CALIFORNIA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

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Basic Principles of Forest Fuel Reduction Treatments

Agee, J.K., C.N. Skinner. 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management 211: 83-96.
http://www.treesearch.fs.fed.us/pubs/36541

Wildfire severity and size are of increasing concern in the western United States, where fire exclusion and subsequent fuel accumulations have resulted in uncharacteristically large, severe wildfires. This pattern of increased fire risk is well-recognized on both management and policy levels, yet the fire community still lacks clear, broadly applicable solutions to the wildfire problem.

A number of treatment options are available on the local level, and land managers employ these options in various combinations and at different time intervals and spatial scales. These options are the focus of a large body of literature, wherein their efficacy, cost, and social acceptability have been examined in detail. However, it can be difficult to navigate this information, and there is a need for a clear, concise analysis of the relative merits of different treatments.

In this paper, Agee and Skinner reviewed related literature, simulated fire behavior in different treatment types, and considered five real-world examples of fuels treatments and wildfire. Using these methods, they distilled a set of basic principles underlying effective treatments that reduce fuels and limit wildfire severity and extent.

Firesafe principles
The authors identify four "firesafe principles" that are essential to successful fuel reduction treatments. Based on their analyses, effective fuel treatments should do the following:

1) Reduce surface fuels.
2) Increase height to the base of live crowns.
3) Decrease canopy density.
4) Keep large trees of fire-resistant species.

These four principles address the drivers of intense surface fires and crown fires, which include surface fuels, ladder fuels, and dense canopies.

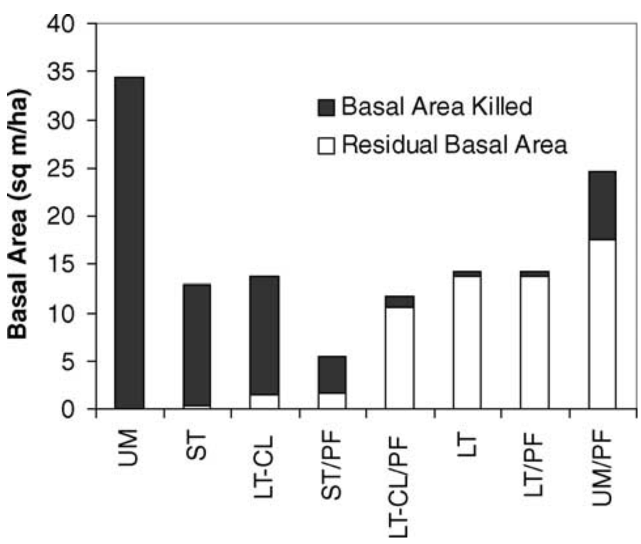
Management Implications

- Fuel reduction treatments are most likely to be successful if they are planned within a landscape context that takes into account historical burning patterns, rates of fuel accumulation, and the scale of treatment needed for the particular landscape.
- Successful fuel reduction treatments to prevent severe and/or large wildfires in the western U.S. will address the reduction of surface fuels, ladder fuels, and canopy bulk density.
- Both prescribed fire and thinning can be used to reduce fuels. However, thinning techniques have little effect on surface fuels, while prescribed fire alone has little effect on canopy density.
- Fuels reduction treatments must be repeated at intervals appropriate for the particular landscape to maintain effectiveness.
- Thinning treatments should be accompanied by post-thinning surface fuel reduction treatments.

Comparing treatments

Two primary strategies are used to reduce fuels: prescribed fire and thinning. Prescribed fire is effective at reducing surface fuels and moderately effective at reducing ladder fuels, but it is not generally effective for reducing canopy density. The beneficial effects of one prescribed fire alone are relatively short-lived, as the fire can create new fuels from small understory trees that are killed. Thinning is most effective for canopy and ladder fuel treatments, and depending on harvesting and yarding techniques it can either increase or decrease surface fuels. A common treatment is thinning followed by prescribed fire, which has a combined influence on the entire fuel profile.

To compare the relative efficacy of these popular treatments, the authors simulated the effects of various thinning techniques – with and without follow-up prescribed fire treatments – on stand structure and fuels in a typical dry conifer forest with a J-shaped diameter distribution and large trees of fire-resistant species up to 80 cm in diameter. Severe wildfire was then simulated in each treatment type to determine the influence of treatments on post-wildfire stand structure and tree survival.



Survival from a severe-fire-weather wildfire of the stand structures included in the study. English equivalents for basal area: multiply by 4 to ascertain approximate sq ft / ac. Columns are organized by absolute amount of residual basal area (white part of column). UM: unmanaged, ST: selection thin, LT: low thin, CL: commercial limit (>15 cm), PF: prescribed fire.

In general, prescribed fire alone produced the best results in these simulations. However, it is important to consider fuel treatments in the context of their ecological and social landscapes, as treatment effects will vary by species composition, topography, and management history. The most effective treatments may involve a mix of strategies.

Real-world examples

Real-world opportunities to test fuel treatment effectiveness are few, mostly limited to areas that have experienced post-treatment wildfire. This paper presents five case studies of severe wildfires that burned over areas that had been previously treated. These case studies result in several additional lessons that supplement the four primary firesafe principles. One of the most important lessons is that when thinning or producing shaded fuelbreaks across the landscape, the shape of the treated area is important: the more "edge" that exists relative to the entire treatment area, the more tree mortality there is likely to be. Another lesson emphasizes the importance of following thinning treatments with surface fuel reduction treatments so that thinning does not actually worsen the fuels problem.

All in all, the real-world examples reinforce the importance of paying attention to residual fuel and forest structure when performing fuel reduction treatments. Although treatments cannot be implemented over all landscapes, this paper sounds the hopeful note that with care and a proper consideration of the landscape, fuel reduction treatments can be remarkably effective at reducing the negative effects of future severe wildfires in areas throughout the western U.S.

Suggestions for further reading

Brown, R.T., Agee, J.K., & Franklin, J.F. 2004. Forest restoration and fire—principles in the context of place. Conservation Biology 18: 903-912.

Ritchie, M.W., Skinner, C.N., & Hamilton, T.A. 2007. Probability of wildfire-induced tree mortality in an interior pine forest of northern California: effects of thinning and prescribed fire. Forest Ecology and Management 247: 200-208.

Schmidt, D.A., Taylor, A.H., & Skinner, C.N. 2008. The influence of fuels treatment and landscape arrangement on simulated fire behavior, Southern Cascade range, California. Forest Ecology and Management 255: 3170-3184.