Goldspotted Oak Borer (GSOB)

Teacher Background Reading

Locally, oak trees have been killed by an insect called the goldspotted oak borer. Foresters and other professionals call it “GSOB” for short. The goldspotted oak borer is a “jewel beetle,” with very shiny front wings. The oak borer attacks large diameter or mature coast live oaks, canyon live oaks, and black oaks, all common in California. One way to stop the spread of this insect is to dry oak firewood for two years before moving it.

These two lessons are most relevant to students who live in oak woodlands or in areas with oak mortality, and the activities focus on local observations. The student reading covers the life cycle of this insect, tree structure and function, and the insect’s method of damage. This reading also describes the insect’s introduction and invasive spread, and what can be done to reduce oak tree losses. Before doing this lesson, students should complete the two lessons about internal structure of trees and on oak communities (Grade 4, lesson 2 and Grade 5, lesson 2). In addition, the “Planting Acorns” lesson provides for students to take action to replace oak trees that have died.

Grade 4, Lesson 2 is named “Transportation Inside Trees” and focuses on internal structure and function of trees. The learning outcomes are that students will understand that tree trunks have specialized cells that transport water, nutrients, and food and provide strength for the tree. The schoolyard observations and student reading focus on the role of xylem and phloem in transporting water, nutrients, and food within the tree. Students are introduced to the cross-sections of a tree and the annual production of wood within tree rings.

Grade 5, Lesson 2 is named “Food Webs” and features the oak community ecosystem and ways that plants and animals are connected to each other. The learning outcomes are that students will understand that ecosystems are made up of interdependent organisms and the physical environment, and that students will describe relationships in their schoolyard and in oak communities by developing food chains and webs. The lesson has a 3-page Student Reading “Life in an Oak Community.” Students are asked to identify food chains from the reading, then link them into an oak community food web. ■

Vocabulary

Wood-boring beetle: an adult beetle that has shiny hard front wings and has immature life stages that develop inside a tree

Goldspotted oak borer: a wood-boring beetle that attacks and kills mature oak trees in California

Invasive species: an animal or plant that was introduced from another place, and has limited local natural controls

Pest: an animal or plant that is harmful to humans, ecosystems, or to agriculture production

Goldspotted Oak Borer /Lesson 1:
Understanding a Local Pest

Learning Outcomes

Students will understand the biology of an insect pest and its relationship to local oak trees.

MATERIALS

- Map of the community
- Display of Google Earth image within a mile of the school, and of an area with many dead oak trees
- Student reading, "Oaks and the Goldspotted Oak Borer"
- Brochure about the goldspotted oak borer

Getting Ready

Print color copies of brochure (one for each 3-4 students) or project online brochure in classroom, from http://ucanr.org/sites/gsobinfo/files/58949.pdf. Look at information available online at www.gsob.org.

ENGAGE:

Ask students where they have seen dead oak trees, oaks without leaves, and oak trees cut down. What do the areas look like? Ask students to recall places with big oak trees in meadows, along creeks and in parks and different oak species. What does it feel like, to be sitting or standing under a big oak tree?

EXPLORE:

Show an area map from Mapquest or GoogleEarth that has dead oak trees. This could be within a mile of the school or an area in the community. Ask a park ranger or forester (from the USDA Forest Service or California Department of Forestry and Fire Protection) to identify those areas. Ask students to mark locations of dead oak trees or oak trees that have been cut down.

EXPLAIN:

Students read "Oaks and the Goldspotted Oak Borer." Color photos are essential to understanding the life cycle. Show the tri-fold brochure, "Goldspotted Oak Borer: A New Threat to Oaks in Southern California."

ELABORATE:

Students draw the life cycle of the goldspotted oak borer and an oak tree. Students should show about five feedback loops before the oak tree is dead. This would include the adult flying from another tree or from firewood, adults laying eggs, larvae feeding, pupae forming, and adults emerging ("D"- shaped exit holes).

EVALUATE:

Students make a poster explaining why firewood should not be moved until it has dried for a year. Send posters to your local forester or park ranger.

REFERENCES:

University of California Extension Service. Goldspotted oak borer (brochure). http://ucanr.org/sites/gsobinfo/files/58949.pdf

Antunez de Mayolo, K. (2008). Investigating the oak community: A curriculum guide for grades 4-8 (pp. 36-39). Oakland: California Oak Foundation. www.ucanr.org/sites/gsobinfo/files/58949.pdf

Curriculum Standards

Next Generation Science Standards

4-LS1-1a. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

California Science Standards

Life Sciences, Grade 4

2. All organisms need energy and matter to live and grow. As a basis for understanding this concept:

c. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.

3. Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:

a. Students know ecosystems can be characterized by their living and non-living components

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

h. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.

California Common Core Standards

Grade 4

Literacy – Reading

RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Literacy – Writing

W.4.2d Use precise language and domain-specific vocabulary to inform about or explain the topic.

Literacy – Language

L.4.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 4 reading and content, choosing flexibly from a range of strategies.

Grade 5

Literacy – Reading

RI.5.3. Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

Literacy - Speaking and Listening

SL.5.2. Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

Literacy - Language

L.5.3. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 5 reading and content, choosing flexibly from a range of strategies.

Goldspotted Oak Borer /Lesson 2:
Collecting Data as a Citizen Scientist

Learning Outcomes

Students will collect scientific data, learn about the life cycle of the goldspotted oak borer (GSOB), and observe the consequences of human behaviors (moving firewood).

This lesson is taught at the Cuyamaca Outdoor School, operated by the San Diego County Office of Education for students and teachers in the sixth grade. It logically follows the lesson, "Goldspotted Oak Borer—Understanding a Local Pest."

The goldspotted oak borer is a "jewel beetle," with very shiny front wings. The oak borer attacks large diameter or mature coast live oaks, canyon live oaks, and black oaks.

With this lesson, students will participate in a "citizen science" project, collecting data that will help scientists and land managers learn more about the distribution of GSOB and its effects on oak trees.

Students will understand and practice skills identified in the Next Generation Science Standards and Common Core:

- Students will "think like a scientist."
- Students will be involved in a real world citizen science project.
- Students will use scientific evidence and tools to participate in creating solutions to real world environmental problems.
- Students will learn how our behaviors have real world environmental consequences.
- Student will synthesize and present findings in a group setting.

MATERIALS

The following materials are provided for the lesson, by staff at the Cuyamaca School:

- One GSOB Life Cycle sheet
- One beetle life cycle and emergence hole sheet
- GSOB "credit card" with key information
- iPad with GSOB Survey Application (App)

To conduct this lesson using readily-available resources, provide the following materials for each group of students:

- One GSOB color brochure
- At least two copies of the GSOB Data Form
- Clipboard
- Pencil
- Four magnifying lenses
- 10-foot string to measure tree circumference
- Journal

ENGAGE:

Begin the lesson in a stand of mature oak trees. Ask students to point to a tree and have them put thumbs up or thumbs down if they think it's a healthy or sick tree.

Have students answer the following questions in pairs or groups:

1. What do you think affects the health of a tree?
2. How many of you have ever used dead wood to make a fire?
3. What do you know about the life cycle of an insect?

Discuss the life cycle of the GSOB and the GSOB survey project.

1. Show a visual of the life cycle of a GSOB.
2. In small groups have students read the GSOB pamphlet.
3. Ask students to describe the life cycle stages of GSOB that occur in oak trees.

EXPLORE:

Students will first practice survey skills on one designated tree in groups of 3 or 4 (same tree for entire class). Give each pair of students a magnifying lens, if available. Record evidence onto the GSOB Data Form, about the designated oak tree.

At Cuyamaca Outdoor School, students are given a GSOB "credit card" (this card has information and pictures of oak trees and of the goldspotted oak borer). The instruction card reads:

> *Use the GSOB "credit card" to identify a canopy of an oak tree, bark staining, D-shaped exit holes in bark, adult GSOB, larva, evidence of larval feeding under bark, and any other findings.*

The D-shaped exit holes are about the size of a capital D on a printed page. The emergence holes for the goldspotted and other oak borer insects are illustrated in this guide, "Goldspotted Oak Borer: Pest Notes 74163," January 2013, at http://www.ipm.ucdavis.edu/PDF/PESTNOTES/pngoldspottedoakborer.pdf.

EXPLAIN:

Small groups share what they observed about the oak tree and evidence of the GSOB. Ask them what was difficult and easy about the data collection and the GSOB Data Form.

ELABORATE:

Each group is assigned a new tree to survey, recording data about that tree on another GSOB Data Form. If available, students input data on iPad into the GSOB Internet Survey Application (App). The data may be entered online, at http://ucanr.org/sites/gsobinfo/Help_Monitor/Report_Goldspotted_Oak_Borer_Symptoms/ (some fields need to be left blank, as that data was not collected). The GSOB Data Form can be uploaded at the end of the online report.

Ask the following closure questions of the students:

1. How do you think humans contribute to the spread of GSOB?
2. How can humans help stop the spread of GSOB?
3. What ideas do you have to fix this problem?
4. Thinking about the GSOB life cycle, why should people not transport firewood to unaffected areas?

EVALUATE:

Have students write in their Journal about what they have learned. Ask them to describe the relationship of the life cycle of the GSOB and the death of an oak tree caused by the GSOB. They can include sketches of the GSOB life cycle.

Curriculum Standards

Next Generation Science Standards

Disciplinary Core Ideas

MS-LS1-4. Growth and development of organisms. Animals engage in characteristic behaviors that increase the odds of reproduction.

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influences the growth of organisms.

Crosscutting concepts: Cause and effect

Cause and effect relationships may be used to predict phenomena in natural systems.

Phenomena may have more than one cause and some cause and effect relationships in systems can only be described using probability

Science and engineering practices: Constructing explanations and designing solutions

Construct a scientific explanation based on valid and reliable evidence obtained from sources (including students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Connections to nature of science:

Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observations

Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes

Common Core standards

RST.6-8.4 Determine the meaning of symbols, key terms, and other domain specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics

GSOB/Lesson 1: Student Reading

Oaks and the Goldspotted Oak Borer

Sometimes insects can kill a tree! Locally, oak trees have been killed by an insect called the goldspotted oak borer. Foresters and other professionals call it “GSOB” for short.

The goldspotted oak borer is a beetle. Beetles have two pairs of wings, and the front wings are hardened like a shell. The goldspotted oak borer is a “jewel beetle,” as the front wings are very shiny and metallic in color. There are 3,000 species of jewel beetles in the world.

The oak borer attacks coast live oaks, canyon live oaks, and black oaks. Canyon and coast live oaks are common in California along streams and in meadows. They are called “live oaks” because they remain green and “live” throughout winter, when other oaks lose their leaves and are “dead”-looking. Black oaks grow in forests, and their leaves turn yellow and drop in the autumn.

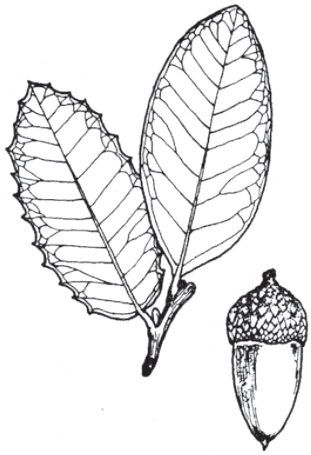


Fig. 172. Quercus chrysolepis Liebm. Leaves, fruit, × ¾.

Canyon live oak

Fig. 166. Quercus agrifolia Née. Leaves, fruit, × ¾.

Coast live oak

Fig. 178. Quercus kelloggi Newb. Leaf, fruit, × ½.

Black oak

Life cycle of the goldspotted oak borer

The oak borer follows the common insect life cycle. Adult beetles lay eggs during the summer on the bark of coast live oaks, canyon live oaks, and black oaks. The eggs hatch and the larvae bore their way inside, through the bark of the tree. The larvae feed and live inside the tree for several years. Then the larvae go through a pupation phase, and turn into adult beetles. The adult oak borer insects “bore” holes in the bark to exit the tree. Because their mouth parts are shaped like the letter “D,” they make an exit hole shaped like a “D.” When a tree has D-shaped holes, it is evidence that oak borers are living inside the tree. The adults fly to other oak trees and lay eggs on the bark.

The larvae feed inside the bark in the cambium, which is the living tissue that produces xylem and phloem. The xylem cells transport water to the leaves. The phloem cells transport the sugars from the leaves to the roots and the rest of the tree. The oak borer

larvae eat this living tissue, so the tree stops transporting water, nutrients, and food. The tree usually dies in three to six years.

Spread of insects to new places

The goldspotted oak borer is native to northern Mexico and southeastern Arizona. There, the insects and the trees have evolved together, and the oak borer kills only a few trees each year.

This oak borer is an invasive pest species. An invasive species is a non-native plant or animal that has been introduced and negatively affects native plants and animals. Invasive species have few predators or natural controls. In California, oak trees have limited natural defenses against the oak borer. There are few insects or birds that feed on oak borers.

Invasive plants and animals that affect humans, ecosystems, or agricultural production are called pests. These pests are mostly introduced accidentally, from other countries or states. They can "hitchhike" or travel on food, wood, plants, packing materials, vehicles and ships. Sometimes exotic species are introduced as new food crops or new pests to control other pests. Pests crowd out and replace native plants and animals. Pets can become invasive animals when pet owners release their pets to get rid of them.

Oak wood is sold and bought as firewood. Scientists believe that this oak borer was introduced to San Diego in oak firewood that was brought from southeastern Arizona. The oak borer has spread in oak firewood to other locations in San Diego County and Riverside County.

When dead oak trees are cut down, they still have living cambium inside the bark and living oak borer larvae. If the firewood is moved soon after the tree dies, the larvae mature inside the firewood and the adult insects exit and fly to new oak trees. After two years, the oak borer larvae in the wood have died, and the firewood can be moved safely.

What can be done?

Currently, there are few management options to save oak trees that are attacked by goldspotted oak borers. The best thing we can do is to stop the spread of the oak borers. Firewood should not be moved until it has dried out for two years. Foresters are working hard to tell people to buy firewood from the local area and to make sure it has no oak borers. Foresters and arborists (tree care professionals) can help to determine if wood is "safe" to move.

New oak trees can be grown from acorns. It takes 40 to 100 years for an oak seedling to grow into a large oak tree. Foresters are doing studies to better understand the life cycle of goldspotted oak borers and oak trees, and looking for ways to control the oak borers in the future. ■

GSOB/Lesson 1: Student Reading

Life Cycle

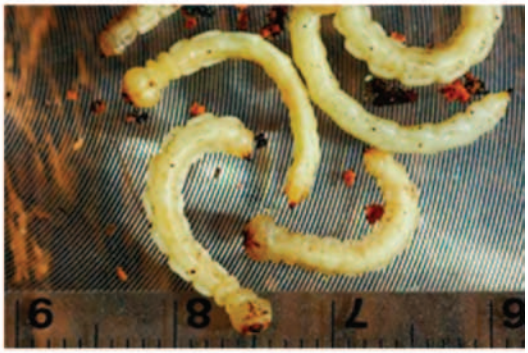
of the Gold Spotted Oak Borer (beetle)

Adult

(Pictured 2x larger than life size)

Eggs

Very tiny, less than .25 cm



Larvae

(Pictured 2x larger than life size)

Pupae

(Pictured 2x larger than life size)

THE GOLDSPOTTED OAK BORER

Goldspotted oak borer adults are smaller than a penny. Adults are about 7/16 of an inch (1 cm) in length with six distinguishing orange spots on the wings.

Larvae are legless and white in color. Mature larvae can reach 13/16 of an inch (2 cm) in length. Larvae possess two pincher-like spines at the tip of the abdomen.

CURRENT AREA OF INFESTATION

In California the goldspotted oak borer is currently found only in San Diego County, primarily in and around the Descanso Ranger District of the Cleveland National Forest.

DON'T MOVE OAK FIREWOOD!

Moving oak firewood has the potential to introduce this new pest to more California locations.

Please, do not move oak firewood!

For additional information:

www.gsob.org

GOLDSPOTTED OAK BORER

A NEW THREAT TO OAKS IN SOUTHERN CALIFORNIA

The goldspotted oak borer is an oak pest new to southern California. It was linked in 2008 to oak mortality in San Diego County that has been occurring since 2002. The beetle is new to California, but has long been present in southeastern Arizona, Mexico, and Guatemala. This woodborer is aggressively attacking three oak species. Repeated attacks occurring over several years can kill mature trees. This new pest has the potential to kill native oak species throughout California.

These agencies are equal opportunity employers

BEETLE IMPACTS

Feeding galleries of the goldspotted oak borer larvae are often black in color with no specific pattern. Larvae feed under the bark primarily on the wood surface.

High densities of larval galleries can patch kill areas of inner bark and lead to tree death. Patches of dense galleries are often indicated by dark, wet staining on the bark exterior.

Black or red staining on the main stem or larger branches can signify injury from the goldspotted oak borer.

EVIDENCE OF INJURY

Woodpeckers chip away outer bark to forage on goldspotted oak borer larvae. Woodpecker foraging in coast live oak exposes the dark larval galleries and inner bark .

When new adult beetles emerge, they create D-shaped exit holes about 3/16 of an inch (4 mm) in diameter. These exit holes indicate that tree damage is extensive.

Twig die-back and crown thinning can be symptoms of goldspotted oak borer injury.

HOST TREES

Coast live oak is an evergreen species with cupped leaves. Its acorns are slender and sharply pointed.

Canyon live oak is an evergreen species. The underside of older leaves have a gray appearance while newer leaves have fine red hairs.

California black oak is a deciduous species that is found at higher elevations, at 5,000-7,000 ft in southern California.

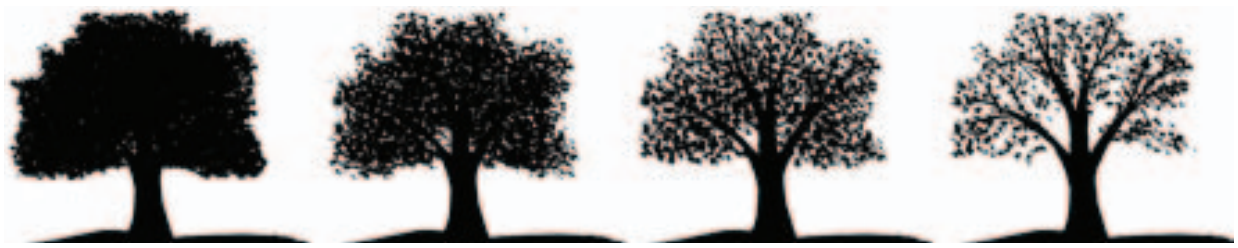
GSOB/Lesson 2: Student Handout

Goldspotted Oak Borer Data Form

Names of Citizen Scientists_____

Location of Tree_____

Evidence	**Observation** *(Circle one for each evidence category)*
1. Species	Canyon Live Oak Coastal Live Oak California Black Oak
 Canyon live oak	 Coast live oak
 Black oak	
2. Size To get diameter, wrap measuring tape around tree and divide by three.	Sapling -Trunk < 5” diameter Mature -Trunk 5”-20” diameter Old Growth- Trunk > 20” diameter
3. Crown Rating Step back 20 feet and look at top of tree. Compare top of tree to crown rating sheet.	Healthy/Full crown Moderate Thinning Minor Thinning Severe Thinning Tree Dead



Healthy/Full crown | Moderate Thinning | Minor Thinning | Severe Thinning

Evidence	**Observation** *(Circle one for each evidence category)*
4. D-Shaped Holes Use credit card and sample to identify how many exit holes in tree in a square foot (about the size of a piece of paper)	None: 0 Low: 1-3 Moderate: 4-6 High: 6 or more
5. Woodpecker Damage Look for chipping away of outer bark. Look for reddish color underneath.	Bark Flaking, Acorn Holes? Yes No
6. Larval Feeding Patterns Look for irregular squiggly lines on wood surface.	Irregular Pattern on Wood? Yes No
7. GSOB Larvae Look for larvae and compare with photos in color brochure.	Yes No
8. GSOB Adult Look for shiny beetles and compare them with photos in the color brochure.	Yes No
9. Tree Status Make a determination based on your answers to the first eight questions.	Not GSOB attack Can't determine if GSOB attack Probable GSOB attack Definite GSOB attack
10. Coordinates Use GPS and write down the coordinates of your tree.	

Collaboration of

Funding provided by Proposition 84
Through the California Department of Forestry and Fire Protection
Urban and Community Forestry Program

Additional resources for educators available at
http://sdchildrenandnature.org

Grade 4/Lesson 2:
Transportation Inside Trees

Water, nutrients, and food move up and down in trees.

Learning Outcomes

Students will understand that tree trunks have specialized cells that transport water, nutrients, and food and provide strength for the tree.

MATERIALS

- Celery stalks, one for each pair or small group of students, preferably with leaves at the top
- Sturdy beaker or glass jar (so celery stems don't tip it over)
- Red food coloring (and additional colors if you would like to extend this activity)
- Tap water
- Scissors or knives to cut celery
- Student journal to record data
- Tree "cookies" or horizontal cross sections of trees (about 1" thick), one per group of 3-4 students
- Copies of Student Reading, "Transportation Inside Trees"
- Student journals or plain paper, and colored pencils
- Optional-white carnations as an extension of the lesson

Getting Ready

Review the Teacher Background Reading.

Have pencils and journals (or plain paper and clipboards) ready for students to take outside to draw their trees.

Gather materials for the experiment and have materials divided for groups of 2-4 students.

Have your copy of the Student Reading available to use on the document camera or have copies available for each student or to read in pairs.

ENGAGE:

Review vocabulary with the class.

This activity can be done outdoors. Ask students to tell about where the water pipes go in their house, apartment, or school buildings. (Under and through the house to the bathrooms, kitchen, garden, washing machine and then to the street and sewer pipes.) How does this work in our bodies with our blood? Engage students in a discussion about how blood circulates water, food, and many other materials in the body through arteries and veins. Compare these to the tree "pipes" that are specialized cells that carry water, nutrients and food to different parts of the tree. Use a tree on the schoolyard and have students point to plant parts and use vocabulary to explain the trees ability to get food and water to its parts.

EXPLORE:

Go to their tree in the schoolyard. Draw an outline drawing of the tree, with branches, stem and roots. Make sure it shows the difference in scale, how big the trunk is and how small the branches are. Then draw arrows showing the direction that water and nutrients move from the roots to the leaves. Draw arrows for where food moves from the leaves to the trunk and roots, and from one part of the tree to another. Look carefully at the bark.

All flowering plants have xylem and phloem, just as trees do. The movement of water through the stem can be easily observed in celery. In the classroom, set up the materials for students to do experiments with the dye, water and celery.

Start by asking students what they think will happen if the celery is placed in the colored water. Have the students record what they think will happen to the celery. Put a few drops of red food coloring in a sturdy beaker or glass jar. Start with a stalk of celery for each pair of students. Use a knife to cut about 1/4 inch off the bottom of the celery stalk. Put the cut end of the celery into the cup of food coloring. The colored water will travel up the celery stalk in the xylem (water tubes) and the leaves will slowly change color.

Start with 3-4 small pieces of celery for each group of students. After 30 minutes, remove the celery from the cup. Use a knife to cut the celery in half, for a cross section. Ask students to figure out how to observe the dye and measure how far the colored water travels in the stalk. Let students try different methods.

Invite students to ask questions about what would happen if conditions of the plant (size of stalk) or environment (temperature?) were changed. Then write a scientific (testable) question and predict reasonable outcome based on a cause and effect relationship. (For example, water will move faster in the celery if it is kept at room temperature, compared with keeping celery in refrigerator. Or making diagonal cuts in the celery disrupts water movement.) Students can design a simple experiment to test these questions, using multiple stalks of celery. Provide more stalks of celery for each group. They can record data in their science journals.

EXPLAIN:

With a partner or in your small group, discuss the scientific question and the information gathered to test the question. Share with the entire class. Ask students what the results tell them about water moving in a tree. What happens if the celery or the tree is cut across the xylem?

The celery experiment shows and tracks capillary action in a plant using a celery stalk, by the movement of colored water. The xylem or tubes that transport water can easily be seen by looking for the colored circles on the bottom of the stalk. The rate of capillary action (or water movement) can be measured by monitoring the appearance of colored circles up the length of the stalk.

Students read the “Transportation inside Trees” student reading.

ELABORATE:

Look at the tree cookies, one per group. Identify the structural elements (bark, xylem or sapwood, heartwood). Cambial layer and phloem are too narrow to see in most trees. Trees produce new wood every spring and summer, and this annual growth can be seen in the tree rings. Each ring represents a year of growth, so count the age of the tree from the rings.

Ask students to remind you what things a tree needs in order to grow (water, sunshine, soil/nutrients, and space to grow). Ask students why one ring might be thicker than another (more nutrients, water, or sunshine one year). Ask why a ring might be thinner one year (drought, poor conditions for growing).

EVALUATE:

Draw a picture in which the xylem and phloem could be destroyed. (Fire, insects, drought, a tree limb breaking off) Share pictures and explain how this could effect your tree.

What would happen if the xylem and phloem cells were destroyed? How would the water get from the roots to other parts of trees? How would the food get from the leaves to other parts of trees?

What could happen to the tree? Discuss.

REFERENCES:

American Forest Foundation (2012). Tree Factory. *In Project learning tree: Pre K-8 environmental education activity guide (6th ed., pp. 269-272).* Washington, DC:

American Forest Foundation (2012). Tree Cookies. *In Project learning tree: Pre K-8 environmental education activity guide (6th ed., pp. 327-331).* Washington, DC:

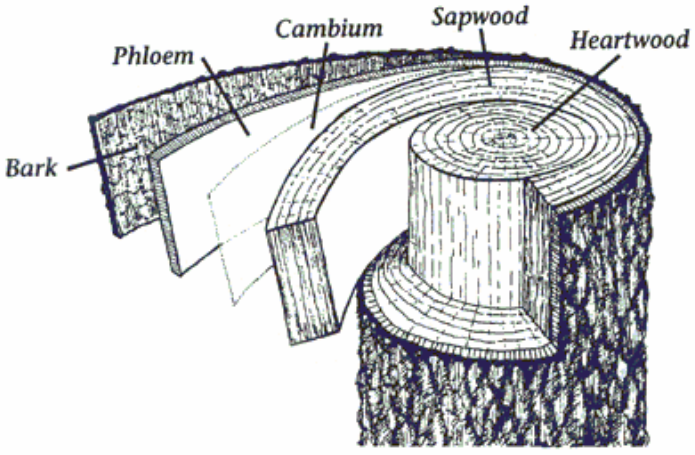
Grade 4/Lesson 2: Student Reading

Transportation Inside Trees

The trunk and branches are the “pipes” inside trees. They contain the xylem cells that transport water and nutrients to the leaves. These cells are called sapwood. The stem and branches also have the system of phloem cells, also called inner bark, that transport the sugars from the leaves to the rest of the tree. Xylem and phloem are made from a thin layer of cells inside the bark, called the cambium.

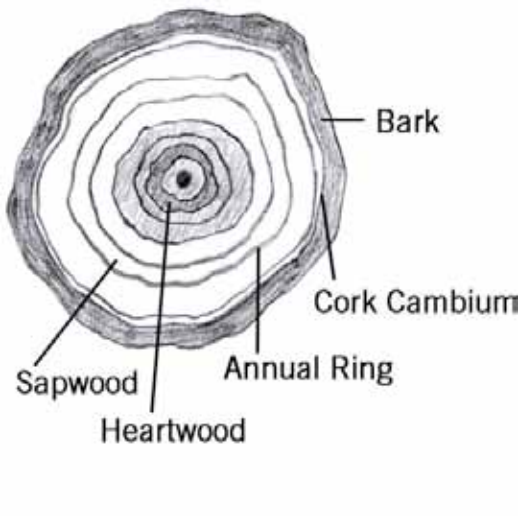
The trunk provides support for the branches, which in turn support the tree’s leaves. The strength of the trunk comes from wood produced by the xylem each year. Older xylem becomes part of the heartwood, which is the center of the tree. It is the wood used to make lumber and furniture. Wood has thick cell walls that are mostly cellulose, which is made into paper and many other products.

Here’s a look at a tree trunk from the inside to the outside (see diagram)



The wood produced each year can be seen in annual rings in the cross-section of a tree. Every growing season, a tree adds a new layer of wood to the trunk and branches. The wide light-colored “early wood” is produced when the tree is growing rapidly in the spring. The narrow dark “late wood” is produced in the drier summer and fall. Trees produce wide tree rings when there is abundant rainfall. In a drought year they produce narrow tree rings. Therefore, tree rings provide historical evidence for climate conditions.

Bark protects the tree from injury caused by insects and other animals, by other plants, by disease, and fire. Bark characteristics vary from species to species. It may be thin, thick, spongy, rough, smooth, or covered with spines.



A cross-section of the tree shows annual rings, produced by xylem cells each year.

Roots are the sponges that absorb water and nutrients for the tree, from the soil. The tree's roots also help anchor the tree in the ground. Trees have lateral roots that spread out from the tree and cover a broad area. Many trees also have a taproot that grows straight into the ground. As a tree's taproot and lateral roots grow away from the tree, they branch into finer and finer roots called rootlets. The rootlets themselves are covered by very fine root hairs that absorb the water from the soil. ■

Vocabulary

Broad-leaf: a tree with wide leaves, generally deciduous

Cambium: a very thin layer of cells growing just inside the bark, making cells that become new phloem and xylem cells

Conifer: a tree that bears its seed in cones, with needle-shaped leaves that are evergreen

Deciduous: a plant that periodically loses all its leaves, before cold winter temperatures or in response to drought

Dichotomous key: uses comparisons to identify an object

Evergreen: a plant that keeps its leaves year-round

Heartwood: the older hard non-living wood that is produced from xylem cells, and provides strength for the tree to grow tall and straight

Phloem: connected cells inside the bark that transport sugars from the leaves to other parts of the plant

Xylem: connected cells that transport water and nutrients from the roots to above-ground parts of the plant (also called sapwood in trees)

Find a spot in nature you can use for the lessons - either in the schoolyard or in a park nearby with trees or bushes. Check for any hazards. Describe the boundaries of the outdoor area that you will be using for the lessons and explain acceptable and unacceptable behaviors outdoors. Much of the class discussion, etc. can also be done outside.

Note: Worksheets are available for all lessons, though please save paper when possible by having students use journals, notebooks or scratch paper.

Grade: 5

Relationships

Oak tree communities include many organisms that are a part of food webs.

Teacher Background Reading

The relationships among plants and animals can be observed directly and documented by students as a food web. Students can explore the plants and animals in schoolyard, in a nearby park with trees and shrubs, a canyon, or other open space. By reading about local oak communities, students can learn how oaks have many relationships and provide rich habitats for wildlife. Healthy oak woodlands can support up to 350 species of animals. This includes many insects, birds, reptiles and amphibians, and mammals.

Food chains show how energy moves from one organism to another in the form of food. The arrows point from the primary source of food to the next thing that eats it, and so on. The arrows show the direction that the energy is flowing. Food webs describe the interconnection of the food chains in an ecosystem, and give a picture of how plants and animals in an ecosystem are related to each other. ■

Vocabulary

Carnivore: an animal that eats meat as the main part of its diet

Communities: all the different plant and animal populations interacting with each other in an ecosystem

Decay: to decompose through the action of bacteria and fungi

Decomposers: organisms such as fungi, bacteria or invertebrates that feed on and break down dead plant and animal matter

Decomposition: the mechanical or chemical breakdown of dead material

Ecosystem: a biological community of interacting organisms and their physical environment

Food chain: a series of organisms linked together by food energy, each organism eaten by the next one in the chain

Food web: the complex and interlocking series of food chains

Herbivore: an animal that eats plants as the main part of its diet

Omnivore: an animal that eats both animals and plants

Scat: animal droppings

Grade 5/Lesson 2:

Food Webs

Students take a look at their schoolyard and an oak community ecosystem and discover ways that plants and animals are connected to each other.

Learning Outcomes

Students will understand that ecosystems are made up of interdependent organisms and the physical environment. Students will describe relationships in their schoolyard and in oak communities by developing food chains and webs.

MATERIALS:

- Schoolyard Relationships journal from Lesson 1 (with "Food Web" worksheet added) Students can also use journals, notebooks or scratch paper.
- Colored pencils or crayons
- Clipboards or folders - 1 per pair of students
- Copies of "Student Background Reading" - 1 per student
- Drawing paper - for schoolyard food webs
- Optional: yarn, scissors - for schoolyard food webs

Getting Ready

Review the Student Background Reading.

Copies of Student Background Reading "Life in an Oak Community" (or print one copy of student reading and use document camera to read as a class), and "Food Webs" worksheet added to the Schoolyard Relationships journal from Lesson 1. (Students can also use journals, notebooks or scratch paper.)

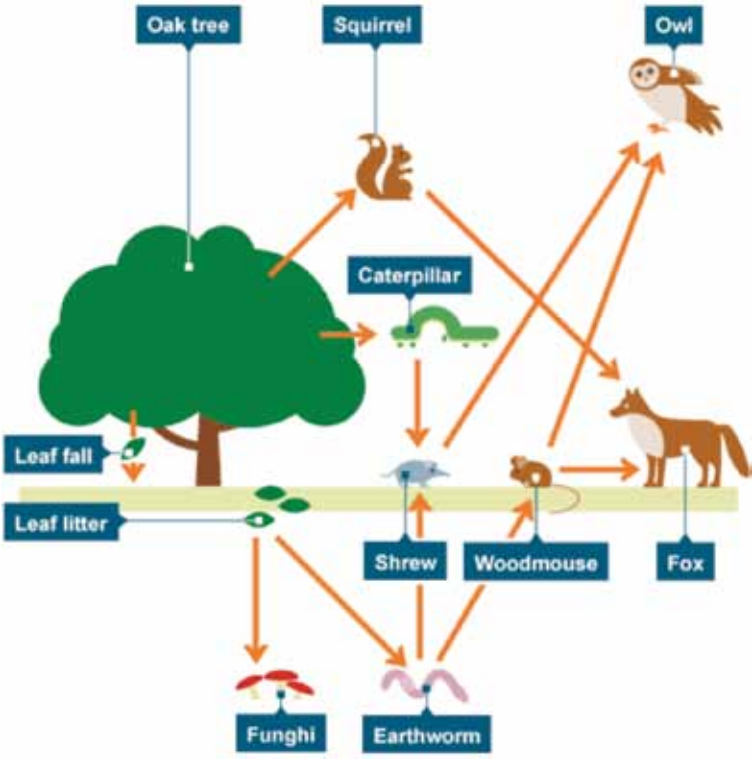
If you have an iPad in the classroom or a Smartphone, Audubon Society has some fantastic apps that could be used in the classroom (or in the field) if students want to identify or get more information about an animal or plant.

ENGAGE:

Write the words “food chain” on the board. Ask students to share an example of a food chain. Write the example on the board. If students are struggling, start writing down parts of this example: leaf → deer → mountain lion. Have them help you create another food chain.

Food chains show how energy moves from one organism to another in the form of food. The arrows point from the primary source of food to the next thing that eats it, and so on. The arrows show the direction that the energy is flowing.

Explain that, in reality, it is rare for an animal to eat only one type of food. After drawing two food webs on the board, draw arrows to connect the two food chains making a web. A food web describes the interconnection of the food chains in an ecosystem and gives a clearer picture of how plants and animals in an ecosystem are related to each other.



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EXPLORE:

Have students read the Student Reading “Life in an Oak Community”. Have students get into the same groups as Lesson 1 and ask them to identify 1 or 2 food chains from the reading. Once each group has identified two food chains, have them share out to the class and write them on the board.

As a class, link the student-generated food chains into an oak community food web. Allow students to share out more organisms from the reading to complete the food web with animals found in an oak community.

Pass out the “Food Webs” worksheets and have students add the page to their journals. Instruct the groups to go out into the schoolyard to their study areas.

Referring to the animals, insects and plants that they recorded in the Relationships Journal in Lesson 1, have the students write out two food chains or webs in their journals on the page labeled “Study Area Food Web”. Remind them to include arrows showing the flow of energy: tree sap → ant → small bird. They can sketch the plant or animal if they don’t know its name.

EXPLAIN:

In or out of the classroom, have each student pair up with a student from another group to create a schoolyard food webs. Students should use a combination of their schoolyard food chains and include at least 12 plants, animals and decomposers. Have students draw this schoolyard food web on the page in their journal listed “Schoolyard Food Web.” *(Optional: students can create a more elaborate food web model by using construction paper to draw the plants and animals, and string or yarn to connect them.)*

Circulate between the groups to check for understanding. Remind students that decomposers are good organisms to help interconnect their food webs. If time permits, have each group share their schoolyard food web.

ELABORATE:

As a class, read the Student Reading “Life in an Oak Community” and ask the students to listen for relationships that could be food chains. Ask students to name some differences between their schoolyard food web to the oak community food web (the oak community food web is much larger and has more organisms) and write them on the board.

Lead a discussion about the food webs:

What would happen if one of the links is removed from the oak community food web? (Organisms that depend on it are affected, either good or bad. The web itself changes shape, as animals could die and their predators would have to find other food sources.)

Would the community still survive? (It wouldn’t necessarily destroy the community, but it could, depending on which animal died. You never know the consequences of disrupting the web.)

What would happen if a link is removed from your schoolyard food web? (It would change the dynamic of the environment, a little or a lot depending on which link was removed.)

What would happen if a shrub is removed? A tree removed? (Shelter, food and

anything else the shrub or tree provides would be lost. Potentially the organisms would have to move and find new resources or die)

What if chemicals are sprayed on the shrubs and the insects die? (Insects are an important part of the chain and could be an important food source for another animal or provide an important role for another organism that needs it to survive.)

What could make a plant or animal fall out of the food web and disappear? (This could result from loss of food source, shelter, new predator or disease.)

Were the changes more dramatic when the ecosystem was composed of many parts or when it had fewer parts? (The changes are more dramatic when the system is smaller.)

How are humans part of the oak community web? (Humans have a variety of impacts that are both good and bad, such as cutting oak trees for lumber or for firewood, hunting animals, grazing cattle, releasing pesticides into the environment, planting oaks, and restoring habitat for animals.)

How are humans part of the schoolyard web? (Grazing cattle, releasing pesticides into the environment, planting oaks, and restoring habitat for animals.)

EVALUATE:

In their Relationship Journal, on the "My Food Web" page, have students design a food web that includes themselves and the plants and animals that they eat and get energy from. Students should use the knowledge they have learned in these lessons and classroom discussions about oak community and school yard food webs. Ask them to include at least 12 plants and animals, and some decomposers (such as worms in composting food scraps, or flies on rotting garbage).

EXTENSION:

Create a food web with natural materials. Have some clear collection containers on hand, such as repurposed food containers for insects. Ask students to collect leaves, insects, fungus and decaying matter, grass, worms in soil, etc and create a food web outdoors, using yarn to connect items. Do this activity at the base of a tree or bush and supplement with drawings or words on index cards. Remember to return any live insects near where you found them.

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American Forest Foundation (2012). Web of Life. In *Project learning tree: Pre K-8 environmental education activity guide* (6th ed., pp. 194-196). Washington, DC: Author.

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Grade 5/Student Reading

Life in the Oak Community

Oaks are common in San Diego. Canyon live oaks are found at lower elevations and in urban canyons. Coast live oaks and Engelmann oaks grow in meadows in East County. Black oaks grow in the mountains. They provide shelter, food, water, and places where wildlife live and reproduce.

Who lives in the oak community?

Oak communities are one of the richest habitats for wildlife. Healthy oak woodlands can support up to 350 species of animals. This includes many insects, birds, reptiles and amphibians, and mammals.

Barn owls, wood ducks, and many other cavity-nesting birds use oaks as their homes. In winter, squirrels sleep in hollowed-out portions of trees. Bees also use these cavities to build their hives. In spring, many bird species nest in oaks. In the summer, squirrels nest in oaks.

Nematodes, tiny round worms, and earthworms live within an oak's root system. The leaf mulch at a tree's base is home to many insects and spiders. Slugs, snails, beetles, millipedes, centipedes, caterpillars, earwigs, and ants live around the base of the tree. Many of these organisms help decompose dead leaves and branches, making the soil more fertile.

Many insects make themselves at home in oaks. Bark beetles eat through the living tissue just under the tree's bark. The tunnels create intricate patterns in the wood underneath the bark. Many oaks have galls, with insects living inside them. The oak tissue sometimes becomes irritated by insect eggs and grows a gall around them. This protects the insect and doesn't harm the oak tree.

Sometimes insects can kill the oaks. Locally, oak trees are threatened by an insect called the gold-spotted oak borer. The larvae live under the bark in the living cambium, where the nutrients and water move up and down the tree. The larvae eat this

living tissue, and this causes the tree to die after 5 to 6 years. The adult oak borer insects exit the tree in early summer. They can fly about a mile, and lay their eggs on the bark of other oak trees. The eggs hatch and the larvae start eating the cambium in the new oak trees. They follow the life cycle of insects!

Who lives in dead oaks?

Oaks continue to support the community even after they die. When a tree dies, its nutrients are recycled back into the environment through decomposition. Wood-eating insects invade a dead or dying tree. They break it down for other invaders to eat and live there. Plants and fungi absorb nutrients from the decaying wood. Here's a look at some common things you may find on, in, and around dead wood.

Many animals depend on decaying logs as places to hide from the elements. Beetles and other animals may spend the winter inside a rotting log. Some beetles, wasps, slugs, and other animals lay their eggs in decomposing wood. Salamanders may wait inside a log during the day, to stay cool and damp. Then they come out at night to hunt for food.

Some animals eat wood! Termites, sow bugs, carpenter ants, and wood roaches are scavengers that eat or tunnel through wood. They help break down the log into nutrients and soil. Many of those animals also eat other kinds of plant matter, such as dead leaves. Centipedes, beetles, and spiders are predators that feed on the wood-eating animals. Birds, skunks, and other animals tear into logs to eat these predators!

What foods do oak trees provide?

About two dozen different bird species eat acorns. Scrub jays, wood ducks, mountain quail, and flickers are just a few of these acorn eaters. Some woodpeckers also feed on the oak sap. One of the most colorful birds found in the oak community is the acorn woodpecker. This bird drills a hole in a tree's bark or in utility poles with its bill. Then the woodpecker pushes an acorn into the hole for storage. Acorn woodpeckers may store 200 acorns or more on a single tree trunk or branch!

Squirrels and scrub jays collect and hide acorns so that they can eat them later in the winter. These animals play an important role in helping new oak trees grow. Since well-hidden acorns are protected from freezing and drying, some of the stored acorns grow into new trees.

Many insects depend on oaks for food, too. Insects eat acorns and also eat oak leaves, twigs, bark, and wood. Many of these six-legged animals become meals for insect-eating birds.

Mule deer also eat acorns. Other wildlife species depend on the grasses, fungi, seeds, berries, insects, and many other foods that are found in oak communities.

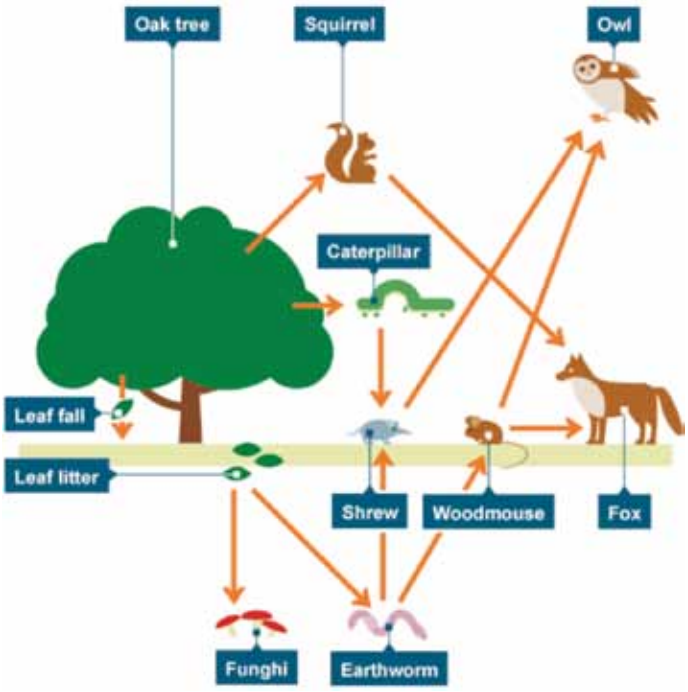
Acorns were a primary food resource or staple for the Kumeyaay and other native Californians. The Kumeyaay harvested acorns in the fall around late October and early November. The whole community would go into the mountains and foothills to camp. They gathered acorns that fell from the trees and carried them in baskets. The Kumeyaay knew how to choose ripe acorns and acorns that were not infested with worms. They were careful not to take too many acorns. They knew special ways to store and prepare the acorns for food.

Oak Communities and the Food Chain

One way that plants and animals are connected is through energy. All life depends on the ability of green plants to use sunlight. Through this process, called photosynthesis, plants take energy from sunlight and make that energy available to animals as food.

A food chain is a simple way of showing energy relationships between plants and animals. An example of a food chain is: sun → plant → seed→ mouse→ owl. This shows that a seed is eaten by a mouse, which in turn is eaten by an owl. However, it is rare for an animal to eat only one type of food. Plant eaters (herbivores) eat the plants directly. Animal or flesh-eaters (carnivores) in turn eat herbivores or other carnivores, thus forming a food chain. Omnivores eat both plants and animals.

A food web describes the interconnection of food chains in an ecosystem. The food web gives a more complete picture of how plants and animals in an ecosystem are related to each other.



Plants and animals depend on each other in other ways besides food. For example, plants may depend on animals for pollinating flowers, dispersing seeds, and keeping insect populations in check. Animals may depend on plants for shelter from storms or cold weather. They may find shade under plants, to stay cool. ■