The Effect of Precommercial Thinning on Fire Potential in a Lodgepole Pine Stand

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Fire managers are aware that precommercial thinning increases the fire hazard of a given area, and that resistance-to-control, rate-of-spread (ROS), fire intensity, and ignition potential may also be affected (Appleby 1970, Dell 1975, Dell & Franks 1971, Fahnestock 1968). Thinning slash is additional debris superimposed upon the naturally-fallen fuel that already exists in a stand. In any appraisal of fire hazard and proposed fuel treatment measures, natural residues must be taken into account (Olson & Fahnestock 1955). The question is, "How much and to what degree does precommercial thinning influence potential fire behavior in a thinned versus unthinned stand?"

An Illustration

In August of 1975, a precommercial thinning operation was conducted on 54 acres of pure, even-aged lodgepole pine on the North Park Ranger District of the Routt National Forest in north-central Colorado. This thinning operation provided an opportunity to compare quantitatively fuel characteristics and potential fire behavior before and after thinning. The operation was contracted by the Forest Service to a private firm at approximately $45 per acre and called for 12- x 12-foot spacing (302 trees/acre) with directional felling to prevent "jackstrawing." Lopping of slash was required only on material larger than 3.0 inches in diameter. No further fuel treatment measures were planned because their costs could not be justified.

Prior to the thinning, residual fuels and timber stand description measurements were completed as part of a broader investigation in fuels description of lodgepole pine stands by the senior author. Post-thinning fuel sampling was conducted by the staff of the Fuel Management Research Project of the Rocky Mountain Forest and Range Experiment Station, stationed at Fort Collins, Colo.

Site and Stand Characteristics

The area was located on an upper-slope site at approximately 9,200 feet in elevation with a westerly aspect and an average terrain slope of 13 percent.

Based on the examination of basal fire scars on isolated stand residuals

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Figure 1.—General view of the stand prior to thinning.

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and on increment cores from dominant overstory trees, it was found that the stand originated from a wildfire in 1872. Mean stand structure characteristics were determined from standard 1/300-acre fixed plots. Density of live stems was 5,250 per acre, and for dead stems it was 900 per acre. The average live stem height was 25 feet, and distance from ground to live crown base was 17 feet (fig. 1). The mean diameter at breast height (4.5 feet above the ground) for live stems was 2.8 inches, and for dead stems it was 2.1 inches.

Figure 2.—Fuel conditions as a result of precommercial thinning.

Fuel Characteristics

Understory vegetation consisted primarily of scattered "half-shrubs" such as kinnikinnick and whortleberry. The forest floor was totally covered by needle litter which enhanced horizontal fuel continuity.

An inventory of downed woody debris and organic matter was conducted within a 1-acre portion of the area using the planar intersect sampling method (Brown 1974) and needle litter collections. The results are summarized in table 1. Note the large amounts of rotten material greater than 3.0 inches in diameter on the site. This was the result of the antecedent fire-killed stand.

In virtually all categories, fuel weights doubled following thinning. Radical changes occurred in the 1.0- to 2.99-inch size class and in the seed cone components. More significant was the large amount of suspended fuel particles generated by the thinning, which resulted in an optimumly aerated and continuous fuel bed (fig. 2).

Fuel Description Item	Before Thinning	Contributed by Thinning	After Thinning
Loading, tons/acre			
<0.24" size class	0.4	0.7	1.1
0.25–0.99" size class	1.5	1.9	3.4
1.0–2.99" size class	2.4	15.9	18.3
3.0" + rotten size class	23.8	—	23.8
3.0" + sound size class	0.2	5.3	5.5
Forest floor litter	1.2	—	1.2
Needle foliage	—	2.9	2.9
Seed cones	1.0	7.3	8.3
Herbaceous vegetation (live & dead)	0.02	—	0.02
Ave. diameter of 3.0" + material, inches			
Rotten	6.2	—	6.2
Sound	4.0	3.3	3.3
Dead fuelbed depth, feet	0.3	1.5	1.5
Forest floor duff depth, inches	2.5	—	2.6

Table 1.—Mean ground and surface fuel description characteristics before and after the precommercial thinning operation.

Analysis of Fire Potential

The recent development of mathematical fire-behavior models allows us to complete the fuel appraisal process based on the fuels description data shown in table 1. The models (Albini 1976) can be used as management tools to visualize "real world" fire situations. In the case at hand, relative differences in fire behavior characteristics, rather than actual values are the important points. Using the fire spread and intensity model (Rothermel 1972) developed at the Northern Forest Fire Laboratory in Missoula, Mont., quantitative estimates of fire ROS and intensity were calculated for three different situations:

- before thinning
- after thinning
- as if the fuel bed depth were reduced to 6 inches by mechanical crushing or some other compacting measure.

Two assumptions made were that (1) the area was regarded as 1-year old in a "red slash" condition, and (2) the mechanical crushing would not alter the physical structure and composition of the thinning slash other than the fuel bed depth.

Fire Potential Predictions

The predictions showed that ROS after thinning would be approximately 3.5 times greater than in the unthinned stand (fig. 3). Reaction intensity (the rate of heat output per unit area) could be expected to be 3 times greater than that before thinning (fig. 4). If mechanical crushing is used as a fuel treatment method in the area, reductions in fire ROS and intensity can be achieved. In fact, the fire behavior is predicted to be even less intense than before the thinning operation! This is due to a more compacted fuel bed.

At a 5-percent dead fuel moisture content (1-hr. time lag) and with a 10 mi/h windspeed, flame lengths in the thinning slash would exceed 7 feet. Under the same conditions and considering a half hour delay from detection to arrival on the fire scene by initial attack forces, the area burned would be approximately 5 acres and have a perimeter of 32 chains.

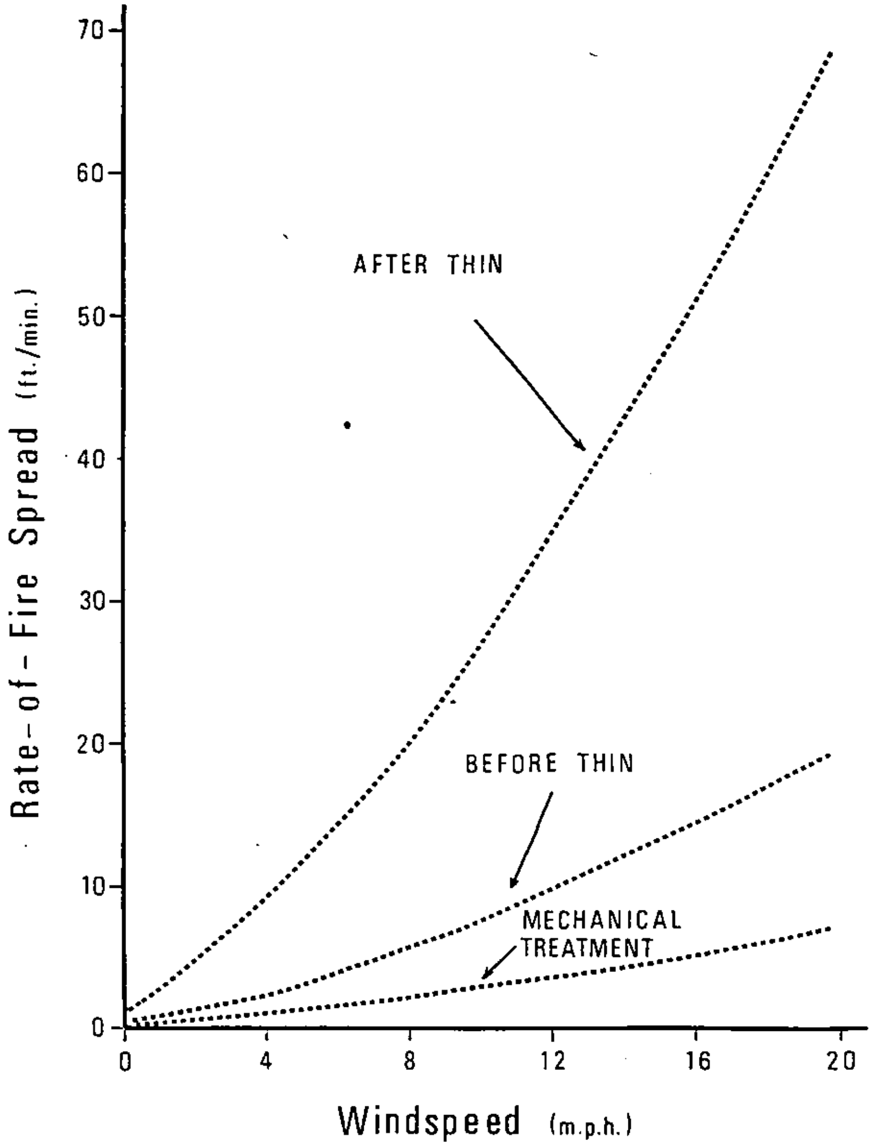

Figure 3.—Predicted rate of spread at 5-percent dead fuel moisture content (1-hour time lag) for the fuels before and after the precommercial thinning and the influence of mechanical crushing.

Conclusions and Implications

This small-scale investigation has shown quantitatively, from both a fuel attrition and potential fire behavior standpoint, the effects of precommercial thinning in a "doghair" lodgepole pine stand. "Simulation" of mechanical crushing revealed a viable alternative in fuel modification necessary to reduce the fire hazard to an "acceptable" level. Direct initial attack by hand crews on a fire in the thinned slash would not be possible under many burning conditions. Fire duration or persistence as a result of the deep duff layer and large quantities of rotten debris could cause extensive mopup work.

Loss of direct and indirect silvicultural investment (contract and salary monies), the value of the residual stand itself, surrounding area values, associated suppression costs if a fire were to occur, and the expense of cost-effective fuel treatment must be weighed before and after thinning. Extra fire protection measures (i.e., fuelbreaks) may not be a viable alternative, as aesthetics and wildlife habitat values must be taken into account as well.

Before the economies of the situation can be adequately evaluated, fire risk, frequency of critical fire weather conditions, and the longevity of the slash hazard (i.e., foilage retention) must be considered. The point to be remembered is that land managers need a reliable system for evaluating the effectiveness of various fuel treatment measures. If prethinning fuel inventory and stand description data are obtained, the existing fire behavior models can be used to help make more intelligent decisions concerning fuel treatment alternatives.

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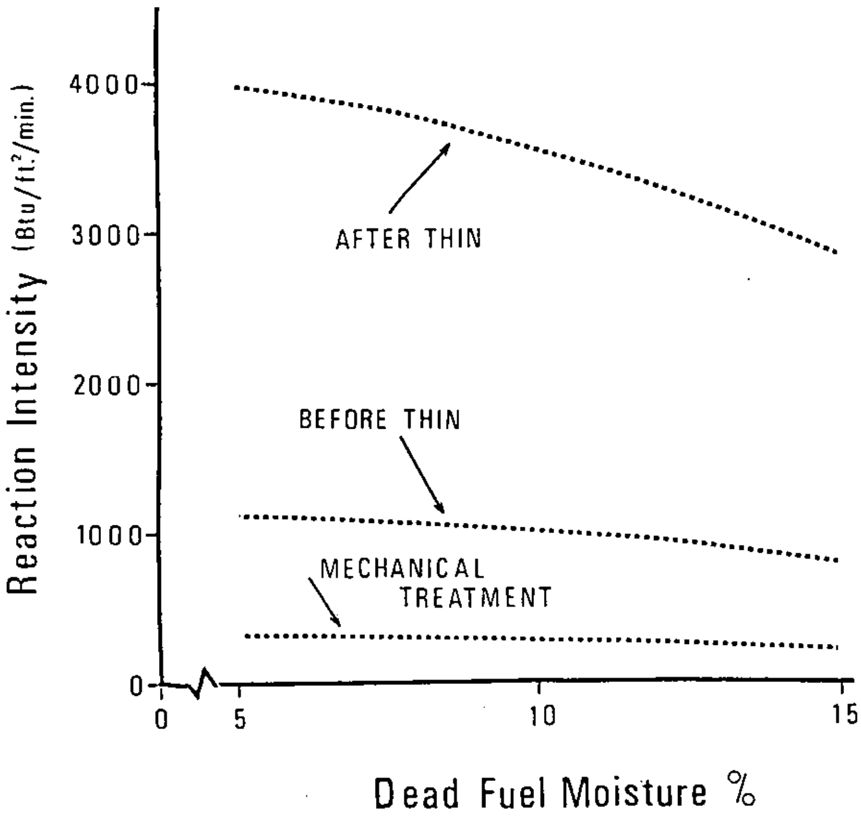

Figure 4—Predicted reaction intensity at 5 percent dead fuel moisture content (1-hour time lag) for the fuels before and after the precommercial thinning and the influence of mechanical crushing.

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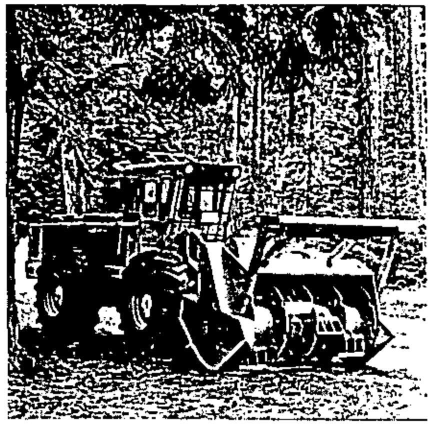

This forestlands residues machine was designed at the Forest Service Equipment Development Center at San Dimas, Calif. This second generation developmental model, completed in May 1977, is being tested in the Pacific Northwest. See the lead story in this issue for more information.

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