Opportunities Abound for Affordable Mechanical Fuels Treatment in Dry Mixed-Conifer Forests

BY JEREMY S. FRIED AND THERESA B. JAIN

Jeremy Fried

Theresa Jain

The dry mixed-conifer forests that cover millions of acres in 12 western states experience low- to mixed-severity fire regimes; are typically heterogeneous in species composition, forest structure, and fuel dynamics; and grow quickly enough to generate concern about fuel treatment longevity. Yet compared to stands of pure ponderosa pine, there has been little research on fuel treatment effectiveness and economics in these forests.

Treating fuels everywhere is impractical and likely not cost effective. Only some of the many possible kinds of treatments will be effective in any particular stand, and there are some stands that seem to defy effective treatment; in many more, effective treatment costs greatly exceed benefits. We modeled effectiveness and costs of three kinds of mechanical treatments on 5,000 FIA inventory plots that sample dry mixed-conifer forests in California, Oregon, Washington, Idaho, Montana, and Utah and found that, on average, compared to a no-treatment case, treatment led to more resilient forests over time, lower forest carbon emissions, and greater retention of the live trees that constitute an important component of wildlife habitat.

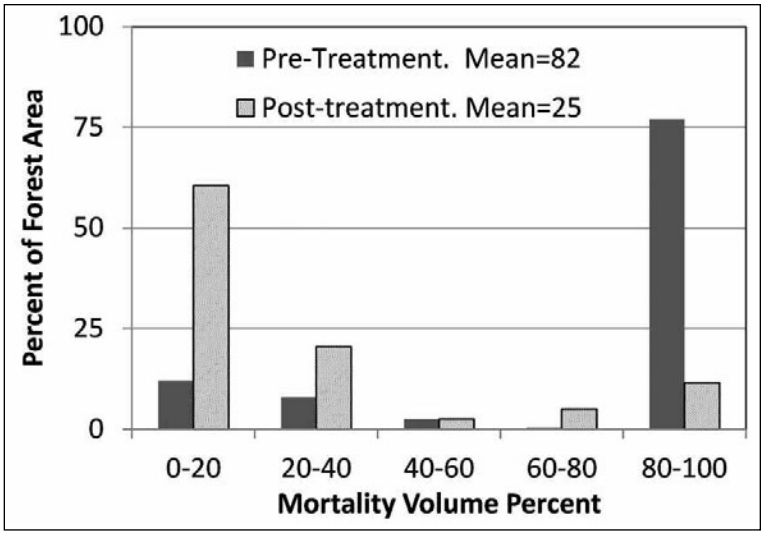
Defining fire hazard

We evaluated hazard via four attributes computed by the FFE-FVS (Fire and Fuels Extension of the Forest Vegetation Simulator) model for each forested condition in this FIA dataset under severe fire weather. Hazard thresholds for each attribute were constructed from information obtained via focus groups with fire and fuels managers. When compared to these thresholds, the attributes *probability of torching* (ptorch, expressed as a percent) and *torching index* (TI, defined as the wind speed in miles per hour at which crown fire initiation would be expected) identify conditions where fires are likely to transition from surface to canopy fuels, involving the crowns of some to all trees. Fuel treatments are often designed to minimize such torching fire behavior, and hazard thresholds of >20 mph for TI and <20% for ptorch provide an aspirational basis for torching hazard mitigation. *Surface flame length* (SFL) serves as a proxy for both fire intensity and fire suppression effectiveness (e.g., high flames may preclude direct attack). Direct attack on the fire perimeter is usually possible when SFL <4 ft., but rarely so when >4 ft., so fuel treatments that keep SFL below 4 ft. could promote fire suppression effectiveness. *Mortality volume percent* (MortVolPct), computed as predicted post-fire mortality volume expressed as a percent of pre-fire, live tree volume, serves as an indicator of economic and resource loss, lost carbon storage opportunity, and the viability of stands post-treatment. We set a 30% threshold for this hazard. We used these four attributes (TI, ptorch, SFL, and MortVolPct) and their associated thresholds as indicators of fuel treatment effectiveness. We also considered and report a composite hazard score calculated as the number of these four attributes by which a plot, and the acres it represents, qualifies as hazardous, producing a hazard score between 0 and 4. Treatments that reduced hazard score were considered effective. Over 90% of the 33 million acres we analyzed were rated hazardous, and about a sixth of these

could be effectively treated, according to our definitions, by one of the prescriptions we simulated. Described by what is left as a residual stand, these were (with percent of acres on which the treatment proved the best choice in parentheses):

- "leave trees >21 in." (34%);
- "leave early seral species" (42%); and
- "leave 50 percent canopy cover" (24%).

Leave trees >21 in. was most effective in Douglas-fir and true fir types and entailed removing, on average, 30% of the volume or 3800 cu. ft. *Leave early seral species* was most effective in pine and larch types (which were more likely to contain early seral species trees in numbers sufficient for a viable residual stand) and removed, on average, 26% of wood volume or 1400 cu. ft.



SOURCE: www.fs.fed.us/rm/pubs/rmrs_gtr292.html

Figure 1. Percent of Douglas-fir and true fir forest area, in central and eastern Oregon and Washington, by Mortality Volume Percent (percent of live tree volume in trees predicted by FFE-FVS to die when subjected to fire under severe weather), pre- and post-treatment for the 1.03 million acres on which one or more treatments were considered effective.

What we learned

Having results for thousands of real, representative places on the ground provides more complete information about what can be accomplished than would rules of thumb or averages from case studies. For example, predicted tree mortality shifts dramatically post-treatment in the Douglas-fir and true fir forests of central and eastern Oregon and Washington. Pre-treatment, most stands experienced 90 to 100 percent mortality; treatment changed the distribution so that volumetric mortality rates below 20% dominate; the mean value of 25 is primarily influenced by the few cases where, despite improvements in other indices, MortVolPct remained high (see Figure 1).

	Merchantable Wood		Energy Wood			Costs				
	Volume removed	Value removed	Mass removed	Energy wood value	value as % of all product value	Treatment cost		Energy wood haul costs as % of all cost	Net revenue	Area
Forest type group	ft^3/ acre	$/acre	Green tons per acre	$/acre		$/acre	$/100 ft^3		$/acre	Thousand Acres
Douglas/true fir	1,757	3,050	16	582	22	2,217	410	6	1,016	2,177
Pine and larch	1,266	2,143	13	468	23	1,021	146	7	1,340	456
Aspen	994	405	6	215	63	857	275	25	-791	112
Cedar	2,010	3,655	17	607	28	1,574	543	6	2,294	108
Other species	2,003	2,587	27	989	34	1,974	274	10	988	2,558
All	1,823	2,699	21	765	29	1,954	319	9	1,015	5,412

SOURCE: www.fs.fed.us/rm/pubs/rmrs_gtr292.html

Table 1. Mean production, economic, and area attributes by forest type group.

Volumes of merchantable and energy wood and cost and revenues due to treatment operations varied considerably among forest type groups, but in the types that are, in practice, most frequently treated (Douglas-fir, true fir, and pine and larch), merchantable wood recovered amounted to 1 to 2 thousand cubic feet per acre and net revenue averaged over $1000/ac. despite high on-site costs averaging 1-2 thousand dollars per acre (see Table 1). Energy wood, the tops and limbs of all trees and the boles of non-merchantable trees that could be chipped for production of

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biomass energy, accounted for about a fifth of the total product value. The fraction is relatively small because there was less of it and it has a lower unit price, but since delivery of energy wood to the landing is already "baked-in" to the cost of most whole tree harvest prescriptions, only delivery costs were attributed to energy wood, and these accounted for only 6-7 percent of all treatment costs. It rarely, if ever, makes financial sense to burn logging residues at the landing unless delivery costs are exceptionally high, which can occur when bioenergy facilities are rare or access to treatment areas is challenging (e.g., for chip vans).

When woody material removed by a fuel treatment is utilized for wood products and bioenergy, revenues contribute a great deal to off-setting treatment costs and, on most acres, can more than offset the costs of treatment activities and transportation of harvested material, although this varies geographically and whether stands are assumed to be treated only when all hazards have been mitigated or when even one hazard has been mitigated.

For example, in Utah, mean net revenues were always negative, and were negative in the northern and central Rocky Mountains when it was assumed that all hazards must be mitigated. Aspen had negative mean net revenues because of the low commercial values of harvested material (most trees in this type are utilized for energy wood in our scenarios). In most scenarios, net revenue was greater for pine and western larch than for Douglas-fir and true fir, and scenario assumptions are extremely influential. For example, let's compare two scenarios. The first required that all hazards be mitigated and specified that ties (in terms of composite hazard score) among treatments that achieve this goal be resolved in favor of the treatment with the lowest residual stand ptorch value. The resulting mean net revenue per acre for pine and fir was $825 and -$33, respectively. In the second scenario, where ties were resolved by choosing the treatment with the greatest net revenue, mean net revenues were $921/acre and $283/acre, respectively, for pine and fir. This highlights the importance of hazard and effectiveness definitions, as well as how to determine the "best" treatment when there is more than one way to achieve a given hazard score.

To be truly effective in mitigating fuel hazard, it is important to pursue all options that promote self-funding fuel treatments. Given the current and likely future federal budget climate, it is hard to imagine successful implementation of anything but treatments that pay their own way for the foreseeable future. The future of active forest management on public lands may well depend on reconciling ourselves as foresters and natural resource professionals to that hard reality. ◆

Jeremy S. Fried is a research forester with the PNW Research Station in Portland, Ore. He can be reached at 503-808-2058 or jsfried@fs.fed.us. Theresa B. Jain is a research forester with the Rocky Mountain Research Station in Moscow, Idaho. She can be reached at 208-883-2331 or tjain@fs.fed.us.

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