

Outreach and Education Efforts to Counter the Spread and Impact of Goldspotted Oak Borer¹

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Abstract

The goldspotted oak borer (GSOB) *Agrilus auroguttatus* (Coleoptera: Buprestidae), has killed over 80,000 oaks across all land ownerships, costing over \$8 million in public and private funds for mitigation and response. Linked to oak mortality in San Diego County in 2008, this exotic beetle likely arrived in California through infested firewood from Arizona and attacks three native oak species found through California and southern Oregon: coast live oak (*Quercus agrifolia*), California black oak (*Q. kelloggi*), and canyon live oak (*Q. chrysolepis*). The University of California Division of Agriculture and Natural Resources (UC ANR), the U.S. Department of Agriculture Forest Service (USDA FS), and California Department of Forestry and Fire Protection (CAL FIRE) lead collaborative program development to slow GSOB expansion by educating clientele about GSOB-associated oak mortality and the danger of firewood imports. Over 5,100 stakeholders throughout southern California were identified and contacted utilizing both traditional and digital educational delivery strategies, including outreach and training events, print and online resources and a Citizen Scientist/GSOB Early Warning System for detection and monitoring. While it is impossible to measure the extent of GSOB spread mitigated through this effort, we believe we have dramatically reduced the purchase of GSOB-infested firewood in the communities targeted in our outreach.

Key words: *Agrilus auroguttatus*, forest pest, goldspotted oak borer, GSOB, invasive insect education and outreach, oak management, oak woodlands, *Quercus agrifolia*, *Quercus chrysolepis*, *Quercus kelloggi*

Introduction

In 2007 it became obvious that red oaks were dying in unprecedented numbers in San Diego County at rates far beyond the mortality seen in recent droughts. By the time the goldspotted oak borer (GSOB) *Agrilus auroguttatus* (Coleoptera: Buprestidae), was linked to oak mortality in 2008 (Coleman and Seybold 2008), thousands of acres of oak woodlands were already heavily impacted (Scott and others, Mapping the spread of the goldspotted oak borer (*Agrilus auroguttatus*), an invasive exotic bark beetle, these proceedings). It became obvious that a coordinated, rapid outreach

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response was essential to prevent the spread of GSOB to other woodlands in California. This outreach faced similar problems found with most exotic pest outbreaks—limited understanding of the origin, extent and intensity of the loss. Little scientific data was initially available except that GSOB had never been considered a pest problem for oak populations within its native range of southeast Arizona. However, once introduced into California, the beetle thrived. Research and programming about a closely related exotic beetle, the emerald ash borer (EAB) *Agrilus planipennis*, provided a general framework for response (Herms and McCullough 2014), but the application of EAB management techniques to GSOB was unclear.

GSOB damage appeared to be limited to three species of oak; however, the extent and timing of loss was poorly understood. This uncertainty created an exceptionally large group of affected clientele across the oak woodlands of California. The momentum of the problem was obvious: Every GSOB-infested oak represented an opportunity for the pests' spread to new locations. With thousands of cords-worth of GSOB-infested trees suddenly available for firewood, there was an urgent need to change the behavior of the firewood market. GSOB larvae readily survive throughout firewood production, pupate and emerge as breeding adults wherever firewood was moved or stored.

Most counties throughout California have at least one to all of the three susceptible oak tree species: coast live oak, *Quercus agrifolia*; California black oak, *Q. kelloggii*; and canyon live oak, *Q. chrysolepis*. Approximately 1.2 million hectares (3 million acres) of susceptible oaks occur from southern California into southern Oregon, with a strong likelihood that eastern red oaks could also be attacked. The distribution of GSOB damage has been patchy at all landscape scales, leaving many individual oaks and even entire woodlands unaffected (Scott and others, Mapping the spread of the goldspotted oak borer (*Agrilus auroguttatus*), an invasive exotic bark beetle, these proceedings). At the onset, clientele ranged from homeowners, arborists, park ecologists, ranch managers, to a wide variety of other individuals interested in oaks. Management units ranged from single oaks in residential landscaping up to thousands of hectares in county parks, state parks and national forests.

To slow the spread of GSOB, a large number of unrelated stakeholders needed to be reached and comprehend the potential threat posed to the environment, public safety, property values, outdoor recreation opportunities, and cultural resources. Initial outreach efforts matched the breadth of the stakeholders and were undertaken by a number of local, state, and federal agencies and organizations based in southern California. A number of these groups had previously collaborated to develop resources and capacity to solve other issues with wildfire, drought, and conifer mortality. These efforts coalesced around the University of California Cooperative Extension (UCCE) and the U.S. Department of Agriculture Forest Service-Forest Health Protection (USDA FS FHP) with a division of labor developing organically and with a remarkable degree of cooperation. This culminated in the education and outreach committee coordinated by the Cleveland National Forest, with representatives from UCCE, USDA FS FHP, California Department of Forestry and Fire Protection (CAL FIRE), San Diego County Agricultural Commissioner, City of San Diego Parks, California State Parks, and the Greater San Diego Resource Conservation District. CAL FIRE staff adapted an existing Incident Action Plan, to match the evolving needs for managing GSOB. The Incident Action Plan identified objectives, tasks and established an organizational structure, which helped to formalize existing ad hoc relationships.

By 2009, the University of California Division of Agriculture and Natural

Resources (UC ANR) began an aggressive program to forewarn oak tree managers in uninfested areas in southern California, including the remaining uninfested communities within the known GSOB infestation area. The goal was to establish a flexible education and outreach program with activities focused on increasing clientele understanding of GSOB impacts, distribution, management and problems posed by the movement of firewood. We utilized workshops, community and local government presentations, interagency meetings, webinars and conference calls to slow and ideally mitigate the import of infested firewood. Clientele were asked to participate in the GSOB early warning detection system, a citizen scientist oak health-monitoring program. Communities were encouraged to prepare a rapid response plan that could be implemented immediately in the event of GSOB discovery.

Funding for GSOB research was limited by the 2008 economic downturn, but by 2010 enough information existed to train woodland managers and landowners about the general nature of GSOB impacts and the possible range of management actions that could be taken. Over the next 3 years, a great deal of field and laboratory observations were made on GSOB life history (Coleman and others 2012, Flint and others 2013, Haavik and others 2012, Haavik and others 2013) so that information could be extended on the nature of GSOB-associated impacts.

Framework development

Our goal was to develop a GSOB public education and outreach program framework that would provide clientele educational opportunities and resources to: (1) learn about GSOB spread and firewood movement; (2) discuss options for management once infestation had occurred; and (3) encourage planning for GSOB outbreaks and preemptive management of oaks and oak woodlands in general. Our target audience included agency staff, tree service professionals, landowners, natural resource managers and the general public. There were three tiers of action: (1) training professionals and agency staff to monitor and manage GSOB; (2) make landowners aware of the GSOB problem to change oak firewood use and production and help them detect and manage GSOB; and (3) raise public awareness in general about the potential loss of oaks and danger of moving infested firewood. Traditional and digital outreach methods were utilized and tools were designed to support multiple tiers of action: web-based and in-person trainings; news media; print materials and regular and electronic mail communications. Additionally, program staff provided relevant input and collaboration for new and existing state, regional and countywide coordinating workgroups and projects. Program content was initially developed from existing insect pest and oak tree management information and ad hoc observations. We capitalized on the extensive research and outreach information developed on the emerald ash borer (Herms and McCullough 2014), oak woodland management (UC ANR Oak Woodland Management web page, http://ucanr.edu/sites/oak_range/) and integrated pest management best practices (UC ANR Integrated Pest Management program, <http://www.ipm.ucdavis.edu/>) when developing resource materials including links to other sources of information for the management of oak woodlands and GSOB. Our Education and Outreach group developed new content collaboratively. This ad hoc group created a conduit between research and outreach that allowed us to identify research needs and rapidly turn research information into outreach. The diversity of our group gave us the flexibility to reach different clientele as we learned about the extent and pattern of GSOB impacts.

To develop a program that was efficient, effective and sustainable, it was

imperative to collaborate and quickly organize coordinating planning and work groups. In addition to ad hoc cooperators, we were able to get the involvement of local, regional and state resource managers by informing them of the threat posed by GSOB to their management units. Their activities and the involvement of researchers were formalized by a series of meetings organized by USDA FS FHP. This resulted in the formation of the GSOB Steering Committee, which developed an incident action plan; a research needs assessment, project prioritization, and strategies for securing funding. Though Steering Committee collaboration, UC ANR applied for and was awarded 2-year funding (July 2010-June 2012), through the American Recovery and Reinvestment Act, to develop GSOB education and outreach programming. Additional funding was secured from the USDA FS State and Private Forestry and CAL FIRE. The funding established a hub for coordination ultimately evolving into a position for a GSOB program coordinator.

In order to extend our impact beyond committee members, we identified more than 5,100 agency staff and stakeholders to train as a second tier for outreach. The group included land managers, tree care professionals, natural resource educators, community organizations and citizen leaders with interests relating to oak trees. Although there was some representation with statewide interests, most of these stakeholders were professionally active and/or resided in one or more of six southern California counties: San Diego, Riverside, Orange, San Bernardino, Los Angeles and Ventura. This was the target group for primary outreach activities and developing local area collaborative partnerships. An additional group began formation during these initial outreach efforts as an Early Warning System program (EWS) of citizen scientists recruited and developed to assist with monitoring and detection efforts in their communities.

Firewood movement and the transfer of pests and diseases had become an issue in California as well as at the national level. With the GSOB-firewood link identified, UC ANR partnered with public and private organizations to initiate the formation of the California Firewood Task Force through the California Forest Pest Council. Voluntarily self-restricting the movement of GSOB-infested wood was the immediate management strategy encouraged to public and private property owners, firewood vendors and consumers to limit the expansion of the beetle to new locations in the state. Through this group, broader firewood research and public outreach messaging and activities became possible. In fostering a collaborative environment for program development, UC ANR was able to rapidly create and extend a coordinated GSOB education and outreach program utilizing a variety of traditional and digital outreach strategies simultaneously.

Education resources

The Internet is the major communication channel for contemporary society and offers a huge opportunity for knowledge transfer. Several online trainings and program tools were established and utilized during the program development period, including web-based, social media and electronic mail functions. Simultaneously, printed resources were developed for use with more traditional outreach activities such as workshops, community meetings and public information displays.

Website

The GSOB website (www.gsob.org) (fig. 1) was created and has served as the hub of current public information and resources. The website features information on basic

GSOB identification, biology, impacts, threats, and distribution maps; news on pre and post infestation management strategies; firewood concerns; frequently asked questions and answers, training opportunities and links to downloadable print materials, webinar recordings, videos, and other resources. During the first 2 years in operation, there were more than 400,000 unique ‘hits’ on the site. Also incorporated are dedicated social media channels (Facebook, You Tube and Flickr) and a GSOB blog, all linked through the website.



Figure 5—Goldspotted oak borer website, www.gsob.org.

Providing stakeholders and the public a web-based means to stay informed, engaged with GSOB issues and encouraged to take action was an important consideration. Several different online survey tools have been developed for the site. The “Report GSOB Symptoms” survey provided the public a means to report suspected GSOB infestation that would create a follow up inspection by one of several members of the collaborative group. Other surveys developed allowed users to volunteer for the EWS citizen scientist oak monitoring and detection program, register for upcoming events, and subscribe to a group email list for current news and information on GSOB. The survey tools provide user-friendly public interaction while yielding the collaborative group valuable information for research, management, monitoring, and determining the effectiveness of communications efforts.

Outreach publications

The development and distribution of print materials have been important components for GSOB education and outreach. As new research data, clientele information and resource needs were realized, we have worked in collaboration with our GSOB education partners to develop and produce informational publications and GSOB awareness products. Key projects include program logo and branding, outreach packets, two types of GSOB identification cards, community and vendor firewood advisory flyers, the Community Preparedness Planning Guidelines brochure, an expanded GSOB pamphlet, updated versions of the GSOB tri-fold brochure, public service announcements, firewood best management practices pamphlet, tabletop outreach displays, a variety of GSOB awareness promotion items and the coordination of Spanish language adaptations. Print materials have been distributed at outreach events and via cooperators. Although more than 50,000 pieces have been

professionally printed, digital file versions of most print materials are featured on the website allowing for on-demand printing and extended distribution. We also assisted our cooperators by distributing printed materials they had developed and produced related to GSOB, oak woodland management and the danger posed by firewood.

GSOB identification kits and tabletop displays

Over 300 GSOB identification kit have been produced and distributed to agencies and individuals for use to educate agency personnel, the tree-care industry and citizen scientists about GSOB. The kits include a CD with publications, posters, a preserved GSOB adult and a piece of bark with GSOB exit holes.

Two professional-grade tabletop displays were produced for use at various venues to help communicate the GSOB threat using large pictures and posters (fig. 2). Members of the GSOB outreach group are allowed to check out a display for use at various events. Along with the displays, samples of GSOB-infested bark and tree trunk cross-sections showing GSOB larval feeding damage to the tree's cambium also drew the interest of attendees, allowing them hands-on examination.



Figure 6—Complete tabletop displays are available for outreach events.

Training and outreach

During the 2-year initial program development period, clientele understanding of GSOB and related oak woodland management was primarily facilitated through a series of training events including nine in-depth day long workshops, webinars, field trainings and numerous presentations to local community groups. All activities were cooperatively organized and delivered with agency, University, local Native American tribes and community partners. Participant evaluations were solicited from participants at the conclusion of many of these events and responses were overwhelmingly positive.

Traditional mail outreach

A mass mailing of information packets were sent to approximately 3,000 property owners in or near GSOB infested areas in San Diego County. With the cooperation from officials in Riverside County, about 5,200 property owners in the mountain

community of Idyllwild received an informational letter warning about GSOB several months prior to its discovery there in 2012. Approximately 120 firewood dealers in southern California were sent an informational letter in late 2010 warning them about the dangers of GSOB in firewood. Additionally, over 100 GSOB information and outreach resource packages were mailed to southern California offices of County Agriculture Commissioners, local county UC Cooperative Extension, Natural Resource Conservation Service, water districts, landscape and tree care professional associations, tourist visitor centers, regional preserves, county parks and Tribal associations.

Workshops

Workshops were held throughout southern California: seven during year 1 and two the 2nd year. Information was delivered to resource managers, industry professionals, landowners and other stakeholders through multi-agency presentations, hands-on displays, outreach materials, and, at some venues, short field trips. Presenters for the day-long workshops are coordinated from a cadre of specialists and scientists, who have research and work experience with goldspotted oak borer and related oak woodland issues. The presentations covered topics including: cause and extent of oak mortality; current range of infestation and at-risk areas; identification and assessment; integrated pest management; infested wood utilization and disposal; firewood management; and oak woodland restoration and resiliency. Through evaluation surveys conducted at the end of each workshop, 86 percent participating responded they were ‘very likely’ to share the information with others, potentially reaching more than 23,000 additional people. Six-month post-workshop survey respondents indicated that 98 percent had taken some action to help manage GSOB ranging from sharing the information with others, becoming an oak monitoring volunteer, organizing another GSOB event to changing their firewood movement behavior or subscribing to the GSOB listserv. Survey results also provided us a clearer understanding of topic interests and information needs, which help future GSOB outreach programming be relevant and timely.

Webinars

In addition to workshops, two live webinars were hosted with the recordings of those webinars made available on the website for on-demand viewing. One webinar presented information on the threat of GSOB and the other involved restoration after GSOB attack. Both webinar events featured multiple presenters, active links to resources, interactive question and answer segments and evaluation surveys.

Agency training and meetings

There has been a GSOB educational component at most agency meetings we have participated in where GSOB is a key agenda item. In addition to meetings, we have also conducted GSOB-specific training for a number of individual agencies or in joint sessions of several agencies. Audiences have included various local, federal, state and tribal agencies. These events have occurred from San Diego County to as far north as San Luis Obispo County. Certain interagency meetings like the Forest Area Safety Task Force and the GSOB Task Force meetings incorporate a GSOB education component as an important part of organizing for action where the participants are updated on the latest GSOB management and education and outreach

resources available.

Local community outreach

Local community outreach events provided a forum for in-person, two-way communication and learning with over 600 professionals and stakeholders. Venues included town hall meetings, homeowner association meetings, focused community events (for example Earth Day), civic clubs, advisory committees, volunteer associations, and other formal and informal community groups.

Field training

Hands-on field training has proven to be one of the most popular and effective methods for teaching agency personnel, industry professionals and private citizens how to identify GSOB attack and give them an appreciation of how devastating a GSOB infestation can be in oak woodlands. William Heise County Park in Julian, San Diego County was a good venue for holding some of these field training sessions because it had all three susceptible species of oak trees within the 398.6 ha (985 ac) oak woodland park. Unfortunately, the park has had to remove over 2,000 large diameter oaks killed by GSOB due to the safety hazard they posed to visitors. Attendees were taught to recognize signs such as GSOB exit holes, thinning crowns, bark staining and woodpecker foraging for GSOB larvae (fig. 3). They also witnessed, first-hand, the challenges the park encountered to manage the wood and slash resulting from the removal of more than 2,000 large oak trees.



Figure 7—Training at William Heise Park in San Diego for citizen scientists and agency personnel.

Youth education

We worked cooperatively with the Cuyamaca Outdoor School to develop a curriculum and a field exercise that taught students about GSOB and other invasive pests. This program has given students the opportunity to learn about and conduct field surveys of oaks looking for signs of GSOB attack and other tree health problems (fig. 4). Students collected tree information and mapped healthy and

GSOB-infested trees. Nearly 12,000 6th graders from San Diego County go through this program every year. Because Cuyamaca Outdoor School is located near the epicenter of GSOB mortality in San Diego County, messages about the danger of moving infested firewood and the impact of GSOB are visible and well instilled.



Figure 8—Sixth grade students practice identifying GSOB symptoms during camp at the Cuyamaca Outdoor School.

Conclusions

To date, there has been no evidence of long-range dispersal of GSOB after the first year of our program. Though GSOB was discovered in two adjacent counties, evidence indicates that the initial Riverside and Orange County infestations date back to 2010 or earlier. While we do not believe we have stopped the movement of all GSOB-infested wood, we are confident that we have dramatically reduced the naïve purchase of GSOB-infested firewood within the communities targeted in outreach.

The GSOB public education and outreach program utilized a combination of traditional, digital, and social communication channels. The collaboration of many diverse partners provided synergy and promoted creativity and a sense of ownership. The use of internal GSOB collaborative communications and file sharing group aided collaboration. The program has been flexible enough to grow as new research information, resources and agency and volunteer participants have joined the effort. Resources were strategically developed as a team and designed to increase outreach effectiveness, encourage adoption, promote program sustainability, and facilitate future program development. This program framework is readily adaptable for new invasive pests such as the polyphagous shot hole borer.

The GSOB website is a robust, cost-effective and sustainable means to deliver and receive GSOB information with a wide range of audiences. Online training resources such as recorded webinars and GSOB attack identification aids contribute to the viability of the program. The online reporting tools, event calendars, links and GSOB expert contact information continue to be one of the primary ways to keep stakeholders engaged and raise awareness amongst new clientele.

The program has received positive feedback about its content, format and quality from a variety of users, including private citizens, tree service professionals, agency personnel and peers working on similar invasive pest issues. Constructive comments have resulted in program modifications and content production. We have successfully

contacted all the large landowners in San Diego County and educated concerned residents in all the communities with susceptible oak woodlands. We know that we have changed the behavior of many arborists, foresters and firewood producers/consumers. The program has provided property owners, businesses, agencies, and elected officials with the latest information on GSOB identification, management and prevention measures as well as outreach resources (fig. 5). It has also brought together diverse interest groups to work for the common purpose of preventing the spread of GSOB and reducing its impact in infested areas. These education and outreach efforts should continue as long as there is a need and support for them.

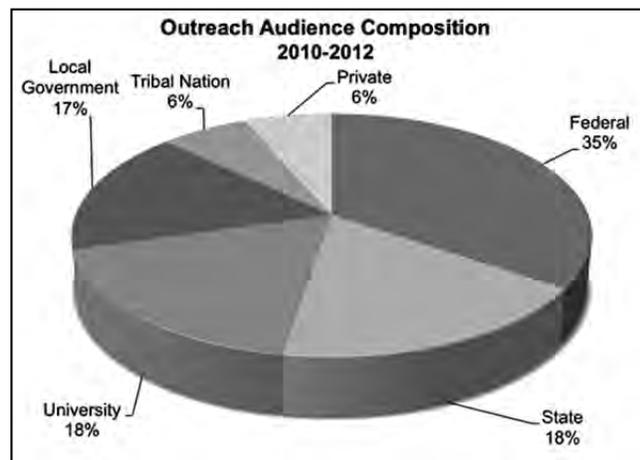


Figure 9—More than 5,100 stakeholders were contacted through a variety of outreach activities.

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