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INSIDE

"Science affects the way we think together."
Lewis Thomas

BIOENERGY FROM TREES: USING COST-EFFECTIVE THINNING TO REDUCE FOREST FIRE HAZARDS

Jeremy Fried

Mechanical thinning is one way to reduce crown fire hazard while providing opportunities to create renewable energy. Landowner objectives, forest type, and proximity to processing facilities are factors to consider when assessing the potential for this treatment to accomplish both goals.

IN SUMMARY

Increasingly large and severe wildfires threaten millions of forested acres throughout the West. Under certain conditions, mechanical thinning can address these hazardous conditions while providing opportunities to create renewable energy and reduce our carbon footprint. But how do land managers decide whether thinning is a good idea? How do they decide where to begin, and what to do with the removed trees? Prioritizing treatment areas and determining the most effective techniques for fuel hazard reduction depends on various factors such as owner objectives, forest types, and the availability of processing facilities.

Scientists from the Pacific Northwest Research Station created an analytic system that allows forest managers to simultaneously assess fuel hazard treatment effectiveness, the location and capacity of processing facilities, and financial feasibility. The analysis framework uses the nationwide Forest Inventory and Analysis database, which enables foresters and analysts to use it as a tool to inform decisionmaking.

Researchers applied numerous policy scenarios to a 28-million-acre, four-ecosystem region of Oregon and northern California. The study showed that converting trees and logging residue that would otherwise have little or no commercial value into bioenergy shows promise for offsetting some treatment costs. Results indicate that removing large quantities of merchantable trees would be necessary to achieve fire hazard reduction goals.

"Since the house is on fire, let us warm ourselves."
—Italian proverb

As unusually severe wildfires become more common across the West, land managers and policymakers are scrambling to develop socially acceptable, economically feasible ways to reduce the hazardous conditions that lead to them. In fact, the 2003 Healthy Forests Restoration Act mandates that forest managers implement fire hazard reduction projects to reduce the risk to communities. The act also calls for improving the utilization of forest biomass that could be collected as fuel for bioenergy facilities rather than left to fuel wildfires.

Prescribed fire is a useful and cost-effective approach in some situations, but may not be feasible where air quality is a concern. And with this approach, any opportunity for utilizing the biomass is lost. Consequently, land managers have identified mechanical thinning as a way to reduce the risk of stand-replacing fire, offset carbon emissions from burning fossil fuels, and potentially reap value from the harvested biomass.

A mechanical thinning program of this magnitude, however, has proven to be extremely controversial. Forest managers need ways to determine where implementing large-scale thinning operations will yield success as measured by multiple standards and interest groups.

Decisionmakers need “social license” for their actions. In other words, the public must accept proposed thinning activities as a reasonable way to deal with the problem. Investors need a viable business climate, which means that laws, regulations, and operating costs must align in ways that make establishing processing facilities practical. Finally, a thinning program must produce enough raw material to warrant investing in new processing facilities or expanding existing facilities.

KEY FINDINGS

- The FIA BioSum analytical framework provides a statistically representative foundation for identifying landscapes where fuel treatments could reduce unwelcome consequences of wildfire while supporting bioenergy generation.
- An analysis of 28 million acres in Oregon and northern California revealed that substantial numbers of larger, merchantable trees need to be removed to accomplish fire hazard reduction goals as measured by the torching and crowning indices.
- The study area is capable of annually producing up to $590 million in net revenue and up to 12 million green tons of biomass, which could be used to produce up to 1009 megawatts of electricity over a decade.
- Pricing structure analyses indicate that biomass processing facilities with capacities below 15 megawatts may not be cost competitive with larger facilities. In some situations, however, site-specific considerations could make smaller facilities practical.

Forest types, owner objectives, resources, markets, and communities vary widely, so there is no single solution that will sufficiently address every situation. Pacific Northwest (PNW) Research Station scientists Jeremy Fried, Jamie Barbour, Roger Fight (retired), and P.J. Daugherty (now with the Oregon Department of Forestry) designed an analysis framework called FIA BioSum (Forest Inventory and Analysis Biomass Summarization) to help managers make critical decisions about silvicultural treatment options.

BioSum helps users prioritize areas to be thinned, estimate yields, assess opportunities for utilizing bioenergy, locate wood bioenergy facilities, and project returns on investment. The analysis framework uses the publicly available Forest Inventory and Analysis database, which helps foresters and analysts throughout the United States inform decisionmaking.

“BioSum can identify the ‘low-hanging fruit’—regions where reducing the fire hazard can be accomplished with good results while producing enough revenue to at least cover treatment costs,” says Fried. He and his colleagues recently used BioSum to assess a four-ecosystem, 28-million-acre region of Oregon and northern California. They wanted to know which treatments could be applied to these acres to maximize effectiveness in reducing fire hazard while returning value by converting the biomass to energy and recovering value from the merchantable wood.

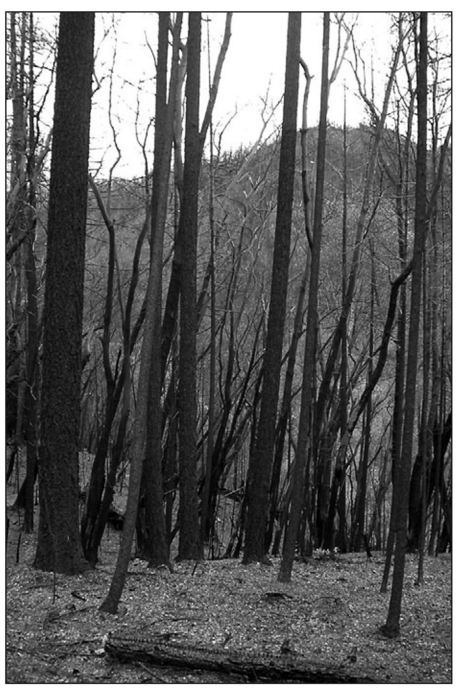
Unlike earlier studies, this one factored in projected costs of harvesting and transporting the removed biomass from the forest to processing facilities. BioSum also allowed the researchers to determine where processing facilities might be built or expanded to make thinning economically viable.

ASSESSING EFFECTIVENESS

When assessing the effectiveness of silvicultural treatments to reduce the potential for stand-replacing fire, managers pay attention to the “torching index” and “crowning index.” The torching index reflects the windspeed at which a fire that is spreading at ground level through surface fuels—downed wood, shrubs, decaying organic matter, and so forth—will climb into the crowns of the taller trees on “ladders” composed of tree branches, saplings, and shrubs.

The crowning index expresses the windspeed above which a fire would spread from crown to crown and engulf the entire stand in flames. In both cases, lower values indicate more hazardous conditions. If a crown fire can occur even at low windspeeds, the stand will be more vulnerable. A treatment is usually deemed effective when it elevates both the torching and crowning index.

Elevating the indices in tandem is not easy, says Fried, and not everyone agrees about which index should be given priority. “Forest



Jeremy Fried

The aftermath of a crown fire leaves little seed source for regenerating the forest.

Purpose of PNW Science Findings

To provide scientific information to people who make and influence decisions about managing land.

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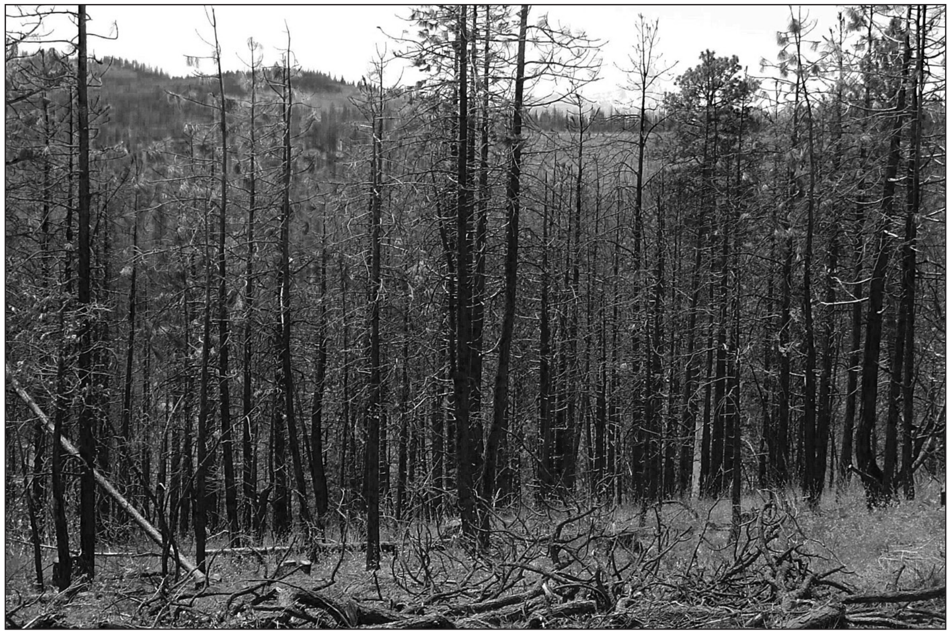
managers tend to gravitate toward the crowning index," he says. "However, the fire community says the crowning index isn't really a problem because true crown-to-crown spread is unlikely except under the most extreme weather conditions. When the weather is that extreme, it is unlikely that any fuel treatment will be effective. If torching can be completely prevented, the fire will not get into the crowns in the first place, and active crown fire cannot occur." For these reasons, those interested in managing for fire tend to give more weight to the torching index.



Eini Lowell

This stand was severely scorched. A few trees may ultimately survive, but stand mortality will likely be nearly as high as if it had been burned by a crown fire.

In their study, Fried and his colleagues tested multiple policy scenarios, including giving the crowning and torching indices equal weight. Trees measuring 7 to 21 inches in diameter were considered potentially merchantable, and those measuring 3 to 7 inches were considered "submerchantable," meaning that they traditionally have lower or no value. They concluded that removing significant quantities of merchantable trees would be necessary to maximize treatment effectiveness based on the torching hazard. The finding opens the door to possible agreement between the fire community and timber producers on a management policy that would achieve the objectives of both communities.

Jeremy Fried

The thinning treatment in this stand has likely raised both the crowning and torching indices, reducing the potential for crown fire.

Fried was surprised by this finding. "It seemed plausible that removing small trees would take care of the problem," he says. "But it turns out that in most stands, you have to remove a significant fraction of trees that are 10 to 21 inches in diameter if you're going to be effective as measured by improvement in the torching and crowning indices."

Although some stakeholders might not want large trees to be removed, because of the nature of the stands in the study area, removing merchantable trees was the only way of reducing the threat of wildfire, regardless of the owner objectives specified. "When you pick the treatment that minimizes the removal of merchantable wood, it tends to be a lot less effective—in fact, sometimes not effective at all," says Fried. The study suggested that even when the objective was to minimize merchantable volume, about two-thirds of the removed weight consisted of saw logs.

Jeremy Fried

This stand of ponderosa pine would score low on both torching and crowning indices. A fire occurring even under moderate weather conditions would likely kill most trees in this stand.

The research team determined that about 8.1 million acres in the study area could be treated with moderate effectiveness using 1 of 10 treatments modeled in BioSum. A treatment was considered moderately effective if it substantially improved either the torching or crowning index. To improve both indices, or to improve crowning index without making the torching index worse, they estimate that only about 4 million acres could be effectively treated.

WRITER'S PROFILE

Marie Oliver is a science writer based in Philomath, Oregon.

EXPLORING BIOMASS MARKETS

When the team began working on this project in the late 1990s, the U.S. Forest Service was attempting to identify solid wood products that could be made out of small-diameter wood, says Barbour. The idea was that perhaps rural communities that had lost their income from reductions in federal timber harvests could create businesses that would make products from the wood that was removed during thinning.

Early research focused on the use of trees that are less than about 9 or 10 inches in diameter at breast height. Product suggestions included rustic furniture, softwood flooring, and the *vigas* and *latillas* used in Spanish-style construction. Although some rural communities were helped as a result, such a focus did not lead to great success in reducing the wildfire hazard. “Manufacture of those kinds of products can be viable in small quantities, and when the companies that make them locate in rural communities, they do make a real difference,” says Barbour, “but the limited volumes they require hardly make a dent in the fire hazard.”

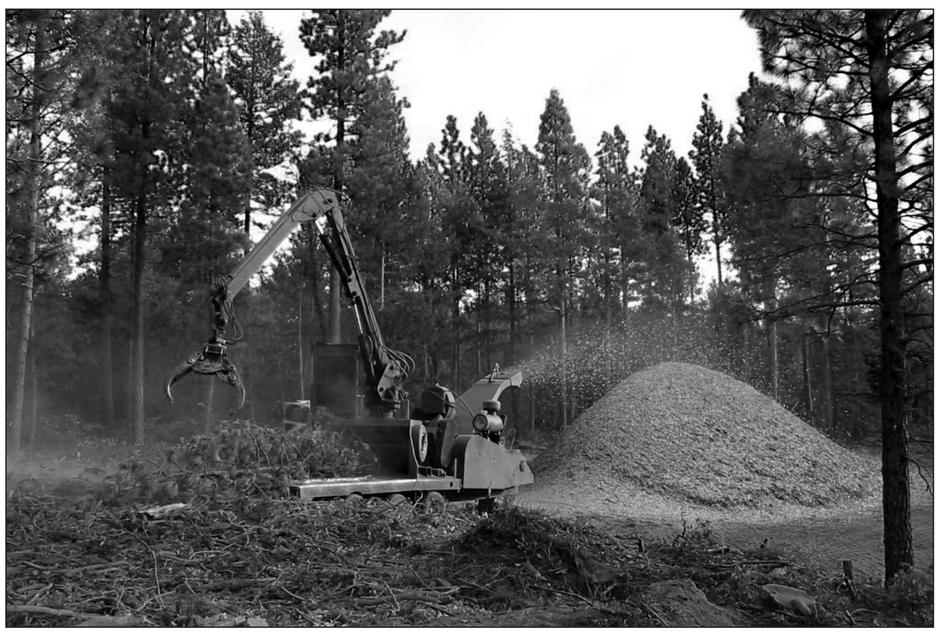
Other potential markets include mills that process pulp for making paper products, but those mills—where they still exist—require immense volumes of “clean chips,” which are made after removing the limbs, needles, and bark from the trees. Processing millions of small trees this way is simply not cost effective. Instead, foresters put whole trees into a chipper, creating what the industry calls “hog fuel.”

Fried says the only existing market for hog fuel is bioenergy. “You throw it in a burner and use that to heat water and make electricity,” he says. California has been generating electricity in this way since the 1980s. The state’s biomass industry has created more than 3,600 new jobs, primarily in rural areas, according to the California Biomass Energy Alliance.

The research team’s analysis of the 28-million-acre study area estimates that the region could potentially produce up to $590 million annual net revenue over a decade. Revenue would be generated by annually selling 0.8 to 1.2 billion cubic feet of solid wood and 6 to 12 million green tons of woody biomass that could provide 496 to 1009 megawatts of bioenergy capacity. For comparison, the installed capacity of Bonneville Dam on the Columbia River is approximately 1093 megawatts.

Jeremy Fried

Thinned material can be brought to the landing for chipping if the slopes are sufficiently gentle.



Jeremy Fried

Chipped on site, the biomass can be trucked directly to the bioenergy facility.

LOCATING BIOENERGY FACILITIES

A unique feature of BioSum is that it allows users to simultaneously assess and optimize treatment effectiveness, revenue sources, and bioenergy processing facility location and capacity. In the study region of Oregon and northern California, results showed that the optimal spatial distribution of processing facilities would feature fewer large plants as opposed to more closely spaced, small facilities.

By using existing conversion efficiency data, researchers assumed that larger plants would pay higher prices because they can produce more energy per ton. The study’s pricing structure analyses indicated that facilities with capacities below 15 megawatts are not cost competitive unless they can achieve conversion levels that are 94 percent as efficient as those achieved by larger facilities.

With fewer processing plants between treatment areas, it would be necessary to haul the biomass greater distances, but Fried says the additional cost is small relative to the price premium available from larger plants. For that reason, the extra hauling expense would not significantly affect net revenue in the study area. If smaller plants could increase their efficiency, the situation might be different. The team believes that upgrading existing facilities to handle more volume seems to make the most sense for the Oregon-California area studied.

Nothing, however, is cut and dried. “It’s not just a matter of plant size, it’s also a matter of efficiently processing combinations of saw logs, obtaining permits and social license, and so forth,” says Barbour.

LAND MANAGEMENT IMPLICATIONS

- The FIA BioSum analytic system is a powerful tool for assessing fuel treatment prescription options and identifying locations where investment in bioenergy and merchantable wood conversion capacity will be economically attractive.
- The tool can help managers determine cost-risk tradeoffs and target areas that will require subsidies to accomplish treatments.
- Portions of the Oregon and California study area have high potential for developing bioenergy capacity and sustaining or expanding processing facilities.
- In the area studied, removing large trees is necessary to meet fire hazard reduction goals and be cost effective; most of the softwood biomass would come from the tops and limbs of commercial-size trees.

REALITY CHECK

In theory, it appears that applying thinning treatments in the study area can potentially reduce the wildfire hazard while generating income and producing bioenergy that could offset fossil-fuel consumption. But Fried adds a caveat. As discussed, most of the volume that would come out of the forests would be in merchantable wood, and he questions whether the facilities in the study area are anywhere close to having the capacity to process materials removed from nearly 1 million acres per year.

“There would be a tsunami of wood coming out if you had the objective of treating every one of the 8 million acres that could be effectively treated in the next 10 years,” he says. “We’d probably be lucky to treat 100,000 acres per year. If you don’t have a place nearby where you can get money for the wood and you have to truck it out of state, the haul costs become so big that this opportunity kind of falls apart.”

It also falls apart if the merchantable wood is not harvested. “Our analysis found that most of the softwood biomass comes from the tops and limbs of merchantable trees, not the small trees that earlier work had focused on,” says Barbour. “And this material cannot be manufactured into clean chips using existing technologies.”

It’s important to remember that the results are specific to a targeted area of Oregon and northern California, and would not necessarily be applicable to other regions.

The research team doesn’t pretend that BioSum has all the answers, only that it can narrow the scope of inquiry. “It’s making gross assumptions just to give you a bird’s-eye view—an approximation of what’s possible out there under certain circumstances,” says Fried.

> *“Have you got a problem?*
> *Do what you can where you*
> *are with what you’ve got.”*
> —Theodore Roosevelt

FOR FURTHER READING

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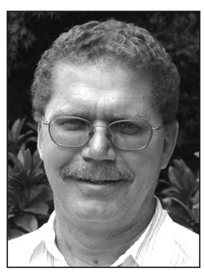

JAMIE BARBOUR is the research program manager for the Focused Science Delivery (FSD) Program at the PNW Research Station. The FSD Program helps policymakers, natural resource managers, and the public more effectively use current knowledge about natural resource management by conducting analyses of existing scientific information that address current and emerging issues in forest policy and management. Barbour has a Ph.D. and M.S. in wood and fiber science from the University of Washington and a B.S. in botany from Washington State University. Before joining the station in 1993, he worked for Weyerhaeuser's Technology Center and then Forintek Canada Corp., where he conducted research on the effects of different forest management practices on the physical properties of wood products and the biological conditions of managed forests.

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