# 3–1 What Is Ecology?

"Floods hit Texas!" "Wildfires char three states!" "Drought withers Florida!" Such news often flashes across television screens, newspapers, and the Internet. We are fascinated and frightened by these natural events, but there are other stories, as well. Some tell of projects to restore wetlands in southern Florida and along the Mississippi River for the purpose of controlling floods and droughts. Others report on improvements in air and water quality as a result of changes in the gasoline that we put in our cars. Like all organisms, we interact with our environment. To understand these interactions better and to learn how to control them, we turn to the science called ecology.

## Interactions and Interdependence

**Ecology** (ee-KAHL-uh-jee) is the scientific study of interactions among organisms and between organisms and their environment, or surroundings. The word *ecology* was coined in 1866 by the German biologist Ernst Haeckel. Haeckel based this term on the Greek word *oikos,* meaning house, which is also the root of the word *economy.* Haeckel saw the living world as a household with an economy in which each organism plays a role.

Nature's "houses" come in many sizes—from single cells to the entire planet. The largest of these houses is called the biosphere. The **biosphere** contains the combined portions of the planet in which all of life exists, including land, water, and air, or atmosphere. It extends from about 8 kilometers above Earth's surface to as far as 11 kilometers below the surface of the ocean.

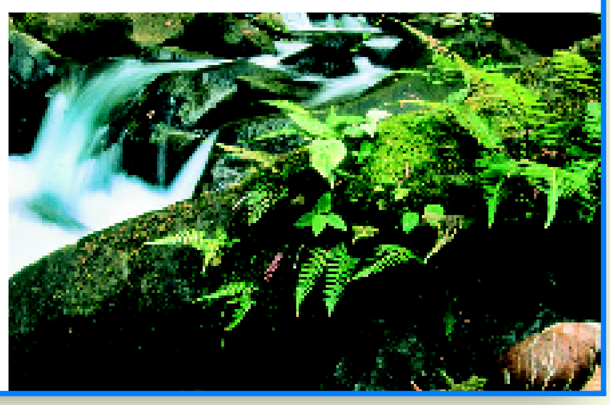
Interactions within the biosphere produce a web of interdependence between organisms and the environment in which they live. Whether it occurs on top of a glacier, in a forest like the one in **Figure 3–1,** or deep within an ocean trench, the interdependence of life on Earth contributes to an ever-changing, or dynamic, biosphere.

### Guide for Reading

**Key Concepts**
- What different levels of organization do ecologists study?
- What methods are used to study ecology?

**Vocabulary**
ecology
biosphere
species
population
community
ecosystem
biome

**Reading Strategy: Asking Questions** Before you read, rewrite the headings in this section as *how, what,* or *why* questions about ecology. Then, as you read, write brief answers to your questions.



▶ **Figure 3–1** Organisms and their environment are interdependent. This giant land snail could not survive without plants and algae to eat, and the plants and algae could not grow unless bacteria and other organisms helped recycle nutrients in the water and soil. **Classifying** *List the organisms that you see in the photograph. Then, list the nonliving parts of the environment with which the organisms interact.*

## SECTION RESOURCES

**Print:**
- ***Teaching Resources,*** Section Review 3–1
- ***Reading and Study Workbook A,*** Section 3–1
- ***Adapted Reading and Study Workbook B,*** Section 3–1
- ***Lesson Plans,*** Section 3–1

**Technology:**
- ***iText,*** Section 3–1
- ***Transparencies Plus,*** Section 3–1

## Section 3–1

## 1 FOCUS

### Objectives

**3.1.1** ***Identify*** the levels of organization that ecologists study.
**3.1.2** ***Describe*** the methods used to study ecology.

### Guide for Reading

**Reading Strategy**

Before students begin their outlines, point out that one major topic below each heading is identified by bold type preceded by the key symbol. Encourage students to rephrase the Key Concepts in their own words. Also point out the highlighted, boldface Vocabulary terms and their definitions.

## 2 INSTRUCT

### Interactions and Interdependence

**Make Connections**

**Earth Science** Call on a volunteer to read the definition of *ecology* aloud. Ask: **What nonliving things in their environment do organisms interact with?** *(Sunlight, air, water, soil, rocks)* **In what ways are these nonliving things essential to organisms?** *(Accept all reasonable descriptions of how abiotic factors meet organisms' needs.)* L2

**Build Science Skills**

**Applying Concepts** Point out that no organism exists in isolation but that all types of organisms on Earth depend on one another for their survival. Ask: **What evidence do you see that people in our society today are aware of the interdependence of living things?** *(Laws have been enacted to reduce air, water, and land pollution and to protect endangered species. People are encouraged to conserve natural resources through recycling and in other ways.)* L1 L2

**Answer to . . .**

**Figure 3–1** *The snail, ferns, mosses, and other plants are organisms. They interact with the rocks, water, air, and light.*

## 3–1 (continued)

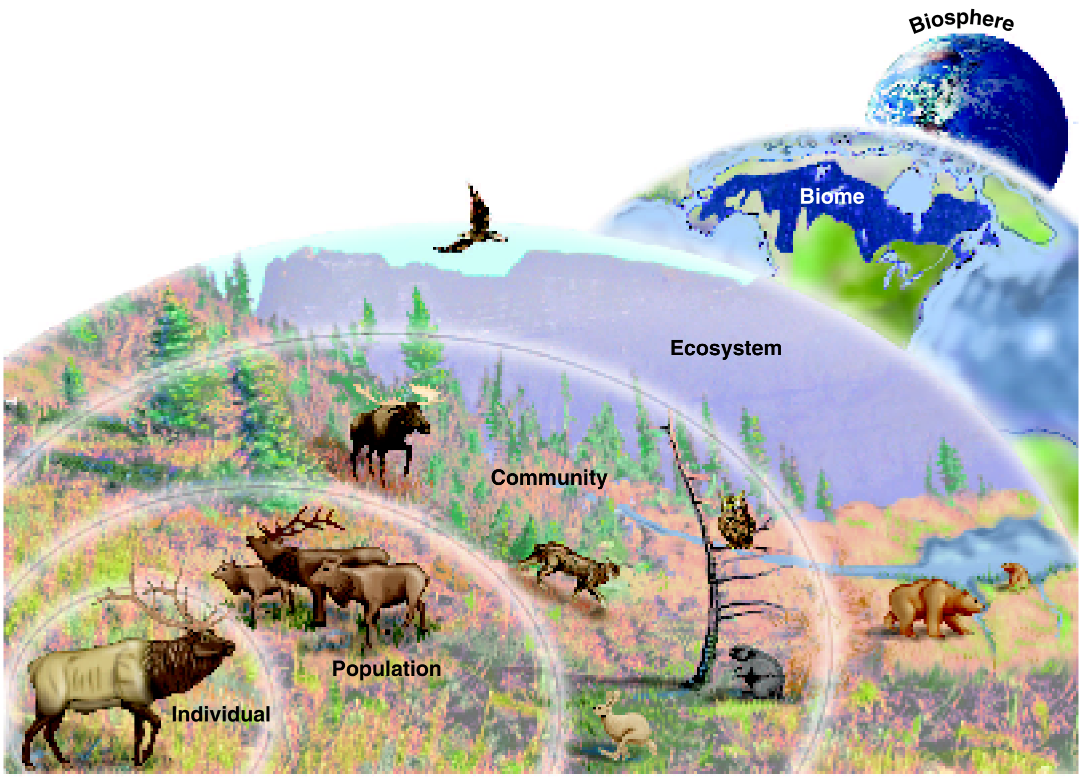
## Levels of Organization

### Use Visuals

**Figure 3–2** As the class looks at the figure, call on students at random to define the term that identifies each level of organization: *population, community, ecosystem, biome,* and *biosphere*. Then, ask: **Can a group of rabbits and a group of field mice make up the same population in an ecosystem?** *(No, because individuals that make up a population must be of the same species)* **Could a biome in Brazil near the equator be the same as a biome in northern Canada? Explain.** *(No, because those two biomes would have different climates and different dominant communities)* L2

### Build Science Skills

**Applying Concepts** To reinforce levels of organization, have students make posters or bulletin-board displays similar to the illustration in Figure 3–2, but with different examples of the six levels of organization. Students can draw the illustrations themselves or use pictures they have cut or photocopied from magazines and books. Have students work in small groups, and encourage each group to focus on a different biome. Have students scan Section 4–3 to identify major biomes. L2




▲ **Figure 3–2** **The study of ecology ranges from the study of an individual organism to populations, communities, ecosystems, biomes—and, finally, to the entire biosphere.** The information that ecologists gain at each level contributes to our understanding of natural systems.

## Levels of Organization

**To understand relationships within the biosphere, ecologists ask questions about events and organisms that range in complexity from a single individual to the entire biosphere.** The many levels of organization that ecologists study are shown in **Figure 3–2.**

Some ecologists study interactions between a particular kind of organism and its surroundings. Such studies focus on the species level. A **species** is a group of organisms so similar to one another that they can breed and produce fertile offspring. Other ecologists study **populations,** or groups of individuals that belong to the same species and live in the same area. Still other ecologists study **communities,** or assemblages of different populations that live together in a defined area.

Ecologists may study a particular ecosystem. An **ecosystem** is a collection of all the organisms that live in a particular place, together with their nonliving, or physical, environment. Larger systems called biomes are also studied by teams of ecologists. A **biome** is a group of ecosystems that have the same climate and similar dominant communities. The highest level of organization that ecologists study is the entire biosphere itself.

CHECKPOINT *What is an ecosystem?*

**ESL SUPPORT FOR ENGLISH LANGUAGE LEARNERS**

**Vocabulary: Word Analysis**

**Beginning** Draw a circle labeled *Earth* on the board. Shade the outer portion of the circle and an area surrounding the circle, and label the shaded circle *biosphere.* Write *biosphere* on the board, and draw boxes around the prefix *bio-* and the base word *sphere.* Point out that *bio-* means "life" and *sphere* means "ball or circle." Have students write *biosphere* on their paper and define the term using short phrases, single words, or pictures. L1

**Intermediate** Extend the beginning-level activity by having the students list other words that use the prefix *bio-*. Possible answers include *biology,* the study of life, and *biography,* a book about someone's life. L2

## Ecological Methods

Ecologists use a wide range of tools and techniques to study the living world. Some, like the scientists in **Figure 3–3,** use binoculars and field guides to assess changes in plant and wildlife communities. Others use studies of DNA to identify bacteria in the mud of coastal marshes. Still others use radio tags to track migrating wildlife or use data gathered by satellites.

**Regardless of the tools they use, scientists conduct modern ecological research using three basic approaches: observing, experimenting, and modeling. All of these approaches rely on the application of scientific methods to guide ecological inquiry.**

**Observing** Observing is often the first step in asking ecological questions. Some observations are simple: What species live here? How many individuals of each species are there? Other observations are more complex and may form the first step in designing experiments and models.

**Experimenting** Experiments can be used to test hypotheses. An ecologist may set up an artificial environment in a laboratory to imitate and manipulate conditions that organisms would encounter in the natural world. Other experiments are conducted within natural ecosystems.

**Modeling** Many ecological phenomena occur over long periods of time or on such large spatial scales that they are difficult to study. Ecologists make models to gain insight into complex phenomena such as the effects of global warming on ecosystems. Many ecological models consist of mathematical formulas based on data collected through observation and experimentation. The predictions made by ecological models are often tested by further observations and experiments.

▲ **Figure 3–3** **The three fundamental approaches to ecological research involve observing, experimenting, and modeling.** These ecologists are studying a rain forest ecosystem in Sri Lanka. They are using field observations to collect data on vines and other plants.

### 3–1 Section Assessment

1. **Key Concept** List the six different levels of organization that ecologists study, in order from smallest to largest.
2. **Key Concept** Describe the three basic methods of ecological research.
3. Identify two ways in which you interact every day with each of the three parts of the biosphere—land, water, and air.
4. **Critical Thinking** **Applying Concepts** Suppose you wanted to know if the water in a certain stream is safe to drink. Which ecological method(s) would you choose, and why?
5. **Critical Thinking** **Applying Concepts** Give an example of an ecological phenomenon that could be studied by modeling. Explain why modeling would be useful.

**Thinking Visually**

**Creating a Table**
Refer to **Figure 3–2,** which shows the various levels of organization that ecologists study. In a table, provide examples of the ecological levels where you live—individuals, populations, communities, and ecosystems—that could be studied by ecologists. *Hint:* You may wish to use library resources or the Internet.

### 3–1 Section Assessment

1. Individual, population, community, ecosystem, biome, biosphere
2. Observing involves using the senses to gather information. Experimenting involves testing hypotheses in a laboratory or natural ecosystem. Modeling involves making representations of ecological phenomena.
3. Student answers should give examples of interactions with land, water, and air.
4. Most students will choose experimenting, which would involve testing a hypothesis about whether the water is safe to drink. Some students might choose modeling, which would involve using a model to investigate whether pollutants or organisms could enter the water.
5. Answers may vary. A typical response might suggest using a mathematical model to study the effects of global warming on an ecosystem.

## Ecological Methods

### Build Science Skills

**Classifying** Divide the class into groups of three, and have each group list one specific example of each ecological method, with all three examples relating to the same type of ecosystem. Then, let groups exchange lists and identify the ecological method that each example represents. L1 L2

## 3 ASSESS

### Evaluate Understanding

Using the diagrams they drew for the Inquiry Activity on page 62, have students write a paragraph describing how the organisms shown in the diagram depend on one another and on nonliving things in their environment.

### Reteach

Call on one student to name an individual organism, a second student to identify the population to which the organism belongs, a third student to describe the community of which the population is a part, and a fourth student to describe the community's ecosystem. Repeat this procedure until every student has had at least one turn.

**Thinking Visually**

The information in students' tables may vary, because students may choose to include any of the populations common in the ecosystems in the area where they live. Each table should include columns for individuals, populations, communities, and ecosystems. Library resources or the Internet could provide students with specific examples of populations that live in the types of ecosystems in their area.

**Interactive Textbook**

If your class subscribes to the iText, use it to review the Key Concepts in Section 3–1.

***Answer to . . .***

CHECKPOINT *A collection of all the organisms that live in a particular place, together with their nonliving, or physical, environment*

## Technology & Society

After students have read this feature, you might want to discuss one or more of the following:

- From their previous learning, students may know how the destruction of forests affects the global carbon-oxygen cycle and water cycle. Have them share this information in a class discussion. Then, ask: **Why is it important for ecologists to be aware of forest destruction? How do you think they would use this information?**
- Discuss the role of phytoplankton in the carbon-oxygen cycle. (You may want to have students preview Energy From the Sun on page 68.)

## Research and Decide

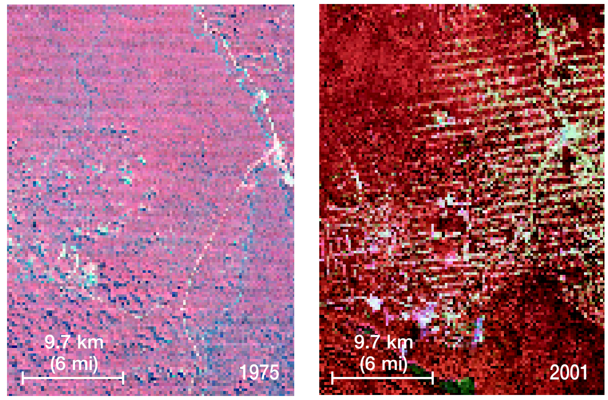
Have students write a report on what they found in their research on satellite use in ecological studies. Ask students to expand on the discussion in this feature about such use by ecologists and then propose ways governments might use the data collected. For example, a local government might study satellite images over time to find out about wetlands in order to make sure development doesn't destroy important natural areas.

Go Online
PHSchool.com

Students can research the use of satellites in ecology on the site developed by authors Ken Miller and Joe Levine.

## Technology & Society

# Exploring Ecology From Space



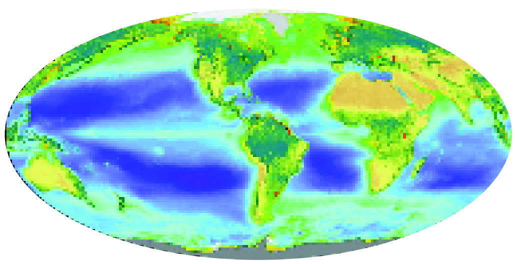

Modern research in global ecology would not be possible if all its tools were earthbound. Studies on a planetary scale require enormous data-gathering networks. Through a process called remote sensing, satellites extend the range of information that ecologists can collect within the biosphere.

Remote-sensing satellites are fitted with optical sensors that can scan several bands of the electromagnetic spectrum and convert those bands into electrical signals. The signals are run through a computer and converted into digital values, which are used to construct an image.

Remote sensing provides detailed images of essentially every square meter of Earth's surface. How else could scientists view all the world's lakes and oceans to see where concentrations of algae are the highest? Or view areas of destroyed forests in places like the Amazon Basin or northern Russia?

## Global Change

The false-color image below was assembled from data gathered by NASA's Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project. The project's goal is to study factors that affect global change and to assess the oceans' role in the global carbon cycle, as well as other chemical cycles. The different ocean colors indicate varying concentrations of microscopic algae. Blue represents the least amount of algae, and red represents the highest amount. On land, the dark green areas have the most vegetation, and gold land areas have the least.



## Rain Forest Destruction

Satellite images that show the presence or absence of vegetation are useful in studying the effects of human activity on natural ecosystems. The two images above, taken 26 years apart, show the same tract of land in a Brazilian rain forest. Red areas show undisturbed forest, and whitish areas show places where trees have been cut and cleared. Note the "fishbone" pattern of vegetation clearing. This pattern occurs because cutting of forests typically begins along existing roads and rivers and then spreads out as new roads and paths are cut.

Data in images such as these, especially when taken over time, help ecologists estimate the rate at which rain forests are being cut down. These data are also valuable in discussing the effects of development with local governments.

## Research and Decide

Use library or Internet resources to learn more about the use of satellites in ecological studies. Decide how ecologists and local governments might use the data in their discussion.

Go Online
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**For:** Links from the authors
**Visit:** PHSchool.com
**Web Code:** cbe-2031

### BIO INSIGHTS — FACTS AND FIGURES

***Terra in space***

Launched in 1999, the school-bus-sized Terra—the "flagship" spacecraft in NASA's Earth Orbiting System—has been described as "a sort of Hubble Space Telescope aimed at Earth." The amount of data that Terra collects each day—about 100,000 encyclopedia volumes' worth—roughly equals the amount of data collected by the Hubble telescope in one year.

Terra circles 705 kilometers above Earth's surface in a polar orbit that carries it past the equator at 10:30 AM each day, when cloud cover over Earth's landmasses is minimal. The satellite's five instruments monitor Earth's radiation balance, sea surface temperatures, levels of greenhouse gases and changes in land cover use, ice sheet volume, and atmospheric chemistry. Data from Terra also may have practical applications, such as managing crops and coastal fisheries and assessing natural hazards such as volcanic activity, earthquakes, floods, and fires.