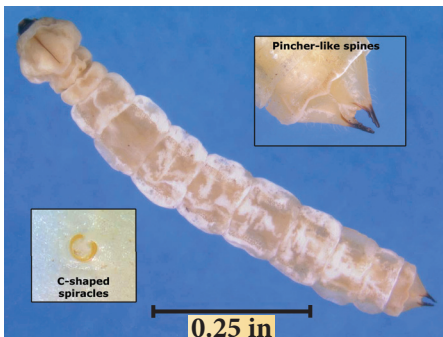


# Goldspotted Oak Borer

## Field Identification Guide



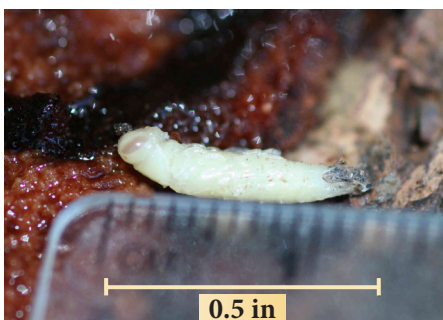
**Figure 1. Adult goldspotted borer.**  
Photo by Stacy Blomquist, USDA Forest Service, Southern Research Station.



**Figure 2. GSOB larva with close up of spiracles and spines.** Photo by Stacy Blomquist, USDA Forest Service, Southern Research Station.



**Figure 3. Mature larva in hairpin configuration.** Photo by Tom W. Coleman.



**Figure 4. Pupa in outer bark.** Photo by Tom W. Coleman.

The goldspotted oak borer (GSOB), *Agrilus auroguttatus* (Coleoptera: Buprestidae), is a flatheaded borer new to California that poses a significant threat to oak trees. The pest is native to southeastern Arizona, although a related species occurs in southern Mexico and northern Guatemala. GSOB was first collected and identified in California in 2004 in San Diego County but was not linked to extensive oak mortality until 2008. As of 2010, GSOB has killed an estimated 21,500 trees covering 1,893 square miles in San Diego County in forests, parks, and residential landscapes.

GSOB larvae feed beneath the bark of certain oaks near the interface of the phloem and xylem, the nutrient and water conducting tissues of plants. The larvae damage both of these tissues as well as the cambium, a unicellular layer between the phloem and xylem that is responsible for the radial growth of the tree. Trees die after several years of injury inflicted by multiple generations of the beetle. Currently there are no effective tools for protecting trees once infestation occurs.

### IDENTIFICATION

Capture of adult GSOB on sticky traps in infested areas of San Diego County and observations of immature life stages suggest that this pest completes one generation each year. Adults are about 0.4 inch long and 0.08 inch wide with a slender, bullet-shaped body (Figure 1) and are agile flyers. They are primarily black with an iridescent green sheen and have six gold-colored spots on their forewings, hence the common name.

Eggs are extremely small (0.01 inch), dull colored, and rarely observed on trees. They likely are laid singly or in clusters in bark cracks on the main stem and larger branches of oaks.

Larvae are white, legless, and about 0.8 inch long when mature (Figure 2). GSOB larvae can be distinguished from those of other wood boring beetles by C-shaped spiracles and two pincherlike spines on the end of their abdomen. Mature larvae can be found in a hairpin configuration in the outer bark (Figure 3) from early fall until early summer.

Pupae also are found in the outer bark from late spring to early summer; they resemble the adults in size and shape but are primarily white and soft bodied (Figure 4). When adult beetles emerge from the pupal cell in the bark, they make a diagnostic D-shaped emergence hole; see External Symptoms below. Adult GSOB feed on oak foliage and make notches along leaf margins (Figure 5), but tree mortality results from larval feeding. This pest is known to kill three species of native oaks in California; for more information, see the sidebar Which Oak Species Are Attacked? on Page 3.

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**Figure 5. Adult GSOB and chewing damage on leaf.** Photo by Tom W. Coleman.



**Figure 6. Thinning of coast live oak crown.** Photo by Tom W. Coleman.



**Figure 7. Thinning of California black oak crown.** Photo by Tom W. Coleman.

## TREE SURVEYS: WHAT TO LOOK FOR

When surveying forest, park, or landscape areas for GSOB, begin by examining older, mature trees and/or those trees exhibiting thinning and dieback of foliage in the crown. If GSOB injury is found on older trees, surveys should continue on smaller diameter trees in the same area. When searching for signs of GSOB, focus on the lower 8 feet of the main stem and directly around the root collar.

### External Symptoms

Symptoms of GSOB infestation can include premature twig dieback and thinning in the crown (Figures 6 and 7) that worsens progressively over several years. Other factors can cause similar tree decline, so it is important to confirm the presence of GSOB larvae in trees.

Larval feeding occurs primarily on the main stem (or trunk) and larger branches of mature oaks. Elevated levels of larval injury are indicated by black, wet staining or dark red bleeding on the bark (Figures 8, 9, and 10), resulting from a build-up of tree sap around patches of dead phloem. Bark staining varies greatly in size with dark patches ranging from less than 1 square inch to 0.5 square foot, and there can be multiple stained or bleeding areas on the stem.

When new adults emerge through the outer bark, their exit holes (Figure 11) are D-shaped and 0.15 inch wide. Exit holes often are found along the lower 6 feet of the main stem, at the very base of the tree, or adjacent to bark-stained areas. From fall to early summer, woodpeckers forage for larvae and pupae in the outer bark, exposing the brick-red phloem (in coast live oak) and signifying an infested tree (Figure 12). Woodpecker foraging often exposes the black larval galleries or pupal cells. Inner bark that has been exposed from woodpecker foraging darkens to black over time. Woodpecker activity, although high in certain areas, has been insufficient to control GSOB or slow its spread.

### Internal Symptoms

Beneath the bark, larval feeding galleries are found primarily in the inner bark and surface of the wood. To expose larval galleries, carefully shave



**Figures 8, 9, and 10. Bark staining and bleeding resulting from GSOB larval feeding.** Photos by Tom W. Coleman.



**Figure 11. D-shaped holes indicate locations where adult beetles have emerged.** Photo by Tom W. Coleman.



**Figure 12. Inner bark exposed to woodpecker foraging is first red but later darkens.** Photo by Tom W. Coleman.



**Figure 13. Removal of bark exposes the meandering larval galleries filled with dark frass.** Photo by Tom W. Coleman.



**Figure 14. Extensive feeding kills large areas of phloem leaving areas of dead tissue.** Photo by Tom W. Coleman.

a small area of bark down to the wood surface. Larval feeding occurs in a meandering pattern and has a black appearance when the bark is freshly removed (Figure 13). Larval galleries are tightly packed with dark-colored frass. Extensive larval feeding can kill large areas of the phloem, leaving areas of dead tissue often filled with tree sap (Figure 14). This feeding activity eventually girdles and kills trees.

## WHICH OAK SPECIES ARE ATTACKED?

Extensive research on the host range of GSOB has not been completed. However, in Southern California, GSOB is known to injure and kill three native species of oak: coast live oak, *Quercus agrifolia*; California black oak, *Q. kelloggii*; and canyon live oak, *Q. chrysolepis*. In extremely rare cases, GSOB also can injure Engelmann oak, *Q. engelmannii*, but injury has not been linked with significant tree mortality on this species.



Coast live oak, *Q. agrifolia*



California black oak, *Q. kelloggii*



Canyon live oak, *Q. chrysolepis*



Engelmann oak, *Q. engelmannii*, can be attacked but is not known to be killed.

## MANAGEMENT

Preventing movement of infested wood (primarily firewood) to new areas is essential for slowing the spread of this exotic borer to other regions of the state. Wood from infested trees should be kept within several miles from its origin and *never* moved outside of the current area of GSOB establishment in San Diego County. Grinding wood to less than 1 inch particle size can eliminate wood borers in infested wood and is recommended where trees are being removed. Leaving wood on site for more than two years after the tree has died will reduce the risk of moving GSOB in cut wood. Double tarping freshly cut wood with clear plastic or bagging wood from May to October can trap emerging GSOB and reduce localized GSOB populations for homeowners. These trapped GSOB adults cannot disperse and feed, and ultimately they will die. Solarizing infested logs can reduce emergence rates and trap emerged beetles but cannot be relied on to kill all larvae in logs.

Information on using insecticides to manage GSOB is limited. Insecticide treatments for controlling wood borers are more effective for preventing infestation of healthy trees and are unlikely to control larvae in infested trees. Trees with moderate or severe injury from aggressive wood borers are difficult if not impossible to save with current management tools.

Preliminary lab experiments have shown that treatments with the contact insecticides carbaryl and bifenthrin can kill GSOB adults in lab feeding and walking assays. Foliage from trees treated with systemic insecticides have been less effective in controlling GSOB in these assays. Duration of efficacy for contact treatments, efficacy in the field, and the likelihood that these treatments can save trees is currently unknown. If used, insecticide treatments should be limited to protecting high-value trees that have not been significantly infested with GSOB. Timing is critical. Contact insecticides should be applied prior to GSOB adult activity, which begins in early to mid-May. Contact treatments should be applied to the main stem, large diameter branches, and as much of the foliage as possible to reduce numbers of GSOB adults and their egg laying. Trees should be re-treated every year until additional data is collected regarding the duration of efficacy. Carbaryl and bifenthrin can have significant negative impacts on natural enemies, bees, wildlife, and water quality. Research is continuing on effective insecticide treatments for GSOB.

Although woodpeckers are known to forage on goldspotted oak borer larvae, their feeding is not sufficient to significantly suppress populations. No other significant natural enemies of the pest are currently known in California, but research on biological control is continuing.

If you suspect goldspotted oak borer infestation in your oak trees, contact your county department of agriculture or UC Cooperative Extension office.

## TREE HEALTH RATING

A tree health rating for GSOB-infested trees has been developed for land managers and others wishing to evaluate trees; for more information, see the sidebar Health Rating for GSOB-Infested Trees. The rating is based on assessing four factors:

- The severity of crown thinning and dieback;
- The density of exit holes;
- The degree of bark staining; and
- The presence or absence of woodpecker foraging.

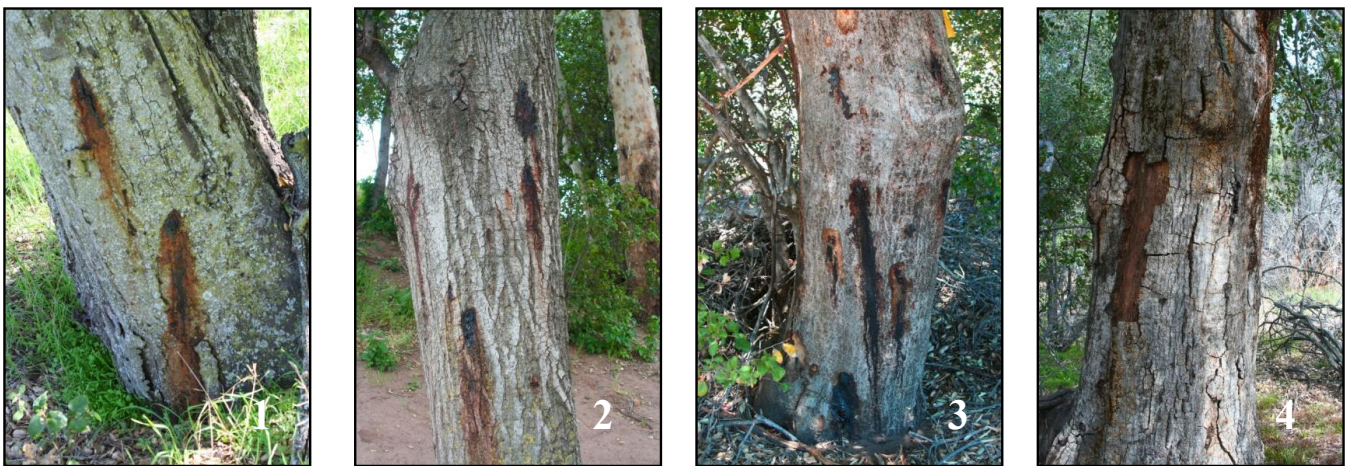
Trees with a crown rating greater than 3, an exit hole rating of 3, and a bark staining rating of 4 from GSOB injury likely will die in the next few years.

## HEALTH RATING FOR GSOB-INFESTED TREES



### CROWN RATING

**1.** Full, healthy crown (0% leaf loss). **2.** Minor twig dieback and/or light thinning (10-25% leaf loss). **3.** Moderate thinning and twig dieback (25-50% leaf loss). **4.** Severe dieback to larger branches (>50% leaf loss). **5.** Tree is dead.



### BARK STAIN RATING

**1.** One to five areas of staining present on lower stem (<8 feet). **2.** Six to ten stained areas. **3.** Greater than ten areas of staining on the lower stem. **4.** Bark cracking evident on main stem.



### EXIT HOLE RATING

**1.** Can find at least one D-shaped exit hole on the main stem. **2.** Can find a few exit holes (10-25) in clumps on the main stem. **3.** Exit holes are scattered and abundant (>25).

**WOODPECKER FORAGING (+/-)** Present or absent

## AUTHORS

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This field guide is available online at [http://www.ipm.ucdavis.edu/PDF/MISC/GSOB\\_field-identification-guide.pdf](http://www.ipm.ucdavis.edu/PDF/MISC/GSOB_field-identification-guide.pdf). Published Jan. 13, 2011.

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