



# Forest Health Protection

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## Special Project Report

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To: District Ranger, Eagle Lake Ranger District, Lassen National Forest

Subject: Swain's Hole Prescribed Burn – Survivability of Fire-Injured Trees  
(NE-SPR-07-04)

Thank you for allowing Forest Health Protection (FHP) to implement and monitor fire-injured trees in the 2001 Swain's Hole prescribed burn. We have now completed the monitoring of 134 trees in this fall burn area (Table 1).

The Swain's Hole prescribed burn area is adjacent to Forest Road 33N13 and generally across from Swain's Hole Reservoir (Figure 1). The stands are a mix of ponderosa and Jeffrey pine (including many large diameter trees), western juniper and white fir. The objectives of the burn were to reduce the potential for catastrophic fire by removing the buildup of understory fuels and to restore understory vegetation. Most of the area was mechanically thinned prior to burning, removing most small diameter material, except for in an old growth retention area (OGRA). This OGRA contains many large diameter pines (30+” DBH) with a dense understory of small pines mixed with a few scattered juniper and white fir. However, most of the old growth pines in the OGRA have very few small trees growing underneath their crowns and the stand structure within these old growth pockets is very similar to the old growth pockets in the thinned stands. The accumulation of duff and litter around the boles of the large diameter pines in both the thinned and unthinned areas was excessive, typical for eastside pine stands that have not experienced fire in 100+ years. This prescribed burn consumed 95 – 100% of this material.

Most large fires in California over the last decade have occurred in pine types. These fires have allowed FHP to monitor the survivability of fire-injured ponderosa and Jeffrey pine providing valuable documentation regarding survival criteria for these species. The Swain's Hole prescribed burn, completed during the fall of 2001, provided an additional opportunity to improve upon and/or modify the current cambium survivability criteria for large diameter ponderosa and Jeffrey pine with significant cambium injury and little or no crown injury. In the spring of 2002, FHP sampled and tagged fire-injured trees; evaluating crown and cambium kill, and insect activity (Tables 2 - 5). These trees were then monitored for 5 years to document mortality (Table 6).

Information obtained from this prescribed fire has greatly contributed to our knowledge on the effects of fire-injuries to tree survivability and has also increased our awareness as to the high level of cambium injury that can be expected when burning the deep duff and litter layers that exist at the bases of old growth pines. Nearly every sampled tree (97%) had some level of cambium kill (Table 3) near ground line despite the presence of very thick bark. This indicates that the lower boles of these trees were intensely heated over a long period of time by the relatively slow combustion of the duff and litter. However, even with over half of the sampled trees having cambium kill ratings (CKR) of 3 and 4, there was very little mortality observed during the study. While the CKR has proven to be a significant variable in predicting tree mortality when combined with crown injury and insect activity, a high CKR alone does not indicate imminent mortality (Hood et al. 2007). Furthermore, the fact that these trees had very little to no crown injury, due to a combination of high crown base heights and a lack of ladder fuels, and that they were generally growing in open stands, which typically results in improved health and vigor, may have helped them survive their basal injuries.

Red turpentine beetle (RTB) attacks were limited within the Swain's prescribed burn area despite the presence of many large diameter pines with cambium injury (Table 5). Many prescribed burns conducted in eastside pine stands in northeastern California have resulted in high numbers of RTB attacked trees. Spring burns, which are generally conducted prior to or during peak RTB flights, have occasionally resulted in higher numbers of attacked trees than fall burns, which are generally conducted during periods of low RTB flight activity. The low number of RTB attacked trees in the Swain's Hole prescribed burn area may be due in part to it being a fall burn or it may be that there was generally a low RTB population in the local area to draw from.

The presence of RTB attacks on fire-injured trees in the Swain's Hole prescribed fire did not result in their mortality. This is supported by the monitoring that shows 80% of the trees that sustained RTB attacks within the first year post-burn have survived (Table 8). This is consistent with other FHP monitoring studies, insect and disease evaluations and condition reports that have shown very little correlation between the presence of RTB attacks on large fire-injured pines and imminent mortality (2002 McNally Fire, 2004 Prattville underburn, Forest Pest Conditions in California 1962, 1983, 1987, 1993, 1994, 1996-2004). Even though the presence of RTB attacks on fire-injured trees cannot predict mortality independently, the presence of RTB attacks, when combined with crown and cambium injuries, has been shown to slightly increase the probability of mortality and is a good variable to use when trying to predict the survivability of fire-injured trees (Hood et al. 2007).

There exists concern over the cambium sampling method of chopping or drilling small holes at the base of a tree in that it could lead to mortality by further injuring an already weakened tree. While this method does cause additional injury when areas of live cambium are sampled, it has never shown to be a factor in tree mortality. The Swain's Hole control trees, which were not sampled for cambium injury, were set up to further examine this issue. Based on our monitoring data, cambium sampling did not increase the likelihood of mortality compared to controls. Trees that were sampled had a survival rate of 92% while the control trees had a survival rate of 94% (Table 7).

The Swain's Hole prescribed burn effectively removed the duff and litter from around the bases of large diameter pines with very little tree mortality. This type of successful result is not always achieved when conducting prescribed burns in eastside pine areas that contain many large diameter, old growth trees. As previously discussed, these results may be partially explained by the lack of crown injuries, which were likely due in part to the limited ladder fuels found in these open stand conditions and limited amounts of understory brush. These stand conditions were largely created by the mechanical thinning treatments conducted prior to prescribed burning. Higher levels of crown kill on large diameter trees should be expected when burning in denser stands or in stands with taller and denser brush. The range of cambium injury levels, if all the duff and litter is consumed, would likely be similar to the Swain's Hole prescribed burn regardless of stand density. However, if dense brush is burned close enough to tree boles it could increase the level of cambium injury and/or the amount of bole area affected. Recent FHP fire-injured tree studies have shown that large diameter pine (20 to 50" DBH) that sustain a CKR of 4 have a high probability of mortality with as little as 35 - 45% crown kill (Hood et al. 2007). To minimize the levels of crown and cambium injury to large diameter pines during future prescribed burns, it is highly recommended that ladder fuels be removed and duff and litter be raked away from tree boles prior to burning.

In conclusion, FHP greatly appreciate the cooperation of District personnel in setting up and completing this study and look forward to working with you again as opportunities arise. Please contact me if you have any questions.

*/s/ Danny Cluck*

Danny Cluck  
NESA Entomologist

## **References**

Hood, S.M., Smith, S.L. and D.R. Cluck. 2007. Delayed Conifer Tree Mortality Following Fire in California. In: Proceedings for the 2005 National Silviculture Workshop: Restoring Fire-Adapted Forested Ecosystems. General Technical Report PSW-GTR-203. Pacific Southwest Research Station, USDA Forest Service, Albany, CA p. 261-283.

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## **SWAIN'S HOLE DATA SUMMARY**

**Table 1.** Total number of trees

<b>Species</b>	<b># of Trees</b>
Jeffrey pine/ponderosa pine	101
White fir	2
JP/PP (control, no cambium sampling)	31
<b>TOTAL</b>	<b>134</b>

**Table 2.** Number of trees by percent remaining live crown length.

<b>Remaining Live Crown (%)</b>	<b>PP/JP</b>	<b>White Fir</b>
1-79%	0	0
80-95%	2	0
96-100%	130	2

- The remaining percentage of the original, pre-fire, crown length.

**Table 3.** Number of trees by cambium kill rating (CKR).

<b>Cambium Kill Rating</b>	<b>PP/JP</b>	<b>White Fir</b>
0	3	0
1	14	1
2	29	0
3	29	1
4	26	0
Control (not sampled)	31	0

- Rating of 0-4 is based on a cambium sample taken in each of four equally spaced directions near ground level. A rating of 0 is equal to no fire damage for any sample and 4 is dead cambium at each sample location.

**Table 4.** Number of trees by diameter breast height.

<b>DBH (inches)</b>	<b>PP/JP</b>	<b>White Fir</b>
20-25	16	2
25-30	43	0
30-35	44	0
35+	29	0

**Table 5.** Number of pines with red turpentine beetle (RTB) attacks in first year post-burn.

<b>Sample group</b>	<b># of trees</b>	<b>RTB present</b>	<b>RTB absent</b>	<b>% w/RTB</b>
Cambium sampled	101	22	79	22%
Cambium not sampled	31	3	28	10%

**Table 6.** Total number of trees and mortality by year.

Season of Rx Burn	# of trees evaluated in 2000 (all live)	2002 Mortality	2003 Mortality	2004 Mortality	2005 Mortality	2006 Mortality	Total Mortality
Yellow Pine	132	0	5	2	1	1	9
White fir	2	0	0	0	0	0	0
<b>TOTAL</b>	<b>134</b>	<b>0</b>	<b>5</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>9</b>

**Table 7.** Number of yellow pine, number of RTB attacked trees and % survival by cambium kill rating (CKR).

Cambium Kill Rating	# of trees	# of RTB attacked trees	% survival
0	3	0	100%
1	14	5	93%
2	29	6	100%
3	29	6	97%
4	26	5	81%
Control (CKR unknown)	31	3	94%

- Rating of 0-4 is based on a cambium sample taken in each of four equally spaced directions near ground level. A rating of 0 is equal to no fire injury for any sample and 4 is dead cambium at each sample location.

**Table 8.** Number of yellow pine and % survival by presence/absence of red turpentine beetle (RTB).

RTB	# of trees	% survival
Present	25	80%
Absent	107	96%

**Figure 1.** Swain's Hole Prescribed Burn, Eagle Lake Ranger District, Lassen National Forest

