pond organisms will grow in each of the three jars.

Make three data tables in your ScienceLog. Be sure to allow enough space to record your observations. Title one table “Control,” as shown below. Title another table “Fertilizer,” and title the third table “Excess Fertilizer.”

Observe the jars when you first set them up and at least once every three days for the next three weeks. Note the color, odor, and any visible presence of organisms. Record your observations.

When organisms begin to be visible in the jars, use an eyedropper to remove a sample from each jar, and observe the sample under the microscope. How have the number and type of organisms changed since you first looked at the pond water? Record your observations.

At the end of the three-week period, remove a sample from each jar and observe each sample under the microscope. Draw at least four of the most abundant organisms, and describe how the number and type of organisms have changed since your last microscopic observation.

**Analysis**

**11** After three weeks, which jar has the most abundant growth of algae? What may have caused this growth?

**12** Did you observe any effects on organisms (other than the algae) in the jar with the most abundant algal growth? Explain your answer.

**13** Did your observations match your prediction? Explain your answer.

**14** How might the rapid filling of natural ponds and lakes be prevented or slowed?

<table>
<thead>
<tr>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

The Earth's Ecosystems 65
**Chapter Highlights**

**SECTION 1**

**Vocabulary**
- abiotic (p. 48)
- biome (p. 48)
- savanna (p. 52)
- desert (p. 53)
- tundra (p. 54)
- permafrost (p. 54)

**Section Notes**
- Rainfall and temperature are the main factors that determine what kind of biome is found in a region.
- The three main forest biomes are the temperate deciduous forest and the coniferous forest, which experience warm summers and cold winters, and the tropical rain forest, where temperatures stay warm.
- Grasslands receive more rain than deserts and receive less rain than forests. Temperate grasslands have hot summers and cold winters. Savannas have wet and dry seasons.
- Deserts receive less than 25 cm of rain a year. Plants and animals competing for the limited water supply have developed special adaptations for survival.
- The tundra biome is found mainly in the Arctic region. Arctic tundra is characterized by permafrost.

**Labs**
- Life in the Desert (p. 132)

**SECTION 2**

**Vocabulary**
- marine (p. 55)
- phytoplankton (p. 55)
- zooplankton (p. 55)
- estuary (p. 59)

**Section Notes**
- The kinds of marine organisms that inhabit an area vary depending on the water depth, the temperature, the amount of light, and the distance from shore.
- The intertidal area is the area where sea and land meet.
- The sea floor is home to biomes as different as coral reefs and thermal vents.
- The open ocean includes unique biomes, including the Sargasso Sea and the cold water oceans around the poles.

---

**Skills Check**

**Math Concepts**

**RAINFALL** Using a meterstick, measure 400 cm on the floor of your classroom. This distance represents the depth of rainfall a rain forest receives per year. Next measure 25 cm. This measurement represents the amount of rainfall a desert receives per year. Compare these two quantities. Express your comparison as a ratio.

\[
\frac{25}{400} = \frac{1}{16}
\]

In 1 year, a desert receives \(\frac{1}{16}\) the rainfall that a rain forest receives.

**Visual Understanding**

**RAIN FOREST** Look at Figure 4, on page 51. There are three layers of a rain forest—the upper story, the middle story, and the ground story. The upper story is the canopy, where most rain forest species live and where there is the most sunlight. The middle story is under the canopy and above the ground. The ground story is dark in most parts of the forest. Most plants in the rain forest grow very tall to compete for light in the canopy. Growth of plants on the ground story is not very dense due to the lack of available light.
**SECTION 2**

**Vocabulary**
- tributary (p. 60)
- littoral zone (p. 61)
- open-water zone (p. 61)
- deep-water zone (p. 61)
- wetland (p. 62)
- marsh (p. 62)
- swamp (p. 63)

**Section Notes**
- An estuary is a region where fresh water from rivers spills into the ocean and the fresh and salt water mix with the rising and falling of the tides.

**Labs**
- Discovering Mini-Ecosystems (p. 133)

**SECTION 3**

- The types of organisms found in a stream or river are determined mainly by how quickly the current is moving.
- The littoral zone of a lake is inhabited by floating plants. These plants provide a home for a rich diversity of animal life.
- Wetlands include marshes, which are treeless, and swamps, where trees and vines grow.

Visit the National Science Teachers Association on-line Web site for Internet resources related to this chapter. Just type in the scilINKS number for more information about the topic:

- **TOPIC:** Forests  
  **scilINKS NUMBER:** HSTL480
- **TOPIC:** Grasslands  
  **scilINKS NUMBER:** HSTL485
- **TOPIC:** Marine Ecosystems  
  **scilINKS NUMBER:** HSTL490
- **TOPIC:** Freshwater Ecosystems  
  **scilINKS NUMBER:** HSTL495
Chapter Review

USING VOCABULARY

To complete the following sentences, choose the correct term from each pair of terms listed below:

1. At the edge of the ___?, the open ocean begins. (continental shelf or Sargasso Sea)
2. ___? are tiny consumers that live in water. (Phytoplankton or Zooplankton)
3. A ___? is a treeless wetland. (swamp or marsh)
4. ___? lose their leaves in order to conserve water. (Deciduous trees or Conifers)
5. The major feature of the ___? biome is permafrost. (desert or tundra)
6. Each major type of plant community and its associated animal communities make up a(n) ___?. (estuary or biome)

UNDERSTANDING CONCEPTS

Multiple Choice

7. The most numerous organisms in the oceans are the
   a. plankton. c. coral animals.
   b. Sargassum. d. marine mammals.

8. Marine ecosystems at the poles are unusual because
   a. animals spend time both in and out of the water.
   b. plankton are rare.
   c. they contain ice.
   d. the salt content of the water is very high.

9. The major factor that determines the types of organisms that live in a stream or river is
   a. the water temperature.
   b. the speed of the current.
   c. the depth of the water.
   d. the width of the stream or river.

10. Marine ecosystems
    a. contain the largest animals in the world.
    b. exist in all ocean zones.
    c. include environments where organisms survive without light.
    d. All of the above

11. Two major factors that determine what kind of a biome is found in a region are
    a. the amount of rainfall and the temperature.
    b. the depth of water and the distance from land.
    c. the wave action and the salt content of the water.
    d. All of the above

Short Answer

12. Describe how a stream changes as it moves from its source toward the ocean.

13. Describe two adaptations of animals to the desert environment.


15. Explain how the salt content in an estuary changes constantly.
Concept Mapping

16. Use the following terms to create a concept map: tropical rain forest, deep-rooted plants, coral reef, canopy, biomes, permafrost, desert, continental shelf, tundra, ecosystems.

CRITICAL THINKING AND PROBLEM SOLVING

Write one or two sentences to answer the following questions:

17. While excavating a region now covered by grasslands, paleontologists discover the fossil remains of ancient fish and shellfish. What might they conclude?

18. In order to build a new shopping center, developers fill in a wetland. Afterward, flooding becomes a problem in this area. How can this be explained?

19. Explain why most desert flowering plants bloom, bear seeds, and die within a few weeks, while some tropical flowering plants remain in bloom for a much longer time.

MATH IN SCIENCE

20. What is the average difference in rainfall between a temperate deciduous forest and a coniferous forest?

21. An area of Brazilian rain forest received 347 cm of rain in one year. Using the following formula, calculate this amount of rainfall in inches.

\[ \text{0.394 (the number of inches in a centimeter)} \times 347 \text{ cm} = ? \text{ in.} \]

INTERPRETING GRAPHICS

The graphs below show the monthly temperatures and rainfall in a region during 1 year.

**Average Monthly Precipitation**

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>8</td>
</tr>
<tr>
<td>Feb.</td>
<td>7</td>
</tr>
<tr>
<td>Mar.</td>
<td>2</td>
</tr>
<tr>
<td>Apr.</td>
<td>6</td>
</tr>
<tr>
<td>May</td>
<td>4</td>
</tr>
<tr>
<td>June</td>
<td>8</td>
</tr>
<tr>
<td>July</td>
<td>6</td>
</tr>
<tr>
<td>Aug.</td>
<td>4</td>
</tr>
<tr>
<td>Sept.</td>
<td>2</td>
</tr>
<tr>
<td>Oct.</td>
<td>1</td>
</tr>
<tr>
<td>Nov.</td>
<td>3</td>
</tr>
<tr>
<td>Dec.</td>
<td>5</td>
</tr>
</tbody>
</table>

**Average Monthly High Temperatures**

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>30</td>
</tr>
<tr>
<td>Feb.</td>
<td>30</td>
</tr>
<tr>
<td>Mar.</td>
<td>30</td>
</tr>
<tr>
<td>Apr.</td>
<td>30</td>
</tr>
<tr>
<td>May</td>
<td>30</td>
</tr>
<tr>
<td>June</td>
<td>30</td>
</tr>
<tr>
<td>July</td>
<td>30</td>
</tr>
<tr>
<td>Aug.</td>
<td>30</td>
</tr>
<tr>
<td>Sept.</td>
<td>30</td>
</tr>
<tr>
<td>Oct.</td>
<td>30</td>
</tr>
<tr>
<td>Nov.</td>
<td>30</td>
</tr>
<tr>
<td>Dec.</td>
<td>30</td>
</tr>
</tbody>
</table>

22. What kind of biome is probably found in the region represented by these graphs?

23. Would you expect to find bulrushes in the region represented by these graphs? Why or why not?

Reading Check-up

Take a minute to review your answers to the Pre-Reading Questions found at the bottom of page 46. Have your answers changed? If necessary, revise your answers based on what you have learned since you began this chapter.
Ocean Vents

These solids form tubes, called black smokers, that extend up through the ocean floor. To humans, this dark, cold, and toxic environment would be deadly. But to a community of 300 species, including certain bacteria, clams, mussels, and tube worms, it is home. For these species, black smokers make life possible.

Life Without Photosynthesis

For a long time, scientists believed that energy from sunlight was the basis for the Earth's food chains and for life itself. But in the last 15 years, researchers have discovered ecosystems that challenge this belief. We now know of organisms around black smokers that can live without sunlight. One type of bacteria uses toxic gases from a black smoker in the same way that plants use sunlight. In a process called chemosynthesis, these bacteria convert sulfur into energy.

These bacteria are producers, and the mussels and clams are the consumers in this deep-sea food web. The bacteria use the mussels and clams as a sturdy place to live. The mussels and clams, in turn, feed off the bacteria. This kind of relationship between organisms is called symbiosis. The closer to the vent the clams and mussels are, the more likely the bacteria are to grow. Because of this, the mussels and clams frequently move to find good spots near the black smokers.

What Do You Think?

- Conditions near black smokers are similar to conditions on other planets. Do some research on these extreme environments, both on Earth and elsewhere. Then discuss with your classmates where and how you think life on Earth may have started.