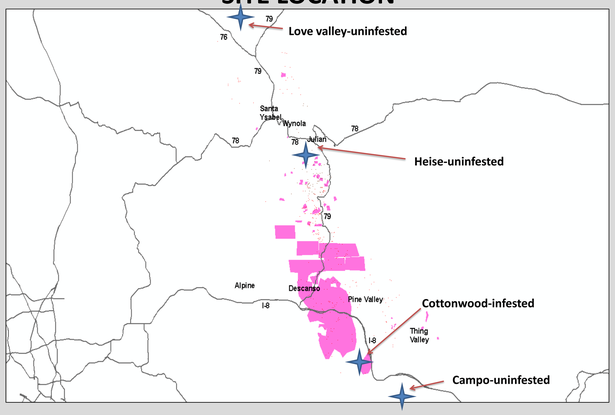
# WC-EM-F-10-01: Monitoring oak health and decline before and after infestation by the goldspotted oak borer (GSOB): Baseline data

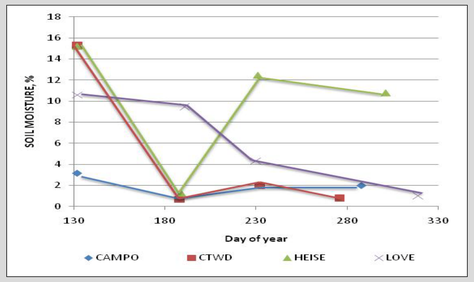
Nancy Grulke[1], Tom Coleman[2], Miles Daly[1], Cesar Godinez[1], Steven Seybold[3]
[1]PSW Research-Riverside; [2]FHP, Southern California; [3]PSW Research-Davis;

## SITE LOCATION



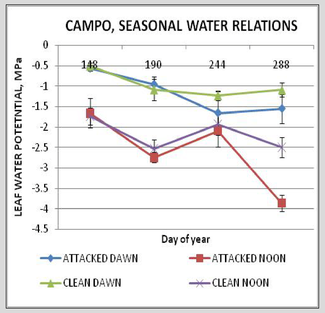

Above: Location of field sites in San Diego County that encompass two infested and two infested sites. Pink shapes and dots indicate areas of high GSOB attack and mortality.

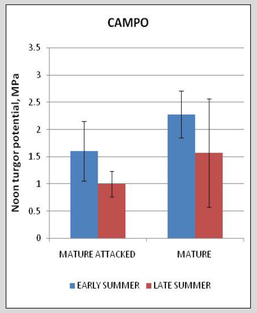
## SEASONAL SOIL MOISTURE




Above: Seasonal soil moisture in the upper 50 cm of soil at the four sites. Although oaks are very deep-rooted, low soil moisture in shallow soil horizons reduce fine root mass, and likely signal to the canopy, increasing water use efficiency (WUE), the ratio between leaf carbon uptake and transpirational water losses.

## ATTRIBUTES OF NEWLY COLONIZED TREES




Above: There were two trees that were newly colonized by GSOB at Campo, a previously uninfested site. Differences in seasonal pre-dawn and noon leaf water potentials (left) and noon leaf cell turgor potential (right) are presented for clean and colonized trees. Only late summer noon leaf water potential differs significantly. However, despite the low leaf water potential in late summer, leaves of attacked trees had lower leaf cell turgor than unattacked trees (right), but still retained turgor. It is unlikely that these attacked trees will die before next spring.

Graphs to the right: examples of differences in water use efficiency (WUE) between early and late summer for trees of differing age classes (A), and for mature trees with differing levels of GSOB colonization(B). In graphs A and B, the y-axes represent the difference between afternoon and morning leaf WUE. WUE is the ratio between photosynthetic carbon gain and transpirational water loss. These graphs demonstrate a shift in the strategy to try to maintain favorable plant water status A) across tree age classes; and 1) among light-, moderate- and heavily-colonized oaks.

At Cottonwood, clean and light-attack mature trees had higher WUE in the morning, a pattern that was maintained through late summer (B).

### Overview:

A beetle new to California, the goldspotted oak borer (GSOB, *Agrilus coxalis*), was identified as the agent responsible for oak mortality in San Diego County. Colonization levels and associated tree health categories have been inventoried, and the expansion and ecology of the beetle is currently being tracked. This study was initiated to test whether (1) coast live oak trees (*Quercus agrifolia*) that were colonized by GSOB were more drought-stressed than those that were not colonized, and (2) after an outbreak, were trees within the infested population more likely to be colonized if trees were more drought stressed. Four sites were evaluated: two sites outside of the infestation zone (north: Love Valley; and south: Campo); and two sites within the infestation zone (north: Heise State Park; south: Cottonwood) (see figure to left). In sites where oaks were not colonized, young, mature and old trees were physiologically assessed. Within areas of infestation, beetle-free ('clean'), and light-, moderate-, and heavily-colonized mature trees were assessed. From May until November, 2009, the 4 sites were visited every 4-6 weeks and the following physiological attributes were measured: leaf pre-dawn and solar noon water potential, solar noon leaf cell turgor, and morning and afternoon leaf water use efficiency (WUE: the ratio between carbon gained and water loss during photosynthesis and transpiration). By the end of the 2009 growing season, two trees at Campo, previously free of GSOB had been attacked, and one tree at Cottonwood died.

### Objectives:

We will validate a health rating system for GSOB-infested trees by linking visual observations with physiological data. 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.

### Key results to date:

**Objective 1:**

•The four sites had different seasonal trends in soil moisture content (upper 50 cm of soil), which suggests different underlying hydrologic regimes and different total available soil water. Mature trees at each site also had different times at which severe drought stress developed, and when and whether there was late summer (early fall) recovery.

•There was high variability within an age class, and within an attack class, confounding interpretation of data. Populations near the limits of their distribution, and exposed to high environmental stress, often exhibit high variability within a trait. High variability in traits can indicate that individuals within group are more susceptible to stressors. Old trees had the greatest within-growing season shift in strategy to try to maintain favorable plant water status, and had the lowest leaf cell turgor, indicating that that age class is likely the most vulnerable. Ground surveys indicate that initial attacks from GSOB within a forest stand prefer older trees.

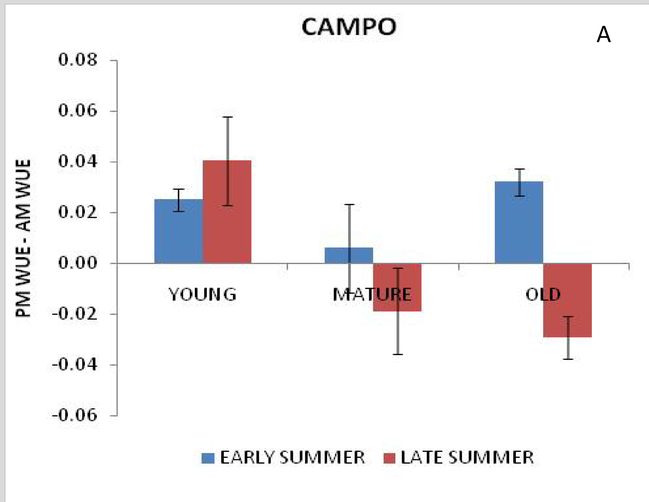
•There were changes in WUE strategy to maintain favorable plant water status through the growing season, and there were differences in late growing season cell turgor from light to heavily-colonized trees. The physiological measures of heavily attacked trees basically documented processes as the trees die. However, these physiological attributes can be used to determine whether a tree is, in fact, dying. For example, trees that were newly attacked at Campo in 2009 had lower noon leaf water potential and lower leaf cell turgor relative to unattacked trees in the same age class. In late summer, heavily attacked trees at Cottonwood had the greatest difference between morning and afternoon WUE, and the lowest leaf cell turgor at noon.

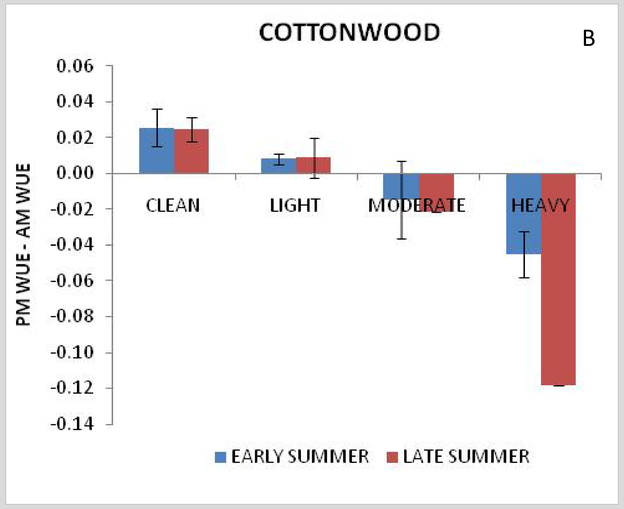
**Objective 2:**

•A hundred sixty trees were tagged in fall 2009 and winter 2010, representing the four stages of crown thinning and die back from GSOB injury. Tree health assessments were conducted on all trees. Additional trees will be tagged and monitored in spring 2010.

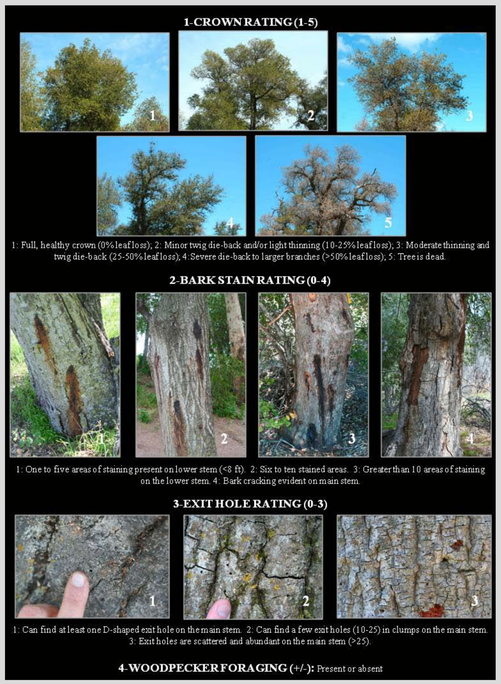
**Objective 3:**

•During peak flight activity this year (May-September), attack density will be monitored on tagged trees spanning across all health classes.



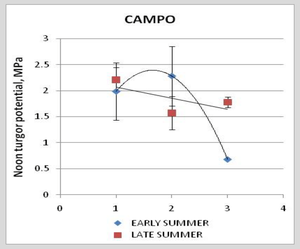
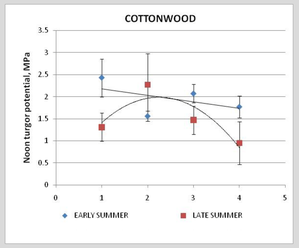



An adult *Agrilus coxalis with gold colored spots on forewings and body.*
Stacy Blomquist, USDA SRS




Above: Coast live oak continues to be severely impacted by GSOB. Developing health class thresholds for management actions will facilitate management efforts and likely reduce the cost of management by avoiding the use of unnecessary treatments.

A tree health rating scale was developed to determine the average time trees succumb to GSOB herbivory, and whether all trees succumb to GSOB herbivory . The health rating incorporates measures of crown thinning and die back, bark staining from larval injury, density of adult exit holes, and presence/absence of woodpecker foraging.

Right, above: Old trees are the first to be colonized by GSOB, and they had the lowest cell turgor, indicating the greatest level of tree drought stress developed by late summer.

Right, below: Once colonized, noon leaf water potential (data not presented) did not differ among clean, moderate-, and heavily-colonized oaks at Cottonwood. Heavily colonized oaks had the lowest turgor of the three groups.