

## New Pest in California: The Goldspotted Oak Borer, *Agrilus coxalis* Waterhouse

The goldspotted oak borer (GSOB) was first detected in 2004 in San Diego Co., California by the California Department of Food and Agriculture during a survey for exotic woodborers. In 2008, it was found in the same county attacking coast live oak, *Quercus agrifolia*, canyon live oak, *Q. chrysolepis*, and California black oak, *Q. kelloggii*, on the Cleveland National Forest. GSOB is playing a major role in on-going oak mortality on federal, state, private, and Native American lands in southern California. GSOB larvae feed under the bark primarily at the interface of the sapwood and phloem on the main stem and larger branches. Larvae kill patches and strips of phloem and cambium, resulting in limb and branch die back and, eventually, tree death. Although the exact origin of the California population is unknown, GSOB has been previously collected in Arizona, Mexico, and Guatemala. Because of host distribution, GSOB has the potential to spread further north in California and cause similar tree mortality. Since very little published information is available on this insect, additional research is needed to determine the life cycle, behavior, and management strategies.

### Identification

Adults are about 10 mm long and 2 mm wide (Fig. 1). They are bullet-shaped and can be identified by the six golden-yellow spots on the dark green forewings. Mature larvae are about 18 mm long and 3 mm wide. They are legless, white, and have a long slender appearance (Fig. 2). The larvae possess two pincher-like spines at the tip of the abdomen. Pupae are found in the outer bark and resemble adults, but are commonly white in color. Eggs are probably laid in bark crevices like other *Agrilus* spp., but have not been observed by the authors.

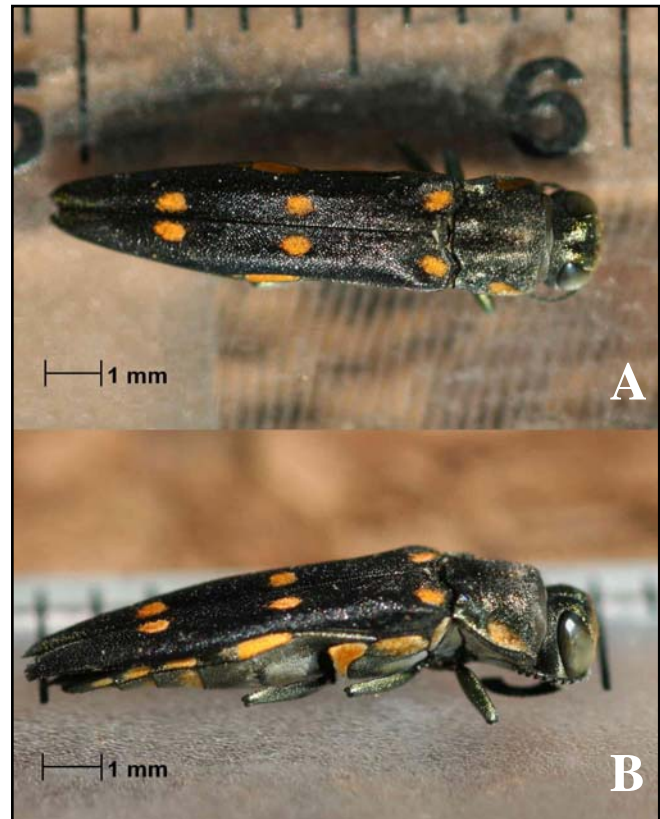


Figure 1. Dorsal (A) and lateral (B) views of the GSOB adult. The six gold spots on the forewings (elytra) are diagnostic for this species.

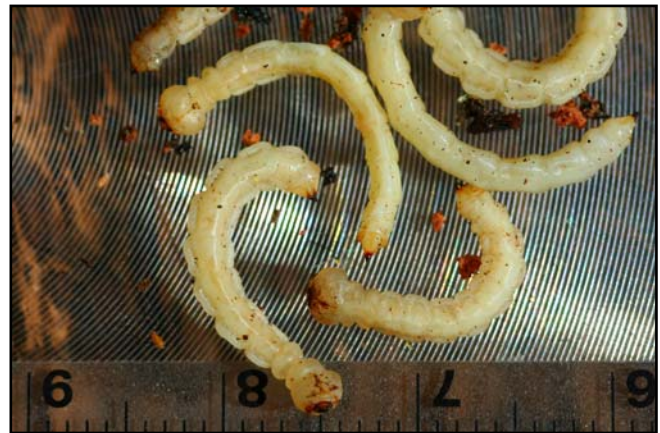


Figure 2. White, legless larvae of GSOB

## Evidence of attack

GSOB attacks can be recognized by extensive bark staining, which can appear as black regions or red blistering with sap oozing from under the bark (Fig. 3). Adult exit holes signify previous GSOB attack. These emergence holes are D-shaped and about 3 mm in width (Fig. 4). On coast live oak, the bark is frequently removed by woodpeckers as they forage for larvae and pupae; this reveals the deep red-colored outer bark that contrasts starkly with the gray exterior bark. The presence of the larvae and their galleries, the emergence holes, and the associated woodpecker damage all distinguish GSOB infestation from infection with *Phytophthora ramorum*, the pathogen that causes sudden oak death. The latter has not been detected in the area of California infested with GSOB.



Figure 3. Bark staining found along the main stem.



Figure 4. D-shaped exit holes of GSOB adults on the bark.

Larvae construct galleries primarily on the sapwood surface along the main stem from the base of the tree up to larger branches. Larval galleries are dark in color and have a meandering appearance with a general vertical orientation (Fig. 5). Extensive larval feeding can strip or patch kill areas of the tree, which turn black as they die (Fig. 6). Stained regions of the bark surface represent patch-killed areas beneath the bark. Patch-killed regions are commonly saturated with sap, which is expelled when the bark is cut open. GSOB attacks also lead to crown thinning, which begins with premature leaf drop and progresses to twig and branch die back (Fig. 7). Crown thinning may only be evident after two to three years of attack. California black oak loses foliage more quickly than evergreen coast live oaks. If their behavior is similar to other flatheaded borers in this genus, GSOB adults likely feed and mate on the foliage.



Figure 5. Larval galleries are primarily found on the sapwood surface.



Figure 6. The bark was removed to show the black patches of cambium killed by GSOB.



Figure 7. Crown thinning and branch die back on coast live oak following numerous attacks by GSOB.

## Background and distribution

GSOB has been known since the late 1800's from museum records from southeastern Arizona, southern Mexico, and northern Guatemala (Fig. 8). Collection dates for these adult museum specimens ranged from May to September. It was first collected in California in 2004. Currently, GSOB occurs in southern California in a 50 x 40 km area east of San Diego (Fig. 8). Damage to oaks was first associated with GSOB in 2008 in San Diego Co., although elevated levels of oak mortality have been aerially mapped on and around the Cleveland National Forest since 2002. There are no reports that link GSOB to development in or damage to oaks outside of California. Although the presence of GSOB in southern California may reflect a range expansion from native populations to the east and south, anecdotal reports suggest that it may have been introduced during the last ten years on oak firewood brought in from Mexico.

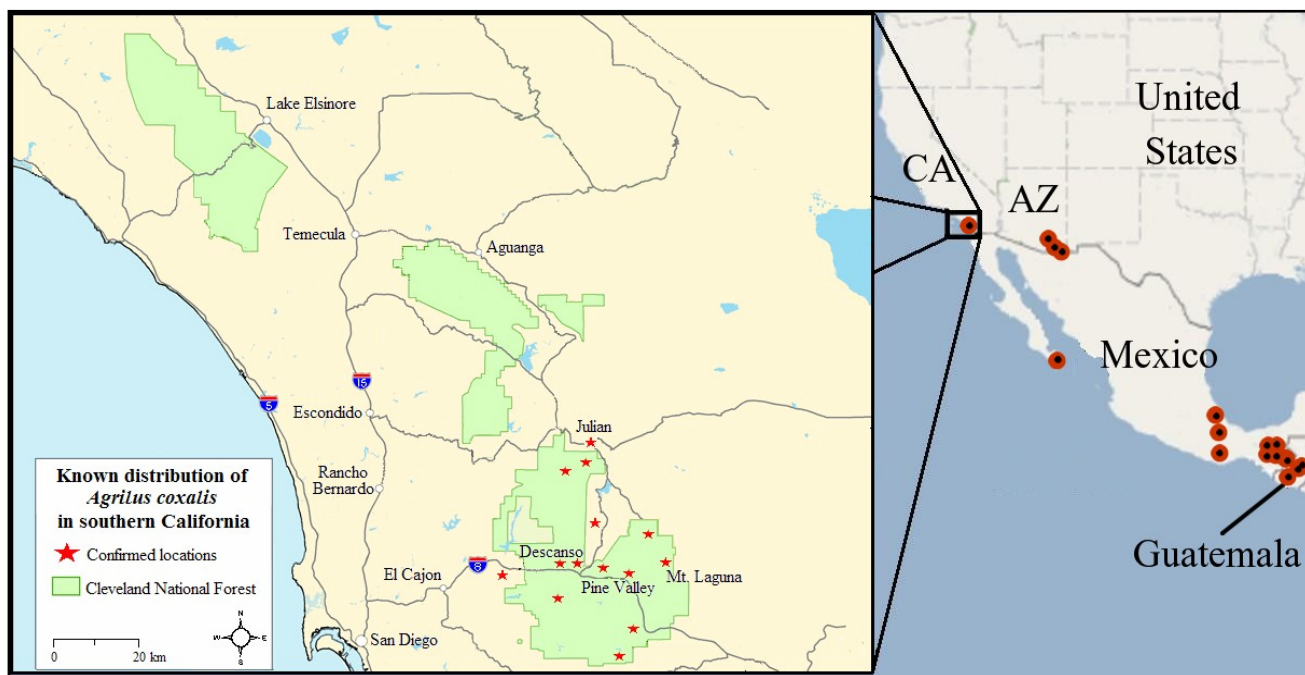


Figure 8. The distribution of GSOB in California as of Oct. 2008 (left), and its native range in Arizona, Guatemala, and Mexico (right).

## Biology and potential impacts on oaks in California

In southern California, initial observations suggest that most of the GSOB population completes one generation in a year with mature larvae present in the tree beginning in late May. Larvae and pupae were observed beneath the bark as late as October, suggesting that some fraction of the population may require more than one year to develop. Preliminary flight trapping suggests that adult activity occurs from June to October with peak flight in late June. However, full season observations will no doubt reveal the presence of young larvae prior to May and adult flight that begins earlier than June. Coast live oak, canyon live oak, and California black oak are the only confirmed hosts of GSOB, but other oak species may be susceptible as well. We have observed attacks from GSOB only in older, mature oaks. GSOB attacks have not been observed in small diameter oaks (<12 cm at breast height). Additional research is needed to clarify the life history and host range of GSOB.

Widespread oak mortality can impact wildlife through loss of a food source and habitat. Dead oaks can create potential hazards, especially near dwellings, along roadways, and in recreational areas. Oak mortality also represents a significant increase in fuel loads across the landscape, which can increase the probability and severity of wildfire.

## Management options

Several *Agrilus* spp. in the U.S., including bronze birch borer, emerald ash borer, and twolined chestnut borer, have very similar life histories and impacts on hardwood trees. Until management guidelines can be developed specifically for GSOB, we suggest that arborists, land managers, forest health specialists, and homeowners consider the following information from other hardwood *Agrilus* spp. when managing oaks for GSOB. These management tactics and associated timing have not been tested for GSOB in southern California.

Systemic insecticides are effective for suppressing *Agrilus* spp. in hosts. Imidacloprid is a systemic insecticide that can be soil-injected, basally drenched, or trunk-injected by using several methods. Soil-injections and basal drenches should be applied immediately adjacent to the root collar of trees for best results. Treating trees early in the spring is the most effective approach for controlling other *Agrilus* spp. because the treatment can kill both adults and larvae. Soil- and stem-injections may not provide adequate suppression in low-vigor trees because the compound will not be transported throughout the tree.

Spraying high-value trees along the main stem, larger branches (>12.5 cm), and foliage with a registered insecticide has been shown to prevent attack from other *Agrilus* spp. Spraying the foliage is crucial because adult *Agrilus* feed and mate here. Spraying with carbaryl or pyrethroids (cyfluthrin, permethrin, or bifenthrin) may provide adequate control. A single preventative spray in the spring, or an additional second spray in mid-summer, is an effective strategy for controlling *Agrilus* spp. throughout the summer. However, preventative insecticide sprays will not affect larvae already present under the bark. Using both systemic insecticides and topical spraying of bark and foliage surfaces may provide the best control for GSOB.

Logs and firewood from GSOB-killed trees or green infested trees should not be removed from infested areas. We emphasize that transporting infested firewood may represent a significant pathway for introducing GSOB into non-infested areas. Removing dead or dying trees infested with GSOB followed by careful handling of infested materials may reduce localized populations. Within infested areas, tarping oak wood with thick, clear plastic sheeting or exposing cut wood to direct sunlight may kill GSOB larvae and pupae. Chipping wood into 2.5 cm pieces is the best method to drastically reduce *Agrilus* spp. survival in cut logs.

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