

Extinction and Biodiversity Loss

LESSON 2

Guiding Question: Why is global biodiversity decreasing?

Knowledge and Skills

- Describe how biodiversity is monitored and explain current biodiversity trends.
- List the major causes of biodiversity loss.

Reading Strategy and Vocabulary

Reading Strategy As you read this lesson, fill out a cause-and-effect diagram for biodiversity loss. Remember that one cause can have multiple effects.

Vocabulary extirpation, endangered species, threatened species, habitat fragmentation, poaching

BIODIVERSITY LOSSES caused by humans are common throughout history. Archaeological evidence shows that waves of extinctions tend to follow whenever people colonize islands and continents. After the Polynesians reached Hawaii, for example, half its birds went extinct. Birds, mammals, and reptiles vanished following the colonization of New Zealand and Madagascar. Dozens of species of large vertebrates died off in Australia after the Aborigines arrived roughly 50,000 years ago. North America lost 33 genera of large mammals after people arrived on the continent 10,000 years ago. Why does human settlement seem to mean extinction for other organisms? And, more important, is there anything we can do about it?

Biodiversity at Risk

Scientists monitor biodiversity closely and have noticed significantly higher than normal extinction rates in recent decades.

Once extinct, a species can never return. Recall that extinction occurs when the last member of a species dies. The disappearance of a particular population from a given area, but not of the entire species globally, is called **extirpation**. The tiger has been extirpated from most of its historic range, but it is not yet extinct. However, as populations become extirpated, the species as a whole is pushed closer and closer to extinction.

Natural Biodiversity Loss If organisms did not naturally go extinct, dinosaurs might be the main attraction at your local zoo. Extinctions usually occur one by one at a pace that paleontologists and other scientists refer to as the *background rate of extinction*. Before modern humans evolved, for example, the fossil record indicates that about one of every 1000 mammal species would typically go extinct every 1000–10,000 years. This means that, before humans, approximately one mammal species out of every 1 million to 10 million went extinct per year.

There have been times, however, when extinction rates have been far above the normal background rate. These events, called *mass extinctions*, have occurred at least five times in Earth's history. Each time more than one fifth of all families and half of all species have gone extinct.



7.2 LESSON PLAN PREVIEW

- Real World** Groups research and share information about local endangered species.
- Differentiated Instruction** Less proficient readers each summarize a cause of biodiversity loss.

7.2 RESOURCES

Modeling Lab, *Overharvesting* • Map It Online • Lesson 7.2 Worksheets • Lesson 7.2 Assessment • Chapter 7 Overview Presentation

GUIDING QUESTION

FOCUS Ask students to work with a partner for a think-pair-share activity. Have students think about the following question: What are some factors that could cause biodiversity to decrease? Ask each pair of students to discuss their thoughts. Call on each pair to share several of their ideas with the class.

BIG QUESTION

Why is it important to protect biodiversity?

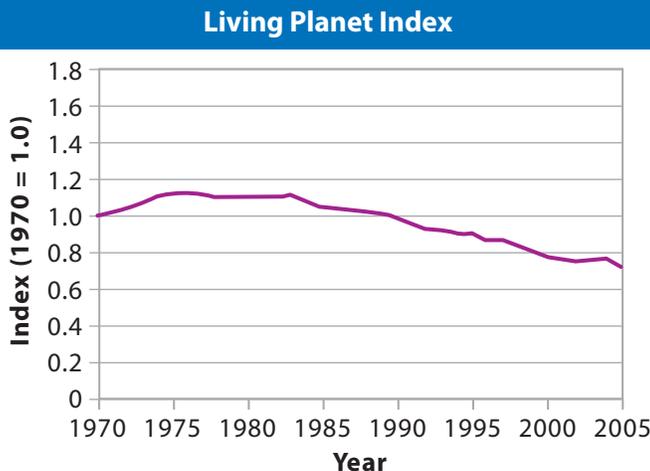
Application Have students apply information about mass extinctions to develop a short slogan reminding others of the importance of protecting biodiversity.

ANSWERS

Reading Checkpoint An endangered species is at serious risk of extinction. A threatened species is likely to become endangered soon.

FIGURE 8 The Living Planet Index

Tigers are one of the more than 1600 vertebrate species whose population trends are summarized by the Living Planet Index. Biodiversity in 1970 is 1.0 on the graph. Between 1970 and 2005, the index fell by roughly 28%. The index for terrestrial species fell by 33%; for freshwater species, 35%; and for marine species, 14%.



Data from World Wide Fund for Nature, 2008. *The Living Planet Report, 2008*. Gland, Switzerland.

A Sixth Mass Extinction? If current trends continue, the modern geologic era, known as the Quaternary period, may see the extinction of more than half of all species. Today, species loss seems to be accelerating as human population growth puts an increasing strain on habitats and wildlife. In 2005, scientists with the *Millennium Ecosystem Assessment* calculated that the current global extinction rate is 100 to 1000 times greater than the usual background rate. Moreover, they projected that the rate will be 10 times as high in future decades. These trends and predictions have caused some scientists to claim that we are in the middle of Earth's sixth mass extinction.

► **Categorizing Risk** To help track biodiversity trends, scientists classify at-risk species as either endangered or threatened. An **endangered species** is one that is at serious risk of extinction. A **threatened species**, or vulnerable species, is one that is likely to become endangered soon throughout all or part of its range. As of late 2009, there were 1321 species in the United States officially classified as “endangered” or “threatened.” The International Union for the Conservation of Nature (IUCN) maintains the IUCN Red List of Threatened Species™, a global list of species facing high risk of extinction. The 2009 Red List reported that 21 percent (1142) of mammal species worldwide, including all remaining subspecies of tiger, are threatened or endangered.

► **Tracking Decline** Scientists at the World Wildlife Fund (WWF) and the United Nations Environment Programme (UNEP) developed a metric called the Living Planet Index to track species decline. This index summarizes population trends for a set number of terrestrial, freshwater, and marine species that are closely monitored and provide reliable data. As seen in **Figure 8**, between 1970 and 2005, the Living Planet Index fell by nearly 30 percent.



Reading Checkpoint

What is the difference between an endangered and a threatened species?



Causes of Biodiversity Loss

 **Habitat change and loss, invasive species, pollution, and overharvesting are the major causes of biodiversity loss. Climate change is also a factor and may become a greater one in the future.**

Reasons for the decline of any given species are often complex and difficult to determine. Moreover, more than one factor is often to blame. Overall, scientists have identified four primary causes of population decline and species extinction: habitat change and loss, invasive species, pollution, and overharvesting. Many scientists think global climate change will become a greater factor in the future.

Habitat Change and Loss Because organisms are adapted to the places in which they live, any major change in their habitat is likely to make it less suitable. Clearing forests for logging or road building, for example, removes the food, shelter, and other resources that forest-dwelling organisms need to survive. Thus, organisms can be caught in “habitat islands,” or patches of suitable habitat type surrounded by “seas” of unsuitable habitat. This pattern, shown in **Figure 9**, is called **habitat fragmentation**. The Sikhote-Alin Mountains, home of the Siberian tiger, is a habitat fragment. The tigers are trapped on the mountains, separated from other regions of suitable forested habitat by unsuitable populated areas.

Scientists have developed models that can predict the species diversity of a habitat fragment based on its size. In general, the larger the fragment, the more species it can support. Studies of oceanic islands have found that the number of species living on an island roughly doubles as island size increases tenfold. This is partly because large islands tend to have more habitats than smaller islands, providing suitable environments for a wider variety of arriving species. The pattern holds up for habitat fragments—the smaller the habitat island, the faster it tends to lose biodiversity.

Habitat change and loss is by far the greatest cause of biodiversity loss today. It is the primary source of population declines for 83% of threatened mammals and 85% of threatened birds, according to UNEP data. As one example, less than 1% of the prairies native to North America’s Great Plains remain. The rest have been converted to farmland. As a result, grassland bird populations have declined by an estimated 82–90%. Of course, human-induced habitat change may benefit some species. Animals such as house sparrows, pigeons, gray squirrels, and cockroaches, for example, do very well in urban and suburban environments. However, the number of species that benefit are relatively few, and these species tend to be generalists that have the potential to become pests.

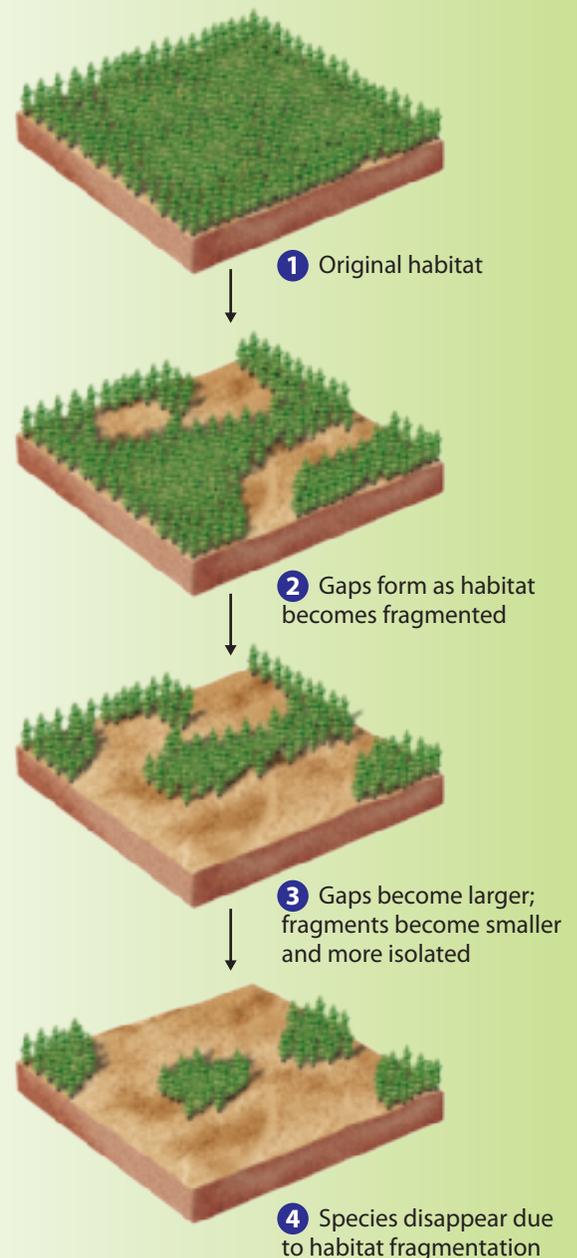


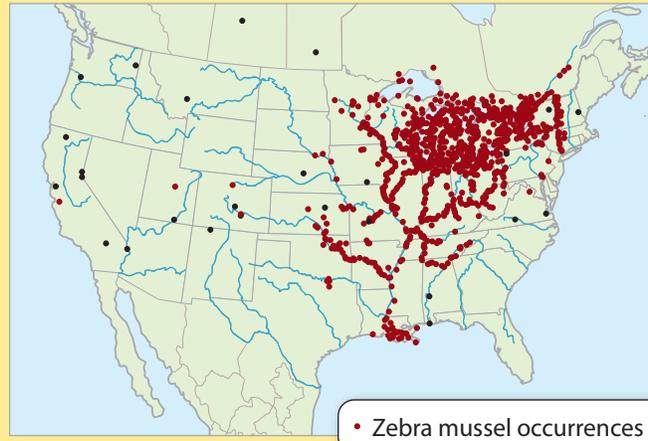
FIGURE 9 Habitat Loss Forest clearing, farming, road building, and other types of human land use and development can fragment natural habitats. As a habitat becomes fragmented, the number of species in the fragments decreases.

Map it

Invading Mussels

Zebra mussels were accidentally introduced to the Great Lakes from European and Asian cargo ships. The map at right shows the extent of the mussels' range as of late 2009.

1. **Apply Concepts** What qualities make zebra mussels invasive? (*Hint: You may want to look back to the chapter *Evolution and Community Ecology*.*)
2. **Interpret Maps** What is the relationship between the major rivers shown on the map (by blue lines) and the spread of zebra mussels?
3. **Infer** Notice the black dots on the map. Some of these locations appear to be inaccessible by inland waterways from the Great Lakes. How do you think zebra mussels got to these places?



Source: U.S. Geological Survey, Gainesville, Florida, November 5, 2009.

ANSWERS

Map It For answers to the Map It activity, see page A-10 at the back of the book.

Reading Checkpoint Invasive species often cause a decline in native biodiversity.

Invasive Species The introduction of non-native species to new environments can sometimes push native species toward extinction. Most organisms introduced to new areas do not survive long because the new area lacks certain conditions necessary for survival. However, some species can survive *too well*. Once released from the limiting factors of predation, parasitism, and competition, an introduced species may become invasive. Non-native species are considered invasive if their populations increase rapidly, spread, and displace native species. Invasive species, such as the zebra mussel, cause billions of dollars in economic damage each year. Very few, such as the honeybee, are beneficial.

Pollution Heavy metals, fertilizers, pesticides, and the toxic chemicals that pollute the air and water can poison people and wildlife. Although pollution is a substantial threat, it tends to be less significant than the damage caused by habitat loss or invasive species.

Overharvesting For most species, hunting or harvesting by humans does not pose a threat of extinction, but there are exceptions. Overharvesting occurs when humans hunt, fish, or harvest a species faster than it can replenish its population. Some species of fish, for example, are facing extinction because of overfishing. Likewise much of the Siberian tiger's population decline is due to overharvesting. Large, few in number, long-lived, and raising few young in its lifetime, the Siberian tiger is just the type of animal that is vulnerable to population reduction by hunting.



FIGURE 10 A Sticky Situation

Pollution, as from an oil spill, can poison humans and other living things. Here, a seabird is getting a bath to wash away oil leaked from a damaged ship in 2007 off the coast of England.



Reading Checkpoint

How do invasive species affect biodiversity?



Hunting nearly drove Siberian tigers to extinction in the early twentieth century. Then after World War II, a decrease in hunting allowed the population to increase to about 250 individuals. The early 1990s, however, brought a boom in **poaching**, the illegal capture or killing of an organism. Organisms are often poached when their parts can be sold illegally. The parts from one tiger, for example, can be sold for about \$15,000 in today's black market, which is a lot of money for poachers in poor regions.

Climate Change Habitat loss, invasive species, pollution, and overharvesting usually affect biodiversity only in certain places and at certain times. In contrast, recent changes to Earth's climate system are beginning to have *global* effects on biodiversity. Extreme weather events such as droughts increase stress on populations. Warming temperatures are causing organisms to move toward the poles and higher altitudes where the climate is cooler. Some species will be able to adapt, but others will not. In the Arctic, where warming has been greatest, polar bears are struggling as the ice they live and hunt on thins and melts (**Figure 11**). Unfortunately for the bears, there is nowhere colder for them to go and their future looks grim. Overall, scientists now predict that a 1.5–2.5°C global temperature increase could put 20–30 percent of the world's plants and animals at increased risk of extinction.

FIGURE 11 On Thin Ice The long-term survival of polar bears (*Ursus maritimus*) is threatened by climate change as Arctic warming melts the sea ice. The bears hunt seals from the icy surface. Less ice means they have to swim farther for food, sometimes drowning in the process.

ANSWERS

Lesson 2 Assessment

1. The Living Planet Index summarizes population trends for a set number of species that are closely monitored. It shows a recent decline in biodiversity.
2. Habitat change and loss, pollution, overharvesting, invasive species, and climate change; habitat change has the greatest overall effect; climate change can affect global, not just local, biodiversity.
3. Answers will vary.

LESSON 2 Assessment

1. **Explain** What is the Living Planet Index and what does it suggest about current biodiversity trends?
2. **Apply Concepts** What are the major factors affecting biodiversity today? Which one currently has the greatest overall effect? How is climate change different from the other factors?
3. **THINK IT THROUGH** Suppose someone tells you that human development increases biodiversity. When a forest is fragmented, he or she argues, new habitats, such as grassy lots and gardens, may be introduced to an area and allow additional species to live there. How would you respond to this claim? Do you agree? Explain your answer.