

Key Terms

biodiversity

protect

biodiversity hotspot

3.1 Measuring Biodiversity

Every year, a news headline reads, “New species discovered in ...” For example, in 2006, scientists discovered 36 new species of fish, corals, and shrimp in the warm ocean waters off the coast of New Guinea. One of these was a shark that “walks” along the bottom of the ocean, shown in **Figure 3.1A**. In 2007, 11 new species of plants and animals were found in the rainforests of Vietnam. These included five species of orchids, one of which is shown in **Figure 3.1B**, a snake, and two butterflies. In 2008, scientists in Fiji found a new iguana. The list goes on.

How many species are there on Earth? So far, scientists have identified about 2 million species. However, estimates of the total number of species on Earth range from 5 million to 100 million. One of the tasks of ecologists is to help document the biodiversity of Earth. **Biodiversity** includes the number and variety of organisms found in a specific region. Part of biodiversity also includes the variety of Earth’s ecosystems. In order for biodiversity to remain high, diverse ecosystems need to remain sustainable. Recall that nutrients and energy cycle through ecosystems, and that what happens in one ecosystem can affect cycles in other ecosystems and in Earth’s three other spheres. Preserving and **protecting** individual species and the ecosystems they inhabit are critical to maintaining biodiversity on Earth.

biodiversity the number and variety of life forms, including species, found within a specific region as well as all the number and variety of ecosystems within and beyond that region

protect to guard legally from harm a species that is listed as endangered, threatened, or of special concern

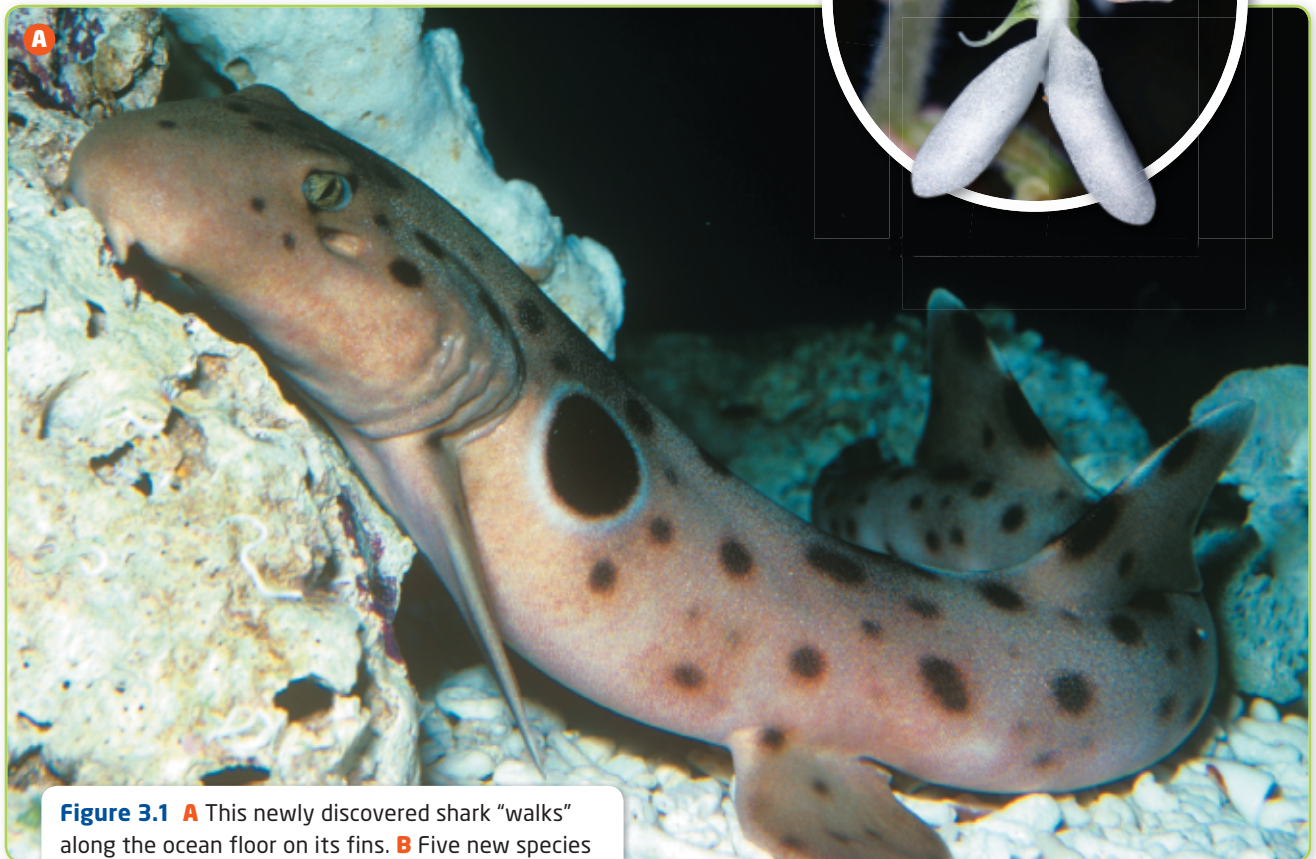


Figure 3.1 **A** This newly discovered shark “walks” along the ocean floor on its fins. **B** Five new species of orchids were discovered in Vietnam in 2007.

How Do Scientists Measure Biodiversity?





Scientists use several methods to measure biodiversity. These include canopy fogging, quadrat sampling, transect sampling, and netting. The method used depends on the types of organisms ecologists are counting and on the habitat. For example, scientists may not be able to use the same method to count insect species living in a tree in a rainforest as they would to count fish species living on a coral reef in an ocean. **Table 3.1** describes different sampling methods in more detail.

Study Toolkit

Interpreting Tables

How does reading the title of **Table 3.1** help you understand what information the table will contain?

Table 3.1 Methods of Measuring Biodiversity

Method	How It Works	In Action
Canopy fogging	Canopy fogging is an effective way of collecting information about the biodiversity of insects. A low dose of insecticide is sprayed up into the top of a tree. When the insects fall, they are collected on a large screen, shaped like a funnel. Scientists may keep and observe some insects. This helps scientists learn more about the life cycle of these insects.	
Quadrat sampling	A quadrat is a known square area that is marked using a pre-made square of plastic, or stakes and string. Quadrats can range in size from 1 m ² to 20 m ² , depending on the type of habitat surveyed. Different species and their numbers within the quadrat are counted. Counting is repeated many times in different places throughout the habitat to get an accurate representation of biodiversity.	
Transect sampling	Transect sampling is done using a transect line. A transect line is usually a rope or measuring tape that has been marked at set intervals, such as every metre. The line is unrolled within the habitat. At every interval, the type and number of species along the line are recorded.	
Netting	Fine mesh nets are used to capture birds and bats in terrestrial ecosystems, and fish and other organisms in aquatic ecosystems. Once captured, an organism is identified. In addition, it may be measured, blood may be taken for genetic analysis, and it may be tagged. In many cases, the organism is then released.	

Documenting Biodiversity and Its Distribution

To protect Earth's biodiversity, scientists need a system for recording the identity of each species and where it exists. Museums house many collections of preserved specimens, such as the insects shown in **Figure 3.2**, as a record of Earth's biodiversity. As well as including specimens from recent investigations—such as insects from canopy fogging—they also contain many specimens from early explorations, some hundreds of years old. The Canadian Museum of Nature in Ottawa and the Royal Ontario Museum in Toronto have massive collections of biological specimens from all over the world.

Since most ecosystems are now influenced by human activities, it is helpful for land-use planners to know the locations of different species, especially rare or sensitive ones. Computer databases can handle huge volumes of such records. Biologists at Ontario's Natural Heritage Information Centre manage such a database and provide biodiversity information relevant to land-use planning.



Figure 3.2 Biological collections housed in museums have helped ecologists catalogue Earth's species.

Canada's Biodiversity

Canada, a large country with many aquatic and terrestrial ecosystems, is home to thousands of species, such as the red mulberry tree shown in **Figure 3.3A**. Recall, from the table in Activity 3-1 on page 87, that plants, insects, fungi (such as mushrooms), and small invertebrates (such as spiders) are far more diverse than larger animals. For example, almost 5000 species of plants have been identified in Canada. Some species, such as the Peary caribou shown in **Figure 3.3B**, are only found in certain locations around the world. Peary caribou are only found in the Canadian Arctic and in Greenland, so Canadians have a special responsibility for their welfare.

Go to [science.ontario](https://science.ontario.ca)
to find out more



Figure 3.3 These two species in Canada need protection. **A** The red mulberry tree is only found in southwestern Ontario. **B** The Peary caribou live mainly in the high arctic islands.

biodiversity hotspot

a place where there is an exceptionally large number of species in a relatively small area

Hotspots of Biodiversity

In analyzing the distribution of the world's biodiversity, ecologists have found that there are “hotspots” of diversity. A **biodiversity hotspot** is a place where there is an exceptionally large number of species in a relatively small area. Hotspots in Canada include Carolinian Canada and the Leitrin Wetlands, both in Ontario. Carolinian Canada, shown in **Figure 3.4**, is an area of deciduous forest in southern Ontario. Although the area makes up only 1 percent of Canada's total landmass, it has a higher number of species than any other ecosystem in Canada. It is estimated to have 2200 plants, including endangered trees and orchids, as well as 40 percent of Canada's breeding bird species. The Leitrin Wetlands, near Ottawa, is home to more than 200 species of plants and 90 species of birds.

In Canada, some of these hotspots have been given special status, which often gives them extra protection from development, such as building houses or industries in the area. For example, Long Point Bay on Lake Erie has been named a World Biosphere Reserve, one of many in an international network of such places that have unique features and a commitment to sustainable development. In the spring and fall, Long Point Bay is home to a rich diversity of wetland species, such as ducks and migrating shorebirds. The Georgian Bay Biosphere Reserve, also shown in **Figure 3.4**, is another Canadian hotspot.

Figure 3.4 Two of Ontario's biodiversity hotspots are the Carolinian Canada and Georgian Bay Biosphere Reserves. **A** Ferns grow on the forest floor of the Carolinian forest in Rouge Park in Toronto. **B** The eastern massasauga rattlesnake, found in the Georgian Bay Biosphere Reserve, is threatened.



Learning Check

1. What is biodiversity?
2. Explain one method used to collect data on biodiversity.
3. Why should scientists record information about biodiversity?
4. How does protecting an ecosystem, such as a wetland, help to preserve biodiversity?

Biodiversity in the Tropics

Although biodiversity in some areas of Canada is high, ecologists have shown that most of the biosphere's diversity hotspots are in the tropics of South America, Africa, and Asia. In tropical East Africa, Lake Malawi, shown in **Figure 3.5**, is home to about 1000 species of fish, many of which can be found only in this lake. Lake Malawi has about the same area as Lake Erie, which is home to about 150 fish species. The results of one study led researchers to conclude that 77 percent of the world's species of vertebrate animals can be found in tropical hotspots that cover only 16 percent of Earth's land surface.

Most tropical hotspots are in developing nations. For example, although Colombia (in South America) is only one ninth the size of Canada, it has four times as many bird species. Developing nations are less likely to have a workforce that has the specialists needed to fill the roles of environmental planners. There are many initiatives in developed nations, such as Canada, to assist in the protection of key ecosystems in these regions.



Figure 3.5 Lake Malawi is a biodiversity hotspot.

Activity 3-2

Biodiversity Index

Scientists can calculate the biodiversity index of an ecosystem using a simple formula. The closer the biodiversity index is to 1, the higher the biodiversity of the ecosystem is.

Materials

- model ecosystems provided by your teacher

Procedure

1. Choose one model ecosystem. Each colour of bead represents a different species. Count the number of different species in the ecosystem. Then count the number of individuals of each species. Calculate the total number of organisms in the ecosystem.
2. Record your data in a table like the one below.

Biodiversity in Ecosystems

Ecosystem	Number of Species	Number of Individuals in Each Species	Total Number of Organisms	Biodiversity
Boreal forest	3	6 of species A 10 of species B 4 of species C	20	$\frac{3}{20} = 0.15$

3. Calculate the biodiversity index for each ecosystem. Divide the number of species in the ecosystem by the total number of organisms in the ecosystem.
4. Repeat steps 1 to 3 for the remaining ecosystem models.

Questions

1. Which ecosystem had the highest biodiversity? Which had the lowest?
2. What are the strengths of using the biodiversity index as a measure of biodiversity for an ecosystem? What are the weaknesses?
3. Give an example of a change to an abiotic or biotic factor in an ecosystem that could change the biodiversity index.

Section 3.1 Review

Section Summary

- Biodiversity is the number and variety of organisms found within a specific region.
- Scientists have identified about 2 million species on Earth.
- Scientists measure biodiversity using several different methods.
- There are places on Earth where there is an exceptionally large number of species in a relatively small area.
- Most biodiversity hotspots are in tropical areas.

Review Questions

- K/U** 1. Use the terms *biodiversity* and *protect* in a single sentence.
- K/U** 2. Use a **Venn diagram** to compare and contrast quadrat sampling and transect sampling.
- A** 3. Identify the method that would be used to analyze the biodiversity in the area shown in the photograph on the right.
- a. What are some possible advantages and disadvantages of this method?
 - b. If you were an ecologist, which method would you use to analyze the biodiversity of fish in a lake?
- C** 4. Argue why scientists should receive funding to record information about biodiversity.
- K/U** 5. Refer to **Figure 3.5** to identify and describe a biodiversity hotspot in the tropics.
- T/I** 6. Scientists have identified about 2 million species. However, estimates of the total number of species on Earth range from 5 million to 100 million. What are some possible reasons why scientists may not have an accurate count of the number of species on Earth?
- T/I** 7. Form a hypothesis to explain why most of the world's biodiversity hotspots are in the tropics.
- K/U** 8. Explain why developed countries, such as Canada, have initiatives to help protect ecosystems in other areas of the world.

