

# Guidance on Drought Related Tree Mortality and Pest Activity

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As drought conditions persist, there will be an increase in forest pest activity and drought related stresses in the Sierra Nevada foothill and mountain forests. The following guidance will cover the most common issues land owners are likely to experience and help answer questions they might have. For further guidance contact:

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**Background:** Pests and disease are endemic to forest habitats and play a role in succession and development as they do in any natural system. Forest pest epidemics of recent years such as large scale tree mortality events in the Rocky Mountains and Transverse ranges of southern California are attributed to a number of factors. Fire suppression and the resulting accumulation of biomass in these habitats combined with drought cycles are often the primary drivers of mortality events. Unfortunately, there is little that can be done to prevent mortality events once trees begin to die. This is why we place such a high premium on forest management – the only way to limit the extent of pest activity is through preventative measures which create healthy densities and structures of forest vegetation.

The group of insects which cause the most damage in these events are generally labeled “bark beetles” (family Curculionidae). They include *Ips* sp., *Dendroctonus* sp., *Scolytus* sp., and others. Effects of each species are variable but all infestations have the potential to expand rapidly as drought persistence increases and weaken trees over successive years. The only way to control base level activity of these pests in lieu of natural fire intervals is through stocking regulation; pre-commercial thinning, competing vegetation control, and commercial harvesting. Once mortality begins in unmanaged stands it will run its course until residual vegetation utilizes the resources available from dead trees to successfully defend attacks.

In overstocked forests mature, over mature, and damaged trees are often disproportionately affected. They are more susceptible to bark beetle attacks because they are more sensitive to fluctuations in water availability. As trees become over mature more vigorously growing trees around them outcompete them for water and increase stress levels which attract beetles. Often the effect of the mortality events is the addition of even more fuel to already overgrown forests.

Starting from the lower elevations and moving up the west slope:

### **Oak and foothill pine habitats:**

Drought stress has been apparent in the blue oak/ foothill pine habitat for the past two seasons. Grey pine (*Pinus sabiniana*) in particular has been and continues to experience high rates of drought related mortality. Forest entomologists from both state and private agencies have not been able to identify one single pest that is causing the mortality. It is believed a combination of different bark beetles and defoliating insects are contributing to mortality. Habitats in this elevation band which are not managed for grazing and have higher tree and shrub densities tend to exhibit higher mortality rates. Grey pine is utilized for low value wood products such as fuel chips and wood shavings. It has little value as saw logs except in times of very strong markets. Post mortality management options are limited. If the tree poses fire or safety hazards it will most likely need to be removed/ fallen. Otherwise treatment is at the discretion of the land owners management goals.

Drought response in Blue oak (*Quercus douglasii*) may be an early senescence. Leaves will yellow or yellow/brown and drop as early as August in years of extreme drought. This was observed in some areas last summer and will most likely appear again this summer. Stands with high mistletoe infestation may have a higher tendency to exhibit this response, which can be sudden. If trees or stands of trees were otherwise healthy prior to leaf drop and no change in conditions (grading, root disturbance) occurred, removal should be avoided until the following season to ensure mortality was the cause of leaf drop. The defoliation response has little effect on growth and survival of blue oak and has evolved as a survival adaptation to drought cycles. Careful inspection of twigs and buds can confirm the tree is still alive.

### **Montane Hardwood Conifer Type:**

This habitat type has higher diversity of broad leaved trees and up to 35% of the stocking is in conifer species such as ponderosa pine, douglas fir, and incense cedar. This is the lower range of conifer species and drought related mortality will be most noticeable in this strata. The pests which affect the conifers in this habitat type will be the same as in the pine and mixed conifer belt. Pest characteristics will be described below.

Post mortality management will often rely on the volume of trees killed, accessibility, and of course the forest products market. Pine, fir, and cedar all have commercial value and if conditions support removal, salvage harvesting is often the best scenario to reduce long term fuels accumulation. As regulated by the CA Forest Practice Rules, harvesting can be done under an "exemption", described in section 1038 of the rules. This allows for more economical permit costs in the document preparation. All harvesting must be planned and documented by a Registered Professional Forester (RPF).

If mortality is primarily in pre-commercial size classes the impact on fuel loading and safety should be assessed to determine management actions. Again, volume of dead material and accessibility will determine feasible management alternatives.

## **Yellow Pine/ Mixed Conifer Type:**

This habitat type is comprised of ponderosa pine, sugar pine, Jeffrey pine, douglas fir, white fir, incense cedar, black oak, live oak, pacific madrone, and others. There are multiple pests which affect these species. Some are host specific such as the Jeffrey Pine beetle, *Dendroctonus jeffreyi*, which only attacks Jeffrey pine, and some affect multiple species such as the mountain pine beetle, *Dendroctonus ponderosae*, which attacks ponderosa pine, sugar pine, douglas fir, coulter pine, and lodge pole pine. Ips beetles (multiple species) attack all pine species in California. Mortality potential is variable between types of pests and generally can be described as the following:

**Bark beetles- Multiple tree hosts** - (*Dendroctonus* species – *D. brevicornis*, *D. ponderosae*, *D. ponderosae*, etc.) attack the bole, or trunk of the tree and cause “pitch tubes” to appear. They occur where the beetle bores into the cambium of the tree. The tree’s defense is to expel the beetle with pitch and these exudations appear as streams of white sap on the trunk, resembling candle wax. As drought conditions persist the tree has less available water to maintain adequate sap reserves to repel the beetle attacks. As beetle populations increase to epidemic levels even healthy trees may succumb to the sheer number of attacks.

Mortality from successful attacks is caused by the beetle carving egg galleries in the cambium and the emerging larvae eating the cambium tissues, plus the introduction of decay fungi carried by the beetle. Detection in the early stages may be difficult because attacks can be anywhere on the trunk of the tree. In this sense, direct control of the pest is difficult. Often, by the time it is detected the brood of new beetles has already molted and moved away from the host tree.

As the cambium is destroyed the mortality pattern is seen across the entire crown of the tree. Foliage will slowly fade from normal needle color to light green to yellow to brown. At this stage there is no way to prevent mortality. If the infested tree is detected early enough – if successful attacks are observable and determined before foliage change, direct control through felling the tree and peeling the bark is possible. This will kill the current brood within the tree. This may be feasible for a small property or highly managed forest where attacks are minimal and can be closely monitored. For large holdings which have overstocking issues there is no feasible way to directly control the pest. Since eggs hatch and larvae develop under the bark spraying is not an option.

**Turpentine Beetle – multiple tree hosts, pine-** (*Dendroctonus valens*) The turpentine beetle can occur as a primary or secondary pest. This species of beetle generally attacks from the root crown to the first 3 to 6 feet of the trunk. Borings are characterized by large amounts of red frass, or dust, and small amounts of crystallized pitch. If it is the only beetle attacking the tree it is rarely lethal, though usually a sign there are other stress problems in the tree. It often follows the other more aggressive bark beetles as the tree is weakened.

**Ips Beetles – all pine species** - (*I. pini*, *I. latidens*, *I.*, *confusus*, etc.) generally breed in slash caused by storm damage or logging residues and attack small diameter wood on live pine trees - generally limbs and tops. On larger trees the pest rarely causes mortality but may occur during drought cycles in trees predisposed to attacks by other stress factors. If the mortality pattern the land owner is observing is restricted to individual limbs or to the top of the tree, the cause is most likely Ips. The age and general health of the tree will determine the extent of the damage. Ips can cause extensive mortality in smaller diameter trees, typically 6 inches and less. These trees are typically predisposed to attacks due to competition stress. Twig borers have similar effects but activity is typically restricted to limbs which are heavily shaded. Activity rarely reaches levels which cause mortality.

**Fir Engraver** (*Scolytus ventralis*) This beetle attacks **white and red fir**. Activity is increased by drought stress but typically stands affected by root pathogens are predisposed to attack. Attacks are not as easily observed as other beetles. Attacks are not always lethal, mortality patterns may be limited to branches or tops.

These are the most common pest species which will increase in number and effect throughout the conifer growing forests of the Sierra during drought cycles. Again, direct control of the species once mortality is seen is typically not practical. Most post mortality management options can be summarized as:

**Hazard Reduction:** Where dead and dying trees pose hazards to life and property, these trees should be felled first.

**Salvage/ Sanitation Harvesting:** where tree sizes, volumes, accessibility, and markets allow, harvesting provides the best alternative to the land owner. Dead, infested, and trees likely to be infested can be removed to reduce hazards and increase water availability in the stand.

**Salvage Harvesting:** This often occurs after mortality events cease and merchantable material is recovered where possible. It differs from sanitation operations by removing only dead material.

**Competing Vegetation/ Pre-commercial Thinning:** The goal is to reduce overall vegetation densities to reduce moisture stress in the stand and to reduce fuel loading. The more complete the removal of thinning residues the better. Chipping and hauling and piling and burning are the best treatment methods to reduce pest build up or attraction.

**Detecting Presence:** Felled trees suspected of containing broods of beetles can be checked by peeling the bark around entry points. If bark beetles are present they will be readily visible. If present, treatment will depend on the volume to be treated. Small numbers of trees can be de-barked. They can also be cut into firewood lengths if they can be left in an area of high sun exposure where they will dry rapidly. Alternatively, logs can be decked and covered with plastic. The plastic must be secure around the base of the deck.

These options are suitable for small volumes. The most effective treatment for large volumes are whole tree chipping. Burning large piles or decks is often not feasible with the timing of pest occurrence.

In all circumstances, whether trees are commercial or pre-commercial in size, any number of conservation practices might be beneficial to assist the land owner after salvage harvesting or to reduce future potential for pest outbreaks. Encourage them to come in or meet with you on their property.