

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
- Student reading, "Oaks and the Goldspotted Oak Borer"
- Display of Google Earth image within a mile of the school, and of an area with many dead oak trees
- 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/gsoinfo/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/gsoinfo/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, $\times \frac{3}{4}$.

Canyon live oak



Fig. 166. *Quercus agrifolia* Née.
Leaves, fruit, $\times \frac{3}{4}$.

Coast live oak



Fig. 178. *Quercus kelloggii* Newb.
Leaf, fruit, $\times \frac{3}{4}$.

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. ■

Life Cycle

of the Gold Spotted Oak Borer (beetle)



Adult

(Pictured 2x larger than life size)



Eggs

Very tiny, less than .25 cm



Pupae

(Pictured 2x larger than life size)



Larvae

(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.

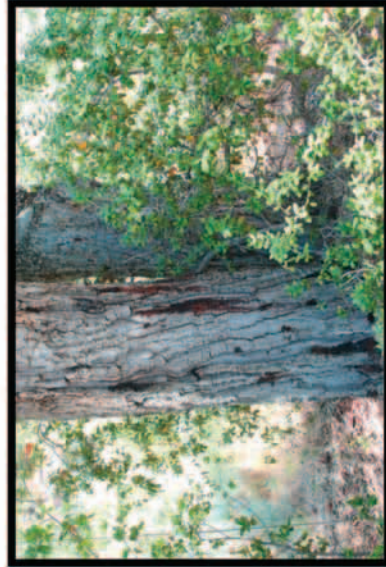
BEEBLE IMPACTS



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.

GOLDSPOTTED OAK BORER (GSOB) SURVEY FORM

Circle the choices that best match the evidence you observe.

1. Species

Match the leaf to the picture on the right and circle the species name of the oak tree.



Coast Live Oak



California Black Oak



Canyon Live Oak

2. Size

For diameter, wrap measuring tape around trunk and divide by three.

Sapling -Trunk < 5" diameter

Mature -Trunk 5"-20" diameter

Old Growth- Trunk > than 20" diameter

3. Crown Rating

Take 20 steps away from tree, look at top of tree. Choose a crown thinness rating.



Healthy



Moderate Thinning



Severe Thinning

4. D-Shaped Holes

Holes are the size and shape of a capital D on a typed page.



None = 0 holes

Low = 1-9 holes

Moderate = 10-25 holes

High = more than 25 holes

5. Woodpecker Damage

Look for acorn holes, flaking outer bark, and reddish color underneath. They are evidence of woodpeckers feeding on insects inside the bark.



Bark Flaking

No Low Med. High

Acorn Holes

No Low Med. High

(OVER)

GOLDSPOTTED OAK BORER (GSOB) SURVEY FORM

Circle the choices that best match the evidence you observe.

6. Larval Feeding Patterns

Look for irregular squiggly lines on wood surface.



Irregular Patterns on Wood

Yes No

7. GSOB Larvae



Can be seen year-round.

Did you actually see the larvae?

Yes No

8. GSOB Adult



Normally seen June to September.

Did you actually see the insect?

Yes No

9. Tree Status

As a team, decide if you think the tree was attacked by GSOB or not.

Not GSOB attack

Can't Determine if GSOB attack

Probable GSOB attack

Definitely GSOB attack

10. Coordinates

Use GPS: write down the 2 coordinates of your tree.

Write tag # of the tree you tag.



N _____ ° _____ . _____ ,

W _____ ° _____ . _____ ,

Tag # _____

Collaboration of



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Program



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