Reduce Fire Hazards in Ponderosa Pine by Thinning

Joe Scott

Thinning treatments in ponderosa pine were developed to reduce fire hazard and maintain the high aesthetic values of the forest while emphasizing either minimum impact, revenue production, or forest restoration.

Forest stands of fire-dependent ponderosa pine cover about 40 million acres (16 million ha) in the Western United States. Ponderosa pine is commonly found in pure stands on dry sites, but in more moist conditions, it is associated with Douglas-fir, lodgepole pine, western larch, and others. Historically, these were often widely spaced stands of large pines with an undergrowth of grasses and forbs. This structure was maintained by frequent surface fires that reduced invading tree species, rejuvenated the understory vegetation, and created a seedbed suitable for ponderosa pine regeneration. Today, by contrast, pine stands are dense, closed-canopy stands, often with thickets of small trees in their understories. As a result, these forests are experiencing insect and disease epidemics and severe wildfires.

Much residential and recreational development exists in the ponderosa pine forest type because many people regard this low forest type as very aesthetically pleasing. Unfortunately, most years these forests become quite flammable during warm, dry summer months. In the last century, wildfires were characteristically of low intensity and severity because they occurred relatively often. However, fires in this type today are likely to be much more severe for a number of reasons:

- Unmanaged ponderosa pine forests often have heavy accumulations of dead and down fuels as a result of decades of accumulation without "cleansing," low-intensity surface fires. These heavy fuels lead to higher fire intensities and increase fire-caused mortality to trees.
- Today's dense forests are more tightly packed with trees, leading to an increased risk of torching and crown fires.
- The establishment of an understory of small trees presents a "ladder" that allows a fire to climb from the surface into the crowns of overstory trees.
- Torching trees and crown fires are a significant source of firebrands that cause fire suppression problems. Firebrands are considered to be a major source for ignition of wildland homes.

Fire managers know that fire hazards in ponderosa pine stands can be lessened by prescribed burning and by thinning trees to lessen the likelihood of a crown fire. Such treatments generally reduce the potential surface fire intensity and keep the fire from spreading into tree crowns. Hazard-reduction treatments such as thinning and prescribed burning have been designed and implemented largely for commercial forest land, where aesthetic concerns are fewer and occur at a different scale (far view as opposed to near view) than for residential and recreational areas. The public is often wary of efforts to apply hazard reduction treatments, especially thinning, to high-value recreational areas. Private landowners also seem to be concerned about applying such treatments on their own residential forest land. Since there are few precedents for applying hazard-reduction treatments in residential and recreational settings, it is difficult to gain the public support necessary to successfully implement such treatments.

The USDA Forest Service's Intermountain Fire Sciences Lab collaborated with the University of Montana School of Forestry and the Ninemile Ranger District of the

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Lolo National Forest to demonstrate three hazard reduction thinning and burning treatments. All treatments were designed to reduce fire hazard and improve forest health. The cost and revenue of conducting the treatments, changes in fuel loading by component, and public perception of aesthetics were compared for each of the three treatments. Following is a summary of the initial results of this demonstration.

Study Area

The study area is located in the Ninemile Ranger District, about 30 miles (48 km) west of Missoula, MT. The area is covered by a dense stand of second-growth ponderosa pine and Douglas-fir, with Douglas-fir constituting a minority of the total basal area. The stand originated after the logging of the late 19th century, with most trees in the stand about 100 years old. A study in this area indicated fire intervals were historically very short, averaging 8 years prior to 1900. No fires have burned in this stand since its establishment.

The study area is at 4,000 feet (1,219 m) elevation, with slopes generally south-facing at 5 to 15 percent. The average diameter is approximately 8 inches (20 cm) for both ponderosa pine and Douglas-fir. The maximum tree diameter is 23 inches (58 cm) for both ponderosa pine and Douglas-fir. Understory vegetation is composed mainly of grasses (dominated by pinegrass), shrubs such as snowberry, kinnikinnick, ninebark, and serviceberry, and Douglas-fir regeneration.

Methods

Four rectangular 6-acre (2.4-ha) treatment units were established within the study area, three for treatments and one for a control. Sample points were established in each unit to measure stand structure and surface fuels before and after treatment. Three thinning treatments to reduce fire hazard were developed with a second objective of improving forest health while maintaining the high aesthetic values of the forest. Details of the treatments follow:

Treatment 1: Minimum Impact. This treatment was designed to be so low in impacts that it would be acceptable to most of the public. The stand was lightly thinned by removing the smallest, least healthy trees and those with low-hanging live crowns. The density of the stand was reduced by about 30 percent to 100 ft^2/acre (23 m^2/ha) of basal area. The cut trees were made into small sawlogs, pulpwood, and firewood. The total sawlog harvest volume was 1.7 thousand board feet per acre (MBF/acre) (9.9 m^3/ha). Logs were skidded using a 50-horsepower (37 kW) farm tractor. The slash from cutting these was piled by hand and burned after drying for one summer. In addition to the logging slash, small Douglas-fir trees (ladder fuels) and existing dead and down fuels were also burned in these hand-built piles.

Treatment 2: Revenue Production. This treatment was designed for application on a wide variety of private and public lands where producing short-term income and reducing fire hazard are desired. The density of the stand was reduced by 50 percent by harvesting all sizes of trees. This treatment produced pulp logs and medium sawlogs. Conventional mechanized logging equipment (feller-buncher, grapple skidder, and mechanical delimber) was used for this whole-tree skidding operation. Total harvest volume was 5.2 MBF/acre (30.3 m^3/ha), much higher than Treatment 1. Slash was piled at a landing and burned after drying over the summer.

Treatment 3: Forest Restoration. In addition to reducing fire hazards, this treatment was designed to restore natural conditions and improve forest health. The density was reduced by 50 percent by cutting the smallest, weakest trees. This treatment produced pulp logs and medium sawlogs. The total harvest volume was 3.6 MBF/acre (21.0 m^3/ha), intermediate between Treatments 1 and 2. The harvest method was the same as Treatment 2, except that some of the slash was "backhauled" by the skidder and spread back in the stand to allow recycling of the nutrients in the slash. The unit was broadcast-burned in the fall under a mild prescription after the slash had dried for one summer.

Treatment units were remeasured after two growing seasons of recovery. The net revenue of each treatment was determined by subtracting the logging and other treatment costs (burning and hand-piling) from the gross revenue expected for current log prices (as of December 1995).

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Visual quality was evaluated for the three treatment units and two control units. While one control was the untreated unit, the second was a nearby unthinned stand that was burned severely in a prescribed fire, then salvaged for firewood and sawlogs. Visual quality was compared using Triad analysis in which viewers were shown 10 sets of three photos and asked to identify which they liked the most and which the least. Data for 28 viewers were tabulated to reveal if any preference among the treatments existed.

Results

Table 1 shows the changes in fuel loading by component for each of the treatments. Treatment 1 (Minimum Impact) showed a lower total fuel load than before treatment because the fuel components most important to fire spread and intensity (herbaceous, needle litter, and 1-hour timelag fuels) were reduced. Small trees (ladder fuels) were nearly eliminated, and the overstory was thinned enough to prevent the spread of a crown fire, but the fuel bed is still well-shaded and sheltered from wind so the fire hazard is low.

Treatment 2 (Revenue Production) showed a slight increase in total fuel load, although litter and 1-hr fuels were both reduced. While herbaceous material increased in response to the increased light and water available, it represents a very small fraction of the total fuel load. The data indicate that duff increased and

A forest unit in the study area 2 years after the "Minimum Impact" treatment was used; this treatment was ranked as having the "highest aesthetic quality." Photo: Joe Scott, Missoula, MT, 1995.

Two years after the "Forest Restoration" treatment, this unit is the most capable of resisting wildland fires. Photo: Joe Scott, Missoula, MT, 1995.

Treatment 2—"Revenue Production"—reduced the stand density by 50 percent; this treatment yielded more short-term income than the other treatments. Photo: Joe Scott, Missoula, MT, 1995.

The untreated control unit, 2 years after the other units were treated as described in this article. Photo: Joe Scott, Missoula, MT, 1995.

Table 1—*Fuel loading (tons/acre) by component for each of the treatment units in the study area. Post-treatment measurements were made 2 years after treatment.*

	Unit 1 Minimum Impact			Unit 2 Revenue Production			Unit 3 Forest Restoration			Unit 4 Untreated
Component	Pre-treatment	Post-treatment	Change in %	Pre-treatment	Post-treatment	Change in %	Pre-treatment	Post-treatment	Change in %	
Herbaceous	.19	.17	-10.5	.22	.26	18.2	.31	.37	19.4	.10
Needle litter	1.25	1.11	-11.2	1.18	.95	-19.5	1.18	.69	-41.5	1.16
1-hr	.23	.17	-26.1	.42	.19	-56.0	.41	.06	-86.5	.27
10-hr	.89	1.19	34.6	1.13	2.23	97.3	1.53	.98	-36.1	.92
100-hr	1.02	1.31	28.5	1.46	1.02	-30.0	1.03	1.46	41.8	.58
1,000-hr sound	5.32	1.64	-69.2	4.03	.80	-80.1	6.15	4.69	-23.8	3.76
1,000-hr rotten	1.67	.69	-58.8	1.49	.89	-40.1	2.77	.33	-88.1	3.49
Duff	17.1	18.2	6.2	15.9	21.3	34.3	17.7	15	-15.4	17.7
Small trees	.11	.02	-81.8	.11	.05	-54.5	.07	0	-100	.09
Total	27.76	24.45	-11.9	25.93	27.72	6.9	31.15	23.54	-24.4	28.06

1,000-hr fuels decreased, though these materials were not directly handled in the treatment. The coarse (especially rotten) material may have been crushed enough by the heavy logging equipment to be considered as duff in the remeasurement. The overstory in this treatment is quite open, making a crown fire impossible and torching unlikely.

Treatment 3 (Forest Restoration) showed the greatest reduction of fuels. All components except 100-hr and herbaceous fuels were reduced. Herbaceous fuels increased in response to the increased light, water, and nutrients available after burning and thinning. The fall broadcast burn effectively reduced the load of duff, needle litter, small trees, and fine fuels. Crown scorch from the burn also raised the live crown base, making a crown fire extremely unlikely, especially given the reduced surface fuels.

The estimated net revenue from these treatments is shown in table 2. Not surprisingly, Treatment 2 produced the most revenue of the three, at $1,067 per acre ($2,637/ha) treated. Treatment 3 produced $459 per acre ($1,134/ha) treated. The high cost of the prescribed burn—$267 per acre ($659/ha)—is due to the season of burn and the small burn unit used here. Spring burning on larger units could increase the net revenue of this treatment to nearly $600 per acre ($1,483/ha). Treatment 1 produced the smallest net revenue, due to the relatively expensive logging method and the small harvest volume per acre. The cost of handpile burning the slash and other fuels amounted to $77 per acre ($190/ha) in this treatment, but would increase if the harvest volume were higher.

The Triad method of comparing visual quality ranks the five "conditions" based on the total point count of all scenes and all viewers. A photo that a viewer selects as the "most preferred" of the Triad set receives two points, since it is preferred over two other scenes. The least preferred receives no points, and the intermediate gets one point. Twenty-eight observers ranked the five treatments by total point count as follows:

Treatment	Total point count
Treatment 1 (Minimum Impact)	384
Treatment 2 (Revenue Production)	345
Treatment 4 (Unburned Control)	332
Treatment 3 (Forest Restoration)	317
Treatment 5 (Burned Control)	302

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Table 2—*Net revenue per acre (and per ha) from the different treatments. Delivered log value was determined from the prices of individual species and the average species mix from all treatments.*

Unit	Harvest volume in MBF/acre (m^3/ha)	Delivered log value in $/MBF ($/m^3)	Logging cost stump to mill in $/MBF ($/m^3)	Additional treatments in $/acre ($/ha)	Net revenue in $/acre ($/ha)
1	1.7 (9.9)	$404 ($171)	$215 (91.1)	$77 ($190)	$246 ($608)
2	5.2 (30.3)		$200 ($84.8)	$3.33 ($8.23)	$1,067 ($2.637)
3	3.6 (21.0)		$200 $84.8)	$267 ($659)	$459 $1,134)
4	0		N/A*	N/A*	$0

*Not Applicable

By this analysis, Treatment 1 was ranked as having the highest aesthetic quality, whereas Treatment 5, the severely burned and then salvaged logged area, was ranked the lowest. However, the relatively low spread in point count indicates that there appears to be strong similarity among treatments. The severely burned area probably scored even higher than it should have, because in the photos it was difficult to tell that most of the trees were dead. In just a few years, these dead trees will fall down, further reducing the aesthetic quality.

Conclusion

This project demonstrated several alternative thinning methods to reduce forest fire hazard and improve forest health in aesthetically sensitive residential and recreational forests. All of the treatments implemented in this study appear to be appropriate for reducing fire hazards in a sensitive and cost-effective manner. Although the treatments are quite similar in design and implementation, there are differences among them, both significant and subtle, that make them appropriate in different situations.

Treatment 1: Minimum Impact. This treatment is highly favored for its aesthetic quality and is preferred over not only the other treatments, but over the untreated stand as well. The treatment was moderately effective in reducing fire hazard by reducing fine fuels, raising the live crown base, removing ladder fuels, and spacing tree crowns. Although this treatment produced significantly less net income than the others (table 2), it nonetheless more than paid for itself, providing a return of $246 per acre ($608 per ha) to the landowner. This treatment is favored on small private residential properties where aesthetic values are high. The Forest Service may find such a treatment useful in areas with very high recreational values and significant public concern over harvesting.

Possible changes to this treatment include a lower residual stand density, perhaps of about 85 square feet per acre (20 m^2 per ha), if the thinning is still done from below, leaving the largest, healthiest trees. The aesthetic acceptance of this treatment is probably derived from the nature of the thinning (from below) and from the low-impact logging and slash disposal methods. A broadcast burn could probably be implemented in this treatment without significant degradation of aesthetic quality if it is conducted after the slash fuels have been reduced by pile-burning. A burn conducted in slash fuels would likely result in too much bark char and mortality for aesthetic acceptance.

Treatment 2: Revenue Production. This treatment, appropriate on a wide range of public and private land, was certainly effective at providing income. It produced more income than the other treatments (table 2), was effective at reducing the fire hazard by thinning the overstory, and ranked high aesthetically.

There is little that could be changed in this treatment to improve its effectiveness. Additional slash treatments such as a broadcast burn could not be justified in light of the income-producing emphasis. Mechanized logging equipment should consistently provide the most cost-effective harvesting in this forest type. Any further reduction in basal area would probably produce an unacceptable aesthetic condition, especially since the thinning is from above. Care must be exercised when implementing a high

thinning to avoid "high grading." The goal of a high thinning is to leave a high-quality stand of trees by thinning in the dominant and codominant crown classes.

Treatment 3: Forest Restoration. This appears to represent a middle-ground treatment that balances aesthetics, income production, and forest health—truly an "ecosystem management" treatment with broad application. Any treatment that couples a low thinning with a broadcast burn should reduce wildfire hazards; the data show that this treatment was the most effective in reducing fire hazard. Even with the high cost of the broadcast burn, this treatment showed a modest return per acre. Unfortunately, aesthetic quality suffers whenever a broadcast burn chars the boles of trees. This type of thinning and burning treatment in the pine type has broad applicability on public lands and increasingly on private lands.

Some changes could be made to improve this treatment. In this implementation, slash was backhauled from the landing and spread with the grapple skidder to retain as much of the nutrient base on the forest floor as possible. While this practice may have long-term benefits for forest productivity, when coupled with a prescribed burn, the increased fuel loads lead to increased mortality, bark char, and crown scorch, with negative implications for aesthetics. It may be preferable to dispose of the slash in a landing pile and broadcast burn the "natural" fuel bed with the small amount of additional slash left after a fully mechanized logging operation. The residual basal area could probably also be reduced slightly, bringing in more income and perhaps helping to create more "natural" conditions, without adversely affecting stand aesthetics.

For more information, contact the Rocky Mountain Research Station for a forthcoming publication that contains further details on this research.

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Mountain Driving Video Now Available

Dick Mangan

"Driving Mountain Roads—Slowing Down," a new video from the USDA Forest Service's Missoula Technology and Development Center (MTDC), is now available to wildland fire service employees and coordinators. The Safety and Fire programs at MTDC developed the video, which highlights the dangers of driving on mountain roads, to help reduce accidents that result in personal injury and property damage. The 20-minute video can be used as a stand-alone training course or can be incorporated into a "Defensive Driving" course.

The video was produced in response to an increasing number of accidents on national forest roads. Because our work force continually changes, many new employees are inexperienced at driving on mountain roads and may not be familiar with the hazards that exist. Experienced Forest Service drivers speak in "real-world" terms in the video about driving successfully on mountain roads and recognizing the limitations of the driver and the vehicle. The video emphasizes the benefit to drivers when they slow down on steep roads to retain control of their vehicles and avoid accidents.

A second video is planned that will be particularly aimed at nonfire personnel such as bus drivers, caterers, and National Guard drivers who play an important part in our large fire suppression effort every year. Its focus is driving during wildfires. It will be available for the spring 1999 training period.

To receive a free copy of "Driving Mountain Roads—Slowing Down," send a fax to MTDC publications at 406-329-3719, or via e-mail, contact them at (pubs/wo_mtdc@fs.fed.us). ■

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