TechLine

Forest Products Laboratory

High-Quality Structural Lumber from Small-Diameter Logs

This unhealthy stand is stocked with 900 stems per acre.

Disease, insect attack, and catastrophic wildfire threaten millions of acres of forestlands in the United States. Thinning these dense, overstocked stands of trees can help reduce the risks mentioned, but the thinning process can be very costly and may exceed the value of the material removed. Using the thinned material to create valuable products is one way to improve the economics of the situation and to promote thinning operations that improve forest health.

Background

In the West, trees smaller than 16 inches in diameter have seldom been used for lumber products. Logs from these small-diameter trees yield a higher volume of bark and sawdust, relative to the volume of solid wood produced.

Objectives

The goal of this project is to evaluate yield and properties of lumber cut from logs smaller than 16 inches in diameter for structural and nonstructural lumber products.

Approach

Logs were sampled from a number of species at several geographic locations and then tested for their mechanical properties. Tree size varied somewhat by geographic location but was generally 4 to 16 inches in diameter. These studies are a cooperative effort among the USDA Forest Service Forest Products Laboratory, Madison, Wisconsin; the USDA Forest Service Pacific Northwest Research Station, Portland, Oregon; and the University of Idaho, Moscow, Idaho.

Outcome

This research will result in a greater understanding of the possibilities of using small-diameter wood for lumber. For example, researchers now know that the yield of lumber from small-diameter trees depends upon species, age of the tree, and stand conditions where the tree is grown. Here are some examples of what has been learned:

- Ninety-year-old Douglas-fir trees thinned from dense stands have smaller knots and contain less “core wood” than trees grown in more open stands. As a result, logs cut from such stands have excellent yields of visually graded structural lumber, especially in the higher grades (Table 1).

- Two-by-fours from a stand of 90-year-old Douglas-fir trees produced excellent yields of Machine Stress Rated (MSR) lumber. This lumber could potentially be used for the production of trusses or wooden I-joists. For example, if graded as if only one grade were being produced at a time, 89% of the lumber would have made a grade that is assigned a bending strength of 2,400 lb/in^2 and a modulus of elasticity of 2 million lb/in^2 (Table 2).

Table 1. Grade yield (%) of structural light framing cut from small-diameter trees thinned from dense stands

Grade	Lodgepole pine	Ponderosa pine	Douglas-fir
Select Structural	13.7	2.4	67.8
No. 1	53.2	4.9	6.9
No. 2	24.1	26.7	17.2
No. 3	5.1	32.3	4.6
Economy	3.9	33.7	3.5

Table 2. Grade yield of MSR lumber thinned from suppressed Douglas-fir trees ≤10 in. DBH (based on board feet from 901 2 by 4s)

Grade	Number of 2 by 4s	Yield (% of total volume)
1650Fb-1.5E	821	93
2100Fb-1.8E	809	92
2400Fb-2.0E	786	89
2850Fb-2.3E	697	79

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Forest Products Laboratory • Technology Marketing Unit
One Gifford Pinchot Dr. • Madison, WI 53726–2398 • 608–231–9200 • 608–231–9592 (fax)
mailroom_forest_products_laboratory@fs.fed.us • www.fpl.fs.fed.us

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A thinned stand with a healthier 150 stems per acre. The removed material has potential to be used as structural lumber.

- Ponderosa pine does not grow well in shade. Grade yields of lumber cut from 100-year-old suppressed ponderosa pine trees are much lower because of larger knots and excessive warp during drying. The warp is due to a higher volume of “core wood” in the logs.

- For the production of glued-laminated (glulam) beams, a high percentage of suppressed-growth Douglas-fir would have qualified for the higher quality “tension lamination” grades used on the outside of a glulam beam and more than two-thirds for one of the “L” grades (Table 3). Most of the remaining lumber could still be sold as Structural Light Framing, Light Framing, or STUD.

Table 3. Grade yield of laminating grades for 2 by 4s cut from small-diameter trees thinned from dense stands

Grade category	Grade yield (%)
Tension Lamination	46.4
"L"-grades	22.6