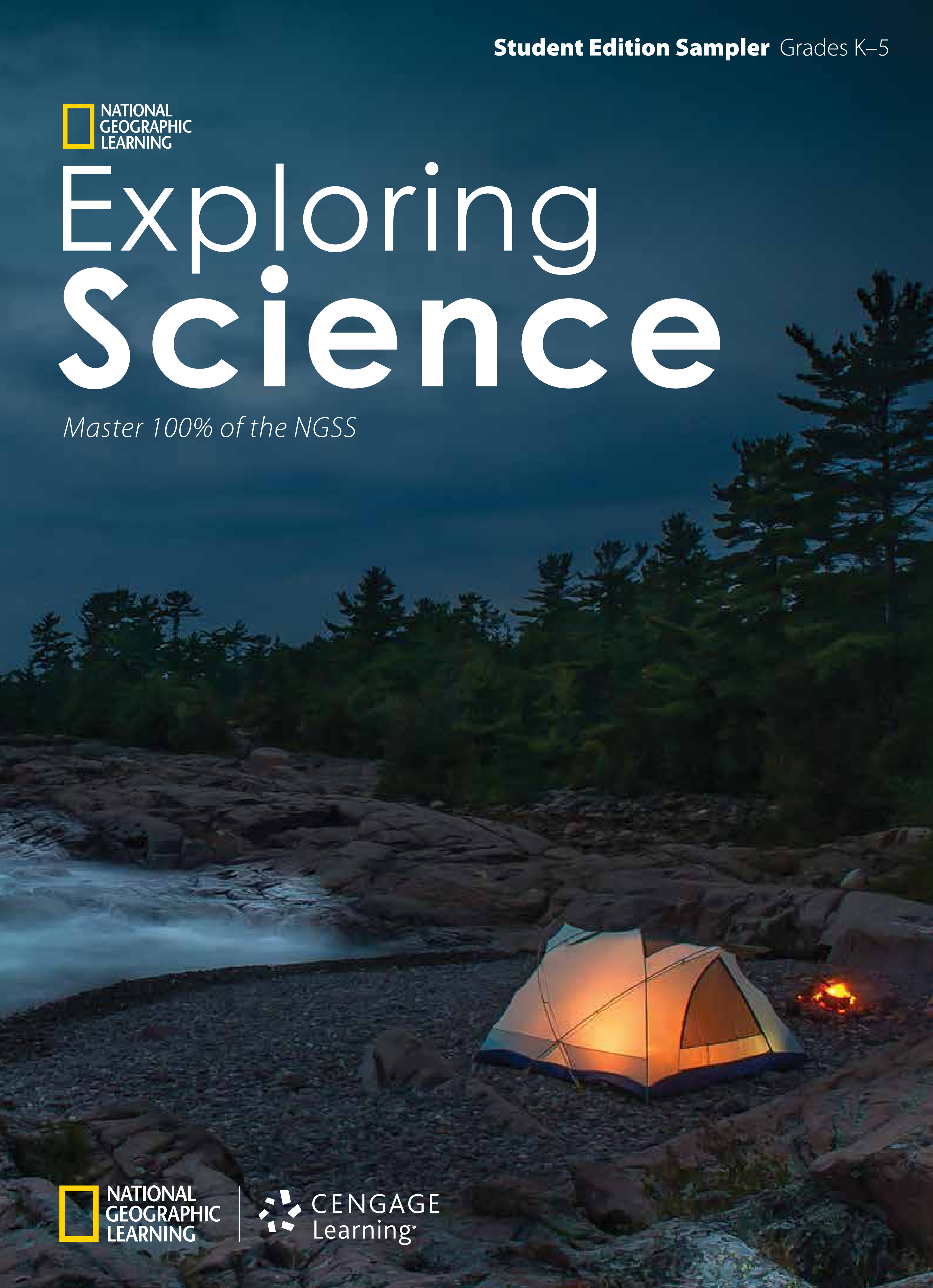
Student Edition Sampler Grades K–5

NATIONAL GEOGRAPHIC LEARNING

Exploring Science

Master 100% of the NGSS



NATIONAL GEOGRAPHIC LEARNING | CENGAGE Learning

NATIONAL GEOGRAPHIC LEARNING | CENGAGE Learning

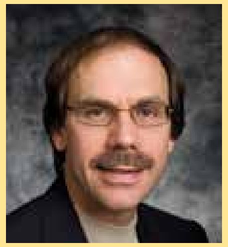
Exploring Science

Master the Next Generation Science Standards

Exploring Science helps you teach the Next Generation Science Standards (NGSS) with confidence and ensures your students master 21st century science skills. Combine instruction in Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts to meet the rigor of the Performance Expectations within the NGSS.

- Focus in-depth on 100% of the NGSS for grades K–5
- Introduce real-world science research with National Geographic Explorers, scientists, and photographers
- Connect NGSS content with investigations, engineering practices, and case studies for complete NGSS emersion

Program Authors



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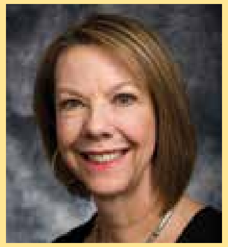

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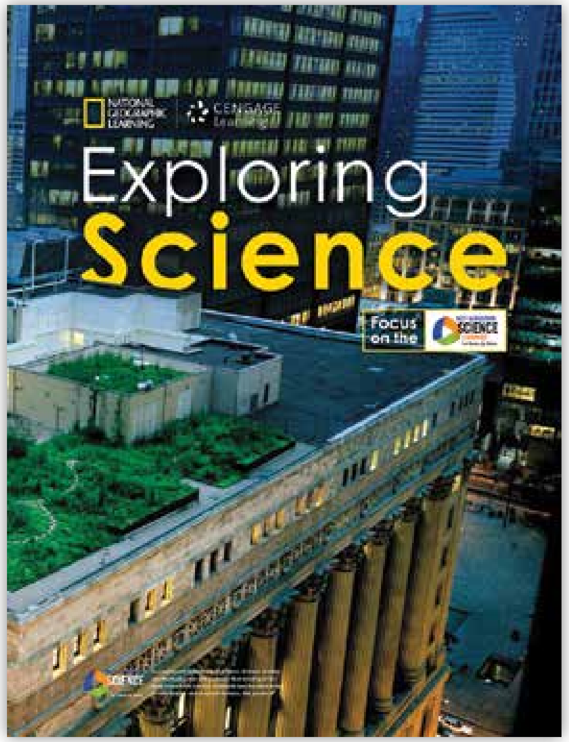
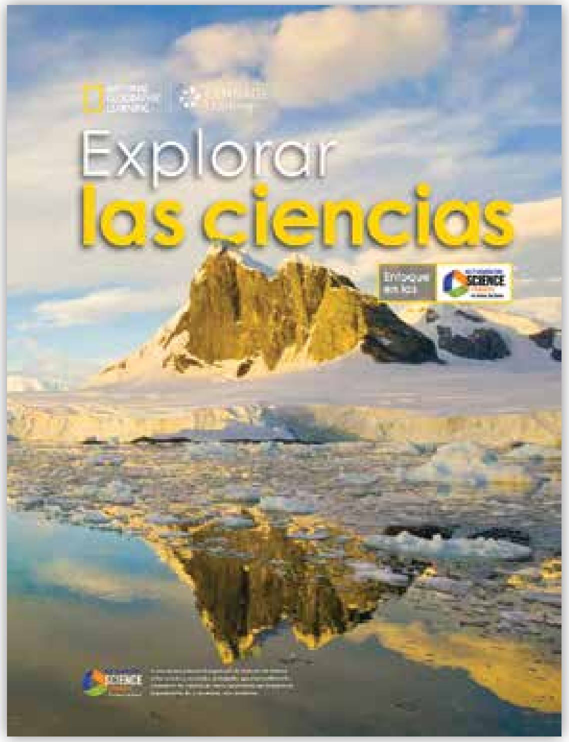
Print books and Interactive eBooks available in English and Spanish



Grade 4 Print Book in English

Grade 4 Interactive eBook in English

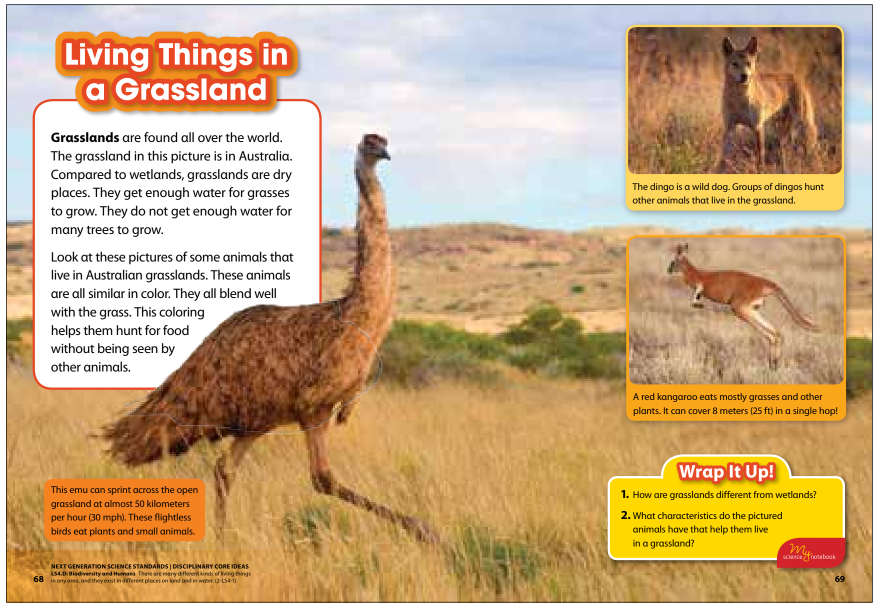


Grade 2 Print Book in Spanish

Grade 2 Interactive eBook in Spanish

Student Support

Print books and Interactive eBooks available in English and Spanish.

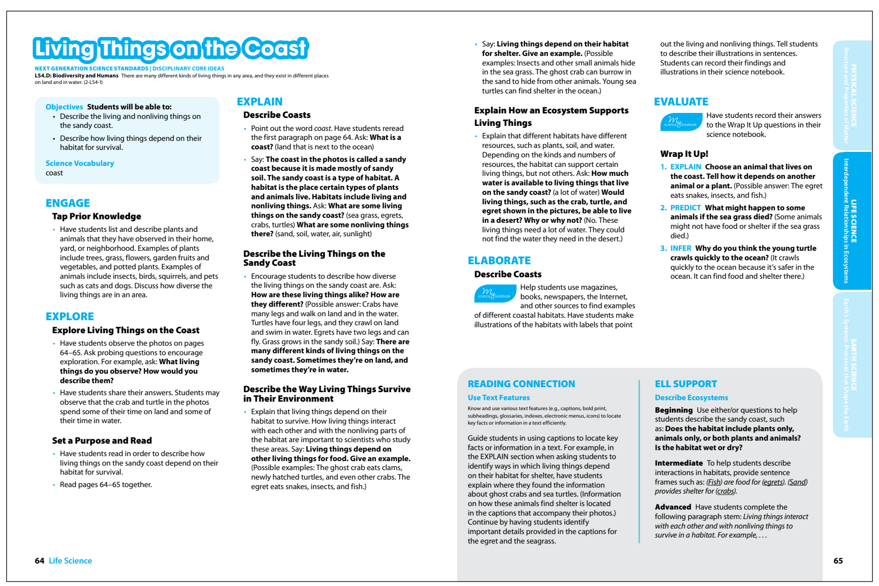


Grade 2

Students receive all of the resources needed to gain a deep, long-lasting understanding of the NGSS. National Geographic visuals and content capture student interest while reinforcing their understanding of the NGSS.

The Interactive eBook includes the same content as the print, but is presented in an interactive and engaging way for students. Additional enhancements include vocabulary games, matching activities, text-to-speech capability, and a digital notebook.

Teacher Support



Grade 2

Each page of the student book focuses on a specific Next Generation Science Standard. The standard being taught is displayed on the page for clarity and simplicity.

Teacher's Guides for each grade utilize the 5E model to implement and assess the NGSS. Complete the NGSS Performance Expectations with lessons that include all Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts.

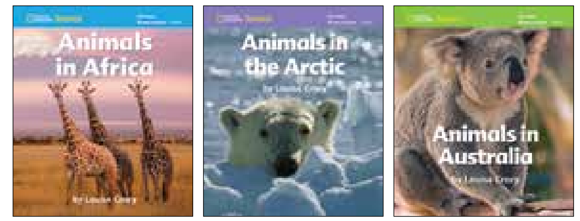
Exploring Science through Literacy

Supplemental Next Generation Science Standards Support

Leveled science readers support Disciplinary Core Ideas from the Next Generation Science Standards (NGSS). Multiple reading levels provide core idea content and National Geographic images and graphics to capture student interest. Online Teacher's Guides support science content and literacy skills enhancement in the same lesson. Available in English and Spanish.

Grades K–2

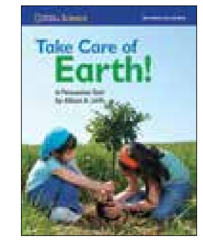
Support reading skills development and introduce core ideas in science topics based on the NGSS.



Low | Mid | High

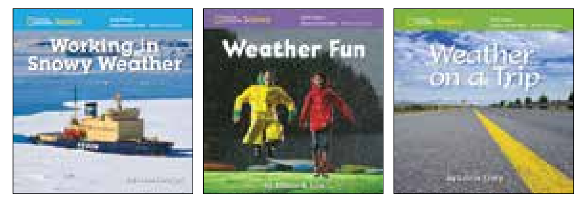
Become an Expert

- 9 readers per grade
- Low, mid, and high reading levels



Write About Big Books

- 1 Big Book per grade
- Model persuasive writing



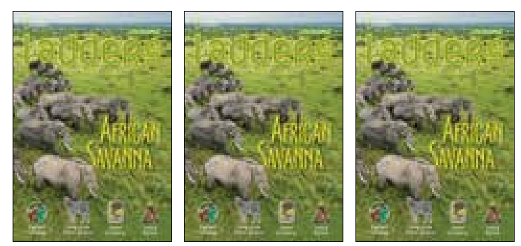
Low | Mid | High

Explore on Your Own

- 9 readers per grade
- Low, mid, and high reading levels

Grades 3–5

Continue more advanced literacy skills development with engaging images and connections to real-world science.



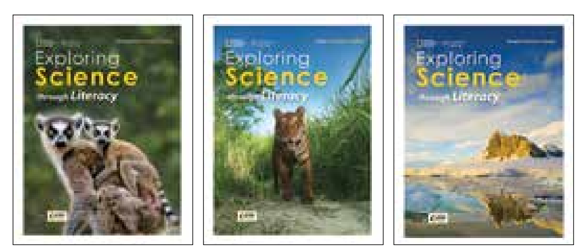
Below-Level | On-Level | Above-Level

Ladders Science

- 6 readers per grade
- Each title has three reading levels

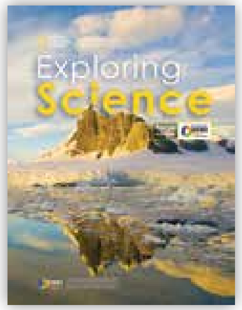
Online Teacher's Guides Grades K–5

Literacy and science content program support.



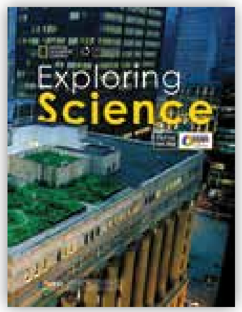
» Introduce science background and vocabulary
» Combine science content and literacy instruction in one lesson
» Includes ELL support
» Additional writing and research activities increase engagement

Exploring Science Sample Contents



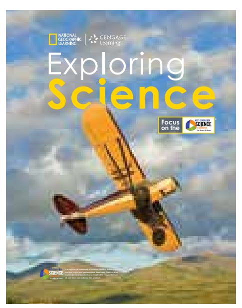
Grade 2 Student Edition

Life Science Unit (complete)



Grade 4 Student Edition

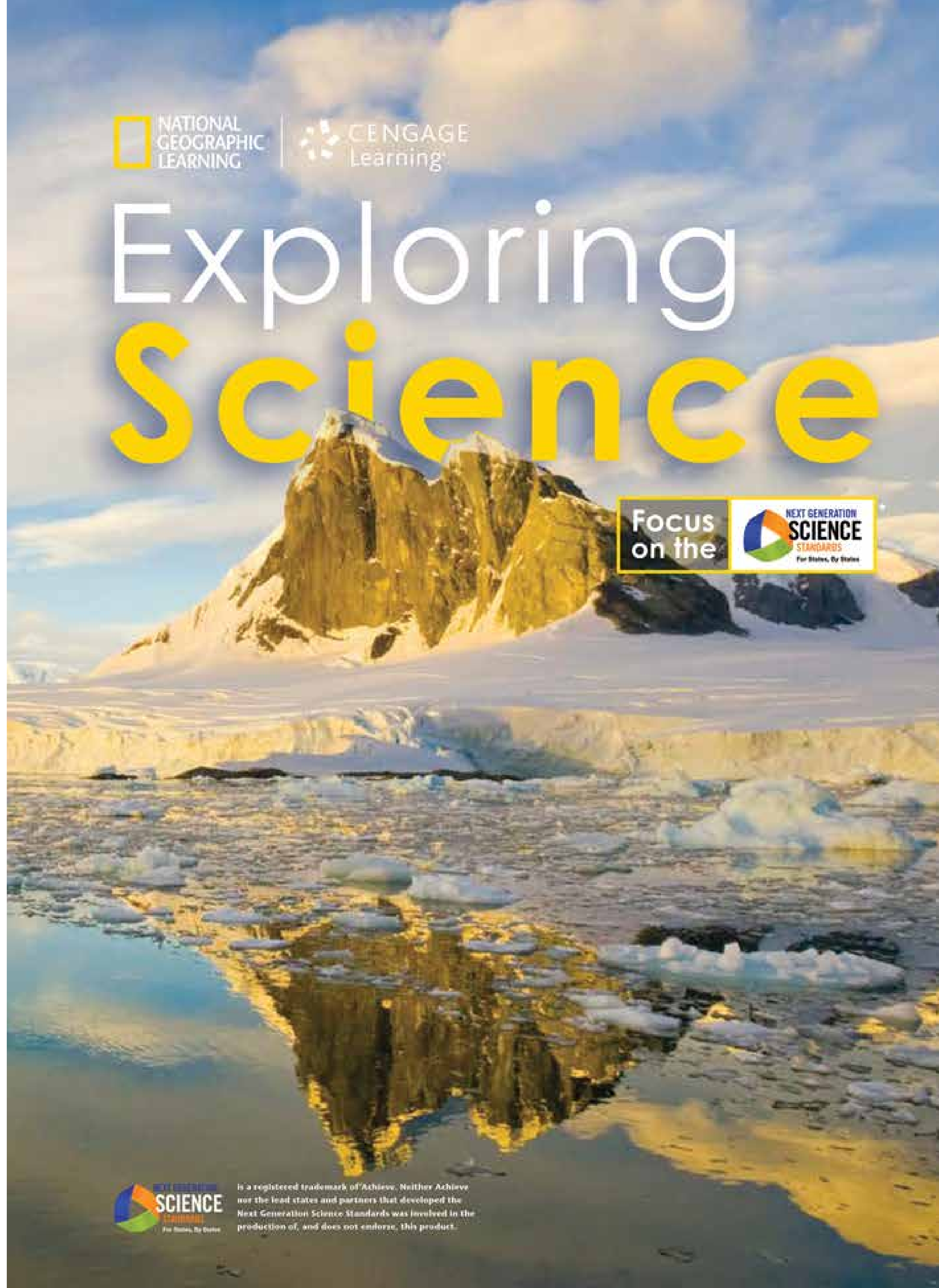
Earth Science Unit (excerpt)



Grade K Physical Science Big Book

Pushes and Pulls (excerpt)

On facing page: Exploring Science Grade 2 Student Edition



Life Science

Interdependent Relationships in Ecosystems

Monarch butterflies rest on a tree in Mexico.

What Plants Need

Plants need light and water. Plants **depend** on light and water to live and grow.

Some plants need a lot of light. These poppies growing in a field get sunlight all day.

Poppies grow well in direct sunlight.

The poppies also need rain every few days to survive and grow.

Rain gives the foxglove plant the water it needs to live.

Wrap It Up!

1. What are some things that plants depend on to live and grow?
2. Many people grow plants indoors. How can plants grow inside where it does not rain?

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS2.A: Interdependent Relationships in Ecosystems
Plants depend on water and light to grow. (2-LS2-1)

Investigate

Plants and Light

What happens if radish plants do not get enough light?

You know that plants need light to grow. Now you will investigate how plants grow with different amounts of light.

Materials

radish plants

tape

water

spoon

1. Label the cups **Sunlight** and **No Sunlight.** Observe the plants in both cups. Record your observations.

2. Place the **Sunlight** cup in a sunny place. Predict what will happen. Record your prediction in your science notebook.

3. Place the **No Sunlight** cup in a dark place. Predict what will happen. Record your prediction in your science notebook.

4. Give both plants two spoonfuls of water every day. Observe the plants every day. Record what you observe.

Wrap It Up!

1. What did you keep the same for both plants?
2. What did you change between the two plants?
3. How did the plants grow? Were your predictions correct?

My science notebook

Plan and Investigate

You have investigated whether plants need light to grow. Now you will make a plan and investigate what happens if plants do not get water.

My science notebook

1 Plan an investigation.
Think about how to do your investigation. What materials will you need? How many plants should you test? How will you know that water makes the difference in how your plants grow?

Write down your plan. Draw a picture of what your investigation will look like. Label your drawing.

2 Conduct an investigation.
Carry out your investigation. Record your data in your science notebook.

3 Review your results.
Look at your data. Did one plant grow better than the others? Do your results answer the question?

4 Share your results.
Tell others how your investigation worked. Use evidence to explain how your results answer the question.

Rain provides this fuchsia plant with the water it needs to survive and grow.

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.

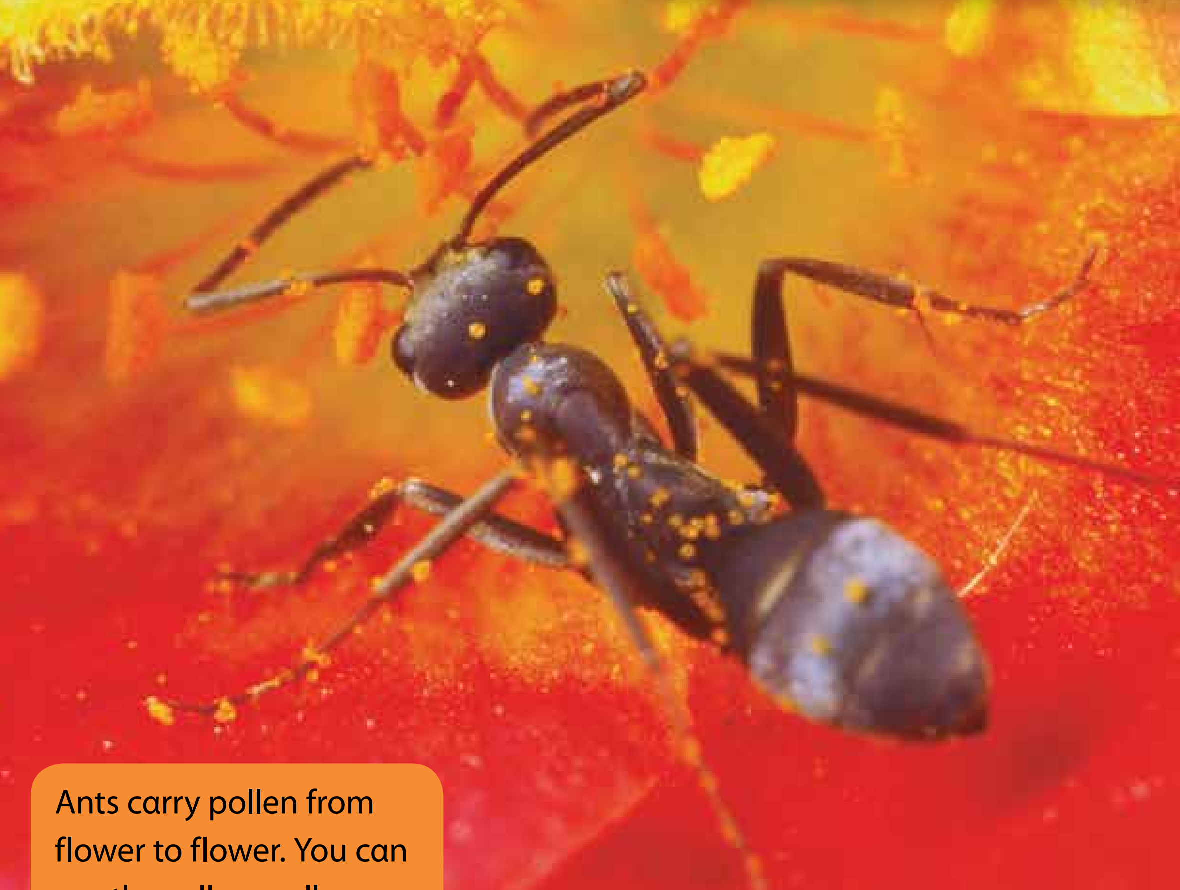
Animals Pollinate Flowers

Flowering plants make **pollen.** When pollen is moved from one plant to another, seeds can form. Seeds can grow into new plants.

Some animals get food from flowers. Pollen sticks to an animal when it visits a flower for food. The animal **pollinates** the next flower it visits. Some pollen from the first flower is left on the second flower. Plants depend on animals for pollination.

Hummingbirds pollinate flowers as they collect food.

Pollen sticks to the moth's feet.



Ants carry pollen from flower to flower. You can see the yellow pollen sticking to the ant's back.

Wrap It Up!

1. Why is pollination important to plants?
2. What are some ways that animals move pollen from flower to flower?

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS2.A: Interdependent Relationships in Ecosystems
Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)

NATIONAL GEOGRAPHIC LEARNING | *Science and Engineering*
Case Study

Save the Bees!

Do you like strawberries? Watermelon? Thanks to bees, we have fruits and other foods to eat. Bees pollinate many plants that make food. Some pollinated flowers transform into fruits that people eat. Dino Martins is a scientist who studies bees and other insects.

Problem

Dino Martins is worried. There are fewer bees today than there were in the past. Fewer bees mean fewer fruits and other foods. People need food, so people need bees, too.

This Braunsapis bee is pollinating coriander flowers. People grind and use coriander seeds as a spice.

NATIONAL GEOGRAPHIC | **Explorer**

Dino Martins says, "Spend five minutes a day with an insect. It will change your life." His work with insects is changing many lives.

There are many kinds of bees. Dino Martins studies bees in Africa.

Amegilla bee

Stingless bee and Nomia bee

Carpenter bee

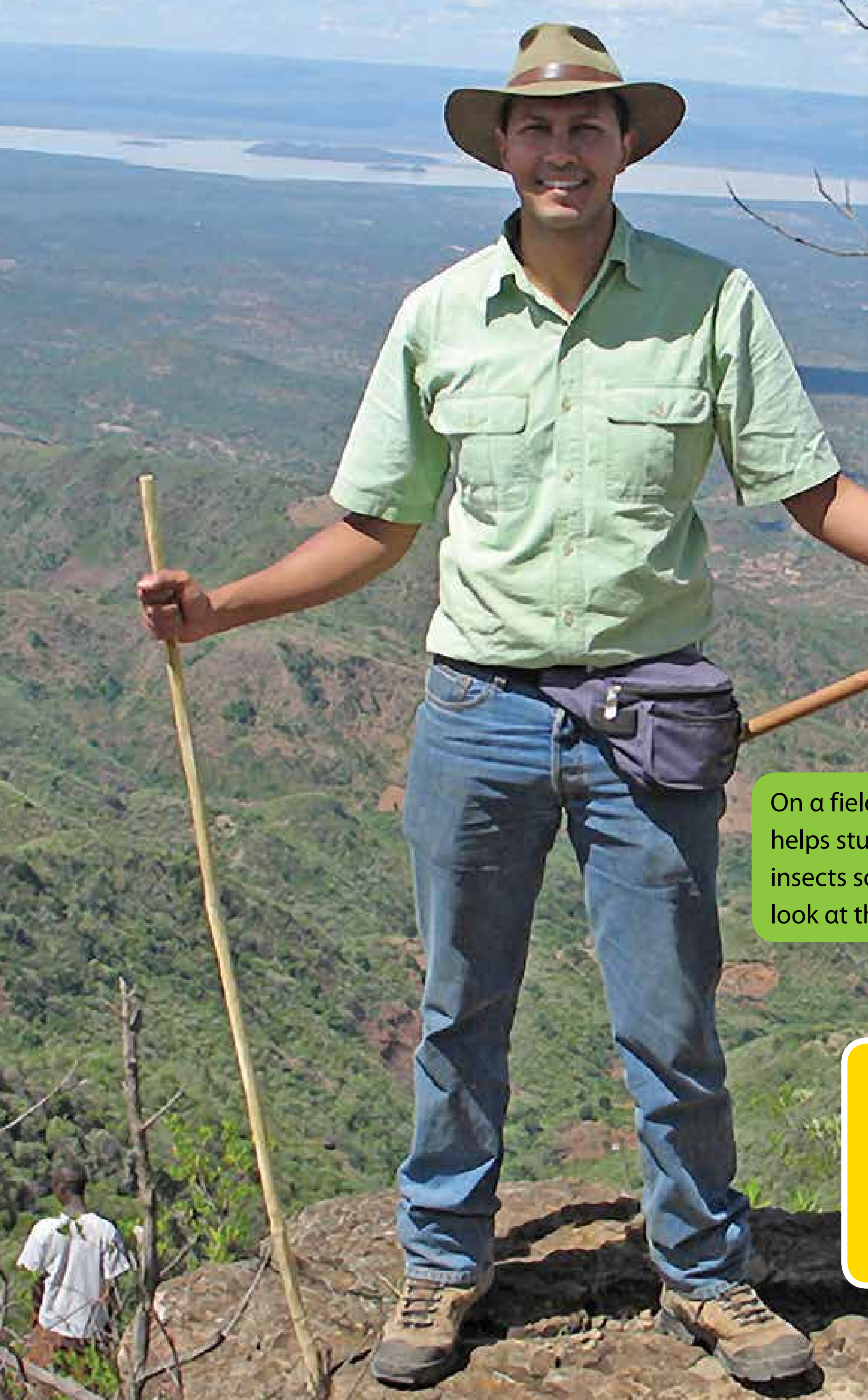
NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS2.A: Interdependent Relationships in Ecosystems
Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)

Solution

Dino Martins helps people protect bees. That way, there will be more bees to pollinate flowers. He teaches farmers that bees pollinate crops. Farmers who protect bees harvest more food. We need plenty of food for people to eat.

Some bees' habitats have been destroyed. Dino Martins shows people how to make bee houses. Bee houses help bees survive.

A bee house on a farm gives bees shelter near crops that they pollinate.



On a field trip Dino helps students collect insects so that they can look at them up close.

Dino teaches people about the types of bees that help the plants on their farms.

Wrap It Up!

1. Why are bees important?
2. What might happen if there were no bees?
3. Why do you think Dino Martins' work is important?

My science notebook

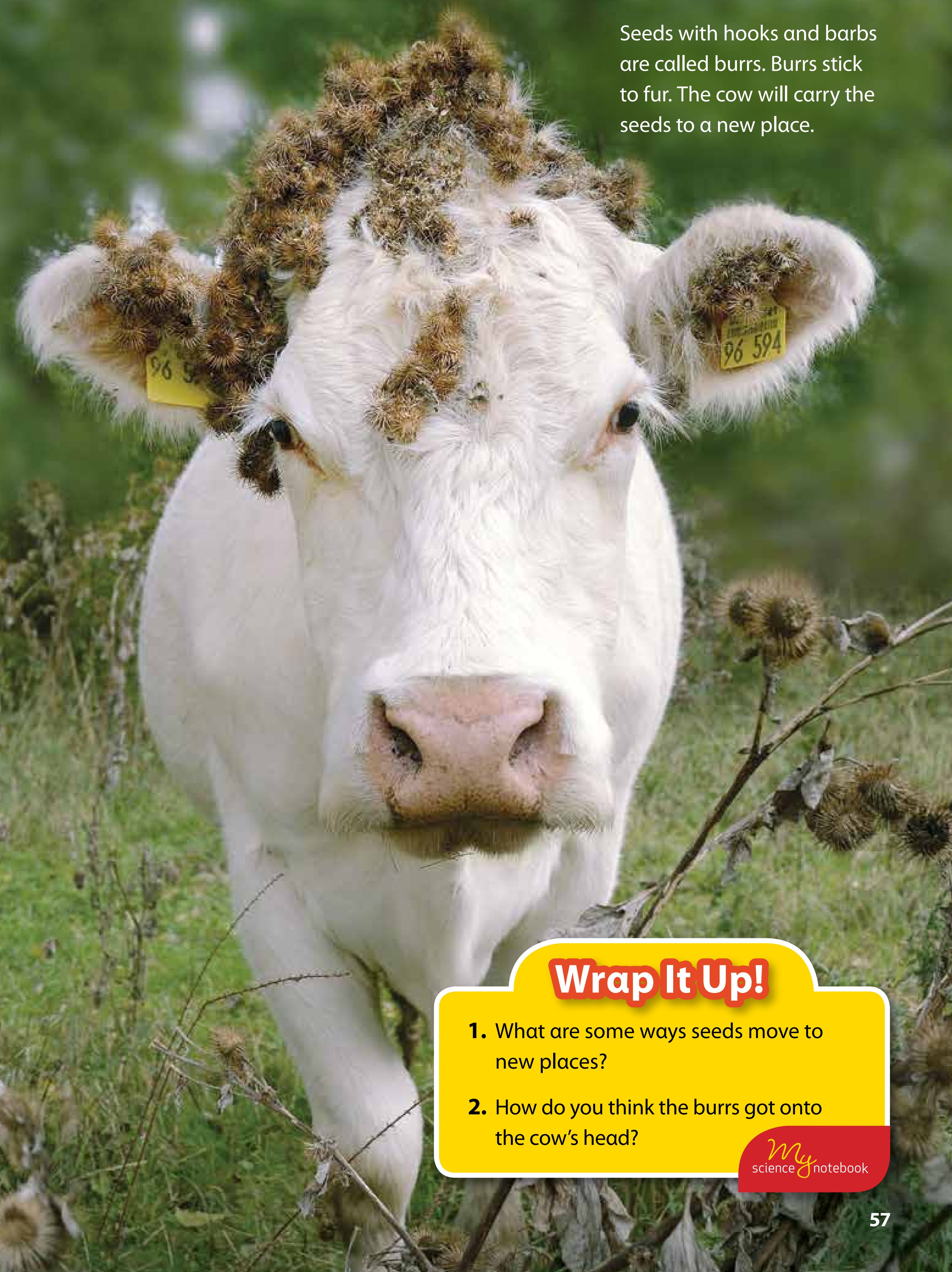
Animals Spread Seeds

Many plants make seeds that grow new plants. Seeds need their own space to grow. A seed may not be able to grow too close to its parent plant. It may not get enough light or water there.

How can a seed move to a new place? Animals carry some seeds to new places. Many plants depend on animals to move their seeds.

This red squirrel is burying a nut to eat later. If the squirrel forgets the nut, a new tree may grow.

These berries have seeds inside. The waxwing will eat a berry. The waxwing will drop the seed in a new place.



Seeds with hooks and barbs are called burrs. Burrs stick to fur. The cow will carry the seeds to a new place.

Wrap It Up!

1. What are some ways seeds move to new places?
2. How do you think the burrs got onto the cow's head?

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS2.A: Interdependent Relationships in Ecosystems
Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)

Develop a Model

It is close to the end of summer. The burdock plant in the picture has produced a special covering for its seeds. The covering is called a burr. Look closely. The burr has long spiky thorns with hooks on the end. Many of the seeds from the parent plant have traveled quite far away to produce new plants. How did the seeds move?

This is what the burrs look like in fall.

Develop a Model

My science notebook

When scientists want to study how something in real life works, they sometimes make a model. You can, too. Look at the burdock seeds again. Then draw or write out a model of how burdock seeds could travel far from their parent plants.

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Conduct an Investigation

Now you can conduct an investigation to see if your model is on the right track.

Materials

hook tape

feather

fake fur

leather

1. Stick the hook tape to the feather. Pinch them together between your fingers.
2. Carry the feather to a new place. Shake the feather. How is this like what a bird might do? Observe and record what happens.
3. Pick the tape off with your fingers. How is this like what a bird might do? Observe and record what happens.
4. Repeat steps 2 and 3 with the fake fur and the leather.

Explain Your Model

Based on the data you collected in the investigation, was your model correct? Do you need to revise your model? Make changes if you need to. Then use your model to explain how sticky seeds might be moved from one place to another.

Living Things Are Everywhere

Many kinds of living things live all over planet Earth. They live on land and in water. Forests, deserts, oceans, and ponds are full of living things. Different kinds of plants and animals live in different places.

The fish in this kelp forest live in water all of the time.

The hippopotamus spends time on the land and in the water.

The chameleon lives on land all of the time.

Wrap It Up!

1. Where on Earth do plants and animals live?
2. Describe how the animals and habitats shown are alike and different.

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS4.D: Biodiversity and Humans
There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

Living Things on the Coast

Many plants and animals live on the sandy coast. A **coast** is land that is next to the ocean. You can see sea grass, a crab, a turtle, and an egret. These plants and animals depend on the sandy coast for survival.

The ghost crab eats clams and newly hatched turtles. It even eats other crabs. The egret eats snakes, insects, and fish. Insects and other small animals hide in the sea grass.

The ghost crab can burrow into the sand to remain hidden from other animals, such as the egret.

This young sea turtle has just hatched. It crawls quickly to the ocean. The turtle is safer in the ocean. It can find food and shelter there.

The egret will use its sharp bill to catch other animals.

The grass provides food and shelter for some animals.

Wrap It Up!

1. Choose an animal that lives on the coast. Tell how it depends on another animal or a plant.
2. What might happen to some animals if the sea grass died?
3. Why do you think the young turtle crawls quickly to the ocean?

My science notebook

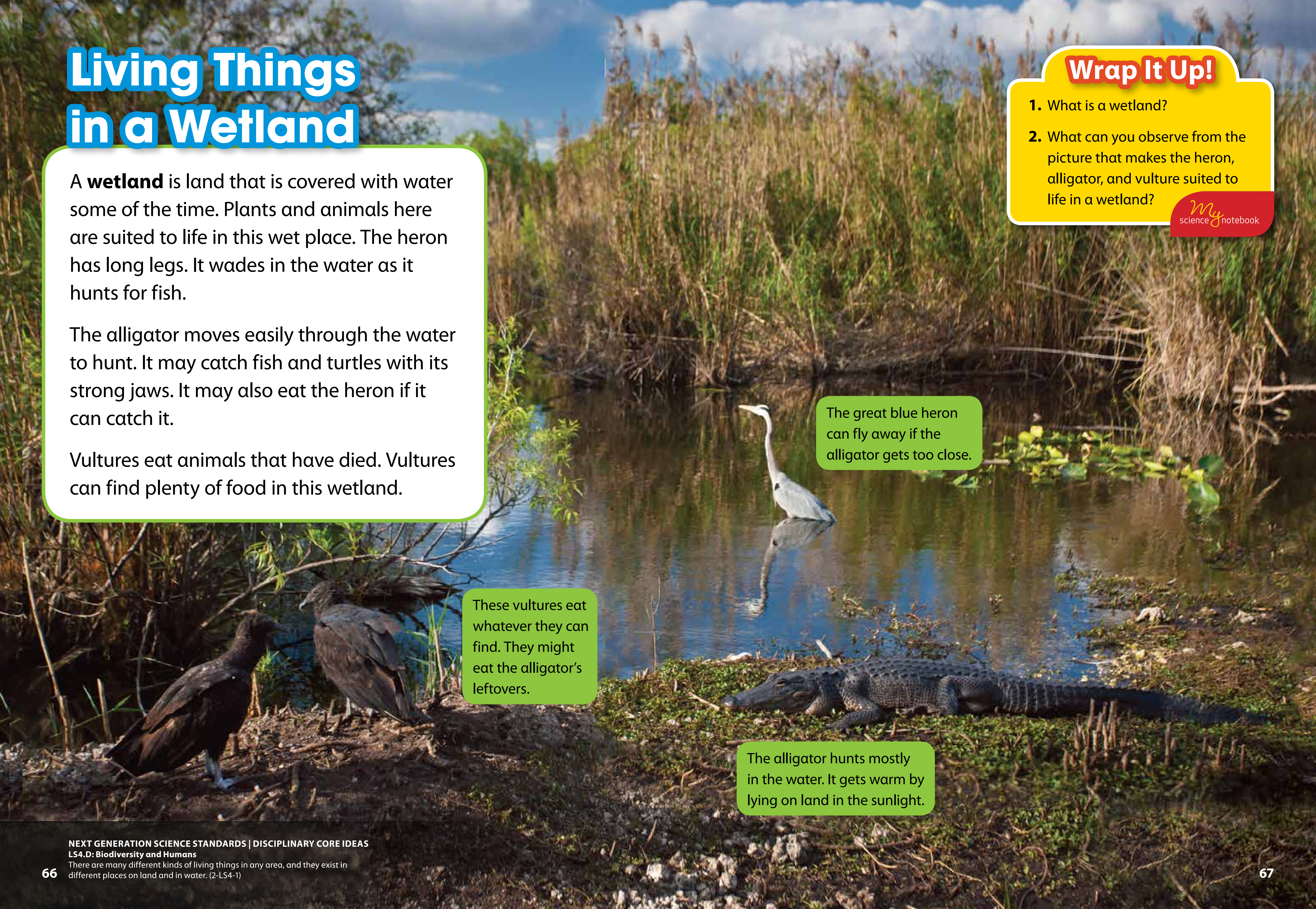
NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS4.D: Biodiversity and Humans
There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

Living Things in a Wetland

A **wetland** is land that is covered with water some of the time. Plants and animals here are suited to life in this wet place. The heron has long legs. It wades in the water as it hunts for fish.

The alligator moves easily through the water to hunt. It may catch fish and turtles with its strong jaws. It may also eat the heron if it can catch it.

Vultures eat animals that have died. Vultures can find plenty of food in this wetland.



The great blue heron can fly away if the alligator gets too close.

These vultures eat whatever they can find. They might eat the alligator's leftovers.

The alligator hunts mostly in the water. It gets warm by lying on land in the sunlight.

Wrap It Up!

1. What is a wetland?
2. What can you observe from the picture that makes the heron, alligator, and vulture suited to life in a wetland?

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS4.D: Biodiversity and Humans
There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

Living Things in a Grassland

Grasslands are found all over the world. The grassland in this picture is in Australia. Compared to wetlands, grasslands are dry places. They get enough water for grasses to grow. They do not get enough water for many trees to grow.

Look at these pictures of some animals that live in Australian grasslands. Why do you think these animals are all similar in color? They all blend well with the grass. This coloring helps them hunt for food without being seen by other animals.

This emu can sprint across the open grassland at almost 50 kilometers an hour (30 miles an hour). These flightless birds eat plants and small animals.

The dingo is a wild dog. Groups of dingos hunt other animals that live in the grassland.

A red kangaroo eats mostly grasses and other plants. It can cover 8 meters (25 feet) in a single hop!

Wrap It Up!

1. How are grasslands different from wetlands?
2. What characteristics do the pictured animals have that help them live in a grassland?

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
LS4.D: Biodiversity and Humans
There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

NATIONAL GEOGRAPHIC LEARNING | Think Like a Scientist

Make Observations

Africa has different habitats. Some are hot and dry. Others are wet. Look at the map to find deserts, rain forests, and other habitats in Africa. Each habitat has many plants and animals that live there.

Look at the pictures of plants and animals from different habitats in Africa. Then answer the questions.

1. What does the map show? *My science notebook*

2. Choose two habitats. Compare the plants and animals that live there. How are they alike? How are they different?


Western lowland gorilla


Pineapple

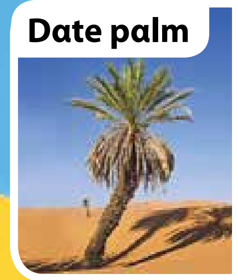

Flower beetle

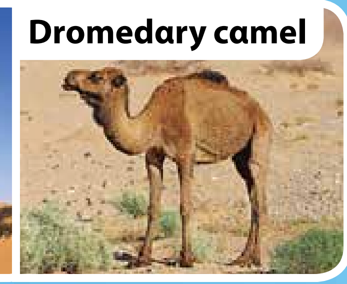

Savanna grasses


Elephant


Ostrich

Habitats in Africa


Date palm


Dromedary camel

Cape pangolin


Great white shark


Black-footed penguin


Sea grass

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

NATIONAL GEOGRAPHIC LEARNING | Science Career

Field Biologist

A biologist is a scientist who studies living things. A field biologist studies plants or animals where they live.

Tim Laman is a field biologist and a photographer. He studies living things in places such as rain forests and coral reefs. He takes photos of the living things that he studies.

Tim does much of his research in places where the animals' homes are in danger. He hopes his research will make people want to take better care of natural places.

Tim Laman takes photos of birds from treetops. Here he is in New Guinea.

NATIONAL GEOGRAPHIC | Explorer

Tim Laman loved to explore the mountains and oceans of Japan as a boy. He hopes the photos he takes help tell the stories of some of Earth's endangered species.

Blue bird of paradise

Greater bird of paradise

Wilson's bird of paradise

NEXT GENERATION SCIENCE STANDARDS | CONNECTIONS TO NATURE OF SCIENCE
Scientific Knowledge Is Based on Empirical Evidence
Scientists look for patterns and order when making observations about the world.

Los animales polinizan a las flores

Las plantas fabrican **polen**. Cuando el polen se traslada de una planta a otra, pueden formarse semillas. Las semillas pueden crecer hasta convertirse en plantas nuevas. La mayoría de las flores tienen sus raíces en el suelo. No pueden moverse. Muchas **dependen** de los animales para que lleven el polen a otras flores.

Algunos animales obtienen alimento de las flores. El polen se pega a un animal cuando va a una flor para buscar alimento. El animal poliniza la próxima flor donde va. Una parte del polen de la primera flor queda en la segunda flor. Las plantas dependen de los animales para que se produzca la polinización.

Los colibríes **polinizan** a las flores cuando buscan alimento.

El **polen** se pega a las patas de la polilla.

Las hormigas trasladan el **polen** de una flor a otra. Puedes ver el polen amarillo pegado en la parte trasera de la hormiga.

¡Resúmelo!

1. ¿Por qué la polinización es importante para las plantas?
2. ¿De qué manera los animales trasladan el polen de una flor a otra?

Mi cuaderno de ciencias

Living Things on the Coast

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS

LS4.D: Biodiversity and Humans There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

Objectives **Students will be able to:**

- Describe the living and nonliving things on the sandy coast.
- Describe how living things depend on their habitat for survival.

Science Vocabulary

coast

ENGAGE

Tap Prior Knowledge

- Have students list and describe plants and animals that they have observed in their home, yard, or neighborhood. Examples of plants include trees, grass, flowers, garden fruits and vegetables, and potted plants. Examples of animals include insects, birds, squirrels, and pets such as cats and dogs. Discuss how diverse the living things are in an area.

EXPLORE

Explore Living Things on the Coast

- Have students observe the photos on pages 64–65. Ask probing questions to encourage exploration. For example, ask: **What living things do you observe? How would you describe them?**
- Have students share their answers. Students may observe that the crab and turtle in the photos spend some of their time on land and some of their time in water.

Set a Purpose and Read

- Have students read in order to describe how living things on the sandy coast depend on their habitat for survival.
- Read pages 64–65 together.

EXPLAIN

Describe Coasts

- Point out the word *coast*. Have students reread the first paragraph on page 64. Ask: **What is a coast?** (land that is next to the ocean)
- Say: **The coast in the photos is called a sandy coast because it is made mostly of sandy soil. The sandy coast is a type of habitat. A habitat is the place certain types of plants and animals live. Habitats include living and nonliving things.** Ask: **What are some living things on the sandy coast?** (sea grass, egrets, crabs, turtles) **What are some nonliving things there?** (sand, soil, water, air, sunlight)

Describe the Living Things on the Sandy Coast

- Encourage students to describe how diverse the living things on the sandy coast are. Ask: **How are these living things alike? How are they different?** (Possible answer: Crabs have many legs and walk on land and in the water. Turtles have four legs, and they crawl on land and swim in water. Egrets have two legs and can fly. Grass grows in the sandy soil.) Say: **There are many different kinds of living things on the sandy coast. Sometimes they're on land, and sometimes they're in water.**

Describe the Way Living Things Survive in Their Environment

- Explain that living things depend on their habitat to survive. How living things interact with each other and with the nonliving parts of the habitat are important to scientists who study these areas. Say: **Living things depend on other living things for food. Give an example.** (Possible examples: The ghost crab eats clams, newly hatched turtles, and even other crabs. The egret eats snakes, insects, and fish.)
- Say: **Living things depend on their habitat for shelter. Give an example.** (Possible examples: Insects and other small animals hide in the sea grass. The ghost crab can burrow in the sand to hide from other animals. Young sea turtles can find shelter in the ocean.)

Explain How an Ecosystem Supports Living Things

- Explain that different habitats have different resources, such as plants, soil, and water. Depending on the kinds and numbers of resources, the habitat can support certain living things, but not others. Ask: **How much water is available to living things that live on the sandy coast?** (a lot of water) **Would living things, such as the crab, turtle, and egret shown in the pictures, be able to live in a desert? Why or why not?** (No. These living things need a lot of water. They could not find the water they need in the desert.)

ELABORATE

Describe Coasts

Help students use magazines, books, newspapers, the Internet, and other sources to find examples of different coastal habitats. Have students make illustrations of the habitats with labels that point out the living and nonliving things. Tell students to describe their illustrations in sentences. Students can record their findings and illustrations in their science notebook.

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. **EXPLAIN** **Choose an animal that lives on the coast. Tell how it depends on another animal or a plant.** (Possible answer: The egret eats snakes, insects, and fish.)
2. **PREDICT** **What might happen to some animals if the sea grass died?** (Some animals might not have food or shelter if the sea grass died.)
3. **INFER** **Why do you think the young turtle crawls quickly to the ocean?** (It crawls quickly to the ocean because it's safer in the ocean. It can find food and shelter there.)

READING CONNECTION

Use Text Features

Know and use various text features (e.g., captions, bold print, subheadings, glossaries, indexes, electronic menus, icons) to locate key facts or information in a text efficiently.

Guide students in using captions to locate key facts or information in a text. For example, in the EXPLAIN section when asking students to identify ways in which living things depend on their habitat for shelter, have students explain where they found the information about ghost crabs and sea turtles. (Information on how these animals find shelter is located in the captions that accompany their photos.) Continue by having students identify important details provided in the captions for the egret and the seagrass.

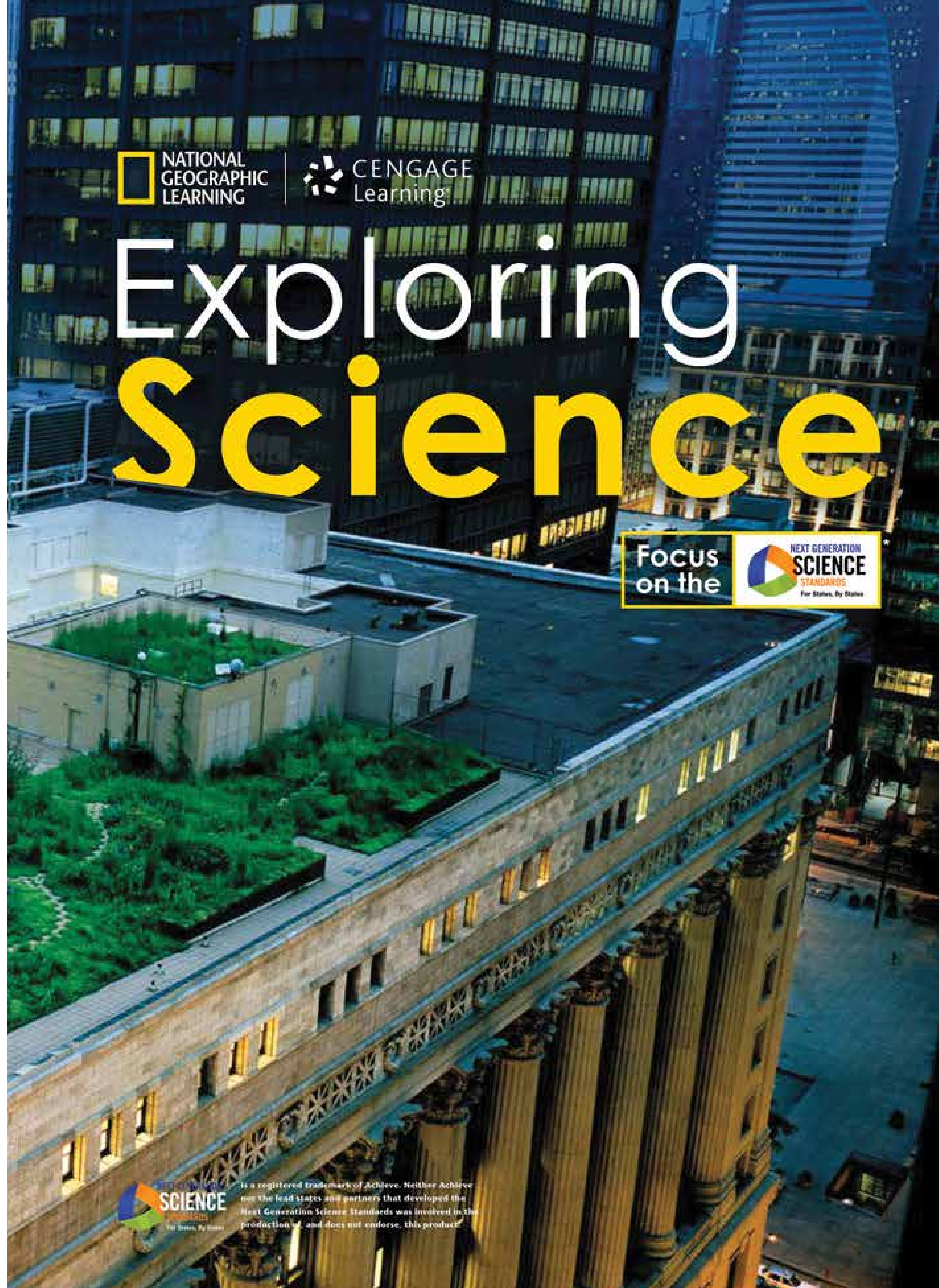
ELL SUPPORT

Describe Ecosystems

Beginning Use either/or questions to help students describe the sandy coast, such as: **Does the habitat include plants only, animals only, or both plants and animals? Is the habitat wet or dry?**

Intermediate To help students describe interactions in habitats, provide sentence frames such as: *(Fish) are food for (egrets). (Sand) provides shelter for (crabs).*

Advanced Have students complete the following paragraph stem: *Living things interact with each other and with nonliving things to survive in a habitat. For example, . . .*



On facing page:
Exploring Science Grade 4
Student Edition

Earth Science

Earth's Systems: Processes that Shape the Earth

The Sakurajima volcano in southern Japan has erupted almost continuously since 1955.

Natural Hazards

Natural processes are constantly changing Earth's surface. In some cases, these processes are harmful to humans and other living things. Something that is harmful or dangerous is called a **hazard.** Earthquakes, tsunamis, and volcanoes are three natural processes that can be hazardous to humans.

Earthquakes

An **earthquake** is the shaking of Earth's surface caused by sudden movement of rock beneath the surface. Earthquakes can cause buildings to collapse and roads and bridges to buckle. They may also break power lines and water pipes.

Volcanoes

Volcanoes form when molten rock from deep inside Earth rises to the surface. Volcanic eruptions can spew hot ash and molten rock high into the air. When these materials come down, they can bury buildings and roads and damage crops. Volcanic ash in the air can also disrupt airline traffic.

Tsunamis

A **tsunami** is a series of ocean waves caused by an underwater earthquake, an underwater volcanic eruption, or a landslide. Anything that causes Earth's surface to move beneath the water also moves the water. When large tsunamis come ashore, they can destroy buildings, roads, or even entire villages.

Wrap It Up!

My science notebook

1. **Define** What does the word *hazard* mean?
2. **List** What are three of the natural processes that can be hazardous to humans?
3. **Infer** Why might a volcanic eruption be dangerous for airline traffic?

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). (4-ESS3-2)

Earthquakes

An earthquake is a natural process caused by the movement of parts of Earth's surface. Earthquakes start along a fault boundary. A **fault** is a break in Earth's surface where huge slabs of rock slip past, move away from, or push against each other. The slabs of rock often become locked together along a fault line. If the slabs break free, energy is released and moves through the rocks. This makes the ground shake.

Several million earthquakes occur every year. Most of them happen far from people or are too weak for people to notice.

Strong earthquakes can be very dangerous. Their violent shaking can raise and lower the land and change the course of rivers. Powerful earthquakes can damage buildings and other structures. Roads buckle, railroad tracks twist, and bridges collapse. Water pipes and electric power lines break. It can take years for people to repair the damage caused by a strong earthquake.

A 2007 earthquake destroyed this building in Osaka, Japan.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Wrap It Up!

My science notebook

1. **Define** What is a fault?
2. **Cause and Effect** How can an earthquake affect structures built by humans? Give three examples.
3. **Apply** How might an earthquake affect people's ability to get from place to place?

Investigate

Earthquakes

? How can you demonstrate liquefaction?

During earthquakes, many buildings have collapsed or tilted and sunk into the ground. Why? Often the buildings were built on loose materials such as rocky soil, sand, or mud. There is also a lot of water in the ground. When the earthquake shook the ground, these materials became liquid-like. The change of a solid area of ground such as sand or mud into a less stable liquid-like condition is called **liquefaction.** Liquefaction is one of the hazards caused by earthquakes.

In this investigation, you will use a model to learn how earthquakes affect structures built on sand or mud.

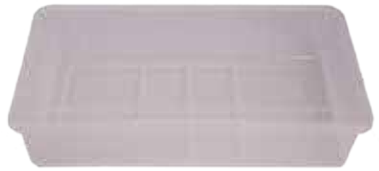
Materials

sand

water

wooden block

plastic pan



mallet

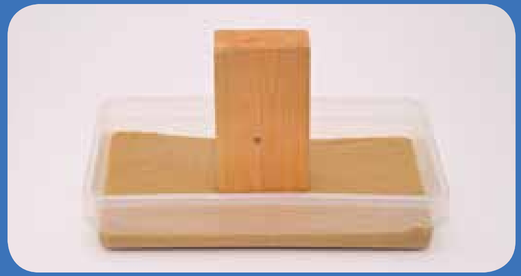
NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

1 Fill the pan with sand, leaving about 9 cm at the top.

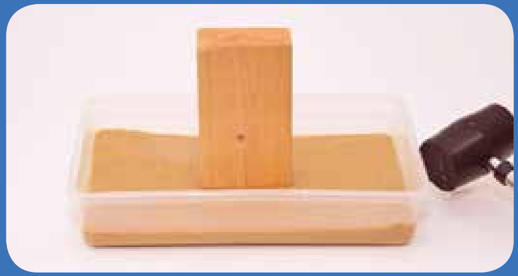
My science notebook

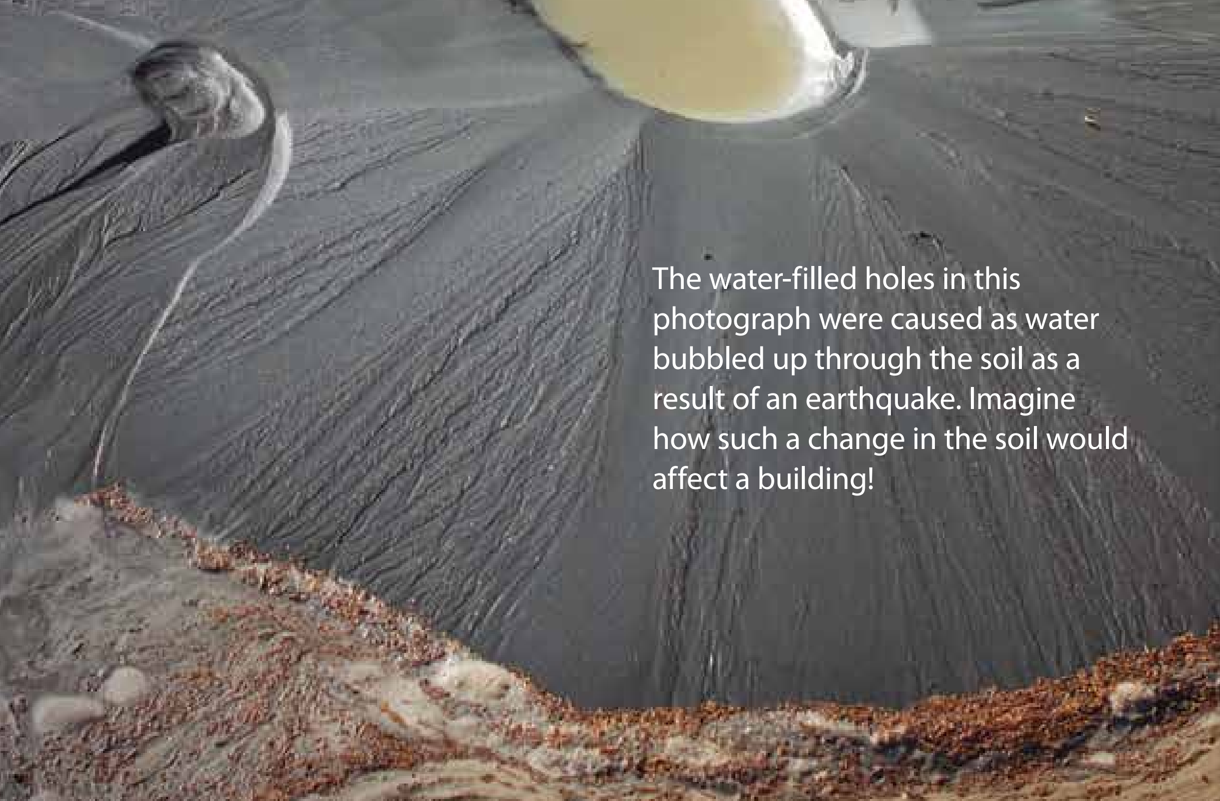
2 Place the pan on a table. Then pour in water to just below the surface of the sand. Record your observations.

3 Push one end of the block down into the wet sand so it stands up like a building. Predict what will happen when you repeatedly tap the mallet against the pan. Record your prediction.



4 Hold the pan in place. Very gently tap the side of the pan repeatedly with the mallet. Observe what happens to the sand and the block. Record your observations.





The water-filled holes in this photograph were caused as water bubbled up through the soil as a result of an earthquake. Imagine how such a change in the soil would affect a building!

Wrap It Up!

My science notebook

1. **Explain** What did the block represent? What did hitting the pan with the mallet represent?
2. **Analyze** How did hitting the pan with the mallet affect the block?
3. **Revise** How could you change the model to test ways to make buildings constructed on sand or mud more stable? Write your plan. Include a diagram of how your test would work.

Tsunamis

A tsunami is a series of fast-moving ocean waves caused by an earthquake, or an underwater volcanic eruption, or a landslide. In places where the ocean is deep, tsunami waves may be only a few centimeters high. As the waves approach shore, they increase in height. Some tsunami waves come ashore gently. Others become huge walls of water.

The Great Tōhoku Earthquake of 2011 in Japan set off a series of tsunamis. A few minutes after the earthquake, one tsunami crashed over this seawall in Miyako City. Tsunamis up to 12 meters (39 feet) tall destroyed coastal areas across northeastern Japan.

When a large tsunami smashes into land, its turbulent water can destroy houses, roads, and other structures. People may be swept away. Very large tsunamis can destroy entire villages.

This tsunami was caused by a strong earthquake that struck Japan in March of 2011.

Wrap It Up!

My science notebook

1. **Recall** What are three events that cause tsunamis?
2. **Explain** How do some tsunamis change when they reach land?
3. **Summarize** Why are tsunamis dangerous?

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). (4-ESS3-2)

Volcanoes

A volcanic eruption is a natural process on Earth's surface. Volcanoes form when **magma,** or melted rock inside Earth, rises to the surface. In some types of volcanoes, molten rock **erupts** through an opening. Magma that erupts onto Earth's surface is called **lava.** Sometimes the lava flows down the side of the volcano and hardens into rock.

Mt. Sakurajima on the main island of Japan erupted on August 18, 2013.

Hot, expanding gases in magma can cause explosive eruptions. Hot ash and lava released during an eruption may quickly bury or destroy nearby forests, fields, and towns. Such eruptions are a hazard to the people living nearby. The ash in the air makes it difficult to breathe. Volcanoes may also release poisonous gases.

There is little people can do to limit the dangers of a volcano. The safest solution is to not live close to one.

Ash covered these rental cars in Kagoshima, Japan, after Mt. Sakurajima erupted.

My science notebook

Wrap It Up!

1. **Identify** What are some of the hazards caused by erupting volcanoes?
2. **Compare and Contrast** What is the difference between magma and lava?
3. **Research** What were the effects of the most recent volcanic eruption closest to where you live?

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Reducing the Impact of Natural Hazards

Natural hazards cannot be eliminated, but people can take steps to reduce their impact. For example, engineers can design buildings and bridges to withstand the violent shaking of earthquakes. This reduces damage and saves lives.

The suspension bridge contains a motion-detection system, which warns drivers of earthquake danger.

The San Francisco-Oakland Bay Bridge in California is designed to withstand a major earthquake.

Wrap It Up!

My science notebook

1. **Review** What features can help protect the bridge from earthquake damage?
2. **Evaluate** The features that help keep bridges safe during an earthquake also make the bridges more expensive. Do you think all bridges should have these features?

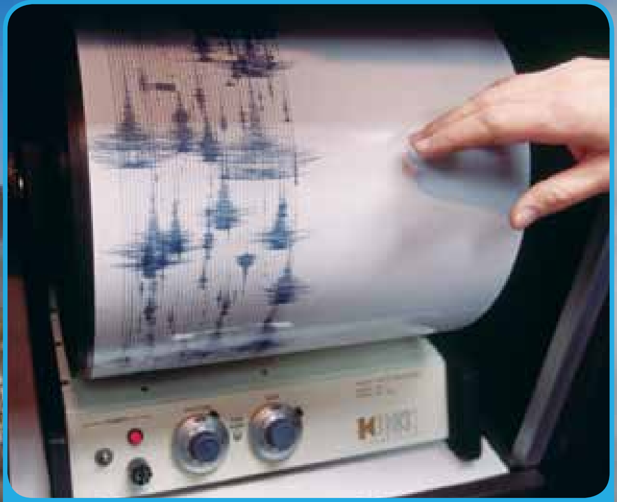
NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Early Warning Systems

If people know that a natural hazard is likely to occur, they can take steps to reduce its impact. But how can people know when they are in danger? Scientists use many methods to help predict when natural hazards are likely to happen.

Seismometers measure earthquake activity. An increase in small earthquakes can mean a larger earthquake is about to happen or a volcano is becoming more active. If a volcanic eruption is predicted, people can **evacuate,** or move to safer areas. Governments can prepare emergency supplies, such as food and water. Emergency workers can be ready to help with injuries. All of these steps reduce the impact and help save lives.

Seismometers detect earthquake shock waves. Different types of earthquakes near a volcano can be signs of increasing volcanic activity.



Ground motions sensed by seismometers are converted into electronic signals. The signals are transmitted by radio and recorded on **seismographs**.

Scientists use several devices and methods to constantly collect information about a volcano's activity. Radio transmissions allow the data to be sent instantly to a monitoring system. Scientists can tell what is happening with a volcano almost as soon as it happens. They can also use that information to predict what is likely to happen next.

In addition to tracking seismic activity, scientists also monitor gases, temperature, and water at a volcano site. A change in the amount of carbon dioxide and other gases given off by the volcano can signal a coming eruption. So can temperature changes at the surface and within areas of rock. Scientists monitor water levels and look for changes in chemistry in water near volcanoes, too.

Swelling, sinking, or cracking of the ground near a volcano can mean magma is moving beneath the surface. Tilt meters detect quick magma movements.

Scientists continually monitor the gases coming out of active volcanoes.

Wrap It Up!

My science notebook

1. **Describe** What information do scientists collect to monitor volcanoes?
2. **Explain** How is the information used to reduce the impact of volcanic eruptions?

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

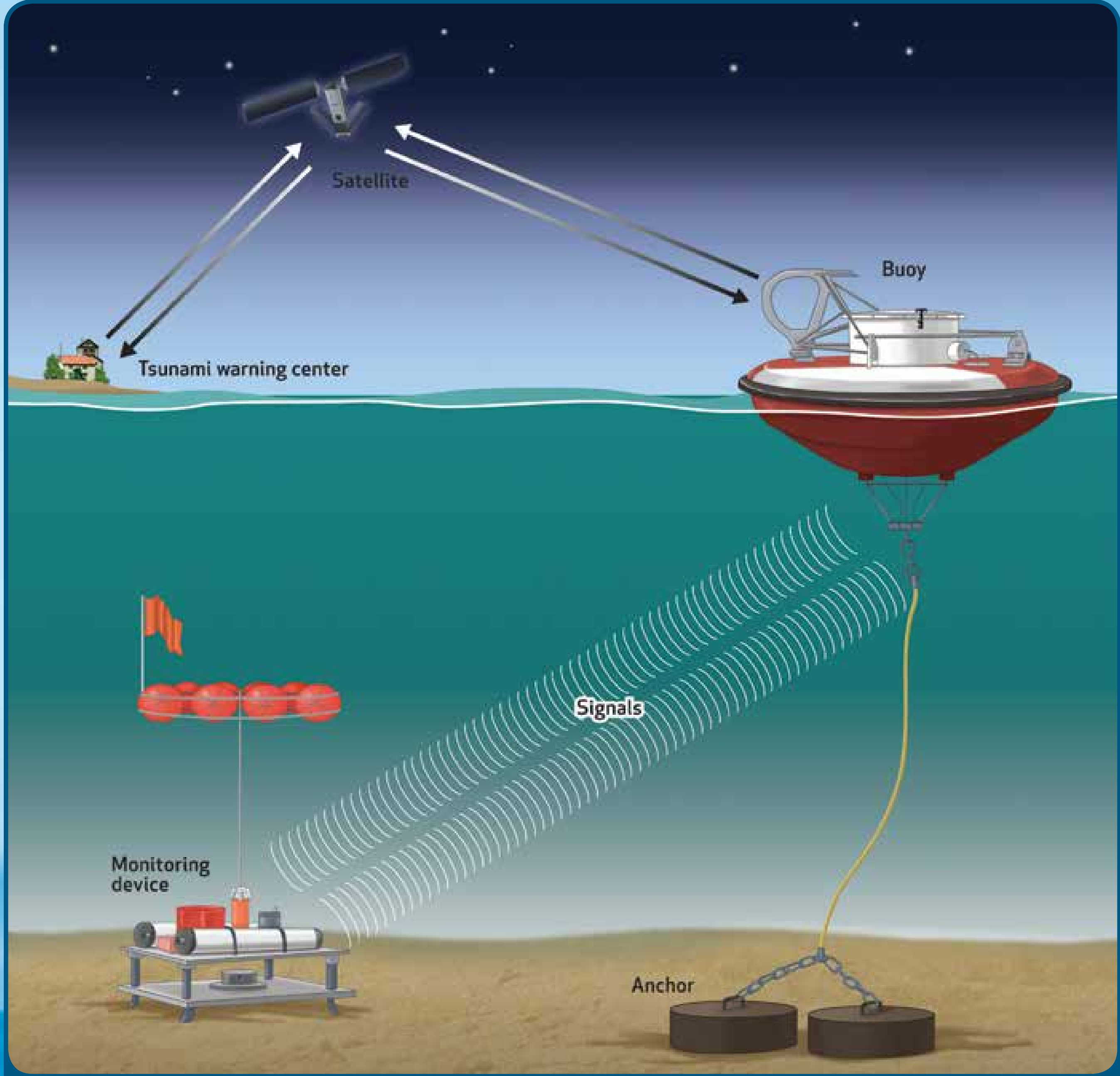
Tsunami Detection

Most of the events that cause tsunamis occur on the floor of the ocean. It's not easy to collect seismic activity data there. It's also not possible to monitor the entire ocean floor. A sudden earthquake or landslide on the sea floor can cause a tsunami that may strike land hundreds or even thousands of kilometers away.

Scientists use a system of floating devices called buoys to measure changes in the depth of ocean water. A pattern of depth changes can indicate that a tsunami has formed. If scientists can detect a tsunami as soon as it happens, they can alert people on land that a tsunami may be on the way. People can then leave areas near the coast and move inland or to higher ground.

The tsunami warning buoy is floating on the ocean.

The map shows the ring of tsunami warning buoys that encircles the Pacific Ocean.



Buoys receive data from monitoring devices on the sea floor. When the system of buoys detects a tsunami, a satellite transmits a signal to a tsunami warning center. The warning center then alerts people that a tsunami is approaching. In some cases, loud horns sound the alarm. Then people can quickly move away from the coast.

Wrap It Up!

my science notebook

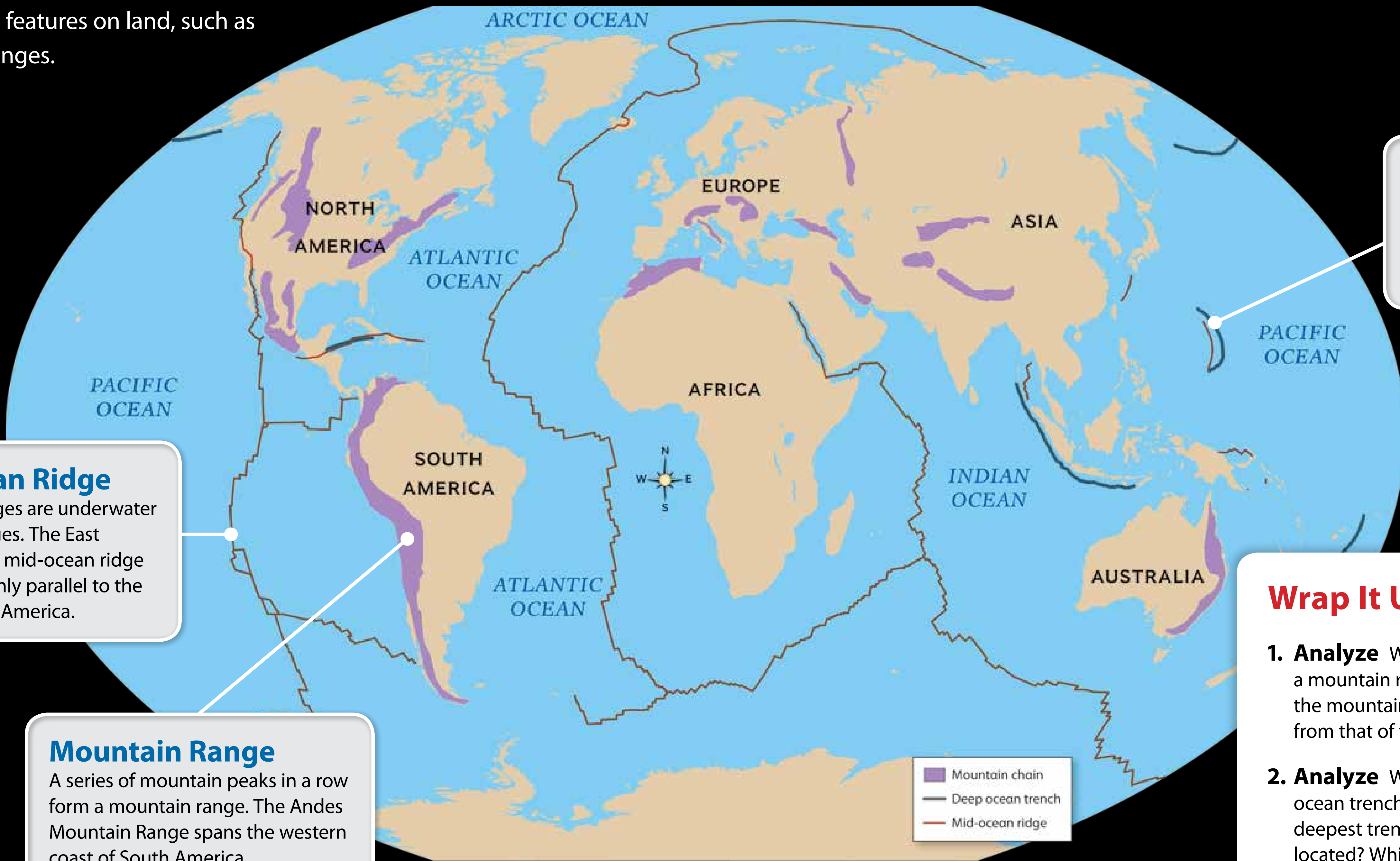
1. **Describe** How do scientists detect tsunamis?
2. **Explain** Why are satellites useful in predicting tsunamis?

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Patterns of Water and Land Features

Maps can be used to find the location of land and water features on Earth. This map shows some of the major features on land, such as mountain ranges.

The map also shows two major features found on the ocean floor—mid-ocean ridges and deep ocean trenches. A **mid-ocean ridge** is an underwater mountain chain made up of thousands of volcanic peaks. A **deep ocean trench** is a steep underwater canyon.



Deep Ocean Trench

Ocean trenches are steep underwater canyons. The Mariana Trench is the deepest place in the world's oceans.

Mid-Ocean Ridge

Mid-ocean ridges are underwater mountain ranges. The East Pacific Rise is a mid-ocean ridge that runs roughly parallel to the coast of South America.

Mountain Range

A series of mountain peaks in a row form a mountain range. The Andes Mountain Range spans the western coast of South America.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS2.B: Plate Tectonics and Large-Scale System Interactions
The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water feature areas of Earth. (4-ESS2-2)

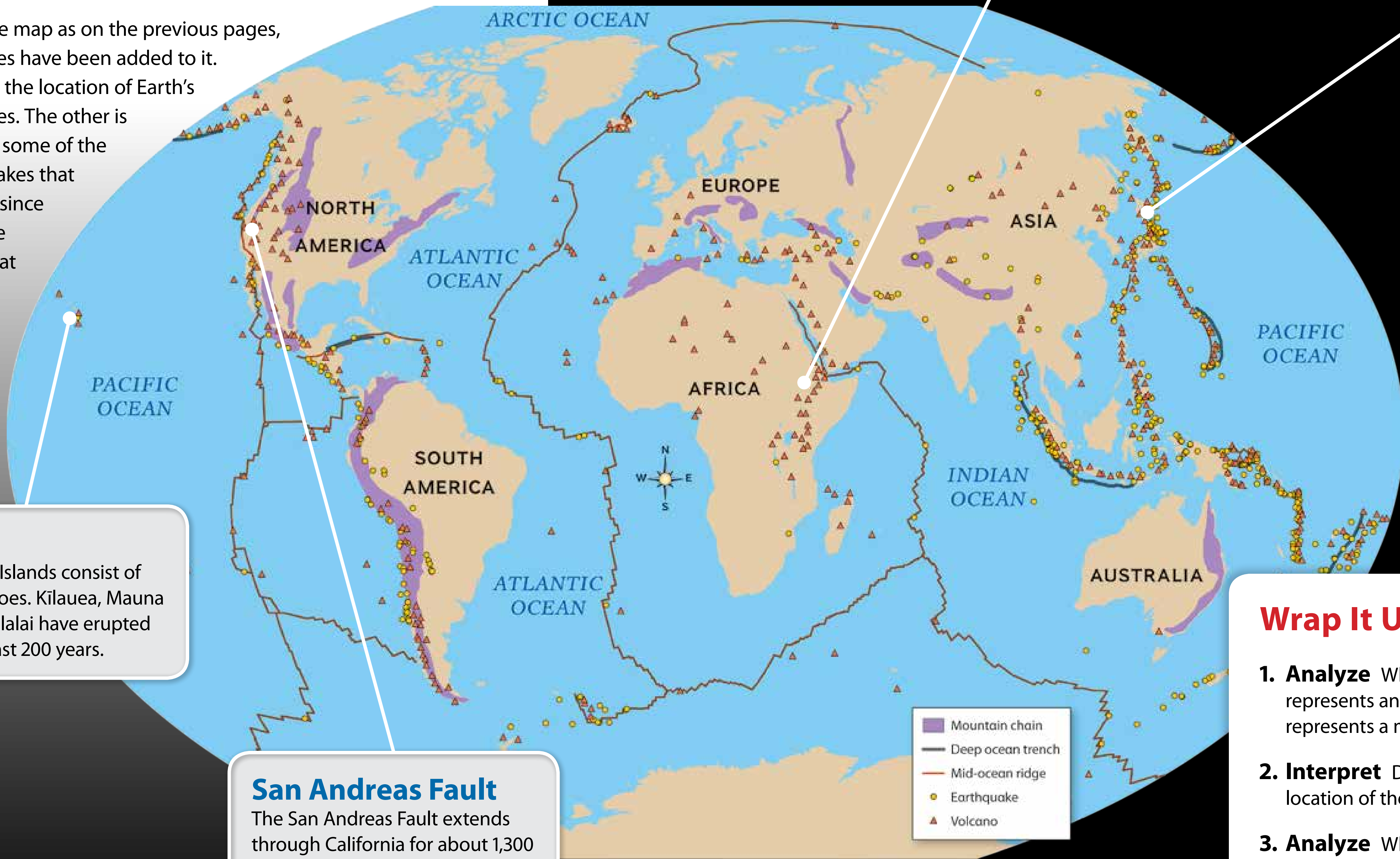
My science notebook

Wrap It Up!

1. **Analyze** What symbol on the map represents a mountain range? How does the location of the mountain range in South America differ from that of the main mountain range in Asia?
2. **Analyze** What symbol represents a deep ocean trench? The Mariana Trench is the deepest trench on Earth. In which ocean is it located? Which continent is located to the west of this trench? *Hint*: Use the compass rose to find directions.
3. **Interpret** Describe the location of the East Pacific Rise.

Analyze and Interpret Data

This is the same map as on the previous pages, but two features have been added to it. One of these is the location of Earth's active volcanoes. The other is the location of some of the major earthquakes that have occurred since 1900. Study the map to see what patterns you can find.



Great Rift Valley

The Great Rift Valley is a trench that runs for approximately 6,000 kilometers (about 3,700 miles) through South East Africa.

Japan

Japan consists of a chain of hundreds of islands.

Hawai'i

The Hawaiian Islands consist of many volcanoes. Kīlauea, Mauna Loa, and Hualalai have erupted within the past 200 years.

San Andreas Fault

The San Andreas Fault extends through California for about 1,300 kilometers (about 800 miles). It is the site of frequent earthquakes.

Wrap It Up!

My science notebook

1. **Analyze** Which symbol on the map represents an active volcano? Which symbol represents a major earthquake?
2. **Interpret** Describe the pattern in the location of the active volcanoes.
3. **Analyze** Where do most earthquakes take place?
4. **Interpret** Compare the locations of earthquakes and volcanoes. What pattern do you see?

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.

Building for the Future

Problem

How can engineers make buildings more earthquake resistant?

In March 2011 a powerful earthquake just off the coast of Japan shook the ground and set off an enormous tsunami. The earthquake and tsunami damaged more than one million buildings and killed or injured thousands of people. Yet most buildings survived the earthquake, and many lives were saved. Why was the damage in Japan less than might have been expected? Because earthquakes are common in Japan, the government requires all new buildings to be designed and built to withstand earthquakes.

The recent disaster has inspired an engineer named Masaaki Saruta and his team to develop structures that are even more resilient. The engineers know they cannot prevent earthquakes, but they can develop solutions that will lessen the impact of these disasters.

This building was destroyed by an earthquake in Japan.

Masaaki Saruta works at the Shimizu Corporation in Tokyo, Japan. He is the group leader of the Vibration Control Engineering Group. Saruta and his team of engineers design buildings to withstand the destructive forces of earthquakes.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ESS3.B: Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Solution

Over the years, the engineers at Shimizu have developed a variety of earthquake-resistant designs. In some of the designs, buildings are separated from their foundations by a system of pads or bearings. This is called base isolation, and it separates the frame of a building from the violent shaking of an earthquake.

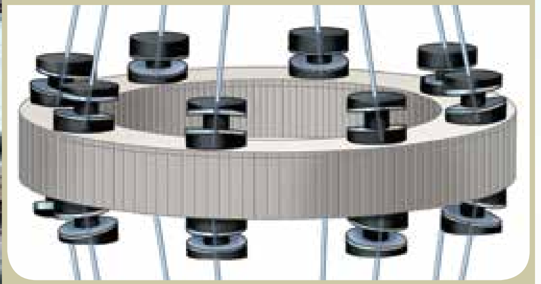
Masaaki and his team invented a new kind of base isolation called the core-suspended isolation system (CSI). In CSI, the core of a building is a large pillar of reinforced concrete. The floors of the building hang from the top of the core. The core is isolated from the rest of the building by large rubber bearings. When an earthquake strikes, the core absorbs the vibrations. The core may sway, but the floors of the building do not sway. Instead they remain upright.

The team has also designed a building that partially floats on water! The building stands on rubber bearings and its foundation rests in a pool of water. To test their design, they built a large model of the building. Their tests showed that water reduces the movement of a building. But the real test came during the March 2011 earthquake, when the engineers found that the features of their building cut the effects of shaking by more than half.

Masaaki says, “We want to come up with technologies that save people’s lives.” His team’s engineering solutions are helping to accomplish this goal.

The Safety and Security Center was constructed using the core-suspended isolation system.

The building is suspended, or hangs, over a strong concrete core.



If the core shakes during an earthquake, layers of rubber bearings prevent much of the motion from being transferred to the building. This reduces damage.

Wrap It Up!

My science notebook

1. **Summarize** Describe how a building is constructed using the core-suspended isolation system.
2. **Explain** How does CSI lessen the impact of an earthquake?
3. **Relate** How are base isolation and core-suspended isolation systems related?

Generate and Compare Solutions

You've read about Masaaki Saruta and his team's work to design and build earthquake-resistant buildings. Now it's your turn to use some of the same techniques engineers use. Working with a team, you'll design and test model houses to see if you can design and build a more damage-resistant structure.

1. Define the problem.

How can you make a house more earthquake-resistant?

2. Find a solution.

- Work with a team. Think about how earthquakes damage buildings. You may need to do some research to find out more about earthquake damage to different kinds of structures. Then you can decide what kind of house you are going to build, how you will build it, and what kind of damage you want to prevent. Record your ideas as you develop your plan.

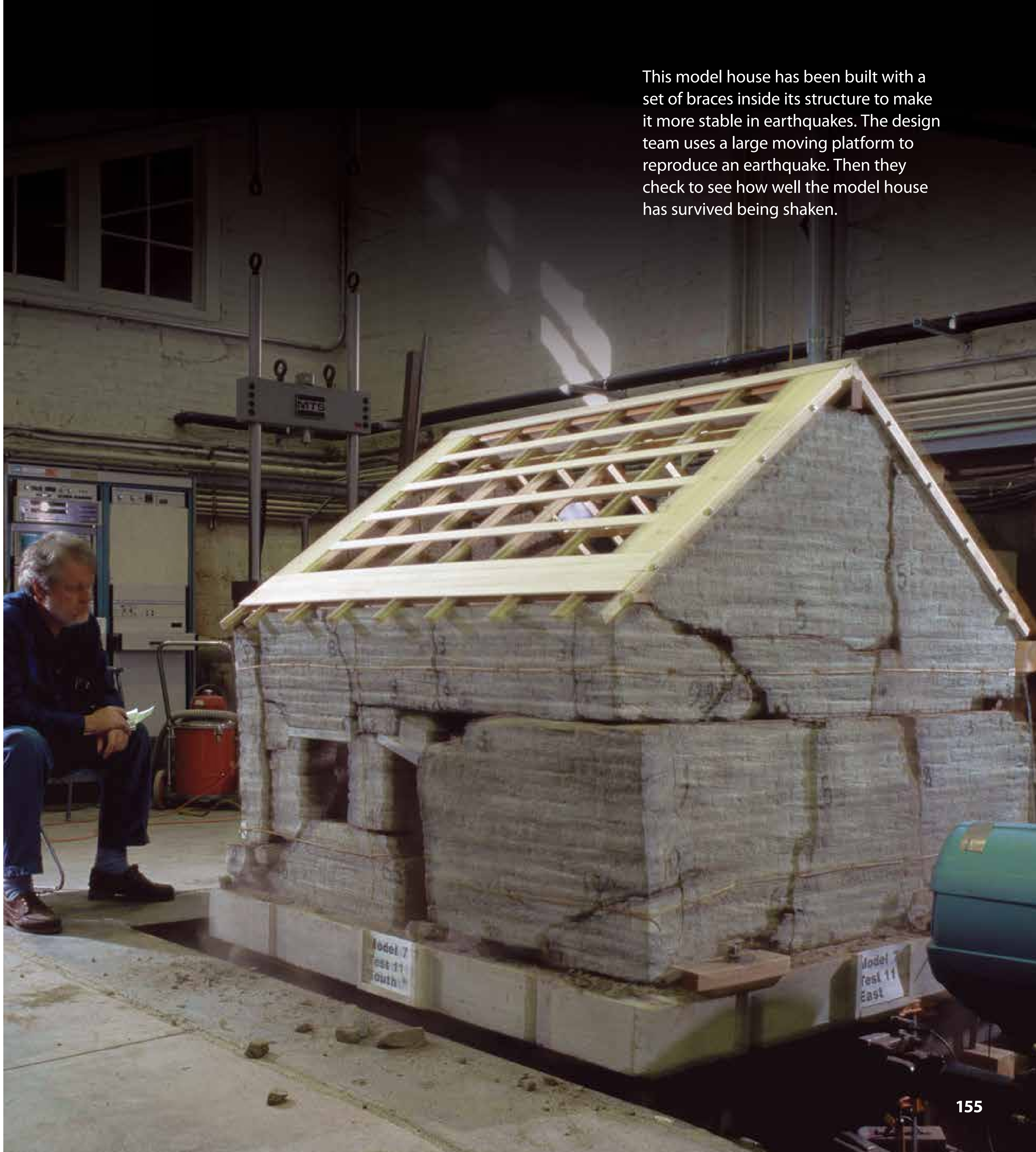
- Now think about the materials you'll need and the methods you'll use to make your house earthquake resistant. How will you determine whether your house is resistant to earthquakes? How will you simulate an earthquake? Write out a plan for your investigation.

3. Test your solution.

- Collect the materials you need and build your model house. Subject the house to an earthquake. What damage did it cause? How might you protect the house from this damage? Build a new house and test your ideas. Record your observations.

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

DISCIPLINARY CORE IDEAS
ETS1.B: Designing Solutions to Engineering Problems
Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)



This model house has been built with a set of braces inside its structure to make it more stable in earthquakes. The design team uses a large moving platform to reproduce an earthquake. Then they check to see how well the model house has survived being shaken.

- Adjust your design, and test again. Be sure that you conduct a fair test. In a fair test you change only one variable each time you carry out the test. Record your observations each time you carry out a new test.

4. Refine or change your solution.

- Analyze your results. Which solutions worked best? How do you know?
- Once you have at least two solutions for making your house resistant to earthquake damage, develop a document or presentation that clearly describes your findings. Use diagrams with labels to explain your solutions, and provide evidence from your tests to support your selection of the best designs.
- Share your designs with another team. Explain your evidence showing why you selected these two designs as the best ones. Record comments and suggestions from your classmates. Which of their ideas would improve your plan? After you have discussed your design solutions with your classmates, revise the design of your house to make it even more earthquake resistant.

5. Present your solution.

When you are satisfied that your solution is the best you can make it, revise your presentation. Then share your solutions with the class.

The team examines cracks in the model to evaluate how well the construction resisted damage during the shaking.

NATIONAL GEOGRAPHIC LEARNING | Science Career

Crisis Mapper

What can help speed medical aid to areas destroyed by tsunamis? What can help direct rescue helicopters to areas struck by earthquakes? What can help the United Nations deliver food and water to people suffering from droughts?

A map! Not just any map, but an online map with accurate information. In **crisis mapping,** Patrick Meier combines information from government and international agencies with tweets and text messages sent by volunteers. He and his team use this information to update an online map of the areas where disasters have struck. Crisis mapping saves lives by providing rescue workers with an up-to-the-minute picture of what is going on and where help is needed.

After the 2010 earthquake in Haiti, Patrick's efforts assisted citizens, aid workers, and the U.S. Coast Guard. Patrick's team of volunteers mapped the impact of the earthquake in near real time, providing professionals with the most up-to-date information available.

NATIONAL GEOGRAPHIC | Explorer

Patrick Meier is a leader in the field of crisis mapping. Patrick didn't always think he would be working with new types of maps. In school he liked the subjects computer science and philosophy. Later in college he studied humanitarian affairs. In his work he combines his love of geography and technology in a way that helps people around the world.

NGL Science How did you get into mapping?

Patrick Meier When I was 12, the first Gulf War broke out. I had a big map of the Middle East and started physically mapping the updates with crayons and pens and markers.

NGL Science What have you and your team tracked so far?

Patrick Meier Haiti started it all. A month later there was an earthquake in Chile. Then the floods in Pakistan that summer. Russian fires in July. Floods in Brisbane in January. A major earthquake in Christchurch, New Zealand, that February.

NGL Science What are people saying about your crisis-mapping technology?

Patrick Meier Many humanitarian organizations say our crisis-mapping technology is revolutionizing disaster relief efforts. . . . Now we can pinpoint urgent needs instantly, saving time and lives.

Pastizal de las grandes llanuras

En la zona central de Estados Unidos, llueve más que en el desierto pero menos que en el bosque. En la región, se desarrollan pastizales, también llamados praderas. Esta gran área de tierra está cubierta por césped y muchas clases de flores silvestres, pero pocos árboles.

Para adaptarse a las cambiantes estaciones, el bisonte muda su grueso pelaje invernal cuando el clima se torna cálido.

Este gallo de las praderas se alimenta de pastos que crecen en una pradera de Nebraska.

El clima en los pastizales varía según la estación. Los inviernos son fríos y los veranos son calurosos y secos. Las plantas de las praderas desarrollan raíces largas que pueden absorber y almacenar agua. Durante períodos extremadamente secos, es común que se produzcan incendios. Muchas plantas de las praderas vuelven a crecer después de un incendio porque sus raíces están protegidas por debajo del suelo.

Los pastos de la pradera tienen adaptaciones que los ayudan a sobrevivir veranos largos y calurosos.

Aquí crecen pocas especies de árboles porque no hay la cantidad de lluvia suficiente y los incendios destruyen los árboles jóvenes.

Estas coloridas flores atraen a las abejas y a las avispas que ayudan a que las plantas se reproduzcan.

Mi cuaderno de ciencias

¡Resúmelo!

1. **Describe** ¿Cómo es el clima en la pradera durante el verano?
2. **Resume** ¿Cuál es una manera en que las plantas de la pradera sobreviven a los extremos cambios de clima?
3. **Infiere** ¿Cuándo llueve más en los pastizales?

ESTÁNDARES DE CIENCIAS DE NUEVA GENERACIÓN | IDEAS DISCIPLINARIAS BÁSICAS ESS2.A: Materiales y sistemas de la tierra
La lluvia ayuda a dar forma a la tierra y afecta a las clases de seres vivos que se encuentran en una región. (4-ESS2-1)

Earthquakes

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS

ESS3.B: Natural Hazards A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Objectives **Students will be able to:**

- Describe earthquakes.
- Identify the hazards to humans that result from earthquakes.

Science Vocabulary
fault

ENGAGE

Tap Prior Knowledge

- Ask students to share a few personal experiences with water waves based on a trip to a beach or a wave pool or the waves that form when a rock is dropped into a puddle or pond. Ask: **How do waves move?** (Accept any reasonable responses. Possible answer: Waves move through the water toward a beach. When a rock is dropped into a puddle, waves move outward from where the rock hit the water.)

EXPLORE

Explore Earthquakes

- Have students observe the photo on pages 132–133. Ask probing questions to encourage exploration. For example, ask: **What happened to the building shown here? What do you think caused this damage?**
- Have students share their answers. Students may say that the building collapsed. Some students may say that the ground shook and caused this damage.

Set a Purpose and Read

- Have students read in order to identify the hazards to humans that result from earthquakes.
- Have students read pages 132–133.

EXPLAIN

Define Fault

- After students read page 132, ask: **What is a fault?** (A fault is a break in Earth's surface where huge slabs of rock slip past, move away from, or push against each other.) **What often happens to slabs of rock along a fault line?** (The slabs of rock often become locked together.)

Describe Earthquakes

- Remind students that earthquakes are a result of natural processes, meaning that they are caused by forces in nature. Ask: **What causes earthquakes?** (Movement of slabs of rock along a fault causes earthquakes.)
- Say: **Explain what happens when locked slabs break free.** (Energy is released and moves through the rocks.) Elicit how this action is much like water waves moving outward when a rock is dropped into standing water.
- Ask: **What happens to the ground when the energy moves through the rocks?** (The ground shakes.)

Identify Hazards Caused by Earthquakes

- Ask: **How can strong earthquakes affect land features?** (Strong earthquakes can raise and lower the land. They can also change the course of rivers.)
- Ask: **What hazards to humans can result from strong earthquakes?** (Strong earthquakes can damage buildings and other structures. They can cause roads to buckle, railroad tracks to twist, and bridges to collapse. Also water pipes and electric power lines can break.)
- Say: **Describe the damage caused by the 2007 earthquake in Osaka, Japan, shown in this photo.** (Possible answer: The earthquake completely destroyed the building. Windows were broken, and much of the structure collapsed. Students may also infer that with damage this extensive, water lines and power lines within the building would have been destroyed.)

ELABORATE

Research Earthquake Damage

Step 1: According to the United States Geological Survey (USGS), the March 2011 earthquake that struck Japan had a magnitude of 9.0, making it one of the strongest earthquakes on record. Have students conduct research to find images and descriptions of the damage that this quake caused.

Step 2: If time permits, have small groups of students work together to use the data they have collected to make a collage documenting the damage.

Extend Your Thinking About Earthquake Hazards

- Have students extend their thinking about earthquake hazards by discussing the following example. Say: **Damage caused by earthquakes often results in broken power lines.** Ask: **How might these lines pose a hazard to humans?** (Possible answers: Broken power lines can electrocute people who touch them. Without electricity, people do not have lights, heat, and refrigerators. People cannot have fresh food and may not be able to cook their meals. People may become ill if their food is not kept cool.)

EVALUATE

Have students record their answers to the Wrap It Up questions in their science notebook.

Wrap It Up!

1. **DEFINE** **What is a fault?** (A fault is a place where giant slabs of rock in Earth's outer layer slip past, move away from, or push against each other.)
2. **CAUSE AND EFFECT** **How can an earthquake affect structures built by humans? Give three examples.** (Students may list any three of these possible examples: The violent shaking of an earthquake can cause buildings to collapse, bridges to collapse, roads to buckle, and railroad tracks to twist. In addition, water pipes and power lines may break.)
3. **APPLY** **How might an earthquake affect people's ability to get from place to place?** (Answers will vary. Possible answer: Most people get from place to place on roads. Earthquakes can cause roads to buckle and bridges to collapse. People who ride trains could not do so if tracks were twisted. Some students may suggest that downed power lines or broken water pipes could make traveling difficult or impossible.)

SCIENCE BACKGROUND

Liquifaction

In addition to damaging structures as a result of violent ground shaking, earthquakes may also cause liquefaction. Liquefaction is a process in which a saturated soil temporarily acts like a liquid rather than a solid as earthquake waves pass through it. The waves cause the soil to flow or collapse. Students will model the effects of liquefaction in the Investigate activity on the following pages.

READING CONNECTION

Use Details and Examples

Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

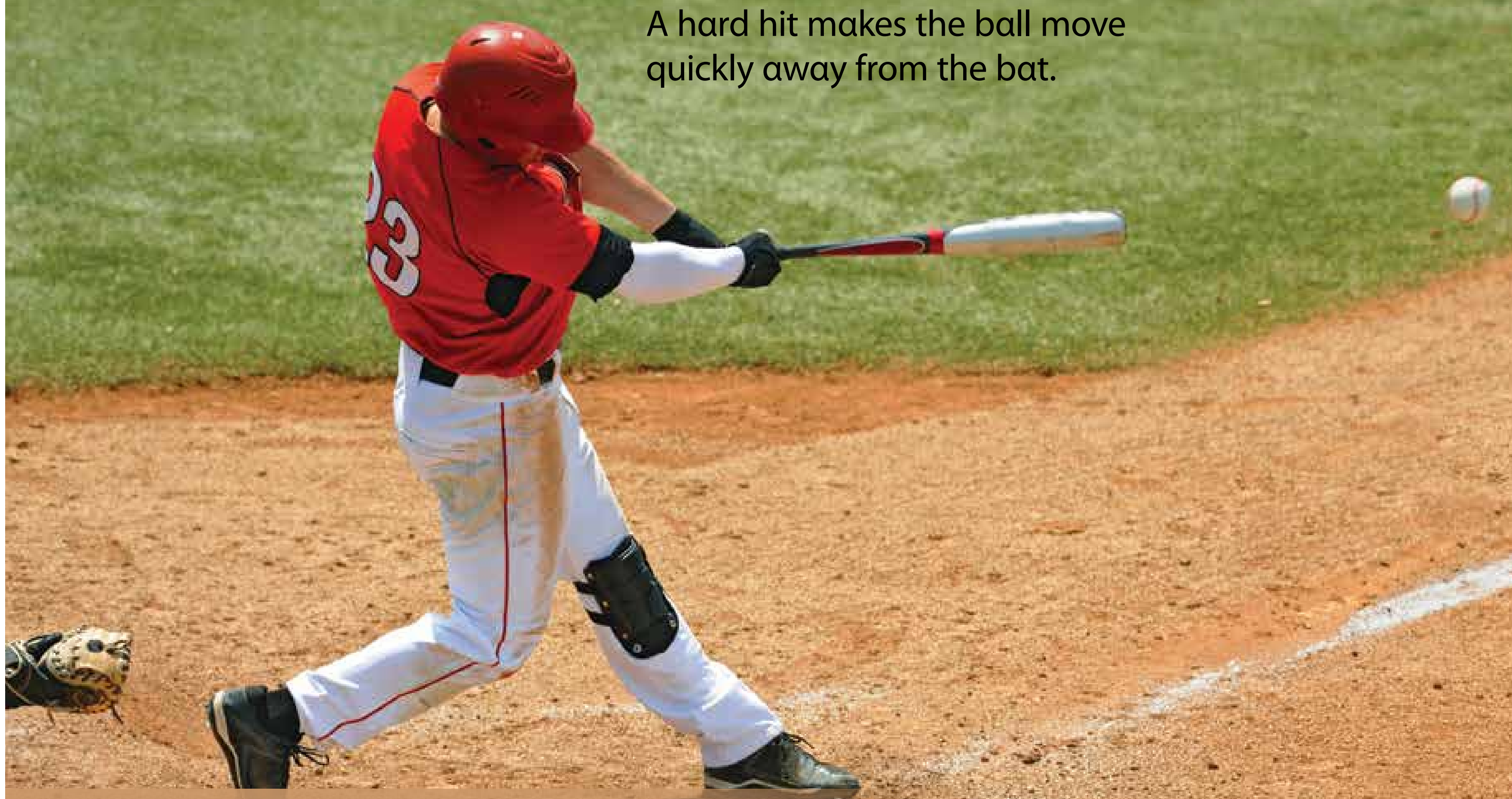
Guide students in using details and examples from the text to tell what the text says explicitly and to draw inferences from the text. For example, in the EXPLAIN section when asking students to describe the damage caused by the 2007 earthquake in Osaka, Japan, have students give details explicitly stated in the text, such as damaged buildings and other structures. In the ELABORATE section when asking students to extend their thinking about earthquake hazards, ask students to use what they already know to infer how broken power lines pose a hazard to humans.

Changing Speed

Hitting a ball changes the ball's direction.

It also changes the ball's speed.

Speed is how fast something is moving.



A hard hit makes the ball move quickly away from the bat.

A soft hit makes the ball move slowly away from the bat.

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS

PS2.A: Forces and Motion
Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2)

PS2.B: Types of Interactions
When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

Wrap It Up!

What is speed?

My science notebook

Investigate

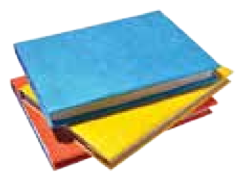
Changing Speed

? How can you change the speed of an object?

Materials

board

3 books



toy car

1. Make a ramp.
   Use 1 book and the board.

2. Put the car at the top of the ramp.
   Let the car go.
   Observe and record.
3. Make a ramp.
   Use 3 books and the board.

4. Put the car at the top of the taller ramp.
   Let the car go.
   Observe and record.

Wrap It Up!

How did the speed of the toy car change?

My science notebook

NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
PS2.A: Forces and Motion
Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1), (K-PS2-2)

Plan and Conduct an Investigation

How can you use pushes and pulls to make things move?

1. Choose an object.
2. How can you use hard and soft pushes and strong and weak pulls to make the object move?
3. Draw your ideas.
4. Test your ideas.
   Record what happened.
5. How can you use pushes and pulls from different directions to make your object move?
6. Draw your ideas.
   Test and record.
7. Compare how different pushes and pulls moved your object.

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

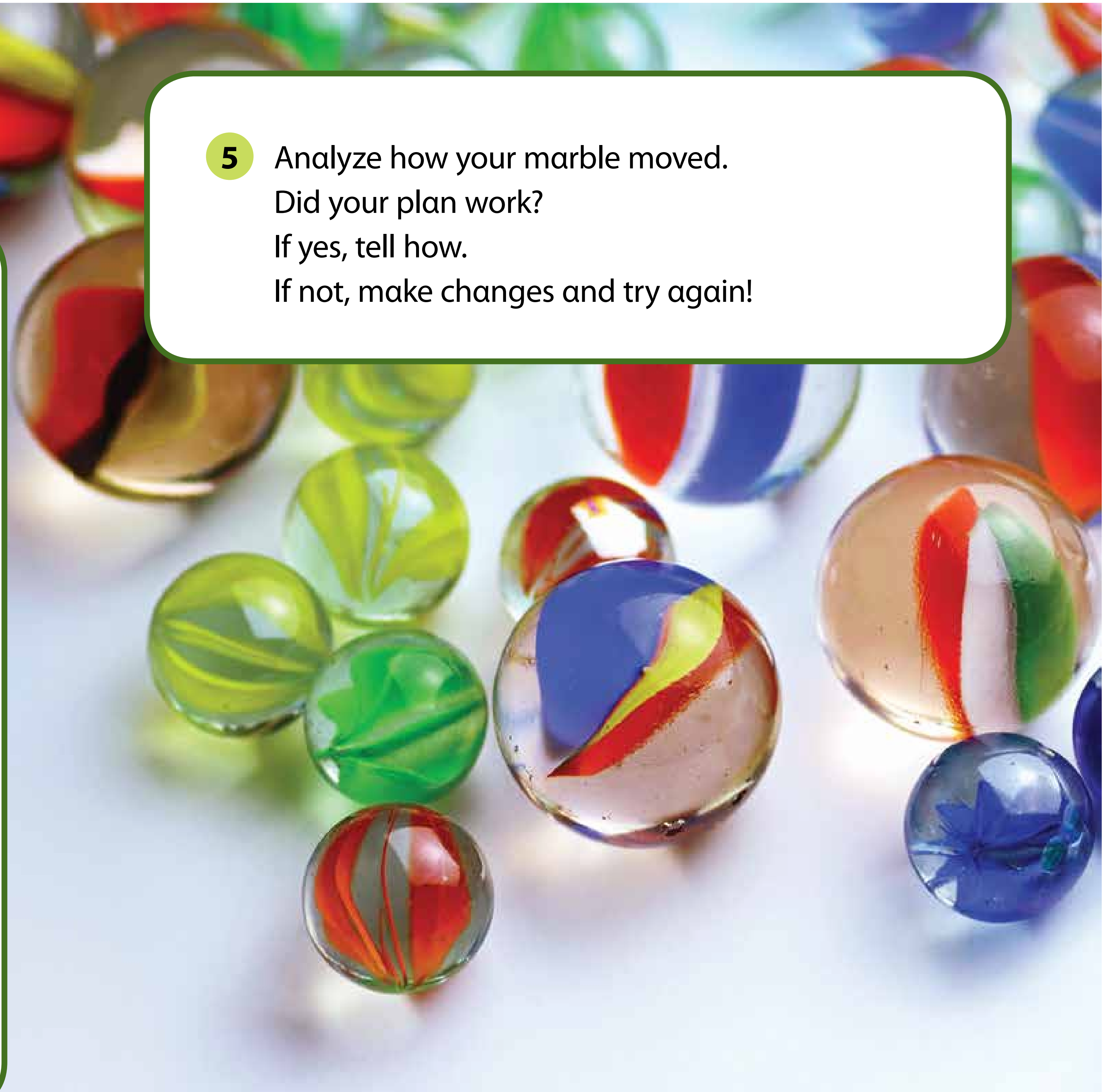
Analyze Data

You know ways to make objects move.

You can put the ways together!

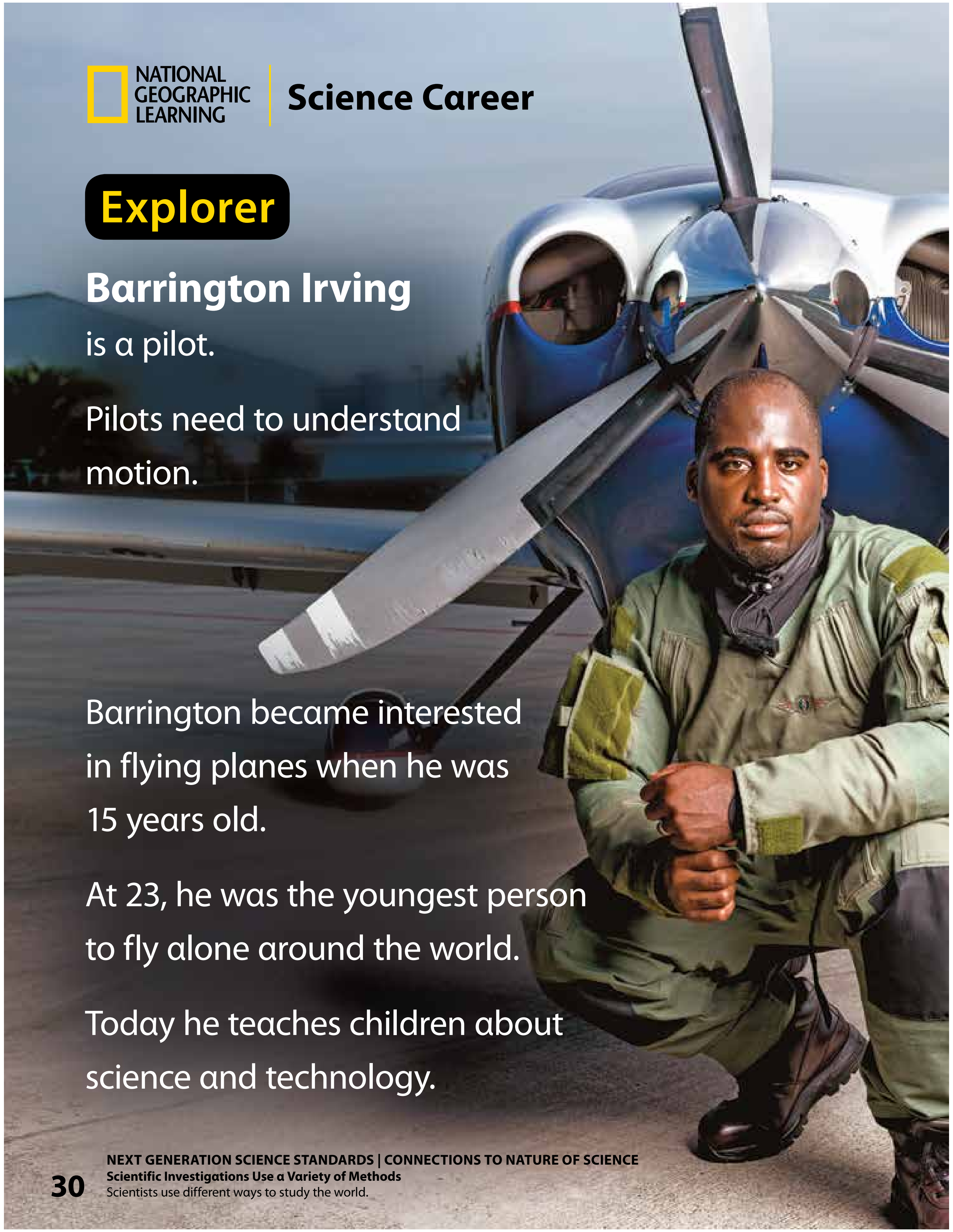
You can design a way to make a marble move in different ways.

1. **Problem:** How can you make a marble
   - roll across the floor,
   - change directions, and
   - knock down some cups?
2. Make a plan and draw a picture. My science notebook
3. Test your idea.
4. Record your results.
5. Analyze how your marble moved.
   Did your plan work?
   If yes, tell how.
   If not, make changes and try again!



NEXT GENERATION SCIENCE STANDARDS | DISCIPLINARY CORE IDEAS
ETS1.A: Defining Engineering Problems
A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to K-PS2-2)

NEXT GENERATION SCIENCE STANDARDS | PERFORMANCE EXPECTATION
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.



NATIONAL GEOGRAPHIC LEARNING | **Science Career**

Explorer

Barrington Irving

is a pilot.

Pilots need to understand motion.

Barrington became interested in flying planes when he was 15 years old.

At 23, he was the youngest person to fly alone around the world.

Today he teaches children about science and technology.

NEXT GENERATION SCIENCE STANDARDS | CONNECTIONS TO NATURE OF SCIENCE
Scientific Investigations Use a Variety of Methods
Scientists use different ways to study the world.

Notes:

Master the Next Generation Science Standards

- » Focus in-depth on 100% of the NGSS for grades K–5
- » Introduce real-world science research with National Geographic Explorers, scientists, and photographers
- » Connect NGSS content with investigations, engineering practices, and case studies for complete NGSS emersion

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