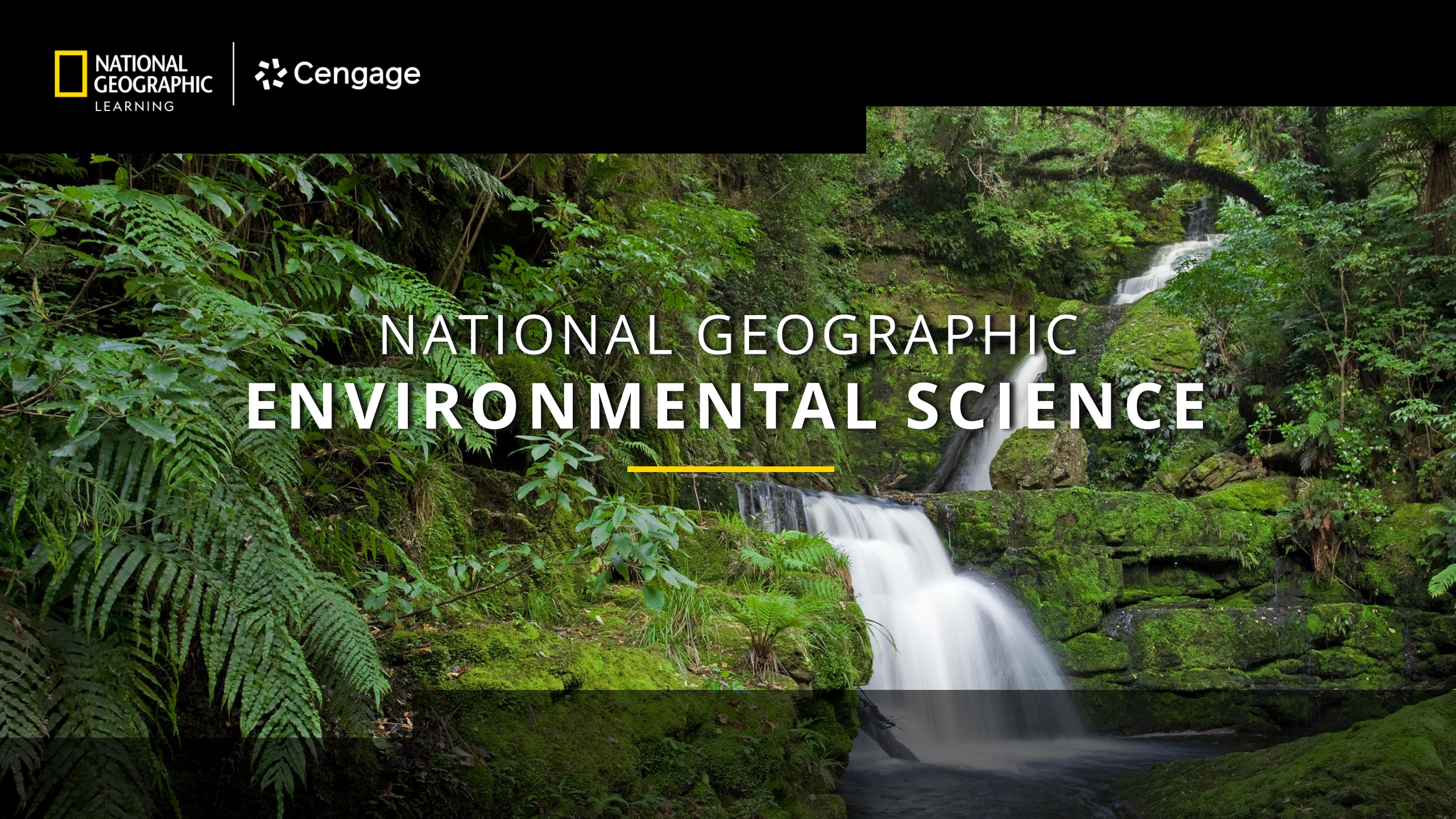


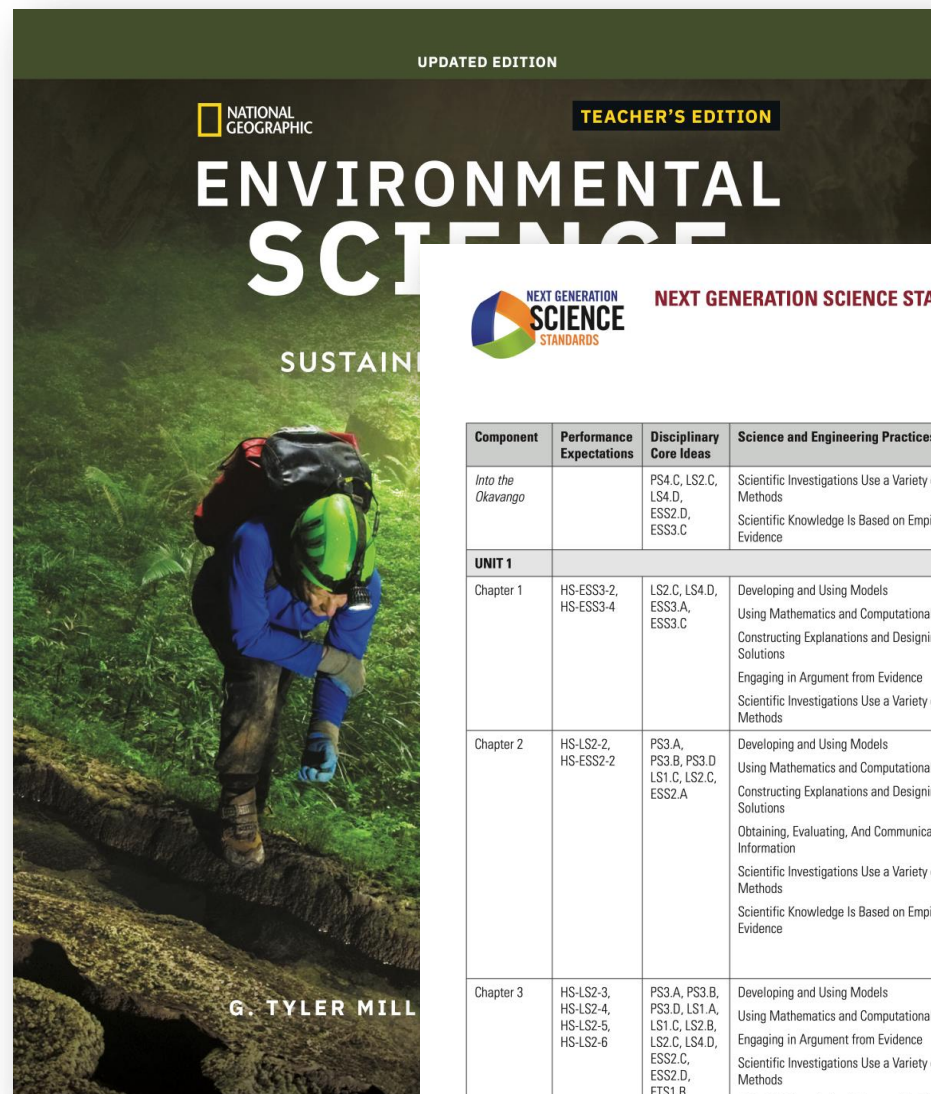


NATIONAL GEOGRAPHIC ENVIRONMENTAL SCIENCE



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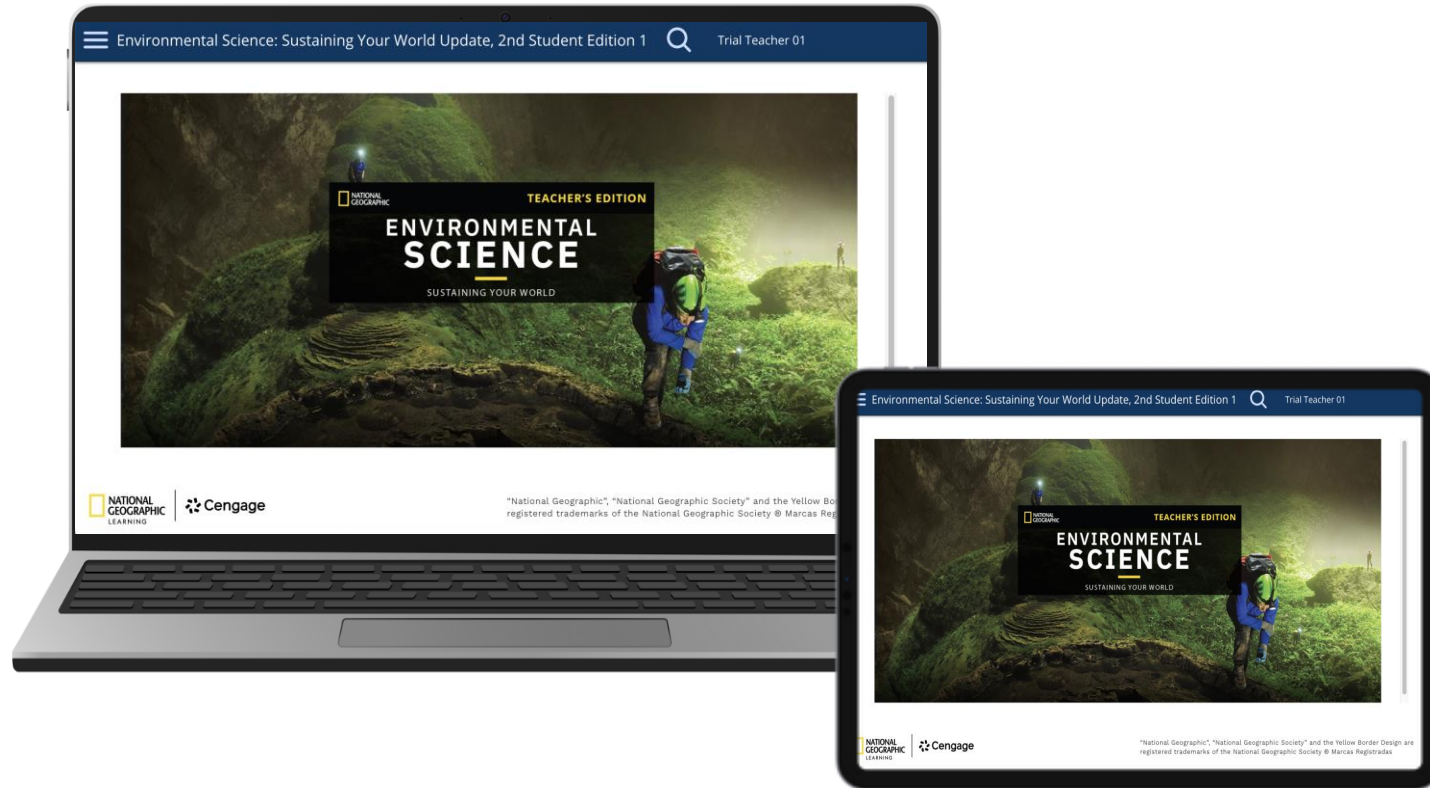
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NEXT GENERATION SCIENCE STANDARDS BY CHAPTER

Component	Performance Expectations	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts
<i>Into the Okavango</i>		PS4.C, LS2.C, LS4.D, ESS2.D, ESS3.C	Scientific Investigations Use a Variety of Methods Scientific Knowledge Is Based on Empirical Evidence	Stability and Change Science Is a Human Endeavor
UNIT 1				
Chapter 1	HS-ESS3-2, HS-ESS3-4	LS2.C, LS4.D, ESS3.A, ESS3.C	Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Scientific Investigations Use a Variety of Methods	Patterns Cause and Effect Scale, Proportion, and Quantity Stability and Change Science Is a Human Endeavor
Chapter 2	HS-LS2-2, HS-ESS2-2	PS3.A, PS3.B, PS3.D, LS1.C, LS2.C, ESS2.A	Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Obtaining, Evaluating, And Communicating Information Scientific Investigations Use a Variety of Methods Scientific Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect Scale, Proportion, and Quantity Systems and System Models Energy and Matter Stability and Change Scientific Knowledge Assumes an Order and Consistency in Natural Systems Scientific Knowledge Is Open to Revision in Light of New Evidence Science Is a Human Endeavor
Chapter 3	HS-LS2-3, HS-LS2-4, HS-LS2-5, HS-LS2-6	PS3.A, PS3.B, PS3.D, LS1.A, LS1.C, LS2.B, LS2.C, LS4.D, ESS2.C, ESS2.D, ETS1.B	Developing and Using Models Using Mathematics and Computational Thinking Engaging in Argument from Evidence Scientific Investigations Use a Variety of Methods Scientific Knowledge Is Open to Revision in Light of New Evidence	Scale, Proportion, and Quantity Systems and System Models Energy and Matter Stability and Change Science Is a Human Endeavor

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Phenomena
Driving Question



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Chapter Case Study
Engineering Focus/Projects
GIS Story Maps
Lesson Activities
Media Library
Audio Podcasts



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Core Ideas & Skills
Lessons



EVALUATE

Lesson Checkpoints
Formative Assessment
Summative Assessment
Chapter Investigations



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Program Consultant



Christopher Thornton
Vice-Chair, Committee
for Research and
Exploration



Dan Buettner
Author
National Geographic
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Featured



Robert
Ocean
National
Explorer-in



Jennifer
Environment
National
Emerging

Featured Explorers *continued*



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Conservationist
National Geographic
Environmental Editor



Sylvia Earle
Oceanographer
National Geographic
Explorer-in-Residence



Jim Estes
Ecologist and
Evolutionary Biologist
National Geographic
Grantee



John Francis
Marine Biologist
National Geographic
Grantee and
Vice President for
Research, Conservation,
and Exploration



Christopher Golden
Ecologist and
Epidemiologist
National Geographic
Emerging Explorer



Jerry Glover
Agroecologist
National Geographic
Emerging Explorer



Jane Goodall
Primatologist
National Geographic
Explorer-in-Residence



Yu-Guo Guo
Chemist
National Geographic
Emerging Explorer



Caleb Harper
Urban Agriculturalist
National Geographic
Emerging Explorer



Zeb Hogan
Ecologist and
Photographer
National Geographic
Fellow



**Osvel Hinojosa
Huerta**
Conservationist
National Geographic
Emerging Explorer



Thomas E. Lovejoy
Tropical and
Conservation Biologist
National Geographic
Fellow



Juan Martinez
Environmental
National Geographic
Emerging Explorer



Nalini Nadkarni
Biologist and Forest
Ecologist
National Geographic
Grantee



Erin Pettit
Glaciologist and
Geophysicist
National Geographic
Emerging Explorer

Featured Explorers *continued*



Sandra Postel
Freshwater
Conservationist
National Geographic
Fellow



Andrés Ruzo
Geologist
National Geographic
Young Explorer



Enric Sala
Marine Ecologist
National Geographic
Explorer-in-Residence



Joel Sartore
Photographer
National Geographic
Fellow



Anna Savage
Evolutionary Geneticist
National Geographic
Young Explorer



**Çağan Hakkı
Şekercioglu**
Ornithologist and
Conservation Ecologist
National Geographic
Emerging Explorer



Shah Selbe
Engineer and
Conservation
Technologist
National Geographic
Emerging Explorer



Hayat Sindi
Science Entrepreneur
National Geographic
Emerging Explorer



Tristram Stuart
Author and Campaigner
National Geographic
Emerging Explorer



Gregg Treinish
Adventurer and
Conservationist
National Geographic
Emerging Explorer



Anand Varma
Natural History
Photographer
National Geographic
Young Explorer



Katey Walter Anthony
Aquatic Ecologist and
Biogeochemist
National Geographic
Emerging Explorer and
Blackstone Innovation
Challenge Grantee



Edward O. Wilson
Biologist and Author
National Geographic
Hubbard Award
recipient



Xiaolin Zheng
Nanoscientist
National Geographic
Emerging Explorer

UNIT 1

ECOLOGY AND ECOSYSTEMS

An Arctic fox (*Vulpes lagopus*) in its tundra habitat in autumn.

The Arctic fox (*Vulpes lagopus*) is an example of an animal uniquely adapted to its ecosystem. These adept hunters' relatively small size and thick fur protect them from the frigid winters of the Arctic tundra. They can withstand external temperature differences of 90–100°C (160–180°F) from their internal body temperatures. Their coats change color seasonally from white to brown, camouflaging them from predators and making it easier for them to hunt prey. Though the Arctic fox is not endangered globally, some local communities are threatened by overhunting, competition with other fox species, and loss of habitat due to climate change.

Because of this, legislatures in affected regions are implementing hunting ordinances as well as other regulations aimed at limiting the decline of Arctic fox populations.

In this unit, you will learn about ecology and the complex interactions between different parts of the Earth system. You will examine why global citizens find it important to assure the sustainability of the planet's ecosystems and how maintaining our planet's future hospitability depends on the preservation of habitats and resources.

CHAPTER 1 THE ENVIRONMENT AND SUSTAINABILITY

CHAPTER 2 SCIENCE, MATTER, ENERGY, AND SYSTEMS

CHAPTER 3 ECOSYSTEM DYNAMICS

ENGINEERING PROJECT 1: Design a Method for Treating Contaminated Soil



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hypothesis states that “biodiversity ensures ecosystems against a decline in their functioning because many species provide greater guarantees of functioning even if others fail.” Ecosystems that are biologically diverse are more likely to include species with traits that enable them to adapt to changes in the environment, such as disease or drought. Such species could help an ecosystem maintain its resilience even if other species are lost.

checkpoint What is the significance of the insurance hypothesis?

FIGURE 4-4
North America's Biomes The midsection of North America contains a variety of biomes, each with its own characteristic climate and mix of species.

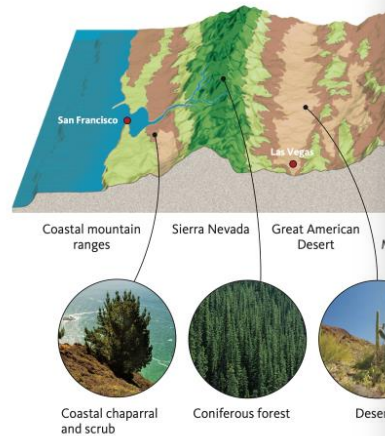


FIGURE 6-3

Ocean Currents and Climate This generalized map of Earth's current climate zones shows the major ocean currents and upwelling areas (where currents bring nutrients from the bottom to the surface). Based on this map, what is the general type of climate where you live?



FIGURE 6-4

Global Air Circulation As air rises and falls in Hadley cells (right), it is also deflected to the east or west (left), depending on where the cell is located. The resulting global winds help to distribute heat and moisture in the atmosphere. How do Hadley cells relate to the areas of forest, desert, and grassland?

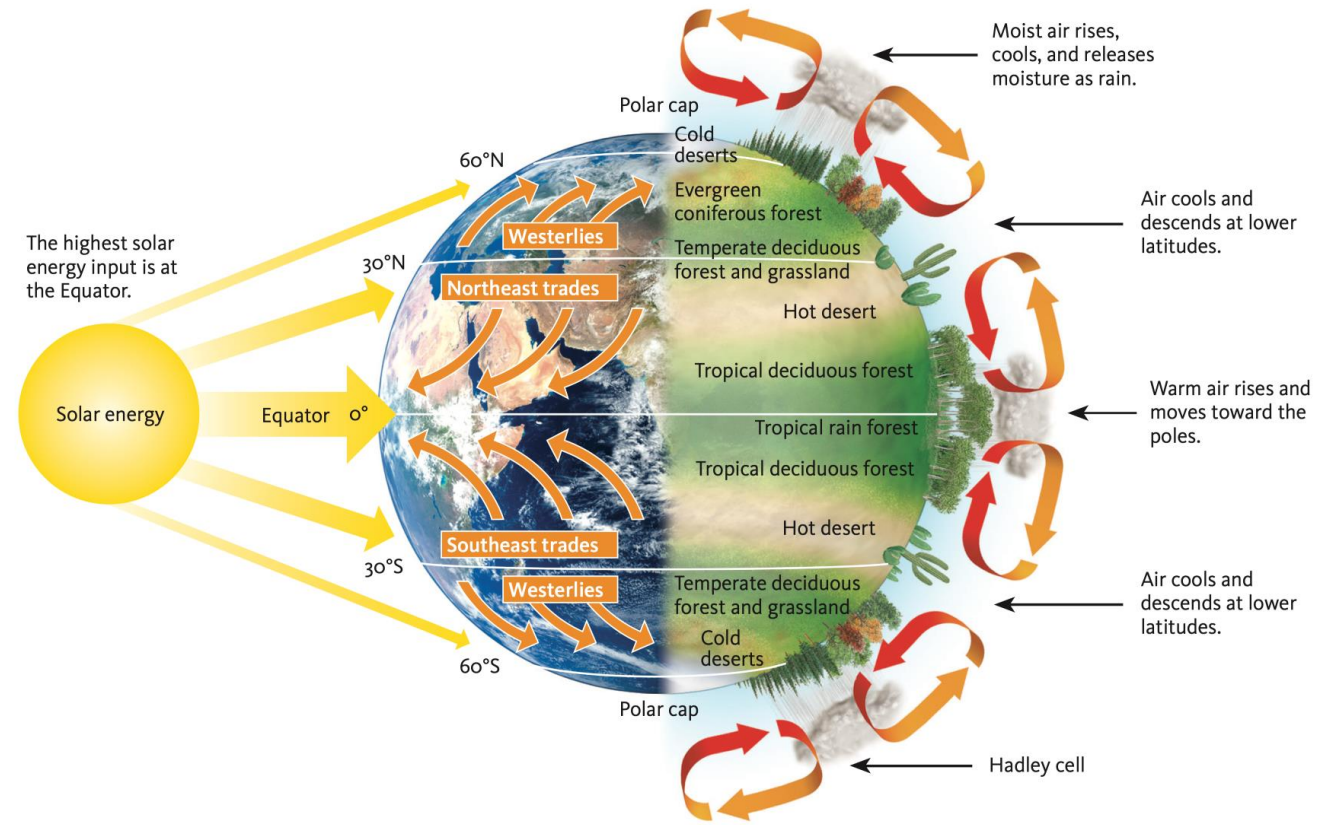




FIGURE 9-17

FIGURE 9-17
Severe soil erosion due to overgrazing by cattle has led to desertification.



FIGURE 5-5
ON ASSIGNMENT Photographer Tim Laman caught the moment a moray eel opened wide to let a cleaner shrimp feed on parasites in its mouth. Which type of interspecies relationship does this image illustrate?

CHAPTER 2

SCIENCE MATTER ENERGY ANALYSIS

IN THIS CHAPTER

Crosscutting Concepts

- Patterns
- Cause and Effect
- Systems and System Models
- Energy and Matter
- Stability and Change

Science and Engineering Practices

- Developing and Using Models
- Using Mathematics and Computational Thinking

- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Disciplinary Core Ideas

- Definitions of Energy
- Conservation of Energy and Energy Transfer
- Energy in Chemical Processes
- Ecosystem Dynamics, Functioning, and Resilience

THE PRESIDENT is the nickname given to this giant sequoia, towering about 75.25 meters (247 feet) high. This forest giant consists of the same basic types of particles that make up all life—namely, long chains of carbon. Where did the sequoia get all that carbon? The enormous tree absorbed most of its carbon directly from the atmosphere. Understanding exchanges in matter is key to understanding ecosystems.

KEY QUESTIONS

- 2.1** What do scientists do?
2.2 What is matter?

- 2.3** What is energy?
2.4 What are systems?



Pause

New Paths to Engaging Science

with National Geographic Explorer Nalini Nadkarni

Nalini Nadkarni has all the academic credentials anyone could ask for. She's a Ph.D. biologist and forest ecologist at the University of Utah, where she's also Director of the Center for Science and Mathematics Education. She's accrued an impressive record of fieldwork, using mountain-climbing techniques, construction cranes, walkways, and hot air balloons to explore the canopies of rain forests on four continents.

But Dr. Nadkarni's real passion is finding ways to bring that important work to people outside the scientific community. She suggests that "if you want to go beyond that small percentage of people who are already environmentally and scientifically aware, you have to make your work somehow link with a passion, interest, or profession of someone who isn't interested in science or nature."

Nadkarni has found some very creative ways to reach new audiences. She invited George "Duke" Brady, a California rap singer, to join her on a tree-climbing expedition. Nadkarni believes Brady's resulting rap about his experience appealed to students in a way that more traditional approaches may not have. That's just one example. Here's another: Treetop Barbie. Combining science and fashion, this popular doll wears the clothing of a forest ecologist and comes with a field guide to canopy plants and animals.

Nalini Nadkarni's most ambitious effort has involved one of the last places you might expect—the prisons of the Washington State Department of Corrections. The Sustainability in Prisons Project

helps incarcerated men and women contribute to conservation and ecological research. The benefits go both ways, Nadkarni insists. The prisoners have a purpose and learn useful skills on the job as they do scientific work, and the scientific community benefits from their projects and the data they gather.

Some of those projects involve time-consuming and meticulous procedures. For example, inmates raise frogs, rear butterflies, catalog moss species, and practice beekeeping. Inmates volunteer for such projects, Nadkarni explains, because they can contribute to society despite being confined. In turn, the inmates hear guest lectures and acquire job skills.

The prisons participating in the Sustainability project often begin to follow more sustainable practices, such as recycling, composting, and organic gardening. Nadkarni covered the walls of an exercise room in one prison with a picture of trees. To everyone's surprise, violence in that unit decreased. Nadkarni's conclusion? "There isn't a person on Earth who couldn't use a connection with nature."

Nadkarni has found some unique ways to bring science to communities that need it. She shows us that all the content knowledge in the world isn't worth much without critical thinking and creativity.

Thinking Critically

Evaluate What factors do you think would be involved in implementing programs similar to the Sustainability in Prisons Project? List some possible pros and cons.

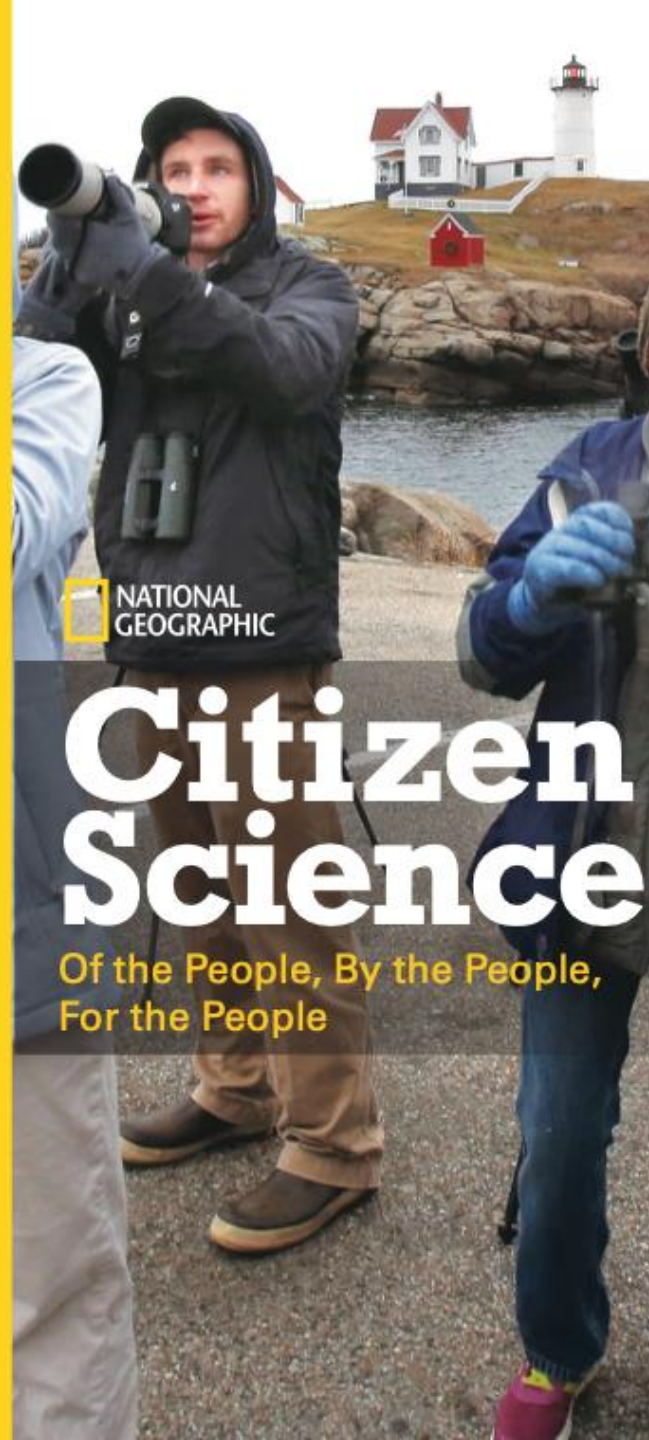


Nadkarni prepares to climb a tree in Costa Rica's Monteverde Cloud Forest Reserve.



Into the Okavango

with National Geographic



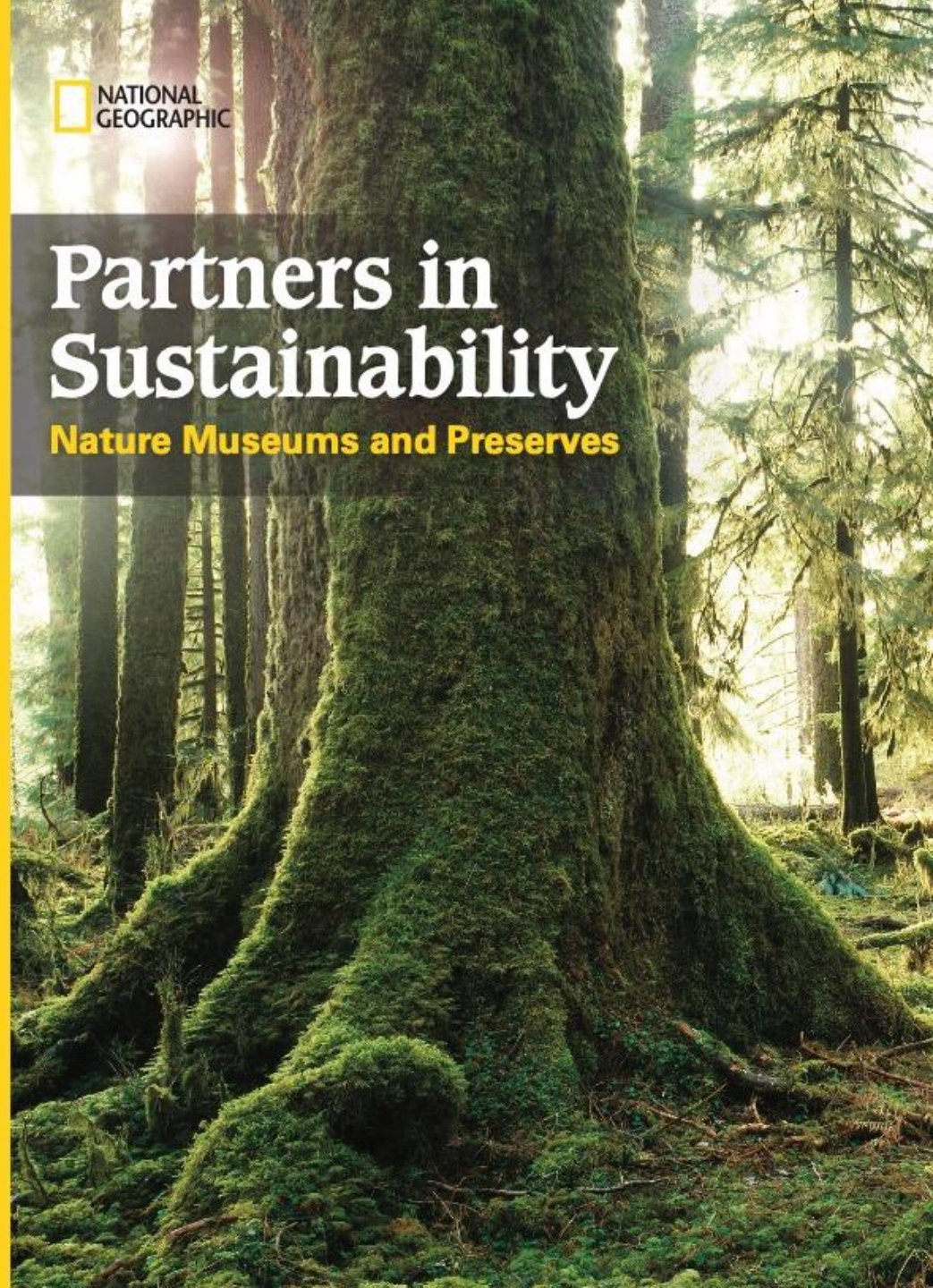
Citizen Science

Of the People, By the People,
For the People



Partners in Sustainability

Nature Museums and Preserves



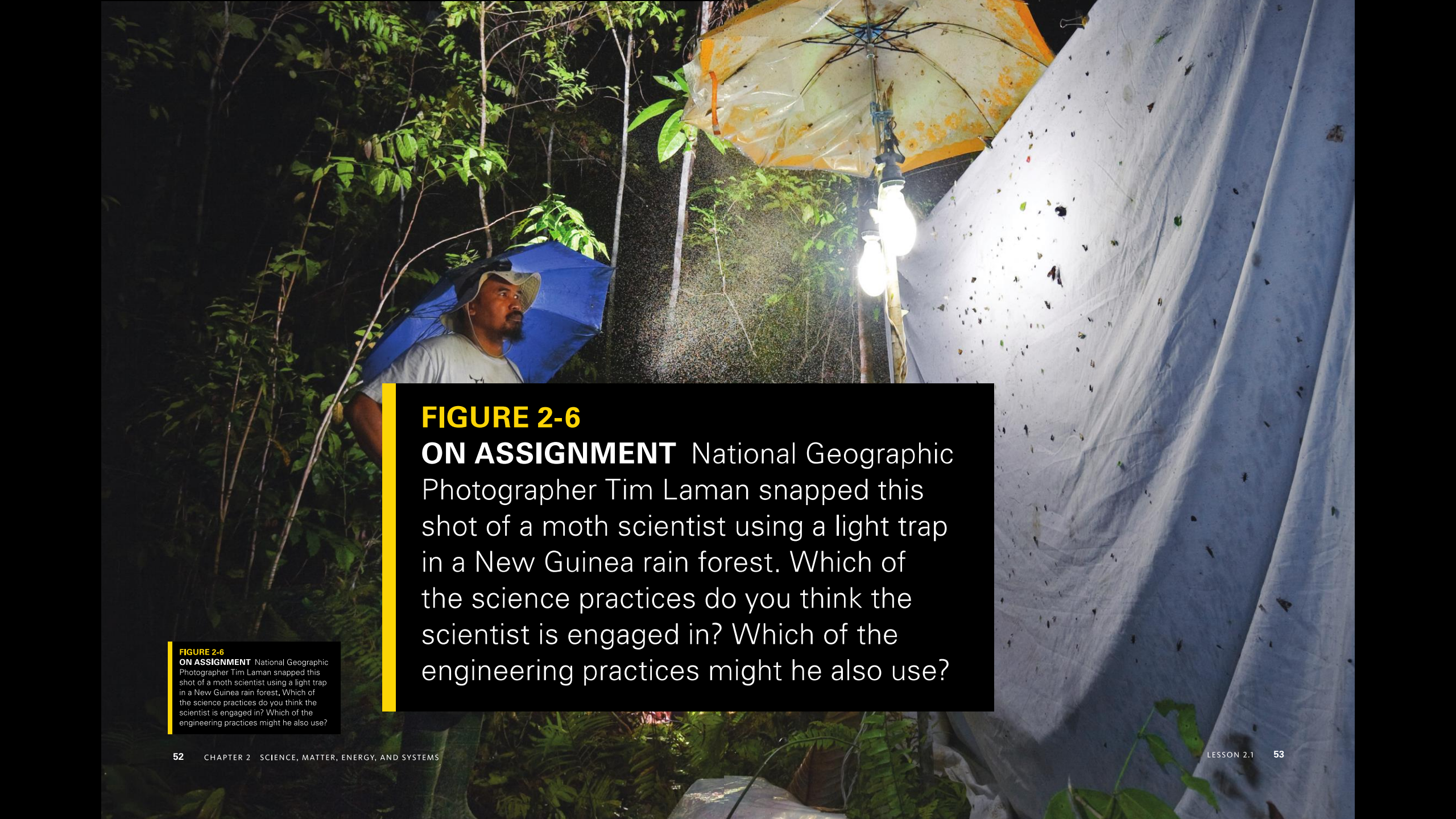
A photograph of a man in a rainforest at night. He is wearing a light-colored shirt and a hat, and is holding a blue umbrella. He is looking up at a light trap that is illuminated by a bright light. The light trap is made of a white sheet of material and is covered with many small, dark moths. The background is dark and filled with the silhouettes of trees and foliage.

FIGURE 2-6

ON ASSIGNMENT National Geographic Photographer Tim Laman snapped this shot of a moth scientist using a light trap in a New Guinea rain forest. Which of the science practices do you think the scientist is engaged in? Which of the engineering practices might he also use?

FIGURE 2-6

ON ASSIGNMENT National Geographic Photographer Tim Laman snapped this shot of a moth scientist using a light trap in a New Guinea rain forest. Which of the science practices do you think the scientist is engaged in? Which of the engineering practices might he also use?

CASE STUDY

Experimenting with a Forest

Suppose a logging company plans to cut down all of the trees on a hillside near your home. You are very concerned and want to know about the possible harmful environmental effects.

One way to learn about such effects is to conduct a controlled experiment. To conduct an experiment, scientists begin by identifying key variables, such as water loss and soil nutrient content. Then, they set up two groups. One is the experimental group, in which a chosen variable is changed in a known way. The other is the control group, in which the chosen variable is not changed. Then they compare the results from the two groups.

In 1963, botanist F. Herbert Bormann, forest ecologist Gene Likens, and their colleagues began carrying out such a controlled experiment. Their goal was to compare the loss of water and soil nutrients from an area of uncut forest (the control site) with one that had been stripped of its trees (the experimental site).

The researchers built V-shaped concrete dams across the creeks at the bottoms of several forested valleys in the Hubbard Brook Experimental Forest in New Hampshire. The dams were designed so that all surface water leaving each valley had to flow across an area where scientists could measure its volume and dissolved nutrient content.

First, the researchers measured the amounts of water and dissolved soil nutrients flowing from an undisturbed forested area in one of the valleys (the control site) (Figure 2-1, left). These measurements showed that an undisturbed mature forest is very efficient at storing water and retaining nutrients in its soils.

Next, they set up an experimental site (Figure 2-1, right). One winter, they cut down all the trees and shrubs in that valley, left them where they fell, and sprayed the area with herbicides to prevent the regrowth of vegetation.

The researchers then compared the outflow of water and nutrients

in this experimental site with those in the control site.

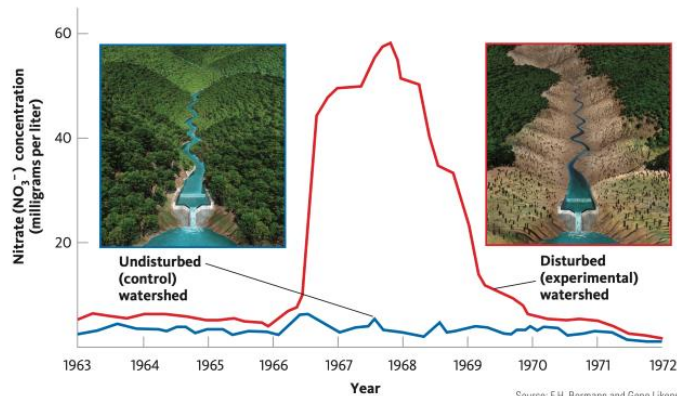
The scientists found that, with no plants to help absorb and retain water, the amount of water flowing out of the deforested valley increased by 30–40%. As this excess water ran rapidly over the ground, it eroded soil and carried dissolved nutrients, such as nitrates, out of the topsoil in the deforested site (Figure 2-1). Overall, the loss of key soil nutrients from the experimental forest was six to eight times that in the nearby uncut control forest.

In this chapter, you will learn how scientists study nature and about the matter and energy that make up the world. You will also learn about scientific laws that govern the changes to matter and energy. And you will learn the important difference between a scientific hypothesis and a scientific theory.

As You Read Think about how ecologists might use basic chemistry and the laws of matter and energy to study ecosystems.

FIGURE 2-1
Nitrate Results

This graph shows the concentrations of nitrate ions in water from the forested watershed (control site) and the deforested watershed (experimental site).



Source: F.H. Bormann and Gene Likens

CASE STUDY

Experimenting with a Forest



SCIENCE TALK Ideas about Matter and Energy

Before students begin, find out what they already know about matter, energy, and systems. **Prompts:**

- Matter and energy differ in that . . .
- One of the most common elements in organisms is . . .
- Forms of energy include . . .

Use students' answers to preview basic chemistry and the laws of matter and energy in the study of ecosystems.

2.2 What Is Matter?

CORE IDEAS AND SKILLS

- Define matter and identify its building blocks.
- Distinguish between physical and chemical changes.
- Describe the law of conservation of matter.

KEY TERMS

matter	ion	chemical
element	pH	reaction
compound	organic	law of
atom	compound	conservation of
isotope	physical change	matter
molecule	chemical change	

Matter Consists of Elements and Compounds

Matter is anything that has mass and takes up space. Matter commonly exists in one of three physical states—solid, liquid, or gas—at a given temperature and pressure. Chemically, matter can be an element or a compound.

Elements An **element** is a type of matter with a unique set of properties that cannot be broken down into simpler substances by chemical means. Chemists refer to each element with a unique symbol, such as C for carbon and Ca for calcium. The known elements are arranged on the basis of their chemical behavior. The chart of these elements is called the periodic table of elements (as shown in Appendix 3). The periodic table currently contains 118 elements. Some of these elements have only been observable in laboratory experiments.

Most matter consists of **compounds**, which are combinations of two or more different elements held together in fixed proportions. For example, water is a compound that consists of the elements hydrogen (H) and oxygen (O).

The **atom** is the basic building block of matter. An atom is the smallest unit of matter into which an element can be divided and still have its distinctive chemical properties. Atoms are incredibly small. More than 3 million hydrogen atoms could sit side by side on the period at the end of this sentence.

Each atom contains certain numbers of three subatomic particles (Figure 2-7).

- Neutrons—particles with no charge that are located in the nucleus (center) of the atom
- Protons—particles with a positive (+) charge that are located in the nucleus of the atom

- Electrons—smaller particles with a negative (−) charge in rapid motion outside the nucleus

Each element has a unique atomic number equal to the number of protons in the nucleus of its atom. Carbon (C) has 6 protons in its nucleus, so it has an atomic number of 6. Uranium (U) has 92 protons in its nucleus. It has an atomic number of 92. The mass number of an atom is the total number of both the protons and the neutrons in its nucleus. Most of an atom's mass is concentrated in its nucleus. Because electrons have so little mass compared with protons and neutrons, the mass number does not include electrons.

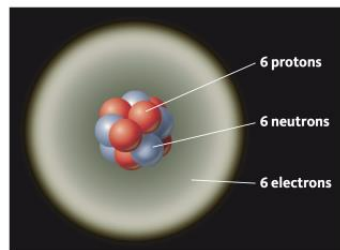
Atoms of a particular element can vary in the number of neutrons they contain, and therefore, in their mass numbers. The forms of an element that have the same atomic number but different mass numbers are called **isotopes**. For example, the three most common isotopes of carbon are carbon-12, carbon-13, and carbon-14.

Molecules A second building block of matter is the **molecule**, a combination of two or more atoms of the same or different elements. The atoms are held together by forces known as chemical bonds. For example, a water (H_2O) molecule consists of two atoms of hydrogen (H_2) bound to one atom of oxygen (O).

Ions A third building block of some types of matter is an **ion**—an atom or group of atoms with a positive or negative charge (+ or −). Chemists use a superscript after the symbol of an ion to indicate the number of positive or negative electrical charges it has. For example, sodium ions (Na^+) have a net positive one charge. Chloride ions (Cl^-) have a net negative one charge. In this chapter's Case Study,

FIGURE 2-7

Atom This simplified model depicts a carbon-12 atom. The atom's nucleus consists of six protons, each with a positive electrical charge, and six neutrons with no electrical charge. Six negatively charged electrons move rapidly outside its nucleus.



Bormann and Likens measured and compared the loss of nitrate ions (NO_3^-) from disturbed and undisturbed forests in their experiment (Figure 2-1). The nitrate ion is a nutrient that is essential for plant growth.

CONSIDER THIS

You are composed of many of the same elements that are found in Earth's crust.

In addition to water, your body is made of calcium, phosphorus, potassium, sulfur, sodium, chlorine, magnesium, and iron. How do these elements get from rocks (Figure 2-9) into your body? They are broken down into soil, taken up by plants, and absorbed from your food. You will learn more about the cycling of matter in Chapter 3.

Ions are important for measuring a substance's acidity in a water solution. Acidity is based on the comparative amounts of hydrogen ions (H^+) and hydroxide ions (OH^-) in the solution. Scientists use the **pH scale** as a measure of acidity.

Pure water (not tap water or rainwater) has an equal number of H^+ and OH^- ions. Pure water is considered a neutral solution and has a pH of 7. A solution that has more H^+ ions than OH^- ions is an acidic solution, or an acid. Acids have a pH less than 7. A solution that has more OH^- ions than H^+ ions is a basic solution (Figure 2-8). It may also be called an alkaline solution or a base. A base has a pH greater than 7.

checkpoint How do elements and compounds differ?

FIGURE 2-8

The pH Scale The pH scale describes the acidity of solutions.

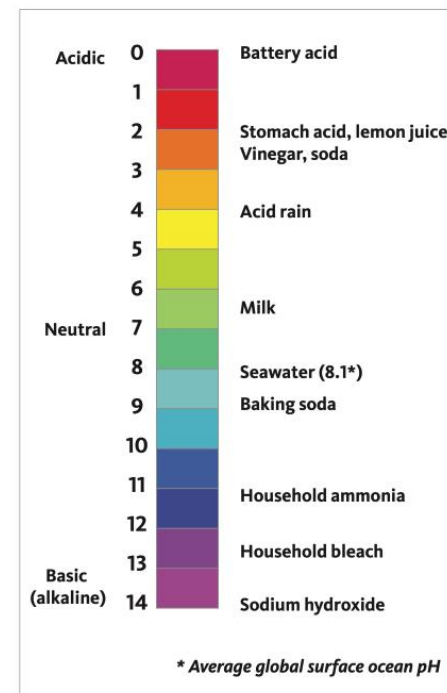


FIGURE 2-9
From Rocks to Organisms The mineral apatite is composed of the elements calcium, phosphorus, oxygen, hydrogen, fluorine, and chlorine. Apatite is a main source of nutrients for plants in soil.

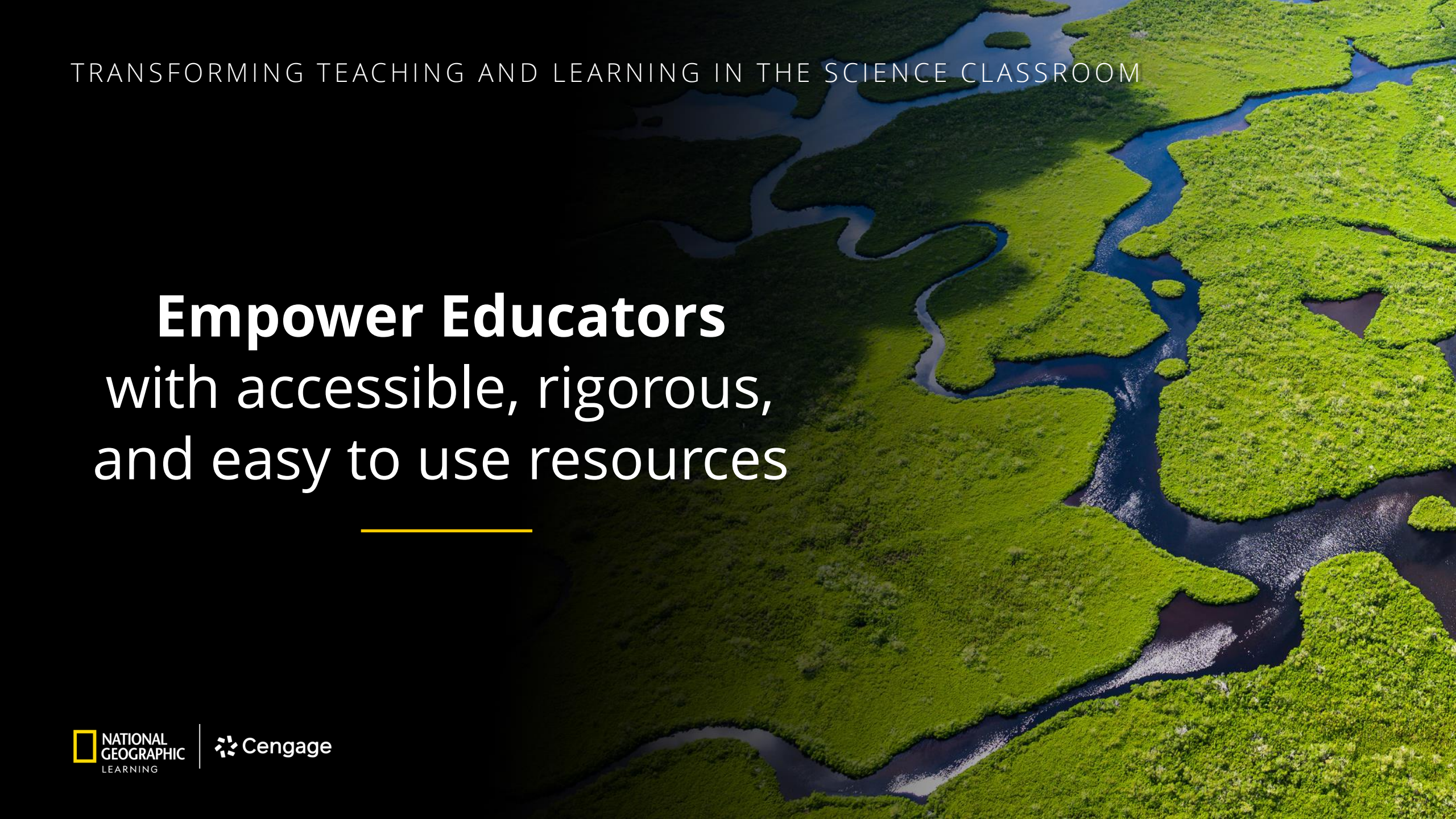


Biomes, Climate and Food Production

|Unit 3|

Hidden impacts of a seemingly safe combustion by-product

September 18, 2021 1/2x



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PLANNING GUIDE

Chapter 1 Planning Guide | The Environment and Sustainability

PAGES	CHAPTER CONTENTS	DIFFERENTIATED SUPPORT	BEYOND TALK	DIGITAL RESOURCES	
14–18 2 days	Chapter Introduction National Geographic Explorers At Work: Reconnecting People with Nature, with Juan Martinez Case Study: The Greening of American Schools	READ WITH PURPOSE Preview the Chapter, p. 18	ON THE MAP Kimbe Bay, p. 14 (<i>world map</i>) • Access to Nature, p. 16 (<i>population density map of United States</i>) ABOUT THE EXPLORER Juan Martinez, p. 16	Watch “Emerging Explorer: Juan Martinez” Pre-Learning Assessment (Pre-Test) Chapter 1 Pre-Test PowerPoint lecture tools	
19–23 2 days	1.1 What Are Some Key Factors of Sustainability? - Discuss the study of environmental science and its goals. - Describe the concept of sustainability and its significance to environmental science. - Understand the link between ecosystem services and natural resources. KEY TERMS: ecology, ecosystem, ecosystem service, environment, environmental science, environmentalism, inexhaustible resource, natural capital, natural resource, nonrenewable resource, renewable resource, sustainability	READ WITH PURPOSE Previewing, p. 19 ELL Illustrated Vocabulary, p. 19	READY TO GO Environmental Science, p. 19 ARTS IN SCIENCE Bottled or Filtered?, p. 22 • Ecolabeling, p. 22	Watch “Sustainability, with Sir David Attenborough” Cognero test bank <i>Maps and Map Analysis</i> , Fig. 4	
23–28 2 days	1.2 How Are Our Ecological Footprints Affecting Earth? - Recognize some major environmental problems that lead to natural capital degradation. - Describe the purpose of the ecological footprint and IPAT models. KEY TERMS: ecological footprint, environmental degradation, nonpoint source, point source, pollution	READ WITH PURPOSE Compose Captions, p. 24 ELL Defining Terms, p. 23 DIFFERENTIATED INSTRUCTION Impact of Individuals, p. 24 (<i>pieces of “clean” trash</i>)	ON THE MAP Island Life, p. 25 (<i>map of Western Hemisphere</i>) TECH IT OUT Average Incomes, p. 26 READY TO GO Sources of Pollution, p. 26	Cognero test bank <i>Maps and Map Analysis</i> , Fig. 4 <i>Reading Graphs and Maps</i> , Fig. 6 Tragedy of the Commons: Trash in the Ocean (Guided Inquiry)	
28–35 2 days	1.3 What Causes Environmental Problems and Why Do They Persist? - Discuss the major causes of environmental problems. - Describe the different forms of environmental degradation that can result from affluence and from poverty. - Explain how one’s environmental worldview affects one’s attitude toward living sustainably. - Compare the three major categories of environmental worldviews. KEY TERMS: Earth-centered worldview, environmental ethics, environmental worldview, exponential growth, human-centered worldview, life-centered worldview	National Geographic On Assignment The Selinda Spillway, Botswana	READ WITH PURPOSE Use Either/Or Sentences, p. 28 ELL Peer Conferencing, p. 28 DIFFERENTIATED INSTRUCTION Worldviews, p. 34	ON THE MAP Population Density, p. 29 (<i>political map of China</i>) • Life on the River, p. 32 (<i>map of Africa</i>) READY TO GO Comprehending Billions, p. 30 • Ecotourism, p. 32 • Cause and Effect, p. 33 • Environmental Ethics, p. 35 ABOUT THE PHOTOGRAPHER Beverly Joubert, p. 32 ARTS IN SCIENCE My Worldview, p. 35	Watch “Half the World Denied Basic Sanitation”; “Pollution in China” <i>NG Weekend:</i> Listen to Beverly and Dereck Joubert Cognero test bank <i>Reading Graphs and Maps</i> , Figs. 1 and 3
36–39 1 day	1.4 What Is an Environmentally Sustainable Society? - Describe the rise of environmental conservation and protection in the United States. - Explain the basic difference between preservation and conservation. - Discuss how people can achieve an environmentally sustainable society. KEY TERMS: environmentally sustainable society, natural income	National Geographic Explorers At Work Dennis Dimick	READ WITH PURPOSE Timelines, p. 36 ELL Demonstrate Meaning, p. 36 (<i>pennies, grains of rice</i>) DIFFERENTIATED INSTRUCTION Environmental Timeline, p. 37	READY TO GO Earth Day, p. 37 • Environmental Legacy, p. 38 ARTS IN SCIENCE Environmental Organizations, p. 39	Cognero test bank
40–43 2 days	STEM Tying It All Together The Greening of the American Mindset Chapter 1 Summary and Assessment STEM Activity A Develop Models: Ecological Footprints Activity B Take Action: Promoting Environmental Sustainability	<i>National Geographic Learning Framework</i> Attitudes Empowerment Skills Communication Knowledge Our Living Planet	SUMMARIZE Word Wall, p. 41 Activity A Develop Models: Ecological Footprints, p. 43 Activity B Take Action: Promoting Environmental Sustainability, p. 43	Post-Learning Assessment (Post-Test) Chapter 1 Assessment Chapter 1 Post-Test	

DIFFERENTIATED INSTRUCTION



DIFFERENTIATED INSTRUCTION

Mapping Energy Transformations

Ask students to think about ways they use energy

in their everyday lives. (electrical energy)

move their bodies, vehicles

create a chain, tracing the source of energy

back to its previous forms. (solar energy)

notice all energy we use starts with the sun

- **Struggling Students:**

Have students map energy back to one of the

quality energy, such as high-quality energy

thermal energy, concentrated solar energy

speed wind, or the burning of fossil fuels

- **Advanced Learners:**

Have students trace the energy chain beyond the

energy chain beyond the source and describe what happens to the energy

next.



ENGLISH LANGUAGE LEARNERS

Pronounce Words

Help students decode and pronounce multisyllabic terms. Display the terms

hydrologic cycle, nitrogen cycle, and phosphorus cycle.

Point to each term and say it slowly once,

enunciating each syllable. Then, blend the parts

together and say the word quickly. Pronounce each

term and have students repeat.

Have pairs of students skim through the lesson

to find the phrases used in context and read the

sentences that include the phrases to their partner.



DIFFERENTIATED INSTRUCTION

Negative Feedback Loops

Ask students to think of an example of a negative feedback

loop in nature. For example, an increase in

cloud cover causes an increase in

cloud cover. This increase, in turn, causes a decrease in

solar radiation and a decrease in the atmosphere.

Have them identify the one in Figure 2-15,

which shows different parts of the system

working to keep the system stable.

Students: Provide a list of

negative feedback loops in nature

to choose among, such as predator-prey

relationships of prey and predators.

Advanced Learners: Ask them to identify

one that could cause the negative

feedback loop to turn into a positive one.

Case Study

Tying It All Together

CASE STUDY

Experimenting with a Forest

Suppose a logging company plans to cut down all of the trees on a hillside near your home. You are very concerned and want to know about the possible harmful environmental effects.

One way to learn about such effects is to conduct a controlled experiment. To conduct an experiment, scientists begin by identifying key variables, such as water loss and soil nutrient content. Then, they set up two groups. One is the experimental group, in which a chosen variable is changed in a known way. The other is the control group, in which the chosen variable is not changed. Then they compare the results from the two groups.

In 1963, botanist F. Herbert Bormann, forest ecologist Gene Likens, and their colleagues began carrying out such a controlled experiment. Their goal was to compare the loss of water and soil nutrients from an area of uncut forest (the control site) with one that had been stripped of its trees (the experimental site).

The researchers built V-shaped concrete dams across the creeks at the bottoms of several forested valleys in the Hubbard Brook Experimental Forest in New Hampshire. The dams were designed so that all surface water leaving each valley had to flow across an area where scientists could measure its volume and dissolved nutrient content.

First, the researchers measured the amounts of water and dissolved soil nutrients flowing from an undisturbed forested area in one of the valleys (the control site) (Figure 2-1, left). These measurements showed that an undisturbed mature forest is very efficient at storing water and retaining nutrients in its soils.

Next, they set up an experimental site (Figure 2-1, right). One winter, they cut down all the trees and shrubs in that valley, left them where they fell, and sprayed the area with herbicides to prevent the regrowth of vegetation.

The researchers then compared the outflow of water and nutrients

in this experimental site with those in the control site.

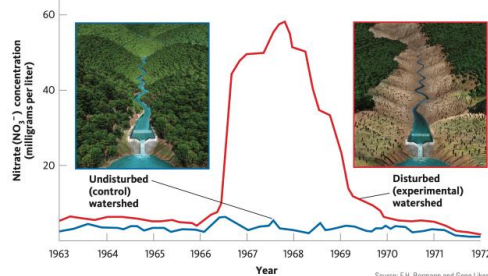
The scientists found that, with no plants to help absorb and retain water, the amount of water flowing out of the deforested valley increased by 30–40%. As this excess water ran rapidly over the ground, it eroded soil and carried dissolved nutrients, such as nitrates, out of the topsoil in the deforested site (Figure 2-1). Overall, the loss of key soil nutrients from the experimental forest was six to eight times that in the nearby uncut control forest.

In this chapter, you will learn how scientists study nature and about the matter and energy that make up the world. You will also learn about scientific laws that govern the changes to matter and energy. And you will learn the important difference between a scientific hypothesis and a scientific theory.

As You Read Think about how ecologists might use basic chemistry and the laws of matter and energy to study ecosystems.

FIGURE 2-1

Nitrate Results
This graph shows the concentrations of nitrate ions in water from the forested watershed (control site) and the deforested watershed (experimental site).



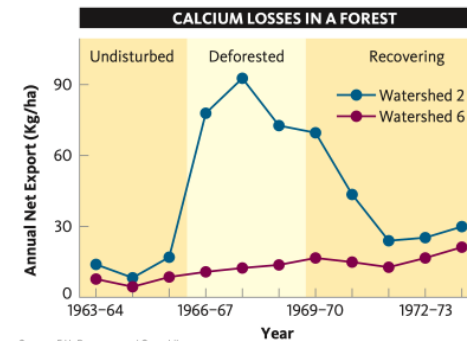
Source: F.H. Bormann and Gene Likens

TYING IT ALL TOGETHER STEM

The Hubbard Brook Forest Experiment

In the controlled experiment discussed in this chapter's Case Study, the clearing of a mature forest degraded some of its natural capital. Specifically, the loss of trees and other vegetation altered the ability of the forest to retain and recycle water and other critical plant nutrients. Key nutrients that would normally have been recycled were lost through erosion.

FIGURE 2-16



Source: F.H. Bormann and Gene Likens

CHAPTER 2 ASSESSMENT

Review Key Terms

Select the key term that best fits each definition. Some terms will not be used.

atom	ion	science
chemical change	isotope	scientific
chemical reaction	kinetic energy	hypothesis
compound	law of conservation of matter	scientific law
data	matter	scientific method
ecological tipping point	model	scientific theory
electromagnetic radiation	molecule	second law of thermodynamics
element	organic compound	system
energy	peer review	thermal energy
feedback loop	pH	
first law of thermodynamics	physical change	
	potential energy	

1. A field of study focused on discovering how nature works
2. Involves practices including asking questions and constructing explanations
3. One of two or more forms of an element with the same atomic number but different mass numbers
4. Stored energy
5. Anything that has mass and takes up space
6. When a sample of matter undergoes this type of change, there is no change in its chemical composition
7. A wave of changing electrical and magnetic fields
8. A testable answer to a scientific question or explanation
9. The energy of the moving particles that make up matter
10. The capacity to do work
11. The smallest unit of matter into which an element can be divided and keep its distinctive chemical properties
12. A well-tested and widely accepted explanation of some aspect of the natural world
13. A representation or simulation of a system

14. States that energy cannot be created or destroyed in a physical or chemical change
15. A measure of acidity
16. Contains at least two carbon atoms combined with atoms of one or more other elements
17. Occurs when an output feeds into a system as input and causes changes in that system

Review Key Concepts

18. Describe three practices that scientists use to learn about nature.
19. What is matter?
20. What are elements and compounds?
21. What is pH?
22. Describe an example of a chemical change.
23. Why are organic compounds important to living organisms?
24. Define the law of conservation of matter.
25. What is the difference between kinetic energy and potential energy?
26. Explain why thermal energy is classified as kinetic energy.
27. What is the law of conservation of energy, also known as the first law of thermodynamics?
28. What is the second law of thermodynamics?
29. What are the main components of a system?
30. Describe an example of a negative feedback loop.

Think Critically

31. What ecological lesson can be gained from the experiment on the clearing of forests described in the Case Study that opened the chapter?
32. Suppose you observe that all the fish in a pond have disappeared. How might you use the scientific practices to determine the cause of this fish kill?
33. Reread the caption for the hydroelectric power plant (Figure 2-13). Infer the difference between an energy transformation and an energy transfer.

34. Use the second law of thermodynamics to explain why we can use oil only once as a fuel. Or, in other words, why can't we recycle its potential energy?

35. Because of the law of conservation of matter, there is no way to truly "get rid of" wastes. Why is the world not filled with waste matter?

Chapter Activities

A. Experiment: Runoff STEM

As described in the Case Study, ground cover affects the amount, quality, and composition of runoff. In this lab, you will create a model to help you conduct a controlled experiment similar to the larger study led by Bormann and Likens. During the experiment, you will use your model to answer the question, "How does ground cover affect the amount, quality, or composition of water runoff?"

Materials

3 plastic bottles	3 plastic cups
scissors	watering can
soil	string
twigs, bark, leaves, and/or plant debris	plants, seedlings, or pieces of sod

1. With the bottles lying on their side, cut each one lengthwise, leaving the bottom and opening of the bottle intact.
2. Place equal amounts of soil in each of the 3 bottles. Press down firmly and ensure that the soil is below the opening of the bottle.
3. Punch two holes in each of the cups and tie the string to create a handle. This will be used to hang over the bottle opening and collect the "runoff."

4. Look at the materials provided. As a group, discuss which two types of ground cover you would like to use in your experiment. Remember that you need a control, so the third bottle will only contain the soil.
5. Write your hypothesis. Identify your independent and dependent variables.
6. Place the ground covers chosen in the two remaining bottles and label them accordingly.
7. Hang the cups from the necks of the three bottles with the various ground covers in them.
8. Using the watering can, filled to a predetermined line, pour the water onto the soil at the end opposite to the opening and make observations about the water that flows into the cups.

Questions

1. What differences did you notice in the water collected in the cups? Why do you think these differences occurred?
2. Compare and contrast this model with the experiment done by Bormann and Likens. What conclusions could you draw from this model about the role of ground coverings in nature?

B. Citizen Science

National Geographic Learning Framework

Attitudes | Responsibility
Skills | Observation
Knowledge | Our Living Planet

Chemical conditions are critical factors affecting water quality. Acidity and the amount of dissolved ions, including nitrates and phosphates, must stay within certain ranges to support living things. The U.S. EPA and other organizations offer test kits that citizens can use to help monitor local bodies of water. For example,

pH strips can be used to test for acidity and nitrate strips test nitrate ion concentration.

Join a citizen science group to monitor the quality of a local lake, estuary, stream, or wetland. Gather in small groups with your classmates to share your experiences.

ASSESSMENT HANDBOOK



ENVIRONMENTAL SCIENCE

ASSESSMENT HANDBOOK

Name _____

Class _____

Date _____

CHAPTER 1 PRETEST

1. Biodiversity is one key to the long-term sustainability of life on Earth.
A. True
B. False
2. Using natural resources is considered a sustainable practice because most natural resources are in limitless supply and cannot be degraded or depleted.
A. True
B. False
3. Ecosystem services are services that are supplied by humans for the environment.
A. True
B. False
4. In a healthy, functioning ecosystem, chemicals and nutrients are constantly recycled and reused.
A. True
B. False
5. One of the main goals of environmental science is to help humans use the environment in a way that is economically profitable.
A. True
B. False
6. Point sources of pollution are dispersed and often difficult to identify.
A. True
B. False
7. The average individual ecological footprint varies between areas or countries.
A. True
B. False
8. The most effective way to deal with pollution is to focus on cleanup efforts.
A. True
B. False

ENVIRONMENTAL SCIENCE 1 OF 1

Name _____

Class _____

Date _____

CHAPTER 1 POST-TEST



1. Which of the following is NOT a factor of sustainability?
A. economics
B. ethics
C. biodiversity
D. natural capital
E. solar energy
2. Which resource does NOT need to be cycled by ecosystems because a continuous, unlimited supply is available?
A. solar energy
B. water
C. pollinators
D. carbon
E. natural gas
3. Suppose you are part of a community with a sustainable yield of fish. Which of the following would be true?
A. The yield of fish is increasing each year.
B. No other species of fish have been inadvertently caught.
C. The rate of harvest does not exceed the fish population's rate of recovery.
D. The community has harvested enough fish to meet its nutritional requirements.
E. The fish are being harvested using humane methods.
4. Together, natural resources and ecosystem services are referred to as _____.
A. inexhaustible resources
B. natural capital
C. environmental degradation
D. biodiversity
E. ecological footprints
5. Which of the following qualifies as point-source pollution?
A. a sewer pipe dumping raw sewage into a stream
B. fertilizer runoff from agricultural fields
C. exhaust from vehicles in a county
D. solid waste from consumers in a city
E. pollutants emitted by power plants in a region

ENVIRONMENTAL SCIENCE 1 OF 3

2

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Question Sets Options

- NG Environmental Science, 1e, © 2024
 - C01_The Environment and Sustainability
 - C02_Science Matter Energy and Systems
 - C03_Ecosystem Dynamics
 - C04_Biodiversity and Evolution
 - C05_Species Interactions Ecological Succession and Population Control
 - C06_Ecosystems and Climate
 - C07_Saving Species and Ecosystem Services
 - C08_Sustaining Biodiversity An Ecosystem Approach
 - C09_Food Soil and Pest Management
 - C10_Water Resources and Water Pollution
 - C11_Geology and Nonrenewable Mineral Resources
 - C12_Nonrenewable Energy Resources**
 - The initial amount of low-quality energy available from an energy resource

Tests Options

- My Tests
- Shared Content
- NG Environmental Science, 1e, © 2024

Chapter 12 Test X

File Edit Test **Question** Number of questions: 20

View: 10 questions Go to: Questions 1-10

Indicate the answer.

1. Which factor limits the growth of a population?

- the limit of resources
- efforts to control population
- the need to safely store radioactive waste
- the development of affordable nuclear fuel
- government subsidies and tax breaks for renewable energy

ANSWER: d

2. What would NOT make an energy resource more competitive in the marketplace?

- subsidies
- tax breaks
- full-cost pricing
- technology improvements
- affordable pricing

ANSWER: c

3. Which equation best represents net energy?

- net energy = energy output + energy input
- net energy = initial low-quality energy – energy input
- net energy = energy input – energy output
- net energy = energy output – energy input
- net energy = high-quality energy + low-quality energy

ANSWER: d

4. The world's top consumer of crude oil is _____.

- Venezuela
- the United States
- China
- Saudi Arabia
- Japan

ANSWER: b

5. Fracking technology has resulted in _____.

- better methods for refining crude oil

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Normal Outline View Slide Sorter Notes Page Reading View Slide Master Handout Master Notes Master Ruler Gridlines Guides Notes Zoom Fit to Window Macros

18 Generalist and Specialist Species

- Generalist species (broad niches)
 - Eat wide variety of foods
 - Can live in a wide range of environments
 - More resource competition but less prone to extinction
- Specialist species (narrow niches)
 - Have specialized diets
 - Live in only a few types of habitats
 - Less competition but more prone to extinction

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19 A Specialist and a Generalist

Figure 4-8

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20 Specialization Reduces Competition

Figure 3-20

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21 Native and Nonnative Species

- Native species
 - Naturally originated in a specific ecosystem, suited to conditions there
- Nonnative species
 - Immigrate or are introduced (deliberately or accidentally) into an ecosystem
 - Can become invasive
 - Outcompete/displace native species
 - Spread rapidly if they find a favorable niche
 - Often lack predators, face disease in native habitat

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22 Keystone Species Play Critical Roles in

Slide 1 of 48 English (United States) Notes Comments 75%

Environmental Science, 2e

SUSTAINING YOUR WORLD

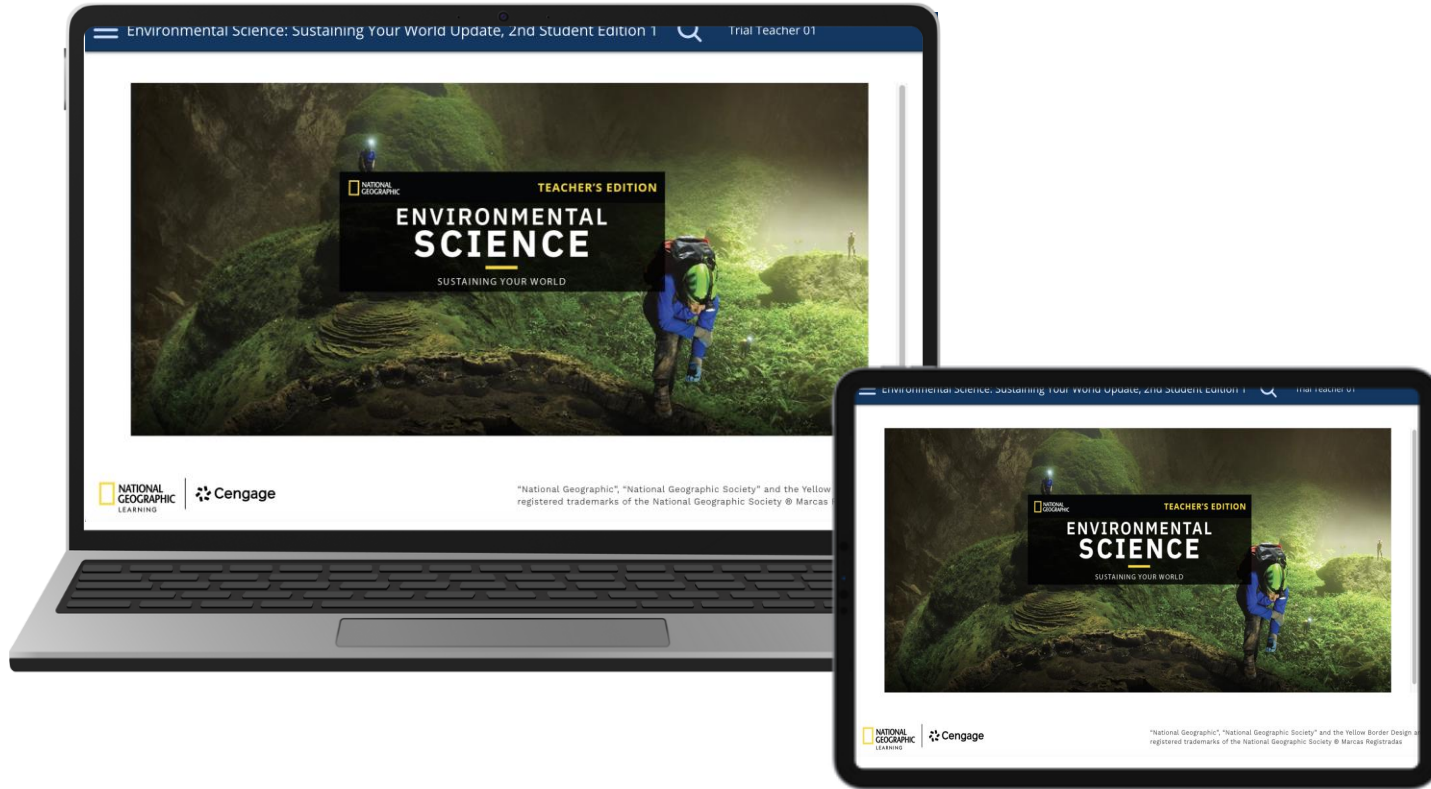
G. TYLER MILLER | SCOTT E. SPOOLMAN

Unit 2

Biodiversity

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DIGITAL LEARNING RESOURCES

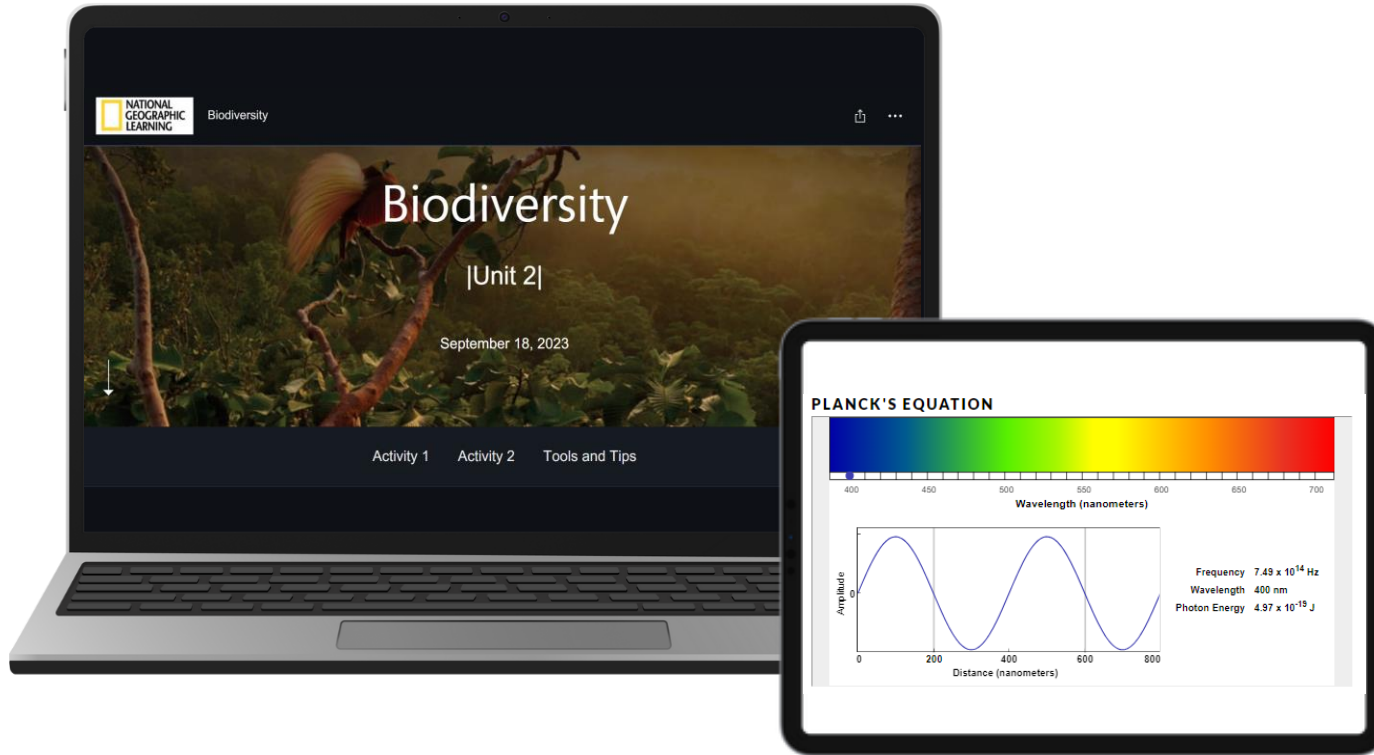




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