

# Science

FINDINGS

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*“Science affects the way we think together.”*

Lewis Thomas

## FUEL REDUCTION AND FOREST RESTORATION TREATMENTS: ONCE IS NOT ENOUGH

Andrew Youngblood



Although they are the most difficult and expensive to implement, restoration treatments that use both thinning and burning move forest stands closest to the restoration goals of the Fire and Fire Surrogates study.

*“Keep in mind that fire is a natural part of the environment, about as important as rain and sunshine... fire has always been here and everything good has evolved with it.”*

—Harold Biswell

Reports of “catastrophic wildfires raging through tinder-dry forests” seem to take up a larger portion of the evening news with each passing summer. And although it is true, there is a trend toward larger and more severe wildfires, it is also true that fire has been a ubiquitous component of many forest

ecosystems. Indeed, wildfire may be the single most important agent of change in forests worldwide. It’s just that the character of wildfire is changing.

Historically, fire burned through forests in drier climates quite frequently—every couple of decades or less. These are the so-called fire-dependent forests. Because woody vegetation never had much time to accumulate between burns, fires were not very intense and typically remained on the surface, only occasionally torching into tree canopies. The product of repeated, low-severity fire was forests of large, widely spaced trees. Open canopies allowed ample sunlight to reach the forest floor, where grasses and low shrubs dominated the understory.

## IN SUMMARY

Frequent, low-intensity fires were historically a common feature in many dry forests of the United States. Today, largely owing to fire exclusion and past management practices, many of these fire-dependent forests contain significantly more small trees and fewer large trees than occurred under the natural fire regime. These altered conditions increase the probability of unnaturally severe wildfires, susceptibility to uncharacteristic insect outbreaks, and drought-related mortality. Restoration of these forests is a priority for forest managers throughout the country. Unfortunately, little information exists about the effectiveness or ecological consequences of commonly used fuel reduction and forest restoration strategies. In response, a national research project called the Fire and Fire Surrogates Study is conducting operational-scale experiments to evaluate restoration treatments at 13 sites across the country.

As part of this study, researchers working in dry, low-elevation forests in northeastern Oregon evaluated several fuel reduction and forest restoration treatments: a commercial thin, a prescribed burn, and a combination of the two. Thinning and the combination of thinning and burning reduced the density of live overstory trees, and burning and the combination of thinning and burning reduced the density of small-diameter trees. Overall, the treatments failed to completely meet the objective of restoring stands to historical conditions, yet each treatment successfully modified stand density, likely reducing the risk of high-severity fire. The results suggest that repeated treatment over time will be necessary to mitigate the impact of a century of fire suppression.



*Fire suppression and past logging practices have resulted in unnaturally high tree densities, which has increased the probability of severe wildfires, insect outbreaks, and drought-related mortality.*

Today, largely owing to a century of fire suppression and past logging practices, many fire-dependent forests are shadows of their former selves. Large trees typically remain, but they are inundated by young trees and woody shrubs that have established in the absence of fire. These small trees create a continuous ladder of woody vegetation from the ground to the treetops and dramatically increase competition for water, nutrients, and light. In many cases throughout the West, the absence of fire in dry forests has led to a shift in tree species from fire-resistant ponderosa pine and Douglas-fir to grand fir and other species intolerant of fire.

## FIRE AND FIRE SURROGATES

**B**ottom line: dry forest restoration means lowering the density of trees. Certainly there are other important components, but if dry forests are to be resilient to future fire and other stressors, there must be fewer trees. Ideally, only the largest trees will remain. The obvious question, then, is how best to remove the small trees: fire, chain saw, or some combination of the two?

Fire is the oldest tool in the forester's toolbox. Long before there were chain saws, long before there were axes even, fire was used to manage forests. And today, prescribed fire remains a popular and effective way to eliminate low vegetation under a controlled setting.

According to Youngblood, there are several advantages to using fire. "Fire is a natural process in these systems. It stimulates plant species that are adapted to fire, while eliminating those that are not. Prescribed fire also creates a diversity of conditions, burning hotter in some areas while missing others

<b>KEY FINDINGS</b>	
•	Thinning and the combination of thinning and burning reduced the density of live overstory trees, whereas burning and the combination of thinning and burning reduced the density of small-diameter trees.
•	No treatment fully met the restoration goals; the combined thin and burn was the only treatment that reduced tree density below the threshold where serious mortality from bark beetles might be expected.
•	No single application of prescribed burn or thinning treatments fully restored ecosystem structure and function within the dry forests of this study that had been removed from their natural fire regime over the past century.

"Collectively, these altered conditions may contribute to increased probability of unnaturally severe wildfires, susceptibility to uncharacteristic insect outbreaks, and drought-related mortality," explains Andy Youngblood, research forester at the PNW Research Station in La Grande, Oregon. "There is broad agreement that some form of restoration is needed to move stands from their current structure and developmental trajectory to conditions that more closely incorporate historical fire regimes that existed before Euro-American influences."

Although it may be clear that something must be done, exactly what the best path to restoration looks like remains an open question.

"There is no single right treatment," says Youngblood. "While historical information offers insight into one resilient forest condition, there may be other equally resilient targets that managers may choose, particularly given the fact that the future climate may not resemble the past."

Youngblood recently completed the first phase of a long-term experiment in the Blue Mountains of northeastern Oregon. He made a side-by-side comparison of several approaches to forest restoration in dry ponderosa pine- and Douglas-fir-dominated forests.

entirely, which can have ecological benefits," he says. "The downside to using fire as a restoration tool is that it lacks precision. Once we ignite a treatment unit, it's impossible to know which trees will be killed and how well we'll meet our density targets. Prescribed fire also has the big drawback of producing smoke. There are huge social and legal constraints associated with producing smoke and reducing air quality, which impedes the widespread use of burning."

Mechanical thinning is the other common approach to fuel reduction and forest restoration. "From a managerial perspective, thinning is easy to design, and there is a high degree of precision regarding what is retained and what is removed. Thinning also can produce some revenue, which can offset some of the costs of restoration," says Youngblood. "However, timber sales often become complicated and time-consuming on federal land. Also, when used as a surrogate for fire, thinning may achieve some of the desired stand

structure, but it is fundamentally different from fire and may produce different ecological responses."

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“We have a wealth of knowledge about underburning, thinning, and other silvicultural treatments. We’ve been doing these things for years,” he says. “But there is little information about their efficacy across broad regions or among multiple fire-dependent ecosystems for sustaining healthy forest ecosystems and regulating fuels.”

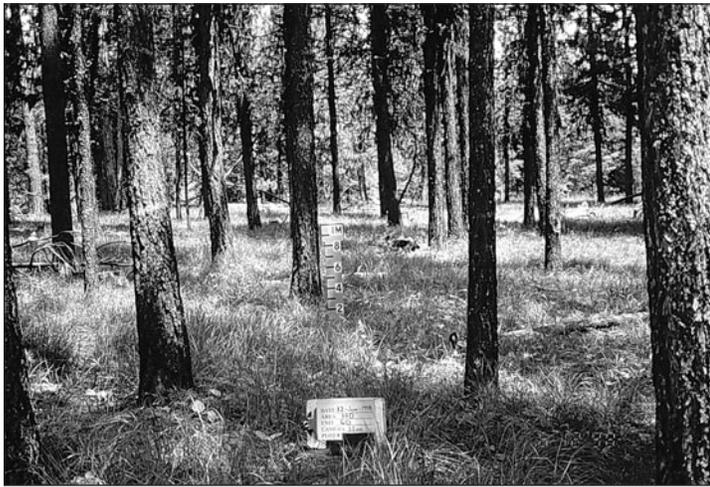
As yet, there has been no comprehensive comparison of fuel reduction and forest restoration treatments to guide managers and decision-makers. This is why the multiagency Joint Fire Science Program has funded a national research project, called the Fire and Fire Surrogates (FFS) Study, to assess how ecological processes may be changed if fire “surrogates,” such as thinning, are used instead of, or in combination with, fire.

The FFS Study is a network of 13 sites spanning central Florida to the Pacific Northwest. At each site, the same commonly applied treatments are evaluated in side-by-side comparisons. In the Pacific Northwest there are three sites with common features in terms of climate and species composition: the Northern Rocky Mountain site in western Montana, the Northeastern Cascades site in Washington, and the Blue Mountains site in northeastern Oregon.

“Sites in the East have different species—oaks, hickories, and southern pine—but, just like the western sites, the target species are those that would have persisted under similar frequent, low-severity fire regimes,” explains Youngblood.

“We measured the same variables with the same protocols across the whole network. We calculated small-mammal abundance; foraging-bird abundance and nest success; carbon balance and sequestration and nitrogen dynamics; understory plant species diversity and invasive nonnative plant species dynamics; abundance of down woody fuel; indices of stand structure such as species composition, tree density, and tree diameter; and future fire behavior under various weather scenarios. All of these variables are measured before and after the treatments.”

“Our hope is that managers will be able to look at the findings from across the network and say, for example: Since there’s been a common response across all the sites similar to mine, I can be fairly certain that the same thing will occur.”



U.S. Forest Service

The images above show the same stand before and after a thinning treatment followed by a prescribed burn. Thinning removed some of the medium-sized trees, whereas fire eliminated the smallest trees, creating stand conditions more closely aligned with restoration goals.

## RESTORING THE BLUE MOUNTAINS

As a participant in the national FFS Study, Youngblood and several colleagues have completed a holistic investigation of changes in tree structure, down logs, and understory plant composition resulting from several different restoration treatments in the Blue Mountains in northeastern Oregon near the town of Enterprise.

“Every year there are high-severity fires on the Wallowa-Whitman, Umatilla, and Malheur National Forests in northeastern Oregon,” says Youngblood. “Forests that were once characterized by widely spaced ponderosa pines and Douglas-firs are now dense with live and dead small firs. The forest floor contains high levels of down wood and woody shrubs, all of which increase the risk of stand-replacing wildfires.”

As at all of the FFS sites, Youngblood and his colleagues examined the effects of four commonly used approaches for fuel reduction and forest restoration. These approaches included a single-entry thinning of just the smaller but commercially valuable trees, a late-season prescribed burn, a thinning followed by burning, and, finally, a no-action treatment, which served as a control.

All of the treatments were conducted at an operational scale, meaning they were similar in size to the types of fuel reduction and forest restoration treatments that managers conduct in the “real world”—25 to 50 acres. “Often, forest research is conducted on small plots—sometimes just a fraction of an acre—then the results are extrapolated to an operational scale,” says Youngblood. “In contrast, and despite the fact that they are more expensive and difficult to implement, all the treatments

in the FFS study are conducted at realistic scales.” To further ensure their findings were robust and useful to managers, each treatment was replicated four times across the landscape and the locations were randomly assigned.

Each treatment was approached with a working hypothesis, which essentially summarized the intention of that treatment and the best possible outcome associated with it. For example, the hypothesis associated with the single-entry thinning treatment was: “Forest ecosystems are best conserved by restoring ecosystem structure, and thinning can restore tree density, species composition, and the spatial pattern of the tree component.”

In contrast, the working hypothesis for the prescribed burn was: “Forest ecosystems are best conserved by restoring ecosystem processes, such as frequent, low-intensity

fire, which will remove fuel accumulations, increase the availability of nutrients, reduce dense regeneration that serves as a fuel ladder, increase forage production, and decrease the risk of stand-replacement wildfire.”

For the combined thin and burn, the hypothesis was: “Forest ecosystems are best conserved by restoring both structure and processes.”

And, finally, for the no-action control: “Forest ecosystems are best conserved by passive management, with no active manipulation of ecological processes or forest structure, except for a continuation of fire suppression.”



## LAND MANAGEMENT IMPLICATIONS



- Thinning, burning, and a combined thinning and burning failed to completely restore the structure of dry ponderosa pine and Douglas-fir stands to historical conditions, suggesting that repeated treatments over time will be necessary.
- The short-term changes in structure and composition appear minor compared to those reported after stand-replacement wildfires. This suggests that the majority of understory species have adapted to the same disturbance regimes that the active treatments attempted to mimic, and that the effects of the treatments were minor compared to the environmental complexity that exists within northeastern Oregon forests.

## A FIRST STEP TOWARD FOREST RESTORATION

Youngblood and his colleagues returned to the sites 6 years after the treatments were conducted to evaluate their effects in light of the hypotheses. Several key findings about the effects of fuel reduction and forest restoration treatments on forest ecosystems have emerged from this research.

“Thinning, burning, and a combination of thinning and burning used in this study each modified stand structure and composition,” says Youngblood. “Yet these changes were minor compared to those reported after stand-replacing wildfires.”

Thinning reduced the density of medium-sized trees—those between 4 and 10 inches in diameter. These were trees large enough to be commercially valuable but not so large that they were part of the overstory. Thinning had little effect on the abundance of down logs and did not appreciably alter the understory species composition.

Burning also had little effect on the overstory trees, but did eliminate many of the small-diameter Douglas-firs and tree seedlings. Unlike thinning, the burn did not eliminate many of the medium-sized trees. Burning

reduced the density of down logs and had notable effects on the understory species composition. Several fire-adapted perennial species, such as white spiria, pinegrass, and elk sedge, increased in abundance.

Thinning followed by burning was the only treatment that met the density target for forest restoration and was the only treatment resulting in tree density below the threshold where serious mortality from bark beetles might be expected in the near future. According to Youngblood, this was because the thinning eliminated the medium-sized trees, and the fire eliminated the smallest trees. As expected, the abundance of down logs was similar to the burn-only treatment. The relative success of the combined thin and burn supports the hypothesis that restoring both structure and process is the best way to conserve forest ecosystems.

“I happen to think that the combination treatment is the best of both worlds,” says Youngblood. “The commercially valuable material is removed up front and then you get all the benefits of the fire and the diversity of conditions it creates. In these initial stages of restoration, it has the most potential to push stands the furthest toward our goal.”

Unfortunately, just as the benefits of thinning and burning are additive, so too are the difficulties. “The costs and complications of setting up a timber sale in addition to a prescribed burn on public land can be quite significant,” says Youngblood.

Trygve Steen



*Prescribed burning eliminates the smallest trees and increases habitat diversity. However, the lack of precision can make it difficult for forest managers to anticipate the outcome of a restoration treatment.*

### WRITER'S PROFILE

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## ONE STEP AT A TIME

“A broad array of structural changes resulted from our restoration treatments, and each can be seen as a first step in the process of restoring historical forest structure and ecosystem process, as well as reducing the risk of uncharacteristically severe wildfires,” says Youngblood, “and our results should be seen as indicative only of the first in a series of planned treatments.”

An additional treatment in the next 10 or 15 years would move stands closer to the goal of fewer but larger trees. “Currently we don’t know how many treatments full restoration will take,” he says. “But we have asked for funding to address that question.” And then there also is the maintenance factor. “Even after the restoration goals have been met, those successes are only temporary. Just like fires that returned every decade or so, stand maintenance also will have to occur on this timescale.”

According to Youngblood, mitigating nearly a century of fire exclusion and fuel accumulation in dry forests will not be a quick fix. Instead, fuel reduction and forest restoration will engage the efforts of forest managers for years to come.

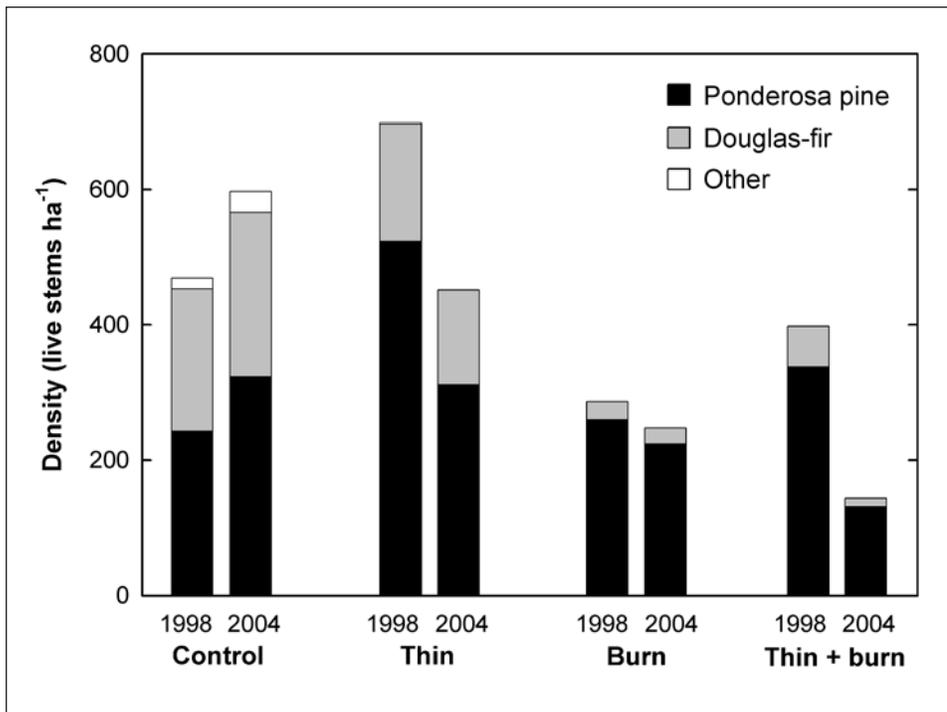
*“The important thing is not to stop questioning.”*

—Albert Einstein

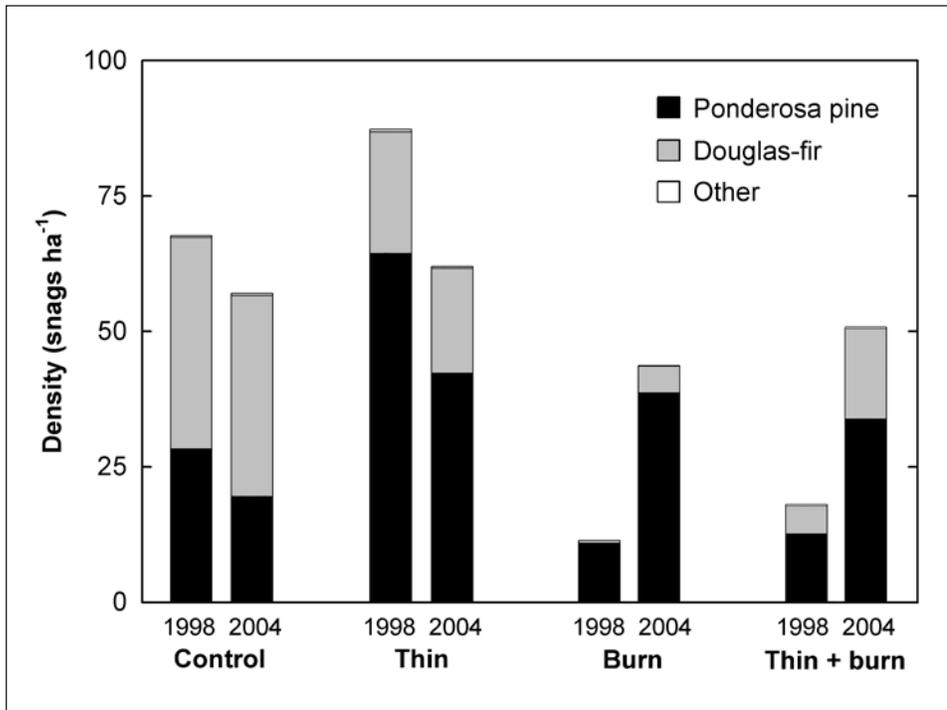
## FOR FURTHER READING

Youngblood, A.; Metlen, K.L.; Coe, K. 2006. *Changes in stand structure and composition after restoration treatments in low elevation dry forests of northeastern Oregon*. *Forest Ecology and Management*. 234: 143–163.

Metlen, K.L.; Fiedler, C.; Youngblood, A. 2004. *Undergrowth vegetation response to fuel reduction treatments in the Blue Mountains of northeastern Oregon*. *Northwest Science*. 78: 175–185.



Reducing tree density is the primary objective of the restoration treatments. Of the four treatments tested, a commercial thin followed by a prescribed burn was the most effective.



Standing dead trees, or snags, are an important component of wildlife habitat but also can act as fuel during a wildfire. Prescribed burns tended to increase the abundance of snags.