

# Evaluating Rapid Response to a Goldspotted Oak Borer Diaspora<sup>1</sup>

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## Abstract

In 2012, the goldspotted oak borer (*Agrilus auroguttatus*, GSOB) was discovered in the mountain community of Idyllwild, 56.3 km north of its known area of infestation. This was the third time that a point of outbreak was discovered >32.2 km from the GSOB infestation area, suggesting that human transport of GSOB has substantially expanded the halo of California communities at imminent risk of GSOB-associated oak mortality. Even though this pattern of dispersal puts more communities at risk, the isolated nature of these new points of infestation offer some hope that their damage could be reduced or controlled by a rapid, initial response. Idyllwild suffered a major die-off of conifers in 2003, pre-adapting the community with an organizational structure, a tree removal/disposal infrastructure, and even some funding that was needed for a GSOB rapid response. Federal, state, and local agencies turned these attributes into a GSOB rapid response plan which also included components of detection, management, and education. As of 2014, our ad hoc response group had mapped the extent of oaks in decline in the region around Idyllwild, contacted all landowners and community residents through mailings and public meetings, conducted three training workshops, and surveyed approximately 154 properties. A total of 53 infested oaks have been found at 20 locations in Idyllwild and the adjacent community of Pine Cove, with the majority removed within a month of their discovery. Cross-sections from dead oaks indicate that infestations began in 2009, and that infested oak firewood may have been delivered to multiple locations generating simultaneous outbreaks. Although detections of GSOB-infested oak increased each year, we believe this represents an increased rate of discovery rather than an increased rate of infestation.

*Key words:* community outreach, goldspotted oak borer, rapid response

## Background

The goldspotted oak borer (*Agrilus auroguttatus*, GSOB) was first detected in California in 2004 (Westcott 2005); by the time it was linked to oak mortality in 2008 (Coleman and Seybold 2008a, 2008b), it had already spread over a 150 km<sup>2</sup> (60 mi<sup>2</sup>) area of San Diego County. Its distribution has remained patchy, suggesting multiple, often disjunct, points of infestation rather than generalized spread along the margin of the infestation area (Scott and others, Mapping spread of the goldspotted oak borer (*Agrilus auroguttatus*), these proceedings). The most notable of these disjunct outbreaks occurred in 2008 in Marion Bear Park, and in 2010 in the town of Ramona, 45 km and 30 km west respectively, of the known infestation areas. The life history of GSOB is ideally suited for transport in firewood, and this human-assisted movement appears to be the most likely reason for these diasporas, and the patchy nature of its distribution in general (Flint and others 2013).

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Idyllwild is a mountain resort community of approximately 6000 properties in the San Jacinto Mountains of southern California, surrounded by the San Bernardino National Forest. The landscape of the community is a combination of mixed conifer with areas of shrub understory, dominated by Jeffrey, ponderosa and coulter pines (*Pinus jeffreyi*, *P. ponderosa*, and *P. coulteri*) in a broad valley between large granite plutons. Idyllwild and the adjacent community of Pine Cove are dominated by residential housing with some organizational camps and schools, and a commercial district of shops, restaurants, and inns. The median priced home in 2014 was \$275,000 (\$208/ft<sup>2</sup>) with about 5 percent of properties at >1 million dollars. These structures are built into a second-growth mixed-conifer forest with approximately 60 percent of the homes belonging to absentee owners for use as resort cabins.

Nearly every home and many of the businesses heat partially or completely with firewood. Campgrounds and organizational camps in and around the community all allow campers to bring in firewood for use in fire rings. Firewood is an important commodity to the community but it is not regulated in any way.

The two GSOB-susceptible species, California black oak (*Quercus kelloggii*) and canyon live oak (*Q. chrysolepis*), typically contribute from 20 to 100 percent of the forest canopy on each property, in many cases forming dominant components of yards and landscaping.

Both Idyllwild and Pine Cove are unincorporated and therefore under the jurisdiction of the County of Riverside for infrastructure, planning, codes, permits and taxation. They are within State Responsibility Area (SRA) for fire protection provided by the California Department of Forestry and Fire Protection (CAL FIRE) who share concurrent jurisdiction with Riverside County Fire Department. These two agencies collaborate on fuels and forest management projects that benefit all mountain communities, including Idyllwild which has its own fire protection district. Both communities are surrounded by San Bernardino National Forest on three sides and Mount San Jacinto State Park on the other. Having multiple local service districts, an active Fire Safe Council, the U.S. Department of Agriculture, Forest Service (USDA FS) San Jacinto Ranger District office, and a joint CAL FIRE/County Fire field office within its boundaries gives the community a fairly high level of self-governance. Other county and state agencies also have offices or staff in or near Idyllwild.

The San Jacinto Mountains form the north end of the Peninsular Ranges; although there are large areas of contiguous forests along this string of mountains, oaks in Idyllwild are separated from oak stands in San Diego County by approximately 47 km (20 miles) of relatively low elevation mountains in the rain-shadow of the Palomar Mountains. Idyllwild is approximately 60 km north of the northernmost GSOB infestation area in San Diego, with over half of this distance nearly devoid of susceptible oaks.

In 2002, massive numbers of conifers began to die in the San Jacintos as a result of a drought-induced bark beetle outbreak which greatly increased the

community's risk to a catastrophic fire. In response, all local, state and federal agencies along with the Mountain Communities Fire Safe Council (MCFSC) and Southern California Edison (SCE) joined together to form the Riverside County Mountain Area Safety Taskforce (MAST). The MAST proceeded to develop an Incident Action Plan (IAP) for reducing the threat through coordinated fuels reduction projects and community emergency preparedness. Large amounts of federal funding became available for removing dead and dying trees both inside and outside the community and a robust infrastructure for removing and disposing of dead trees was developed which included a community tub grinding site.

Prior to the 2012 GSOB discovery, Idyllwild had been part of a regional outreach effort by University of California Cooperative Extension (UCCE), CAL FIRE, and the USDA FS to prevent the importation of GSOB- infested firewood by second-home owners and visitors from San Diego. This initiated a community-based GSOB awareness program spearheaded by Marshall Smith, reporter for the Idyllwild Town Crier newspaper. A 2010 town hall meeting with County Supervisor Jeff Stone provided UC personnel a chance to brief him and interested members of the community about the GSOB threat (Smith 2010). About the same time, a GSOB presentation was given to all the members of MAST.

On the heels of the first town hall meeting, several County of Riverside departments, including the Agricultural Commissioner, County Counsel, and Code Enforcement, were tasked by County Supervisor Stone with determining options to prevent the importation of infested firewood from San Diego County. The County mailed a letter to every property owner in the community warning them about GSOB and the threat posed by importing infested firewood. Public concern became so great that some members of the community to begin scrutinizing firewood being sold from the backs of trucks in the town square and questioning the seller about the wood's origin. The Idyllwild Garden Club posted roadside signs warning residents not to purchase non-local oak firewood.

A decade before GSOB was found in Idyllwild, the emerald ash borer (*Agrilus planipennis*) prompted the development of a number of management techniques and rapid response efforts when it began killing record numbers of ash trees in the eastern United States. Research on this closely-related species provided information on pesticides and control methods that could be adapted to GSOB. The identification of GSOB in San Diego County predated its discovery in Riverside County by 4 years, during which time detection, management and education/outreach efforts were begun. Outreach included meeting with to Riverside and other counties adjoining to San Diego to encourage them to be prepared for GSOB. Fortunately, the Riverside County Supervisor representing the Idyllwild area took the warning to heart and directed the County Agricultural Commissioner's office and other county agencies to be prepared to apply these techniques in case GSOB reached the county.

## The initial detection and response to GSOB in Idyllwild

In October of 2012, CAL FIRE Forester Kathleen Edwards found GSOB in a California black oak along the major state highway through Idyllwild. This oak had died earlier that fall and was initially recognized by its failure to drop dead leaves. The find was confirmed by CAL FIRE Pest Management Specialist Kim Corella and genetically linked to the San Diego County GSOB population (T. Coleman and R. Stouthammer, personal communication). The black oak had a relatively high rate (see Haavik and others 2012, Jones and others 2013) of GSOB infestation; triggering the ad hoc development of a rapid response program for detection and management of GSOB.

Members of the ad hoc committee had developed the response to the massive conifer die-off in 2003, which facilitated the coordinated multi-agency response following the initial discovery of GSOB. The group had previously developed working relationships, which allowed them to immediately focus on actions rather than defining agency roles and responsibilities. Although there was no source of funding for outreach efforts for GSOB, many components of the previous program were still in place and could be adapted to GSOB. A key component was the linkage that had been created between management agencies and landowners, including an organizational structure (MAST) to identify and remove dead and dying trees.

With the aid of UC personnel, the Riverside County MAST immediately formulated and implemented an IAP for managing GSOB. The IAP identified objectives, outlined the organizational structure and assigned operational tasks to be performed. Operational tasks included outreach/education, survey/detection, managing infested oaks, disposal plan, and exploring additional IPM options. There were eight components of this plan:

- (1) Community outreach: extension of basic information on GSOB, its impact on oaks, and its transport in firewood to public at large in Idyllwild and Pine Cove.
- (2) Community-wide GSOB detection: established a GSOB “Hotline” for Idyllwild and Pine Cove residents to report suspicious oak deaths or declines and get answers to questions.
- (3) Training for resource managers and professionals: training local foresters, resource professionals, arborists, to recognize and report GSOB infested oaks.
- (4) Surveys and detection of GSOB damage: develop the capacity of MAST to survey the extent and severity of GSOB damage by incorporating information from trained professionals.
- (5) Landowner education and action: (a) develop the capacity of MAST agency personnel and volunteer to inform owners of GSOB infested oaks about their management options, and (b) management options to protect uninfested oaks.
- (6) Management protocols for infested oaks: develop and initiate management protocols for GSOB infested oaks including timely removal and disposal.

- (7) Funding: find resources for the removal and disposal of dead and dying oaks.
- (8) Preventing transport of GSOB infested wood: develop policies and procedures to prevent importation of additional GSOB-infested wood into the community or export of infested wood to other locations outside the community.

### **Community outreach**

The discovery of GSOB was announced in the local newspaper, providing an outlet for general information and to solicit property owners to report suspect trees. This was followed by a press release from the CAL FIRE regional office to emphasize the significance of this new discovery to the rest of the state. Prompted by the Riverside County Agricultural Commissioner's office, Supervisor Jeff Stone paid for the mailing of an informational letter to the 5,200 property owners within 2 months of the discovery. The letter was jointly drafted by UCCE, CAL FIRE and the Agricultural Commissioner's office and mailed under the signature of the County Fire Chief. The letter included a GSOB hotline number, the GSOB website URL and a reporting site for GSOB observations. This represented the first formal action taken by the ad hoc committee. Immediately following the letter, the ad hoc group hosted a town hall meeting in January 2013 to brief the public and answer their questions. The Town Crier continued to run articles to maintain resident's exposure to GSOB. Members of the ad hoc committee participated in events like Earth Day, distributed information at the local post office and other government offices in Idyllwild and gave GSOB presentations to civic groups and clubs. To educate campers about the dangers of transporting GSOB in firewood, campgrounds in and around Idyllwild were provided with GSOB "Buy It Where You Burn It" posters to display in their campgrounds. The Idyllwild Garden Club paid for and installed roadside signs warning the community about the potential dangers of oak firewood at various points in and around the community.

### **Outcomes and Observations**

The 5,200 private property owners in Idyllwild can be grouped into two target audiences: full-time residents (30 percent) and absentee owners (70 percent). Two methods of outreach were able to reach both groups: mailings and the local newspaper.

The Town Crier, with a circulation of approximately 2,800, has a percentage of out of town subscribers that roughly matches the percentage of absentee owners. This local newspaper was instrumental in getting the public's attention and boosting attendance at the town hall meeting. The official press release announcing the discovery of GSOB generated both regional and statewide news coverage. The mailing was the only sure way of contacting all of the property owners, but we were unable to document how many owners read or responded to it. Nevertheless, the public meeting was

attended by 130 persons, about twice the normal turnout for a town hall meeting. The benefit of these public outreach activities is that they contacted a fairly large audience and, in the process, solidified the general policy goals of the ad hoc committee.

Despite the concerted effort of the large number of professionals and press, certain members of the community still complained that they had not been contacted about GSOB. Anecdotal evidence contradicts this sentiment; volunteers from the fire safe council indicate that the majority of persons they have contacted have claimed to have already heard about the problem of GSOB, though some have apparently been exposed to inaccurate rumors about GSOB management in this tight knit mountain community. The issue may not be a failure to contact all the public about GSOB, but rather ensuring that all get complete and accurate information about GSOB and its management. Knowledgeable volunteers imbedded in the community have been invaluable in correcting inaccuracies that were created by fear and ignorance.

Public outreach for GSOB has triggered enlightened self-interest to change behaviors regarding firewood, but follow-up is needed to ensure that they have adequate information to make good management decisions about trees on their property.

An inherent problem in rapid response ad hoc actions is that less effort is devoted to measuring effectiveness. While it is critically important to contact the public at large, it was difficult to commit the resources to measure the impact of mass media and general mailings on public response to GSOB.

### ***Community-wide GSOB detection***

One of the first tasks of the ad hoc group was to determine the extent of the outbreak. The entire Idyllwild community was enlisted to help survey for GSOB by providing them with reporting pathways identified in outreach materials. These included the existing GSOB reporting system at the GSOB.org website and the creation of a dedicated GSOB phone “hotline” specifically for Idyllwild. Property owners were encouraged to use these pathways to report suspect trees or to request tree inspections on their property; the interaction on the hotline also provided an opportunity to answer their questions about GSOB management including the infested-tree removal assistance program. The “landowner letter” also encouraged all property owners to closely examine their oak firewood piles and report wood exhibiting possible signs of GSOB attack. Occasional GSOB articles in the Town Crier combined with some paid ads by the Fire Safe Council urged continued public vigilance and participation in GSOB and infested-firewood detection efforts.

### **Outcomes and observations**

The GSOB Hotline and GSOB.org website have generated approximately 150 reports of suspected GSOB infestations. Although this number represents only

3 percent of all the properties in Idyllwild, it may reflect the limited extent of GSOB damage, which has been found on <1 percent of the properties. The GSOB volunteers reported that their site visits typically generated requests from adjacent property owners who asked what they were doing and then also wanted their trees checked. Property owners who had their trees inspected tended to share what they learned about GSOB with their neighbors. One absentee owner from San Diego responded to the public inquiries about firewood and related that he had purchase firewood from San Diego and brought it up to Idyllwild about a year earlier; his wood pile was examined and revealed a few GSOB exit holes and galleries in a few pieces of wood still in the pile. A small group of informed activists took it upon themselves to examine wood sold by street-side firewood sellers and providing the vendors with GSOB brochures.

### ***Training for resource managers and professionals***

Idyllwild has a disproportionately large number of agency personnel, professional arborists, and passionate volunteers that were eager to be trained to recognize and report GSOB infested oaks. Soon after the initial Idyllwild discovery, UCCE staff partnered with USDA FS Forest Health Protection to conduct training for key personnel from public agencies and Southern California Edison where they taught them how to identify GSOB attack and GSOB management. In addition to the classroom training held in Idyllwild, a subsequent group field trip to San Diego County was organized to visit the heavily-infested and severely impacted areas of San Diego County.

### **Outcomes and observations**

The trainees have been responsible for detecting most of the infested trees identified in Idyllwild, many of which were observed during the person's normal course of regular duties. The field trip to San Diego significantly increased participants' competence and confidence in identifying GSOB, and let them find and identify GSOB infested oaks at a time when most of Idyllwild fieldwork yielded only negative surveys results. This reinforcement proved to be remarkably important; it not only helped their surveying skills, it rekindled their commitment to keep Idyllwild from suffering the same levels of devastation. Employees from CALTRANS, the county road department and SCE have identified infested trees within their respective rights of way and coordinated subsequent tree removal and disposal. The ultimate value of this training was that the incidental observations of the participants became the primary way of finding GSOB-infested trees.

### ***Survey and detection***

The first step in detection was to map susceptible and possibly impacted oak woodlands. UCCE staff used false-infrared bands from the 2012 NAIP imagery of Riverside County overlaid onto parcel maps to map California black oak location and canopy condition to help determine priority areas for survey. All the streets with declining canopies were surveyed by vehicle by UCCE staff within the first 2 months following the initial discovery. USDA FS Forest Health Protection checked for infested trees in the vicinity of newly discovered GSOB trees. At the same time, USDA FS San Jacinto Ranger District personnel began to survey National Forest land near the community interface. SCE arborists, CALTRANS and the Riverside County road department (TLMA) began reporting suspicious trees on their respective rights-of-way. Both state and county park staff surveyed their respective lands in and near the community.

With nearly 5,200 private properties to survey, most of which require property owner permission to make access, surveying all the oaks within the community was a daunting task. Fortunately, the MCFSC and their “Woodies” volunteer group, along with members of the Idyllwild Garden Club offered to help with the task. After receiving GSOB survey training, the volunteers were given maps showing them high-priority survey areas they had been assigned. CAL FIRE and UC personnel co-developed survey protocols and reporting procedures for the volunteers and provided expert confirmation when the volunteers identified a new infested tree. The results of all surveys are tracked in a shared GIS database. Incorporated as part of the inspection, the volunteers provide the property owners or tenants with information and outreach materials.

### **Outcomes and observations**

The map generated from the aerial imagery proved to be relatively inefficient in locating GSOB outbreak areas because it failed to identify the widely-scattered, individual infested trees. At the same time, mapping accurately identified declining oaks, but could not discriminate GSOB-infested oaks from the large number of oaks declining from drought (2012). As a result, surveys based on these maps were also relatively inefficient. Although this technique did not allow close access to check for exit holes, it further refined the set of suspect oaks and did yield approximately five GSOB-infested oaks. The majority of detections resulted from incidental observations made by professionals during the course of their normal duties. Inexperienced volunteers conducting surveys in uninfested areas tend to lose motivation very quickly and drop out of the program. Providing volunteers with frequent feedback, appreciation and direction motivates them to continue. Working within a local organizational structure (like the fire safe council) has made the volunteers feel more effective and appreciated. Coordination and

communication between professionals and volunteers greatly has improved the efficiency and effectiveness of surveys. Approximately 1/3 of all GSOB trees that have been identified and removed have been within SCE, CALTRANS or Riverside County TLMA (the county road department) rights of way; it was very important to include these groups in the survey and detection program as well as teach them about GSOB management.

### ***Landowner education***

Landowners invariably ask what management is recommended if GSOB is found on their property or in nearby neighborhood trees. In addition to providing them the UC-IPM Guide (Flint and others 2013) and directing them to the [gsob.org](http://gsob.org) website, they receive a verbal explanation about management options for infested trees as well as protecting uninfested trees from attack.

By fortuitous chance, members of the ad hoc GSOB management group came into contact with volunteers from the local fire safe council (the Woodies) shortly after the initial discovery of GSOB. The Woodies happened to be conducting chainsaw training across the highway as the first GSOB tree was being removed; they took great interest in the proceedings and offered their help. Their mission had been to help landowners mitigate tree and fire hazards across the community, however they immediately grasped the potential threat GSOB posed to the community and were captured as full participating partners in the rapid response to GSOB. This new partner gave the ad hoc committee greater credibility with the community and dramatically increased access to landowners. In the course of conducting parcel surveys of oaks, these volunteers are able provide landowners with information and educational materials on GSOB. The volunteers have been cautioned not to make specific management recommendations but rather to direct the landowner to the appropriate agency or tree care professional for more detailed information.

Landowners were provided the UC IPM Guide and directed to other literature to find out more information about the use of pesticides as preventative treatments against attack by GSOB to protect high-value oaks on their property. They were also advised that the Riverside County Agricultural Commissioner maintains a list of properly licensed pest control businesses on the [gsob.org](http://gsob.org) website. Certain pesticide operators have attended one of the GSOB workshops or participated in a 2013 pesticide operator training meeting conducted by the Riverside Agricultural Commissioner in partnership with UCCE, USDA FS and CAL FIRE. One local pesticide company conducted carbaryl applications on oaks at no charge to the property owners in 2014 with the expectation of a clientele for that service in upcoming years. Property owners are cautioned to check on claims made by pesticide operators about the efficacy of treatments that are proposed, especially in light of the need for proper timing of applications.

## **Outcomes and observations**

The parcel inspections conducted by the volunteer surveyors provided an excellent opportunity to educate the property owner about GSOB. The existence of the Woodies as an organized and recognized group within the community greatly facilitated the organization and management of a volunteer surveyor force. It was difficult to always provide landowners with definitive answers. For instance, there was strong confidence in making recommendations to remove and chip infested trees to kill larvae in those trees, but we lacked data as to its actual effectiveness in preventing or reducing GSOB infestation in surrounding trees. Similarly, until definitive field results about the efficacy of preventative pesticide applications become available, discussions with landowners about pesticide options require us to disclose the limits about our current state of knowledge. This lack of definitive information on pesticide effectiveness has likely contributed to the fact that not many landowners have opted for preventive pesticide treatments yet.

### ***Management protocols for infested oaks***

Grinding GSOB-infested woody material with a 3 inch-minus (7.6 cm or less) screen was known to be an effective treatment for preventing the emergence of adults (Jones and others 2013). The last phase of Riverside County Fire's grant-funded bark beetle tree removal program and the associated community tub grinding site were both still in operation in 2012 when GSOB was discovered. MAST working with UCCE and USDA FS experts, quickly developed protocols for the prompt removal and proper disposal of GSOB-infested oaks. Permission was granted to utilize the existing tree removal program and funds to pay for the removal and disposal of GSOB-infested trees. The community had a built-in advantage in that it had an operating grinding site. The protocols MAST developed called for rapid removal (within 2 weeks) of a GSOB tree that was identified during the GSOB flight season (April through September) and that the tree be hauled to the community grinder where it was to sit no longer than 48 hours before being ground to a 3 inch-minus standard. For infested trees found on public lands, such as state and county road rights of way, they were cut and hauled using a combination of public agency resources. For infested trees discovered on private property, the property owner had to voluntarily agree to the tree removal; in return they were not charged with any of the removal or disposal costs. For infested trees discovered near their power lines, SCE used their own resources to cut and dispose of trees following the protocols.

Removing large oak trees generated a lot of biomass in foliage, branches and trunks. Larger limbs and tree trunks from infested trees required special handling to prevent GSOB spread. Smaller-sized material from the tree was not a threat to spread GSOB, but could increase the fire hazard in this very fire-prone area; just cutting down a tree and leaving it as-is on site is generally not an option. There is an inherent cost for proper disposal. Developing biomass processing options which will facilitate utilization of the material will

help to offset the cost of removal and processing while also reducing the impact on the solid waste stream.

In a mountain community like Idyllwild, oak firewood represents the greatest value of any products that can be produced from GSOB-infested oaks. However, the costs for debarking the wood, or putting it in a containment structure for 2 years seasoning, greatly erodes its net value. The labor, handling and other costs associated with those two methods to make the wood “safe” for sale or transport are currently a significant disincentive for most in the firewood business.

Wood ground to a 7.6 cm or less standard or better can be used for fueling a biomass power plant or used in soil amendment products. The costs of processing, handling and shipping chipped oak wood from the Idyllwild grinding site still exceed revenue generated from the purchase of the chips. Therefore, the grinding operation is subsidized by tipping fees paid at the grinding site.

Finally, owners were given information about systemic and barrier spray pesticides (UC IPM 2013) as a means to prevent possible emergence of adults from GSOB-infested oaks that were not removed after discovery. This technique had proven highly effective in stopping adult emerge in experiments on saw logs (Scott and Turner, unpublished data), and the usage was covered under EPA pesticide labeling. The ad hoc committee and the Riverside County Agricultural Commissioner’s Office provided GSOB training for pesticide applicators, but the costs of these treatments were not supported by grants or other funds.

The MAST agencies in partnership with the tree care industry, with UCCE and the County Agricultural Commissioner’s seek to develop additional IPM options and prescriptions for managing GSOB in this forest community. In addition to providing individual landowners and land managers a matrix of options for GSOB prevention and control, a community-wide plan will be developed; without the cooperation of neighboring property owners, control efforts may be in vain. Mt. San Jacinto State Park has offered to host a GSOB IPM demonstration project for the purpose of educating the community.

### **Outcomes and observations**

The Idyllwild community had a distinct advantage in that it had an existing infrastructure, funding and sufficient corporate knowledge about GSOB management to allow them to rapidly develop and implement effective GSOB management protocols. The community readily accepted the new program because it had been forewarned about the threat of GSOB starting in 2010 and was also very familiar with the existing tree removal program. The Idyllwild community grinding site had to unexpectedly close during the peak of the 2014 GSOB flight season because the owner left town on a firefighting contract; fortunately, an alternative grinding site was available but was 40 miles and a 2.5 hour round trip distant.

Nevertheless, the desire to retain the firewood from GSOB infested oaks has proven to be a stumbling block for the citizen reporting program. The

default model was to allow owners to keep only the trunks and branches less than 15.2 cm (6 inches) in diameter, taking most of the firewood away. Small limbs and branches were chipped and scattered on site in most cases. A number of property owners were more concerned about losing the potential source of oak firewood than they were about the infested tree causing the spread of GSOB to their other trees or around the neighborhood. Some community members failed to report suspected oak tree on their property out of fear that they would lose the firewood. This prompted agencies to look for ways to remove infested bark while leaving the GSOB-free wood to property owners. Sawyers tried to remove bark by cutting it away as planks with chainsaws or by using a chainsaw-powered debarker. Both of techniques yielded more wood for property owners, and reduced the hauling costs and tipping fees associated with tub grinding. Unfortunately, the labor costs of debarking still exceed the cost of grinding the whole tree, even when the value of the firewood is taken into consideration. The MAST continues investigating methods of separating GSOB-infested bark from the bulk of the wood to give homeowners an option of paying for debarking infested trees at the home site so they can keep the firewood. Some debarking methods leave intact bark which must be disposed of properly in a timely manner. The details on how to ensure that will happen still have to be worked out.

Several property owners with lightly-infested (but still living trees) refused to participate in the infested tree removal program and those trees were neither cut nor removed. There was a persistent thought among some owners that their trees might recover; they could not be swayed with evidence that contradicted this view. Some owners considered the protection of their uninfested oaks more important than the preservation of an infested tree. However the emotion and inertia associated with leaving a GSOB-infested tree also overwhelmed this consideration. That said, relatively few homeowners have opted for treating their trees with pesticides.

### ***Funding***

The rapid response to GSOB in Idyllwild has been facilitated by residual funding left over from a State Fire Assistance grant awarded to Riverside County Fire Department. However, these funds have now all been expended. County Fire has subsequently applied for more dollars through the California Greenhouse Gas Reduction Fund in order to maintain the program of assisting private property owners with the disposal of their GSOB-infested oaks. CALTRANS, Riverside County TLMA, and SCE have used their own resources to remove infested trees within their rights of way. The three major land management agencies in the community, San Bernardino National Forest, Mt. San Jacinto State Park and Riverside County Parks Departments, would have to identify funds or other resources in order to remove infested trees on their respective lands if that ever occurs. CAL FIRE does have hand crew resources (conservation camps) that can perform tree felling, bucking, de-limbing, and chipping work on public lands and even private lands as a

result of the California Board of Forestry and Fire Protection's declaration of a GSOB Zone Of Infestation covering the infested area.

### **Outcomes and observations**

Without a reliable source of funding for direct control activities like removing and grinding of infested trees, it will be difficult for any community to mount a consistent, aggressive rapid response. There are also costs associated with producing and distributing outreach materials. The personnel costs of time spent on conducting surveys, education and outreach activities, control and prevention activities also need to be factored. Collaboration by all interested stakeholders was the key to past success in Idyllwild and may lead to better chances of obtaining funding.

### ***Preventing transport of GSOB infested wood***

Aggressive control actions to contain and possibly eradicate a small and isolated GSOB population could be thwarted if additional infested material is imported into the community. Therefore, efforts continue to educate the firewood sellers and their consumers about the danger of buying infested firewood. The County of Riverside does have a roadside vendor ordinance which can exert some control due to the need for a business license, but so far their efforts have had little impact on the sale of firewood from the backs of pickup trucks and stake sides. Due to the infestation, now all oak firewood originating from Idyllwild must be considered potentially infested by GSOB which poses a threat if it is moved within the community or outside to other areas. The MAST agencies are working on a strategy for this problem.

### **Outcomes and observations**

Multiple agencies and a multitude of individual citizens will be potentially affected by policies and regulations that may be developed. It will be very important to get public buy-in and acceptance in order to be effective. An aggressive campaign to prevent additional infested wood from coming to the community would be greatly aided by regulations and enforcement of an imported wood ban. Regulatory control of firewood was explored by Riverside County even prior to the discovery of GSOB in Idyllwild, but determined to be infeasible. However, now that there is a new firewood-borne threat (polyphagous shot hole borer) that poses a threat not only to oaks but other native and agricultural species, there may be movement on the regulation front. Policies, protocols and perhaps even regulations will need to be developed in order to ensure that wood leaving the area has been inspected and deemed free of GSOB.

## Evaluating the effectiveness of mounting a rapid response

The rapid response to GSOB in Idyllwild did not substantially deviate from most models of rapid response; it contained elements of preparedness, detection, and response (USDA APHIS PPQ 2015). The ultimate goal was to contain and control the GSOB infestation in Idyllwild. And like most rapid response plans, the ultimate success of these efforts may take years to achieve. However, neither residents nor agencies ever considered a no action alternative, because the initial outbreak was limited in size and severity and they had succeeded with a similar tree mortality problem in the past.

Our initial attempts to prepare the community seem to have come too late to prevent the importation of GSOB-infested firewood. Although preparedness efforts began with outreach meetings 2 years prior to the discovery of the GSOB infestation, the beetle probably arrived in Idyllwild a year prior to our efforts. Following the initial detection, we immediately contacted every property owner by mail, held workshops and public meetings to help everyone recognize the impact GSOB could have on Idyllwild.

In regards to detection, the initial detection of GSOB was not due to a systematic search but occurred as a result of an incidental observation of GSOB damage by trained agency personnel. It has proven difficult to motivate volunteers or find agency resources to survey for GSOB in communities until there is evidence that GSOB is present. Furthermore, we have found it difficult to detect a GSOB infestation until 1 or 2 years after the initial attack. After the initial detection, a more systematic detection program located 52 GSOB-infested oaks, but mostly after the trees displayed signs of decline. Systematic surveys that identified GSOB attacks (exit holes) without signs of canopy decline were rare. The exception occurred when we surveyed all of the trees adjacent to a heavily infested tree. We are reasonably certain that our detection system is locating most of the heavily infested trees, but it is difficult to use the absence of observation to prove the efficiency of our system.

The response included a direct control program, consisting of rapid removal and disposal of infested trees, which was implemented immediately after the discovery of the first infested tree. Direct control seemed reasonable and appropriate given the new, small and isolated nature of the infestation and was facilitated due to the existing infrastructure and funding. We had previously observed in San Diego County that heavily-infested trees could release large quantities of beetles. While this observation may be irrelevant in an area where trees are already under heavy GSOB attack, removing a heavily-infested tree at the onset of an outbreak may remove a substantial proportion of the adult GSOB population. In one infested California black oak discovered in Idyllwild, over 1,000 beetles emerged from a sample of 5.6 m<sup>2</sup> (60 ft<sup>2</sup>) of bark; extrapolated to the whole bark surface of the trunk and larger branches, this tree had the potential to produce nearly 8,000 adults. In turn, those adults could have produced over 100,000 eggs (Lopez 2013).

Our experience in Idyllwild suggests that given similar circumstances of a new GSOB outbreak, communities should consider mounting a comparable rapid response effort. Preparedness will be key to a timely rapid response.

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