TEACHER'S GUIDE

Trailblazer
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In This Guide

This guide contains language arts and science lessons for articles in this issue of Explorer Trailblazer.

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 Trailblazer will be within the 350-750L range.

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- Magazines
- Classroom Posters
- Projectable Magazine
- Interactive Whiteboard Lesson
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Quest for the Quetzal

LANGUAGE ARTS LEXILE 600L

Objectives

- Students will predict definitions and then write sentences to better understand unfamiliar words.
- Students will identify recognize sentences that describe cause/effect relationships in the text.

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**
- **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

Inform students that the purpose of this article is to introduce readers to quetzal, a beautiful bird that lives in Central America.

Explain to students that writers use several different strategies to make logical connections in a text. Good readers always search for these connections when they read. One common strategy to look for is cause-and-effect.

Display pages 2-3 of the projectable edition. Read aloud the headline and text. Then model how to identify an example of cause-and-effect. **Say:** *Sometimes when you read, you find a simple cause-and-effect statement. One thing caused another thing to happen. And other times, you realize you've found one part of the relationship but not the other. For example, the headline tells us that we are going to read about the quetzal, which the photo shows us is a type of bird. The text says the bird needs our help. What we don't know is why the bird needs our help. Whatever that cause is, it's the other half of this cause-and-effect relationship. There might even be more than one cause. This bird could need our help for many different reasons.*

Give each student a copy of the **Language Arts Assessment Master**. Have students read the article on their own. As they read, instruct students to record a cause-and-effect statements from each section of the article. Then have students complete a sentence telling why quetzals need our help.

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 green metal sheen. They have golden-green feathers on their heads that form a spiky crest. They have red feathers on their chests. Males have two long tail feathers.) *Where do quetzals live?* (throughout Central America) *What are quetzals like?* (They are cautious birds.) *How do you know?* (When danger is near, they turn their bodies to hide their red chests from predators.) Invite students to share what else they learned about quetzals.

• **Predicting Definitions** Have students turn and talk to discuss what they learned about the three 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.

• **Describe Connections** After reading the article, remind students that making connections can help them understand what they've just read. One type of connection is the relationship between cause and effect. Invite students to turn and talk to share their **Language Arts Assessment Masters** in small groups. Instruct students to compare their results. Did each partner identify the same cause-and-effect relationships? If not, do all of their examples make sense? If partners find some examples to be confusing, encourage them to review the article to see where the connection went astray. Rejoin as a class. Discuss how identifying cause-and-effect relationships throughout the article helped students explain why the quetzal needs our help.

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.

- *Why does the writer call the quetzal Central America's most beautiful bird?*
- *How are male quetzals different from the females?*
- *What surprised you about what you read?*

Quest for the Quetzal

SCIENCE

Objectives

- Students will recognize the significance of a male quetzal's tail feathers.
- Students will understand how a changing habitat affects quetzals.

Resources

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

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.

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 recognize the significance of a male quetzal's tail feathers and to understand how a changing habitat affects quetzals.

Quest for the Quetzal

SCIENCE

EXPLAIN

Examine the Quetzal's Tail Feathers
Display page 5 of the projectable magazine. Read aloud the caption and hold up a meter stick to show student just how long the male quetzal's tail feathers can grow. **Say:** *Every part of a quetzal's body has a purpose. That includes the extra-long tail feathers on the male birds. These feathers help the male bird find a mating partner.* Explain to students that some birds twitch their tail feathers to attract attention. Others use their feathers as part of a dance. Brainstorm ideas about how a male quetzal might use its tail feathers to attract a mate. Then give each student a copy of the **Content Assessment Master**. Instruct students to draw a picture of a male quetzal. Challenge them write their own theory about how why the male's tail feathers are so long and how he uses his tail feathers to attract a mate.

Recognize the Impact of Changing Habitats
Display pages 8-9 of the projectable magazine. Have students review the text in small groups. Rejoin as a class and **ask**: *What have people done to the quetzal's habitat?* (chopped down forests) *Why is this a problem?* (Areas where quetzals live are separated from each other. This makes it hard for them to find food or mates.) *What can people do to help?* (Connect the habitats.) Discuss other things people can do to help the quetzal survive.

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. Divide the class into small groups. Instruct groups 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. 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.

- *Why do quetzal habitats need to be connected?* (If the habitats aren't connected, quetzals can only search for food or a mate in a tiny area. Connecting habitats lets them search over a larger area.)

- *What kind of habitat do quetzals live in?* (They are mostly found in high cloud forests and on mountain ranges where it is misty and cool.)

- *Why do male quetzals have long tail feathers?* (to attract a mate)

If you wish, have students complete the **Comprehension Check** to assess their knowledge of concepts mentioned in the article.

Name _____ Date _____

VOCABULARY ASSESSMENT: Quest for the Quetzal

Use this organizer to study each vocabulary word in the article.

Word			
Predicted Definition			
Sentence			
Definition from the Article			
Sentence			

Name _____ Date _____

LANGUAGE ARTS ASSESSMENT: Quest for the Quetzal

Record a cause-and-effect relationship from each section of the article.

Section	Cause → Effect
1524, Guatemala	→
A Stunning Bird	→
The Resplendent Quetzal	→
An Uncertain Future	→
Other Threats	→
New Understanding	→

Complete the sentence.

Quetzals need our help because _____

_____

_____.

Name _____ Date _____

CONTENT ASSESSMENT: Quest for the Quetzal

Draw a picture of a male quetzal. Write to tell why you think his tail feathers are so long. Tell how you think they help him attract a mate.

Draw	Write
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____

Name _____ Date _____

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. What is a quetzal?

   Ⓐ a mammal

   Ⓑ a reptile

   Ⓒ a bird

2. What is the biggest threat to the quetzal's survival?

   Ⓐ predators

   Ⓑ loss of habitat

   Ⓒ disease

3. What do a male quetzal's tail feathers help him do?

   Ⓐ guard eggs

   Ⓑ climb trees

   Ⓒ find a mate

4. How did the Mayans and Aztecs honor quetzals in their cultures?

   Ⓐ They made feather headdresses.

   Ⓑ They ate them at feasts.

   Ⓒ They traded them like gold.

5. Name two things people have done to help quetzals.

_____

_____

_____

_____

Out on a Limb

LANGUAGE ARTS LEXILE 620L

Objectives

- Students will identify and explain connections between vocabulary words.
- Students will use information gained from the text and photos to demonstrate an understanding of the topic.

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

- **carbon dioxide**
- **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.

Give each student a copy of the **Vocabulary Assessment Master**. Instruct students to record each word and its definition. Have them think about how the vocabulary words are related. Tell them to record five connections they see. For example: Roots, seeds, and leaves are all parts of plants.

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.

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

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**. Then have students read the article on their own. As they do, instruct them to write four questions they have about key concepts in the text. Tell them to record each answer and tell where they found it in the article.

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.) *How can you figure out a tree's age?* (Count the rings in its trunk.) *Why would the article call plants "food factories?"* (Plants make their own 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** in small groups. 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, have students share their **Language Arts Assessment Masters** in small groups. Instruct students to compare the questions they came up with and the answers they recorded for each. Have students discuss how using text, photos, and the diagram helped them answer their questions more quickly. As a class, identify other types of resources that could help them learn even more about trees.

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 the most interesting thing you learned about trees when you read the article?*
- *How do trees grow up and out?*
- *What surprised you about what you read?*

Out on a Limb

SCIENCE

Objectives

- Students will understand the life cycle of a tree.
- 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 trees as they read the article.

Set a Purpose and Read

Have students read the article to understand the life cycle of a tree, understand the process of photosynthesis, and recognize that trees are a very diverse group of organisms.

Out on a Limb

SCIENCE

EXPLAIN

Understand a Tree's Life Cycle
Display page 12 of the projectable magazine. Tell students to examine the photo of the oak tree. Then display page 12. Zoom in on the photo of the leaf. **Ask:** *How are these two photos connected?* (An acorn, like the one in the leaf photo, could have grown into an oak tree.) *Could that acorn grow into any other tree you see in this article?* (no) *Why?* (An acorn is a seed. Each type of seed grows into a specific kind of tree.) As a class, review the section "Circle of Life." Discuss how a seed grows into a tree. Then give each student a copy of the **Content Assessment Master**. Encourage students to think of different types of trees. Have them create a diagram that shows the life cycle of tree. Instruct them to draw and label the seed, seedling, young tree, and adult. Review the results. Did students draw cones for all evergreen trees?

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?* (Water enters the leaf and sugar exits the leaf.) *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.)

Recognize Diversity in Trees
Display page 12 of the projectable edition. Review the major parts of a tree. (leaf, trunk and branches, bark, roots) Then 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 the parts are unusual.

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. As a class, 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 important 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.

- *What is a seed?* (a part of a plant from which a new plant can grow)
- *What kind of tree grows seeds inside a cone?* (an evergreen)
- *What are the stages in the life cycle of a tree?* (seed, seedling, young tree, adult tree)

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.

Name _____ Date _____

VOCABULARY ASSESSMENT: Out on a Limb

Record each vocabulary word and its definition.

Word	Definition

Write five sentences to tell how different words are connected.

1. _____

2. _____

3. _____

4. _____

5. _____

Name _____ Date _____

LANGUAGE ARTS ASSESSMENT: Out on a Limb

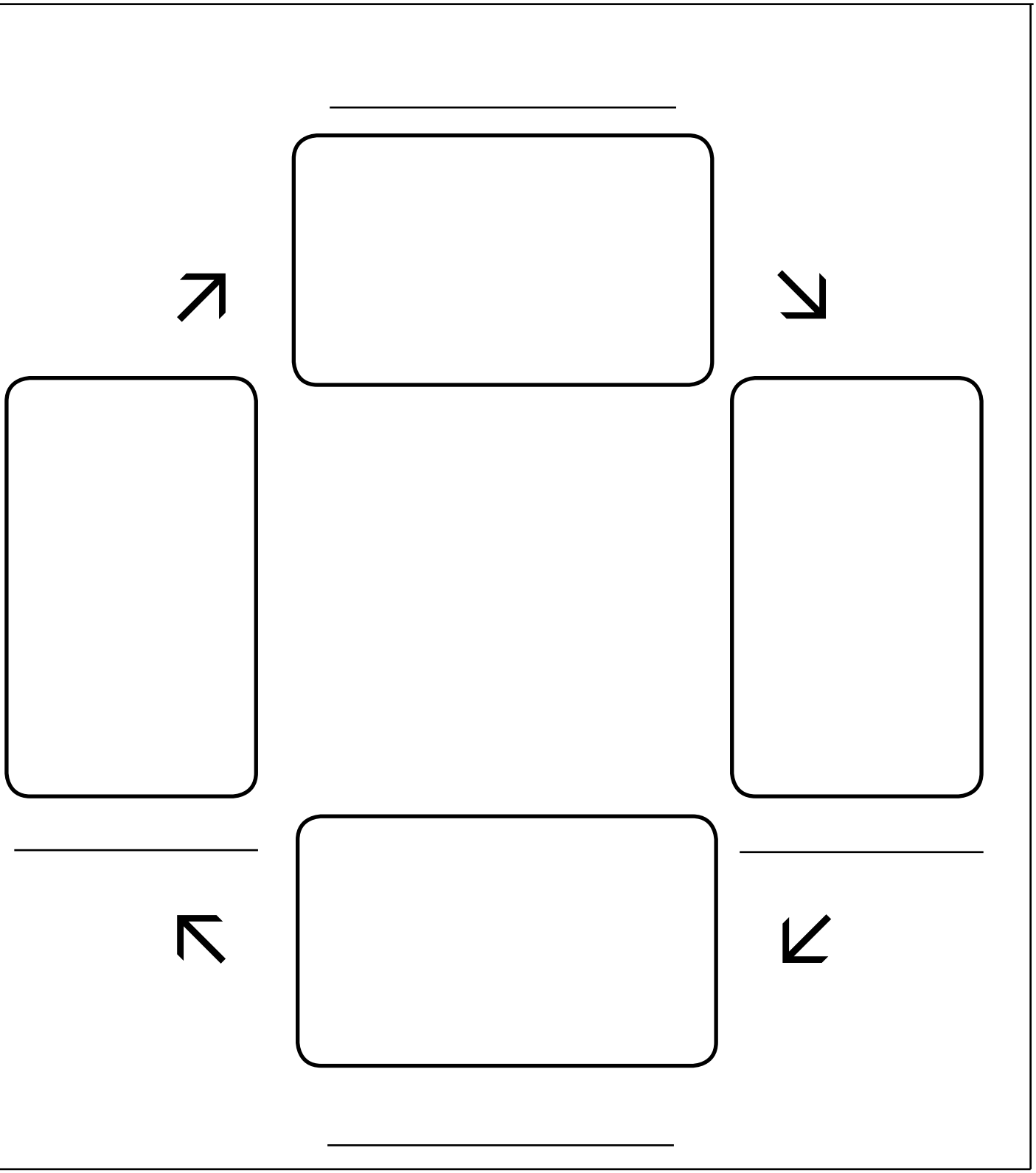
Write four questions you have about the article. Record the answers.
Tell where you found the answers in the article.

Question	Answer	Source

Name _____ Date _____

CONTENT ASSESSMENT: Out on a Limb

Draw and label the life cycle of a tree. Include the seed, seedling, young tree, and adult tree.



Name _____ Date _____

COMPREHENSION CHECK: Out on a Limb

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

1. Which part makes food for a tree?

Ⓐ the roots

Ⓑ the branches

Ⓒ the leaves

2. How are evergreens different from other trees?

Ⓐ They have seeds and leaves.

Ⓑ They have cones and needles.

Ⓒ They have pollen and sprouts.

3. Which plant part can grow into a new plant?

Ⓐ a leaf

Ⓑ a seed

Ⓒ a trunk

4. What happens to trees as they grow?

Ⓐ They get taller.

Ⓑ They get wider.

Ⓒ They get taller and wider.

5. Tell how plants make their own food.

_____

_____

_____

_____

Signs of Life?

LANGUAGE ARTS LEXILE 540L

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

- **crater lake**
- **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 *crater lake*. Instruct students to write the word *crater lake* 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 *crater lake* in the text. (page 20, column 1) 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 a crater lake is a body of water. A body of water 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 *crater lake* appears. Point out that the paragraph reveals one important fact: Crater lakes were created by volcanoes long ago. Have students record this fact. Then have them record additional facts related to crater lakes as they read the article on their own. Have students explore the remaining vocabulary word in this same way. Challenge students to use what they learned to make logical connections between the two 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 aren't connected to anything else. They could have developed their own species.) *What would happen if he found fish that only lived in this part of the world?* (The lakes would need to be protected from human development.) 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? Why is a crater lake a good place to find new species of fish?*

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 was it like traveling to Lake Edib? What did Cutler do once he got there?*
- *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 throught all of this to find fish?* (He was looking for new species of fish.) Brainstorm ideas about why he might have though 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.)

SCIENCE

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 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, nets, traps, and a jug of chemicals. As a class, conduct research to learn more about these supplies and how Cutler may have used them. Challenge them to identify additional supplies a scientist who studies fish 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 is speciation?* (the formation of new species)
- *What did Cutler find in the crater lakes besides fish?* (frogs, dragonflies, diving birds, shrimp, and crabs)

If you wish, have students complete the **Comprehension Check** to assess their knowledge of concepts mentioned in the article.

Name _____ Date _____

VOCABULARY ASSESSMENT: Signs of Life?

Record information from the article about each vocabulary word.

Word	Familiarity with the Word			Knowledge of the Word	
	I know the word very well.	I've seen or heard the word before.	I don't know the word.	What I think the word means:	How the article defines the word:

Name _____ Date _____

LANGUAGE ARTS ASSESSMENT: Signs of Life?

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

Definition	Part of Speech
Connections	Facts

Word

Definition	Part of Speech
Connections	Facts

Word

Name _____ Date _____

CONTENT ASSESSMENT: Signs of Life?

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.

Pictures			
Captions			

Name _____ Date _____

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 creates crater lakes?

Ⓐ earthquakes

Ⓑ glaciers

Ⓒ volcanoes

2. Where did Joe Cutler go to study crater lakes?

Ⓐ Asia

Ⓑ Africa

Ⓒ Europe

3. What was he searching for in the lakes?

Ⓐ new species of fish

Ⓑ common species of frogs

Ⓒ multiple species of alligators

4. What did he discover?

Ⓐ All of the lakes had fish in them.

Ⓑ Some of the lakes had fish in them.

Ⓒ None of the lakes had fish in them.

5. Tell why a new species might be found in a crater lake.

_____

_____

_____

_____

Trailblazer

ANSWER KEY

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
Mayan: Mesoamerican Indian people inhabiting southeast Mexico, Guatemala, and Belize, whose civilization reached its height around AD 300-900

Assess Language Arts, page 7
Answers will vary but should relate logical cause-and-effect relationships from the article. Students may note that quetzals need our help because their habitat is disappearing.

Assess Content, page 8
Students' drawings should resemble the photos of quetzals in the article. Explanations will vary.

Comprehension Check, page 9
1. C; 2. B; 3. C; 4: A; 5: Possible responses: People have built wildlife preserves and national parks, connected habitats, and enforced punishments against those who harm the birds.

Out on a Limb

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

carbon dioxide: a gas, made up of carbon and oxygen, that is present in the air
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.

Assess Language Arts, page 15
Questions and answers will vary. Students should cite specific sources within the text.

Assess Content page, 16
Students should draw and label a seed, seedling, young tree, and adult tree in the correct order. If they draw an evergreen tree, the seeds should be inside a cone.

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

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.

crater lake: a body of water filling a circular, steep-sided volcanic crater
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 both 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. B; 3. A; 4: B; 5: The lakes aren't connected to anything else. So if a species developed in one of these lakes, it might not be able to move somewhere else. It would only live in the lake where it developed.