



Forest Health Protection

Pacific Southwest Region



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To: Viejas Tribal Council
Subject: Oak mortality on the Viejas Reservation from the goldspotted oak borer (FHP Report # SC-09-06)

Background

Reports from the Viejas Fire Department have indicated that oak mortality on the Viejas Reservation has increased over the past couple of years. On April 27 and 28, 2009, Tom Coleman, Forest Health Protection Entomologist, surveyed the Viejas Reservation with the Viejas Fire Department for oak injury and tree mortality caused by the goldspotted oak borer (GSOB), *Agrilus coxalis*. This oak borer is a new pest to coast live oak, California black oak, and canyon live oak in San Diego County. GSOB is non-native to California and has been causing ongoing oak mortality across all land ownerships adjacent to Cuyamaca Rancho State Park and the Descanso Ranger District, Cleveland National Forest for the past six years. It was first identified as the cause of the on-going oak mortality in San Diego County in May of 2008. Since 2002, GSOB has killed an estimated 17,000 oaks in San Diego County. GSOB is aggressively attacking trees, and is attacking 90% of the oaks in areas on the Cleveland NF where mortality has been mapped for several years. Additional information about GSOB can be found at <http://www.fs.fed.us/r5/spf/fhp/socal/index.shtml>.



Figure 1. Coast live oak mortality from the goldspotted oak borer in Ma Tar Awa campground.

The survey confirmed that GSOB was associated with recent mortality and mortality in older snags on the Viejas Reservation (Fig. 1).

Current condition of oaks

Coast live oak was surveyed in eleven areas on the reservation where it is abundant. Engelmann oak is not injured or killed by GSOB, so was not examined during this survey. A total of 343 oaks was assessed across the 11 areas during this survey (Appendix 1). Tree diameter at breast height and a tree health rating were assessed for most of these trees. Average diameter was 30.4" at breast height. Tree health of infested oaks on the reservation is still fairly good. Signs and symptoms of GSOB infestation (crown thinning, bark staining, and D-shaped holes on the bark where adults emerge; Figs. 2 and 3) were, on average, low in severity, even on infested trees. Signs of GSOB infestation were often difficult to detect because of the low infestation levels and recent infestations.

Averaged across all sites in the survey, the level of coast live oak infested with GSOB is 52%. The highest detected level of coast live oak infestation was 72%, along Brown's Rd. No current GSOB infestation was detected in the area of King's Creek, Capitán Grande Reservation. Tree infestation was low (10%) surrounding the eating place and cemetery. Severe fire injury to oaks from the 2003 Cedar Fire in this area may be deterring colonization from GSOB.

Infestations levels were 69% south of the outlet center; 50% on the casino grounds; 10% on the production area for the casino; 52 % at the Ma Tar Awa campground; 67% for the area adjacent to the fire station, tribal hall, and school; and 37% for two areas along Viejas Creek. Thirty-two trees were encountered that have been recently killed or were previously cut due to GSOB-caused mortality.

Discussion and Recommendations

Oak mortality is currently occurring at low levels on the Viejas Reservation and trees are in healthier conditions than further east, on the Cleveland NF. This is probably due to the shorter time trees have been exposed to GSOB. The initial point of introduction for GSOB is believed to be centered near the Cuyamaca Rancho State Park and the Cleveland NF. The earliest collection record for GSOB in California occurred within the State Park and oak mortality was initially detected on each of these recreation areas in 2002. The infestation appears to be expanding outward from these areas.

Descanso and Pine Valley are currently experiencing high levels of injury and mortality from GSOB. After several years of injury and repeated attacks, oaks eventually succumb to damage from GSOB. Viejas oaks are currently on the edge of the infestation and have not experienced long periods of repeated injury from GSOB. Trees can produce callus tissue to try to regain function after larval feeding, but buildup of populations in attacked trees further increases tree stress and depletes the trees' resources, leading to tree death. Current studies are underway to assess other tree stresses that may predispose trees to GSOB attack. However, preliminary tests of tree health have not found that stresses on oaks in the region from drought or other sources have been severe enough to cause attacks. Drought stress hastens mortality for trees with current GSOB infestations.

Older oaks on Viejas are those that are primarily getting injured and killed from GSOB. Borers related to GSOB tend to prefer older, even declining trees, but GSOB can attack and kill even small diameter oaks. Management efforts should initially focus on high-value trees in areas with high infestation levels and target the older size classes first.



Figure 2. Staining represents extensive larval feeding from GSOB under the bark.



Figure 2. D-shaped exit holes on the main stem signify GSOB infestation.

Management alternatives

No research had been conducted on the biology and management of GSOB prior to 2008. Studies are underway to better understand this woodborer and potential management options. Several *Agrilus* species in the U.S. have very similar life histories and impacts on other hardwood trees. Until management guidelines can be developed specifically for GSOB, we suggest using information from these other hardwood *Agrilus* species to manage oaks for GSOB. The following management tactics and associated timing are currently being studied and have not been tested for GSOB in southern California.

Preventive treatments for high-value trees

Preventing initial infestation of oaks by GSOB may be more successful for reducing tree mortality than treating already infested trees. Systemic insecticides are effective for suppressing *Agrilus* species in hardwood hosts. Systemic insecticides can target the adults and possibly the larvae feeding under the bark. Imidacloprid is a systemic insecticide that is commonly applied by soil injections, basal drenches, or trunk injection using several methods. Soil-injections and basal drenches should be applied immediately adjacent to the root collar of trees for best results. Other *Agrilus* species have been effectively controlled by treating trees early in the spring when soil moisture is high and trees are actively up-taking water and producing a new flush of growth. After a spring rain may be the best time to treat. Systemic treatments should be re-applied every year until additional research indicates longer-term effectiveness. Soil-injections and basal drenches do not injure the tree cambium, whereas trunk-injections may cause minor wounding and eventually girdle trees after repeated treatments. Soil- and stem-injections may not provide adequate suppression in severely injured trees because the compound will not be effectively transported throughout the tree. Systemic insecticides, especially stem injections, may not be effective in fire injured trees.

Spraying high-value trees along the main stem, larger branches (>5" in diameter), and foliage with a topical non-systemic insecticide have been shown to prevent other hardwoods from being infested by other *Agrilus* species. With this method, spraying foliage is crucial because adult *Agrilus* feed and possibly mate here. Spraying with carbaryl or pyrethroids (cyfluthrin, permethrin, or bifenthrin) may provide adequate control. Spraying carbaryl has been shown to prevent infestation of bark beetles on pines for up to two years. A preventative spray of pyrethroids in the spring, with or without an additional second spray in mid-summer, is an effective strategy for controlling *Agrilus* species throughout the summer. Spraying does not inflict additional wounds to trees and the insecticide is effective immediately, but previous research has shown that efficacy of pyrethroids may not last longer than a single summer due to breakdown by UV light and such preventative insecticide sprays will not affect larvae already present under the bark. Using a combined approach with systemic insecticides and topical spraying of bark and foliage surfaces may provide the best control for GSOB. Treating trees with an insecticide does not guarantee protection. Label recommendations should be followed when using insecticides.

Cultural control

Removing dead or dying trees infested with GSOB followed by careful handling of infested wood may reduce local populations. However, movement of unseasoned firewood is a potential route through which this insect could spread into additional areas of California and expand the area of oak mortality. Moving firewood out of infested areas is strongly discouraged.

Cutting recently dead or dying oaks with heavy infestations in early spring prior to adult emergence can possibly reduce localized populations, if wood is properly treated after cutting. Borers in infested wood can be killed by the mechanical action of chipping or possibly by heating wood and bark through tarping, bark removal, and splitting wood into small pieces and exposure to sunlight. Chipping wood is the best way to ensure beetles will not survive in cut logs and larger branches. Chipping all wood will minimize the spread and reduce populations of GSOB. If infested material can not be chipped, cover wood with thick clear plastic sheeting. Covering wood with a clear plastic tarp or exposing cut wood to direct sunlight heats the wood, and may prevent emerging borers from flying to new trees. Tarping should begin as soon as a recently killed tree is cut down and continue through the end of the next summer season. Whenever logs or firewood are tarped, soil should cover the edges of the tarp to trap emerging beetles and enhance heating. To further enhance mortality of GSOB populations in cut wood, cut large pieces of wood into smaller pieces to enhance drying and then scatter in full, direct sunlight for an entire growing season, preferably in an area with a southern exposure. Turn firewood monthly to expose all edges to direct sunlight. Because borer larvae mature in the bark, removing or destroying the bark also can facilitate controlling GSOB.

Mulching, watering, soil aerations, and fertilizing oaks may increase oak health and delay tree mortality. GSOB has been observed attacking trees that already receive supplemental watering, and watering can increase the risk of root disease. If watering is used as an approach to promote oak vigor, it may be best to mimic natural precipitation by applying water only in early spring, and watering deeply, after it is known if there is a significant water deficit from the wet season, instead of watering at the height of moisture stress in summer when surface soil moisture is naturally lower and additional water could cause unseasonal growth.

Impacts if no action is taken

Oak mortality from GSOB in San Diego County is hypothesized to be occurring from a lack of natural enemies and/or a lack of evolved host resistance in California oaks. In contrast, in GSOB's native regions, oak injury or mortality has never previously been reported from this species. Tree mortality has persisted in southern California over the past six years and will most likely continue in currently infested areas. The average time period it takes for GSOB to kill a tree is not currently known. Studies currently underway will determine this time period. Without preventive measures, it is expected that trees with current infestations will die within several years, depending on tree health. Even before those trees die, additional trees will become infested, to die in future years. The high oak mortality in the communities of Descanso and Pine Valley offer a warning of the potential impact that this beetle could have on coast live oak on the Viejas Reservation if no action is taken.

Conclusion and opportunities

Additional oak mortality is expected to occur across the reservation from GSOB. It is my recommendation to focus management efforts on high-value trees that are uninfested. Insecticide treatments will work most effectively on uninfested trees, but may also be able to save trees with light infestations that are currently common across the reservation. Efforts should be made to properly manage firewood and its movement within and off the reservation to limit the spread of this new pest.

In 2009, Forest Health Protection has studies underway to determine the length of the GSOB life cycle and times of emergence to help time control efforts, the current distribution of

GSOB in southern California, current infestations levels and their impacts on forest stands, efficacy of insecticide treatments for preventing tree mortality from GSOB, assessments of GSOB emergence from treated and untreated firewood, relationship between tree health and susceptibility of oaks to GSOB injury, optimal methods of trapping adult beetles for surveying GSOB populations, comparison of GSOB in California to native populations in Arizona, and oak management and restoration methods. Trapping for GSOB by Forest Health Protection will occur on the reservation to determine the presence or absence in areas with out visible symptoms and the densities of populations.

Also, Forest Health Protection has programs that provide some funding for responding to forest health issues, including goldspotted oak borer-caused mortality. Call for proposals for funding projects in the 2009-2010 fiscal year will come out later in the summer, and will be circulated to all the groups that we serve, including the Viejas Reservation.

If there are additional questions or forest health concerns, please contact Forest Health Protection, Southern California Shared Service Area.

/s/ Tom W. Coleman

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Appendix 1. Areas surveyed on the Viejas Reservation for goldspotted oak borer injury and mortality are circled in black.

