NATIONAL GEOGRAPHIC

Florida Grades 9-12

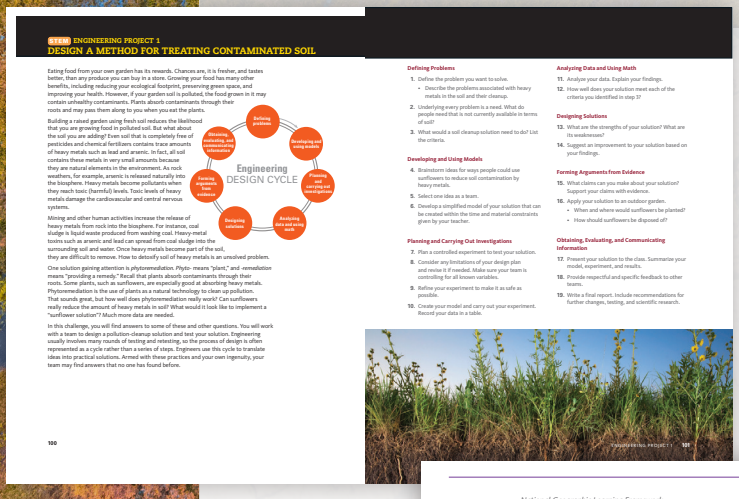
ENVIRONMENTAL SCIENCE

SUSTAINING YOUR WORLD

Florida Edition

CREATE ACTIVE CRITICAL-THINKERS AND ENVIRONMENTAL SCIENCE DOERS

Students take an active role in understanding environmental science issues through critical thinking practice and 3-Dimensional hands-on lessons with labs, citizen science activities, digital mapping and data analysis, and local community and home-based projects.


STEM ENGINEERING PROJECT 1

DESIGN A METHOD FOR TREATING CONTAMINATED SOIL

Eating food from your own garden has its rewards. Chances are, it is fresher, and tastes better, than any produce you can buy in a store. Growing your food has many other benefits, including reducing your ecological footprint, preserving green space, and improving your health. However, if your garden soil is polluted, the food grown in it may contain unhealthy contaminants. Plants absorb contaminants through their roots and may pass them along to you when you eat the plants.

Building a raised garden using fresh soil reduces the likelihood that you are growing food in polluted soil. But what about the soil you are adding? Even soil that is completely free of pesticides and chemical fertilizers contains trace amounts of heavy metals such as lead and arsenic. In fact, all soil contains these metals in very small amounts because they are natural elements in the environment. As rock weathers, for example, arsenic is released naturally into the biosphere. Heavy metals become pollutants when they reach toxic (harmful) levels. Toxic levels of heavy metals damage the cardiovascular and central nervous systems.

Mining and other human activities increase the release of heavy metals from rock into the biosphere. For instance, coal sludge is liquid waste produced from washing coal. Heavy-metal toxins such as arsenic and lead can spread from coal sludge into the surrounding soil and water. Once heavy metals become part of the soil, they are difficult to remove. How to detoxify soil of heavy metals is an unsolved problem.

One solution gaining attention is phytoremediation. *Phyto-* means "plant," and *-remediation* means "providing a remedy." Recall that plants absorb contaminants through their roots. Some plants, such as sunflowers, are especially good at absorbing heavy metals. Phytoremediation is the use of plants as a natural technology to clean up pollution. That sounds great, but how well does phytoremediation really work? Can sunflowers really reduce the amount of heavy metals in soil? What would it look like to implement a "sunflower solution"? Much more data are needed.

In this challenge, you will find answers to some of these and other questions. You will work with a team to design a pollution-cleanup solution and test your solution. Engineering usually involves many rounds of testing and retesting, so the process of design is often represented as a cycle rather than a series of steps. Engineers use this cycle to translate ideas into practical solutions. Armed with these practices and your own ingenuity, your team may find answers that no one has found before.

Engineering DESIGN CYCLE

100

Defining Problems

1. Define the problem you want to solve.
   - Describe the problems associated with heavy metals in the soil and their cleanup.
2. Underlying every problem is a need. What do people need that is not currently available in terms of soil?
3. What would a soil cleanup solution need to do? List the criteria.

Developing and Using Models

4. Brainstorm ideas for ways people could use sunflowers to reduce soil contamination by heavy metals.
5. Select one idea as a team.
6. Develop a simplified model of your solution that can be created within the time and material constraints given by your teacher.

Planning and Carrying Out Investigations

7. Plan a controlled experiment to test your solution.
8. Consider any limitations of your design plan and revise it if needed. Make sure your team is controlling for all known variables.
9. Refine your experiment to make it as safe as possible.
10. Create your model and carry out your experiment. Record your data in a table.

Analyzing Data and Using Math

11. Analyze your data. Explain your findings.
12. How well does your solution meet each of the criteria you identified in step 3?

Designing Solutions

13. What are the strengths of your solution? What are its weaknesses?
14. Suggest an improvement to your solution based on your findings.

Forming Arguments from Evidence

15. What claims can you make about your solution? Support your claims with evidence.
16. Apply your solution to an outdoor garden.
    - When and where would sunflowers be planted?
    - How should sunflowers be disposed of?

Obtaining, Evaluating, and Communicating Information

17. Present your solution to the class. Summarize your model, experiment, and results.
18. Provide respectful and specific feedback to other teams.
19. Write a final report. Include recommendations for further changes, testing, and scientific research.

ENGINEERING PROJECT 1 101

B. Take Action

National Geographic Learning Framework

Attitudes | Responsibility
Skills | Problem-Solving
Knowledge | Our Living Planet

For one week, weigh the food that is purchased in your home and the food that is thrown out. Keep track of the types of food you eat from day to day, using categories like fruits, vegetables, meats, dairy, and even more specific categories if you wish. For instance, you might weigh packaging and separate your data into "landfill" and "recyclable" data.

1. Record and compare your data.
2. Develop a plan to increase your food sustainability, for example, by cutting your household food waste in half.
3. Develop a similar study for your school cafeteria and report the results and your recommendations to school officials.

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.

Students become science doers with citizen science projects, analyzing their personal or local environmental footprints, and through labs and Engineering Projects.

Authentic National Geographic Experiences

Environmental Science: Sustaining Your World, Florida Edition truly delivers the world to classrooms with real stories from National Geographic Explorers who share their diverse perspectives in solving environmental issues. National Geographic feature articles and images from some of the world's best photographers complete the environmental science story for students.

Introduce phenomena to students through the stories and real-world experiences of National Geographic Explorers and photographers

ENGAGE STUDENTS WITH AUTHENTIC ENVIRONMENTAL SCIENCE STORIES

5E Instructional Path

ENGAGE

- Explorers At Work
- 3D Lesson Design
- Real World Issues & Phenomena
- Driving Question

EXPLORE/EXPLAIN

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

ELABORATE

- Tying it All Together
- Hands On Labs
- Investigations
- Core Ideas & Skills Lessons
- Laboratory Experiments

EVALUATE

- Lesson Checkpoints
- Formative Assessments
- Summative Assessments
- Chapter Investigations

Students experience real-world stories from National Geographic Explorers and photographers who inspire students to think creatively about solving environmental science problems. Case Studies and Science Focus features show how an understanding of diverse ecosystems is critical to students' lives.


NATIONAL GEOGRAPHIC | EXPLORERS AT WORK

Sustainable Agriculture: Is It Possible?

with National Geographic Explorer Jennifer Burney

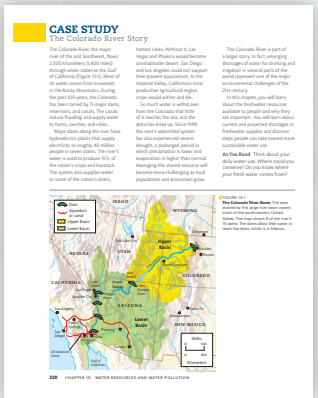
Explorers At Work show diverse perspectives to solving real-world phenomena using concepts from the chapter


NATIONAL GEOGRAPHIC | EXPLORERS AT WORK

Rescuing the Colorado River Delta

with National Geographic Explorer Osvel Hinojosa Huerta

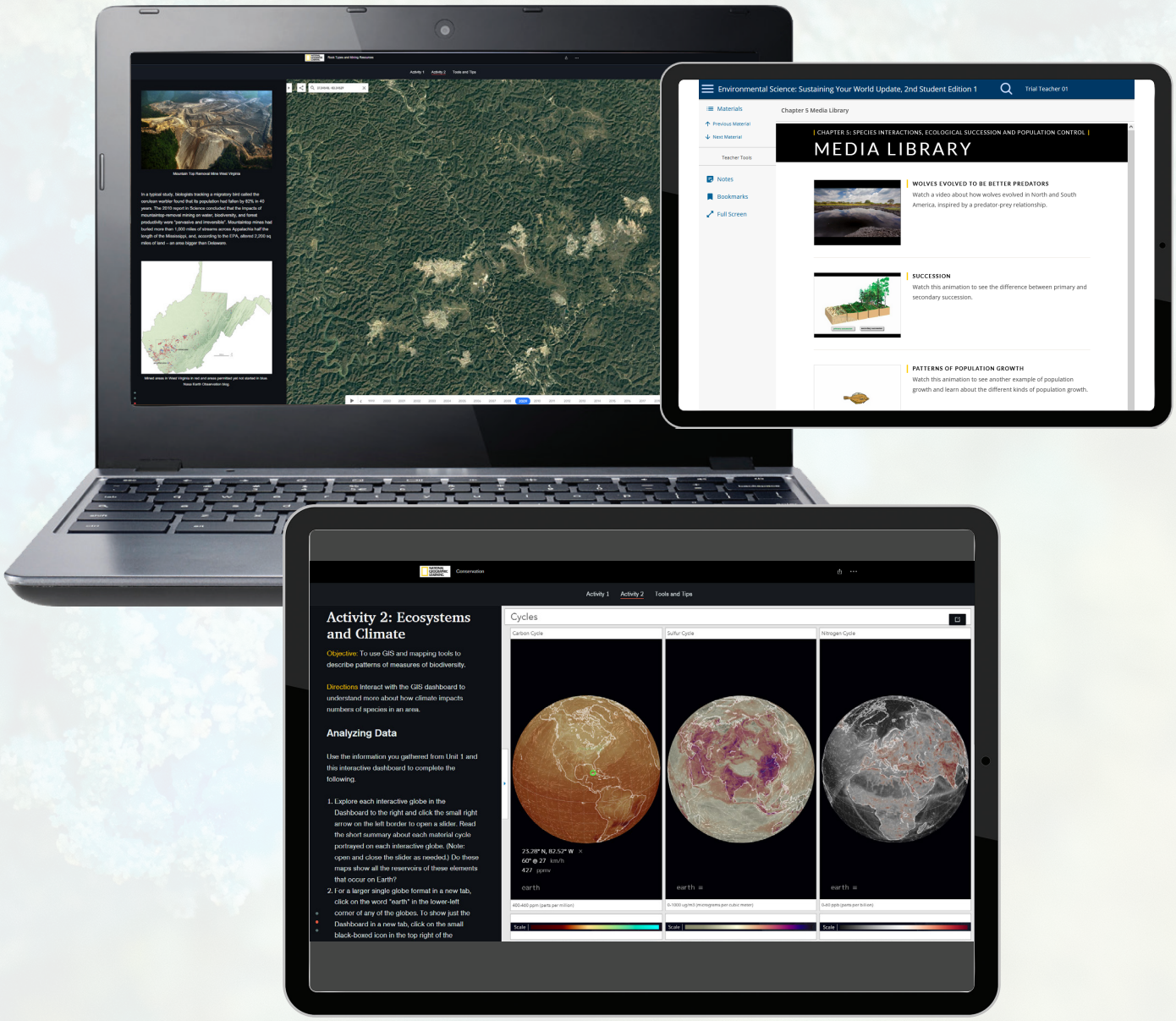
Case Studies and Science Focus features encourage deeper thinking of environmental science issues and show human decisions require trade-offs with positive and negative impacts


CASE STUDY
The Colorado River Story


SCIENCE FOCUS 17.1

DIGITAL STORYTELLING AND ENGAGEMENT

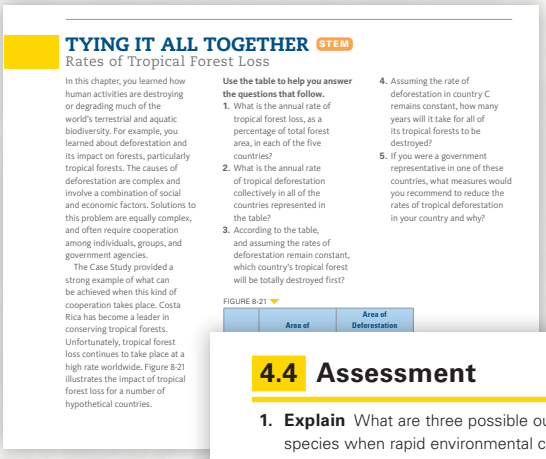
The digital platform makes it easy for students to connect with environmental science stories from a variety of perspectives. Geographic Information System (GIS) maps connect data and human impacts in a visually stunning way. National Geographic and BBC videos and animations engage students further.



PREPARE STUDENTS FOR COLLEGE AND CAREERS

Skills introduced in *Environmental Science: Sustaining Your World* cultivate problem-solving and critical thinking needed for college and careers. Students analyze issues to determine impacts, make claims using evidence, and build communication and group work skills needed beyond high school.

Assessments to Measure Success



TYING IT ALL TOGETHER STEM
Rates of Tropical Forest Loss

In this chapter, you learned how human activities are destroying or degrading much of the world's terrestrial and aquatic biodiversity. For example, you learned about deforestation and its impact on forests, particularly tropical forests. The causes of deforestation are complex and involve a combination of social and economic factors. Solutions to this problem are equally complex, and often require cooperation among individuals, groups, and government agencies.

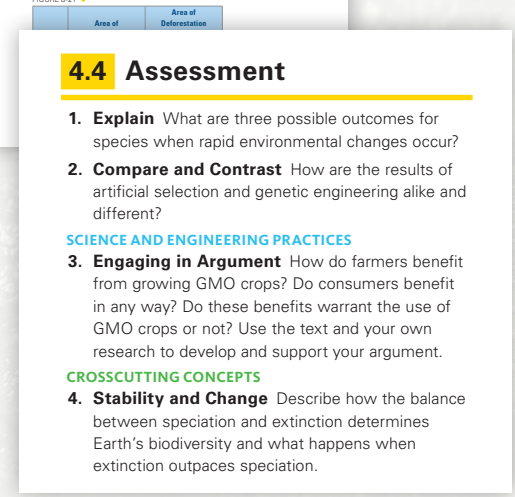
The Case Study provided a strong example of what can be achieved when this kind of cooperation takes place. Costa Rica has become a leader in conserving tropical forests. Unfortunately, tropical forest loss continues to take place at a high rate worldwide. Figure 8-21 illustrates the impact of tropical forest loss for a number of hypothetical countries.

Use the table to help you answer the questions that follow.

1. What is the annual rate of tropical forest loss, as a percentage of total forest area, in each of the five countries?
2. What is the annual rate of tropical deforestation collectively in all of the countries represented in the table?
3. According to the table, and assuming the rates of deforestation remain constant, which country's tropical forest will be totally destroyed first?
4. Assuming the rate of deforestation in country C remains constant, how many years will it take for all of its tropical forests to be destroyed?
5. If you were a government representative in one of these countries, what measures would you recommend to reduce the rates of tropical deforestation in your country and why?

FIGURE 8-21

	Area of	Area of Deforestation



4.4 Assessment

1. **Explain** What are three possible outcomes for species when rapid environmental changes occur?
2. **Compare and Contrast** How are the results of artificial selection and genetic engineering alike and different?

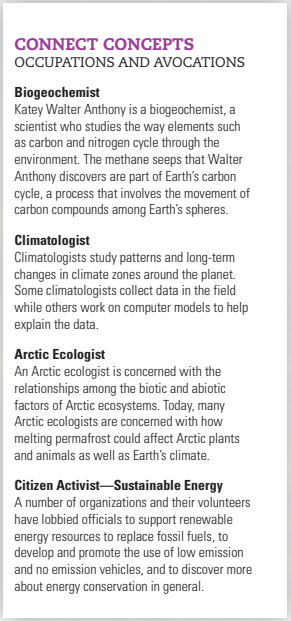
SCIENCE AND ENGINEERING PRACTICES

3. **Engaging in Argument** How do farmers benefit from growing GMO crops? Do consumers benefit in any way? Do these benefits warrant the use of GMO crops or not? Use the text and your own research to develop and support your argument.

CROSSCUTTING CONCEPTS

4. **Stability and Change** Describe how the balance between speciation and extinction determines Earth's biodiversity and what happens when extinction outpaces speciation.

Digital and in-book assessments measure different Depth of Knowledge as well as fostering practice with the Science and Engineering Practices and Crosscutting Concepts from the NGSS



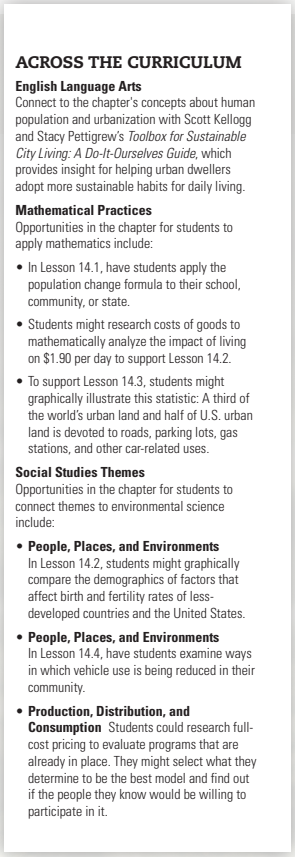
CONNECT CONCEPTS
OCCUPATIONS AND AVOCATIONS

Biogeochemist
Katey Walter Anthony is a biogeochemist, a scientist who studies the way elements such as carbon and nitrogen cycle through the environment. The methane seeps that Walter Anthony discovers are part of Earth's carbon cycle, a process that involves the movement of carbon compounds among Earth's spheres.

Climatologist
Climatologists study patterns and long-term changes in climate zones around the planet. Some climatologists collect data in the field while others work on computer models to help explain the data.

Arctic Ecologist
An Arctic ecologist is concerned with the relationships among the biotic and abiotic factors of Arctic ecosystems. Today, many Arctic ecologists are concerned with how melting permafrost could affect Arctic plants and animals as well as Earth's climate.

Citizen Activist—Sustainable Energy
A number of organizations and their volunteers have lobbied officials to support renewable energy resources to replace fossil fuels, to develop and promote the use of low emission and no emission vehicles, and to discover more about energy conservation in general.



ACROSS THE CURRICULUM

English Language Arts
Connect to the chapter's concepts about human population and urbanization with Scott Kellogg and Stacy Pettigrew's *Toolbox for Sustainable City Living: A Do-It-Ourselves Guide,* which provides insight for helping urban dwellers adopt more sustainable habits for daily living.

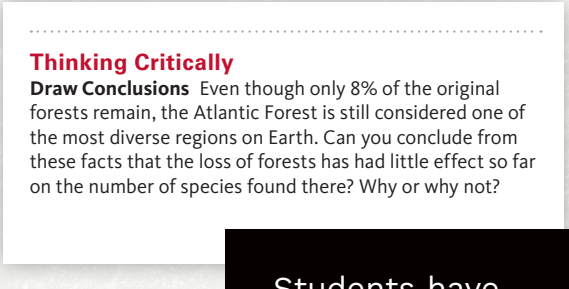
Mathematical Practices
Opportunities in the chapter for students to apply mathematics include:

- In Lesson 14.1, have students apply the population change formula to their school, community, or state.
- Students might research costs of goods to mathematically analyze the impact of living on $1.90 per day to support Lesson 14.2.
- To support Lesson 14.3, students might graphically illustrate this statistic: A third of the world's urban land and half of U.S. urban land is devoted to roads, parking lots, gas stations, and other car-related uses.

Social Studies Themes
Opportunities in the chapter for students to connect themes to environmental science include:

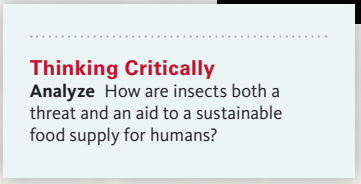
- **People, Places, and Environments** In Lesson 14.2, students might graphically compare the demographics of factors that affect birth and fertility rates of less-developed countries and the United States.
- **People, Places, and Environments** In Lesson 14.4, have students examine ways in which vehicle use is being reduced in their community.
- **Production, Distribution, and Consumption** Students could research full-cost pricing to evaluate programs that are already in place. They might select what they determine to be the best model and find out if the people they know would be willing to participate in it.

The Teacher's Edition encourages sharing career options related to the Explorers At Work features and guides teachers to build skills in other high school disciplines



Thinking Critically
Draw Conclusions Even though only 8% of the original forests remain, the Atlantic Forest is still considered one of the most diverse regions on Earth. Can you conclude from these facts that the loss of forests has had little effect so far on the number of species found there? Why or why not?

Students have many opportunities to practice critical thinking skills

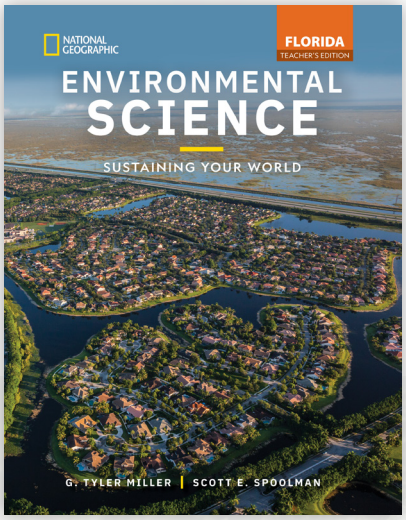


Thinking Critically
Analyze How are insects both a threat and an aid to a sustainable food supply for humans?

COURSE SUPPORT AND TEACHER TOOLS

ALIGNED TO THE NGSSS

Teachers are supported in the classroom with a thoughtfully designed Teacher's Edition and a wealth of teacher resources built in to the *MindTap* digital platform.



Teacher's Edition

The print and digital resources guide teachers through each unit and chapter to prepare students for 3-Dimensional skills, practices, and Performance Expectations including lessons built on the 5E lesson model, background information, and connections to Math and English Language Arts.

KEY TERMS STRATEGY

ENGLISH LANGUAGE LEARNERS **Make Word Connections** Before reading, ask students "or" questions, such as the following, and have them guess the answers orally. Repeat the questions after students have read the lesson.

- Is a fossil a permanent change in DNA *or* the preserved remains of prehistoric organisms?
- Does adaptation mean a trait that gives an individual an advantage *or* variety in the genetic makeup of individuals in a population?

DIFFERENTIATED INSTRUCTION

Specialist Species Review with students the characteristics of specialist species. Have students research one specialist species and use the characteristics you discussed to determine why it is considered a specialist.

- **Struggling Students:** Have students research one of the species listed in the text. Students should write a summary paragraph describing the species' specialized diet and/or habitat.
- **Advanced Learners:** Have students choose their own species to research. Students should explain what makes the species a specialist and use evidence from their research to develop a scenario that describes an environmental disturbance and its impact on this species.

QUICK HANDS ON **Mathematics Connection** The angular walls on the building shown in Figure 2-4 are made up of triangular pieces placed together. This is an example of a *tessellation*, which is created when one or more shapes are repeated to cover an area without any gaps. Ask students to create a tessellation using a shape other than a triangle. An easy way to do this is to create a stencil for the shape. Begin by cutting a square piece of paper into two or four different pieces. Then tape the pieces back together on opposite sides with their straight edges aligned.

Teachers are provided with targeted support for 3D instruction, differentiated instruction, and cross curricular connections to Math, English Language Arts, and other science disciplines.

ACROSS THE CURRICULUM

English Language Arts

Connect the chapter's focus on species interactions, ecological succession, and population control to *The Rarest of the Rare: Vanishing Animals, Timeless Worlds* by Diane Ackerman. This book, appropriate for high-school readers, relates observations about the disappearance of rare and endangered species and ecosystems. Ackerman shares insights from her personal encounters with wildlife and covers topics such as feeding, migration, courtship, and mating.

Mathematical Practices

Opportunities in the chapter for students to apply mathematics include:

- Students can use mathematics to explain the exponential and logistic growth shown in Figure 5-10.
- To support Figure 5-13, students can research to find examples of early, constant, and late loss survivorship curves and explain the numbers in each case.

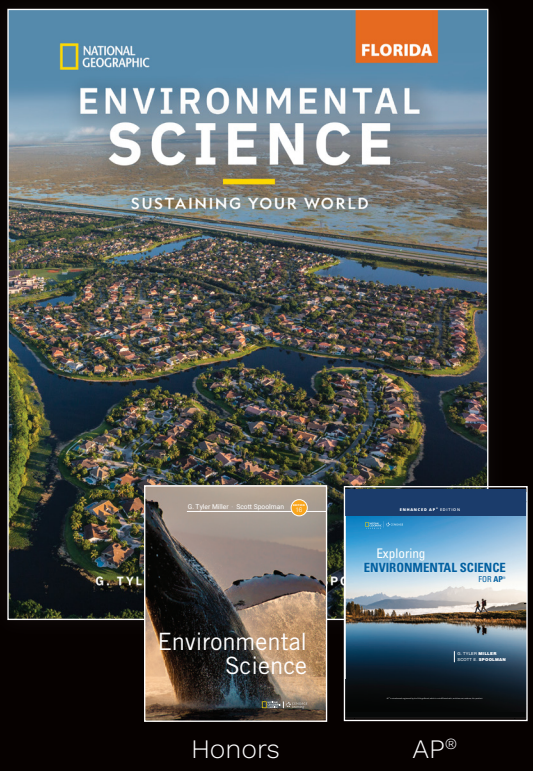
IN THIS CHAPTER

Crosscutting Concepts

- Cause and Effect
- Systems and System Models
- Stability and Change

Science and Engineering Practices

- Developing and Using Models
- Analyzing and Interpreting Data
- Constructing Explanations
- Using Mathematics and Computational Thinking



Honors AP®

Environmental Science: Sustaining Your World, Florida Edition is part of our series to meet the needs of on-level, honors, and AP® Environmental Science. Help students become expert problem-solvers and to think critically about science issues with our high school environmental science solutions.

All environmental science programs are authored by G. Tyler Miller and Scott E. Spoolman who deliver a consistent voice across the series with a commitment to sharing stories of sustainability and positive environmental outcomes.

Get the power of National Geographic for all your core and on-level science needs. See our other high school solutions for a true National Geographic experience.

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