TREE NOTES

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

Arnold Schwarzenegger
Governor
State of California

Dale T. Geldert
Director

Mike Chrisman
Secretary for Resources
The Resources Agency

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Identifying Dead and Dying Conifers on Private Land In California

Don Owen

Foerest Pest Management Specialist, 6105 Airport Road, Redding, CA 96022

The first section of this document will help property owners and others identify when a conifer is truly dead. The second section discusses the more challenging task of determining if a tree is dying. The definition of "dying trees" as stated in the **California Forest Practice Rules** is used as a basis for this discussion.

Dead Trees

Identifying a dead tree is, for the most part, relatively straight forward, but there are situations where a live tree may appear to be dead. One of the first clear signs that a conifer is dead is a uniform change in foliage color throughout the *entire* crown of the tree. The foliage of most conifers first turns yellow and later light brown and reddish/brown. Eventually the needles begin to fall, leaving behind bare branches. If some portion of the crown retains green needles, then part of the tree is still alive and the tree has a chance of surviving.

Some needle diseases and winter damage can cause foliage throughout the crown of a tree to change color. This change in color is typically noticed in the spring of the year, a time when these trees are often mistaken for dead trees. If you look closely at the foliage on these trees, it is usually possible to find some green remaining - the bases of needles may be green or there maybe green needles interspersed among brown needles (hence the change in color is not uniform throughout the crown). If the tree is truly dead, there will be no green left in the foliage. Living trees that suffer from needle disease or winter damage will produce new green needles when they break bud and renew growth in the spring. Hence, these trees will "green-up" during the growing season. Conversely, a tree that fails to break bud and produce new growth is dead.

Another condition that often erroneously leads to the conclusion that a tree is dead or dying is fall color change. Conifers typically retain needles for several years, but each fall the oldest needles change color and are shed. The amount of foliage shed from year to year can vary considerably. When trees are under drought stress, a large complement of older needles may change color, causing a large portion of crown to look yellow. The youngest needles, however, remain green - a sure sign the tree is still alive. Heavy cone crops may also create the appearance that the top of a tree is dying.

If there is doubt as to whether a tree is alive or dead, a simple test is to cut or chop into the inner bark or phloem. The phloem is the living portion of the bark immediately adjacent to the wood. On a live conifer, the inner bark is cream-colored, often with a tinge of pink, and moist. When the inner bark is dead, it is brown and may be dry. When the inner bark is dead around the entire circumference of the tree trunk, the tree is dead. It is possible to find trees that have a portion of the inner bark that is alive and a portion that is dead. Such trees may have received a non-lethal injury that killed only a portion of the bark, or they may have received a lethal injury and are still in the process of dying.

Dying Trees

Determining if a tree is dying can be considerably more difficult than determining if it is dead. While the foliage of a dead tree will have changed color uniformly throughout the crown, the foliage of a dying tree will be green in whole or in part. The California Forest Practice Rules defines a dying tree as one that meets one or more of the following criteria:

- Fifty percent or more of the foliage-bearing crown is recently dead (as indicated by a uniform change in color over that part of the crown). ***Dead tops that have no foliage do not count toward this 50%.***
- Successful bark beetle attacks with indications of dead cambium and brood development are distributed around the circumference of the bole. **The key concept here is that the beetles have successfully girdled the tree. Evidence of beetle attack such as pitch tubes or pitch streamers, even if they extend around the tree, do not necessarily mean that the attacks have been successful.**
- Seventy-five percent or more of the circumference of the lower bole is girdled by wildlife. **This principally relates to bear damage.**
- The tree is designated by a Registered Professional Forester as likely to die within one year. **This a**

professional judgment based on training and experience.

The 50% and 75% criteria are straight forward, but determining if a tree is dying from bark beetle attack requires expertise and careful inspection of the tree. A green tree can be dead or dying from beetle attack, but such a determination needs to be made by a qualified evaluator. Different tree species are attacked by different beetles, more than one species of beetle will attack an individual tree, and the different beetle species vary in their ability to kill trees. Similarly, the indicators of beetle attack will differ based on beetle and tree species.

Evaluating Bark Beetle and Wood Borer Attacks

Beetle attacks on a healthy conifer typically produce some sort of resin (pitch) flow from the attack site. This may be in the form of pitch streamers, pitch tubes, or pitch granules. The pitch is the tree's defense against the invading beetles and a sign that the tree is fighting back. It takes large numbers of beetles to kill a relatively healthy tree and it is not uncommon to find trees that have successfully repelled attack and survived. If all attacks produce resin flow, there is no reason to believe the tree is dying.

Trees under stress may not be able to adequately defend themselves. Beetle attack is a dynamic process and the tree's defenses may fail as more and more beetles attack the tree. Quite often the initial beetle attacks will produce resin flow, while later attacks produce no resin. If a tree has pitch tubes or pitch streamers, it is a good idea to look closer to see if other attacks are present. If there are numerous attacks with little or no resin flow, the tree most likely is dying. The ultimate test involves cutting into the tree bole and inspecting the inner bark, preferably at a spot where dry boring dust has accumulated - indicating the site of an attack with no resin flow. If beetle larvae are present, the tree is most likely dying.

Following are some general guidelines for evaluating beetle attacks on various conifers species.

Incense Cedar

The beetles that attack incense cedar are not considered tree-killers. Incense cedars will be very close to death by the time bark and wood boring beetles colonize them. Generally, there will be little or no external evidence of beetle attack. Cedar bark beetle attacks may produce small amounts of yellow boring dust, but it is difficult to see. If there is some doubt as to whether an incense cedar is dying, cutting into the bark and finding beetle larvae and/or brown inner bark will indicate it is already dead or likely to die. Because incense cedars are not attacked by aggressive beetles, they tend to die more slowly than other conifers.

True firs

The fir engraver beetle, *Scolytus ventralis*, is the principal beetle attacking red and white firs. It is a tree-killer, but not an especially aggressive one. It can cause top-kill and branch dieback but such damage does not always indicate that the tree is dying. Fir trees need to be under drought or some other stress to be killed by the fir engraver. Trees are attacked and killed during the summer, but the foliage on some of these trees will not change color for many months. Many dead trees are not identified until the spring following their death. Attacks on relatively healthy trees will produce ribbons of pitch running down the bole of the tree. Do not assume these trees are dying. At the end of a drought when beetle populations are still high but tree resistance has improved, it is common to find many trees with pitch streaming. Successful fir engraver attacks are indicated by small piles of yellow-brown boring dust in bark crevices. In the late summer and fall, look for this boring dust as an indicator the tree is dead or dying. By winter, this dust may be gone and you may need to look for other indicators, such as foliage color changes and woodpecker feeding. If you suspect a green tree is dead, cut into the bole and examine the inner bark to confirm this.

Douglas-fir

A number of beetles attack stressed Douglas-fir, but significant tree mortality due to these beetles is uncommon in California. The Douglas-fir beetle, *Dendroctonus psuedotsugae*, is most likely to kill trees after its populations have built-up in windthrown timber or trees damaged by fire, defoliation or other factors. Orange-brown boring dust in bark crevices is a sign the tree has been attacked and is dying. Pitch streaming may or may not be present on the upper half of the bole. The Douglas-fir engraver, Scolytus unispinosus, rarely kills trees, but occasionally it will kill young, drought-stressed Douglas-fir after beetle populations have increased in logging slash. Look for boring dust in bark crevices.

Douglas-fir on drier sites are often attacked by the flatheaded fir borer, *Melanophila drummondi*. Branches and tops are often killed, but tree mortality is rare or may take many years to occur. Attacks are marked by pitch streaming, although severely stressed trees may show little or no external evidence of attack.

Pines

The bark beetles that attack pines are among the most aggressive. The western pine beetle, *Dendroctonus brevicomis*, attacks ponderosa and Coulter pines; the mountain pine beetle, *Dendroctonus ponderosae*, attacks many different pines, including sugar, ponderosa, Coulter, western white and lodgepole pines. A related beetle, the Jeffrey pine beetle, *Dendroctonus jeffreyi*, attacks only Jeffrey pine. All native pines in California are also attacked by one or more species of

Ips or engraver beetles, as well as the red turpentine beetle, *Dendroctonus valens*.

All of the preceding beetles, except for the engraver beetles, produce pitch tubes when they attack a relatively healthy pine. When attacks produce dry boring dust instead of pitch tubes, this is an indicator the tree may be dying or already dead. The red turpentine beetle colonizes the base of pines where its attacks are readily observed. Because of this, red turpentine beetle attacks are particularly useful in evaluating the status of a number of different pine species. Pitch tubes of the red turpentine beetle are larger than pitch tubes of any of the other beetles and are reddish to purplish in color, depending on the tree species. Fresh tubes are soft and somewhat shiny, while old tubes are dull and hard. Old tubes on ponderosa pine often have a yellowish color. Old pitch tubes on a tree are generally of little concern because they represent past attacks that failed.

New attacks by the red turpentine beetle can provide information on the tree's current condition. Individual attacks may produce a pitch tube, crumbly resinous material, and/or dry boring dust. If all the attacks are marked by either a pitch tube or crumbly resinous material, it *should not* be assumed that the tree is dying. If little or no resin is being released by the tree, attacks will be marked by dry boring dust. Because a tree's condition can change over time, it is typical to have some resinous attacks and some dry attacks on trees that are dying. Unfortunately, dry boring dust coming from red turpentine beetle attacks *does not always mean that the tree is dying*. Dry dust can be produced as beetles bore through the thick outer bark at the base of the tree. They must bore through the outer bark before reaching the phloem and in doing so can produce noticeable amounts of dry dust. Pitch is not released until the beetles reach the phloem/cambial region.

It is important to note that the red turpentine beetle rarely kills trees on its own. If red turpentine beetle attacks are producing dry boring dust and the tree is indeed dying, then it should be possible to find evidence that other beetles are attacking the tree. Trees with large amounts of dry boring dust scattered around the base of the tree are likely dead or dying, but still it is a good idea to look for other indicators of the tree's condition - other beetle attacks, woodpecker feeding, and changes in crown color. If some doubt remains, cut in to the bark at a point where dry dust is accumulating and look for beetle larvae.

Red turpentine beetle attacks typically start at ground line and may extend up the tree bole for several feet. On a larger tree, other beetles typically initiate their attacks above head height, but will extend their attacks down to near ground level as more and more attacks occur. As with the red turpentine beetle, the initial attacks of other *Dendroctonus* beetles will typically produce pitch tubes. If the tree is dying, attacks will produce dry boring dust. Woodpeckers may chip off bark to feed on bark beetle larvae. Small amounts of woodpecker feeding often can be seen on perfectly healthy trees, but extensive feeding on a green tree most likely indicates the tree is infested with beetles and is dead or dying. Most bark beetle broods will be exiting the tree at about the time the foliage is changing color, leaving behind small round exit holes in the bark.

Jeffrey pines in the San Jacinto Mountains represent a special case because these trees are not attacked by the Jeffrey pine beetle. The red turpentine beetle attacks the base of these trees, but attacks higher on the bole are often made by the California flatheaded borer, *Melanophila californica*. Borers are different from bark beetles and no pitch tubes or boring dust are associated with their attacks. Borer attacks are recognized by the presence of pitch streaming down the bole of the tree. The attacks are difficult to interpret because the insect does not need to kill the tree in order to survive. Larvae may be pitched out and killed by the tree or they may survive in an incipient stage for many years beneath the bark. Numerous pitch streamers may be an indicator the tree is under stress, but the pitch streamers do not mean the tree is dying. If numerous streamers are present, look for other indicators of the tree's condition - RTB attacks, foliage color changes, and woodpecker feeding. Most dead or dying pines will have successful RTB attacks. If you suspect a green tree is dying, look for dry boring dust around the base of the tree and cut into this area to determine if there are RTB larvae and/or brown-discolored inner bark.

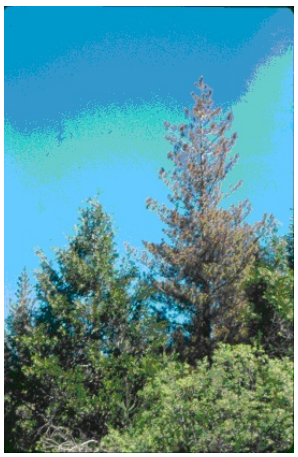
Acknowledgements and Disclaimer

Thanks to staff of the California Department of Forestry and Fire Protection and the USDA Forest Service for reviewing this manuscript. These guidelines are for use on state and private lands, but are not intended to be a substitute for the California Forest Practice Rules or any related policies of the California Department of Forestry and Fire Protection. National Forests and other Federal lands have separate guidelines for identifying dead and dying trees.

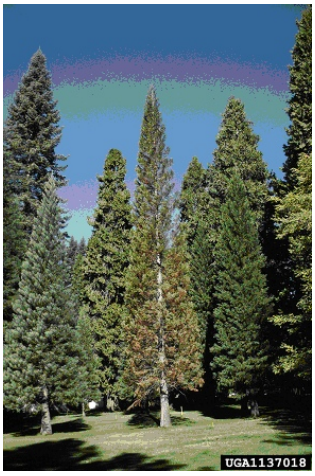
All photographs were taken by the author. Digital reproductions of many of the photographs were provided by Forestry Images and can be found on their website, www.forestryimages.org.

Gallery of Signs and Symptoms - Dead, Dying, and Living Conifers

Sugar Pine Needle Cast. One year's complement of needles was killed by this needle disease. These branches were collected in the spring before the flush of new growth. The subsequent flush of new foliage was unaffected. The appearance of dead needles throughout the crown of the tree was alarming, but the disease had an insignificant impact on tree health.



Sugar Pine Needle Cast. This tree has suffered from needle cast several years in a row. While a single year of infection is typically insignificant, chronic yearly infections can cause a decline in the tree's vigor. This live tree is at or near the point where a Registered Professional Forester might judge it as likely to die within one year.



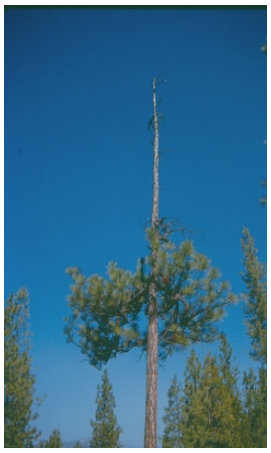
Annosum Root Disease on Giant Sequoia. This live tree has green, yellow, and brown needles. It is important to know the cause of such symptoms to appreciate the severity of the disease. Knowing that this tree is suffering from annosum root disease, A Registered Professional Forester would be justified in classifying it as a dying tree.

Redbelt on Ponderosa Pine. The needles on this tree received winter damage. Although the crown of the tree has an overall brown cast, closer inspection reveals that needle bases are green. The damage is minor and the tree is neither dead nor dying.

A Sugar Pine killed by Mountain Pine Beetle. This tree is dead and the foliage has just faded to yellow/green. As the needles dry, they will further fade to yellow, straw, and red/brown. The change in color is uniform throughout the crown, i.e. no green needles remain. If you were to cut into the bark, you would find beetle larvae and dead phloem.

Ponderosa Pines killed by Western Pine Beetle. This photo was taken September 1. These trees were green in early July and had faded to yellow/green by early August.

Ponderosa Pines with recently killed tops. These tops were most likely killed by *Ips* bark beetles. According to the forest practice rules, if fifty percent or more of the foliage-bearing crown is recently dead, a tree is defined as dying. The tree in the upper left photo has less than 50% top dieback and therefore would not qualify as a dying tree. The tree on the lower left photo has approximately 50% dieback and therefore would qualify. Survival of both of these trees depends greatly on whether or not bark beetles successfully attack the remainder of the bole. The best way to predict survival of these trees is to look for evidence of such attack.



Ponderosa Pine with an old dead top. This top has no foliage and was not killed recently. The presence of such a top does not qualify this as a dying tree.

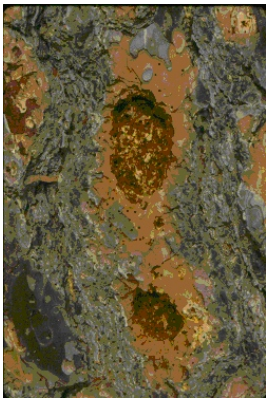
Port Orford Cedar killed by Root Disease. This photo illustrates the difference in color between living, cream-colored phloem and dead, brown phloem. In this case, the brown phloem is a symptom of infection by a root pathogen. The tree is girdled by the infection and is dying. Bark beetles have begun colonizing the area above the infected phloem.

Pitch Tubes of Red Turpentine and Western Pine Beetles. Conifers defend themselves from beetle attack by producing and releasing pitch or resin. On pines, pitch tubes will be produced as long as the tree can defend itself. Pitch tubes alone do not indicate the tree is dead or dying.

Resin Streamers on White Fir. This is the bole of a tree cut during a logging operation. The resin streamers were present before the tree was harvested. Like pitch tubes, resin streamers are a sign that the tree is defending itself from attack -- either by bark beetles or wood borers. Resin streamers alone do not indicate the tree is dead or dying.

Boring Dust from Bark Beetle Attacks. When a conifer is incapable of defending itself from bark beetle attack, little or no resin will be released. As the beetles tunnel into the bark, they will expel a "dry" boring dust from their entrance holes. No pitch tubes or streams will be produced. Dry boring dust is an indicator that the tree is dead or dying. Confirmation of this is made by cutting into the bark and finding beetle larvae.

Red Turpentine Beetle Larvae. Bark beetle larvae are creamy white, legless, small (up to about 3/8", but generally smaller) and have dark heads.



Woodpecker Feeding and Western Pine Beetle Exit Holes on Ponderosa Pine. Woodpeckers will feed on beetle larvae and pupae beneath the bark of dead and dying trees. Extensive woodpecker feeding on a green tree may be an indication the tree is dying. If there is some doubt about the status of the tree, cut into the bark and inspect the phloem. Most trees will have changed color by the time bark beetle broods begin to exit through the bark.