

SECTION 3

Grassland, Desert, and Tundra Biomes

In climates that have less rainfall, forest biomes are replaced by savanna, grassland, and chaparral biomes. As less rain falls in these biomes, they change into desert and tundra biomes. As precipitation decreases in an area, the diversity of the species in the area also decreases. But while the number of different species is often smaller in areas that have less precipitation, the number of individuals of each species present may be very large.

Savannas

Parts of Africa, western India, northern Australia, and some parts of South America are covered by grassland called *savanna*.

Savannas are located in tropical and subtropical areas near the equator and between tropical rain forest and desert biomes. Because savannas are full of grasses, scattered trees, and shrubs, savannas contain a large variety of grazing animals and the predators that hunt them. As shown in **Figure 16**, savannas receive little precipitation throughout the year. Savannas have a wet season and a dry season. Many animals of the savanna are active only during the wet season. Grass fires sweep across the savanna during the dry season and help restore nutrients to the soil.

Plants of the Savanna Because most of the rain falls during the wet season, plants must be able to survive prolonged periods without water. Therefore, some trees and grasses have large horizontal root systems by which they obtain water during the dry season. These root systems also enable plants to quickly grow again after a fire. The coarse savanna grasses have vertical leaves that expose less of their surface area to the hot sun to further help the grasses conserve water. Some trees of the savanna also lose their leaves during the dry season to conserve water. Trees and shrubs often have thorns or sharp leaves that keep hungry herbivores away.



Objectives

- ▶ Describe the difference between tropical and temperate grasslands.
- ▶ Describe the climate in a chaparral biome.
- ▶ Describe two desert animals and the adaptations that help them survive.
- ▶ Describe one threat to the tundra biome.

Key Terms

savanna
temperate grassland
chaparral
desert
tundra
permafrost

Figure 16 ▶ Savannas have periods of heavy rainfall followed by periods of drought.

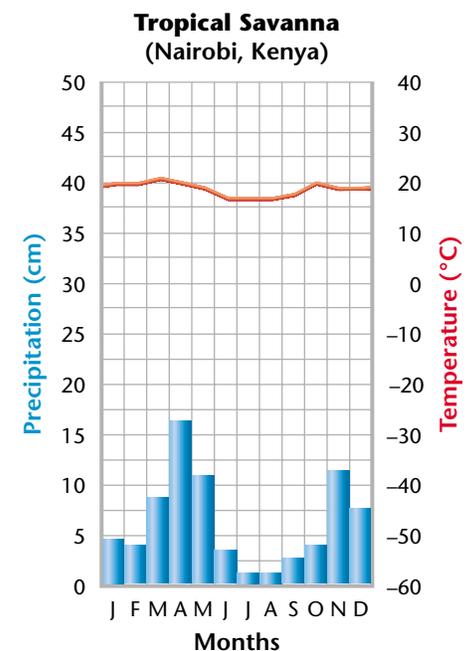


Figure 17 ► Herbivores of the savanna reduce their competition for food by feeding on vegetation located at different heights. Elephants feed on tree leaves, while impala graze on grasses.

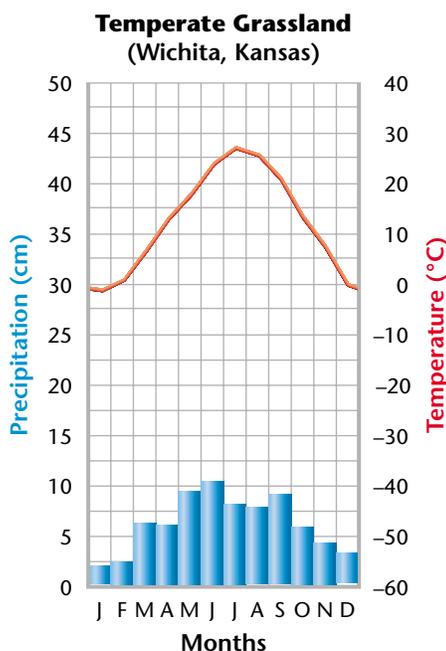


Geofact

Deep Soil Gravel or sand becomes fertile soil when decomposers slowly break down organic matter such as dead leaves. Decomposers work most effectively in hot, wet weather. As a result, the world's deepest soil is in grasslands. In grassland biomes, winters are cold and summers are dry, which causes leaves to break down slowly. So, organic matter builds up over time. Some North American prairies had more than 2 m of topsoil when the first farmers arrived.

Animals of the Savanna Grazing herbivores such as the elephants shown in **Figure 17**, have adopted a migratory way of life. They follow the rains to areas of newly sprouted grass and watering holes. Some predators follow and stalk the migratory animals for food. Many savanna animals give birth only during the rainy season, when food is most abundant and the young are more likely to survive. Also, some species of herbivores reduce competition for food by eating vegetation at different heights than other species do. For example, small gazelles graze on grasses, black rhinos browse on shrubs, and giraffes feed on tree leaves.

Figure 18 ► Temperate grasslands are characterized by small amounts of rainfall, periodic droughts, and high temperatures in the summer.



Temperate Grasslands

A **temperate grassland** is a biome that is dominated by grasses and that has very few trees. Most temperate grasslands have hot summers and cold winters. The amount of rainfall that a temperate grassland receives is moderate compared to the amount a forest receives. On average, a temperate grassland can receive 50 to 88 cm of precipitation per year, as shown in **Figure 18**. Although temperate grasslands may seem harsh and dry, they have the most fertile soil of any biome. So, many grassland biomes have been replaced with crops such as corn, soybeans, and wheat. Few natural temperate grasslands remain because many have been replaced by farms and grazing areas.





Temperate grasslands are located on the interiors of continents where too little rain falls for trees to grow. Grassland biomes include the prairies of North America, the steppes of Russia and Ukraine, and the pampas of South America, as shown in **Figure 19**. Mountains often play a crucial role in maintaining grasslands. For example, in North America, rain clouds from the west are blocked by the Rocky Mountains, so the shortgrass prairie east of the mountains receives only about 25 cm of rain a year. Rainfall increases as you move eastward, so taller grasses and some shrubs can grow in areas where more rain falls. Heavy precipitation is rare in the grasslands, so sizzling temperatures in the summer make the grasslands susceptible to fires, which are common in grassland biomes.

Plants of Temperate Grasslands Prairie grasses and wildflowers are perennials, plants that survive from year to year. The root systems of prairie grasses form dense layers that survive drought and fire as well as hold the soil in place. The amount of rainfall in an area determines the types of plants that will grow in that area. **Figure 20** shows how root depth and grass height vary depending on the amount of rainfall. Few trees survive on the grasslands because of the lack of rainfall, fire, and the constant winds.

Figure 19 ▶ Temperate grasslands can be named according to the vegetation that grows there. Steppes (left), have shorter grasses and are located in Europe and Asia. Pampas (right), are made up of clusters of feathery grasses and are located in South America.

Connection to History

The State of Bison More than 60 million bison once roamed the temperate grasslands of North America. But these large grass-eating mammals were almost brought to extinction by the late 1800s because of hunting by western settlers. By 1889, fewer than 1,100 bison remained in North America! The first bill to save the bison was introduced by Congress in 1874. In 1903, President Theodore Roosevelt started the National Wildlife Refuge System to provide protected areas for bison and other animals. Today, North America has more than 200,000 bison.

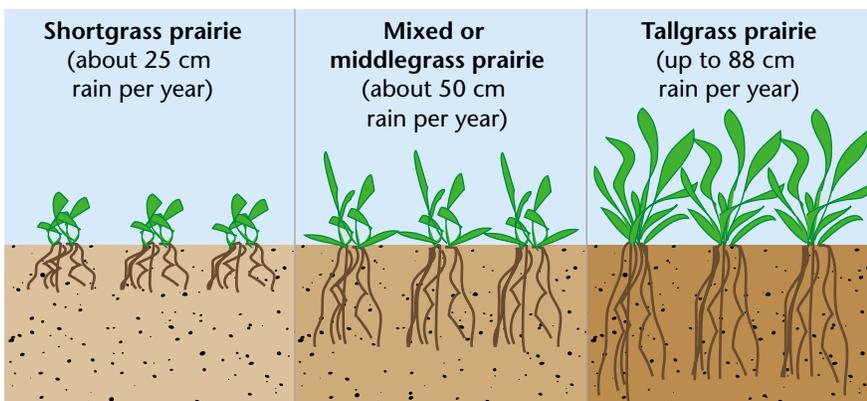
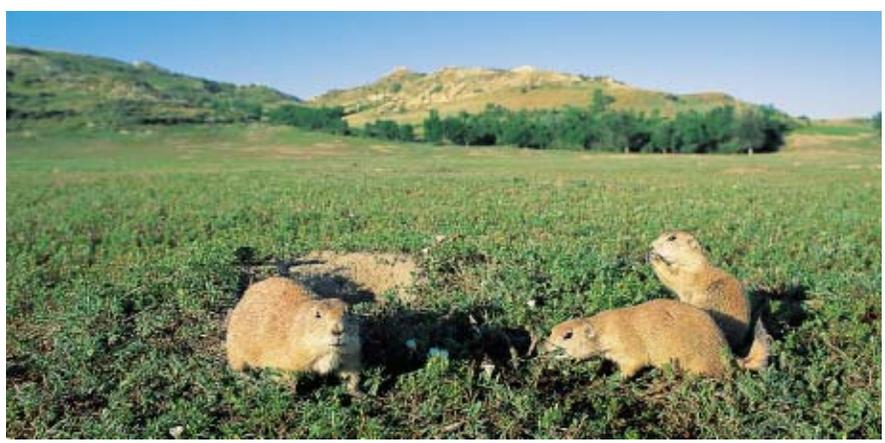


Figure 20 ▶ The height of grassland plants and the depth of their roots depend on the amount of rainfall that the grasslands receive.

Figure 21 ► Prairie dogs, such as those shown here, live in temperate grasslands. Prairie dogs live in colonies and burrow in the ground to build mounds, holes, and tunnels.



QuickLAB



Sponging It Up

Procedure

1. Completely saturate **two small sponges** with **water** and allow the excess water to drain off.
2. Measure each sponge's mass by using an **electric balance**. Record the mass.
3. Using **plastic wrap**, completely cover one of the sponges.
4. Place the sponges outside in a sunny place for 10 to 15 minutes.
5. Measure each sponge's mass after removing it from outside. Record the mass.

Analysis

1. Which sponge lost the most mass? Why?
2. How was the covering you created for the sponge similar to the adaptations of the plants in the chaparral biome?

Animals of Temperate Grasslands Grazing animals, such as pronghorn antelope and bison, have large, flat back teeth for chewing the coarse prairie grasses. Other grassland animals, such as badgers, prairie dogs, and owls, live protected in underground burrows as shown in **Figure 21**. The burrows shield the animals from fire and weather and protect them from predators on the open grasslands.

Threats to Temperate Grasslands Farming and overgrazing have changed the grasslands. Grain crops cannot hold the soil in place as well as native grasses can because the roots of crops are shallow, so soil erosion eventually occurs. Erosion is also caused by overgrazing. When grasses are constantly eaten and trampled, the grasses cannot regenerate or hold the soil. This constant use can change fruitful grasslands into less productive, desertlike biomes.

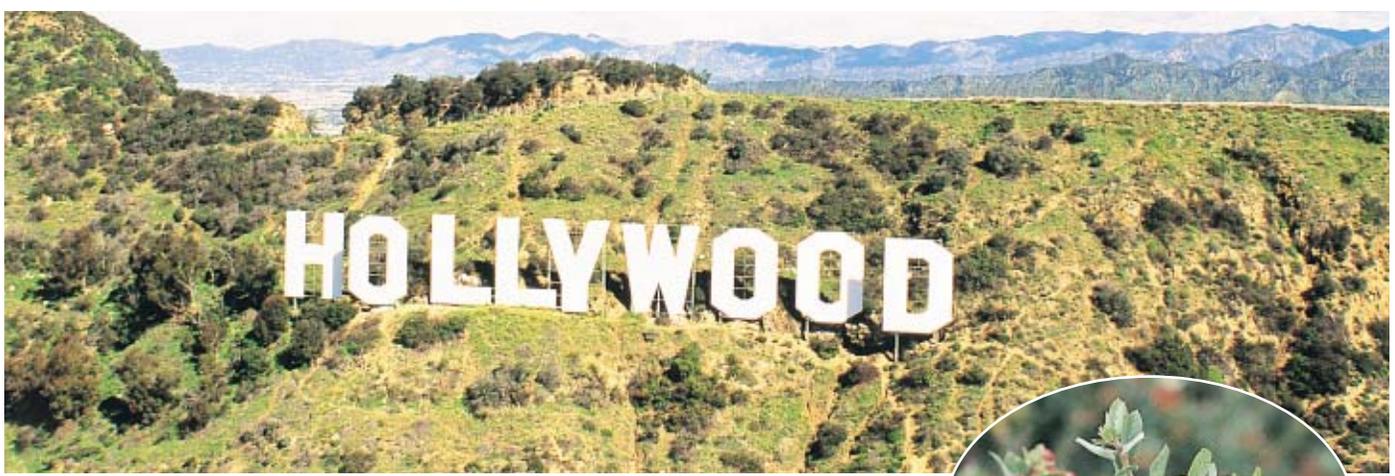
Chaparral

Plants that have leathery leaves are commonly found in temperate woodland biomes. Temperate woodland biomes have fairly dry climates but receive enough rainfall to support more plants than a desert does. Temperate woodlands consist of scattered tree communities made up of coniferous trees such as piñon pines and junipers, as shown in **Figure 22**.

Chaparral is a type of temperate woodland biome that is dominated by more broad-leaved evergreen shrubs than by evergreen trees. Look at the famous white letters that spell Hollywood

Figure 22 ► Temperate woodlands are usually too dry to support a forest, but they receive sufficient precipitation to support vegetation that grows in bunches, such as the piñon and juniper trees shown here.





across green and brown California hills in **Figure 23**. Now imagine the scrub-covered settings common in old westerns. Both of these landscapes are part of the chaparral biome. As shown in **Figure 24**, chaparral is located in the middle latitudes, about 30° north and south of the equator. Chaparral is located primarily in coastal areas that have Mediterranean climates. Chaparral biomes typically have warm, dry summers and mild, wet winters.



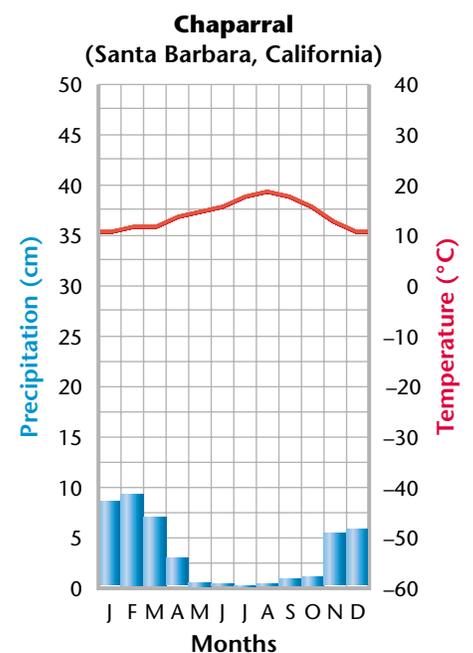
Figure 23 ► The chaparral biome in the Hollywood hills is home to plants such as the manzanita, which is shown above.

Plants of the Chaparral Most chaparral plants are low-lying, ever-green shrubs and small trees that tend to grow in dense patches. Common chaparral plants include chamise, manzanita, scrub oak, olive trees, and herbs, such as sage and bay. These plants have small, leathery leaves that retain water. The leaves also contain oils that promote burning, which is an advantage because natural fires destroy trees that might compete with chaparral plants for light and space. Chaparral plants are so well adapted to fire that they can resprout from small bits of surviving plant tissue. The flammable oils give plants such as sage their characteristic taste and smell.

Animals of the Chaparral A common adaptation of chaparral animals is camouflage, shape or coloring that allows an animal to blend into its environment. Animals such as quail, lizards, chipmunks, and mule deer have a brownish gray coloring that lets them move through the brush without being noticed.

Threats to the Chaparral Worldwide, the greatest threat to chaparral is human development. Because chaparral biomes get a lot of sun, are near the oceans, and have a mild climate year-round, humans tend to develop land for commercial and residential use.

Figure 24 ► Chaparral biomes are located in areas that have Mediterranean climates.



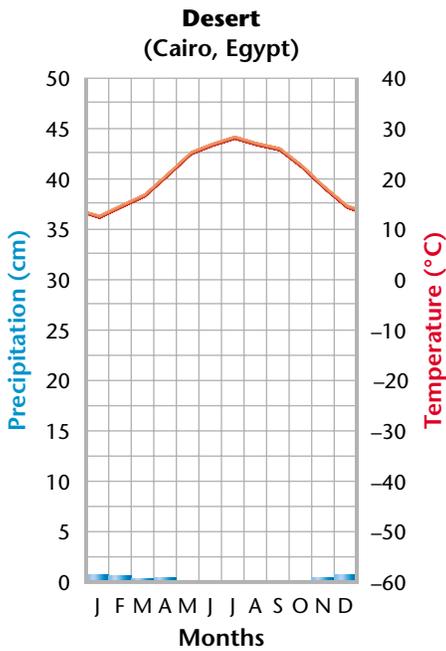


Figure 25 ▶ Deserts are the driest places on Earth. They typically receive less than 25 cm of precipitation a year.

Deserts

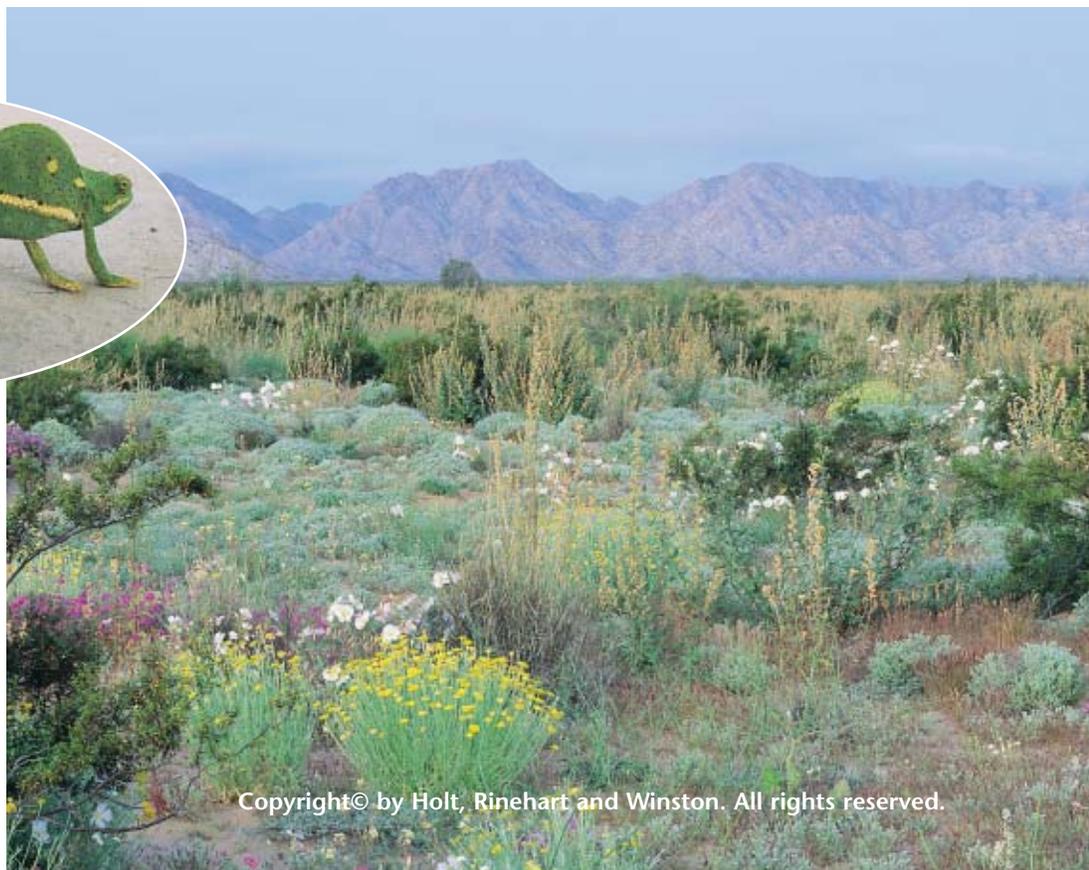
When some people think of a desert, they think of the hot sand that surrounds the Egyptian pyramids. Other people picture the Sonoran Desert and its mighty saguaro cactuses, or the magnificent rock formations of Monument Valley in Arizona and Utah. Many kinds of deserts are located throughout the world, but one characteristic that they share is that they are the driest places on Earth.

Deserts are areas that receive less than 25 cm of precipitation a year and have little or no vegetation. Deserts, as shown in **Figure 25**, also have extreme temperatures. Hot deserts, such as Arizona’s Sonoran Desert and the Sahara in Africa, are closer to the equator than are cold deserts, such as the Gobi Desert in China and the Great Basin of the western United States. Deserts are often located in areas near large mountain ranges because mountains can block the passage of moisture-filled clouds, which limits precipitation.

▶ The flapnecked chameleon lives in the deserts of Botswana.



▶ The plants of the Sonoran Desert in Arizona collect and retain water after rain showers to survive the hot desert temperatures.



Plants of the Desert All desert plants have adaptations for obtaining and conserving water, which allows the plants to live in dry, desert conditions. Plants called *succulents*, such as cactuses, have thick, fleshy stems and leaves that store water. Their leaves also have a waxy coating that prevents water loss. Sharp spines on cactuses keep thirsty animals from devouring the plant's juicy flesh. Rainfall rarely penetrates deeply into the soil, so many plants' roots spread out just under the surface of the soil to absorb as much rain as possible.

Instead of living in dry conditions, some desert plants are adapted to survive for long periods of time without water. When conditions are too dry, some plants die and drop seeds that stay dormant in the soil until the next rainfall. Then, new plants quickly germinate, grow, and bloom before the soil becomes dry again. Some desert plants have adapted so that they can survive even if their water content drops to as low as 30 percent of their mass. Water levels below 50 to 75 percent are fatal for most plants.

Animals of the Desert Reptiles, such as Gila monsters and rattlesnakes, have thick, scaly skin that prevents water loss. Amphibians, such as the spadefoot toad, survive scorching desert summers by *estivating*—burying themselves in the ground and sleeping through the dry season. Some animals, such as the elf owl shown in **Figure 26**, nest in cactuses to avoid predators. Desert insects and spiders are covered with body armor that helps them retain water. In addition, most desert animals are nocturnal, which means they are active mainly at night or at dusk, when the air is cooler.



FIELD ACTIVITY

Miniature Desert Create a miniature desert by growing a small cactus garden. Purchase two or three small cactus plants, or take several cuttings from a large cactus. To take cuttings, carefully break off the shoots growing at the base of the parent cactus. Place the plants in rocky or sandy soil similar to the soil in a desert. Keep the cactuses in bright sunlight, and do not water them frequently. Record your observations of your cactus garden in your **Ecolog**.

Figure 26 ► Desert plants survive harsh conditions by growing deep roots to reach groundwater and by having specialized structures that limit the loss of water. Desert animals bury themselves underground or burrow in cactuses to avoid extreme temperatures and predators.



► Elf owls burrow in cactuses to avoid hot temperatures during the day.



► This sidewinder has a unique way of moving so that only small portions of its body are in contact with the hot sands at any one time.



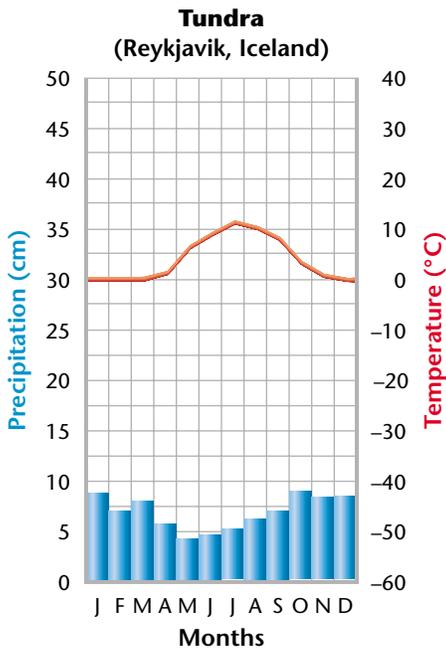


Figure 27 ► The precipitation that the tundra biome receives remains frozen much of the year.



Tundra

Tundra is a biome that is dominated by grasses, lichens, and herbs and that is located primarily north of the Arctic Circle, as shown in **Figure 27**. The tundra soil supports mostly tough grasses and shrubs. Summers are short in the tundra, so only the top few centimeters of soil thaw. Plants flower in the summer, as shown in **Figure 28**. Underneath the topsoil is a layer of soil called **permafrost**, which is permanently frozen soil. The tundra becomes dotted with bogs and swamps when the top layer of soil thaws. In summer, these wet areas are ideal breeding grounds for huge numbers of swarming insects, such as mosquitoes and blackflies, and for the many birds that feed on the insects.

Vegetation of the Tundra Mosses and lichens, which can grow without soil, cover vast areas of rocks in the tundra. The soil is thin, so plants have wide, shallow roots to help anchor them against the icy winds. Most flowering plants of the tundra, such as campion and gentian, are short. Growing close to the ground keeps the plants out of the wind and helps them absorb heat from the sunlit soil. Woody plants and perennials such as willow and juniper have evolved dwarf forms and grow flat or grow along the ground.

Figure 28 ► During its brief summer, the Alaskan tundra is covered by flowering plants and lichens.

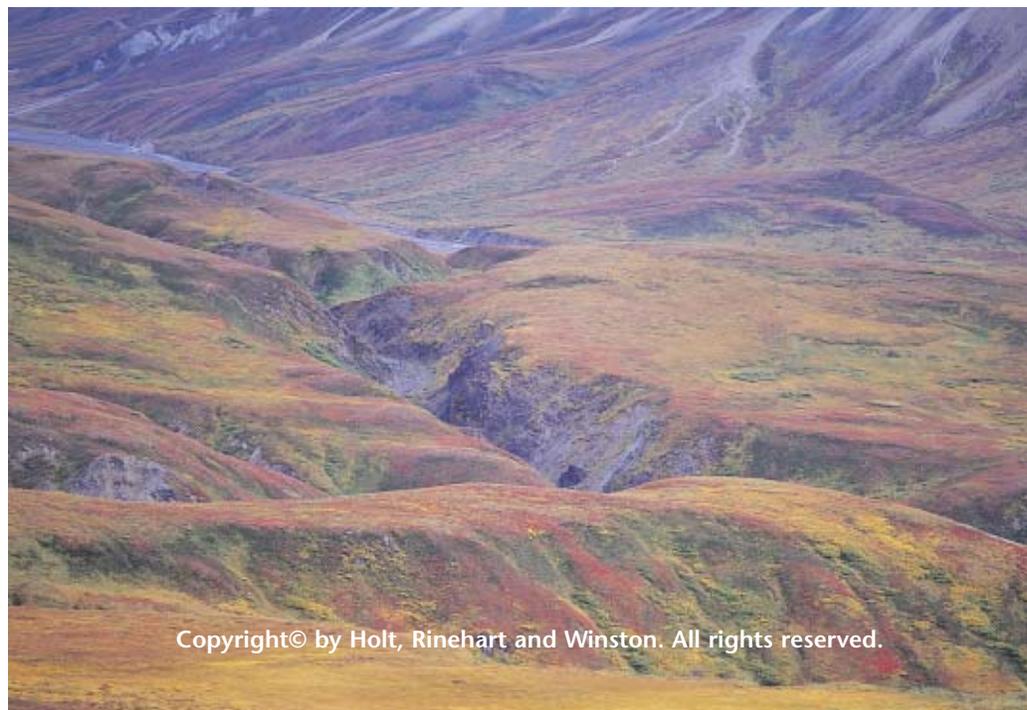




Figure 29 ▶ Many migratory animals, such as geese (left) and caribou (below), return to the tundra each year to breed.



Animals of the Tundra Millions of migratory birds fly to the tundra to breed in the summer. Food is abundant in the form of plants, mollusks, worms, and especially insects. Caribou, as shown in **Figure 29**, migrate throughout the tundra in search of food and water. Hunters such as wolves roam the tundra and prey on caribou, deer, moose, and smaller animals, such as lemmings, mice, and rabbits. These rodents burrow underground during the winter but they are still active. Many animals that live in the tundra year-round, such as arctic foxes, lose their brown fur and grow white fur that camouflages them with the winter snow. These animals are also extremely well insulated.

Threats to the Tundra The tundra is one of the most fragile biomes on the planet. The food chains are relatively simple, so they are easily disrupted. Because conditions are so extreme, the land is easily damaged and slow to recover. Until recently, these areas were undisturbed by humans. But oil has been located in some tundra regions, such as Prudhoe Bay in northern Alaska. Oil exploration, extraction, and transport has disrupted the habitats of the plants and animals in many parts of the tundra. Pollution caused by spills or leaks of oil and other toxic materials may also poison the food and water sources of the organisms that live in the tundra.

MATH PRACTICE



U.S. Oil Production On average, the United States produces an estimated 8.1 million barrels of oil per day. How many millions of barrels of oil does the United States produce in 1 year? If all of the oil-producing countries of the world produce an estimated 74.13 million barrels of oil per day, what percentage of worldwide oil does the United States produce?

SECTION 3 Review

- Describe** two desert animals and the adaptations that help them survive.
- Describe** how tropical grasslands differ from temperate grasslands.
- Compare** the plants that live in deserts with the plants that live in the tundra biome.
- Describe** one threat to the tundra biome.

CRITICAL THINKING

- Making Inferences** Former grasslands are among the most productive farming regions. Read the description of temperate grasslands in this section and explain why this statement is true. **READING SKILLS**
- Analyzing Relationships** Explain why migratory animals such as elephants, giraffes, and bison usually live in temperate grasslands.

1 What Is a Biome?**2 Forest Biomes****3 Grassland, Desert, and Tundra Biomes****Key Terms**

biome, 143
 climate, 144
 latitude, 145
 altitude, 145

tropical rain forest, 146
 emergent layer, 148
 canopy, 148
 epiphyte, 148
 understory, 148
 temperate rain forest, 151
 temperate deciduous forest, 152
 taiga, 153

savanna, 155
 temperate grassland, 156
 chaparral, 158
 desert, 160
 tundra, 162
 permafrost, 162

Main Ideas

- ▶ Scientists classify the ecosystems of the world into large areas called *biomes*.
 - ▶ Biomes are described by their plant life because the plants that grow in an area determine what other organisms live there.
 - ▶ Temperature, precipitation, latitude, and altitude are factors that affect climate, which determines the types of the plants that can grow in an area.
-
- ▶ The major forest biomes include tropical rain forests, temperate rain forests, temperate deciduous forests, and taiga.
 - ▶ Tropical rain forests receive heavy rains and high temperatures throughout the year. They receive about 200 to 450 cm of rainfall a year. They are the most diverse of all biomes.
 - ▶ Temperate deciduous forests experience seasonal variations in temperature and precipitation. They receive 75 to 125 cm of precipitation a year.
 - ▶ Forest biomes are threatened by deforestation through logging, ranching, and farming.
-
- ▶ Savannas are located north and south of tropical rain forests and have distinct wet seasons. Savannas receive 90 to 150 cm of precipitation a year.
 - ▶ Temperate grasslands get too little rainfall to support trees. Grasslands are dominated mostly by different types of grasses and flowering plants. Shortgrass prairies receive about 25 cm of precipitation a year.
 - ▶ Deserts are the driest biomes on Earth. Deserts receive less than 25 cm of precipitation a year.
 - ▶ Plants and animals found in each biome adapt to the environment in which they live.

Using Key Terms

Use each of the following terms in a separate sentence.

1. *biome*
2. *climate*
3. *epiphyte*
4. *tundra*
5. *permafrost*

For each pair of terms, explain how the meanings of the terms differ.

6. *understory* and *canopy*
7. *latitude* and *altitude*
8. *chaparral* and *desert*
9. *tropical rain forest* and *temperate deciduous forest*



STUDY TIP

Concept Maps Remembering words and understanding concepts are easier when information is organized in a way that you recognize. For example, you can use key terms and key concepts to create a concept map that links them together in a pattern you will understand and remember.

Understanding Key Ideas

10. Approximately what percentage of the Earth's species do tropical rain forests contain?
 - a. 7 percent
 - b. 20 percent
 - c. 40 percent
 - d. 50 percent
11. Animal species of the tropical rain forest
 - a. compete more for available resources than species native to other biomes do.
 - b. have specialized adaptations to avoid competition.
 - c. have adaptations to cope with extreme variations in climate.
 - d. are never camouflaged.
12. Migration of animals in the savanna is mostly a response to
 - a. predation.
 - b. altitude.
 - c. rainfall.
 - d. temperature.
13. Spadefoot toads survive the dry conditions of the desert by
 - a. migrating to seasonal watering holes.
 - b. finding underground springs.
 - c. burying themselves in the ground.
 - d. drinking cactus juice.
14. The tundra is most suitable to an animal that
 - a. requires nesting sites in tall trees.
 - b. is coldblooded.
 - c. has a green outer skin for camouflage.
 - d. can migrate hundreds of kilometers each summer.
15. A biome that has a large amount of rainfall, high temperature, and poor soil is a
 - a. temperate woodland.
 - b. temperate rain forest.
 - c. tropical rain forest.
 - d. savanna.
16. The two main factors that determine where organisms live are
 - a. soil type and precipitation.
 - b. temperature and precipitation.
 - c. altitude and precipitation.
 - d. temperature and latitude.
17. Which of the following biomes contains large trees?
 - a. savanna
 - b. temperate rain forest
 - c. chaparral
 - d. desert
18. The most common types of plants in the taiga biome are
 - a. deciduous trees.
 - b. short shrubs.
 - c. coniferous trees.
 - d. grasses.

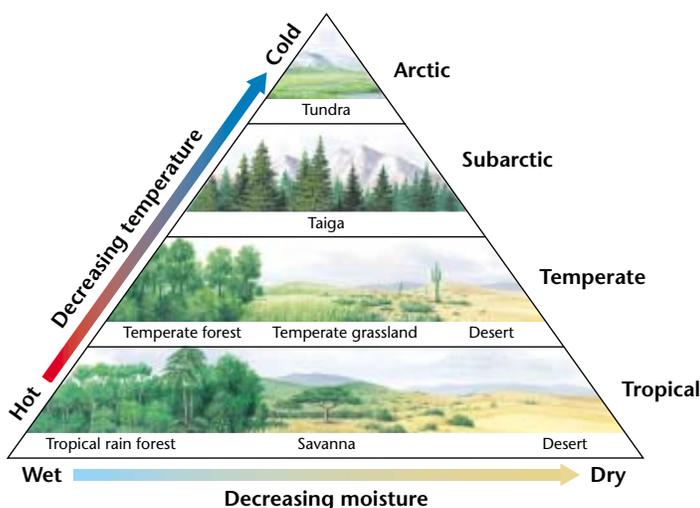
Short Answer

19. Unlike the jungles you see in movies, the floor of an undisturbed tropical rain forest usually lacks much vegetation. Explain why it lacks vegetation.
20. What is the relationship between root systems and erosion in a grassland ecosystem?
21. How might a mountain affect where particular types of biomes are located?
22. Well-preserved mammoths have been found buried in the tundra. Explain why the tundra preserves animal remains well.
23. How does deforestation contribute to a change in climate and increase the chance of floods in a biome?

Interpreting Graphics

Use the diagram below to answer questions 24–26.

24. Why are tall trees found in taiga biomes but not in tundra biomes?
25. As moisture decreases, what happens to the amount of vegetation in an area?
26. What does the diagram tell you about the temperature of and precipitation in temperate grasslands?



Concept Mapping



27. Use the following terms to create a concept map: *threats to an ecosystem, erosion, overgrazing, logging, grasslands, rain forests, tundra, deserts, oil extraction, and irrigation.*

Critical Thinking

28. **Comparing Processes** American prairies and Asian steppes contain different plant species but are dominated by grasses. Write a short paragraph that explains why the two grasslands contain different species but the same types of plants. **WRITING SKILLS**
29. **Classifying Information** Read the description of tropical rain forests in this chapter, and list two factors that are responsible for the biodiversity of this biome. Describe two reasons for the decline of tropical rain forests, and discuss actions that some countries have taken to protect tropical rain forests. **READING SKILLS**
30. **Analyzing Relationships** If you took a population of squirrels from the southeastern United States and introduced them into a Central American rain forest, they would probably not survive. Why do you think the squirrels would not survive even though they are naturally adapted to life in a forest?
31. **Making Inferences** How might prairie fires set from natural and human causes have affected the evolution of fire resistance in prairie grasses?

Cross-Disciplinary Connection

32. **Geography** Use a world map to find locations of the various biomes. Then, make a poster that contains photos or illustrations of plants and animals native to each biome.

Portfolio Project

33. **Food Webs in Your Community** Do a special project on the ecosystems in your community. Use field guides of your area to find out what plants and animals live in your community. Then, draw a food web that shows how organisms in each ecosystem could be related.



MATH SKILLS

Use the table below to answer questions 34–35.

Amount of Tropical Rainforest		
Country	Amount of tropical rain forest (km ²)	Amount of annual deforestation (km ² /y)
A	1,800,000	50,000
B	55,000	3,300
C	22,000	6,000
D	530,000	12,000
E	80,000	700

- 34. Making Calculations** What percentage of tropical rain forest is being destroyed each year in country A? in country D?
- 35. Interpreting Statistics** If the rate of tropical rain forest deforestation remains constant in country E, in how many years will all of the tropical rain forest in that country be destroyed?



WRITING SKILLS

- 36. Communicating Main Ideas** Describe the importance of conserving the biomes of the world. What can you do to help conserve the world's biomes?
- 37. Writing From Research** Choose one biome and research the threats that exist against it. Write a short essay that describes the threats and any actions that are being taken to help save the biome.



READING FOLLOW-UP

Now that you have read the chapter, take a moment to review your answers to the **Reading Warm-Up** questions in your **EcoLog**. If necessary, revise your answers.



Read the passage below, and then answer the questions that follow.

The Tropics and other regions of high biodiversity include some of the economically poorest countries on Earth. These countries are trying to use their natural resources to build their economies and to raise the standard of living for their citizens. Several conservation strategies offer ways for developing countries to benefit economically from preserving their biodiversity.

For example, in a *debt-for-nature swap*, richer countries or private conservation organizations will sometimes pay some of the debts of a developing country. In exchange, the developing country agrees to take steps to protect its biodiversity, such as setting up a preserve or launching an education program for its citizens. Another idea to help local people make money from intact ecosystems is to set up a national park to attract tourists. People who want to see the ecosystem and its unique organisms will pay money for nature guides, food, and lodging. This idea is called *ecotourism*.

- The main objective of both *debt-for-nature swap* and *ecotourism* is
 - economic gain.
 - education of citizens.
 - preservation of biodiversity.
 - Both (a) and (c)
- According to the passage, which of the following statements is true?
 - Regions of high biodiversity are not worth saving.
 - Intact ecosystems are those ecosystems that are most developed.
 - Debt-for-nature swap is an example of international compromise.
 - Launching education programs for citizens does not help protect ecosystems.

Objectives

- ▶ Collect information from international, national, and local resources about the biome in which you live.
- ▶ **USING SCIENTIFIC METHODS** Perform field observations to identify the name of the biome in which you live.

Materials

binoculars (optional)
 field guide to local flora and fauna
 globe or atlas
 graph paper (optional)
 notebook
 pencil or pen
 ruler



- ▶ **Climatograms** The temperature and precipitation for Austin, Texas is shown in this climatogram.

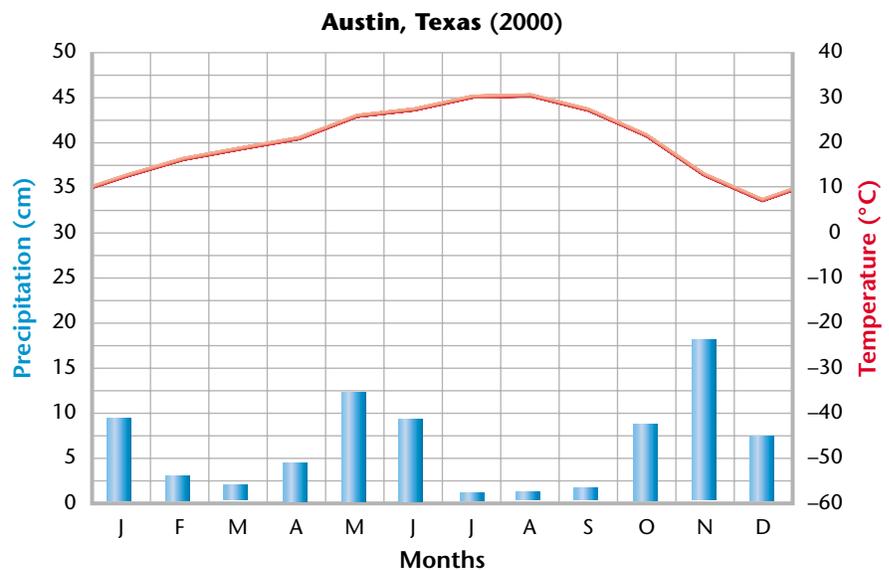
Identify Your Local Biome

In what biome do you live? Do you live in a temperate deciduous forest, a desert, or a temperate grassland, such as a prairie or savanna? In this lab, you will explore certain characteristics of the biome in which you live. With the information you gather, you will be able to identify which biome you live in.

Procedure

1. Use a globe or atlas to determine the latitude at which you live. Record this information.
2. Consider the topography of the place where you live. Study the contour lines on a map or surface variations on a globe. What clues do you find that might help identify your biome? For example, is your area located in near a mountain or an ocean? Record your findings.
3. Prepare a climatogram of your local area. A climatogram is a graph that shows average monthly values for two factors: temperature and precipitation. Temperature is expressed in degrees Celsius and is plotted as a smooth curve. Precipitation values are given in centimeters and are plotted as a histogram.

To make a climatogram of your area, obtain monthly averages for one year of precipitation and temperature from your local TV or radio weather station. Make a data table, and record these values. Next, draw the vertical and horizontal axes of your climatogram in your notebook or on graph paper. Then, show the temperature scale along the vertical axis on the right side of the graph and the precipitation scale along the vertical axis on the left side of the graph. Show months of the year along the horizontal axis. Finally, plot your data.



4. Go outside to observe the plants growing in your area. Bring a field guide, and respond to the following items in your notebook.
 - a. Sketch or describe as many plants that are common in the area as you can. Use your field guide to identify each of these species.
 - b. Describe three or more adaptations of each plant to the local climate.
 - c. Which of the plants that you observed are native to your area? Which have been introduced by humans? Which of the introduced plants can survive on their own in local conditions? Which of the introduced plants require extensive human care to remain alive?
 - d. Look for evidence that animals have left behind—footprints, nests, dens or burrows, hair or feathers, scratches, or urine markings. Sketch or describe as many different animal species as possible. Identify each species by using your field guide.
 - e. Describe three or more adaptations that each animal has developed in order to survive in local climatic conditions.

Analysis

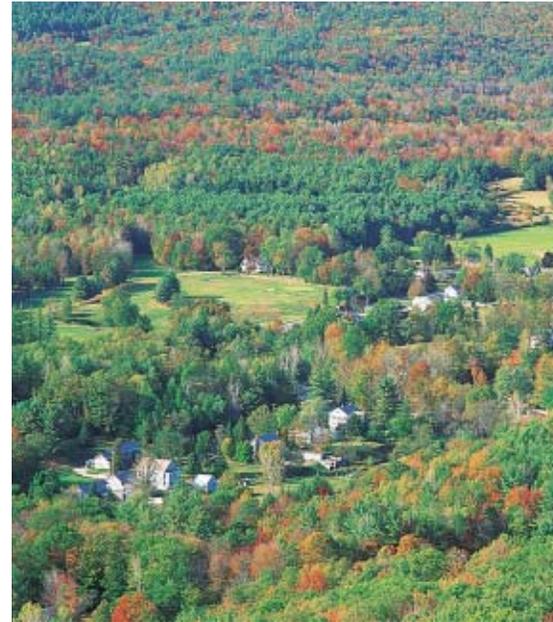
1. **Analyzing Data** Compare your local climatogram to the biome climatograms shown in this chapter. Which biome has a climatogram most similar to your climatogram?
2. **Analyzing Results** Consider your latitude, topographical findings, and observations of local plants and animals. Combine this information with your climatogram, and determine which biome best matches the area in which you live.

Conclusions

3. **Evaluating Results** Does your local climatogram match any of the seven major terrestrial climatograms shown in the chapter? Explain how any differences between your local biome and the biome in the chapter that your local biome most clearly matches might influence the adaptations of local animals and plants.
4. **Applying Conclusions** Organisms create features of the biome in which they live. What features of your biome are created by the organisms that live there?

Extension

1. **Classifying Information** Name three adaptations you observed in the plants that grow naturally in your area. Name at least three adaptations you observed in local animals. Explain in detail how each of these adaptations meets the conditions of your biome.



► **Biomes** These two cities are located in two different biomes. Stamford, Vermont (top) is located in a temperate deciduous forest, and Tucson, Arizona (bottom) is located in a desert.

THE FUTURE OF THE ARCTIC NATIONAL WILDLIFE REFUGE

During the 1970s, Congress passed the Alaska National Interests Land Conservation Act. The legislation gave Congress the responsibility for determining how Alaska's lands will be used. Included in this responsibility is the fate of the Arctic National Wildlife Refuge (ANWR). Oil company geologists believe that oil reserves are under several areas of the northern Alaska coast, including the refuge. Debate has raged about whether Congress should maintain ANWR as a wildlife refuge or open it to oil exploration. Advocates of the refuge feel that the environmental cost of oil exploration would be too high. But those who favor oil exploration in the refuge believe the oil reserves must be tapped to meet U.S. oil needs and to maintain economic security.

Protect the Refuge

Conservationists and ecologists are concerned about the impact that oil exploration would have on animals that live in the refuge. Oil exploration would occur within the 1.5 million acre coastal plain of the

► Migratory birds, such as the Canada geese below, nest and raise their young on the refuge's tundra.



► A small group of muskoxen huddles on the arctic tundra of the Arctic National Wildlife Refuge.

ANWR. This area includes the breeding ground and grazing area for one of the last great herds of caribou in North America. Biologists think that forcing the herd into other areas of the refuge would deprive the caribou of their main food source and would expose calves to increased predation.

In addition, migratory birds from all over the world travel to the refuge's tundra to nest and raise their young during the short arctic summers. Scientists believe that oil exploration would disrupt the nesting and feeding of these birds so much that the birds would be unable to finish rearing their young before the first freeze of early September.

The ANWR is also a habitat for more than 7,000 native peoples. Some of these people depend on the caribou of the ANWR for food, clothing, and tools. Oil exploration and drilling could displace the caribou population, which would drastically affect the culture and way of life for these people.

Opponents of oil exploration in the refuge also point to the

environmental damage that has already been done in nearby Prudhoe Bay. When oil was found there, oil companies joined forces to extract the oil and built a pipeline across the state to reach tankers on the southern Alaska coast. Advocates of the refuge say that the use of this pipeline has exposed the fragile tundra ecosystem to toxic chemicals and destroyed natural habitats. They fear the same fate for the refuge if oil exploration is permitted there.

Advocates of protecting the refuge also point out that no one knows how much oil is available in the refuge. They also point out that even if all of the oil that could possibly be in the refuge were extracted, the oil would supply the United States for only nine months.

Conservationists contend that the development and use of renewable energy resources, such as wind and fuel cells, could reduce the dependence on oil. Laws that require stricter energy conservation measures could also reduce the need for oil in the United States.



- ▶ The pipeline shown above carries oil across the entire state of Alaska.

Open the Refuge

Advocates of oil exploration in the ANWR believe that the current U.S. demand for oil cannot be met by energy conservation alone. Advocates insist that the United States must utilize every domestic source of oil available, including the ANWR. The advocates also point out that the United States depends too much on oil from other countries that control its price and availability. A significant amount of our oil is imported from the Middle East, a politically unstable area. If those countries restrict sales of oil to the United States, our economy

- ▶ Exploration for oil would occur in the northern coastal plain of the Arctic National Wildlife Refuge.

could be seriously affected. Those who favor exploration think economic security should take priority over environmental concerns.

Advocates of oil exploration in the refuge also stress that much of the oil in the Prudhoe Bay area has already been extracted and that oil production will soon begin to decline. The industrial complex that is already in place for the production of oil in Prudhoe Bay could be used for the production of oil from the nearby refuge. New construction in the area would be limited.

Because of the decline of oil in Prudhoe Bay, advocates support oil

drilling in the ANWR for economic reasons. The oil industry supports two-thirds of Alaska's economy and employs 1 percent of the population. If the refuge were open for drilling, oil companies would profit and more jobs might be available for the people of Alaska.

Government studies indicate a 19 to 46 percent chance of finding oil in the refuge, which is a percentage that the oil industry believes justifies exploration. People who favor exploration also suggest that oil companies can now extract oil with less environmental damage than was caused in Prudhoe Bay.

People who oppose the protection of the wildlife refuge believe the economic benefits of oil exploration in this area outweigh any remaining risks of environmental damage.



What Do You Think?

Oil exploration in ANWR could have a negative impact on the animals and people living in and around the refuge, but oil in the refuge may help the U.S. meet its future energy needs. Without knowing what the consequences or benefits will be, do you think that the U.S. should permanently protect the ANWR or open it for oil exploration? Explain.