TITLE: WC-EM-F-10-01: Monitoring oak health and decline before and after infestation by the goldspotted oak borer (GSOB), *Agrilus coxalis*

LOCATION: Cleveland National Forest

DATE: September 29, 2010

DURATION: Year 2 of 2-year project **FUNDING SOURCE:** Fire Plan

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PROJECT OBJECTIVES: We will validate a health rating system for GSOB-infested trees by linking visual observations with physiological data. To accomplish this, we will: 1) Monitor the health of uninfested and infested oaks; 2) Track the decline of oaks at varying stages of GSOB injury; and 3) Monitor GSOB attack density on uninfested and infested oaks.

JUSTIFICATION:
Linkage: The goldspotted oak borer continues to cause mortality of three native oak species across all land ownerships in southern California. Aerial surveys have estimated 21,535 dead oaks between 2002 and 2010 in a 4903 km^2 area. The oldest tree mortality is centered on the Descanso Ranger District, Cleveland National Forest (CNF), but aerial mapping and ground surveys suggest that the zone of mortality is expanding outward (Seybold and Coleman 2010)

Significance: The goldspotted oak borer is exotic to California with a known distribution that is limited to San Diego Co. (<30 to 1675 m elevation). Infestation levels are 100% on mature trees in areas that have experienced long-term tree mortality. This non-native species has a high probability of extending its distribution to northern latitudes following the range of its hosts (California black oak, *Quercus kelloggii*, coast live oak, *Q. agrifolia*, and canyon live oak, *Q. chrysolepis*).

Biological Impact: This invasive pest has the potential to impact an estimated 3.7 million acres of host habitat. Loss of these dominant oaks can alter fuel structure; reduce habitat and food sources for wildlife; affect water quality; and cause hazards to humans. The goldspotted oak borer has the potential to alter significantly and irreversibly the oak woodlands of California.

Scientific Basis/Feasibility: In 2009, four permanent plots were established on the CNF (San Diego Co.) to monitor oak health. The plots are located along a N-S transect from an uninfested site north of the zone of infestation to a newly infested site on the southern boundary of the zone. Preliminary tree health assessments were recorded for 67 coast live oaks (uninfested and infested) throughout the summer. An additional 131 coast live oaks were tagged to follow tree decline and future colonization by GSOB.

Priority Issues: This work will develop a forest management tool to evaluate and quantify the impact of a new exotic species to California. A health rating system will link poor crown conditions resulting from GSOB injury to tree physiological data and determine the time from various stages of decline to tree death. This work will also provide new information on the interaction of GSOB with disturbance events (drought), which is a priority for a risk mapping effort initiated by R5 and the Forest Health Technology Enterprise Team.

DESCRIPTION:

a. Background: In 2008, GSOB was discovered as a significant pest of several oak species in California (Coleman and Seybold 2008). Understanding the biology and management of this relatively unknown exotic insect is critical because it continues to cause dramatically high levels of injury and mortality. Drought was considered to be the sole cause of this mortality for many years, but now that the beetle is clearly the primary mortality agent. Validation of a tree health rating system will assist with decision making for management activities.

b. Methods:

Objective 1. To assess oak health, GSOB-infested and uninfested coast live oaks will be monitored in permanent plots that span the current zone of infestation (the Palomar and Descanso Ranger Districts, CNF). A key point is that some of the plots will be in areas beyond the zone of infestation to capture future impacts of GSOB on trees of various health and size classes. Other plots within the zone of infestation will capture information from coast live oaks of varying stages of decline as a result of previous GSOB injury. Decline ratings will be determined by the degree of crown die back (rating 1-5), adult exit hole density (0-3), bark staining from larval injury (0-4), and presence/absence of woodpecker foraging holes in the outer bark (Coleman and Seybold 2008). Assessments will occur four times throughout the summers of 2010 and 2011 and include measurements of water potential (pre-dawn vs. solar noon leaf cell turgor potential), water use efficiency, tree respiration, leaf and root carbon and nitrogen content, and soil moisture (Grulke et al. 2003). These measurements will help determine tree susceptibility to GSOB by evaluating the degree to which tree drought stress develops in trees of different size classes and attack levels.

Objective 2. Coast live oaks will be tagged and monitored to assess the time to mortality following initial GSOB injury. Infested and uninfested trees will be tagged on the Descanso RD, CNF in areas where tree mortality and beetle population density are high. Tagged trees will be classified according to the same health class ratings as Obj. 1. Trees will be partitioned into 4 crown classes (1-healthy, 2-minor twig die back, 3-moderate die back, and 4-severe die back) so that each health rating class will contain at least 30 replicates (trees) (N=120). Tree tagging and health ratings will begin fall 2009 and be re-assessed in 2010 and 2011.

Objective 3. Beetle success will be monitored on tagged trees from Obj. 2. Clear panel traps (35 x 56 cm) will be affixed to a subsample of these trees to measure beetle flight activity (N=10 for each health rating class from Obj. 2). The traps will be placed on tagged trees at breast height on the north- and south-facing sides and monitored during peak adult flight activity (May to September). To measure beetle success, exit holes will be counted in two predetermined areas on the lower portion of the main stem. Exit hole density will be estimated each fall following summer emergence.

c. Products: The results of this monitoring work will assist land managers by providing the appropriate timing for management actions such as the application of insecticides to trees in the early stages of GSOB infestation. Developing health class thresholds for management actions will facilitate management efforts and likely reduce the cost of management and reduce environmental impact by avoiding the use of unnecessary treatments (Obj. 1). This monitoring work will assist with future surveying and trapping for GSOB by determining whether drought-stressed trees are attacked first. This work will validate previously developed health rating systems and determine the average time that trees succumb to GSOB herbivory, and whether eventually trees in all health classes succumb to GSOB herbivory (Obj. 2). Findings from this effort will be transferred to land managers at local and regional meetings. This work will also provide the basis for a technical report, a peer-reviewed manuscript, and a USDA Forest Service Forest Insect and Disease Leaflet on GSOB.

d. Schedule of Activities:

Year Two	
Objective 1	Continue monitoring uninfested and infested trees within plots (Summer 2011)
Objective 2	Tag additional trees in Fall 2010 and Winter/Spring 2011
	Re-evaluate tagged trees Fall 2010 and Winter 2011
Objective 3	Assess beetle populations on oaks in different health classes (Spring/Summer 2011)
	Count emergence holes on living and dead trees (Fall 2010/2011)

e. Progress/Accomplishments Year 1:

Objective 1. Tree physiology measurements were made at four sites in San Diego Co. Sites span the zone of infestation on the Cleveland National Forest (Noble Canyon Trailhead, Love Valley, Campo, and Cottonwood). Visual health assessments and tree physiology measurement were measured on 70 trees. Tree physiology measurements were monitored four times during the summer of 2010. Health assessments are on-going, so preliminary data ARE not available.

Objective 2. An additional 131 coast live oaks, representing five health classes (uninfested, infested with healthy crown, infested and lightly injured, infested and moderately injured, and infested and severely injured), were tagged on the Descanso RD, CNF during the dormant months (September to February) of 2009 and 2010. There was an increasing trend between mean crown rating and the number of exit holes on the main stem (Fig. 1A). There was a similar trend between the mean crown rating and the number of stained areas on the main stem (Fig. 1B). The number of trees in each crown class were: uninfested (23); healthy (14); lightly infested (22); moderately infested (42); and severely infested (30). Tree health will be assessed following GSOB activity in 2010 and 2011. An additional 10 trees in each health class will be tagged prior to GSOB emergence in 2011. Tree health assessments will be re-evaluated in the fall (2010) following GSOB activity.

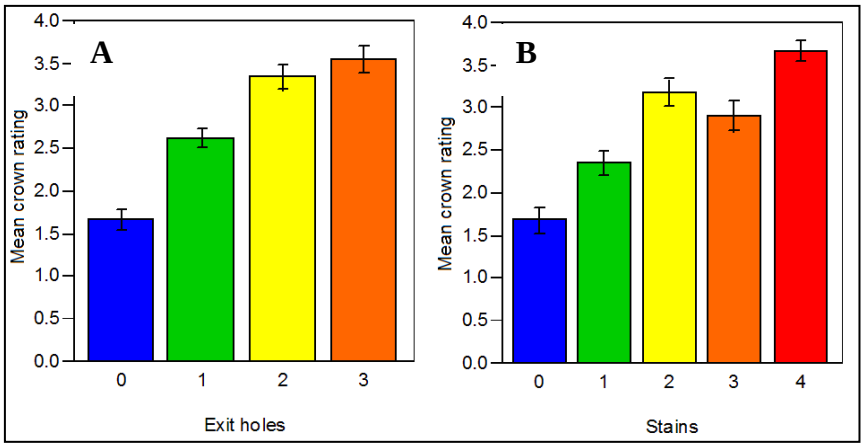

Figure 1. Mean crown ratings for the four exit hole ratings (A) and five bark stain ratings (B). A crown rating of one is considered healthy, whereas a crown rating of four is considered severely injured.

Objective 3. GSPB flight activity and success (landing rates) were monitored on tagged trees from Obj. 2 with sticky coated panel traps. Forty coast live oaks were affixed with panel traps on the northern and southern aspects. Traps were placed on trees during May and monitored until September 2010. Trap catch was measured for trees infested and uninfested trees (Fig. 2). Landing rate was about 10-times higher on infested trees. Landing rate was also higher on trees in the highest infestation crown classes (Fig. 3).

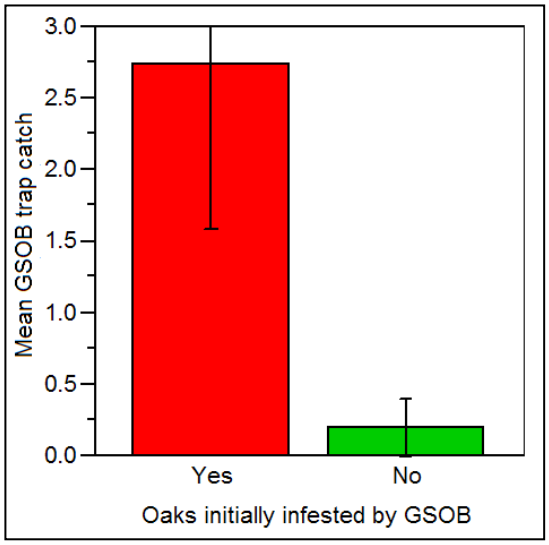

Figure 2. Adult GSOB trap catch from panel traps on initially infested and uninfested trees from 2010.

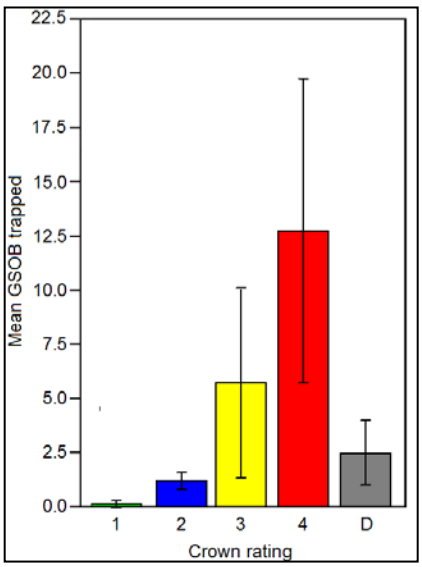

Figure 3. Adult GSOB trapped across the four crown health ratings (1-healthy; 2-lightly injured; 3-moderately injured; 4-severely injured, and D-dead).

COSTS:

	Item	Requested Funding
FY10		
Administration	2 Biological technicians (6 mo.)	18,000
	Travel-Mileage/per diem	6,000
Procurements	Supplies (traps, physiological supplies*)	12,000
	Overhead (PSW, 8%)	2,880
FY10 Total		**38,880**
FY11		
Administration	2 Biological technicians (6 mo.)	18,000
	Travel-Mileage/per diem	6,000
Procurements	Supplies (traps, physiological supplies*)	8,000
	Overhead (PSW, 8%)	2,560
FY11 Total		**34,560**
Project Total		**73,440**

***Funds were used to purchase compressed nitrogen for running the pressure bomb, liquid nitrogen for stabilizing leaves and other tree tissues, maintenance of LI-COR's for measuring photosynthetic rate, and to purchase lab supplies necessary for measuring leaf nutrients and soil moisture.**

REFERENCES

Coleman, T.W. and Seybold, S.J. 2008. Previously unrecorded damage to oak, *Quercus* spp., in southern California by the goldspotted oak borer, *Agrilus coxalis* Waterhouse (Coleoptera: Buprestidae). *Pan-Pac. Entomol.* 84: 288–300.

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