

# Developing an Integrated Pest Management Program for the Invasive Goldspotted Oak Borer in Southern California



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## INTRODUCTION

- The goldspotted oak borer (GSOB), *Agrilus auroguttatus*, is an exotic wood-boring beetle that was likely introduced to southern California via infested firewood from southeastern Arizona.
- Since 2002, oak mortality from GSOB has been recorded continuously in San Diego Co. The exotic beetle was not linked to tree mortality until 2008. Aerial surveys have identified approx. 27,800 dead oaks in southeastern San Diego Co.
- Prior to 2008, no life history information or management options were available for GSOB for the preservation of oak woodlands across all land ownerships.



Adults can easily be identified by the gold pubescent spots on the elytra and thorax.



Mature larvae of the GSOB are ~2 cm in length.



Mature larvae, or pre-pupae, of GSOB are found in the outer phloem.



California black oak and coast live oak are the favored hosts of GSOB in California.



The meandering larval galleries of GSOB are common at the cambial region.



Coast live oak mortality has been recorded extensively in southeastern San Diego Co.

## OBJECTIVE

- Our objective was to develop a GSOB integrated pest management (IPM) program to preserve native oak woodlands in California. The IPM program would assess GSOB biology, monitoring techniques, insecticide treatments, mechanical treatments, biological control, and risk to California.

## METHODS

- In 2009, a GSOB strategic plan was developed by federal, state, and county agencies to reduce the impact of GSOB in California.
- The plan identified research priorities for GSOB biology, monitoring, insecticide treatments, mechanical treatments, biological control, education/outreach, and a risk assessment for California. Federal and state funding was allocated to fill knowledge gaps about this invasive pest in California.
- Collaborators from USDA Forest Service, Forest Health Protection and Research and Development; University of California, Davis and Riverside; USDA Animal Health and Plant Inspection Service; California Department of Forestry and Fire Protection; California State Parks; and San Diego County Parks contributed to developing the integrated pest management program.

## Biology

- GSOB completes one generation/year with adults flying from late May to early September. Adults must feed on foliage to survive, and females have laid ~200-500 eggs/each in laboratory studies.
- Larvae feed primarily in the cambial region; complete four instars; and then move from vascular tissue to the outer phloem to pupate.



GSOB eggs



GSOB larvae, pre-pupae, pupa, and adults



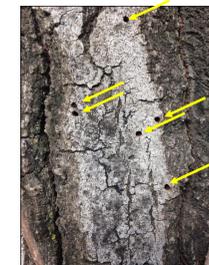
GSOB adults sitting on oak foliage.

## Monitoring

- A tree health rating system was developed based on the degree of crown thinning (1-5); density of adult emergence holes (1-3) and bark staining (1-4); and presence/absence of woodpecker foraging (+/-) to assist with ground surveys and management decisions.
- Ground surveys are the most effective method for delimiting the distribution of GSOB. Purple prism flight-intercept traps have been used in research studies to monitor the adult flight, but no lure has been developed for area wide surveys.



GSOB tree health rating system



GSOB D-shaped emergence holes



Purple prism flight-intercept traps

## Insecticide Treatments

- Stem injections of emamectin benzoate and imidacloprid were effective at killing adults or reducing adult feeding in laboratory bioassays. However, results varied with tree size, species, and application time. Re-treatments are required every other year.
- Contact treatments of carbaryl, bifenthrin, lambda-cyhalothrin, and permethrin killed adults in laboratory bioassays, but must be reapplied annually.



Systemic injection of emamectin benzoate



Dinotefuran did not significantly kill GSOB in lab bioassays.



Application of carbaryl to coast live oak

## Mechanical Treatments

- Grinding infested wood (<7.6 cm particle size) kills all GSOB individuals in infested wood. Tarping infested wood will prevent adult GSOB from escaping, but does not kill the adults. Debarking cut wood will remove all GSOB individuals from the wood, but they can still survive in the bark.



A tub grinder and enclosed ground wood



Tarping/solarization of infested wood



Debarking wood treatments

## Biological Control

- A new species of wasp, *Calosota elongata*, was found associated with GSOB in Arizona. The wasp has also been found in California and was likely introduced with the original GSOB population. Generalist parasitoids, including *Pyemotes tritici* and *Trichogramma* sp., have been associated with GSOB larvae/pupae/adults and eggs, respectively.
- Mass rearing of GSOB has not been effective, so there is no biological control program.



*C. elongata* larvae feeding on a GSOB pre-pupae.



*C. elongata* adult females



*P. tritici* females feeding on a GSOB larva.

## Education/Outreach

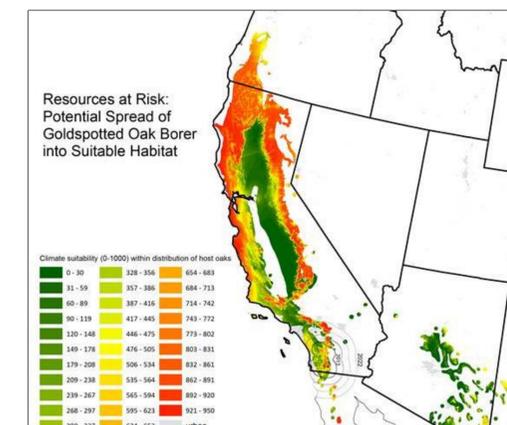
- A centralized website ([www.gsob.org](http://www.gsob.org)) was developed for disseminating GSOB education and outreach material. Numerous meetings were held for private land owners, arborists, and land managers to discuss impact and management information.
- The GSOB program adopted the "Buy it where you burn it" campaign utilized by other invasive species programs. Additional outreach information was developed for spreading awareness about this new pest in California.



Various examples of education and outreach material developed for spreading awareness about GSOB.



## Risk Assessment



- A U.S. pest risk assessment was developed by assessing GSOB's climate suitability (e.g., temperature, moisture, and cold tolerance), host range in Arizona and California, and adult flight distance.
- The predicted spread of GSOB is most likely along the California Central Coast and the lower elevation of the Sierra Nevada Mountain Range (see above).

## FUTURE DIRECTIONS

- The efficacy of the GSOB IPM program will be validated in the future in infested oak woodlands on federal, tribal, state, and county lands.
- More detailed information about GSOB and the IPM program will be available in the GSOB Forest Insect and Disease Leaflet, which should be published in early 2015.

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