



# Ecological Restoration Institute



Fact Sheet: *Meta-analysis of Treatment Effects on Fire Behavior* March 2012

## Meta-analysis Finds Restoration Thinning and Burning Treatments is Best Strategy to Restore Natural Fire Behavior in Western U.S. Forests

Ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*P. jeffreyi*), as dominant species or mixed with other conifer and broadleaf species, cover approximately 25 million acres in western North America. Although these forest types are adapted to a disturbance regime of frequent surface fires, extended fire exclusion and other factors have led to uncharacteristically dense stands and high fuel loadings that often result in large, high-severity crown fires.

Twentieth-century conservationists, such as Aldo Leopold, described changing ecosystem structure, function, and disturbance patterns. Early forest restoration efforts focused primarily on prescribed burning. Land managers and forest ecologists now recognize that prescribed burns on their own may not be an effective strategy because many forests are too dense. More recent experimental and observational studies have incorporated burn only, thin only, and thinning + burning as strategies for restoring these dense, pine-dominated forests.



## Systematic Review and Meta-analysis

There has been a growing body of research about restoration treatments in western forests. The purpose of these experimental treatments is to study how to restore forest structure and disturbance, and reduce fire hazard. These experiments have been followed by observations of fire behavior in treated stands. To synthesize this large body of information, we conducted a systematic review of the effects of forest thinning and burning treatments on forest structure and fire behavior attributes in western U.S. pine forests. Using a systematic review methodology, we found 54 studies with quantitative data suitable for meta-analysis.

The Ecological Restoration Institute is dedicated to reversing declines in the condition of forested communities throughout the Intermountain West, particularly those affected by severe wildfires and insect outbreaks. Our efforts focus on science-based research of ecological and socio-economic matters related to restoration as well as support for on-the-ground treatments, outreach, and education.

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## Results and Qualifications

We found that surface fuels were significantly reduced relative to controls in burn-only treatments, significantly increased in thin-only treatments, and changed little in thin + burn treatments. Forest structure variables (tree density, basal area, and canopy cover) were consistently significantly reduced compared to controls, and most so in combined treatments (thinning + burning). All treatments increased crowning and torching index values relative to controls (i.e., reduced susceptibility to crown fire), but no differences existed between treatments. Similarly, changes in canopy base height and canopy bulk density were not consistently related to treatment intensity, as measured by basal area reduction. Overall, treatments were successful in reducing the potential for passive and active crown fire, but additional studies about fire behavior effects are needed.

There are a number of qualifications to the findings. First, because it is not feasible to subject treated areas to severe fire experimentally, inferences about potential fire behavior rely on imperfect modeling techniques. Second, research has not been done uniformly across the ranges of the pine forests, although we found no significant differences in treatment effects between regions or forest types.

## Management Implications

The meta-analysis showed that although the various treatments were not statistically distinguishable and there was not a linear relationship between treatment intensity and canopy fuels, all treatments had significant effects on the measured forest variables that contribute to low-severity fire behavior. Land managers who are trying to decide which treatment strategy to implement will note that this meta-analysis found:

- thinning + burning had the greatest effect on reducing tree density, basal area, and canopy cover
- thinning alone significantly increased fine and coarse surface fuels
- burning alone significantly reduced canopy fuels and both fine and coarse surface fuels, although the effects can be limited if environmental conditions do not allow for efficient and effective burning.

## Reference

Fulé, P.Z., J.E. Crouse, J.P. Roccaforte, and E.L. Kalies. 2012. [Do thinning and/or burning treatments in western USA ponderosa or Jeffrey pine-dominated forests help restore natural fire behavior?](#) *Forest Ecology and Management* 269, 68-81.

*For more information about the results of this study,  
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