In This Guide
This guide contains language arts and science lessons for articles in this issue of EXPLORER ADVENTURER.

EXPLORER Magazine
EXPLORER classroom magazines are specifically written for each grade, 2-5. Through great storytelling and stunning photographs, the EXPLORER magazines develop literacy skills and teach standards-based science content.

The EXPLORER magazines strive to offer a variety of reading experiences for students with different ability levels in the same class. Thus, all articles have been measured using the Lexile® Framework for Reading. Some articles will be easier to read than others, but all articles in EXPLORER ADVENTURER will be within the 520-950L range.

EXPLORER is part of NATIONAL GEOGRAPHIC EXPLORER’s Education program. For more resources, visit the "For Teachers" tab on EXPLORER’s website, natgeo.org/explorermag-resources.

Your Subscription Includes:
- Magazines
- Classroom Posters
- Projectable Magazine
- Interactive Whiteboard Lesson
- Teacher’s Guide
- App (additional subscription required)
Objectives

• Students will predict definitions and then write sentences to better understand unfamiliar words.
• Students will explain how the writer uses reasons and evidence to support key points in the text.
• Students will use what they learned to write an opinion piece stating their views on why people should work together to help the quetzal.

Resources

• Vocabulary Assessment Master (page 6)
• Language Arts Assessment Master (page 7)

Summary

• The article “Quest for the Quetzal” introduces readers to the resplendent quetzal, a beautiful bird once revered by ancient civilizations. Now, the bird struggles to survive in a changing world.

BUILD VOCABULARY AND CONCEPTS

• Aztec
• culture
• fragmentation
• Mayan

Give each student a copy of the Vocabulary Assessment Master. Point out to students that they may have heard some or all of these words before.

Using that background knowledge as a base, instruct students to predict and write a definition for each word. Then have them write a sentence using each word, based on the definitions they wrote.

Display the Wordwise feature on page 8 of the projectable magazine. Review the definitions as a class. Have students add these definitions to their worksheets. Instruct them to write new sentences, using each word as it is defined in the article.

Invite volunteers to read aloud the before and after sentences they wrote for each word. As a class, examine how new knowledge contributed to students’ understanding of each word.

READ

Write the words reasons and evidence on the board. Then ask: What’s the difference between these two words? Invite students to share their ideas. Guide the class to understand that a reason tells why something happened. Evidence shows how.

Tell students that valid reasons and solid evidence are crucial elements of any text. Writers use them to support key points on the topic.

Display pages 2-3 of the projectable magazine. Instruct students to examine the images of the quetzal. Then invite a volunteer to read aloud the headline and text. Say: Sometimes when you read an article, you have to get a paragraph or two into the text before you can identify the key point the writer is trying to make. Not here. In this article, the writer has stated his main point loud and clear in the headline: Central America’s most beautiful bird needs our help. As a class, brainstorm ideas about why the quetzal might need help.

Give each student a copy of the Language Arts Assessment Master. Instruct students to record the writer’s main point. Have students read the article on their own. As students read, encourage them to search for reasons and evidence that support the writer’s main point. Instruct them to record what they find on the top half of their worksheets.
Quest for the Quetzal

LANGUAGE ARTS

TURN AND TALK

Have students turn and talk to discuss what they learned about quetzals. Ask: What do quetzals look like? [Their necks, backs, and wings have a metallic green sheen. Golden-green feathers on their heads form a bristly crest. The feathers on their chests are bright red. Males have two long tail feathers.] Where do quetzals live? [throughout Central America] Why do quetzals need help? [There are many threats, but the most serious one is loss of habitat.] Invite students to share what else they learned about quetzals.

• Predicting Definitions Have students turn and talk to discuss what they learned about the four vocabulary words. Encourage them to compare their results in small groups. Instruct students to discuss how examining the information they collected impacted their understanding of each term.

• Writing Opinions Remind students that the writer stated that the quetzal needs our help. Guide students as they discuss the following question: How can people help quetzals? Then have students write a brief essay expressing their opinions. Instruct students to introduce the topic clearly and state their opinions in an organized way. Encourage them to use the reasons and evidence they found in the article to support their views. Tell students to begin writing on the front of their Language Arts Assessment Masters and finish on the back.

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

• How does legend explain the bright red feathers on a quetzal’s chest?

• In what ways did the Mayans and Aztecs honor the quetzal as part of their cultures?

• What surprised you about what you read?
**Quest for the Quetzal**

**SCIENCE**

**Objectives**
- Students will examine the structure and function of the quetzal’s body parts.
- Students will understand why the quetzal’s future is uncertain.

**Resources**
- Content Assessment Master (page 8)
- Comprehension Check (page 9)

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**Science Background**

The resplendent quetzal—one of the five quetzal species—is a colorful bird found in the mountainous tropical forests of Central America. Many people consider it to be one of the most beautiful birds in the world.

The quetzal has metallic green feathers on its neck, back, and wings. And its chest feathers are bright red. But the tail feathers on the male are what really make this bird stand out. During mating season, mature males can grow tail feathers that are up to a meter long.

The quetzal’s beauty has not been lost on people. For thousands of years, the quetzal has held an honored place in Central American culture. Long ago, it was an important part of both Aztec and Mayan cultures. Today, it is the national bird of Guatemala.

But the bird’s beauty has also made it a target. Both hunters and collectors have preyed on the bird for its beautiful feathers.

Today, the resplendent quetzal may be one of the most threatened birds of its kind. This is chiefly because as people cut trees and clear land for livestock and crops, the bird’s natural habitat is disappearing. Restoring habitats or connecting those that still exist can help ensure the survival of this beautiful species.

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**ENGAGE**

**Tap Prior Knowledge**

Instruct students to each think of a bird. Invite volunteers to describe the birds they are thinking of. Compare and contrast the results. As a class, discuss how all of the birds are alike. Challenge students to identify interesting ways that the birds are different.

**EXPLORE**

**Preview the Lesson**

Display pages 2-3 of the projectable magazine. Invite volunteers to describe the bird they see. Ask: How is this bird different from other birds you’ve seen? (Students will most likely note the bird’s bright blue coloring and its very long tail feathers.) Read aloud the headline. Point out the word quest. Say: A quest is a search. You’d think that a bird that looks like this would be easy to find. Ask: Why do you think people have to search to find it? Invite students to share their ideas. Tell students that they will learn more about the bird and its plight as they read the article.

**Set a Purpose and Read**

Have students read the article in order to examine the structure and function of the quetzal’s body parts and to recognize why the quetzal’s future is uncertain.
**Quest for the Quetzal**

**SCIENCE**

**EXPLAIN**

**Examine the Quetzal’s Body Parts**
Display page 4 of the projectable magazine. Invite volunteers to read aloud the section “1524, Guatemala.” Then read aloud the first paragraph of the next section, “A Stunning Bird.” Ask: Do you think this is the real reason that quetzal’s have red feathers on their chests. [no] Why? (It’s just a story.) Zoom in on the last paragraph of the section. Say: Quetzals hide their chests when they sense danger. So they must be aware of the bright red feathers. Ask: What do you think is the real purpose of these feathers? Invite students to share their ideas. Then display page 5 of the projectable magazine. Say: Every part of an animal’s body has a function. These tail feathers do, too. Ask: What is their function? (They help male birds attract females.) Invite students to share their ideas about how the feathers help male quetzals attract females.

**Recognize Threats to Quetzals**
Display pages 2-3 of the projectable magazine. Zoom in on the comprehension strategy in the upper left corner of the page. Read the strategy aloud. Say: As the deck states, quetzals are beautiful birds that need our help. Here, we learn that humans are somehow responsible for the problems quetzals face. As you read the article, you’ll learn about the problems people have caused. You’ll also learn about the solutions they’ve found to help quetzals survive. Give each student a copy of the **Content Assessment Master**. With a partner, have students read the article to identify three ways people have harmed quetzals, explain why each is a problem, and identify potential solutions.

**ELABORATE**

**Find Out More**
Display pages 6-7 of the projectable magazine. As a class, review how quetzals have been celebrated in Central American cultures throughout time. Assign each student a partner. Instruct pairs to conduct research. Challenge them to find additional examples that show how quetzals are honored in Central America.

**Extend Your Thinking About Quetzals**
Remind students that the quetzal is legally protected in Mexico, Guatemala, Costa Rica, and Panama. Even so, people do things that harm them every day. People cut trees and clear land. This destroys the quetzal’s habitat. Some people hunt the birds for their feathers or as food. Others capture them to sell as pets. As a class, discuss the importance of protecting species like the quetzal. Guide students to understand that people’s actions can have long-term consequence on nature.

**EVALUATE**

Have students record their answers to the assessment questions in their science notebooks or on a separate sheet of paper.

- How does fragmentation harm quetzals? (It makes it hard for the birds to find food or mates.)

- Why is having two species of quetzal instead of one good news? (It means the birds are more diverse than previously thought.) Why is it bad news? (It means each species is more rare than people thought.)

- How can you recognize the gender of a quetzal? (Look at the tail feathers. Only males have long tail feathers.)

If you wish, have students complete the **Comprehension Check** to assess their knowledge of concepts mentioned in the article.
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<thead>
<tr>
<th>Word</th>
<th>Predicted Definition</th>
<th>Sentence from the Article</th>
<th>Definition</th>
<th>Predicted Definition</th>
<th>Word</th>
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Use this organizer to study each vocabulary word in the article.
**LANGUAGE ARTS ASSESSMENT: Quest for the Quetzal**

Record the writer’s main point. Record reasons and evidence that support that point.

<table>
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<th>Main Point</th>
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<tr>
<th>Reasons</th>
<th>Evidence</th>
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How do you think people can help quetzals? Write about it. Use what you learned to support your opinion.

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<table>
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<tr>
<th>What is the solution?</th>
<th>Why is this a problem?</th>
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</table>
COMPREHENSION CHECK: Quest for the Quetzal

Read each question. Fill in the circle next to the correct answer or write your response on the lines.

1. Where do quetzals live?
   - A South America
   - B North America
   - C Central America

2. Which word best describes the quetzal?
   - A outgoing
   - B cautious
   - C dull

3. What is the most serious threat to quetzal survival?
   - A loss of habitat
   - B disease
   - C predators

4. What have people done to help quetzals survive?
   - A divided their habitats
   - B sold their feathers
   - C built wildlife preserves

5. Identify one way quetzals were an important part of Aztec and Mayan cultures.
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
   ___________________________________________________________
Out on a Limb

LANGUAGE ARTS 730L

Objectives
• Students will identify and explain connections between vocabulary words.
• Students will interpret and explain information visually, orally, and quantitatively to quickly answer questions about the text.

Resources
• Vocabulary Assessment Master [page 14]
• Language Arts Assessment Master [page 15]

Summary
• The article "Out on a Limb" examines trees, exploring both the life cycle of trees and how trees use photosynthesis to survive.

BUILD VOCABULARY AND CONCEPTS

• air
• leaf
• oxygen
• photosynthesis
• root
• seed

Display the Wordwise section on page 17 of the projectable magazine. Invite volunteers to read aloud the words and their definitions. Encourage students to share what they know about each word.

Inform students that the purpose of this article is to teach them about trees. They will learn all about a tree’s life cycle as well as how trees use photosynthesis to survive. Say: As you read, you’ll learn much about trees from the text. But you’ll get information from photos, captions, diagrams, and other items in an article, too. That information can quickly answer some of the questions you have.

Give each student a copy of the Language Arts Assessment Master. Review the questions on the worksheet with the class. Then have students read the article on their own. As they do, instruct them to record each answer and find four additional facts about trees. Tell students to record where they found each answer or fact in the article.

READ
Display pages 2-3 of the projectable magazine. Tell students to look at the photo. Say: When people read, they usually focus on the words. But photos can tell you a lot, too. For example, when I look at this photo, I see a plant with a lot of limbs. If the photographer was lying on the ground when this photo was taken, this could be a close-up image of a bush. But if you look closely at the center of the photo, you’ll find a clue that tells you that isn’t the case. There are people in this photo—and they look really small. This plant isn’t a bush. It’s a giant tree! Ask: What else can you learn by looking at the photo? Encourage students to share their ideas.

After reading the article, divide the class into small groups. Have students share the connections they predicted before reading the article. Instruct them to reevaluate each connection based upon what they have learned. If necessary, have students rewrite their ideas to more accurately reflect connections between different vocabulary words.
Out on a Limb

LANGUAGE ARTS

TURN AND TALK
Have students turn and talk to discuss what they learned about trees. Ask: How are evergreens different from other trees? (Their leaves are green needles. Their seeds grow in cones.) Which plant part tells you the rainbow eucalyptus is poisonous? (its bark) What do leaves do for a plant? (They make food.) Invite students to share what else they learned about trees.

• Finding Connections Explain to students that reading definitions tells people what words mean. But readers can get a more thorough understanding if they recognize how words are connected. Point out that this is exactly what they did when they wrote sentences about the vocabulary words in the article. Instruct students to turn and share the sentences they wrote on their Vocabulary Assessment Masters with a partner. Tell them to discuss similarities and differences in their sentences to get an even deeper understanding of the vocabulary words.

• Interpreting Information After reading the article, remind students that articles contain much more than text. They often contain photos, diagrams, captions, and other text elements, too. These text elements usually highlight important points in the text. Because of that, readers can often find answers to questions more quickly if they study the text elements on the page. Have students share their Language Arts Assessment Masters in small groups. Instruct students to compare the answers they recorded for each question. If their answers differ, suggest that they revisit the text they elements identified as sources and reevaluate their responses.

WRITE AND ASSESS
You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

• How can you recognize an evergreen tree?

• Which tree featured in the article did you think was the most unusual? Why?

• What surprised you about what you read?
Out on a Limb

SCIENCE

Objectives
• Students will understand that a tree’s parts get the tree what it needs to survive.
• Students will understand the process of photosynthesis.
• Students will recognize that trees are a very diverse group of organisms.

Resources
• Content Assessment Master (page 16)
• “Solar Powered!” poster (Teacher’s Edition)
• “Tree Tales” poster (Teacher’s Edition)
• Comprehension Check (page 17)
• Out on a Limb” Interactive Whiteboard (optional)

Science Background
A tree is a type of plant with a woody stem. As the stem grows, it turns into a trunk. The trunk is covered with a protective layer of bark. This allows the tree to live for a long time.

Most trees grow from seeds, and there are two main types of trees that produce seeds: gymnosperms and angiosperms. Gymnosperms grow seeds inside cones. Angiosperms produce flowers. The flowers grow into fruits, which are full of seeds.

All trees have the same basic parts: roots, trunk, branches, bark, and leaves. Roots bring up water and nutrients from the soil. They also anchor the tree into the ground. Branches and the trunk provide additional support. They also create a network for the tree to transport water and nutrients up from the roots. Bark provides protection. And the leaves are where the tree makes its own food.

The process in which a tree or other plant makes food is called photosynthesis. During photosynthesis, the leaves use the energy from sunlight to combine water and carbon dioxide. This reaction creates sugar and oxygen. The sugar provides energy so the tree can live.

ENGAGE
Tap Prior Knowledge
Write the word “tree” on the board. Select volunteers, one student at a time, to say the first word they think of when they see that word. Invite another volunteer to record each response. After you’ve accumulated at least 10 responses, lead a class discussion. Using the recorded words as a base, encourage students to expand upon their prior knowledge of trees.

EXPLORE
Preview the Lesson
Display pages 12 of the projectable magazine. Zoom in on the four images of the tree parts. Ask: What tree part or parts do you see in each photo? (leaf and seed, branches and trunk, bark, roots) Do all trees have these parts? (yes) Do the parts look the same on every single tree? (no) Why? (There are many different kinds of trees. The parts on each kind of tree look different.) Tell students that they’ll learn more about what tree parts look like and what they do as they read the article.

Set a Purpose and Read
Have students read the article to understand that a tree’s parts get the tree what it needs to survive, understand the process of photosynthesis, and recognize that trees are a very diverse group of organisms.
Out on a Limb

SCIENCE

EXPLAIN

Understand What a Tree’s Parts Do
Display page 12 of the projectable magazine. Zoom in on the introduction. Invite a volunteer to read aloud the second paragraph. Ask: What tree parts are named in this paragraph? (roots, leaves, bark, branches, trunks) As a class, match each part to the correct photo below the text. Discuss the structure of each part and what each part does to help the tree survive. Say: This paragraph names several tree parts. And it gives a quick summary of what each part does. But it doesn’t tell you everything there is to know about these parts. In small groups, have students review the article to find additional information about the structure and function of each plant part.

Understand Photosynthesis
Display page 12 of the projectable magazine. Zoom in on the diagram. Discuss what happens during the process of photosynthesis. Then display the “Solar Powered!” poster. Invite volunteers to read aloud the information in the box as you review the diagram on the poster. Ask: What did you see in the diagram in the article that you don’t see on the poster? (The diagram shows that water enters the leaf and sugar exits the leaf. The poster does not.) What did you learn on the poster that wasn’t shown in the article? (Chlorophyll is a pigment that traps sunlight; There are small holes in leaves; Roots take in water from the soil; When carbon dioxide and water combine, using energy from the sun, a reaction takes place; Sugar is the plant’s food.) Give each student a copy of the Content Assessment Master. Challenge students to create their own original diagrams to illustrate the process of photosynthesis.

Recognize Diversity in Trees
Display the “Tree Tales” poster. Invite students to read aloud the blocks of text. Discuss how the parts of each tree are unusual. Review the article as a class. Invite volunteers to identify and describe other trees with unusual parts. Discuss reasons why all trees are alike but also different. (They have the same parts. The parts have different structures and functions.)

ELABORATE

Find Out More
Display pages 16-17 of the projectable magazine. Point out to students that the trees shown here are just three examples of trees with unusual parts. Assign each student a partner. Instruct pairs to conduct research to identify more trees with unusual parts. Challenge students to find photos and write captions describing the unusual parts of each tree they find.

Extend Your Thinking About Trees
Display page 15 of the projectable magazine. As a class, discuss reasons why location and availability of sunlight, water, and nutritious soil would be critical for trees to grow this big. Discuss the impact a changing climate could have on the trees.

EVALUATE

Have students record their answers to the assessment questions in their science notebooks or on a separate sheet of paper.

• Why do leaves need sunlight during photosynthesis? (They use energy from the sun to combine carbon dioxide and water.)

• Where do leaves get the water they need for photosynthesis to take place? (The plant brings water up through its roots.)

• What two things do leaves make during photosynthesis? (oxygen and sugar, which is food for the plant)

If you wish, have students complete the Comprehension Check to assess their knowledge of concepts mentioned in the article. You may also wish to examine the optional Interactive Whiteboard lesson that accompanies this article.
VOCABULARY ASSESSMENT: Out on a Limb

Record each vocabulary word and its definition.

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Write five sentences to tell how different words are connected.

1. ________________________________________________
2. ________________________________________________
3. ________________________________________________
4. ________________________________________________
5. ________________________________________________
## LANGUAGE ARTS ASSESSMENT: Out on a Limb

Answer each question about trees. Record where you found the information in the article.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Source</th>
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<tbody>
<tr>
<td>How do roots help a tree survive?</td>
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<td>How can you tell a tree's age?</td>
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<td>Why is the sun important to trees?</td>
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<td>List four other facts you learned about trees.</td>
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CONTENT ASSESSMENT: Out on a Limb

Create an original diagram that shows the process of photosynthesis.
Read each question. Fill in the circle next to the correct answer or write your response on the lines.

1. What do leaves take in during photosynthesis?
   - light, sugar, and carbon dioxide
   - water, oxygen, and light
   - carbon dioxide, light, and water

2. What do leaves release during photosynthesis?
   - light and water
   - carbon dioxide and sugar
   - oxygen and sugar

3. What does sunlight cause to occur during photosynthesis?
   - melting
   - a reaction
   - evaporation

4. Which plant part absorbs water?
   - leaves
   - roots
   - trunk

5. Explain how plants make their own food.
Objectives

• Students will assess their familiarity with and knowledge of vocabulary words.
• Students will use a variety of techniques to strengthen their understanding of content-related academic terms.

Resources

• Vocabulary Assessment Master (page 22)
• Language Arts Assessment Master (page 23)

Summary

• The article “Signs of Life?” introduces students to National Geographic Young Explorer Joe Cutler, who braves the wilds of west Africa in search of new species of fish.

BUILD VOCABULARY AND CONCEPTS

• aquatic invertebrate
• crater lake
• ichthyologist
• speciation

As a class, discuss the difference between familiarity and knowledge. Guide students to recognize that the more familiar you are with something, the more knowledge you have. Challenge students to explain how this concept applies to words when they read.

Display the vocabulary words on a word wall or on the whiteboard. Give each student a copy of the Vocabulary Assessment Master. Instruct students to write each word on their papers. Review the categories under the header “Familiarity with the Word.” Tell students to make a checkmark to indicate how well they know each word.

Instruct students to write what they think each word means on their worksheets. Then display the Wordwise feature on page 22 of the projectable magazine. Have students write those definitions on their worksheets and compare them with the definitions they wrote.

READ

Inform students that in this article, they will trek through the wilds of west Africa with National Geographic Young Explorer Joe Cutler. Cutler is exploring crater lakes in Cameroon. He is searching for new species of fish. Point out that in order to understand the details of Cutler’s work, readers must understand certain scientific terms.

Give each student a copy of the Language Arts Assessment Master. Tell students that they will use this worksheet to explore words in four different ways: writing definitions, identifying parts of speech, recording facts, and making connections between vocabulary words.

Display the Wordwise feature on pages 22-23 of the projectable magazine. Highlight the word aquatic invertebrate. Instruct students to write the word aquatic invertebrate in the center box on one of their word diagrams. Then have them record its definition. Instruct students to scan the article to locate the bold term aquatic invertebrate in the text. (page 23, column 2) Highlight the word on the screen. Model how to explore the word’s meaning. Say: Identifying the part of speech for this vocabulary word might seem confusing because it contains two words. But if you look at the definition, it’s pretty easy to figure out. The definition says an aquatic invertebrate is a type of small animal. An animal is a thing, and I know that all things are classified as nouns. Instruct students to write noun in the “Part of Speech” section of their diagrams.

Invite a volunteer to read aloud the paragraph in which aquatic invertebrate appears. Point out that the paragraph reveals two important facts: 1) There are thousands of different kinds of aquatic invertebrates and 2) They all live in water. Have students record these facts. Then have them read the article on their own. Instruct them to explore the remaining vocabulary words. Then challenge students to use what they learned to make logical connections between the vocabulary words.
Signs of Life?

LANGUAGE ARTS

TURN AND TALK

Have students turn and talk to discuss what they learned about Joe Cutler and his search for new fish species. Ask: Why did Cutler want to search for fish in the west African lakes? [Nobody had ever studied most of the lakes before.] Why did he expect to find new species of fish? [Most of the lakes are completely isolated from each other. They could have developed their own species.] Why did he want to study the lakes sooner rather than later? [None of the lakes are protected and many are threatened by human encroachment. He thought that if he could teach people about the organisms living in the lakes, they might want to protect them.] Encourage students to share other facts they learned about Cutler’s expedition as they read the article.

• Strengthen Understanding Say: Once you understand what a word means, it’s easier to use it correctly in a sentence. A little bit of background knowledge is all you need. Challenge students to make accurate statements using each of the vocabulary words. Encourage them to use their two vocabulary worksheets as resources. But remind them to be original. Students shouldn’t restate sentences from the article. They should create new sentences of their own.

• Explain Concepts Say: One way to see if you understand information is to try to tell someone else about the topic. If you can’t explain the concept, you might need to read the article again. Have students turn and talk to explain to a partner how different features form inside caves. Prompt discussion with questions such as: What is speciation? Why would a scientist be interested in speciation? How could speciation impact what lives in an isolated lake?

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

• What is an ichthyologist?

• Cutler found fish in some of the lakes he studied but not in others. Why do you think that happened?

• What surprised you about what you read?
Signs of Life?

SCIENCE

Objectives
• Students will understand how crater lakes form.
• Students will understand why crater lakes can contain unique biodiversity.

Resources
• Content Assessment Master (page 24)
• Comprehension Check (page 25)

Science Background
National Geographic Young Explorer Joe Cutler is a Ph.D. student at the University of California, Santa Cruz. He is an ichthyologist who studies speciation. Or, in other words, he’s a scientist who studies fish and specializes in the development of new species.

In 2015, Cutler traveled to the remote volcanic crater lakes found in the southwest region of Cameroon. His quest was to develop a baseline of the area for further scientific study. He also hoped to identify any endemic species that might have developed in the isolated lakes.

Over a six month period, Cutler collected samples from both crater lakes and rivers. He ended up with more than 3,500 fish specimens, representing more than 80 different species. He also collected about 10,000 aquatic invertebrates. Cutler’s work is the most extensive scientific study ever conducted in this part of the world.

ENGAGE

Tap Prior Knowledge
Tell students to imagine that they’re going on a field trip to study fish. The fish are in a lake. Poll the class to see how many students would want to go on a field trip like this. Then tell the class that in order to get to the lake, they have to hike through a jungle and wade through water that’s filled with blood-sucking leeches. Poll the class again. Did the numbers go down? Discuss reasons why a scientist might undertake a trip like this to get to a specific lake where he could study fish.

EXPLORE

Preview the Lesson
Display pages 18-19 of the projectable magazine. Point out the photo of the man. Say: This photo shows Joe Cutler. He is the National Geographic Young Explorer who wrote this article. Invite a volunteer to read aloud the headline and text. Ask: Why did Cutler go through all of this to find fish? (He was looking for new species of fish.) Brainstorm ideas about why he might have thought he could find new species of fish in western Africa.

Set a Purpose and Read
Have students read the article in order to understand how crater lakes form and why crater lakes can contain unique biodiversity.

EXPLAIN

How Crater Lakes Form
Display pages 20-21 of the projectable magazine. Instruct students to examine the two lakes in the photo. Explain to students that crater lakes are formed by volcanic explosions. Ask: What shape is a volcano’s crater? (round) What shape are these lakes? (round) Discuss how the lakes could form over time as the craters fill with water. Challenge students to also explain why most of the lakes are isolated from each other. (The tops of the volcanoes don’t touch, so neither do the crater lakes that form in them.)
**EXPLAIN**
(continued)

**Why Crater Lakes Are Biodiverse**
Continue displaying the photo of the two crater lakes on pages 20-21 of the projectable magazine. Point out that these two lakes are not touching. Because of how they formed, they never have touched and they never will. Say: Some animals, such as frogs or insects, could travel between the lakes. But fish live in water. There is no way for a fish in one of these lakes to swim over to the other. Ask: Knowing that, why do you think Joe Cutler came to these lakes hoping to find new species of fish? (The lakes are self-contained. It’s quite possible that new species developed in the lakes. Unable to spread, it’s also possible that a species found in one of these lakes is not found anywhere else in the world.) Give each student a copy of the Content Assessment Master. Instruct students to draw pictures to show how a crater lake forms, how it fills with water, and how it becomes home to new species of fish. Tell them to write a caption for each picture.

**ELABORATE**

**Find Out More**
Remind students that Joe Cutler is an ichthyologist, or a scientist who studies fish. Point out that in the article he identifies several pieces of equipment that he uses to do his work, such as cameras, photo aquarium, gill nets, dip nets, traps, and a jug of ethanol. Instruct students to conduct research to learn more about these supplies and how Cutler may have used them. Challenge them to identify other supplies an ichthyologist might have taken on a trip like this.

**Extend Your Thinking About Communication**
Explain to students that scientists don’t just collect and analyze data. They also communicate their results. That’s how people learn more about nature. Point out that this article is one way Joe Cutler communicated the results of his expedition. Brainstorm ideas about other ways he could teach others what he learned.

**EVALUATE**
Have students record their answers to the assessment questions in their science notebooks or on a separate sheet of paper.

- **What is a crater lake?** (a body of water filling a circular, steep-sided volcanic crater)
- **What did Cutler hope to find when he studied the crater lakes?** (new species of fish)
- **What did Cutler find in the crater lakes besides fish?** (frogs, dragonflies, diving birds, freshwater shrimp, and crabs)

If you wish, have students complete the Comprehension Check to assess their knowledge of concepts mentioned in the article.
Record information from the article about each vocabulary word.

<table>
<thead>
<tr>
<th>Word</th>
<th>Familiarity with the Word</th>
<th>Knowledge of the Word</th>
<th>How the article defines the word</th>
<th>What I think the word means</th>
<th>I've seen or heard the word before</th>
<th>I don't know the word</th>
<th>I know the word very well</th>
</tr>
</thead>
</table>

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VOCABULARY ASSESSMENT: Signs of Life?

Name _________________________________________                                                                                              Date __________________________
Use this graphic organizer to explore each vocabulary word from a scientific point of view.

Name _________________________________________                                                                                              Date __________________________
<table>
<thead>
<tr>
<th>Captions</th>
<th>Pictures</th>
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Draw pictures to show how crater lakes form, fill with water, and become homes to new species of fish. Write a caption for each picture.
COMPREHENSION CHECK: Signs of Life?

Read each question. Fill in the circle next to the correct answer or write your response on the lines.

1. What forms a crater lake?
   - a landslide
   - an earthquake
   - a volcanic explosion

2. What did Cutler suspect he would find in the crater lakes?
   - lots of alligators
   - boats to travel in
   - new species

3. What did Cutler discover after he studied crater lakes?
   - All of the lakes contained fish.
   - Some of the lakes contained no fish.
   - None of the lakes contained aquatic invertebrates.

4. Which word best describes crater lakes?
   - isolated
   - salty
   - flowing

5. Explain why crater lakes have a unique variety of species.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
Quest for the Quetzal

Assess Vocabulary, page 6
Students’ predictions and the sentences they write will vary. They should record the words and definitions from the Wordwise feature on page 8.

Aztec: American Indian people dominant in Mexico before the Spanish conquest of the 16th century
Culture: the customs, beliefs, laws, and ways of living that belong to a people
Fragmentation: the division of large, continuous habitats into smaller, more isolated pieces
Mayan: American Indian people inhabiting southeast Mexico, Guatemala, El Salvador, Belize, and Honduras whose civilization reached its height around AD 300-900

Assess Language Arts, page 7
Main point: Central America’s most beautiful bird needs our help. Reasons and evidence may vary, but students should note that quetzals are threatened because of disappearing habitat, fragmentation, predators, and people who hunt and collect them. Students should use the reasons and evidence they listed to support their opinions.

Assess Content, page 8
Students may note that people have destroyed quetzal habitats, killed the birds, and captured them for pets. Loss of habitat makes it hard for the birds to find food and mates. Killing and capturing them reduces their numbers. Solutions include stopping harmful behaviors, connecting habitats with wildlife preserves and national parks, and creating laws that protect the birds from hunters and collectors.

Comprehension Check, page 9
1. C; 2. B; 3. A; 4. C; 5: Possible responses: Aztecs and Mayans named a god after the quetzal and they created crowns for nobility out of their feathers.

Out on a Limb

Assess Vocabulary, page 14
Students should record the words and definitions from the Wordwise feature on page 17.

Air: a mixture of gases we breathe
Leaf: the main part of a plant needed for photosynthesis
Oxygen: a gas in the air that humans and animals need to breathe
Photosynthesis: the process of plants using sunlight to make their own food
Root: the part of a plant that attaches it to the ground and draws water and nutrients from the soil
Seed: a part of a plant from which a new plant can grow

Sentences will vary depending on the connections students identify.

Assess Language Arts, page 15
1. Answer: Roots pull up water and nutrients from the soil. Source: section “Circle of Life,” p. 12
2. Answer: To determine a tree’s age, you count the rings in its trunk. Source: section “Growing Up and Out,” p. 14; photo and caption, p. 14
3. Answer: The sun is important to trees because they use its light during photosynthesis, the process in which they make their own food. Source: section “Solar Power,” p. 14

Students’ facts will vary but should come from the article. A source should be cited for each.

Assess Content page, 16
Diagrams should resemble but not be exactly like those on page 14 of the article or the “Solar Powered!” poster.

Comprehension Check, page 17
1. C; 2. C; 3. B; 4. B; 5: Students should outline the process of photosynthesis. Plants take in water, oxygen, and sunlight. They produce oxygen and sugar, which is their food.
ANSWER KEY (continued)

**Signs of Life?**

**Assess Vocabulary, page 22**
Students should record the vocabulary words from the Wordwise feature on page 22, make checkmarks to show how familiar they are with each word, and write definitions in their own words. Then they should record the definitions from the article.

- **aquatic invertebrate**: small animals, such as insects, crustaceans, mollusks, and worms that live in water
- **crater lake**: a body of water filling a circular, steep-sided volcanic crater
- **ichthyologist**: a person who studies fish
- **speciation**: the formation of new species

**Assess Language Arts, page 23**
Students should record words and definitions from the Wordwise feature on page 22 of the article. (see above) They should recognize that all four words are nouns. They should record facts about each word and then identify logical connections between the vocabulary words.

**Assess Content, page 24**
Students show draw pictures showing a volcano with a circular crater exploding, the crater filling with water, and a new species of fish developing in the crater lake. Captions should explain what is happening in each picture.

**Comprehension Check, page 25**
1. C; 2. C; 3. B; 4. A; 5. Most crater lakes are isolated and don’t connect to any other water source. When new species develop in the lakes, many can’t travel to other locations. This causes each lake to have a unique variety of organisms living in its waters.