

SECTION 2

Biodiversity at Risk

The last of the dinosaurs died about 65 million years ago, when a series of changes in the Earth's climate and ecosystems caused the extinction of about half the species on Earth. The extinction of many species in a relatively short period of time is called a *mass extinction*. Earth has experienced several mass extinctions, as shown in **Figure 6**, each probably caused by a global change in climate. It takes millions of years for biodiversity to rebound after a mass extinction.

Current Extinctions

Scientists are warning that we are in the midst of another mass extinction. The rate of extinction is estimated to have increased by a multiple of 50 since 1800. Between 1800 and 2100, up to 25 percent of all species on Earth may have become extinct. The current mass extinction is different from those of the past because humans are the primary cause of the extinctions.

Species Prone to Extinction Cockroaches and rats are not likely to become extinct because they have large populations that adapt easily to many habitats. But species with small populations in limited areas can easily become extinct. Species that are especially at risk of extinction include those that migrate, those that need large or special habitats, and those that are exploited by humans.

An **endangered species** is a species that is likely to become extinct if protective measures are not taken immediately. A **threatened species** is a species that has a declining population and that is likely to become endangered if it is not protected. Additional categories of risk exist for certain legal and biological purposes.

Objectives

- ▶ Define and give examples of *endangered* and *threatened species*.
- ▶ Describe several ways that species are being threatened with extinction globally.
- ▶ Explain which types of threats are having the largest impact on biodiversity.
- ▶ List areas of the world that have high levels of biodiversity and many threats to species.
- ▶ Compare the amount of biodiversity in the United States to that of the rest of the world.

Key Terms

endangered species
threatened species
exotic species
poaching
endemic species

Figure 6 ▶ Biodiversity has generally increased over time, as indicated here by the numbers of families of marine animals. The past five mass extinctions were probably caused by global climate changes.

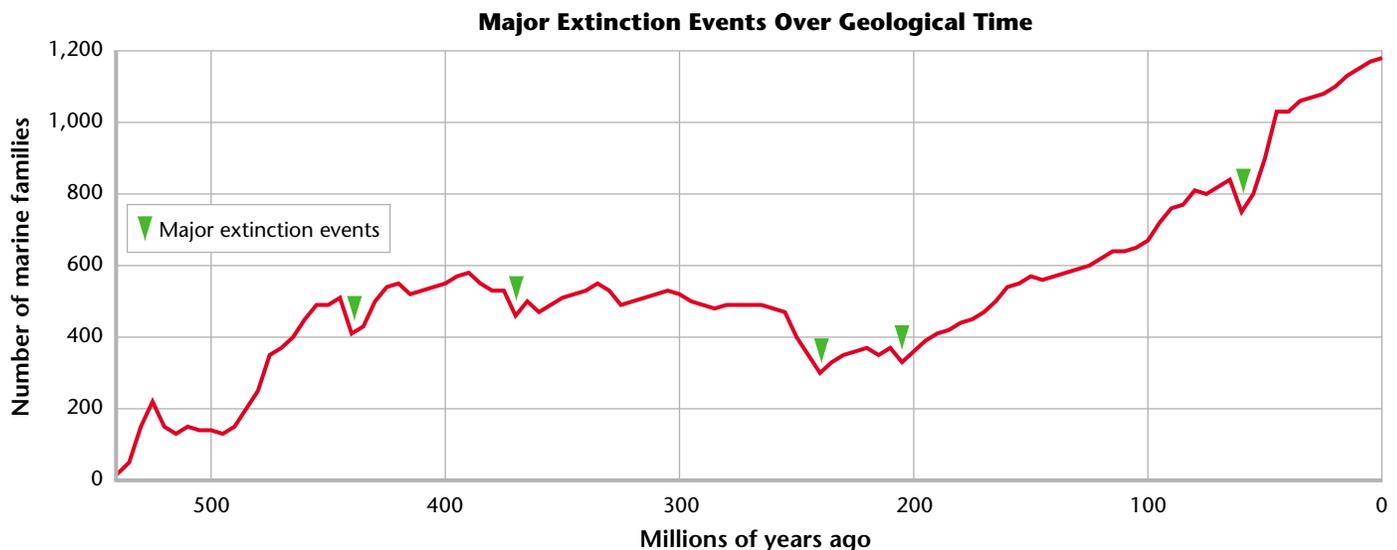


Table 3 ▼

Species Known to Be Threatened or Extinct Worldwide			
Type of species	Number threatened (all categories of risk)	Number extinct (since ~1800)	Percent of species that may be threatened
Mammals	1,130	87	26
Birds	1,183	131	12
Reptiles	296	22	3.3
Amphibians	146	5	3.1
Fishes	751	92	3.7
Insects	555	73	0.054
Other crustaceans	555	73	1.03
Mollusks and worms	944	303	1.3
Plants	30,827	400	0.054

Source: UN Environment Programme.

How Do Humans Cause Extinctions?

In the past 2 centuries, human population growth has accelerated and so has the rate of extinctions. The numbers of worldwide species known to be threatened, endangered, or recently extinct are listed in Table 3. The major human causes of extinction today are the destruction of habitats, the introduction of nonnative species, pollution, and the overharvesting of species.

Habitat Destruction and Fragmentation As human populations grow, we use more land to build homes and harvest resources. In the process, we destroy and fragment the habitats of other species. It is estimated that habitat loss causes almost 75 percent of the extinctions now occurring.

Due to habitat loss, the Florida panther is one of the most endangered animals in North America. The panther and its historical range are shown in Figure 7. Two hundred years ago, cougars—

Figure 7 ▶ Fewer than 80 Florida panthers (right) remain in the wild. Almost all of the habitat (below) of this cougar subspecies has been destroyed or fragmented by commercial and housing development.



a species that includes panthers and mountain lions—ranged from Alaska to South America. Cougars require expansive ranges of forest habitat and large amounts of prey. Today, much of the cougars' habitat has been destroyed or broken up by roads, canals, and fences. In 2001, fewer than 80 Florida panthers made up the only remaining wild cougar population east of the Mississippi River.

Invasive Exotic Species An **exotic species** is a species that is not native to a particular region. Even such familiar organisms as cats and rats are considered to be exotic species when they are brought to regions where they never lived before. Exotic species can threaten native species that have no natural defenses against them. The invasive fire ants in **Figure 8** threaten livestock, people, and native species throughout the southeastern United States.

Harvesting, Hunting, and Poaching Excessive hunting and harvesting of species can also lead to extinction. In the United States in the 1800s and 1900s, 2 billion passenger pigeons were hunted to extinction and the bison was hunted nearly to extinction. Thousands of rare species worldwide are harvested and sold for use as pets, houseplants, wood, food, or herbal medicine.

Many countries now have laws to regulate hunting, fishing, harvesting, and trade of wildlife. However, these activities continue illegally, a crime known as **poaching**. In poor countries especially, local species are an obvious source of food, medicine, or income. Moreover, not all threatened species are legally protected.

Pollution Pesticides, cleaning agents, drugs, and other chemicals used by humans are making their way into food webs around the globe. The long-term effects of chemicals may not be clear until after many years of use. The bald eagle is a well-known example of a species that was endangered because of a pesticide known as DDT. Although DDT is now illegal to use in the United States, it is still manufactured here and used around the world.

Connection to Ecology

Extinction and Global Change

Scientists have worried for some time that environmental pollutants might cause drastic changes in our atmosphere and biosphere. However, it is difficult to draw a direct link from global changes to specific extinctions.

In recent decades, scientists have observed a worldwide decline in amphibian species. Unlike most cases of habitat loss or overhunting, there are no clear causes for these extinctions. But there is growing evidence to indicate two probable causes: the pollution of water sources with hormone-like chemicals and increased UV radiation exposure due to the thinning of the Earth's ozone layer.

Figure 8 ► Mounds made by imported fire ants cover many fields in the southeastern United States. As with many invasive exotic species, these ants had no natural predators and little competition from native species when they were first brought into the country by accident.



MATH PRACTICE

Estimating Species Loss

The annual loss of tropical forest habitat is estimated at about 1.8 percent per year. Some scientists estimate that this habitat loss results in a loss of about 0.5 percent of species per year. Given a low estimate of only 5 million species on Earth, how many years would it take for 1 million species to be lost, if current rates of habitat loss continue?



Areas of Critical Biodiversity

Certain areas of the world contain a greater diversity of species than other areas do. An important feature of such areas is that they have a large portion of **endemic species**, meaning species that are native to and found only within a limited area. Ecologists often use the numbers of endemic species of plants as an indicator of overall biodiversity, because plants form the basis of ecosystems on land. Ecologists increasingly point out the importance of biodiversity in oceans, though marine ecosystems are also complex and poorly understood.

Tropical Rain Forests The remaining tropical rain forests cover less than 7 percent of the Earth's land surface. Yet biologists estimate that over half of the world's species live in these forests. Most of these species have never been described. Unknown numbers of species are disappearing as tropical forests are cleared for farming or cattle grazing. Meanwhile, tropical forests are among the few places where some native people maintain traditional lifestyles and an intimate knowledge of their forest homes. The case study below explains the increasing value of such knowledge in the global marketplace.

CASE STUDY

A Genetic Gold Rush in the Rain Forests

How much is a species worth? To some people, there is money to be made in centers of biodiversity such as rain forests. Thus, the Amazonian rain forests are witnessing an increase in foreign visitors—not just tourists, but scientists searching for genes, glory, or enlightenment into the mysteries of these quickly disappearing treasures.

To biologists, the prospect of discovering new species may be a chance at fame. The first scientist to collect and describe a species often gets to choose a name for that species. For other scientists, researching the unknown inner workings of the rain forests is an adventure similar to the adventures of explorers charting new lands.

But like the quests of early European explorers of the Americas,

some reasons to venture into the wilderness may be economic. The *biotechnology* industry is based on the application of biological science to create new products such as drugs. This industry depends on Earth's variety of organisms—especially their genetic material—for research and development.

In fact, the Brazilian government has taken notice of the increased international interest in the Amazon's amazing biological assets. The government has claimed the right to tax or patent any genetic material harvested from within its borders.

Other researchers are more interested in another special feature of the Amazon—native peoples. Some Amazonian natives, such as the Yanomamö, are still living a lifestyle of intimate connection to their forest



► This botanist is researching the uses of rain-forest plants and other species with the help of local people.

Coral Reefs and Coastal Ecosystems Like rain forests, coral reefs occupy a small fraction of the marine environment yet contain the majority of the biodiversity there. Reefs provide millions of people with food, tourism revenue, coastal protection, and sources of new chemicals. One study in 1998 estimated the value of these services to be \$375 billion per year. But reefs are poorly studied and not as well protected by laws as terrestrial areas are. Nearly 60 percent of Earth's coral reefs are threatened by human activities, such as development along waterways, overfishing, and pollution. Similar threats affect coastal ecosystems, such as swamps, marshes, shores, and kelp beds. Coastal areas are travel routes for many migrating species as well as links to ecosystems on land.

Islands When an island rises from the sea, it is colonized by a limited number of species from the mainland. These colonizing species may then evolve into several new species. Thus, islands often hold a very distinct but limited set of species. For example, the Hawaiian Islands have 28 species of an endemic family of birds called *honeycreepers*. However, honeycreepers and many other island species are endangered because of invasive exotic species.



Geofact

The World's Largest Reef The Great Barrier Reef of Australia is the largest and probably the oldest reef system in the world. It stretches for 2,000 km (1,250 mi) and consists of 3,400 individual reefs.



► The Yanomamö are among the few native peoples of the tropical rain forests who still live traditional lifestyles and use their knowledge of the forests to meet all of their needs.

for their use of the skin excretions of poison dart frogs for hunting.

Often, researchers originally learned of a useful species from a local shaman, or medicine man. Biochemistry researchers have been amazed by the complex combinations of new chemicals they have discovered in many rain-forest species. Some of these chemicals are already being used in research and medicine.

CRITICAL THINKING

1. Expressing Viewpoints To whom do you think the genetic material of the rain forests should belong? What are some ways this benefit of biodiversity might be shared with the whole world?

home, in much the same way as they have for thousands of years.

An important value of such native peoples is their vast knowledge of the variety of species in the ecosystems where they live. Their knowledge includes more than just

being able to recognize or name species. For example, the Yanomamö make use of thousands of plants, fungi, and animals for food, drugs, weapons, and art. Amazonian natives such as the Yanomamö are probably best known

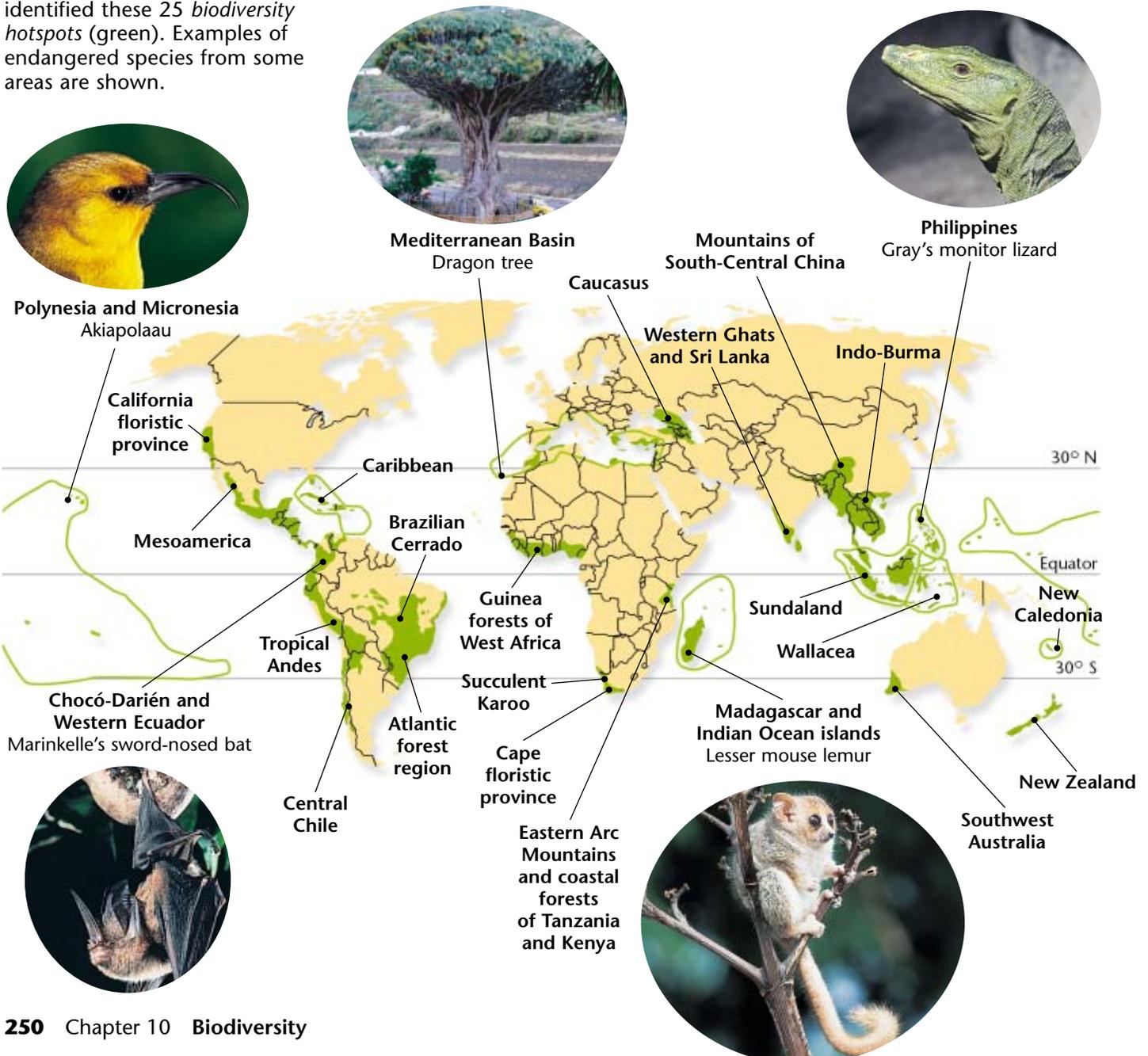
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Biodiversity Hotspots The most threatened areas of high species diversity on Earth have been labeled *biodiversity hotspots*. Twenty-five of these areas, shown in Figure 9, have been identified by international conservationists. The hotspot label was developed by ecologists in the late 1980s to identify areas that have high numbers of endemic species but that are also threatened by human activities. Most of these hotspots have lost at least 70 percent of their original natural vegetation. The hotspots include mostly tropical rainforests, coastal areas, and islands. In Madagascar, for example, only 18 percent of the original forests remain. More than 80 percent of Madagascar’s 10,000 flowering plant species are endemic, as are 91 percent of its 300 reptile species. All 33 species of lemur, which make up a tenth of the world’s primate species, are found only in Madagascar.

Figure 9 ► Conservationists have identified these 25 *biodiversity hotspots* (green). Examples of endangered species from some areas are shown.



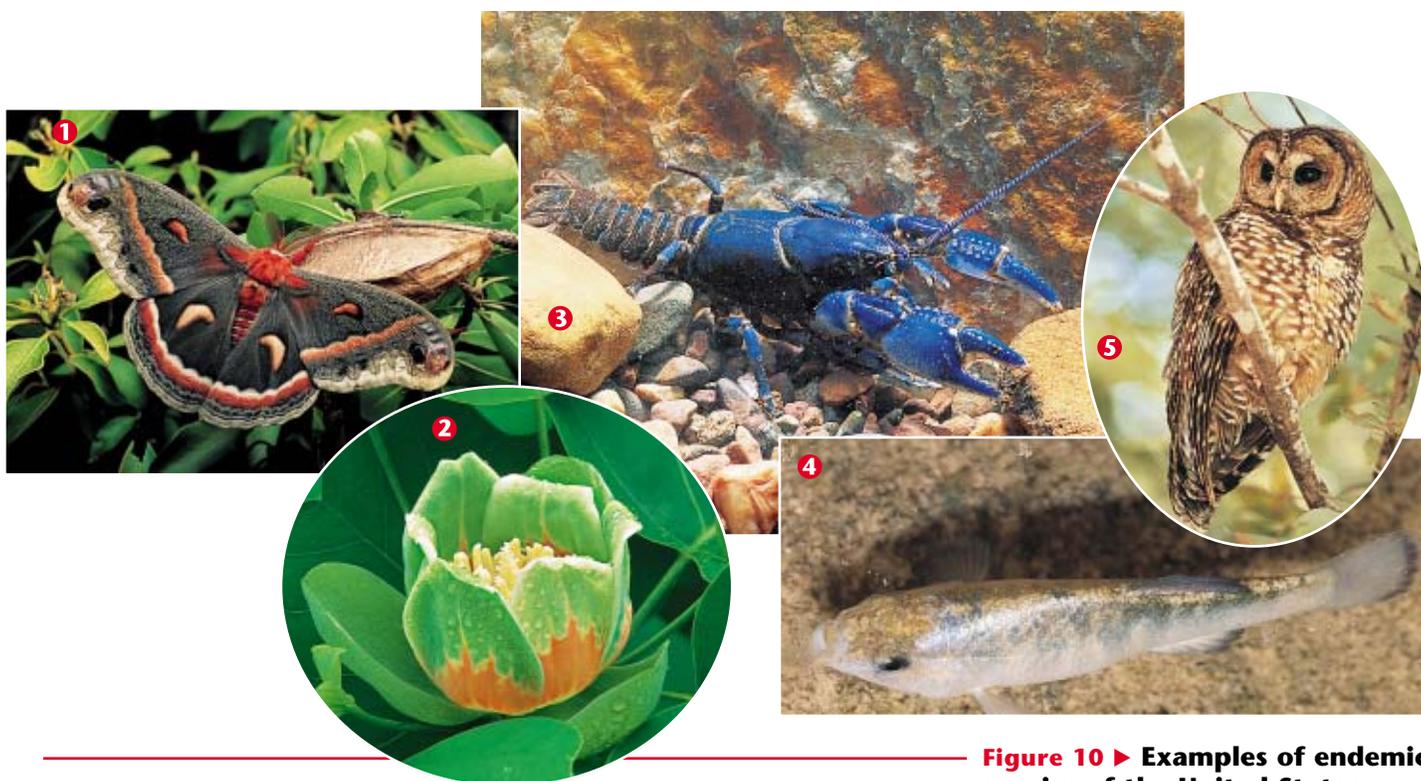


Figure 10 ▶ **Examples of endemic species of the United States** include ❶ the cecropia moth, (declining populations), ❷ the tulip poplar tree (limited distribution), ❸ the crayfish *Cambarus mongalensis* (limited distribution), ❹ the desert pupfish (endangered), and ❺ the northern spotted owl (threatened).

Biodiversity in the United States You may notice that three of the biodiversity hotspots in **Figure 9** are partly within U.S. borders. The United States includes a wide variety of unique ecosystems, including the Florida Everglades, the California coastal region, Hawaii, the Midwestern prairies, and the forests of the Pacific Northwest. The United States holds unusually high numbers of species of freshwater fishes, mussels, snails, and crayfish. Species diversity in the United States is also high among groups of land plants such as pine trees and sunflowers. Some examples of the many unique native species are shown in **Figure 10**.

The California Floristic Province, a biodiversity hotspot, is home to 3,488 native plant species. Of these species, 2,124 are endemic and 565 are threatened or endangered. The threats to this area include the use of land for agriculture and housing, dam construction, overuse of water, destructive recreation, and mining—all stemming from local human population growth.

SECTION 2 Review

- Describe** four ways that species are being threatened with extinction globally.
- Define** and give examples of *endangered species* and *threatened species*.
- List** areas of the Earth that have high levels of biodiversity and many threats to species.
- Compare** the amount of biodiversity in the United States to that of the rest of the world.

CRITICAL THINKING

- Interpreting Graphics** The biodiversity hot spots shown in **Figure 9** share several characteristics besides a great number of species. Look at the map, and name as many shared characteristics as you can.
- Expressing Opinions** Which of the various threats to biodiversity do you think will be most difficult to stop? Which are hardest to justify? Write a paragraph to explain your opinion. **WRITING SKILLS**