

Key Terms

habitat loss
deforestation
alien species
invasive species
overexploitation
extinction
biodiversity crisis

habitat loss the destruction of habitats, which usually results from human activities

deforestation the practice of clearing forests for logging or other human uses, and never replanting them

Figure 3.11 Deforestation results in habitat loss.

3.3 Threats to Biodiversity

For most of modern history, human actions have proceeded without people giving much thought to the sustainability of ecosystems. These actions often include things that drastically alter the conditions in an ecosystem, such as draining wetlands, cutting down trees, and damming rivers. Sometimes, these actions threaten biodiversity within a community or ecosystem and on Earth as a whole. Recall that one measure of biodiversity is the variety of ecosystems on Earth. If human actions lead to the destruction of entire ecosystems, such as wetlands or rainforests, biodiversity on Earth could decrease. As scientists learn more about the effects of human actions on ecosystems, we are paying more attention to decreasing human impact on ecosystems and restoring ecosystems that have already been altered.

Habitat Loss

Habitat loss occurs when events, due to natural disasters or human activities, alter a terrestrial or aquatic ecosystem so drastically that many species can no longer survive there. If the organisms cannot move somewhere else, or if no alternative habitat is available, species may not survive and biodiversity is threatened. Natural sources of habitat destruction are events such as volcanic eruptions, wildfires, droughts, and severe storms, such as hurricanes. Human activities that destroy habitats include **deforestation**, shown in **Figure 3.11**, draining wetlands, and damming rivers.



Deforestation

Deforestation occurs when forests are logged or cleared for human use and never replanted. In some areas of the world, large sections of forests are cut down for timber or cleared for agricultural use. Recall, from Section 3.1, that tropical regions, especially tropical rainforests, often have biodiversity hotspots. Although tropical forests cover only about 7 percent of Earth's land, it is estimated that they contain about half of all the species on Earth. The graph in **Figure 3.12** shows the percent of forest lost in the top 20 countries in which deforestation has occurred.

Canada has a vast boreal plains ecosystem, stretching across Manitoba, Saskatchewan, and Alberta. This ecosystem, which is a mix of plains and boreal forests, is home to more species of breeding birds than any other forest ecosystem in North America. Annual deforestation rates in this area from 1966 to 1994 were almost three times the average rate of deforestation worldwide, with forest cover decreasing by up to 55 percent during that time. Researchers at Environment Canada have found that along one of their survey routes in this ecosystem, the number of bird species declined from a maximum of 105 species in 1987 to only 67 species by 1995.

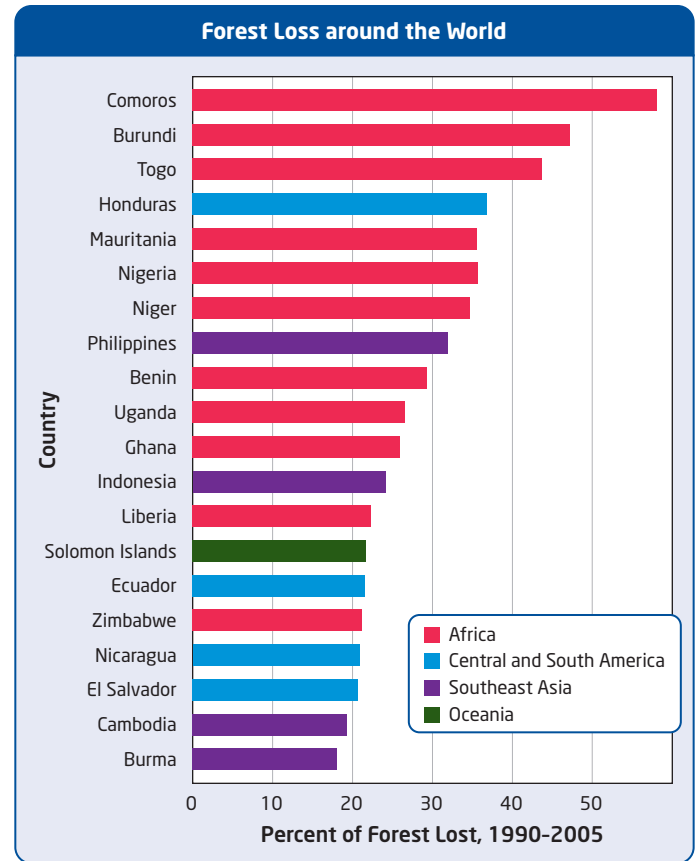


Figure 3.12 Deforestation in tropical rainforests has resulted in the loss of 20 to 50 percent of forests in some countries.



Making a Difference

As a nine-year-old, Severn Cullis-Suzuki witnessed the burning of the Brazilian Amazon rainforest. This experience led her to start the Environmental Children's Organization to help other children learn about environmental issues. Severn and her friends raised enough money to attend the 1992 Rio Earth Summit. At the Summit, Severn, then 12, gave a speech that received international attention. She reminded her audience that decisions they made about the environment would affect future generations. In 2002, Severn attended a UN panel on sustainable development in Johannesburg, South Africa. She brought a pledge from students to be accountable and challenged older generations to lead by example.

Today, Severn is a board member of the David Suzuki Foundation. This foundation was founded by her father, Dr. David Suzuki, who is a geneticist, environmentalist, and well-known broadcaster. It uses science and education to help society achieve sustainability.

What kind of pledge, or commitment, could you make to improve the sustainability of your lifestyle?

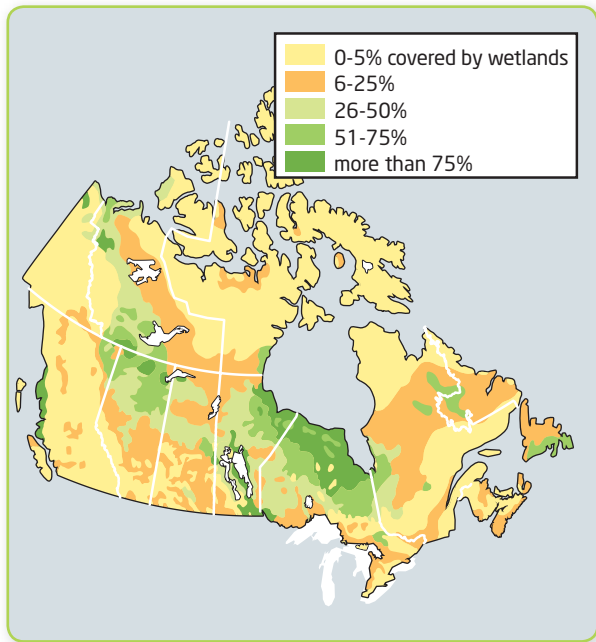


Figure 3.13 Wetlands cover about 14 percent of Canada's total land area.

Draining Wetlands

Wetlands, areas of land that are covered by water for part or all of the year, are an important ecosystem for many different species. They cover about 6 percent of Earth's surface. About 24 percent of the world's wetlands are in Canada. **Figure 3.13** shows that most of Canada's wetlands are in Manitoba and Ontario. Plants, turtles, snakes, mink, and thousands of other organisms live in wetlands. For juvenile animals, wetlands are a protected environment in which they can grow and develop. Every spring and fall, migrating birds also use wetlands to feed and rest. About 30 percent of birds in North America stop in wetlands throughout Canada. Besides providing habitat for many organisms, wetlands perform another important ecosystem service—the plants that grow in them filter sediment and pollution from water.

Wetlands are often drained for farming or for building homes and other buildings. Sometimes, they are drained for mosquito control. Up to 90 percent of wetlands along Lake Ontario have been destroyed. As scientists have learned more about the importance of wetland areas, more work is being done to preserve and protect existing wetlands. You will read more about how wetlands can be restored in Section 3.4.

Alien Species

Species introduced to new parts of the biosphere from other parts go by many names—**alien species**, introduced species, non-native species, and exotic species. Alien species may be released on purpose, but usually they arrive by accident in shipments of food and other goods. Most alien species are harmless or beneficial in their new environments.

However, sometimes alien species are also invasive species. An **invasive species** is one that can take over the habitat of native species or invade their bodies. A native species is one that naturally inhabits an area. In many cases, invasive species upset the equilibrium of an ecosystem, causing problems for the native species. Many alien species invade aquatic ecosystems by way of cargo ships, particularly in ballast water. In order to increase their stability at sea, departing ships pick up water as ballast and hold it in tanks inside the hull. When they arrive at their destination, perhaps halfway around the world, the ballast water is dumped. Ballast water is like a giant aquarium, including microscopic organisms and fish.

alien species a species that is accidentally or deliberately introduced into a new location

invasive species a species that can take over the habitat of native species or invade their bodies



Figure 3.14 Zebra mussels are an invasive species.

Zebra Mussels

Zebra mussels are a species of freshwater mollusc that is native to Asia. They were introduced to the Great Lakes through ballast water in the 1980s. Since then, scientists have been monitoring the impact of this invasive species on the Great Lakes ecosystem. Zebra mussels, shown in **Figure 3.14**, can out-compete native mussels and other native organisms in the lakes. One organism that has declined in number since the arrival of zebra mussels is a small, shrimp-like crustacean that shares the same food source as the zebra mussels. The crustaceans are a food source for many fish, including whitefish and smelt. As the number of these crustaceans has declined, so have the numbers of these fish. Scientists are studying more about the link between the arrival of zebra mussels and the decline of these organisms.

Round Gobies in the Great Lakes

Until 1990, the Asian round goby, shown in **Figure 3.15**, had not previously been found in North America. They probably arrived in ballast water, and they were soon found breeding around Lake Erie shipwrecks. Their population spread widely and grew exponentially. It is too early to tell how round gobies will change the Great Lakes ecosystems, but they certainly will. Within a decade of arrival, they were found in all five Great Lakes, and their western Lake Erie population is now estimated in the billions!

Suggested Investigation

Real World Investigation 3-A,
Zebra Mussels in Lake Ontario,
on page 117



Figure 3.15 The round goby from Asia now lives in the Great Lakes, where it competes with native fish for spawning areas. The round goby is also known to eat the eggs of native fish.

Learning Check

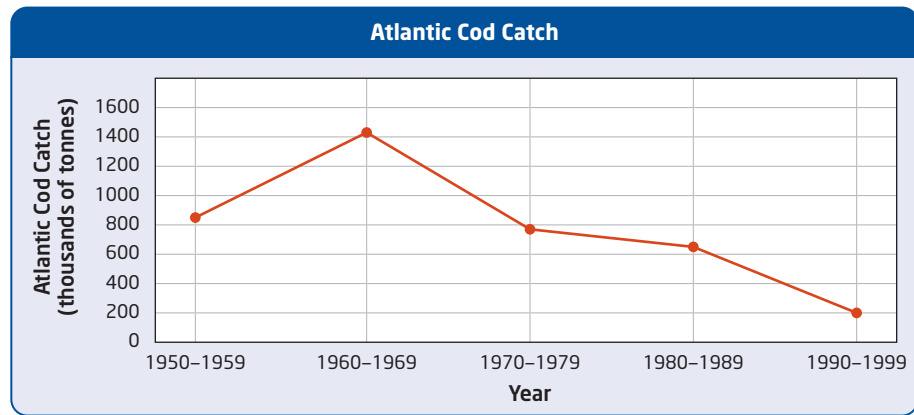
1. What is habitat loss?
2. List two reasons why wetlands are drained.
3. Give three reasons why alien species often do well when they are released in a new part of the world.
4. Describe why round gobies might function effectively as predators and competitors in the Great Lakes.

overexploitation the use or extraction of a resource until it is depleted

Overexploitation

Biodiversity is threatened when **overexploitation** occurs. Overexploitation is the use or extraction of a resource until it is depleted. Overexploitation can lead to dangerously low population numbers, if not the complete disappearance of a species. For example, the population of passenger pigeons was once about 5 billion. However, partly due to overhunting by early North American settlers, the last passenger pigeon died in the early 1900s. Overfishing of yellowfin tuna and Atlantic cod during the past few decades has reduced the numbers of these species by 90 percent. The graph in **Figure 3.16** shows the reduction in the number of tonnes of Atlantic cod caught off the coast of Newfoundland from 1950 to 1999.

Figure 3.16 The reduced catch of Atlantic cod reflects a decrease in population as a result of overexploitation.



Activity 3-3

Alien Invasions

Purple loosestrife (*Lythrum salicaria*) is an alien invasive species that was introduced to North America in the 1800s. In wetlands, purple loosestrife out-competes the native plant species. Controlling purple loosestrife is important to the sustainability of ecosystems around Ontario.

Procedure

1. Study the chart on the right, which contains information about the best methods for controlling purple loosestrife. Then answer the following questions.

Questions

1. What are the different methods used for controlling purple loosestrife?
2. A conservation officer has discovered some isolated purple loosestrife plants, with a low density, in a park. What methods should be used to help control the spread of the plants?
3. Why do you think several methods are needed to control purple loosestrife?

4. Suppose that you are a conservation officer and you need the public's help to remove all the purple loosestrife plants from a wetland area. It is a small area with a medium density of plants. Outline a design for a community action poster that asks people to help clean up on a Saturday. Include details about why the clean-up is important and what tasks need to be done.

Purple Loosestrife Control Methods

Size of Infested Area	Density of Infested Area		
	Low 1-50 plants (1-25% of area)	Medium 50-1000 plants (25-75% of area)	High 1000+ plants (75-100% of area)
Isolated plants			
Small less than 1 acre (0.1-0.5 ha)			
Medium up to 4 acres (0.5-2 ha)			
Large more than 4 acres (more than 2 ha)			

digging and pulling chemical control cutting biological control

Disrupting Connectivity across Ecosystems

What would you think if you read the headline “Salmon help to keep temperate rainforests of British Columbia healthy”? You might be puzzled. How can salmon, which live in aquatic ecosystems, be connected to terrestrial-dwelling trees in temperate rainforests? Dr. Tom Reimchen of the University of Victoria, in British Columbia, has an explanation.

As shown in **Figure 3.17**, salmon are hatched in freshwater streams throughout the temperate rainforest. They then migrate to the Pacific Ocean and spend their adult lives in the marine ecosystem. Every year, thousands of salmon swim upstream to return to the streams in which they hatched to spawn (reproduce). During this time, bears and other organisms, including wolves, bald eagles, and crows, feed on the salmon. In particular, bears move the salmon from the stream beds far into the forest. When the remains of the salmon decay in the forest, nutrients from their bodies, including nitrogen, enter the soil.

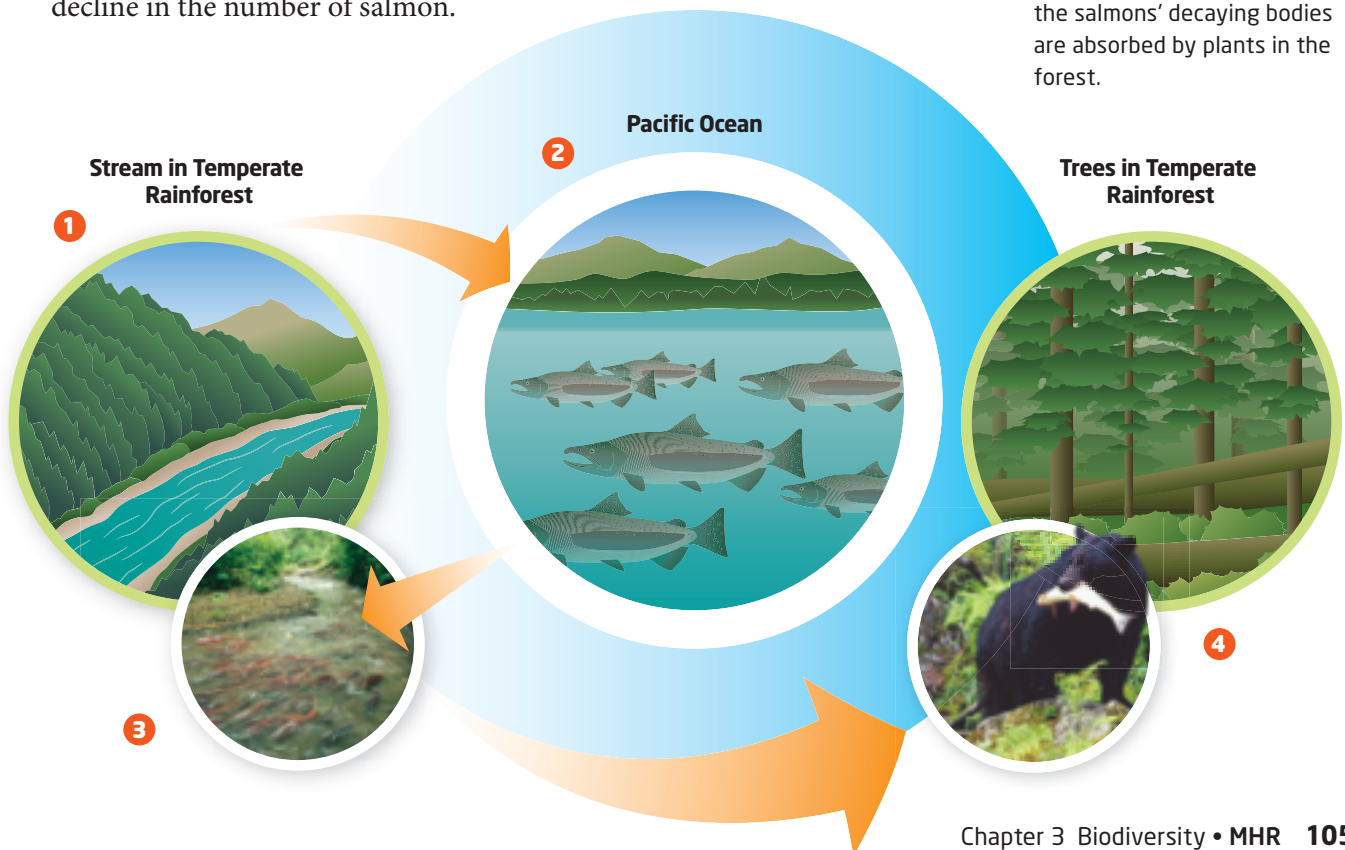
Based on his research, Dr. Reimchen estimates that up to 70 percent of the nitrogen in plants, trees, insects, birds, and bears in the temperate rainforest comes from the Pacific Ocean via the salmon. These nutrients help to increase biodiversity in the forest. He has found that species diversity in areas without salmon is lower than in areas with salmon. Since the 1880s, salmon populations on the west coast of North America have decreased by 80 to 90 percent. This decline in salmon population may result from a number of factors, including overfishing and habitat destruction from logging and dam construction. Studies on the decrease in the salmon population and its effects on the temperate rainforest are ongoing. A reduction in the carrying capacity and in the biodiversity of the temperate rainforest ecosystem are two possible consequences of the decline in the number of salmon.

Study Toolkit

Identifying the Main Idea and Details How do the heading and visual on this page help you identify the main idea of the text?

Figure 3.17 Several ecosystems are connected as a result of the life cycle of salmon and the feeding habits of bears and other animals in the temperate rain forest.

1. Salmon hatch in freshwater streams in the temperate rainforest.
2. Salmon spend their adult life in the Pacific Ocean, picking up nutrients from the marine ecosystem.
3. Salmon return to their birthplace to spawn.
4. Bears move salmon into the forest. Nutrients released from the salmon's decaying bodies are absorbed by plants in the forest.



extinction the death of all the individuals of a species

Extinction Reduces Biodiversity

Extinction occurs when all the individuals of a species have died. Long before humans existed, many species on Earth existed and became extinct in both terrestrial and aquatic ecosystems.

How Does Extinction Occur?

Extinction occurs when the death rate of a species remains higher than the birth rate for a long period of time. The birth rate is the speed at which new individuals are added to a population, and the death rate is the speed at which individuals are removed from the population by death. Over long periods of time, these two rates have to be equal for a species' population to remain stable.

Even in ecosystems that are unaffected by human activities, things never remain the same forever. Sometimes a significant biotic or abiotic feature of a species' ecosystem changes. For example, an abiotic factor for a plant species could be a decline in rainfall that makes soils more dry. A biotic factor for a plant species could be the arrival of a new insect species whose leaf-feeding habit weakens the plants. Such factors may not cause the extinction of the species directly, but if the change results in the death rate being greater than the birth rate over an extended period of time, extinction eventually occurs.

STSE Case Study

Saving Dolly Varden

In 2006, the Gwich'in Renewable Resource Board saw a problem with the declining population of the Dolly Varden, a species of fish in the Rat River in Canada's North. A ban was placed on commercial and sport fishing in the river during periods of migration and spawning. Unfortunately, the population of Dolly Varden continued to decline and the river was closed to all fishing, including fishing by the Gwich'in for food.

The Gwich'in are one of Canada's most northerly Aboriginal peoples. Scientists can learn a lot about ecosystems and sustainability from Aboriginal peoples. The Gwich'in, for instance, have a unique understanding of the Dolly Varden fish because they have interacted with the species for centuries and their traditional use has not threatened the fish. This understanding is called traditional ecological knowledge.

The Dolly Varden Life Cycle

Dolly Varden spend the bulk of the year in salt water and then migrate in the fall to fresh water to spawn. They travel from the Beaufort Sea to fish holes (parts of a river that do not freeze completely) in tributaries (branches) of the Mackenzie River, including the Rat River.



Because of their speckled, pink appearance, Dolly Varden fish are named after a character in a Charles Dickens' novel. The character, Dorothy Varden, wore dresses with pink polka dots.

Patterns of Natural Extinction

By examining fossil evidence, scientists have described two patterns of extinction in the history of Earth. The difference between these patterns is the speed with which they occur. One pattern, called background extinction, is apparent over long periods of time. As ecosystems gradually change over long periods of time, some existing species become extinct while new species appear through evolution.

The second pattern is mass extinction. Mass extinction is thought to happen when there is a relatively sudden change to Earth's ecosystems, making them both unsustainable and unstaying. As shown in **Figure 3.18**, this is believed to have occurred five times in Earth's history. The best-known example of mass extinction is the death of the dinosaurs. Many scientists hypothesize that an asteroid hit Earth 65 million years ago, causing huge changes to Earth's climate and thus eliminating the dinosaurs. Earlier, there was an even more devastating mass extinction of sea life. This is thought to have occurred when an extended period of massive volcanic activity in Asia caused significant climate change around the world.

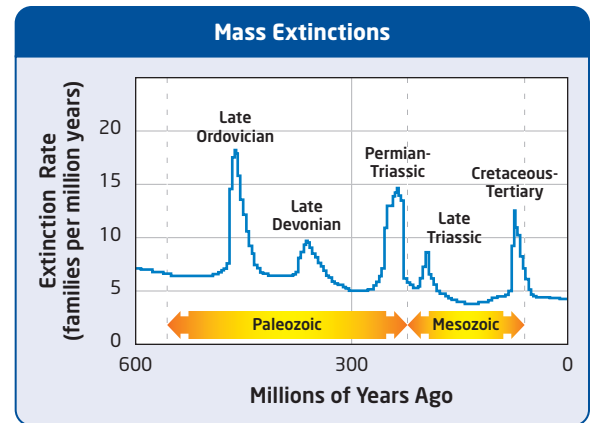


Figure 3.18 Five times in the past there were short periods when many species disappeared. These are known as mass extinctions.



Canadian scientists and members of the Gwich'in community are teaming up to try to save a fish called the Dolly Varden in the Rat River, a tributary of the Mackenzie River.

What is traditional ecological knowledge?

Traditional ecological knowledge is

- collective information held by Aboriginal peoples through their connectedness to the land
- thinking passed down by generations through stories, song, and art
- knowledge that can help to answer complex questions about the environment and sustainability

The Rat River population of Dolly Varden has fallen from about 12 000 in 2002 to only 3500 in 2006. Scientists suspect that the drop in population is due to overfishing, as well as habitat and climate change.

Gwich'in fishers have been hired to catch a small number of the fish for research, but until the population of Dolly Varden begins to increase, the ban on fishing will remain in place.

Your Turn

1. Research the ways in which the Gwich'in have used the Dolly Varden for food and medicine.
2. How would you explain traditional ecological knowledge to a Grade 6 student?
3. Explain why traditional ecological knowledge might be particularly useful in Canada's North.



Figure 3.19 The plains bison is not extinct, but its numbers have been dramatically reduced, primarily due to overhunting. In the 1800s, piles of bison skulls were ground into fertilizer.

biodiversity crisis the current accelerated rate of extinctions

Current Extinction Rates

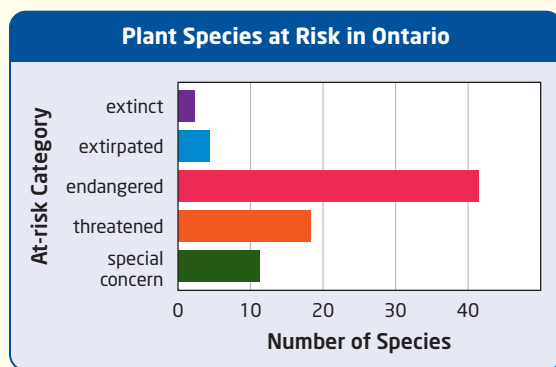
Fossils tell us that for most of Earth’s history, changes to ecosystems have occurred slowly enough or on a small enough scale that only background extinction occurs. But they also tell us that, in rare instances, changes are so big that much—even most—of the biosphere’s biodiversity becomes extinct.

With ever-increasing technological sophistication and a population approaching 7 billion, humans make heavy demands on ecosystems. One of the costs to ecosystems is the extinction of species. Some ecologists estimate that the current rate of extinction is 100 to 1000 times higher than a normal background rate. In one study that assessed the status of over 40 000 species, 39 percent of those species were found to be at risk of extinction. These included species of trees, amphibians, birds, and mammals, such as the plains bison in **Figure 3.19**. This problem has been called the **biodiversity crisis**. Scientists hypothesize that the biodiversity crisis has resulted from the actions of humans. Activities that lead to deforestation, habitat destruction, and air and water pollution are changing the abiotic and biotic conditions in ecosystems. In some cases, the conditions change so much that organisms are unable to survive.

Activity 3-4

Plants at Risk

There are 77 plant species at risk in Ontario. The bar graph below shows how many species are in each category of concern.



Materials

- calculator
- dictionary

Procedure

1. Research and record the definition of each of the categories shown on the y-axis of the graph.
2. Study the graph, then answer the following questions.

Questions

1. Which category contains the most plant species? Which contains the least plant species?
2. There are approximately 2000 plant species in Ontario. What percent of Ontario’s plant species are endangered? What percent are threatened?
3. Deerberry is a small shrub that is threatened. One of the threats to this species is that remaining plants may be trampled by hikers who leave the marked trail in St. Lawrence Islands National Park. Design a one-page flyer to make hikers aware of this issue and persuade them to stay on the marked trail while at the park.
4. Suppose that there are two plant species at risk in your area. One of these species is threatened, and the other is endangered. A local environmental organization has only enough resources to try to save one species. Write a brief persuasive argument for which plant should be saved, based on its status.

Section 3.3 Review

Section Summary

- Threats to biodiversity include habitat loss, the introduction of alien species, overexploitation, and breaking the connectivity among ecosystems.
- Deforestation and draining wetlands can result in habitat loss.
- Extinction is a natural event that has occurred throughout Earth's history.
- Current extinction rates may be accelerated due to human activities.

Review Questions

- K/U** 1. Give two examples of how human actions can lead to habitat loss.
- A** 2. Suppose that you are a member of the town council. A local business has requested permission to expand its buildings onto a nearby wetland. The wetland would be drained and a new hotel would be constructed. The expansion of the business would mean more jobs for the community. How would you vote on this issue? Explain what factors you would consider when making your decision.
- T/I** 3. Occasionally, biologists discover that a species has invaded a new area without the assistance of human beings. For instance, the African cattle egret, the wading bird shown on the right, invaded North America when several individual egrets crossed the Atlantic Ocean. Use a T-chart to summarize the advantages and disadvantages of eliminating a naturally invasive species.
- K/U** 4. Explain how overexploitation can threaten biodiversity.
- C** 5. Write a slogan for a public awareness campaign to identify three human activities that have a negative effect on biodiversity. Share your slogan with your class.
- K/U** 6. Use a Venn diagram to compare and contrast the two patterns of natural extinction.
- K/U** 7. What do scientists hypothesize as possible causes of mass extinctions?
- K/U** 8. What is the biodiversity crisis?



The African cattle egret is an invasive species in North America.