Postfire Tree Management

Postfire Tree Management

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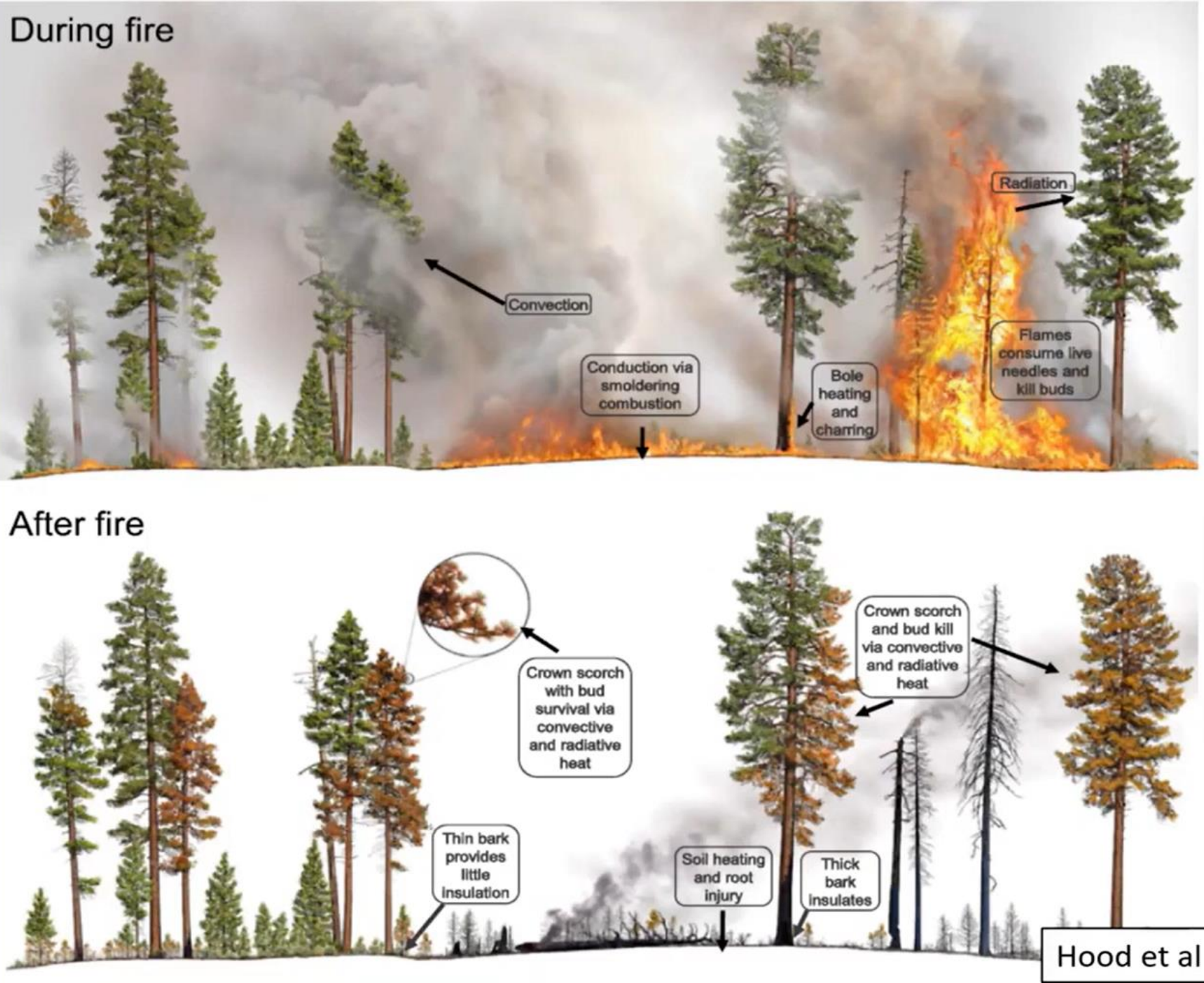
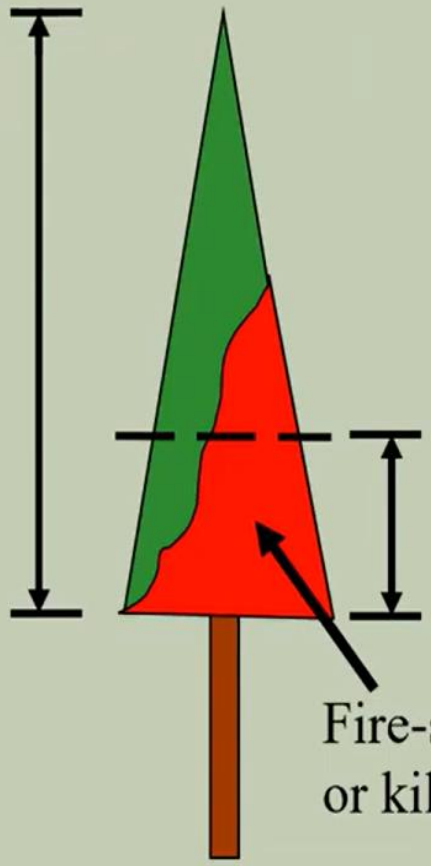
CAL FIRE

Madera-Mariposa-Merced Unit



Hood et al 2018

Original
(pre-fire)
crown
length* (A)



Estimated
length* of
crown scorch or
crown kill (B)

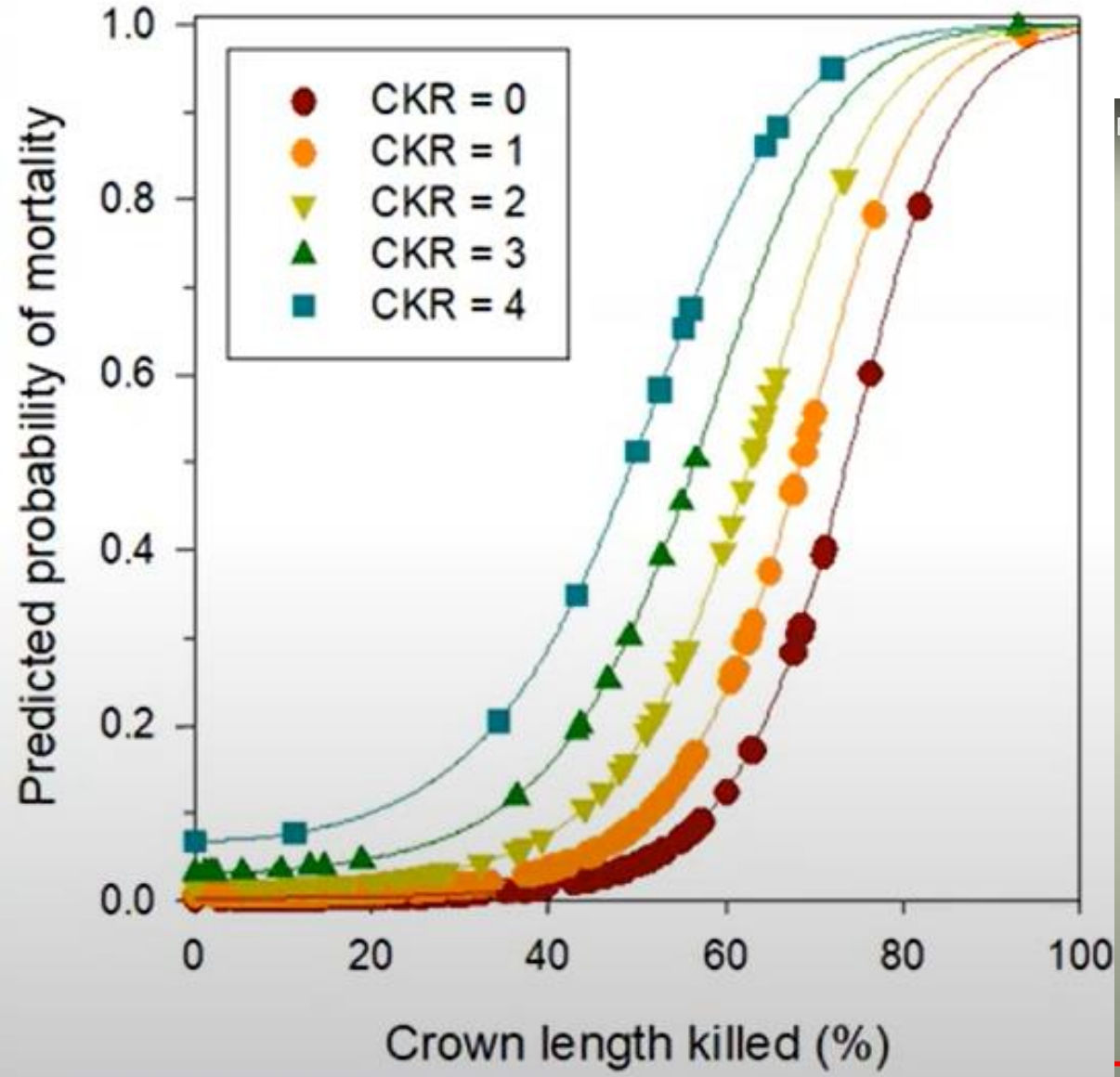
Fire-scorched
or killed

B/A*100 = Percent crown
length scorched or killed

***Estimating length not volume**

(for all species except Douglas-fir and lodgepole pine)

Ponderosa and Jeffrey Pine



Forest Stewardship Follow Up Workshop

Red Turpentine Beetle

Scroll for details

TREE NOTES

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

Edmund G. Brown Jr. Governor State of California | Ken Pimlott Director | John Laird Secretary for Resources Natural Resources Agency

NUMBER: 33 April 2015

Survival of Fire-Injured Conifers in California

Donald R. Owen,[1] Daniel R. Cluck,[2] and Sheri L. Smith[3]

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The intensity of wildfire and the injury it causes to trees varies considerably across a landscape. Conifers are killed outright when all foliage in the crown is consumed by flames or killed by extreme heat. Trees may also sustain lesser injuries to the crown, stem and roots and survive. These trees, however, may die prematurely if the injuries are severe. How well a tree survives fire injury is influenced by a variety of factors, including:

- Tree species
- Tree age, size, and vigor
- Extent and location of injury on the tree

Fire impacts trees by heating and killing tissues such as foliage, buds, inner bark and cambium. In extreme cases, foliage, twigs, bark and decayed wood are consumed. Even though severe fire intensity can kill trees directly, the wood in larger sound roots, branches and trunks is typically not degraded until pest organisms invade the tree.

Table 2. Mortality of **Fire-Injured Sugar Pine** (based on Hood *et al.* 2010)

*** Percentage of live crown killed by fire**

Probability the tree will die ⇨	30%	50%	70%
DBH (diameter of stem at breast height)			
10 to 60”	**40 ***	**50**	**60**

* length of killed crown (brown + consumed foliage) ÷ length of entire crown (all foliage) × 100

Modifications to Table 2 based on Cambial Injury Rating

- Rating of 0 to 3 reduces the probability of mortality 5-15%
- Rating of 4 increases the probability of mortality by 40%

Red Turpentine Beetle

- When pitch tubes are absent, probability of mortality decreases a moderate amount (10-20%)
- When pitch tubes are present, probability of mortality increases a moderate amount (10-20%)

Tables 1a & b. Mortality of **Fire-Injured Ponderosa and Jeffrey pines** (based on Hood *et al.* 2010)

Table 1a. Evaluation made before the next growing season

*** Percentage of foliage killed by fire**

Probability the tree will die ⇨	30%	50%	70%
DBH (diameter of stem at breast height)			
10 to < 30”	**70 ***	**80**	**90**
30 to 40”	**35**	**45**	**60**
> 40”	**15**	**30**	**40**

* length of crown with dead (brown) + consumed foliage ÷ length of entire crown (all foliage) × 100

Modifications to Table 1a based on Cambial Injury Rating

trees 10 to < 30” DBH

- Rating of 0 or 1 reduces the probability of mortality by 20-30%
- Rating of 2 causes no change
- Rating of 3 or 4 increases the probability of mortality by 5-30%

trees ≥ 30” DBH

- Rating of 0 or 1 reduces the probability of mortality by 0-10%
- Rating of 2 increases the probability of mortality by 10%
- Rating of 3 or 4 increases the probability of mortality by 10-30%

For fires that occur before pine foliage has fully elongated (May and much of June): shoots and fire-scorched needles may continue to grow, producing brown needles with green bases (post-fire growth). When this occurs, consider portions of the crown with these needles as alive and utilize Table 1b to rate probability of mortality.

Table 1b. Evaluation made during the growing season following the fire (one winter has passed and the new year’s growth is apparent; any branch with new growth is part of the live crown)

*** Percentage of live crown killed by fire**

Probability the tree will die ⇨	30%	50%	70%
DBH (diameter of stem at breast height)			
10 to < 30”	**40 ***	**50**	**60**
30 to 40”	**10**	**25**	**40**
> 40 to 50”	**--**	**10**	**25**

* length of killed crown (branches with only brown or consumed foliage) ÷ length of entire crown (all foliage) × 10

Modifications to Table 1b based on Cambial Injury Rating

trees 10 to < 30” DBH

- Rating of 0 or 1 reduces the probability of mortality by 10%
- Rating of 2 causes no change
- Rating of 3 or 4 increases the probability of mortality by 15-20%

trees ≥ 30” DBH

- Rating of 0 or 1 reduces the probability of mortality by 5-10%
- Rating of 2 causes no change
- Rating of 3 or 4 increases the probability of mortality by 5-10%

Red Turpentine Beetle

- When pitch tubes are absent, probability of mortality remains the same or decreases slightly (up to 10%)
- When pitch tubes are present on trees10 to < 30” DBH, probability of mortality increases slightly (up to 10%
- When pitch tubes are present on trees ≥ 30” DBH, probability of mortality increases significantly (up to 40%

Table 4. Mortality of **Fire-Injured White Fir** (based on Hood *et al.* 2010)

*** Percentage of live crown killed by fire**

Probability the tree will die ⇨	30%	50%	70%
DBH (diameter of stem at breast height)			
10 to 35”	**65 ***	**75**	**80**
> 35”	**45**	**60**	**70**

* length of killed crown (brown + consumed foliage) ÷ length of entire crown (all foliage) × 100

Modifications to Table 4 based on Cambial Injury Rating:

- Rating of 0 causes no change in the probability of mortality
- Rating of 1 or 2 increases the probability of mortality by 10-20%
- Rating of 3 or 4 increases the probability of mortality by 15-30%

Hazard Tree Alert: white firs have a high probability of stem failure due to cambial kill and subsequent wood decay.

Table 7. Mortality of **Fire-injured Incense Cedar** (based on Hood *et al.* 2010)

*** Percentage of live crown killed by fire**

Probability the tree will die ⇨	30%	50%	70%
DBH (diameter of stem at breast height)			
10 to 60”	**75 ***	**85**	**90**

* length of killed crown (brown + consumed foliage) ÷ length of entire crown (all foliage) × 100

No other variables are recommended.

Postfire Tree Management

Table 3: YELLOW PINE: percent crown length scorched (PCLS) and DBH *(use pre-bud break)***

- *Note: The red turpentine beetle guideline is not used in the pre-bud break model*

Probability of mortality (Pm)	.10	.20	.30	.40	.50	.60	.70	.80	.90
DBH	Percent crown length scorched (PCLS)								
10 - <30"	50	50	70	75	80	85	90	95	100
30 - 40"	10	25	35	40	45	55	60	70	80
>40 - 50"	--	10	15	20	30	35	40	50	65

Table 1. YELLOW PINE: percent crown length killed (PCLK) and DBH *(use post-bud break)***

- Use Table 1 when only assessing crown injury.

Probability of mortality (Pm)	.10	.20	.30	.40	.50	.60	.70	.80	.90
DBH	Percent crown length killed (PCLK)								
10 - <30"	25	35	40	45	50	55	60	65	70
30 - 40"	--	5	10	15	25	30	40	45	60
>40 - 50"	--	--	--	5	10	15	25	30	45

MISCELLANEOUS PAPER No. 60
SEPTEMBER 1961

GUIDELINES FOR ESTIMATING THE SURVIVAL OF FIRE-DAMAGED TREES IN CALIFORNIA

Willis W. Wagener

PACIFIC SOUTHWEST
FOREST AND RANGE
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BERKELEY, CALIFORNIA

FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE

Influence of Fire Date on Survival

Conifers are most susceptible to fire damage early in the growing season, when length growth of the main stem and of twigs is active. This growth is chiefly from food reserves stored during the previous season. Such reserves are at their lowest during the period of length growth. Also, during this time, growing points are tender and easily killed by heat. The length-growth period varies in timing with elevation, species, and duration of snow cover but in California is likely to be at a maximum in June (Fowells, 1941).

Survival in Relation to Growth Rate and Site

The survival chances of a scorched conifer are strongly influenced by the condition of the tree before the fire. Young, fast-growing trees on good sites have the best chance, and old, overmature veterans on poor sites the poorest chance to recover from fire damage. Fire-injured trees of any age that were making slow growth before a fire will have a low recovery potential afterward. On the other hand, vigorous young ponderosa pines on good sites occasionally survive 100 percent heat-killing of foliage in a late-season fire if most of the buds and twigs remain alive. Even on good sites, old, overmature, slow-growing trees are poor risks to live after a fire if damage is at all severe.

Crown Damage

Except for very early-season fires, the crown condition the year following the fire is more important for survival than the condition shortly after the blaze. In ponderosa and Jeffrey pines extensive heat-killing of foliage may sometimes occur with only light damage to buds and twigs. During the succeeding months most of the dead foliage will be shed from twigs that are still alive; a new crop of needles will be put out from them the next growing season. Thus the amount of green crown the year after a fire may be much greater than that a month after in these pines. The new foliage on a defoliated part of the crown is not quite the equivalent of uninjured crown because it bears only current year's needles, but these help greatly in keeping the tree alive until a normal needle complement is attained.

In species with slender twigs and small terminal buds, as in sugar pine, Douglas-fir, and the true firs, or in those without definite terminal buds, as in incense-cedar and giant sequoia, foliage kill and bud and twig kill from fire are not greatly different in amount. Thus, the amount of green foliage present in scorched crowns in these species shortly after a fire is reasonably close to the amount that will be present in the immediately following years.

Damage to Bark and Cambium

Miller (1929) and Salman (1934) each observed that pines with both heavy foliage scorching and moderate to severe cambium kill as a result of fire were more likely to die later from bark beetle attack than pines with only one of these types of injury. Where both types of injury are present, food materials available for repair of the damage are sometimes insufficient to be fully effective.

Postfire Tree Management

Table 1.—Criteria for survival marking of fire-scorched timber in California

Influencing factors	Minimum criteria for survival of—					
	Ponderosa pine Jeffrey pine			Sugar pine Douglas-fir 1/ White fir	Red fir Incense-cedar Giant sequoia	
	Cambium injury	Live crown	Green foliage	Cambium injury 2/	Live crown	Green foliage
		--Percent--			---Percent---	
General specifications						
Fire period—late season Site quality—above average Growth vigor of tree before fire—good	None or light	50 or more	10 or more 3/	None to moderate	45 or more	35 or more
Modifications						
In cambium injury—general specifications as above	Moderate	50 or more	20 or more	--	--	--
In site—below average, Sierra East Side and West Side, other general specifications unchanged	None or light	50 or more	15 or more	None to moderate	50 or more	40 or more
In fire period—midseason other general specifications unchanged	None or light	50 or more	15 to 25 or more	None to moderate	50 or more	40 to 50 or more
In growth vigor—crown small, vigor moderate, other general specifications unchanged	None or light	60 or more	15 or more	None to moderate	55 or more	45 or more

1/ Does not include bigcone Douglas-fir. In this species the percent of live crown is not readily determinable; green foliage should be 20 percent or more.

2/ In sugar pine, includes up to 60 percent basal girdling.

3/ Not an actual green foliage minimum for survival. Seventy percent of the pines in the study with 50 percent or more of live crown but with less than 10 percent of green foliage survived.

Station Bulletin No. 76
May, 2011

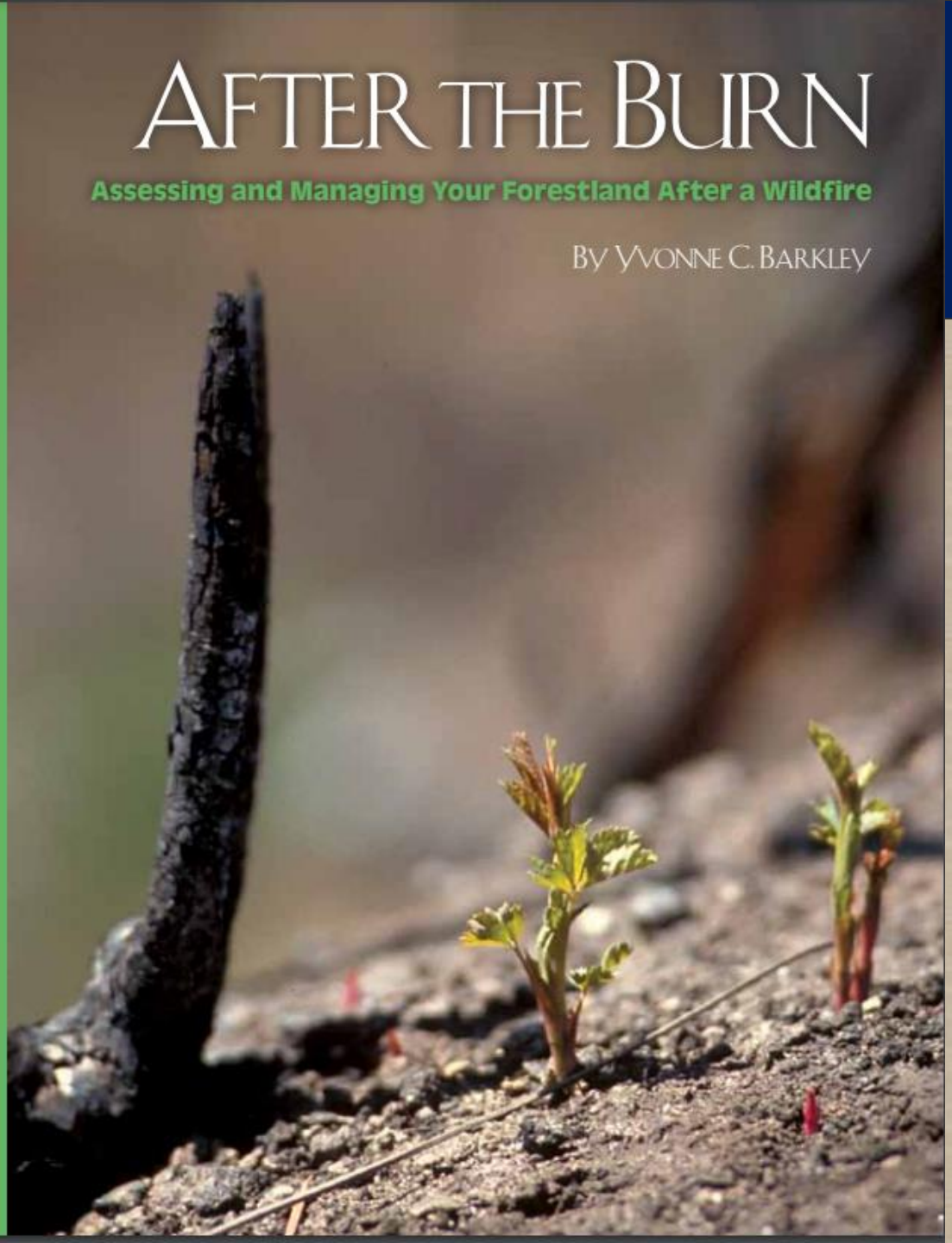
Idaho Forest, Wildlife and
Range Experiment Station
Moscow, Idaho

Director
Kurt S. Pregitzer

After the Burn

Assessing and Managing Your Forestland After a Wildfire

By Yvonne C. Barkley



University of Idaho
Extension

Fire effects.

- Low-intensity fires readily kill seedlings less than 12 inches in height, while larger seedlings, saplings and pole-sized trees may be damaged but not killed, especially if the burn occurred during the dormant season. Trees larger than pole-size are quite resistant to low-intensity burns.
- Cambial damage is most likely to occur when high-intensity fires are maintained by deep duff layer surrounding bases of trees.
- Extensive foliar scorching can occur with only light damage occurring to buds, with some trees able to withstand up to 90 percent crown scorch as long as 50 percent of buds and twigs survive.
- Trees producing heavy cone crops are more prone to mortality because nutrients are diverted to cone development and maturation rather than to recovery.
- Damage to cambium is the more important factor in small-diameter classes of ponderosa pine while crown damage is more important in pole-sized and larger trees.
- Cambium must be completely girdled to kill the tree and trees that only are partially girdled have a good chance of survival.
- Bark charring is a poor indicator of cambium damage in ponderosa pine.

Table 2: Probability of fire-induced mortality for ponderosa pine.

	CROWN SCORCH VOLUME (PERCENT)									
DBH	10	20	30	40	50	60	70	80	90	100
5	49%	53%	60%	68%	78%	86%	93%	97%	99%	99%
6	42%	46%	53%	62%	72%	83%	90%	95%	98%	99%
7	36%	40%	46%	55%	67%	78%	88%	94%	98%	99%
8	30%	34%	40%	49%	61%	74%	85%	93%	97%	99%
9	25%	28%	34%	43%	55%	69%	82%	91%	96%	99%
10	21%	24%	29%	37%	49%	64%	78%	89%	95%	98%
12	15%	17%	21%	28%	39%	53%	69%	84%	93%	97%
14	11%	12%	10%	21%	30%	43%	61%	77%	90%	96%
16	8%	9%	7%	16%	23%	35%	52%	71%	86%	94%
18	6%	7%	6%	12%	18%	29%	45%	65%	82%	93%
20	5%	5%	4%	10%	15%	24%	39%	59%	78%	91%
22	4%	4%	4%	8%	13%	21%	34%	54%	74%	89%
24	3%	4%	3%	7%	11%	18%	31%	50%	71%	87%
26	3%	3%	3%	6%	10%	16%	28%	47%	69%	86%
28	3%	3%	3%	6%	9%	15%	27%	45%	67%	85%
30	3%	3%	3%	6%	9%	15%	26%	44%	67%	85%

Sources/Notes: Table developed by David C. Powell, Forest Silviculturist, Umatilla National Forest, Pendleton, OR. These values are probabilities, expressed as a percent, of ponderosa pines of various diameters being killed by fire. They are based on an equation from Reinhardt and Ryan (1989) and a bark thickness factor from Keane et al. (1989). See Steele et al. (1996) for a description of the calculation methodology. White values on a blue background denote combinations of crown scorch and DBH with a mortality probability ≥ 50%.

Cambium condition.

- Trunk, roots and root collar:
  - 3-4 sites are pale, green and moist – alive.
  - 2 sites are brown and dry – marginal condition.
  - 3-4 sites are brown and dry – dead.

Postfire response.

- Post-fire regeneration is exclusively through seed. Even though trees with scorched foliage may not live long, they serve as important seed sources.
- Fire creates a favorable seedbed for this species by removing competing vegetation and exposing bare mineral soil. Seedling establishment is best when a good seed crop coincides with above average rainfall.
- Post-fire release of nutrients, primarily nitrogen, contributes to successful regeneration.

Predicting mortality. Map predicted mortality. For a mixed-species stand, you may want to map each species' mortality on separate pages.

It is important to determine which trees are dead and which trees are alive and to assess the percent of live trees that will die from secondary effects such as bark beetle invasion, fungal infections and/or a decline in wood quality. There are so many variables involved in assessing postfire tree mortality that it is impossible to apply a formula or standard set of characteristics, making this process more of an art than a science. You will get the most accurate results by using a combination of methods. **Appendix I** (page 50) provides information on predicting mortality using individual tree characteristics, percent crown scorch volume and cambium condition.

Method used to predict mortality by percent crown scorch volume:

- Determine the species of the tree.
- Measure diameter of tree at breast height (dbh).

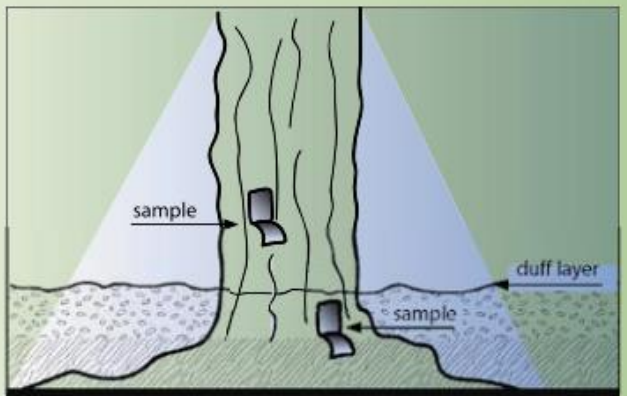


Figure 6. *Assessing cambium condition.*

- Look for brown, dried, or burned foliage. Estimate the amount of foliage scorched; be sure to look at all sides of the crown. Use the tables in **Appendix I** (page 50) for the species being assessed to estimate mortality based on crown scorch volume.

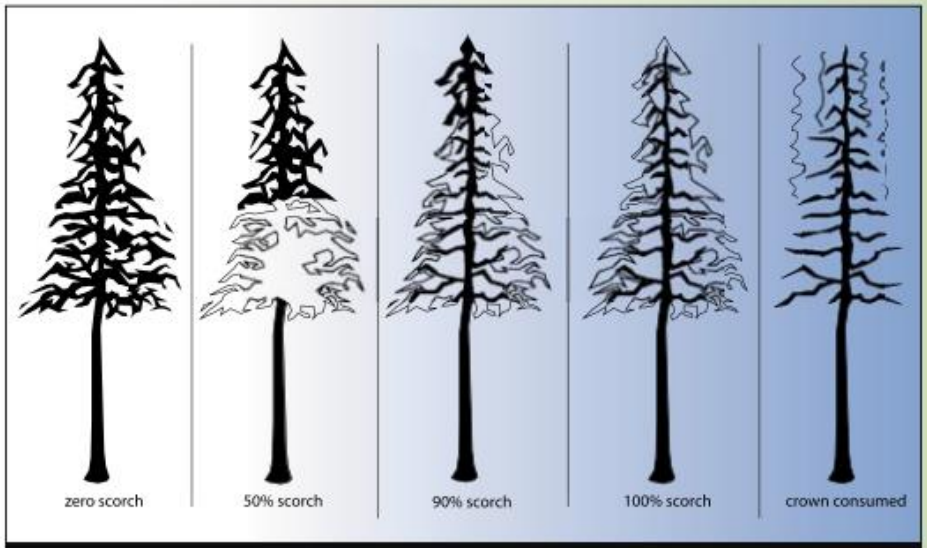


Figure 5. *Assessing percent crown scorch.*

Postfire Management

"While we were at Pistol Creek, the landowners and ranch manager were very interested in learning about what they should do postfire. They wanted to know if they could expect a bark beetle outbreak. Trees needed to be removed – when should that be accomplished so they could still use the wood to rebuild cabins and for firewood? They wanted to plant trees – what kind? How many? When should we plant? And they wanted to minimize their fire risk – what are the best ways to manage fuels? From the various questions asked, I realized that some people see the time after a burn as the end of a good book, while others see it as the beginning of the next chapter." Yvonne C. Barkley[4]

Karen Wattenmaker

Salvage cuts should be done as soon as possible after a burn — by year three much or all of the value has been lost.

Salvage logging

Once you have assessed the status of your land, you will need to make some short- and long-term management decisions. One of the first will be to decide if you will harvest your dead and dying trees. Standing dead trees (called **snags**) serve a multitude of purposes, the primary one being habitat for many woodland species of birds and mammals, and as reserve nutrients as they fall to the forest floor over the coming years. But lots of standing dead trees can be too much of a good thing.

Salvage cuts are often initiated after a disturbance (fire, wind, insect or disease kill) to recover the value of damaged trees and remove hazard trees. Salvage operations usually are not done

Postfire Tree Management

PIPO: Ponderosa pine	Crown scorch	Pre-bud break (volume): • > 85% needles scorched OR • > 40% needles consumed/blackened OR • > 5% and ≤ 40% needles consumed/blackened combined with >50% needles scorched Post-bud break (volume): > 70% crown volume killed (no new growth)
	Bark char	> 90% deep char

Post-fire tree mortality

Forest Health Fact Sheet

November 2020

Crown scorch in ponderosa pine (C. Buhl)

This guide serves as an overview on how to estimate and predict tree mortality after wildfire. A comprehensive guide with complete species-specific post-fire mortality ranking tables is available in the U.S. Forest Service publication (R6-FHP-RO-2020-02): "**Post-fire Assessment of Tree Status and Marking Guidelines for Conifers in Oregon and Washington**". Many ranking guides exist so it is best to use those from your region that were developed from local research or field-verified models. These guides are meant to help determine which trees should be removed in the salvage or sanitation process. The guides are not *exact* but serve as a starting point to understand which aspects of fire damage have the most influence on tree mortality, as well as how much damage each tree species can withstand. Post-fire mortality marking guides should not be used as substitutes for hazard tree marking guides (see "**Field Guide for Hazard-Tree Identification and Mitigation**"). Lastly, expedient tree removal and processing will reduce the amount of insect and fungi-caused defects in fire-damaged timber.

How does fire kill trees?

Wildfire can directly kill trees by heating or burning the crown, trunk and/or roots, which damages photosynthetic and vascular tissues that support tree growth and defense. The ability for a tree to survive after a fire depends primarily on the magnitude of crown and cambium damage. Various conditions can influence these damage levels (e.g., fire intensity, duration, timing, heat conductivity across soil types, bark thickness, basal duff buildup, etc.).

Crown scorch and bole char (USFS R6 FHP)

Crown damage occurs when needles are scorched or consumed by fire which disrupts photosynthesis. Buds and cones may also be damaged, which affects needle and seed production in the short term and tree survival and stand regeneration in the long term. Proportion of the live crown with crown scorch is the metric for crown damage.

Cambium damage occurs when the bole of a tree is charred or "cooked" enough to kill tissues. Cambium tissue includes both phloem and xylem, which are vascular tissues that transport water and nutrients throughout the tree. Trees with high levels of cambium damage but low crown scorch may take years to die from fire damage. For example, xylem tissues, which are deeper in the trunk, are unaffected by bole charring and continue to transport water to the crown for photosynthesis. While cambium and phloem tissues are closer to the surface and therefore more exposed to heat and bole char, which disrupts transport of nutrients from the crown to the roots. When the fine roots eventually start to die back, less water can be obtained and the tree starts to die. Proportions of the bole circumference with bole char or dead cambium is the metric for cambium damage.

Post-fire tree mortality

Quick Marking Guide

November 2020

Species	Criteria	Diameter Class 5 – 11.9"	12 – 20.9"	21"+
ABAM: Pacific silver fir	Crown scorch	> 30% volume		> 40% volume
	Bark char	≥ 50% any char		
ABCO: white fir or hybrids	Crown scorch	≥ 70% volume		
	Bark char	≥ 75% deep char		
ABGR: grand fir	Crown scorch	≥ 60% volume		
	Bark char	≥ 50% any char	≥ 75% moderate or deep char	
ABLA: subalpine fir	Crown scorch	> 30% volume		> 40% volume
	Bark char	> 50% any char		
ABMA: red fir	Crown scorch	≥ 70% volume		
	Bark char	> 75% deep char		
CADE: Incense cedar	Crown scorch	≥ 85% volume		
	Bark char	> 75% deep char		
LAOC: Western larch	Crown scorch	If needles on: ≥ 80% crown length If needles off: average char height over entire tree length > 70%		
	Bark char	> 75% deep char	Bole char not a predictive injury indicator	
PIEN: Engelmann spruce	Crown scorch	≥ 75% volume		
	Bark char	> 75% any char		
PISI: Sitka spruce	Crown scorch	≥ 75% volume		
	Bark char	> 75% any char		
PICO: Lodgepole pine	Crown scorch	≥ 40% volume		
	Bark char	≥ 75% any char		
PIAL: Whitebark pine	Crown scorch	≥ 40% volume		
	Bark char	≥ 75% any char		
PILA: Sugar pine	Crown scorch	≥ 70% volume		
	Bark char	> 90% moderate or deep char		
PIMO: Western white pine	Crown scorch	> 30% volume		
	Bark char	≥ 90% any char		
PIPO: Ponderosa pine	Crown scorch	Pre-bud break (volume): • > 85% needles scorched OR • > 40% needles consumed/blackened OR • > 5% and ≤ 40% needles consumed/blackened combined with >50% needles scorched Post-bud break (volume): > 70% crown volume killed (no new growth)		
	Bark char	> 90% deep char		
PSME: Douglas-fir	Crown scorch	> 65% crown volume		
	Bark char	> 50% deep char	> 75% deep char	
THPL: Western red cedar	Crown scorch	> 20% crown volume	> 40% crown volume	> 60% crown volume
	Bark char	> 50% any char		> 75% any char
TSHE: Western hemlock	Crown scorch	≥ 20% crown volume		
	Bark char	≥ 90% any char		
TSME: Mountain hemlock	Crown scorch	≥ 20% crown volume		
	Bark char	≥ 90% any char		

This guide depicts levels of damage (proportion crown scorch and circumference of bole char) that may result in a 50% probability of tree mortality. If there is evidence of bark beetle or woodborer attack around >50% of the bole circumference the tree will die regardless of fire injury. The full marking guide can be found in USFS Report R6-FHP-RO-2020-02.

Postfire Tree Management

United States Department of Agriculture

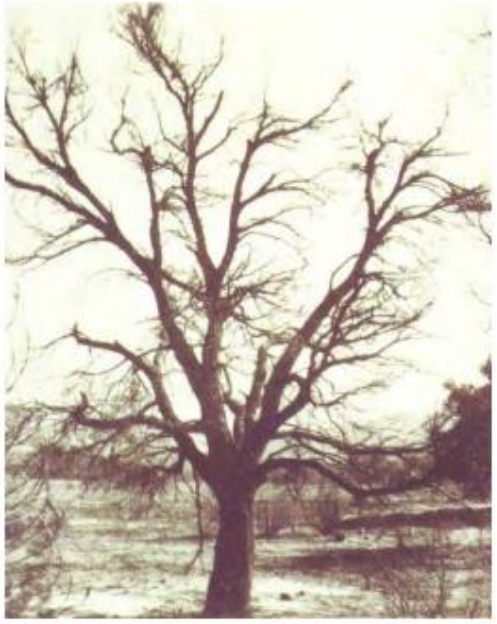
Forest Service

Pacific Southwest Forest and Range Experiment Station

General Technical Report PSW-71

Five Southern California Oaks: identification and postfire management

Timothy R. Plumb Anthony P. Gomez

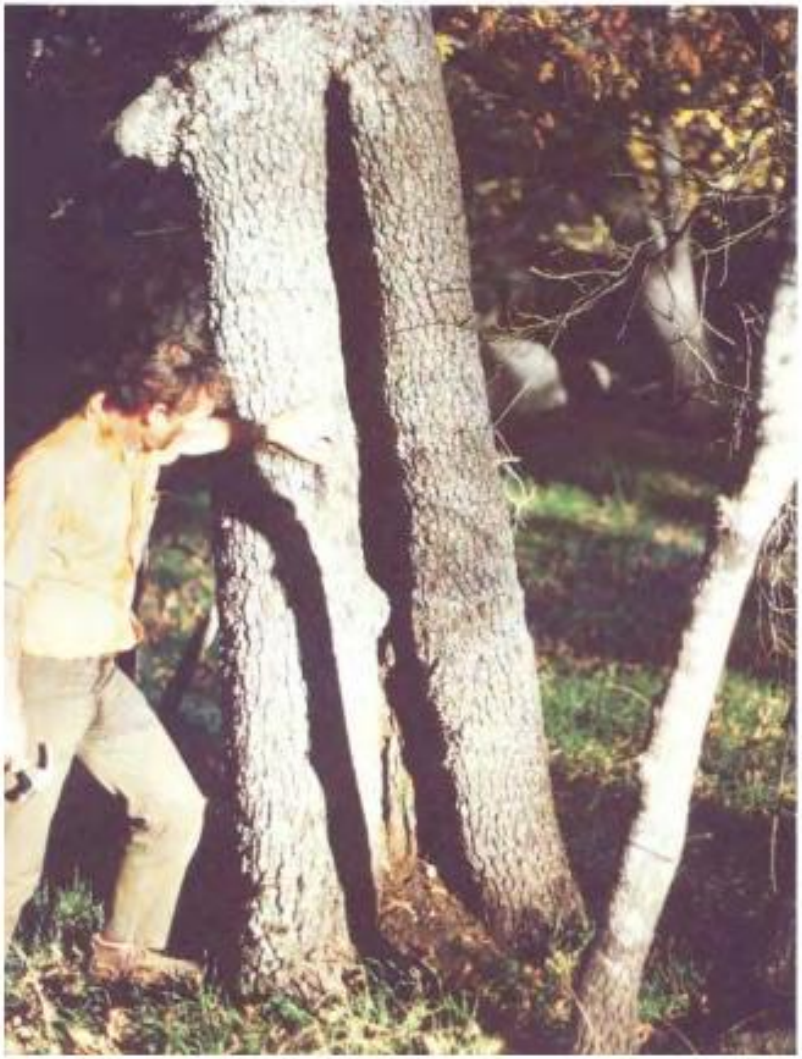


ASSESSMENT OF FIRE DAMAGE

Trees respond to fire immediately as well as later on. Immediate effects range from no obvious damage to complete consumption or heavy charring followed by long-term wood degradation by insects and disease. Delayed effects include sprouting from the tree base, trunk, and branches, and cambium regeneration.

The most common fire damage to the trunk of a tree is a basal wound resulting from death of the cambium (*fig. 59*). Small wounds less than a few inches across may eventually heal with no accompanying heart rot, but large wounds generally become larger because of disease and insects. The cambium attempts to close the wound but usually only curls inward as the damaged woody tissue disintegrates (*fig. 60*). Subsequent fires can enlarge the wound until all that remains is a

Figure 59—California Black Oak: Basal char of a 2-ft (0.6-m) diameter trunk from a low intensity surface fire (top). Damage to the cambium was not as extensive as the char area (bottom).



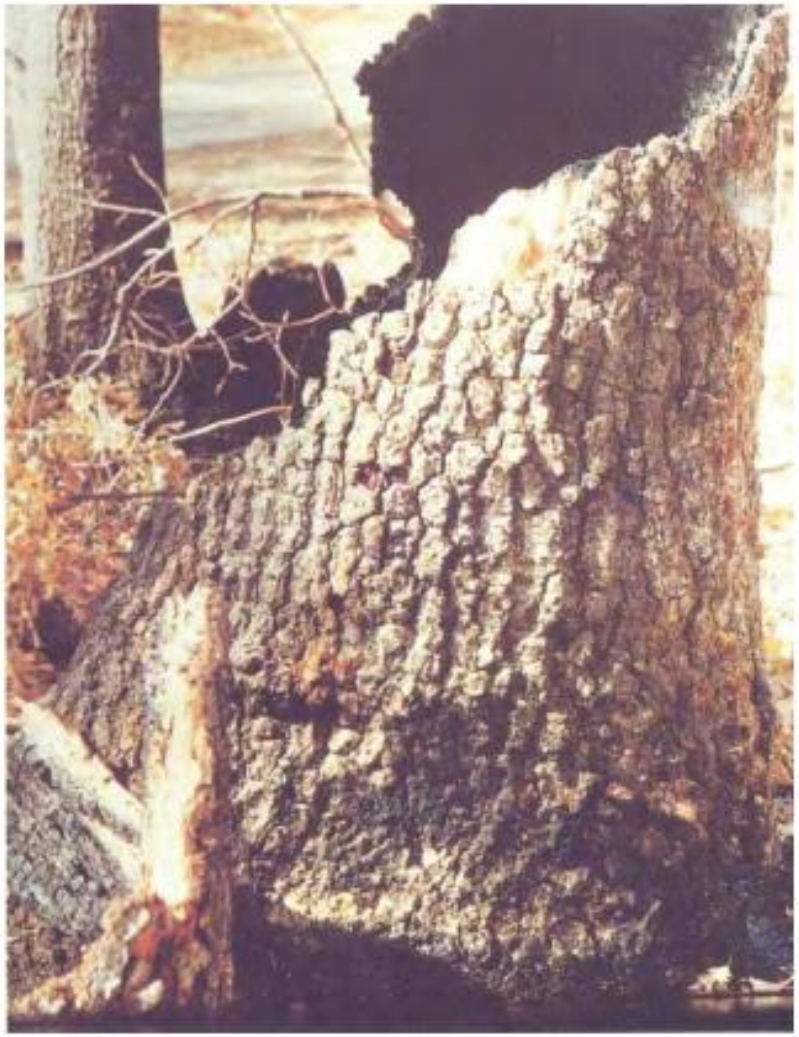
thin ring of live wood and bark (*fig. 61*). At this stage, the tree is a mechanical risk and readily subject to wind damage.

A small wound may greatly reduce a tree's value for lumber, but wildlife, watershed, and esthetic values may not be severely reduced even when a tree is completely hollowed out. In fact, value to wildlife may be improved. A wound that girdles the trunk, even if it is only a few inches wide (*fig. 62*), however, will eventually result in the death of the trunk and crown of the tree. But the crown may remain alive several years after girdling. Trees with healthy-looking crowns, but girdled trunks, may result in an underestimate of fire damage. The potential for a low estimate should be kept in mind during a postfire damage appraisal.

Visual Detection of Injury

To accurately assess fire damage, it is necessary to distinguish between live and dead tissue. The distinction is obvious

Figure 60—California Black Oak: Damaged wood eventually decays; meanwhile, live tissue curls inward as it attempts to cover the wound. Subsequent fires enlarge the wound even more.



when the leaves are burned or heat-killed, but damage to the buds, acorns and, especially the cambium, is not as obvious. Although several methods of detecting damaged and dead tissue have been developed, including chemical and electrical techniques, visual detection is simple, direct, and suitable for field use.

The first step in evaluating fire damage is to assess the condition of the trunk and categorize it into one of three char classes *(fig. 63):* light—spotty char or scorch with scattered pitting of the bark; medium—continuous charring with areas of minor reduction in bark thickness; heavy—continuous charring, pronounced reduction in bark thickness with the underlying wood sometimes exposed. The significance of these char classes in estimating trunk damage will depend on all of the variables listed in the next section on conditions affecting tree damage, for example, burning condition, season of the year, species, and tree characteristics.

Young, smooth stems may show heat damage by a color change from gray to reddish gray *(fig. 26)*. The bark surface is

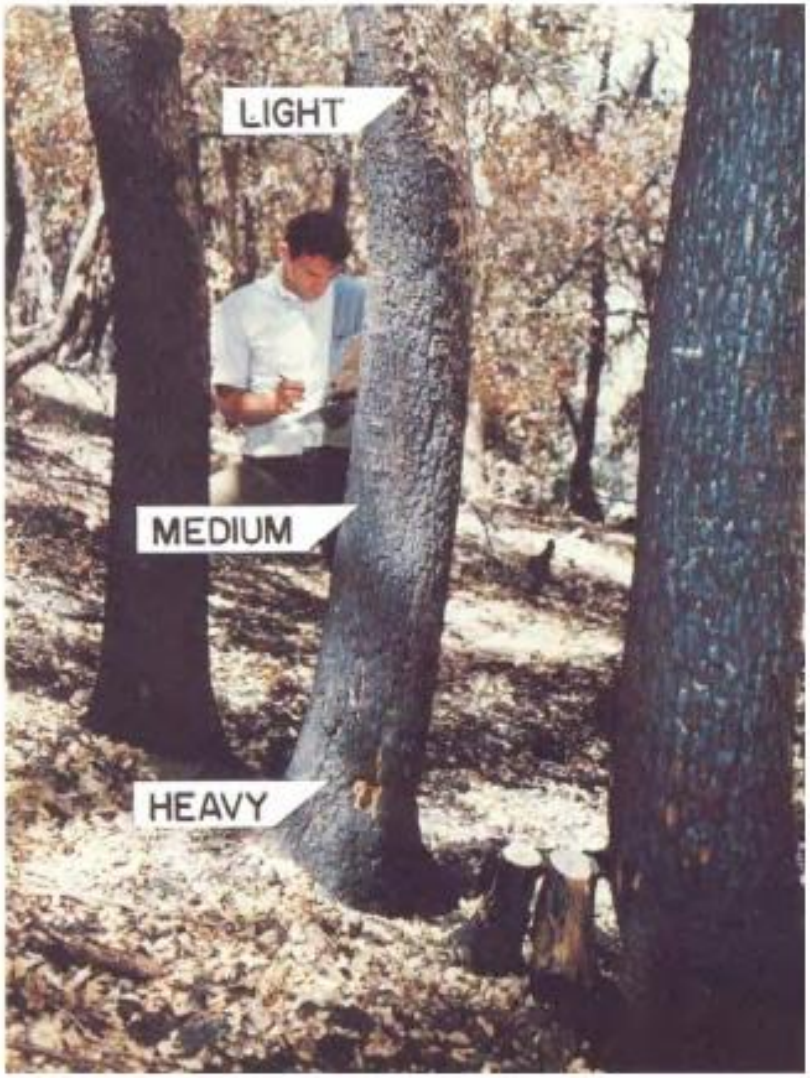
Figure 61—California Black Oak: After repeated fires, a tree may be hollowed out until only a ring of live tissue remains. Wind breakage is common in such trees.

hard and the underlying tissue tan or brown. This contrasts with the soft, gray bark surface of healthy trees that readily scratches off, revealing a soft, green, subsurface layer of bark. Occasionally, small desposits [sic] of dried sap are present that have oozed to the bark surface during the fire.

The second step is to estimate cambium damage. This can be based on the amount of charring, should be checked initially and periodically during a survey. If the bark was completely consumed, or if it has cracked or separated from the wood, it can be assumed that the cambium is dead. If the bark is intact and firmly attached to the wood, it is necessary to cut through the bark to determine the condition of the cambium (*fig. 64*). If the inner bark has a yellow tinge (*fig. 64*), not white or pink, the cambium is either dead or seriously damaged.

The cambium and wood may be stained dark brown or black, even though the inner bark appears healthy. It has not yet been determined if such stained tissue is dead or how long after burning the staining occurs. As a note of caution, it is

Figure 62—Canyon Live Oak: Even a low intensity fire can girdle the base of a fire-sensitive or small tree. Although the trunk and crown may live for several years after a fire, they will eventually die, because of girdling of the trunk. Note the narrow zone of white-colored, live bark at the lower edge of the old bark.



difficult sometimes to determine if the cambium is damaged, especially soon after a fire. Damaged inner bark may remain moist and healthy-looking for weeks after being burned. Often it will have a fermented aroma. The minimum time after injury that it takes this aroma to develop is unknown.

Immediately after a fire, the width of a wound is fairly well approximated by the width of the charred area; however, the height of the wound may exceed the height of the charred area by several feet. A small charred area at the base of a large tree with thick bark, like California black oak, however, may overestimate the amount of damaged cambium (*fig. 59*).

Guides for predicting the spread of butt rot in fire-scarred trees have not been developed for California oaks. Work on eastern oaks indicates that rot may spread upward at a rate of 1.5 to 2.2 inches (3.8 to 5.6 cm) per year, or about 1.5 ft (0.5 m) in 10 years.

Figure 63—Canyon Live Oak: Char classes: *Heavy*—(at base) yellow colored wood exposed through the bark. *Medium*—(at middle) continuous black char, some bark reduction. *Light*—spotty char (upper edge of burned area) with light tan to gray undamaged bark.

Variables Affecting Damage

The amount of damage to trees exposed to fire depends on the interaction of many variables that directly or indirectly affect the temperature of the living cells. Lethal temperature range for most plant tissue is between 110° and 139° F (43° and 59° C), with 125° F (49° C) considered fatal to the cambium. The higher the temperature, the quicker death occurs.

Not all trees are equally sensitive to fire, however, although individual cells fall within the temperature range just noted. The trunk and branches are also protected by a corky layer of bark, which is an excellent insulator. Even a thin layer of bark will give good protection from high temperatures for a short time.

Fire Characteristics

Fire behavior—rate of spread, energy release rate, and duration in particular—affects the amount of damage that occurs. A slow moving fire of low intensity and long duration

Figure 64—Interior Live Oak: Damaged cambium can best be detected by cutting into the wood. A dark or yellowish tone, as shown, indicates cambium kill.

may result in more damage to a tree trunk than a fast moving, high-intensity fire of short duration. The crown with its heat-sensitive leaves and small twigs will suffer greater damage, however, from the high-intensity fire of short duration.

Ambient Temperature

Initial bark temperature may determine whether the cambium is killed. Bark is damaged less in cooler temperatures.

Season of the Year

The amount of tree damage that results from fires has been correlated to the time of year that the fires occur. Conifers tend to be more sensitive to heat damage during the growing season than when dormant. The sensitivity of oaks and other broadleaf species to heat increases as season changes from winter through summer. The seasonal effect may result from (1) internal or physiological differences that affect tree sensitivity to heat, (2) differences in fire intensity, and (3) differences in ambient temperature, with lower temperatures in the spring than in the summer.

Tree Characteristics

Accurate prediction of tree response to fire requires knowledge of tree species, age, diameter, height, and bark characteristics.

Field studies have shown that all oak species do not have the same tolerance to fire nor the same recuperative capacity after being burned. Consequently, it is necessary that damaged trees be correctly identified. Specific fire responses of the species described in this guide are given in a subsequent section.

Variables directly correlated to age that affect fire tolerance are tree height, d.b.h., and bark thickness. Bark composition also changes with tree age and may increase or reduce a tree's fire tolerance.

Trunk diameter is correlated directly with age and stand density and is an important variable affecting tree survival. Large trees are more tolerant to fire than small trees because of thicker bark and a greater capacity to absorb heat and, more important, they have thicker bark. Trees of all species less than 6 inches (15.2 cm) d.b.h. will usually be topkilled by even a low intensity fire. Seedlings and small trees less than 2 inches (5.1 cm) d.b.h. will almost always be topkilled by all fires.

Amount of crown damage is related directly to height above ground. Trees that attain large size may suffer little or no crown damage from a low intensity surface fire if the bottom of the crown is 20 to 30 ft (6 to 9 m) above the ground. If the trunk is girdled, which is possible even from a light fire, however, amount of crown damage is unimportant because the top of the tree will eventually die even though it may take several years.

Bark is the best protection the cambium has against fire damage and other injuries. A natural insulator, it develops into a complex structure as the tree matures. The bark changes from a thin layer of epidermal cells in young stems to a thick, complex, multilayered zone in old trunks composed of outer

Table 1—*Recommendations for harvesting fire-damaged southern California oak trees on the basis of tree size and degree of trunk char* [1]

Species	Tree size and char condition								
	Less than 6 inches d.b.h.			6 to 12 inches d.b.h.			More than 12 inches d.b.h.		
	Light	Medium	Heavy	Light	Medium	Heavy	Light	Medium	Heavy
Coast live oak	Leave	Leave	Cut	Leave	Leave	Leave	Leave	Leave	Leave
California black oak	Cut	Cut	Cut	Leave	Cut	Cut	Leave	Leave	Cut
Canyon live oak	Cut	Cut	Cut	Leave	Cut	Cut	Leave	Cut	Cut
Interior live oak	Cut	Cut	Cut	Leave	Cut	Cut	Leave	Cut	Cut
California scrub oak	Cut	Cut	Cut	Leave	Cut	Cut	([2])	—	—

is uncertain. With the exception of a crown fire in which all trees are completely charred, degree of charring varies and individual tree evaluation is desirable. The suggestion to "cut" assumes that a tree is completely girdled with little or no chance that the trunk or crown will survive.

Coast live oak, which was found to be fire tolerant, can be left with the expectation that the trunk and crown will survive most fires. Some trees are killed under extreme burning conditions, and others are killed for reasons not yet identified. Only heavily charred trees less than 6.0 inches (15.2 cm) d.b.h. will probably be girdled and, for these trees, immediate cutting is suggested.

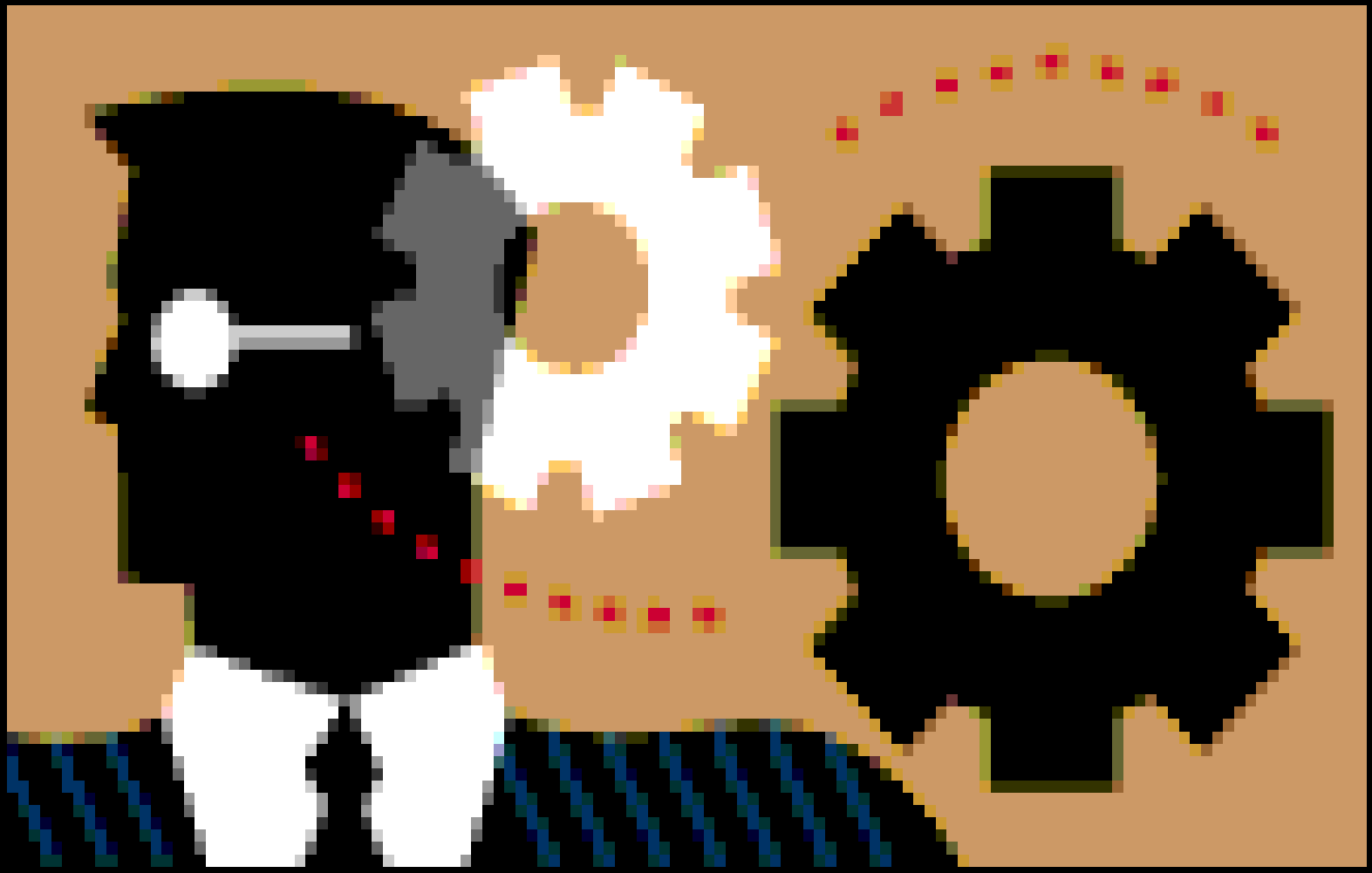
California scrub oak is at the other end of the tolerance spectrum—it is fire intolerant. Generally, it can be cut after most fires, however, lightly charred trees larger than 6.0 inches d.b.h. may survive and should not be cut immediately. In addition to being small, California scrub oak is usually part of a chaparral cover that burns with high intensity. Consequently, the trees are unlikely to survive most fires.

Recommendations for harvesting California black oak, canyon live oak, and interior live oak that have been fire-damaged are about the same for all three species. All trees less than 6 inches d.b.h. can be cut if they have received even light charring that encircles the trunk. Lightly charred trees 6 inches d.b.h. and larger should be left with the expectation that they will survive. Medium and heavily charred trees can be cut as they have little chance of surviving. Large California black oak trees with only medium charring as well as trees of all three species with d.b.h. of 24.0 inches (60.8 cm) or larger, probably can be spared with the hope that they will survive.

Many fire-damaged trees expected to survive have basal wounds that do not completely girdle the trunk. The crown can survive when less than 10 percent of the trunk is left ungirdled. Even in this condition, such a tree can provide all of the amenities of an undamaged tree, except for quality lumber. Consequently, what percentage of the trunk circumference must be damaged to recommend cutting? The prime consideration is whether the tree is currently or potentially a mechanical risk, especially trees in recreation areas. If a wound is narrow, the major portion of the trunk will remain intact, adequately supporting the crown. A tentative guide for cutting partially girdled trees is the following: for trees less than 6 inches (15.2 cm) d.b.h., cut them if more than 75 percent of the trunk is girdled; for trees greater than 6 inches d.b.h., cut them if more than 50 percent of the trunk is girdled.



Postfire Tree Management



Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

We have
***real* trees**

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Forest Health Protection

Pacific Southwest Region

April 2012 (Report # RO-12-01)

Hazard Tree Guidelines For Forest Service Facilities and Roads in the Pacific Southwest Region

Peter A. Angwin, Daniel R. Cluck, Paul J. Zambino, Brent W. Oblinger and William C. Woodruff

These hazard tree guidelines provide a means to identify and abate hazard from trees that are likely to fail and cause injury to either people or property on Forest Service system roads or at Forest Service facilities (i.e. campgrounds, boat ramps, trailhead parking, summer home tracts, administrative sites, kiosks, information centers, etc.) in California. They are intended to provide consistent direction for hazard tree identification and abatement and their use is highly encouraged and fully supported by Forest Health Protection (FHP) staff.

It must be recognized from the outset that even under the best of circumstances and with the highest standard of care, our ability to predict tree failure is not infallible. Simply put, we are limited in our ability to reasonably foresee all tree failures all the time. However, by exercising good professional judgment and using a systematic approach such as the one suggested in these guidelines, it is possible to significantly reduce (but not totally eliminate) the risk of injury to people and damage to property (Figure 1) .

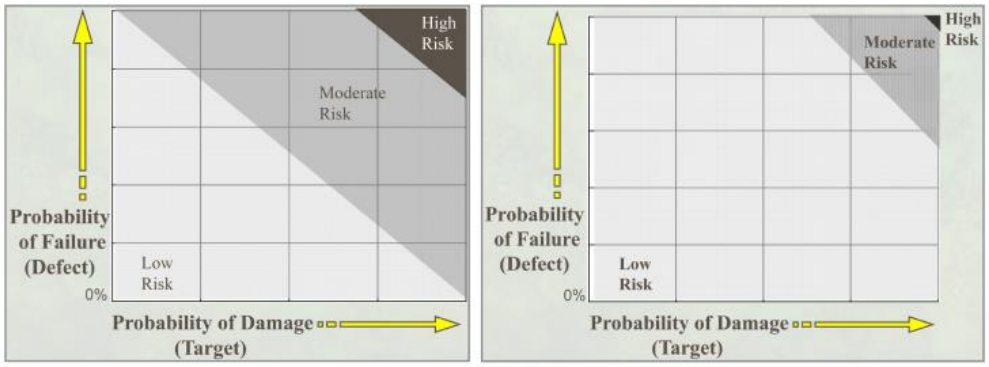


Figure 1. Distribution of risk in a tree population before (left) and after (right) hazard tree inspection and high-priority action (Dunster and Associates Environmental Consultants Ltd.)

Tree Hazards for Conservation Workers

- Tree Hazard incorporates not just the condition of the tree, but also the potential target. So hazard is:

  - Defect: potential for tree failure,

    +

  - Target: potential for serious loss should the tree fail, which includes:
    - potential for hitting and damaging target
    - value of target

Tree Hazards for Conservation Workers

- **Objectives:**
  - **Review common tree defects that indicate failure hazard**
  - **Consider exposure to tree hazards**
    - **Task, duration, and equipment**
  - **Discuss tree hazard responses**
  - **Consider ecological values of defective trees**

Tree Hazards for Conservation Workers

- **Defects:**

Tree Hazards for Conservation Workers

- **Defects:**
- Dead Trees, Tops and Branches

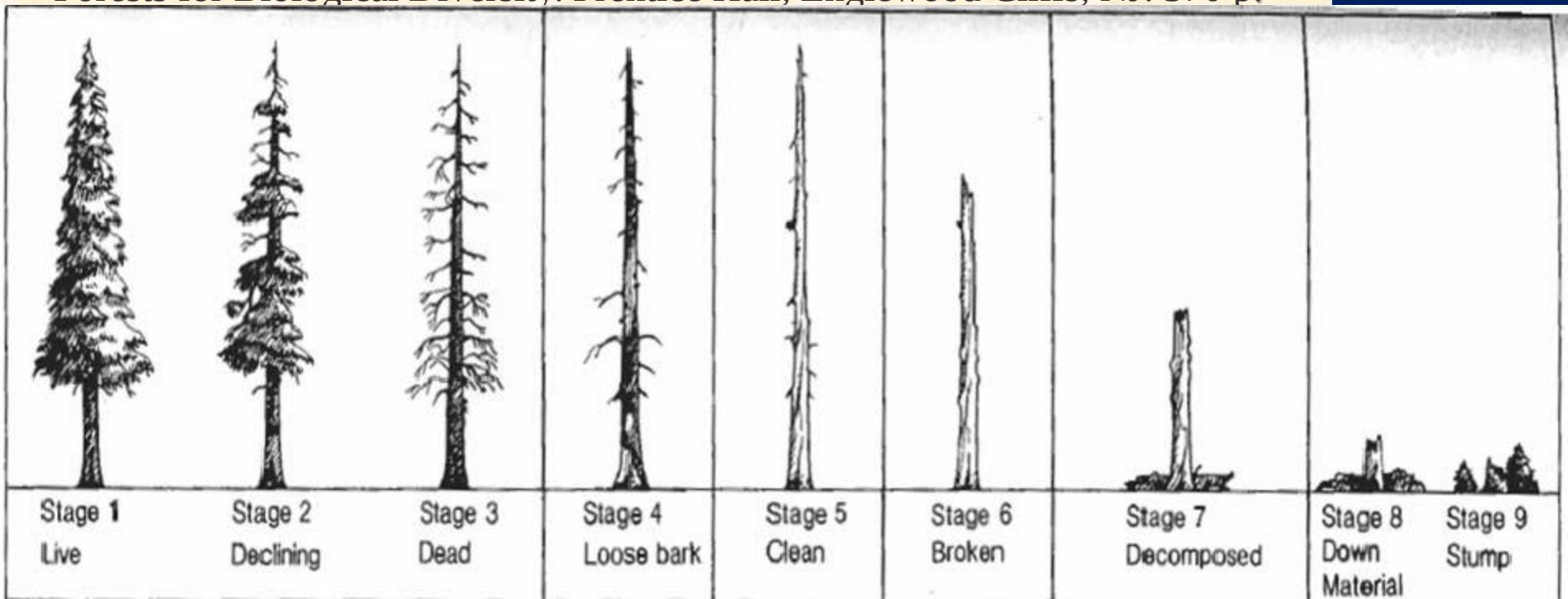
Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

- Snag Classes:

Nine Class Method: Hunter 1990

Hunter, M.L. 1990. Wildlife, Forests, and Forestry: Principles of Managing Forests for Biological Diversity. Prentice Hall, Englewood Cliffs, NJ. 370 p.



Tree Hazards for Conservatio

Tree Hazards for C

- **Defects:**
- Broken trees

Tree Hazards fo

- **Defects:**
- Broken trees

Tree Hazards for Conservation Workers

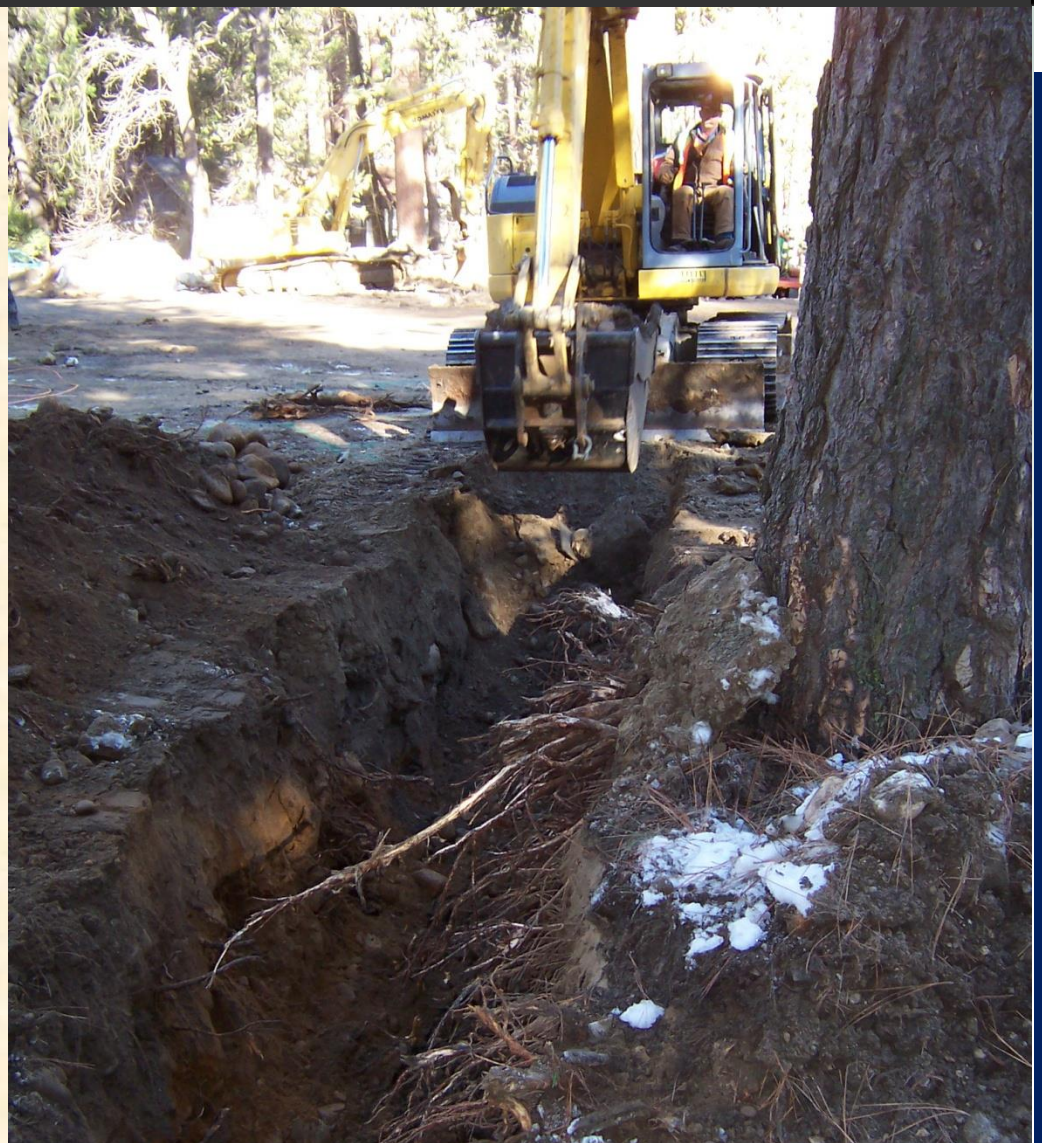
- **Defects:**
- Root problems

Tree Hazards for Conservation Workers

- **Defects:**
- Root problems

Tree Hazards for Conservation Workers

- **Defects:**
- Root Problems
  -soil disturbance



Tree Hazards for Conserv

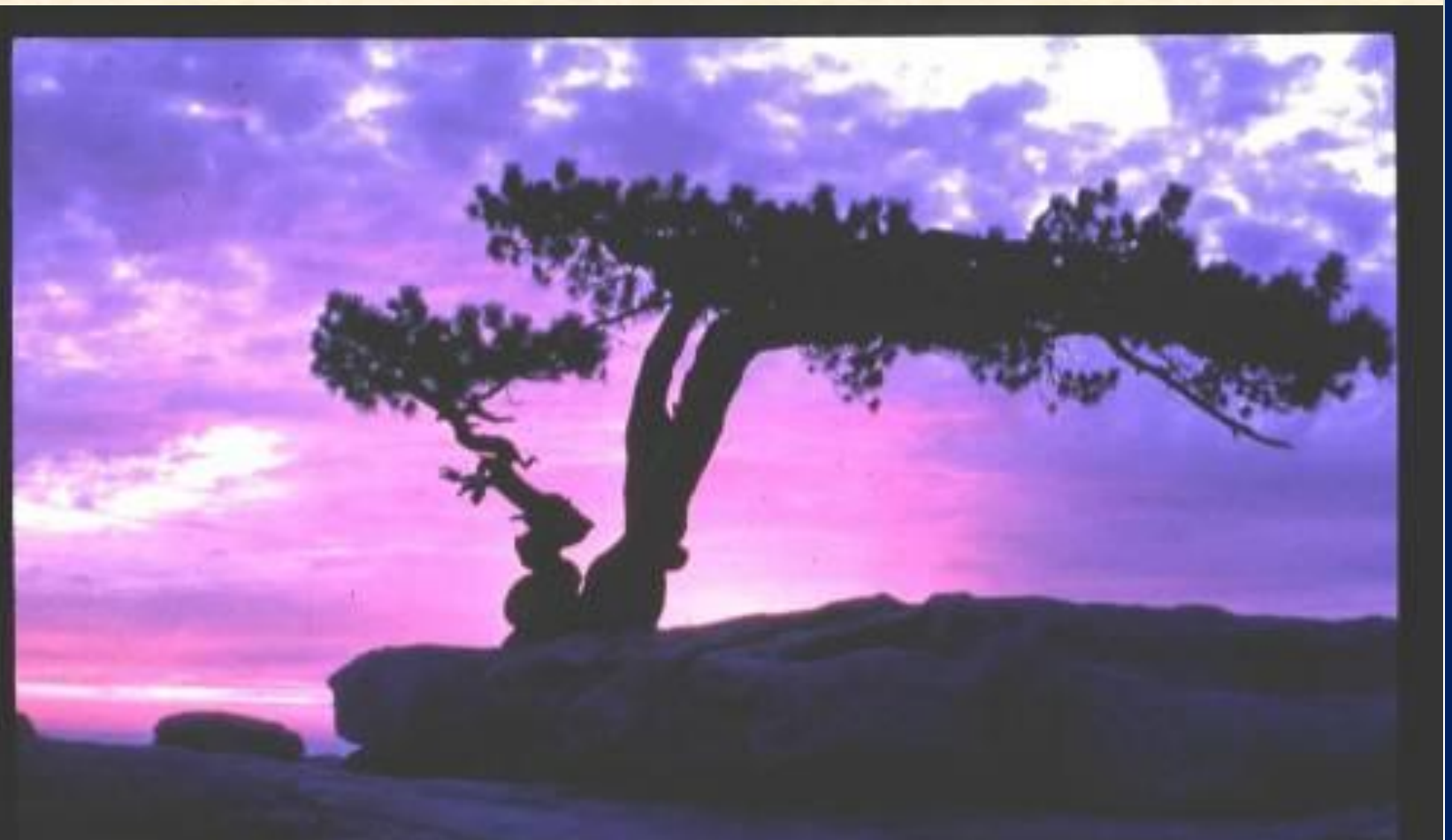
- **Defects:**
- Poor Crown Architecture

Tree Hazards for Conservation Workers

- **Defects:**
- Poor Crown Architecture

Tree Hazards for Conservation Workers

- **Defects:**
- Poor Crown Architecture



Tree Hazards for Conservation Workers

- **Defects:**
- Poor Crown Architecture

Tree Hazards for Conservation Workers

- **Defects**
- Lean

- **1. “Old” lean**

Tree Hazards fo

- **Defects**
- Lean

- **1. “New” lean**

Tree Hazards for Conservation Workers

- **Defects**
- **Lean**
  - **2. “New” lean**

Tree Hazards for Conservation Workers

- **Defects**
- **Lean**
  - **2. “New” lean**

Tree Hazards for Conservation Workers

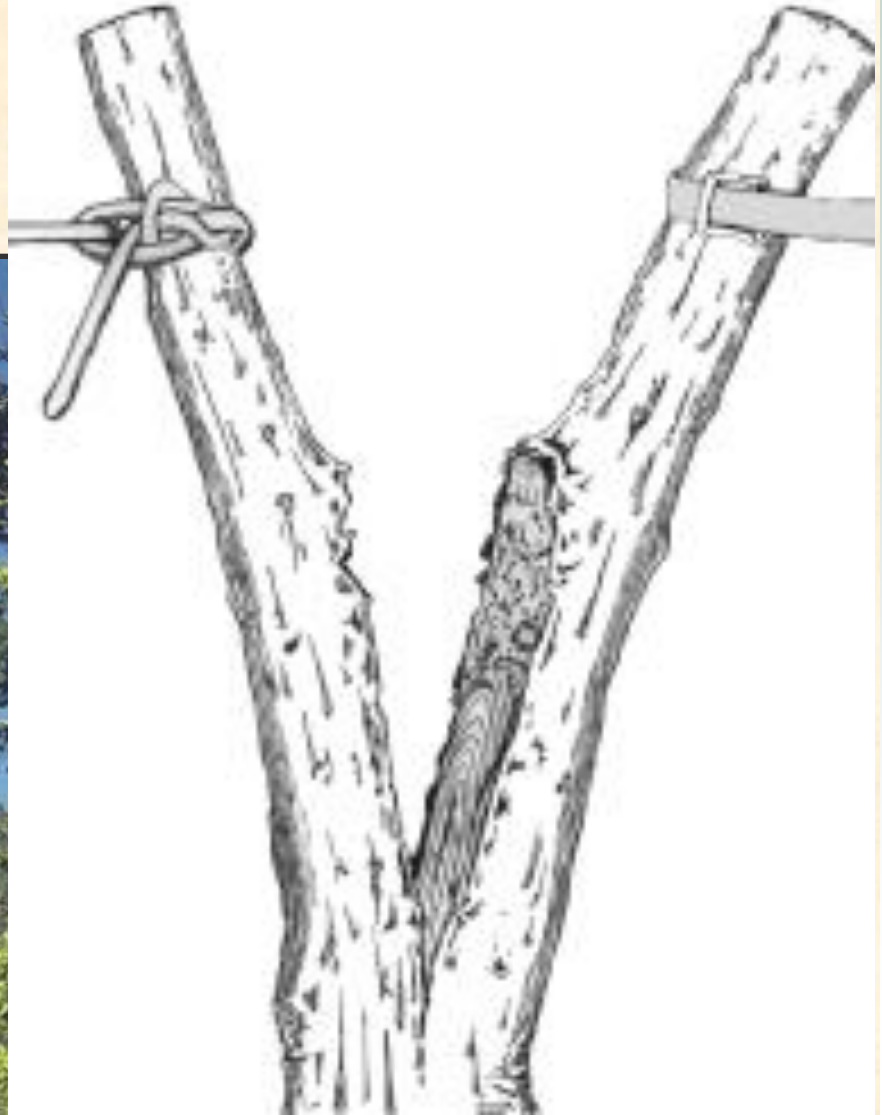
- **Defects**
- **Lean**
  - **2. “New” lean**

Tree Hazards for Conservation Workers

- **Defects**
- Forks
- Without included bark

Tree Hazards for Conservation Workers

- **Defects**
- Forks
- With included bark



Tree Hazards for C

- **Defects**
- Forks
- With included bark

Tree Hazards for Conservation Workers

- **Defects**
- Forks with cracks

Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

- **Defects**
- **Decay**

Tree Hazards for Conservation Workers

- **Defects**
- **Decay**

Tree Hazards for Conservation Workers

- **Cracks, cankers, and wounds**

Tree Hazards for Conservation Workers

Tree F

USDA Forest Service photo credit John Pronos

Tree Hazards

Tree Hazards

Tree Hazards

Tree Hazards fo

Tree H

Tree Hazards


Aw, c'mon.
Don' worry 'bout it.
It's just a little sore
and my Pathologist
says I'm hardly even
contagious...
CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION
CAL FIRE

Tree Hazards fo

Tree Hazards for Conservation Workers

Wound Signals:

- Extreme butt flare
- Daylight
- Check back of tree!

EXPERIENCE YOUR AMERICA

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EXPERIENCE
YOUR
AMERICA

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USDA Forest Service, Forest Health Protection, Northeastern California Shared Services Area

Hazard Tree Alert

True firs that survived wildfires are failing in as little as three years

Black trees.....Be on the lookout for hazardous trees in burned forests. This kind of warning is common when conducting work in areas that have experienced wild or prescribed fires. Fire-killed trees are usually abundant and begin to fall about 3-5 years post-fire, creating very hazardous working conditions. Performing your job in these areas requires you to be extra cautious at a minimum, and under certain weather conditions such as wind, to stay out of areas entirely. Walking a wide path around existing snags is one way to reduce the odds of being struck should one fail.

Green trees.....But what about the surviving trees? Recent monitoring of fire-injured trees has revealed the failure of 8" to 24" dbh red and white fir, with green crowns, in as little as three years. The rate of failure increases dramatically after the fourth year post-fire, especially in conjunction with high winds or heavy snows.

During the 1999 Bucks Fire on the Plumas National Forest the crowns of many true firs were light to moderately scorched. However, these same trees suffered moderate to severe cambium injury and near complete girdling in some cases. Following the fire, frass and/or boring dust from wood boring and ambrosia beetles was evident on many of the tree boles, often indicative of internal injury. Bark sloughing over the last couple of years from the damaged areas of the bole and root collar has revealed extensive decay of the sapwood, however, most of these trees have maintained green crowns. During the fourth year post-fire, a few trees within the burn that had green crowns and extensive bole decay failed. In the fall of 2004, after an early storm brought heavy snow and wind, many more trees failed with these same characteristics. This has also been observed recently in a few fir trees in the 2001 Star Fire (Tahoe National Forest) and the 2000 Storrie Fire (Lassen National Forest). Based on the number of failed green trees observed this year in the Bucks Fire, true firs in these other fire areas are likely to start coming down at a higher rate within the next couple of years. People working in these areas or any other recently burned areas that contain red or white fir with similar fire injury, i.e. moderate to severe bole scorch with light to moderate crown scorch, should consider these trees hazardous until a closer inspection of the bole is completed. Forest Health Protection is currently working on fire-injured tree evaluation criteria to facilitate the early identification of trees that may succumb to the type of decay and failure presented here. For more information, contact Sheri Smith or Danny Cluck of the Forest Health Protection staff at 530-257-2151.

Extensive bole charring on this "live", 12" dbh red fir resulted in cambium kill and subsequent attack by ambrosia and wood boring beetles. Decay is now nearly 100% in pre-fire sapwood.

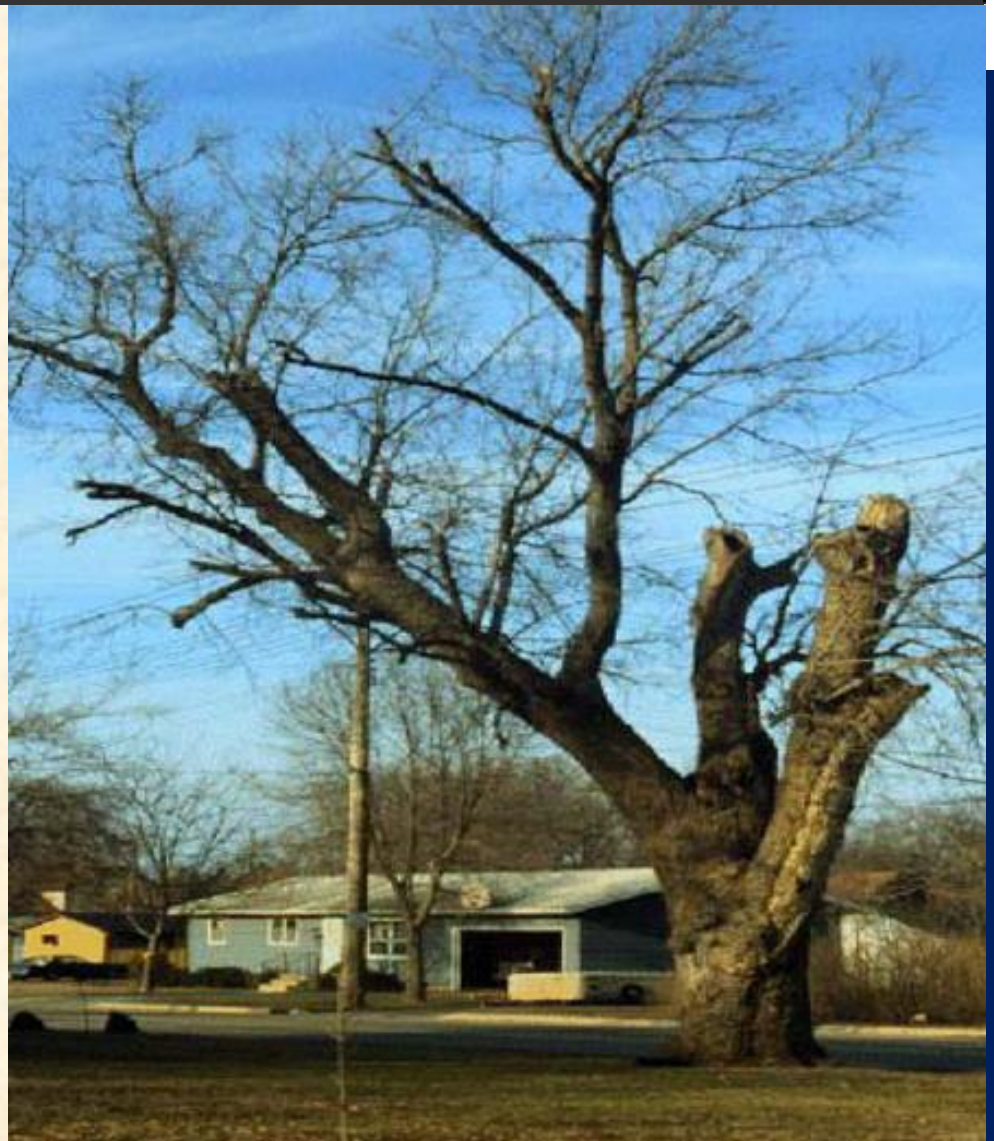
This 18" dbh red fir suffered >50% cambium kill during the 1999 Bucks Fire. It failed in the fall of 2004 with a full green crown.

This 8" dbh, fire-injured white fir was surviving with <5% of its functional xylem and phloem. The crown was still green when it failed in 2004.

Tree Hazards for Conservation Workers

- **Multiple Defects**

?



Tree Hazards fo

- **Multiple Defects**

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Tree Hazards fo

- **Multiple Defects**

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Tree Hazards for Conservation Workers

- **Multiple Defects**

?

Tree Hazards for Conservation Workers

Tree Hazards for Conserv

Tree Hazards for Conservation Workers

- Targets

Tree Hazards for Conservation Workers

- Targets
  - The second component is the **Target** value and represents impact potential and target value (monetary or possibility of injury/death). In this example the values for this element are rated 1-3, with 3 being the highest. A target rated 3 is one with a high value (property or person) and a high likelihood of being impacted in event of failure.
    - Highest Level (3)--Overnight Exposure
    - Campgrounds
    - Lodges, hotels, dormitories
    - Residences
    - 24-hour visitor service facilities

Tree Hazards for Conservation Workers

- Targets
  - Highest Level (3)-- Overnight Exposure

Targets

Medium Level (2)-- Daytime Exposure

Tree Hazards for Conservation Workers

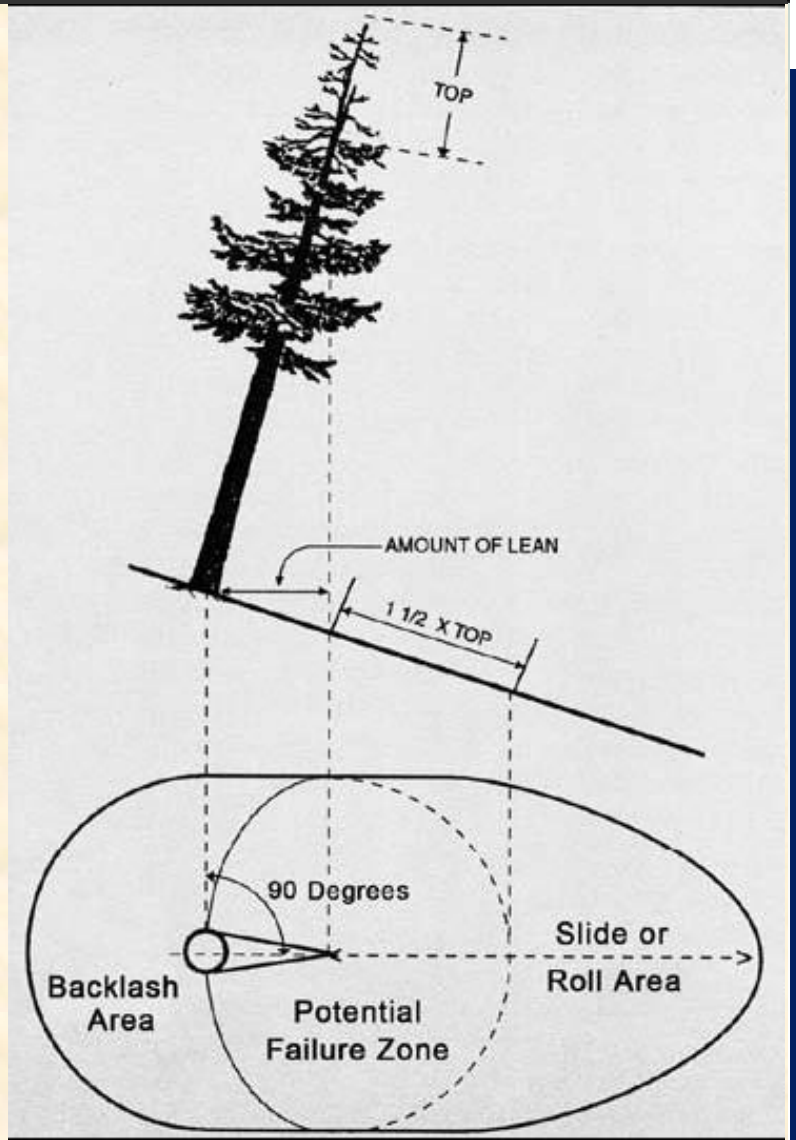
- Targets
  - The second component is the **Target** value and represents impact potential and target value (monetary or possibility of injury/death). In this example the values for this element are rated 1-3, with 3 being the highest. A target rated 3 is one has a high value (property or person) with a high likelihood of being impacted in event of failure.
  - Low Level (1)--Transitory exposure
    - Highway corridors
    - Turnouts
    - Bone Yards

- Targets
  - Low Level (1)--Transitory exposure
    - Highway corridors
    - Turnouts
    - Bone Yards

Tree Hazards for Conservation Workers

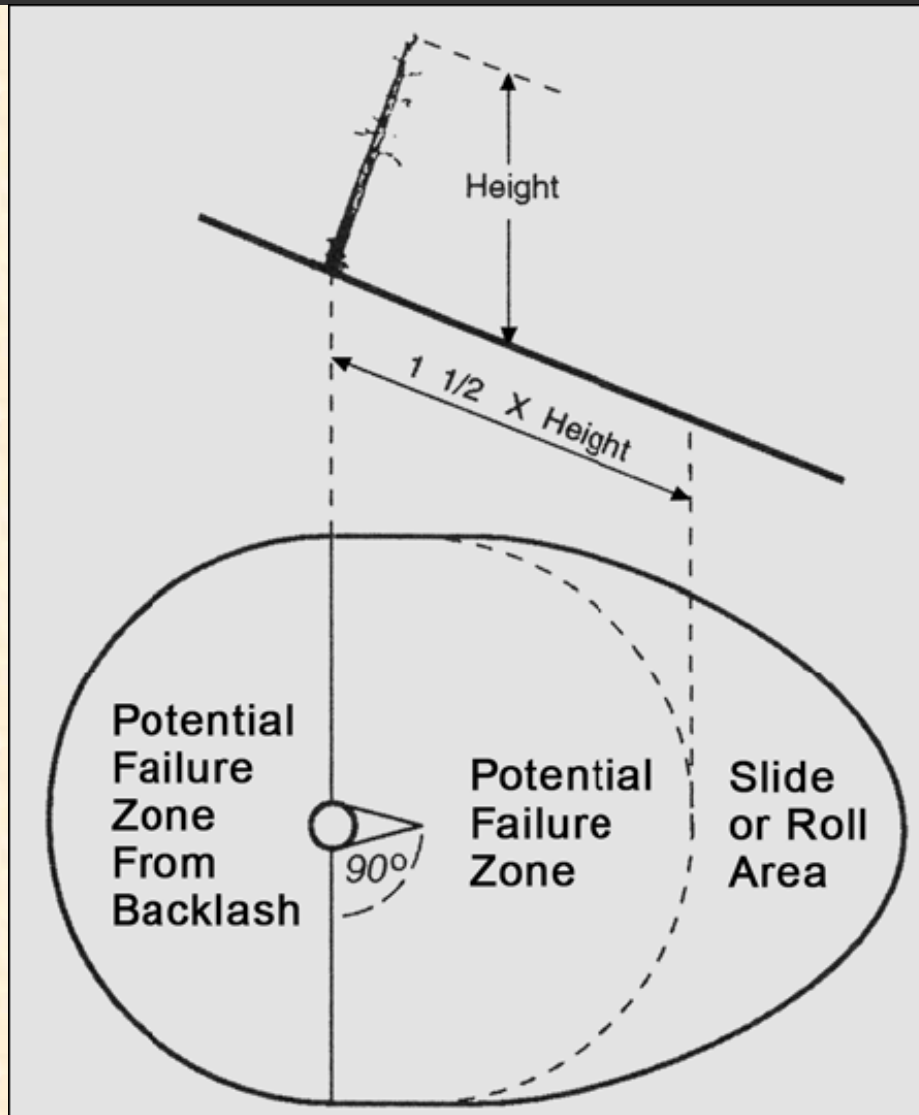
- Targets

  On sloped ground where the dislodged section may slide or roll downhill, the potential failure zone must be extended on the downhill side for whatever distance is necessary to protect workers.



Tree Hazards for Conservation Workers

- Targets
- The failure zone is an area at least 1 ½ times the tree height beginning at the tree base then extending towards the direction of the lean and out 90 degrees on either side of the tree from the lean direction.



Tree Hazards for Conservation Workers

- **Tree Hazard Response**

Tree Hazards for Conservation Workers

- **Tree Hazard Response**
  - **Hazard Abatement**
  - **Hazard Mitigation**

Tree Hazards for Conservation Workers

- **Tree Hazard Response**
  - **Hazard Abatement**
    - **Avoidance**
      - **– Facility design/Placement**
      - **– Preventing construction damage**
      - **– Avoiding or removing old trees**
    - **Site closure**
      - **– Temporary (time to plan mitigation)**
      - **– Seasonal (storm seasons)**
      - **– Permanent (relocate target)**
    - **Warnings--integral component of comprehensive strategy**

Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

Tree Hazard Response

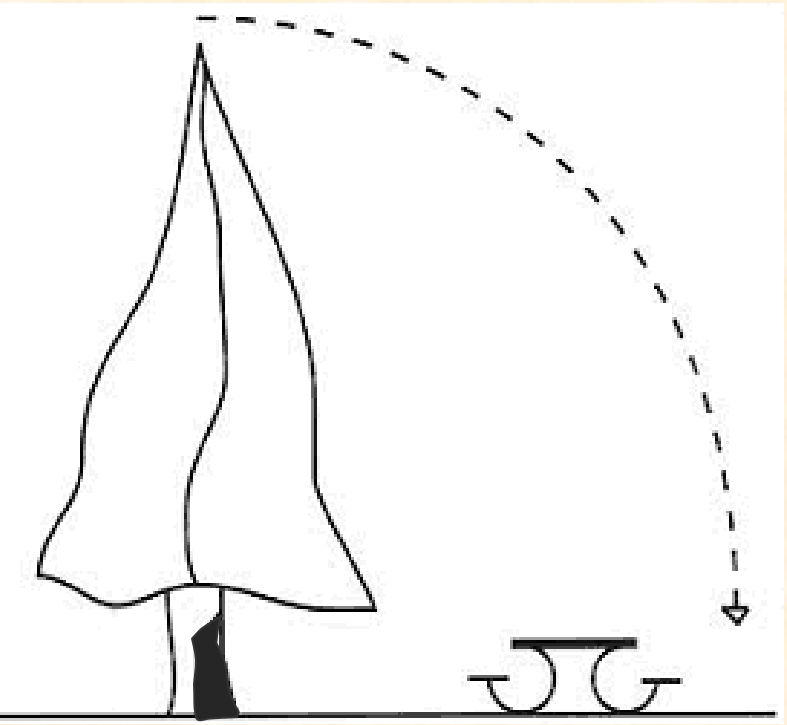
Hazard Abatement

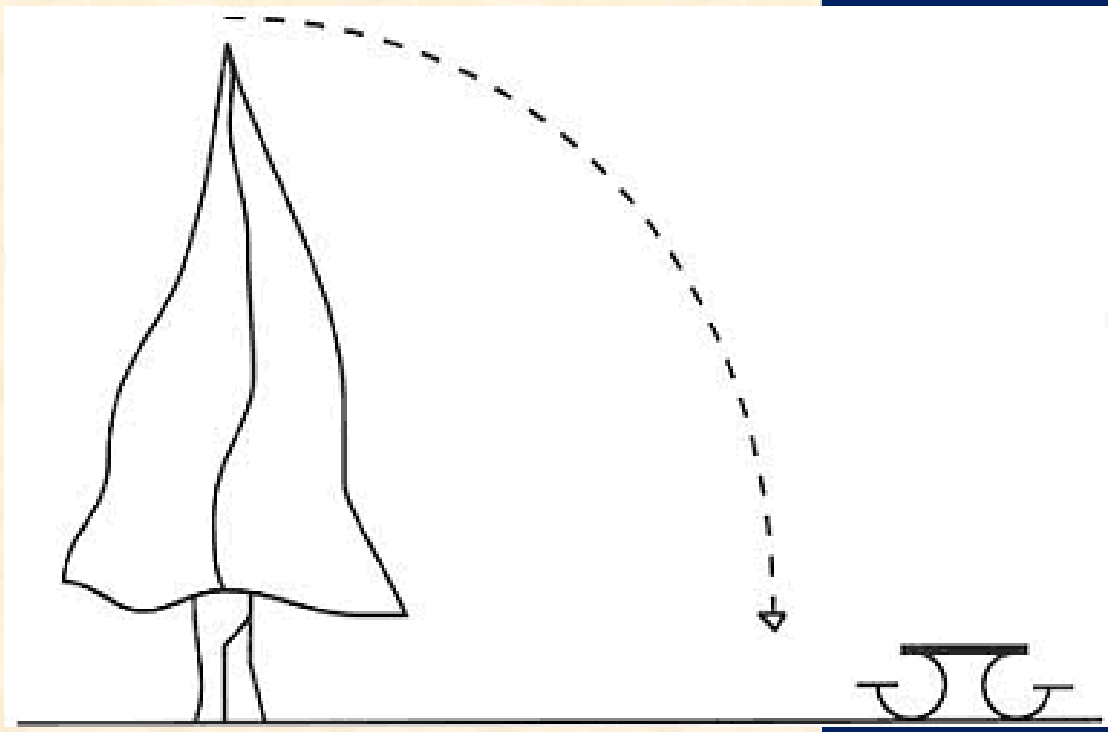
- Avoidance
  - Facility design/Placement
  - Preventing construction damage
  - Avoiding or removing old trees
- **Site closure**
  - **Temporary (time to plan mitigation)**
  - **Seasonal (storm seasons)**
  - **Permanent (relocate target)**
- Warnings--integral component of comprehensive strategy

Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers





Tree Hazards for Conservation Workers

- **Tree Hazard Response**
  - **Hazard Abatement**
    - Avoidance
      - Facility design/Placement
      - Preventing construction damage
      - Avoiding or removing old trees
    - Site closure
      - Temporary (time to plan mitigation)
      - Seasonal (storm seasons)
      - Permanent (relocate target)
    - **Warnings--integral component of comprehensive strategy**

Tree Hazards for Conservation Workers

touch or closely approach any park wildlife. Instead, view wildlife through binoculars or telephoto lenses. A good rule-of-thumb: if an animal is aware of your presence, you're too close.

Tree Failure Advisory

Winter storms with strong winds or heavy wet snow always cause some tree failures, sometimes with property damage or tragic injuries. Trees adjacent to developments such as residences, campgrounds, lodging, offices, parking lots, and some roads are surveyed for defects that may make them likely to fail and injure people or damage property. Yosemite forestry crews prune or remove identified high priority tree hazards.

Some trees without any visible defects fail during storms. To avoid injury or damage to your property, be aware of your surroundings and park in open areas when storms are blowing or forecast.

08/16/2005

Tree Hazards

Tree Hazards for Conservation Workers

Yosemite National Park

National Park Service
U.S. Department of the Interior

Tree Mortality Can Cause Hazardous Conditions

Upon entering Yosemite National Park, you may have noticed patches of discolored trees in otherwise green forests. These parched, brown, dead and dying trees are the result of an ongoing drought, warming temperatures, native bark beetles, and poor forest health. Millions of trees in the southern Sierra Nevada, particularly at lower elevations, have died. In Yosemite, there are an estimated 2.4 million dead trees within about 131,000 acres, especially between 3,000 and 4,500 foot elevations.

Falling branches, limbs, and trees can cause hazardous conditions, and may pose risks to life and infrastructure, especially in developed areas. While in Yosemite, please remain observant of your surroundings, particularly in campgrounds, lodging and picnic areas, roadsides, and while hiking on trails. Contact a park official if you see any potentially hazardous situations.

KEEP YOUR SAFETY A PRIORITY

- **BE AWARE** of your surroundings. Trees, limbs, and branches can fall at any time.
- **BE ATTENTIVE** while hiking on trails, looking up and around regularly, especially during high winds.
- **BE CAUTIOUS** when selecting a place to park, camp, picnic, or rest. Look for high-risk trees and limbs that can fall.
- **BE IN CONTROL.** The increased number of dead trees pose a fire risk. As always, make sure you are in control of your campfire at all times, and that it is completely out when you are finished. Obey all fire restrictions.

Yosemite National Park

National Park Service
U.S. Department of the Interior

Tree Mortality and What Causes It

Tree mortality simply refers to the death of trees in a forest. Tree mortality is a natural process that often benefits a healthy forest ecosystem. However, the recent tree mortality event is unprecedented, with an estimated 102 million dead trees throughout the Sierra Nevada. The immediate cause of this mortality event is a combination of bark beetles and extended drought. Once trees are weakened by the lack of water, they are much more susceptible to bark beetle attack. Simultaneously, warming temperatures and milder winters during the drought have increased native bark beetle populations. More importantly, this mortality event is really a broader symptom of poor forest health in many areas. Historically, wildfire maintained healthy forests by reducing flammable debris, such as dead twigs and needles, and also reducing the overall number of trees in the forest. After over a century of fire exclusion, many forests have extremely high tree densities that greatly increase competition for limited water supplies during drought.

A Bark Beetle's Role In Tree Mortality

Bark beetles are similar in size to a grain of rice. Rising temperatures, below-average rainfall, and increased competition for water as a result of fire suppression have interacted to weaken trees, creating ideal conditions for bark beetles to invade. When adult beetles attack a tree, they bring in fungi that can interrupt the tree's transport of water. They then lay their eggs in the thin layer of tissue between the bark and wood of a tree that transports nutrients, which the larvae feed on. When large numbers of beetles attack, the interruption they cause to water and nutrient flow can eventually kill the tree. One pair of mating beetles can produce more than 12 million beetles a year.

Tree Mortality Forecast

It is possible that tree mortality in California forests will continue for the next three to five years, due to existing trees currently infested by bark beetles or trees that are stressed, weak, and susceptible to bark beetles. Otherwise, it is unknown if high levels of tree mortality will continue in the coming years.

National Park Service Actions Regarding Tree Mortality in Yosemite

The National Park Service (NPS) has made the safety of Yosemite's visitors and employees its primary concern and has increased staff specifically for identifying and removing hazardous trees. Since 2016, NPS employees and its park partners have removed over 5,000 trees each year that posed direct risk to life or infrastructure, from developed areas such as campgrounds, lodging, picnic areas, roadsides, and housing areas. The NPS has also applied a verbenone, an anti-aggregant pheromone, to healthy sugar pines in developed areas to prevent beetle attacks this year. Outside of developed areas, most of Yosemite is designated wilderness, where NPS allows natural processes to prevail. The NPS has also formed partnerships with the US Geological Survey, US Forest Service, and other academic researchers to study the effects of drought and develop management measures concerning prescribed fires and mechanical thinning, which may lessen drought impacts.

Tree Hazards for Conservation Workers

- **Tree Hazard Response**
  - **Hazard Abatement**
  - **Hazard Mitigation**
    - **Take down**
    - **Pruning**
    - **Cabling/Bracing**

Tree Hazards for Conservation Workers

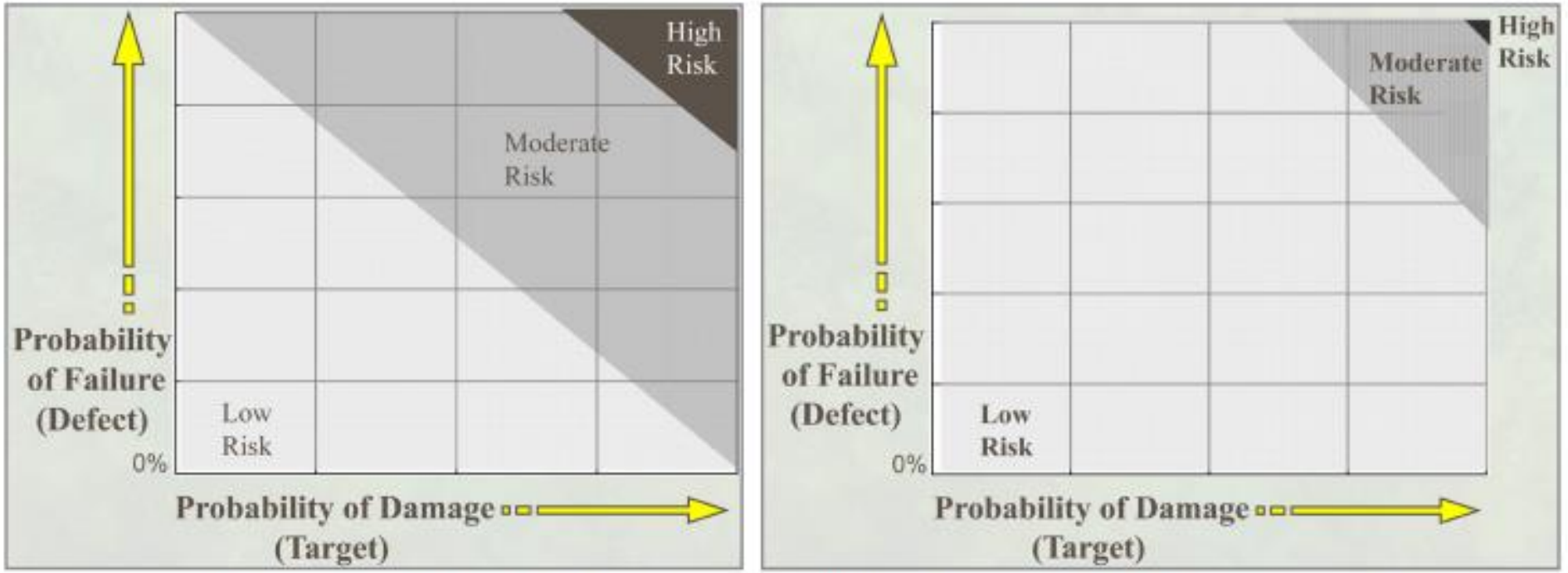
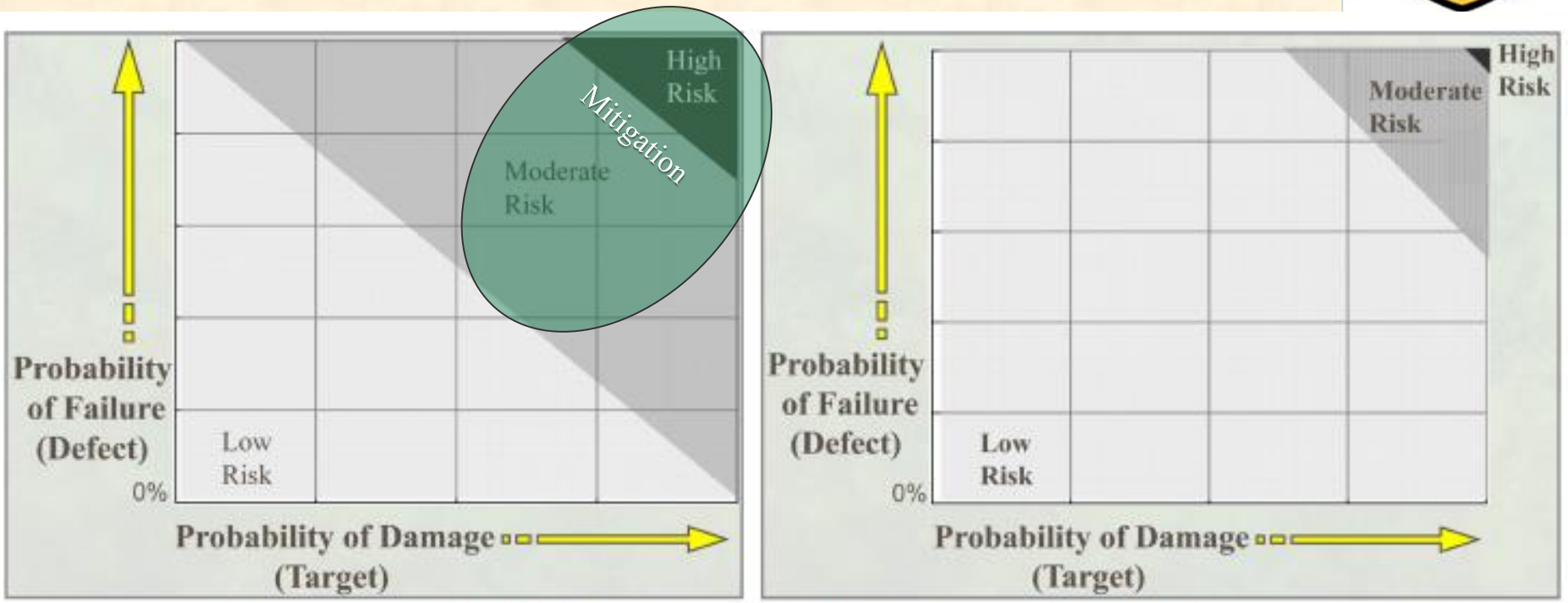


Figure 1. Distribution of risk in a tree population before (left) and after (right) hazard tree inspection and high-priority action (Dunster and Associates Environmental Consultants Ltd.)

Focus mitigation efforts on rated trees with high Probability of Failure (defect) and high Probability of Damage (target) to push the most High Risk and Moderate Risk trees off the graph

Tree Hazards for Conservation Workers



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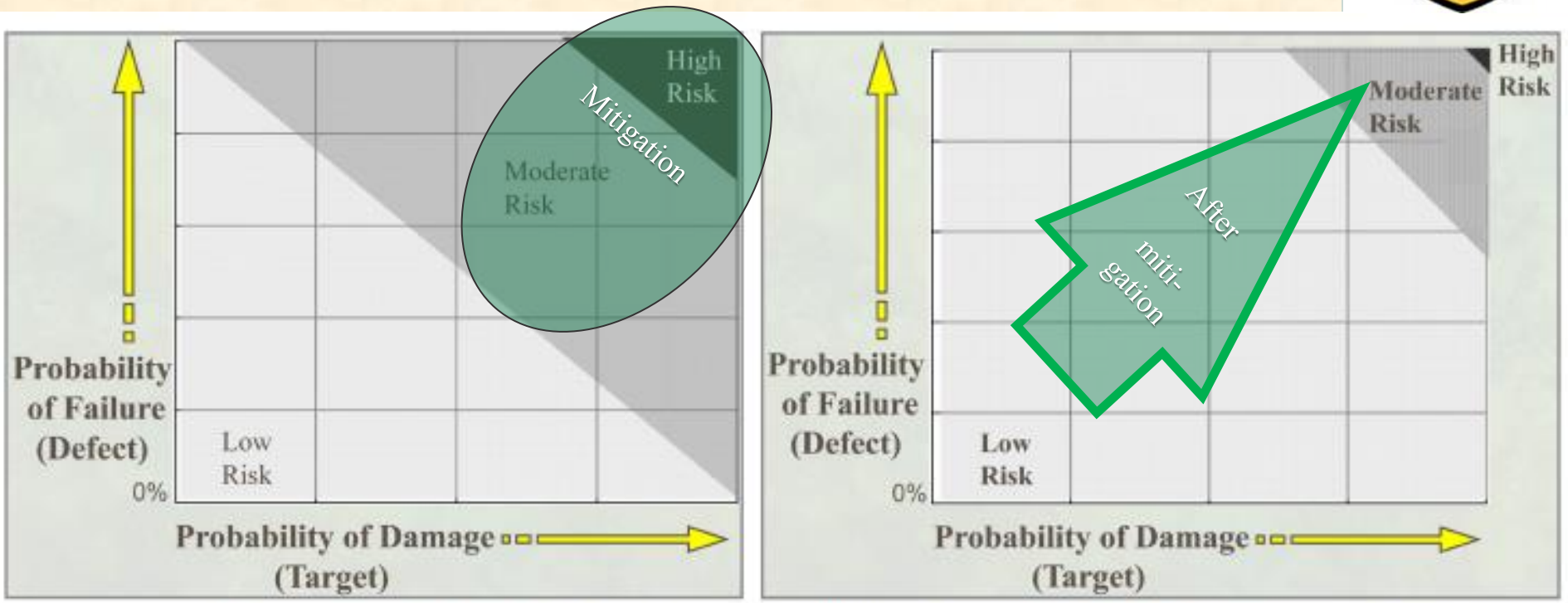

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Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

Safety and Health
Tech Tips

United States Department of Agriculture
Forest Service
Technology & Development Program
April 2008
6700

Felling Hazard Trees With Explosives

Bob Beckley, Project Leader

Felling hazard trees is extremely dangerous. It can also be dangerous to leave hazard trees standing, because they can fall unexpectedly. Removing hazard trees with explosives (figure 1) can be a safe alternative to cutting the trees down. Workers can be a safe distance away when the hazard tree falls. Explosives and ignition systems are safe and reliable when used properly. The Forest Service, U.S. Department of Agriculture, explosives program is one of the agency's safest programs. Certified blasters need a "Hazard Trees" endorsement on their certification card (figure 2) to fell hazard trees with explosives.

Figure 1—Fireline explosives have been wrapped around the trunk of this hazard tree. Note the cutface (scar on the trunk), splits, cracks, and the separation of part of the trunk. Trees with these warning signs can be too dangerous for most sawyers to fell, but are excellent candidates for felling with explosives.

Highlights...

- Some trees with excessive decay or fire damage are too hazardous for sawyers to fell safely. Often, explosives can be used to fell such trees.
- Trees felled with explosives have jagged stumps that appear more natural than sawn stumps, an advantage in wilderness settings.
- In the Forest Service, only certified blasters with a "Hazard Trees" endorsement can use explosives to fell hazard trees.

Figure 2—To remove hazard trees with explosives, blasters must have the "Hazard Trees" endorsement on their certification card.

TD

For additional information, contact: Bob Beckley, project leader, USDA Forest Service, MTDC, 5785 Hwy. 10 West, Missoula, MT 59808-9361. Phone: 406-329-3996, fax: 406-329-3719, e-mail: rbeckley@fs.fed.us

Explosives
Tech Tips

USDA United States Department of Agriculture
Forest Service
Technology & Development Program
September 2013
7700

Production Hazard Tree Blasting

Jim McBreen, Rocky Mountain Region Lead Blaster, and Bob Beckley, Project Leader

Highlights...

- The Forest Service uses explosives to mitigate large numbers of beetle-killed trees, especially on steep ground.
- The Frost Creek-Sawmill Gulch Production Hazard Tree Blasting Project is an example of how prework safety and the loading procedures for explosives were handled correctly.
- This tech tip provides information on how a blasting crew successfully removed 661 hazard trees during one week and the operational lessons they learned.

An epidemic of mountain pine beetle is affecting forests across the Western United States. Currently, hundreds of thousands of acres of lodge pole pine have succumbed to this species of bark beetles. The large continuum of dead trees creates many hazards, more than 150,000 trees may fall each day. As a result, land managers have closed recreation areas, roads, and trails in an effort to protect forest users from the danger of hazard trees falling unexpectedly.

The Frost Creek-Sawmill Gulch Production Hazard Tree Blasting Project demonstrated the practicality of using explosives to fell large numbers of hazard trees. Tree diameters ranged from 6 to 24 inches. The average tree diameter was 16 inches. In drainages with extremely steep slopes and loose footing, removal of hazard trees by mechanical treatment or chain saw felling was considered too dangerous. The Eagle-Holy Cross Ranger District's risk analysis of the area eliminated all methods of traditional mitigation. Use of explosives was determined to be the safest method available (figure 1).

Figure 1—Felling large numbers of trees on steep ground can be safely done with explosives. Do not re-enter the area until blasts clear.

TD

For additional information, contact: USDA Forest Service, MTDC, 5785 Hwy. 10 West, Missoula, MT 59808-9361. Phone: 406-329-3900, fax: 406-329-3719, email: wo, mtdc, jcabolds fed.us

Tree Hazards for Conservation Workers

Dan Fischer /
National Park Service

Tree Hazards for Conservation Workers

Other Legal Considerations:

California state forest and fire laws and regulations are adopted as federal law under the Assimilative Crimes Act (18 U.S.C. 13).

Including California Public Resources Code:

4291 Reduction of Fire Hazards Around Buildings

4292 Power Line Hazard Reduction

4293 Power Line Clearance Required

Lone Cypress

Article Talk

From Wikipedia, the free encyclopedia

The **Lone Cypress** is a Monterey cypress tree located in Pebble Beach, California. Standing atop a granite headland overlooking Carmel Bay, the tree has become a Western icon and has been called one of the most photographed trees in North America.

History [edit]

Early history [edit]

The tree is believed to have been seeded circa 1750 in what was then the Spanish colony of New Spain. However, due to the invasive nature of traditional dendrochronology, the precise age of the tree is unknown and can only be inferred.[1][2]

Over the centuries the tree has been weathered by the wind and salt spray coming off the Pacific Ocean, gradually altering its appearance. The earliest known depictions of the tree's likeness in paintings and photographs date to the 1880s, which shows the tree with a lush dome-shaped canopy.[3]

20th century [edit]

In 1941, a stone retaining wall was constructed around the base of the tree to protect its roots from erosion.[2]

In 1948, a series of cables were installed to help support the tree.[2]

In 1969, the tree was fenced off to the public in order to protect its roots from being damaged from trampling.[2]

In 1984, an unknown arsonist attempted to set fire to the tree. The tree survived with only minor fire scarring.[2]

21st century [edit]

On February 16, 2019, the tree lost one of its limbs during a severe weather event known as a Pineapple Express. This dramatically altered its appearance.[4][5]

Tree Hazards for Conservation Workers

The goals of hazard tree management programs are to maximize public safety and maintain a healthy sustainable tree resource. Although hazard tree management frequently targets removal of trees or parts of trees that attract wildlife, it can take into account a diversity of tree values. With just a little extra planning, hazard tree management can be highly beneficial to wildlife while maintaining the goals of the program. The objective of this information guide is to provide considerations regarding wildlife when making decisions during hazard tree assessments. The decision-making model provided with this guide can be used as a tool during tree inspections.

Tree Hazards for Conservation Workers

What is the link between hazard tree management and wildlife? There are more than 120 species of birds, 140 kinds of mammals and 270 species of reptiles and amphibians that nest and forage in dead or deteriorating trees. Often in hazard tree management, it is the dead and deteriorating parts of a tree, or the entire tree (such as a snag), that is removed. This can negatively impact wildlife populations and species that are dependent on these trees as essential habitat components. It is likely that these trees may not be replaced for years. As the number of cavity trees decrease, wildlife species that depend on cavities may disappear.

Tree Hazards for Conservation Workers

Why are considerations for wildlife important?
Surveys demonstrate that wildlife is important to people. In a recent study, landowners identified wildlife as a key reason for owning land. Other studies show that, in urban areas, 93% of residents want to know how to attract wildlife and support habitat, and each year 49 million people in the U.S. enjoy feeding and watching birds. In addition, some threatened and endangered species use snags, cavity trees, or dead and down logs as important habitat components. When a tree dies, its usefulness does not end, its role simply changes.

Tree Hazards for Conservation Workers

How to identify trees currently and potentially useful to wildlife.

A few ways to identify trees currently used by wildlife include:

- 1. observations of wildlife using a tree
- 2. signs of wildlife use (existing cavities, dens or current woodpecker activity in a tree)
- 3. presence of fresh scat or bird droppings in, on or around a tree

Trees potentially useful to wildlife include:

1. trees with decay
2. trees with fungal conks (a sign of decay)
3. trees with broken off tops and branches
4. trees with old wounds or scars

Tree Hazards for Conservation Workers

If a tree does not have a cavity , it can still be used by wildlife. Dead or partially dead trees without cavities can provide foraging, perching and nesting sites for non-cavity nesting species.

Where and when is it appropriate to consider wildlife in hazard tree management? It is appropriate where and when human safety is not compromised.

Who benefits by using hazard trees and for what purpose?

Tree Hazards for Conservation Workers

forage sites woodpeckers

perches hawks

nest sites chickadees, great blue herons, ospreys, wood ducks, mergansers, woodpeckers

den sites raccoon, fisher, pine marten, porcupine, gray and flying squirrels, cottontail rabbits, snowshoe hare, bear, bobcat

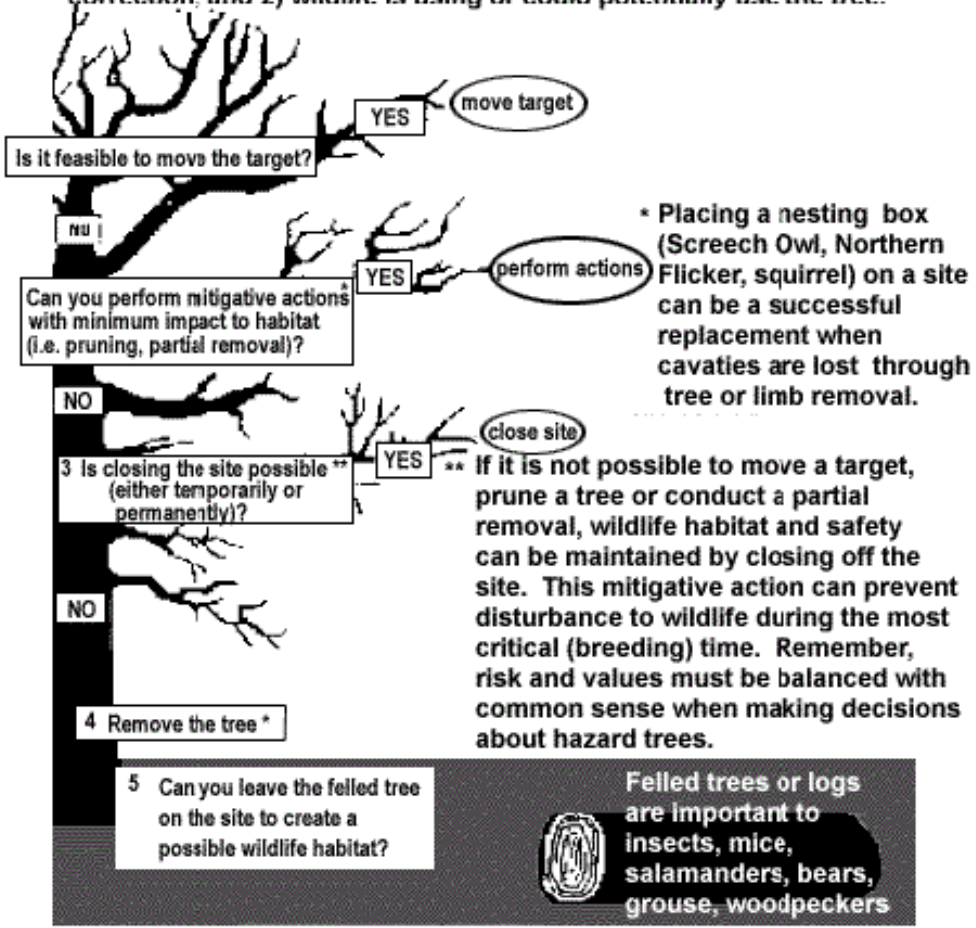
singing perches songbirds

roost sites bats, tree frogs

Tree Hazards for Conservation Workers

Wildlife Habitat / Hazard Tree Decision Model

This model provides a logical order of decision making that will help minimize impact to wildlife and maintain, enhance, and/or create wildlife habitate while addressing hazard tree concerns. Assumptions that are built into the model are: 1) there is a hazard tree that needs correction, and 2) wildlife is using or could potentially use the tree.



* Placing a nesting box (Screech Owl, Northern Flicker, squirrel) on a site can be a successful replacement when cavaties are lost through tree or limb removal.

** If it is not possible to move a target, prune a tree or conduct a partial removal, wildlife habitat and safety can be maintained by closing off the site. This mitigative action can prevent disturbance to wildlife during the most critical (breeding) time. Remember, risk and values must be balanced with common sense when making decisions about hazard trees.


08/01/2005


08/01/2005

Tree Hazards for Conservation Workers


Photo by Marshall Iliff

Tree Hazards for Conservation Workers

Tree Hazards f

Tree Hazards for Conservation Workers

TREE RISK ASSESSMENT QUALIFICATION

Hazardous trees regularly lead to death or injury of arborists and property owners. To address this issue, the ISA has created the Tree Risk Assessment Qualification (TRAQ). TRAQ promotes the safety of people and property by providing a standardized and systematic process for assessing tree risk. The results of a tree risk assessment can provide tree owners and risk managers with information to make informed decisions to enhance tree benefits, health, and longevity.

Through education and training, arborists will learn strategies to systematically identify and assess tree risk. The qualified professional will:

- be proficient with the fundamentals of limited-visual and basic tree risk assessment, as defined in ISA Best Management Practices: Tree Risk Assessment;
- understand the principles of advanced diagnostic techniques for assessing tree risk;
- gather and synthesize information needed to assess tree risk; and
- make reasoned judgments and recommendations for mitigating identified risk.

Matrix 2. Risk rating matrix.

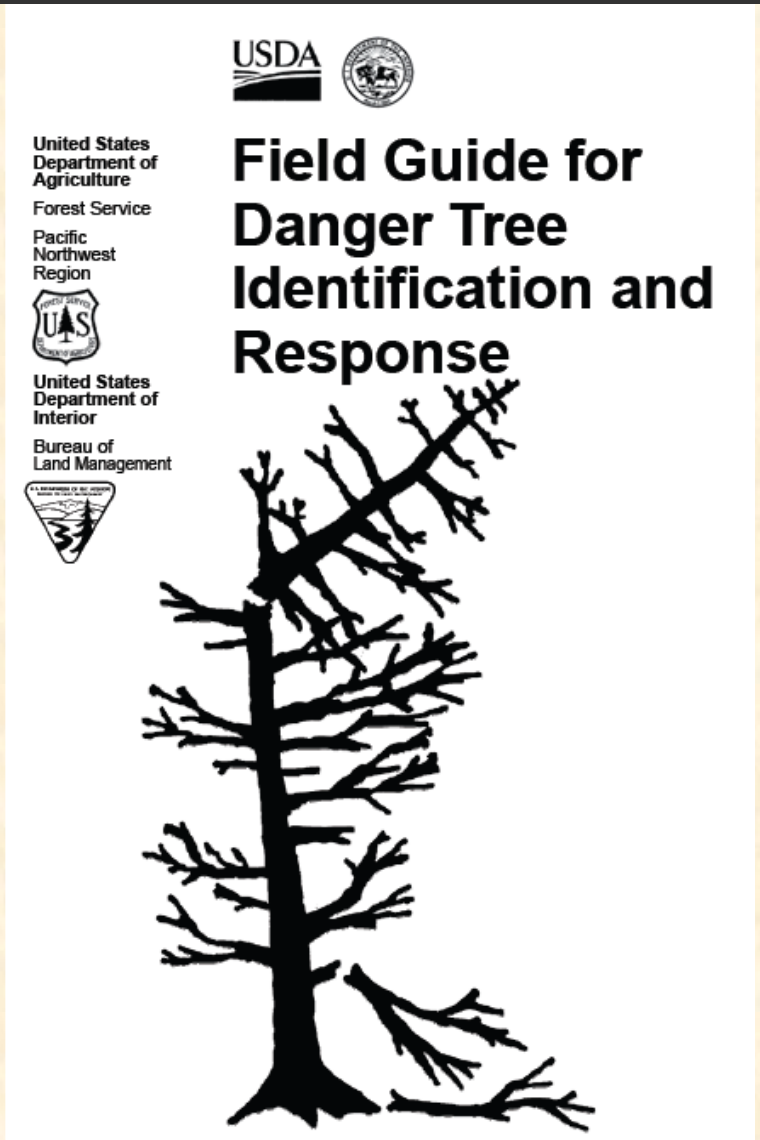
Likelihood of Failure & Impact	Consequences of Failure			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Tree Hazards for Conservation Workers

resources

publications

Tree Hazards for Conservation Workers



Tree Hazards for Conservation Workers

Safe Workplace

- **Trained Observer**
- **Levels of Exposure**
  - **passing through**
  - **working under**
  - **equipment (dozer/aircraft)**
- **Duration of Exposure**
  - **intermittent**
  - **brief**
  - **prolonged**

Tree Hazards fo

Tree Hazards for Conservation Workers

Evaluation of Hazard Trees in Urban Areas.

This book is published by the International Society of Arboriculture.

This is the second edition of this guide which is comprehensive in the information offered and practical in approach. The many photographic illustrations describe common defects, decay patterns and pruning abuses. A form for the collection of data is provided along with guidance on its completion. Species failure patterns are listed and and formulae are given to calculate the strength loss in trees with cavities.The approach to hazard evaluation is based on the work of Paine and others as described in

Hazard Trees a background.

In order for a tree to pose a hazard there must be a likelihood of failure and the risk that, having failed, the tree will do damage. To evaluate the degree of hazard three distinct factors must be assessed.

The factors are.

1/ The likelihood of failure.

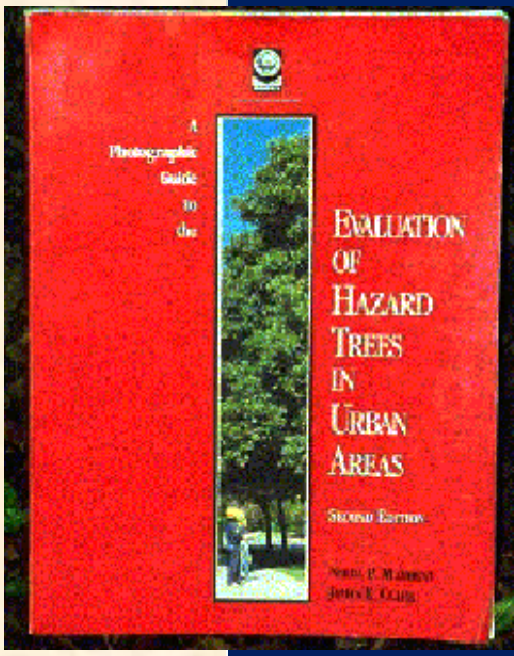
2/ The size of the piece most likely to fail. (from small branch to whole tree)

3/ The presence of a 'target' (something that would be affected in the event of the failure).

The rating relates to the occupancy or use of the target.

The three factors; Failure potential, Target and Size of part are given a numerical rating, 1 to 4. Failure Potential is rated based on known problems in tree species, existing defect or disease and exposure The three numbers added together give a Hazard Rating with the number 12 being a large part the most likely to fail and cause extensive damage to a significant target.

The hazard rating may be used to prioritize treatment and forms part of an ongoing assessment of tree hazard.



HOW to

Recognize Hazardous Defects in Trees

United States Department of Agriculture

Prepared by Forest Service

Northeastern Area State & Private Forestry

NA-FR-01-96

6 Minutes FOR SAFETY

Today's discussion is from the Hazard Tree Category.

CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION
CAL FIRE
SINCE 1885

Hazard Trees – Situational Awareness

Snags (dead, standing trees without leaves or needles in the crowns) and green hazard trees present a significant threat to wildland firefighter safety. Snags typically have much lower fuel moistures than live, green trees; and they burn more readily. In the process, they often throw off embers creating spot fires in advance of the main fire. Snags may burn through more quickly than green trees and can fall without warning. Live, green trees weakened by insects, disease, weather, fire, and age presents another hazard and they can also fall without notice.

- The risk of serious injuries from hazard trees may increase during the night operational period when visibility is reduced.

- While work in cooler, nighttime environments can help control efforts, it also presents an increased risk from unseen falling snags and weakened live trees. Night operations should be restricted in areas of high risk rated dead and dying trees.

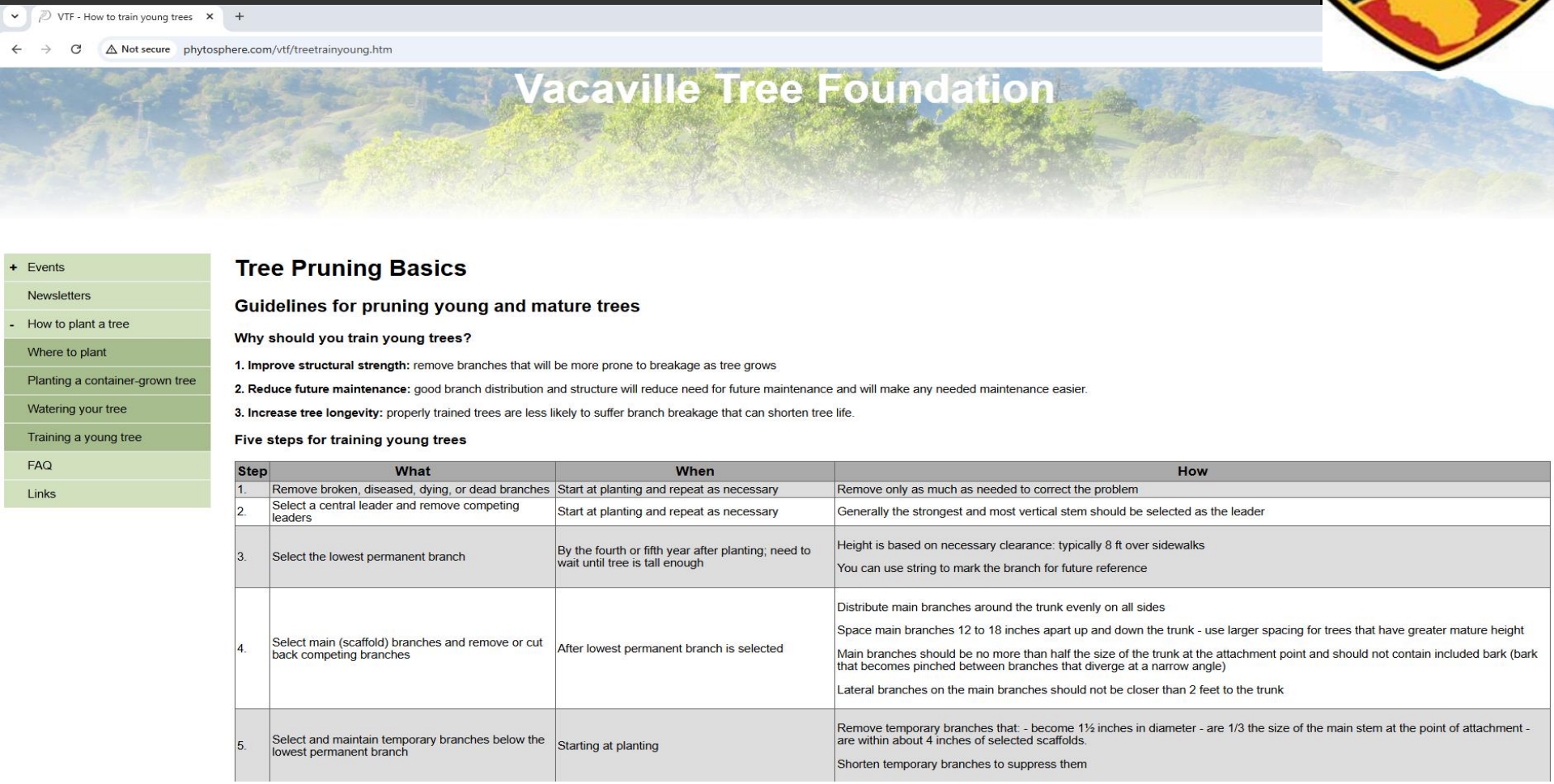
- Environmental conditions that increase risk from hazard trees: Strong or gusty winds from storm cells. Air operations - water or retardant drops, rotor wash from helicopters. Steep slopes with rolling material. Erosion and undercut root systems. Diseased or bug-killed areas (Mountain Pine Beetle).

- Things to consider when assessing the potential dangers of hazard trees: Trees have been burning for an extended period. High-risk tree species (those that are known for rot and shallow root systems) in the area. Numerous downed trees/material. Broken tops and dead limbs overhead. Accumulation of downed limbs, tree decay, cavities, splits, cracks, lack of needles, bark, limbs or other indicators of overhead hazards. Roots damaged by equipment, fire or erosion create hazards.

- Mitigation measures to take: Identify and establish No-Work-Zones (NWZ) in all high-risk areas until the hazard has been mitigated. Instruct firefighters of established NWZ in briefings. Identify with flagging/signs, and show area on maps. Establish lookouts to protect NWZs. Assign only qualified sawyers and Falling Bosses. Order additional professional fallers in advance. Use heavy equipment, and blasters when appropriate. Plan a quick and safe escape routes. Do not turn your back on a falling tree or known hazard. Use lookouts to maintain secure felling areas. Maintain situational awareness.

Tree Hazards for Conservation Workers

Tree Hazards for Conservation Workers

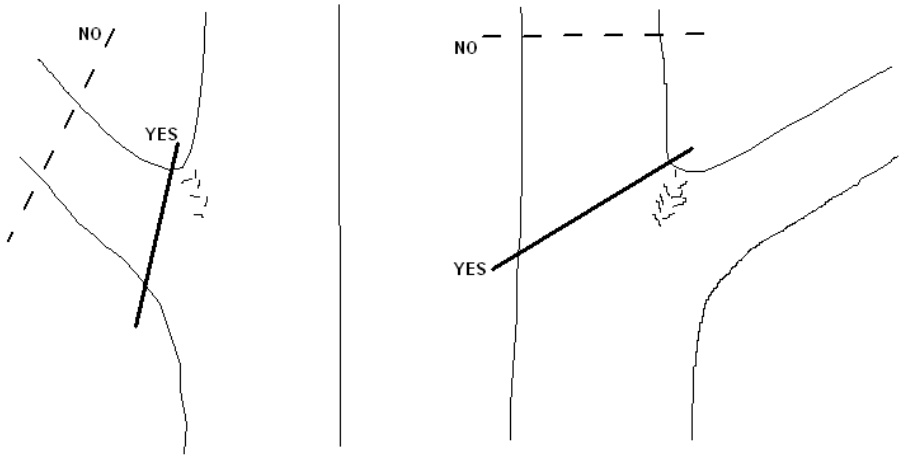


- **Don't remove any more branches than are needed to accomplish steps 1-5.**
- **Don't remove more than about 1/4 of the tree canopy in a single year. Commonly, no more than 5% to 10% of the canopy needs to be removed in a given year during training.**

Tree Hazards for Conservation Workers

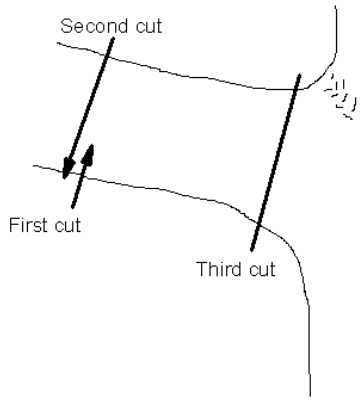
Proper pruning cuts

Best methods for placing pruning cuts on both young and mature trees



No stubs, No flush cuts

When removing a branch, cut all the way back to the main stem without leaving a stub, but don't try to cut flush to the main stem. A small collar of tissue is often present around the base of the stem - cut to the outer edge of that collar.



Use three cuts to avoid tearing bark

When removing a branch with a saw, first cut part way into the branch on the underside about a foot from the area where the final cut will be made. Then cut through the branch from the top. Finally, cut the remaining stub off cleanly near the main stem.

Pruning in this fashion will prevent the bark from tearing due to the weight of the branch, and will result in the smallest possible pruning wound.

Tree Hazards for Conservation Workers

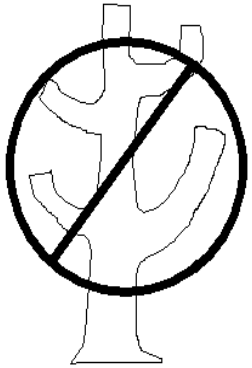
Prune back to a large enough branch

When reducing the length of a branch, place the cut next to a side branch that is:

- at least 1/3 the diameter of the removed stem for stems larger that 3/4 inch diameter
- at least 1/4 the diameter of the removed stem for stems of 3/4 inch diameter or less

For very small branches (up to about 1/2 inch diameter), cut back to a bud if no other branches are available

Don't top your tree!!



Topping (cutting large branches back to stubs) is bad for both you and your tree.

- Topping typically removes 50 - 100% of the leaf-bearing crown of the tree. This seriously weakens the tree, and can lead to branch decay and possibly tree death.
- After topping, trees respond by producing excessive numbers of fast growing shoots from latent buds. These sprouts are poorly attached to the stubbed branches and develop into branches that are prone to break off, especially in high winds.
- Topped trees require more maintenance than properly-pruned trees. Corrective pruning is required to make topped trees less hazardous, but can never really restore the tree to its previous form.

How do I choose an arborist or tree care service?

Recommendations from the International Society of Arboriculture (http://www.isa-arbor.com)

What to look for in an arborist or tree care firm:

- Membership in professional organizations such the International Society of Arboriculture (ISA), the National Arborist Association (NAA) or the American Society of Consulting Arborists (ASCA).
- Certification through the ISA Certified Arborist program.
- California State Contractors license (for jobs over $600.00) and proof of insurance.
- A list of references (Don't hesitate to check.)
- Avoid using any tree company that advertises topping or recommends that a tree be topped or uses tree climbing spikes to climb trees that are being pruned. Knowledgeable arborists know that topping is harmful to trees and is not an accepted practice. Climbing spikes can damage trees, and their use should be limited to trees that are being removed.

Tree Hazards for Conservation Workers

Training Young Trees for Structure and Form

A well-trained tree is easier to maintain than an untrained tree.

Trained trees have good structure, such as a strong central leader, appropriate vertical spacing between branches, branches that are well spaced radially around the trunk, and strong branch angle attachments.

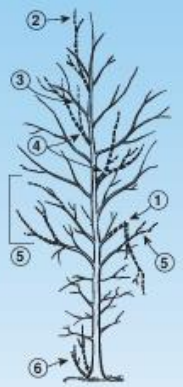
By providing training during the first five years, a tree will be easier to maintain at maturity, live longer, be more structurally sound, and have a lower risk of branch failure. Untrained trees are more likely to have structural defects possibly decreasing their life and an eventual loss of benefits to the urban forest. In addition, there is the loss of invested time and money.

How to Train Young Trees

Recommended 5 step process:

1. Remove broken, diseased, dying or dead branches.
2. Select a central upright leader and remove or head back competing upright shoots.

(see reverse for training steps)



3. Select the lowest permanent (scaffold) branch. This branch is the lowest branch that will remain on the tree through its life. This is determined by the use and location of the tree. Remember a branch at 4' will always be at 4'.
4. Select primary scaffold branches and cut back or remove competing branches. The scaffold branches should be radially spaced around the trunk and vertically spaced 12 – 15" between branches. Select scaffolds with strong branch attachment with diameter being no more than half the diameter of trunk.
5. Select temporary branches below the lowest permanent branch. Remove branches that have a diameter greater than 1/3 the trunk.

No more than 25% of a young tree's canopy should be removed in one year. Training is recommended during the dormant season or winter months.

Each year apply these steps to a young tree until good structure and form is achieved.

For more information about tree pruning contact your local University of California Cooperative Extension office, the ANR publications website at http://anrcatalog.ucdavis.edu, or consult a certified arborist.

Funding for this project made possible from the Elvenia J.

Tree Hazards for Conservation Workers

https://www.google.com/search?q=train+young+trees#fpstate=ive&vld=cid:8804888b,vid:lHnv0AstLK4,st:0

Research Article | Article

Training Young Trees

Richard W. Harris, W. Douglas Hamilton, William B. Davis and Andrew T. Leiser

Arboriculture & Urban Forestry (AUF) August 1975, 1 (8) 154-157; DOI: https://doi.org/10.48044/jauf.1975.036

In many cases, directing the growth of young trees is essential if mature trees are to perform properly in the landscape. This discussion will provide information to help you achieve desirable branch placement and structural strength in trees and may also be useful in training plants to other forms and shapes.

The growth habit of a plant and its landscape use determine how and to what extent you must prune the tree to train it to the desired form. Trees with a strong central leader and a conical shape like conifers, Liquidambar and pin oak, may need little or no pruning. On the other hand, trees with irregular growth habits like Chinese pistache, with poor branch structure like Modesto ash or with vigorous laterals as in flowering fruit trees may need considerable training. Street trees should have higher scaffold branches than trees used for visual screening or windbreaks. Pruning is usually the most effective way to direct the growth of a plant.

Prune a tree only enough to effectively direct its growth and to correct any structural weakness. With light pruning, the dwarfing influence will be minimal.

Branches selected for permanent scaffolds should have wide angles of attachment with the trunk and be smaller in diameter than the trunk. Height of first permanent branch above the ground will depend on the tree's use in the landscape. The position of a limb on a trunk remains essentially the same throughout the life of the tree. In fact, as a branch increases in diameter, the distance between it and the ground actually decreases.

The height of the lowest permanent branch can be a few inches from the ground to more than 12 feet depending on how the tree is to be used. Even though a certain clearance is needed over a street or a patio, a lower height may be selected if the limb is growing in a direction that will not interfere with traffic or use of the area under the tree.

Vertical branch spacing is important in many species for future leader dominance, structural strength, and appearance of the tree. Two or more vigorous branches arising at or near the same level on the trunk are apt to "choke" the leader and limbs above. This is especially true in "fast-growing" trees whose laterals grow from buds formed the previous season—such as flowering fruit trees, mulberry, and zelkova.

Often, on lightly or unpruned trees, the more vigorous branches will be naturally well-spaced while the other branches become relatively weak. Little or no pruning may be needed.

On mature trees closely spaced scaffolds may break out more easily than those with wider spacing. Closely spaced scaffolds will have fewer laterals, resulting in long, thin branches with little structural strength.

Vertical spacing should be greater on a tree that will develop into a large tree with large diameter branches than on a tree of smaller mature size.

Major scaffold branches should be spaced at least 18 inches vertically and preferably 18 to 24 inches. Many mature trees have branches 4 to 12 feet apart.

Radial branch distribution should allow 5 to 7 scaffolds to fill the circle of space around the trunk. This can be done in one or two rotations around the trunk. Although an ascending spiral may appear more symmetrical and pleasing, branches will grow equally well and be as strong even though their origins on the trunk depart from a spiral.

Radial spacing should prevent one limb from being over another when neither limb can develop properly. The lower one may be shaded out with no ascending branches. The upper one may be less vigorous in the presence of the lower which competes with it for water and nutrients.

Direct growth during the growing season as well as when the tree is dormant. Direction during the growing season is usually confined to shoots and branches that are temporary. Pinching the growing point (heading) or complete removal of a shoot (thinning) will reduce its competition with the leader or shoots selected for scaffold limbs. Pinch or remove shoots that are too low, too close, or too vigorous in relation to the leader and shoots selected to become the scaffold branches.

During the first and possibly the second growing season, more shoots should be left unpruned than will finally be selected for scaffolds. This will allow later selection of the best branches when they are more developed, the elimination of unwanted branches, and provides some insurance against wind and pest damage.

Shoots of many species do not branch the season they form. Even the second year, some of these may not develop more than a few or no laterals except near the previous season's terminal. To induce branching, pinch the leader of such plants when the growing point reaches a height at which a lateral branch is desired. Remove 1 to 2 inches of the tip. Buds below the pinch will grow. One usually grows more vigorously than the other shoots. This will become the leader, although it may need encouragement. You can select as a lateral a second developing shoot growing in a desired direction by pinching the tips of the other shoots that were forced. It is better to leave too much space between laterals than to have them too close.

In one season a vigorous tree may permit the forcing of as many as three well-spaced laterals where they are wanted. Without such pinching, the leader would require severe heading during the dormant pruning—to the height at which the lowest lateral is desired.

The development of scaffold branches may be kept in balance with the rest of the tree either by thinning laterals on, or pinching the tips of, the most vigorous ones (or both) during the growing season.

As little as 1 to 2 inches is effective and will not drastically reduce total growth. In fact, it will make unnecessary the removal of a large branch later on when the dwarfing effect will be greater. Early pinching directs growth into the permanent leader and branches.

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Shoots that are crowding desirable shoots should be removed completely. This can be done quickly, with little dwarfing, when shoots are less than 5 inches long.

Pruning during the growing season will reduce the amount of pruning needed during the following dormant period. Growth will be channeled where it will be most effective.

Pruning during the dormant season follows the same principles as those of the growing season. Some severe corrective pruning may be needed. This is more easily seen with deciduous trees when they are dormant.

When a tall upright trunk is desired, keep the leader dominant by preventing laterals from outgrowing it. The problem of laterals outstripping the leader is a common one with many species, especially those having a deliquescent form.

Temporary branches on the trunk will strengthen and protect the trunk. At planting time and during later dormant pruning, choose laterals of weak to moderate vigor to be left as temporary branches. Vigorous low-growing laterals should be removed if less vigorous ones can be selected. Short, horizontally growing laterals can be left unpruned. More vigorous laterals should be headed back to 2- to 3-bud spurs during dormant pruning.

Temporary branches can be spaced 4 to 12 inches apart. Closer spacing may unduly retard height growth. Temporary growth on the southwest side of the trunk also reduces the chance of sunburn injury.

During the growing season, pinching the tips of vigorously growing temporary branches may be necessary to keep them in bounds and reduce competition with the leader and permanent branches. Most trees should be visited at least 2 to 4 times. The first visit is best timed when new growth is 4 to 6 inches long. This requires little time per tree and provides an opportunity to check on any other problems that may be developing.

As a young tree develops a sturdy trunk and a top that effectively shades the trunk, the temporary branches can be reduced in number and eventually eliminated. After two or three years, when the trunks of small trees (e.g. crape myrtle and Japanese maple) are 2 to 3 inches in caliper or larger trees (e.g. elm and sycamore) are 5 to 6 inches in caliper, the number of temporary branches can be reduced over a 2- to 3-year period. Remove the largest ones at each pruning to minimize the size of the pruning wounds.

A tree may not be tall enough when planted for the selection of any permanent lateral branches. If laterals are present or grow below where the lowest permanent branch is wanted, they should be handled as temporary laterals.

When the leader grows tall enough, select the permanent laterals. If the leader does not form branches the season it grows, pinch the growing point to force laterals at the desired heights.

Many times planting a healthy, moderate-size (1/2 to 3/4" caliper, 5 to 6' height) tree will result in a more rapidly growing, better structured plant than is obtainable with a larger (1 to 2" caliper, 8 to 10' height) tree that has been in a container too long.

Nursery trees with low laterals of large size are a problem. For most uses, don't choose such trees if others are available.

Many trees for landscape use are headed in the nursery when they become 4 to 5 feet tall. This forces laterals below the cut. These branches form a compact head giving the tree good proportions when small but with no leader. In many cases, these branches are too low and too close together.

At planting, it may be possible to select the most upright and vigorous branch to become the leader. A second branch may be chosen as the first scaffold if it is high enough above the ground. In some cases, only a leader can be selected. Other branches should be thinned and those remaining treated as temporary branches.

The sooner corrective pruning is done, the less dwarfing influence pruning will have. However, in some cases the pruning must be so severe, that it should be done over at least a 2-year period. This is more true for older nursery trees (3 to 4 years in 5-gallon containers) than for young nursery trees (1 to 2 years in 5-gallon containers).

An upright branch will usually be more vigorous than one that is less so and may be used as a permanent branch if its position is desirable. However, it may compete with the leader. If a more horizontal branch can be selected, it is usually wise to remove the more upright one. As many species of a diffuse or deliquescent branching habit mature, the leader becomes less dominant.

Occasionally, branches will grow vigorously upright on trees that normally have subdued horizontal limbs (many conifers and Liquidambar). Remove these or cut to an outward growing lateral as soon as they are spotted. Otherwise, they will upset the symmetry of the tree.

In contrast to upright branches, these growing more horizontally are usually of low vigor. Horizontal branches will seldom compete with the leader. These branches or twigs are desirable as temporary branches to protect and nourish the trunk. Unless they become too long, the smaller ones can be left unpruned.

Horizontal or drooping limbs may, however, be a problem in some young trees. If they droop because of excessively vigorous growth, buds back from the top of the bend will often grow. The new shoots will usually be more upright. You can select well-placed shoots from these by thinning the lateral back to the selected shoot. Thin out other new shoots that might compete or interfere with the one selected.

If the horizontal or drooping limb has a no well-placed upright laterals, head the branch to an upward-pointing bud slightly back of the top of the bend or to where you want a lateral.

Certain trees are chosen for their drooping branching habit, e.g. weeping willow, Chilean mayten, etc. You may wish to exploit this characteristic.

Prevailing winds may deform trees so that most of the growth is on the downwind side. Depending on wind conditions and the kind of tree, the main leader may or may not be bent by the wind. Many trees, e.g. most conifers, Liquidambar, planetree, have the ability to resist being bent by moderately strong prevailing winds.

In windy locations open up the top of the tree extensively on the downwind side. In certain situations, such a condition may be picturesque and desirable— if not, remedial pruning for more balanced growth can be done.

In windey locations open up the top of the tree by thinning out moderate-size branches. The tree will offer less wind resistance. Thin back branches on the downwind side to laterals to keep the tree more symmetrical.

You may need to head curving branches on the windward side near the point at which they begin to bend with the wind. Prune to a bud pointing into the wind. You may need to repeat this each time the endmost new shoot starts to be bent by the wind. Such a branch will be stockier and able to resist bending. One such pruning may correct the problem.

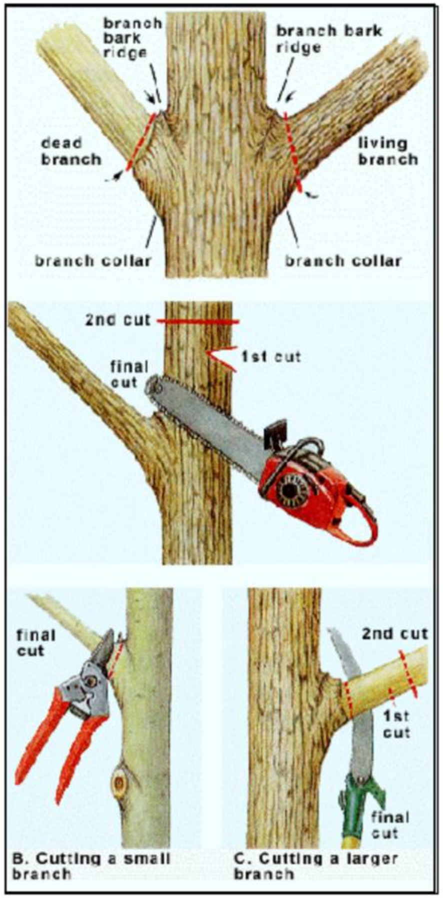
Weak young trees may result from a number of unfavorable growing conditions, either in the nursery or after planting in the landscape. If such problems as girdling or kinked roots, disease, insects, trunk sunburn, poorly drained soil, etc. are not limiting growth, severe pruning may be the last resort that will revitalize the tree. Because of the lack of latent buds, however, most conifers will not respond to such pruning.

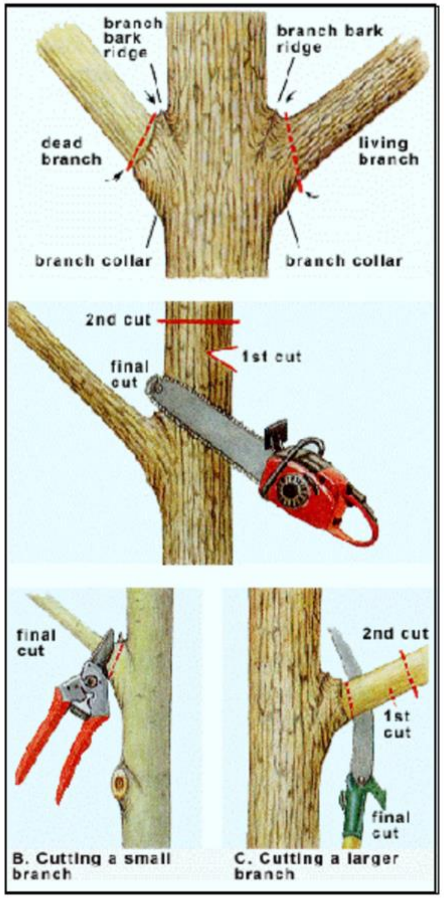
Head the trunk 6 to 12 inches above the ground or graft union. Paint the trunk white to prevent sun damage. New growth will come from latent buds below the cut. When the new shoots are 5 to 6 inches long, choose the one in the best position and pinch back the others. The trunk may need to be recut diagonally above the newly selected leader, which will protect the developing shoot, the new leader, and the base of the trunk. Often a vigorous well-branched leader will develop in the first year to revitalize the tree.

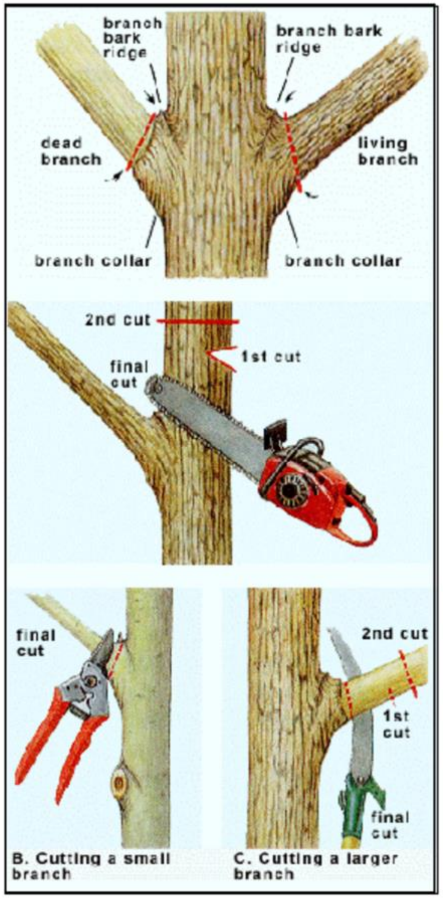
The leader may not maintain its dominance. If you want a new leader remove the original in favor of a strong upright growing lateral. The new leader should be the topmost lateral on the trunk. It is undesirable to leave part of the original leader above the new one because it creates unnecessary competition between the two. Thin back the original leader to the lateral selected as the new leader.

Late in the season several buds may begin growth near the tip of an otherwise branchless leader of scaffold branch. They may grow up to 6 inches in length and be about as large as the terminal. Unless they are thinned out, these branchlets and the terminal will grow weakly the next season. It is best to head to a bud below this tuft of branchlets or to thin the tuft, leaving one branch and the terminal.

Tree Hazards for Conservation Workers







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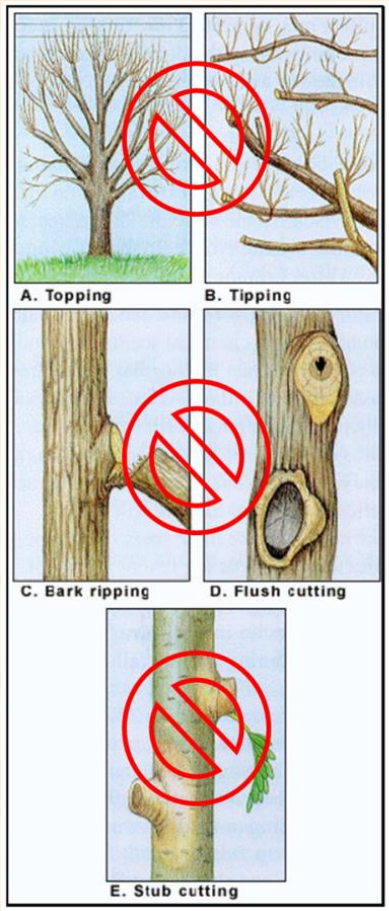

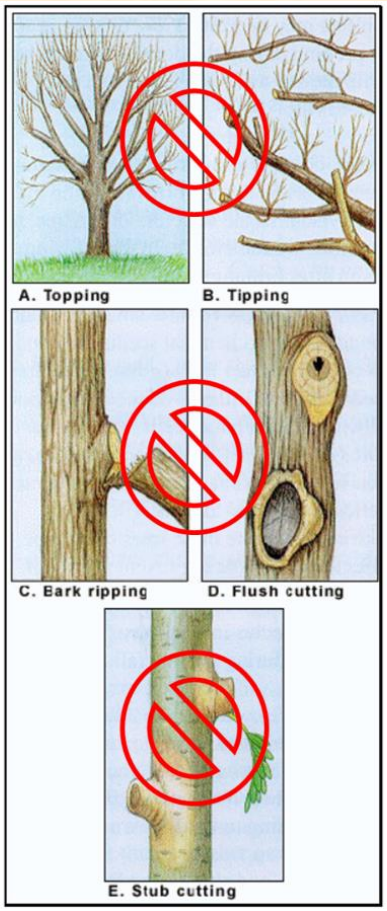

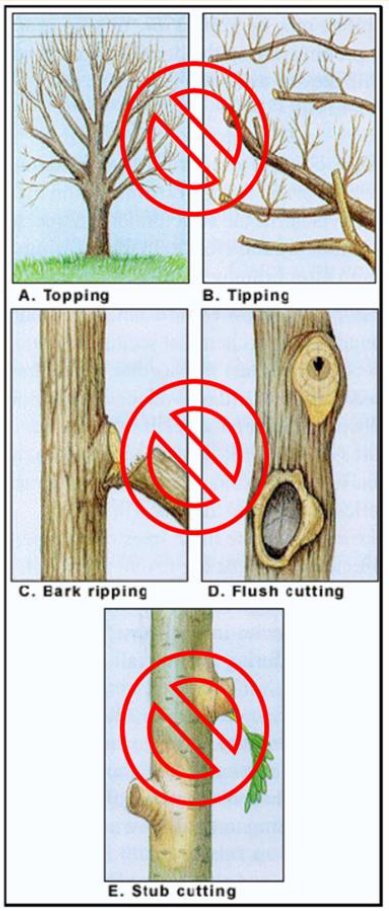

Tree Hazards for Conservation Workers

Tree Hazards

Tree Hazards

Tree Notes #3

Controlling Bark Beetles in Wood Residue and Firewood

Sherburn R. Sanborn, Forester, Resource Management

Each year, timber losses in California forests due to bark beetle attack exceed those caused by wildland fire. Drought conditions worsen this situation. It was estimated that 10 million trees were killed throughout the state in 1989 and 1990 alone, destroying enough timber to build one million three bedroom homes.

Many valuable urban landscape trees are also killed due to drought stress and bark beetle attack. In some urban areas of Southern California, pines are frequently killed by bark beetles transported in infested firewood obtained from dead and dying trees in the Southern Sierra Nevada (personal communication, Eric Oldar, CDF Service Forester). Firewood may harbor immature beetles (larvae) which complete their development, emerge, attack and kill nearby pines in the urban landscape. This problem may be occurring in other areas as well.

This article discusses several techniques that may be used by both forest landowners and urban dwellers to reduce tree mortality by reducing local bark beetle breeding sites. An important first step before applying any of the following techniques is to determine if a potential bark beetle problem exists. Next, identify the species of bark beetle infesting the wood as well as the species of tree (host) infested. Because host preference and life cycle are so variable among different species of bark beetles, reducing tree mortality may depend on the proper selection and timing of control techniques. Because these techniques are preventative in nature, their use may be justified even where bark beetle problems do not exist. This is particularly true where high value trees, such as those in parks or residential areas, are at risk.

Firewood Pests and Regulations

Wood from tree removals, salvage logging, and forest thinning is often used for firewood. The freshly cut wood of many trees can attract bark beetles which can breed in it, while the wood of trees killed by bark beetles may harbor developing brood. Trees of particular importance are pine, true fir, Douglas-fir, elm and eucalyptus. Whenever wood is moved, there is a risk that associated insect and/or disease pathogens are moved as well. This can result in the introduction of new pests or exacerbate existing pest problems. Some bark beetle species become so numerous during periods of drought that they will mass attack and kill healthy trees.

Pine pitch canker is an incurable tree disease that has killed thousands of Monterey pines and other pines in the state. Bark beetles and other insects help move the disease around. Pine logs, firewood, branches, needles, and cones may all be a source of the disease. This material should not transported from one part of the state to another unless you are sure it is disease-free. Contact your local Agricultural Commissioner's office or California Department of Forestry and Fire Protection forester to determine if you are in a pitch canker-infested area.

Elm wood is of particular concern because the European elm barkbeetle which breeds in it vectors the Dutch Elm Disease (DED) fungus. The spread of DED over long distances has invariably been due to the movement of elm firewood from infested areas.

Tree Hazards

Regulations Continued...

The eucalyptus longhorned borer (ELHB), a native of Australia, was introduced into Southern California in 1984. Since then, it has spread to a number locations in the state. Many mature eucalyptus trees have been killed in areas where this insect has become well established. The movement of eucalyptus wood has become an increasing problem because ELHB and other introduced insects can be carried great distances in firewood. The transport of ELHB infested wood is prohibited under section 4714.5 of the Public Resources Code.

Firewood Tarping

Tarping and sealing wood piles with clear plastic is a very effective way to prevent the emergence of beetles from the wood. This technique will also prevent them from colonizing freshly cut uninfested wood. To properly tarp a wood pile you will need the following materials: Six mil clear plastic sheeting of a size sufficient to cover your wood pile This material is available in various sizes at most hardware supply stores. If available, six mil ultraviolet (UV) resistant plastic sheeting such as CIL Durafilm Polyethylene Greenhouse film is excellent. Do not use black plastic because beetles are attracted to areas that are lighter in color and they chew through it.

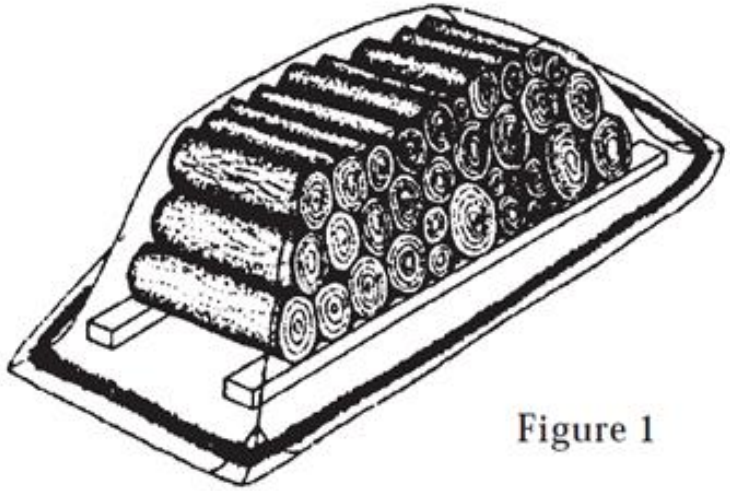

Figure 1

- Lumber such as 2X4'sto use as runners to keep the wood off the ground
- An old tarpaulin, carpet, cardboard, automobile tires or similar material to protect the plastic from tearing.
- Soil, gravel or other material to seal the plastic along the ground.

Figures 1 &2 are examples of how to stack wood. Use these examples and the following procedures to tarp it.

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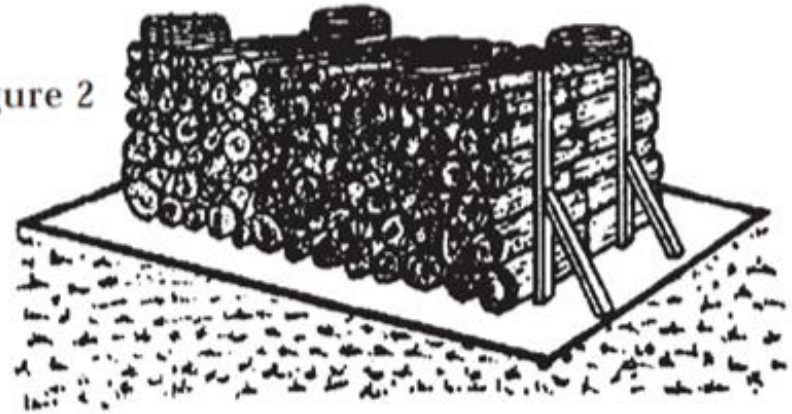
Firewood Tarping Continued...

1. The wood stack can be any size provided it can be covered by a single sheet of plastic that will allow for 12 inches of overlap along the ground.
2. To aid in drying, keep the wood off the ground by stacking it on 2X4 runners. Placing the stack in partial sunlight will reduce drying time, minimize the breakdown of non-UV resistant plastic and render the wood unsuitable for beetle breeding.
3. Prior to covering the stack, make sure there are no sharp projections which could pierce the plastic. Place a tarpaulin, cardboard, automobile tires (see diagrams) or similar material over the top of the stack to protect the plastic.
4. Cover the stack with plastic allowing 12 inches of material to overlap along the ground (see diagram).
5. Seal overlap against the ground with soil, gravel or similar material. Tarp must be sealed entirely around the stack.
6. After sealing, the plastic may become tightly stretched over the wood stack. If this occurs, gently pull up on the plastic allowing 2-3 inches of slack to relieve strain. This will reduce punctures and tears. If the plastic is held too firmly against the bark, tarpaulin, cardboard or other materials, beetles will get between that material and the plastic and escape by chewing their way out. This would necessitate retarping the wood.
7. Inspect tarping frequently for damage. Repair small holes and tears with duct tape. Larger tears may require retarping.

Wood should be tarped for one season after cutting, from April 1 until November 1. Firewood seasoned in this manner through one spring and summer will not support beetle colonization. Any beetle brood present in the wood when it is tarped will be killed.
Wood that is tarped dries more rapidly, particularly during the winter.

Figure 2



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Tree Hazards

Slash Treatment

Slash is woody material generally consisting of branches and tops of trees left behind after commercial logging or thinning operations. Those materials with bark still attached may become a breeding site for bark beetles and can lead to a bark beetle population buildup. There are several techniques which can be used to render this material unsuitable for beetle breeding.

Lop and scatter involves 1) severing branches from bolts 3 inches or larger in diameter, and 2) scattering the branches and bolts so that they receive maximum exposure to the sun. This technique is recommended where pine trees are being logged or thinned particularly when beetles of the genus Ips are already abundant. Heat from the sun increases the temperature under the bark and hastens drying. Both heat exposure and drying can greatly reduce the breeding success of bark beetles. To be effective, lop and scatter slash within one week of slash creation. As an alternative, avoid activities in pine stands that will place "green" slash on the ground from February through June.

To be effective, the remaining techniques must be completed within five weeks of slash creation or before beetle broods emerge:

Piling and burning is another effective technique which will render the slash unsuitable for beetle colonization or will kill beetles infesting the slash. This may be a very cost effective approach in rural areas where burn permits (LE-7) can be obtained through CAL FIRE.

Chipping is a very effective way of reducing bark beetle population buildup in logging slash and wood residue from pruning, thinning or tree removal in urban areas. Chipping destroys most beetle brood present in the wood while leaving chips that are unsuitablefor bark beetle breeding. Many tree services havechippers that can chip wood up to 12 inches in diameter. Wholetreechippers are also available for biomass production.

Debarking logs, or bark removal, destroys the habitat where bark beetles breed and their larvae feed. Once removed, the bark andthe wood are unsuitable for bark beetle breeding. The wood can then be left on site or used for firewood without concern. Wood that is still green or freshly cut is easier to debark than dry or seasonedwood. There are various devices available that can speed the process. They range from steel bars and chain saw attachments to commercial log debarking machines.

Chemical Control

Controlling bark beetle infestations through the application of pesticides have demonstrated varying levels of success. On commercial forest land, insecticides are costly and difficult to apply on a large scale. They can also disrupt the effect of natural enemies, and their effectiveness in controlling beetle outbreaks has been variable. In the urbanizing forest, it is possible to manage bark beetle-caused mortality with insecticide application as a temporary prevention measure or to reduce pocket killing. However, this should be considered a short term remedy used in conjunction with long term practices that improve the growing conditions for the tree.

Conclusion

Whichever technique(s) you choose, be sure to investigate the legal requirements pertinent to your activities. If you are involved in timber harvesting, insure that you are in compliance with the California Forest Practice Rules. The Registered Professional Forester (RPF) or Licensed Timber Operator (LTO) responsible for the timber harvest plan will be aware of current rules. If you plan to burn woody material, you will need a burn permit from the California Department of Forestry and Fire Protection (CDF) or other local agency. There are many communities that have ordinances restricting the removal of trees.

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