Forest Health Protection

Pacific Southwest Region

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To: Forest Supervisor, Angeles National Forest
Subject: Bark beetle activity in Crystal Lake Campground (FHP Report # SC-08-01)

At the request of Karen Fortus and Esmeralda Bracamonte, Resource Officers, San Gabriel River Ranger District, Angeles National Forest, I assessed the Crystal Lake Campground on June 2 and 8, 2008 for causes of recent tree mortality. I focused on pine species in and directly adjacent to the campground which had recently died or were showing signs of decline. Since the last bark beetle preventive spraying in the spring of 2004, new tree mortality is evident within the campground. The western pine beetle (*Dendroctonus brevicomis*) is the primary tree killer of ponderosa pine (*Pinus ponderosa*) and several ponderosa pines in the campground have new, successful attacks by this beetle species.

Background

Southern California experienced widespread tree mortality from drought and bark beetles during 2003-2004. In 2004, dominate and co-dominate high-value pines greater than five inches diameter at breast height in the Crystal Lake Campground were sprayed with carbaryl to prevent bark beetle attacks. The preventive spraying was successful and provided protection against attacks for two years post-treatment. Bark beetle-caused tree mortality is now occurring in campground trees again and additional management strategies should be considered.

Figure 1. Crystal Lake is the only natural lake in the San Gabriel Mountains.

Crystal Lake campground is located approximately at 5,800 ft (Figure 1; N 34.31489°, W 117.83685°). The campground has a diverse species composition primarily comprised of ponderosa pine, canyon live oak (*Quercus chrysolepis*), Bigcone Douglas-fir (*Pseudotsuga macrocarpa*), Jeffrey pine (*P. jeffreyi*), incense cedar (*Libocedrus decurrens*), sugar pine (*P. lambertiana*), and white fir (*Abies concolor*). Knobcone pine (*P. attenuata*), Coulter pine (*P. coulteri*), sweetgum (*Liquidambar styraciflua*), and maple sp. (*Acer* sp.) are also present in the campground at very low densities. The campground is currently closed, but the District is striving to re-open the area by 2009. The long-term average

annual precipitation in Camp Crystal Lake is 35.13 in. per year. Current precipitation in the area is 70% of the long-term annual average.

Observations

I surveyed the entire campground for dead/dying trees and forest health problems. I closely examined approximately 100 trees, mostly ponderosa pine, which were recently killed (within the past 1-2 years), top-killed or had fading foliage (Appendix A). The DBH of assessed trees ranged between 9-42". I found a total of 43 trees in the campground that had died within the last few years a result of successful attacks by western pine beetle, Jeffrey pine beetle (*D. jeffreyi*), pine engraver beetles (*Ips* spp.) and/or the California flathead borer (*Melanophila californica*). Time of tree death was determined by the presence of gray-brown sap rot (*Cryptoporus volvatus*) and dead needle retention. The bark was examined for beetle exit holes; small holes for bark beetles or D-shaped holes for flatheaded woodborers. The bark was chipped away to reveal the crisscrossing, frass packed, sinuous parent galleries of the western pine beetle, or the irregular galleries of wood borer larvae that were packed tightly with frass.

Sixteen trees, including ponderosa pine and white fir had top-kill or fading crowns (Figure 2). Evidence of western pine beetle and pine engraver beetles were found in these ponderosa pines. Bark flaking, woodpecker feeding, and Y-shaped galleries were used to diagnose pine engraver presence. White fir with top-kill had true mistletoe *(Phoradendron bolleanum* subsp. *pauciflorum*), which may have solely killed the tops. Fir engraver may have also attacked and killed the tops of trees, but definite evidence of fir engraver beetles was not detected.

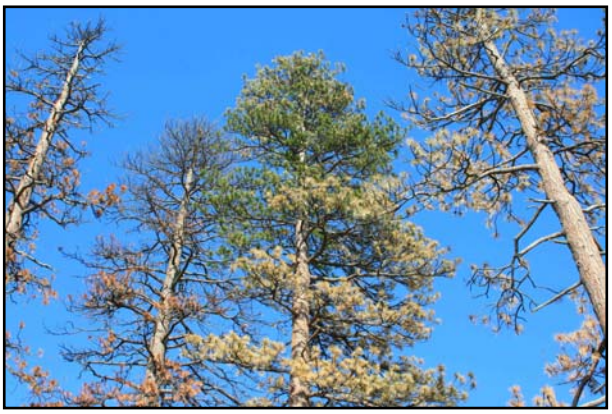

Figure 2. Fading ponderosa pine crowns in Crystal Lake Campground.

Figure 3. Western pine beetle adults and eggs were found under the bark of ponderosa pine.

Fourteen ponderosa pines were found with recent attacks (2008) by western pine beetle in the campground. A couple of trees had unsuccessful attacks. Most of the recent attacks were on trees with previous western pine beetle activity at greater heights along the bole. Red pitch tubes were found on the lower and mid-portion of the bole. Bark was removed to confirm successful attacks and assess the current life stage of new brood; only eggs were present (Figure 3).

Attacks by red turpentine beetle (*D. valens*) were found attacking four ponderosa pines; two of which had also been attacked by western pine beetles. Large, red pitch tubes at the base of the

trees are indicative of attacks by the red turpentine beetle. Two pines were found with only red turpentine beetle activity. Red turpentine beetle attacks do not always cause tree mortality.

Dwarf mistletoe (*Arceuthobium campylopodum*) was abundant on numerous ponderosa pines in the campground. Bark beetle activity was found in several trees infected with dwarf mistletoe. True mistletoe (*Phoradendron sp.*) was also ubiquitous on canyon live oak. No significant disease threats, annosus root rot (*Heterobasision annosum*) or black stain root disease (*Leptographium wageneri*), were found.

Many trees within the campground are stressed due to dwarf mistletoe, site conditions and drought and thus are highly susceptible to bark beetle attack. Many trees with current western bark beetle activity possess crowns classified as fair to poor for crown-vigor ratings (Figure 4), whereas other trees in the area without bark beetles or mistletoe have full, vigorous crowns (Figure 5). These trees should be monitored for rate and casual agents mortality.

Figure 4. Poor (left fading foliage) and fair (right) crown-vigor ratings on these two ponderosa pine. Each tree has western pine beetles.

Figure 5. These ponderosa pines possess full, vigorous crowns.

In order to monitor these trees, I established fixed-radius plots ($^{1}/_{10}$ acre) surrounding trees with current bark beetle attacks to assess total tree density (acre) and basal area (ft^2/ac). Pine (ponderosa, Jeffrey, Coulter, sugar and knobcone) basal area and density was also assessed. The

average total basal area around current western pine beetle-infested trees was 170 ft^2/ac and average trees per acre were 132. Average ponderosa pine basal area in assessed plots was 104 ft^2/ac; there were an average of 40 ponderosa pines per acre.

Discussion and Recommendations

The bark beetle preventive spraying conducted four years ago is no longer protecting pines in the campground. Another two years of protection now calls for another spray treatment. Western pine beetle has killed more than 40 ponderosa pines in the campground over the past four years. Current western pine beetle attacks are found primarily in stressed and unhealthy pines. Recent attacks are primarily along the lower portion of the bole which was strip attacked previously by the same species or by pine engraver beetles. Western pine beetles were found in healthier ponderosa pines; the health being rated based on lack of dwarf mistletoe and dense, full crowns. Healthy trees become vulnerable when western pine beetle builds-up populations in stressed pines and then attacks and causes extensive mortality of healthier ponderosa pine.

Pine engravers commonly attack stressed or injured trees. Ponderosa pine was the only pine species seen with pine engraver attacks. Pine engraver beetles can reach high populations and kill healthy pines; however, attacks usually subside in a year or two. Two Jeffrey pines were found that had previously been killed by Jeffrey pine beetle. The majority of Jeffrey pine is located on the western side of the campground; no recent attacks were seen on these trees. California flathead borer does not build-up into high population densities and aggressive attack trees like bark beetles. It commonly kills stressed pines in one to several years.

Figure 6. A landscape shot of Crystal Lake Campground depicting common tree densities and species composition, and current tree mortality.

Many factors are predisposing pines to attack from bark beetles in the campground. Current ponderosa pine density and basal area in the campground represents a moderate level of

susceptibility (104 ft^2/ac) to bark beetle attacks. A low level of susceptibility to bark beetles is commonly < 80 ft^2/ac basal area. Total tree density (132 TPA) and basal area (104 ft^2/ac) is high for this site. Canyon live oak, which can reach high densities in the understory, may enhance competition for pines. Drought conditions occurring in the region can stress pines and reduce host defenses, thus increasing susceptibility to bark beetles. Dwarf mistletoe also weakens trees, predisposing them to bark beetle attack. Dwarf mistletoe and bark beetles are a common pest complex that can lead to tree mortality. Top-kill caused by pine engravers can lead to declining tree health and subsequent attack from other bark beetle species.

Management Alternatives

Preventive Sprays

To prevent additional bark beetle-caused ponderosa pine mortality in the campground, I recommend spraying the boles of uninfested trees with the insecticide carbaryl. Spraying must reach high on the bole (~30 ft) and be applied to the point of run off to prevent western pine beetle attacks. Spraying even higher on the bole will also prevent pine engraver attacks. Spraying only ponderosa pine can prevent western pine beetle-caused mortality because it does not attack Jeffrey, knobcone and sugar pines. Spraying should focus on ponderosa pines > 6" DBH. High value trees, as determined by District personnel, should be sprayed first. Pines must be sprayed before beetle attack occurs. Due to multiple western pine beetle generations in a year, spraying as soon as possible is the best management practice. Other tree species (fir and cedar) do not require spraying because they are not western pine beetle host species. Spraying sugar and Jeffrey pine is also not an immediate priority because mountain pine beetle and Jeffrey pine beetle are not actively killing trees in the campground. These two pine species are also in fewer densities than ponderosa pine. There are approximately 675 ponderosa pines that are suitable size for western pine beetle attack and are accessible by spray equipment. These trees should be assessed to determine which ones warrant spraying. Spraying insecticides is a short-term solution which can provide adequate control for two years.

Direct Control

There is no general agreement regarding the effectiveness of direct control of western pine beetle. Removing trees currently infested with WPB has been shown to have no effect on reducing the future number of attacked trees, and is therefore, not a treatment that is generally supported by SoCal FHP. There may be limited application to campgrounds. The reason is that removing trees promptly when they have been successfully attacked reduces the pheromone (chemicals beetles use to communicate) source associated with attacked trees. To implement this alternative a complete survey of every ponderosa pine tree in the campground would be necessary to determine which trees have current WPB activity and the five year plan for the campground adjusted to include management guidelines for the current attacks. These trees would require removal, or some other type of method to destroy the beetles, prior to beetle emergence. Yearly treatment and surveillance would be required as long as beetle activity was a significant threat. Trees will remain susceptible to western pine beetle until conditions are altered by long-term management. Several options for direct control are available and further

information is available if the District chooses to implement this alternative. All cut pines must be treated with Sporax to prevent infection by the pathogen that causes annosus root disease.

Salvage

Implementation of this alternative would result in the removal of all dead trees in the campgrounds and surrounding perimeter areas. Value from fuelwood sales may be realized and the immediate threat of hazard trees is reduced. The underlying causes of stand/tree susceptibility are not altered to prevent or reduce mortality. Western pine beetle would continue to cause mortality in the older, large diameter classes. Because of the "group kill" characteristic in these stands there may be openings larger than desired after salvage removal. Some type of revegetation in these areas may be desirable.

Thinning

Thinning is the only long-term management option available to reduce or prevent bark beetle-caused tree mortality. When tree density is not managed, high levels of tree mortality will occur, particularly during severe or protracted droughts. Reducing overall basal area in the campground will increase growth and vigor of the residual trees and lower susceptibility to successful bark beetle attacks. A mixed species composition of drought-tolerant trees with diversity in age classes should be retained. In addition, selecting against ponderosa pines with extensive dwarf mistletoe, poor needle retention and/or low live crown ratios will reduce the number of focal trees for western pine beetles. Thinning a site to 50% of the basal area needed for full site utilization can provide adequate prevention against bark beetles and lower the likelihood of tree mortality for about 20 years. Thinning will also reduce fuels thereby reducing the threats to life and property during high fire danger years. Regardless of tree density, moderate to high levels of tree mortality may occur during extreme and/or protracted drought periods. A thinned stand will be less susceptible over the long term. Radial thinning around the large, old, ponderosa pines and pruning dwarf mistletoe will improve tree health. All cut pines must be treated with Sporax.

Figure 5. Dwarf mistletoe infecting ponderosa pine.

No Treatment

Western pine beetles are currently killing a few, stressed ponderosa pine trees in the campground. If no preventive spraying and thinning are implemented, extensive mortality of ponderosa pine from western pine beetle may occur. Western pine beetle may continue to kill weakened pines and then move to healthier trees once populations are high enough to overcome host defenses. Pine engravers may continue to cause top-kill and mortality in ponderosa pines and facilitate western pine beetle attacks. The additional mortality will increase the need to remove hazardous, dead trees and increase the standing and down fuels if they are not removed.

Larger, older trees may be targeted by the western pine beetles; these trees may be the same ones land managers desire to maintain in the campground. If trees are killed in groups, as is common with western pine beetle, openings of various sizes will result. These openings may require planting. The result of this alternative will be continued mortality at current or increasing levels, unplanned openings and the continued risk associated with hazard trees.

Conclusion

A management approach of preventive spraying of ponderosa pines for short-term protection combined with thinning for long-term prevention will be the best option that enables land manager to meet their goals and objectives for the Crystal Lake Campground. Removal or abatement of the dead and other hazardous trees will also be necessary prior to opening the campground. If preventive spraying is conducted soon, a large number of older, dominant ponderosa pines will be protected from bark beetle attack. SoCal Forest Health Protection (So Cal FHP) can consult with the forest and may provide funding on a competitive basis for preventive spraying and thinning. It is strongly recommended that a vegetation management plan be developed for this campground. SoCal FHP personnel can assist with the development of the vegetation management plan and the project proposal for spraying and thinning. If you have any questions or request further assistance, please contact Tom Coleman at 909.382.2871 or twcoleman@fs.fed.us.

/s/ Tom Coleman

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Appendix A. –Map of Prominent Insect Activity in Crystal Lake Campground

1) Sugar pine with California flathead borers
2) Ponderosa pine with California flathead borers
3) Ponderosa pine previously killed by western pine beetles (WPB)
4) White fir top-killed by true mistletoe; possible fir engraver activity
5) Jeffrey pine with pine engravers (*Ips* sp.) and dwarf mistletoe
6) Bigcone Douglas-fir potentially killed by flatheaded fir borers (*Melanophila drummondi*) and other stressors
7) Jeffrey and two ponderosa pine previously killed by Jeffrey pine beetles (JPB) and WPB, respectively; one pine killed possibly by California flathead borers
8) Ponderosa pine with fresh WPB attacks (N 34.32365°, W 117.83758°)
9) Ponderosa pine with old and new red turpentine beetle attacks
10) Two ponderosa pine previously killed by WPB
11) Ponderosa pine with successful WPB attacks (N 34.32282°, W 117.83272°)
12) Twelve ponderosa pine with old and new WPB galleries; three trees with fresh attacks; four were blown down; top-kill from *Ips* sp. is also occurring in the area (N 34.32487°, W 117.83124°)
13) Five ponderosa pine dead or fading; two active WPB; one with *Ips* sp. or WPB higher in the tree; three old kills from WPB (N 34.32485°, W 117.83032°)
14) Eight ponderosa pine killed by WPB; two trees with fresh attacks (N 34.32680°, W 117.83100°)
15) Two ponderosa pine killed by WPB
16) Twelve older dead trees with attacks from WPB, JPB, *Ips* sp., and California flathead borer (N 34.32805; W 117.83314)
17) Top blown out of ponderosa pine; active WPB (N 34.32420; W 117.83275)
18) Older dead pine; previously killed by WPB
19) Current attacks by WPB; two previously killed by WPB (N 34.32420 °, W 117.83275°)
20) Old WPB kill
21) Ips *sp*. attacking Coulter pine
22) Ponderosa pine possibly top-killed by woodpeckers for use as a granary tree
23) White fir top-killed by true mistletoe, possible fir engraver activity
24) Four dead ponderosa pine; two trees with *Ips* sp.; one tree has active WPB; one unsuccessfully attacked tree (N 34.32509°, W 117.82907°)
25) Fresh attacks from WPB on two ponderosa pines; red turpentine attacks on one tree (N 34.32591°, W 117.82930°)
26) Fresh attacks by WPB (N 34.32698°, W 117.82884°)
27) Four trees with fading foliage; *Ips* sp. and dwarf mistletoe
28) Two older dead ponderosa pines; previously killed by western pine beetles

Appendix A (cont.)