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Top-kill of Ponderosa Pine, Dixie National Forest, Utah

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Abstract—Two 320-acre parcels were surveyed on the Escalante Ranger District, Dixie National Forest, UT, to determine the incidence, cause, and impact of top-killed ponderosa pine. *Pityophthorus confertus* was identified as the causal agent injuring from 1.25 to 2.8 trees per acre. The major impact was loss of height growth, which averaged 2.5 to 4 feet per tree.

Keywords: *Pinus ponderosa, Pityophthorus confertus*, Scolytidae, bark beetles, growth loss

During the summer of 1982, throughout the Escalante Ranger District of the Dixie National Forest, UT, many ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) were dead and/or had dying tops. In Upper Valley, numerous trees had developed multiple leaders or forked tops, apparently in response to top-kill from several years previously. Several factors may be responsible for top-killing: bark beetles belonging to the family Scolytidae, dwarf mistletoe *(Arceuthobium vaginatum* ssp. *cryptopodum* [Engelm.] Hawksw. & Wiens), comandra blister rust *(Cronartium comandrae* Pk.), limb rust (*Peridermium filamentosum*), rodent chewing, and lightning strikes.

Furniss and Carolin (1977) list about 200 insect pest species of ponderosa pine. Among them are the insects causing top-kill of this valuable tree species. In addition, Sinclair and others (1987) mention several diseases of ponderosa pine that also can cause top-kill. This paper presents examples of top-kill caused by the bark beetle *Pityophthorus confertus* Swaine (Coleoptera: Scolytidae).

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During the late 1970's, an outbreak of mountain pine beetle *(Dendroctonus ponderosae* Hopkins) infesting ponderosa pine began on the Dixie National Forest. The Escalante Ranger District started a timber harvest program to combat the infestation. During outbreaks of aggressive bark beetles and during logging operations, much food material, consisting of tops and limbs from infested trees and logging slash, becomes available for the less aggressive or secondary bark beetles to infest, thus making possible large buildups in populations of these beetles. Because top-kill causes volume loss and reduces height growth in old-growth as well as second-growth ponderosa pine, I undertook a study of top-kill during the summer of 1983. My objectives were to determine (1) the extent of the top-kill, (2) the causal agent, and (3) impact of the damage.

METHODS

The first study area, in the vicinity of Hog Ranch Spring, was commercially thinned in 1982 in response to the mountain pine beetle outbreak and had current top-kill. The second area, Upper Valley, had been commercially thinned from 1972 to 1974, before the mountain pine beetle outbreak, and apparently received some damaging top-kill at that time as well as currently. To determine the incidence of top-kill, a 0.5-mile-square area at each site was systematically cruised using four strips, 2 chains wide by 20 chains long, spaced 10 chains apart (1 chain = 66 feet). This yielded a 100 percent sample of 16 acres inside an area of 320 acres, equivalent to a 5 percent sample.

Each top-killed pine and its nearest uninfested neighbor of similar diameter had two increment cores removed, 180 degrees apart, and the following data recorded: diameter at breast height, total height, top-kill causal agent, age, and growth rate. I used high-power binoculars to determine incidence of rodent chewing, dwarf mistletoe, comandra blister rust, limb rust, and lightning strikes.

Nine trees with current top-kill—five near Hog Ranch Spring and four in Upper Valley—were felled, the infested portion of each tree examined, and several bark beetle specimens collected for later identification. Also in Upper Valley, three trees with old top-kill damage were felled and the spike-top or dead portion of the tree was examined for presence of old bark beetle galleries.

Paired *t*-tests were used to detect any height differences between the uninfested trees and those with top-kill.

RESULTS

Using my observations, gathered data, and information from the felled trees, I determined the extent and cause of top-kill and impact of the damage.

Extent of Top-kill

In the Hog Ranch Spring plot I tallied 22 currently infested trees (19 percent of the stand). In the Upper Valley plot I tallied 20 currently infested trees (21 percent of the stand), 45 old top-killed trees (46 percent of the stand), and nine trees damaged by porcupines or other causal agents (9 percent of the stand).

Causes of Top-kill

In all cases, *P. confertus* caused the top-killing. Two trees had a few pine engravers (*Ips pini* Say) mixed in with *P. confertus*. Rodents had damaged eight trees in the Upper Valley plot, but this did not result in top-kill. Although dwarf mistletoe, comandra blister rust, and limb rust had infected ponderosa pine in the area, none of these diseases occurred in the sampled strips. In addition, I saw no lightning-damaged trees.

Impact of the Damage

In the Hog Ranch plot, total height for top-killed trees was not significantly greater than for uninfested trees ($P > 0.2231$) (table 1). However, 59 percent of the time the top-killed tree was the tallest of the pair. In the Upper Valley plot, the currently infested tree was significantly taller ($P > 0.0328$) than its uninfested neighbor and, in addition, the old top-killed trees were significantly shorter ($P > 0.0005$) than the uninfested neighbor (table 1). Taking these height differences into account, with currently infested trees on average ranging from about 2.5 to 4 feet taller than the uninfested trees, and with the old top-killed trees averaging about 4 feet shorter 10 years later, the net result is a loss of up to 8 feet of growth. Along with this reduction in height growth are deformities caused by the top-kill; all the trees had multiple stems (forking), which degrades the sawlog potential of the affected trees (fig. 1).

Because similar diameter trees were selected, no age differences occurred between the paired trees nor any diameter growth differences. Apparently, death of the leader had little effect on the diameter growth of these trees, only the height growth.

DISCUSSION

The literature contains few references concerning the incidence of damage caused by bark beetles of the genus *Pityophthorus*. Widespread top-killing of ponderosa pine in California has occurred in stands of different compositions in both virgin and cutover stands, with beetles selecting the thriftiest

Table 1—Comparison of the heights of uninfested and top-killed trees. Analysis variable is the difference between the uninfested tree height and the top-killed tree height (uninfested tree height minus top-killed tree height)

Plot	Number of trees observed	$\bar{x}$ Tree height	Sum	Mean	T	Prob>T
		Feet				
Hog Ranch:						
Current infested trees	22	49	–53.000	–2.409	–1.255	0.2231
Current uninfested trees	22	46				
Upper Valley:						
Current infested trees	20	52	–83.000	–4.150	–2.302	.0328
Current uninfested trees	20	48				
Old top-killed trees	45	36	179.000	3.978	3.792	.0005
Old uninfested trees	45	40				

Figure 1A and B—Growth deformities caused by top-kill.

trees to a greater degree than less thrifty trees (Salman 1938). In addition, Salman reported that trees having stag tops were apparently the result of old *Pityophthorus* attacks. My observations support those Salman made some 45 years ago.

Amman and others (1974) reported that *P. confertus* is common in lodgepole pines (*P. contorta* Dougl.) infested by mountain pine beetles. They report that in some cases *Pityophthorus* is considered beneficial because it kills suppressed trees and suppressed limbs, thus providing additional growing space for other trees and speeding pruning of lower branches. This contrasts with my conclusion that in ponderosa pine, beetle-caused deformities and slowing of growth are not beneficial to the tree, the forest, or potential sawlog use.

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