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FPL–GTR–110 (Rev.)

Forest Products Laboratory Research Program on Small-Diameter Material

Abstract

Forests in the United States contain a significant amount of small-diameter and underutilized material. These overstocked stands not only increase the risk of insect, disease, fire, and drought damage, but also are costly to remove. Finding economical and marketable uses for small-diameter and underutilized material would alleviate these problems while improving watershed health and providing economic opportunities for local communities to help offset forest management costs. An extensive research program at the Forest Products Laboratory of the USDA Forest Service is focused on searching for economical and marketable uses for small-diameter material. The projects described in this report range from conserving timber through improving sawing technology to developing businesses for using small-diameter material.

Keywords: small-diameter timber, research, value-added, wood utilization, products

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Regional Index of Projects

		Projects by Forest Service Region								
		1	2	3	4	5	6	8	9	10
Project	Page no.	North-ern	Rocky Mt.	South-western	Inter mount.	Pacific SW	Pacific NW	South-ern	East-ern	Alaska
Conservation through BOF technology	4	✓	✓	✓	✓	✓	✓	✓	✓	✓
Improving forest products for rural communities	5	✓	✓	✓	✓	✓	✓	✓	✓	✓
Colville study: ecosystem management	6	—	—	—	—	—	✓	—	—	—
Economic feasibility of small-diameter timber	8	—	—	✓	✓	✓	✓	—	—	—
Quality of pulp from small-diameter trees	9	—	—	—	✓	—	✓	—	—	—
Biopulping of small-diameter material	11	—	—	—	—	—	—	—	✓	—
Polyoxometalates for pulping and bleaching	12	—	—	—	—	—	—	—	✓	—
Structural use of small-diameter round timbers	13	—	—	✓	✓	—	✓	—	—	—
Air-drying of small-diameter round timbers	15	—	—	✓	—	—	—	—	—	—
Connectors for roundwood structural applications	16	—	—	✓	—	—	—	—	✓	—
Measurement of roundwood properties	17	—	✓	✓	✓	—	—	—	—	—
Use of roundwood in a demonstration structure	18	—	—	—	—	—	—	—	✓	—
Use of sound to evaluate standing timber	19	✓	—	—	✓	—	✓	—	✓	✓
Veneer recovery in southwestern Oregon	20	—	—	—	—	—	✓	—	—	—
Nontraditional species for timber bridges	21	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lumber recovery from ponderosa pine	23	—	✓	✓	✓	—	—	—	—	—
Properties of inland species for truss design	24	✓	—	✓	✓	—	—	—	—	—
Mechanical grading of logs for homes	25	✓	—	—	✓	—	—	—	—	—
Utilization options for suppressed Douglas-fir	26	—	—	—	—	✓	—	—	—	—
Debarking of softwood to improve marketing	28	—	✓	—	—	—	—	—	—	—
Composting of wood waste	29	—	—	—	—	—	—	—	—	✓
Wood fiber–plastic composites	30	—	—	✓	—	—	—	—	—	—
Businesses for small-diameter material	32	✓	✓	✓	—	✓	✓	✓	✓	✓
Log-sort yards	33	✓	✓	✓	✓	✓	✓	✓	✓	✓

Forest Products Laboratory Research Program on Small-Diameter Material

Background

Over the past several years, the Forest Products Laboratory has refocused a significant part of its research program on the use of small-diameter and thinning material. The primary reason for this shift is the vast amount of small-diameter and underutilized material in the national forests. These forest stands cannot resist drought and insect attack, and the buildup of dead woody debris is increasing the risk of extensive wildfire. Costs associated with removal of this forest biomass understory are high, ranging from approximately $150 to $500 per acre ($370 to $1,235 per hectare), whether removal is done mechanically or through prescribed fires. Forest Service estimates indicate that approximately 56 million acres (15.6×10^6 ha) of national forests need some kind of removal treatment to reduce the risk of infestation by insects and diseases and to reduce high concentrations of fuel buildup. These treatments would also restore watershed health and maintain biodiversity. Economical and value-added uses for small-diameter material can help offset forest management costs while providing economic opportunities for many small, forest-based communities.

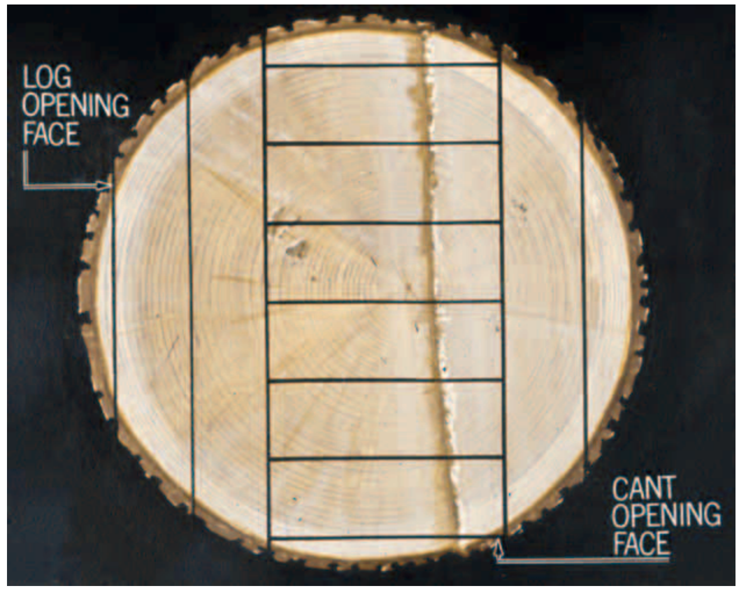
Previous attempts to support proactive management of underutilized and low-valued timber focused on large industrial forestry approaches that require prohibitive capitalization and infrastructure considering the value returned by the products. These capital-intensive investments require a continuous supply of timber from public lands for long periods. The current strategy focuses on using rural-community-based approaches to generate small businesses that can serve local markets with value-added forest products that can be created from the material removed under ecosystem management principles.

The research program at the Forest Products Laboratory (FPL) is aimed at overcoming some technical and economic barriers associated with value-added forest products made from small-diameter materials. Since 1993, as budgets have declined, FPL has shifted some of its research effort to focus on characterizing small-diameter and thinning material, identifying potential uses, and providing technology that can help rural forest-based communities to create successful businesses from the byproducts of ecosystem management. For example, research projects are exploring the potential of small-diameter material in pulp and papermaking, studying the use of roundwood as a structural material for bridges, boardwalks, trail structures, picnic shelters, storage sheds, and other buildings, and evaluating the distribution of lumber grades from small-diameter material.

The following report summarizes past and present research studies on the use of small-diameter material. These studies involve many different regions and rural communities. The information gained in any specific location can usually be applied nationally.

Conservation Through Best Opening Face Technology

Location Nationwide



Approach The purchase of standing timber (stumpage) is the biggest cost of manufacturing softwood dimension lumber. Stumpage can account for as much as 80% of the total cost of manufacturing. To decrease costs, processing efficiencies need to be dramatically improved; industry has responded by automating and increasing production speeds. An unfortunate side effect has been inaccurately manufactured lumber and poor lumber recovery. In addition, higher processing speeds make it impossible for machine operators to make consistently good breakdown decisions. This has a severe impact on recovery because poor sawing decisions have a more adverse effect on lumber from small logs than they do on lumber from large logs.

To satisfy increased demands for more efficient conversion of logs to lumber, the Best Opening Face (BOF) system was developed at the Forest Products Laboratory (FPL) in the early 1970s. The BOF system is a computer simulation model of the sawing process for recovering dimension lumber from sound small-diameter logs. The BOF model simulates the actual sawing process and determines the best opening face for the log. The BOF model helps sawmill operators recover the most lumber from any given log, especially small-diameter logs.

Status Since its development, the BOF program has become the most widely adapted sawmill model for simulating the process of recovering dimension lumber from sound small-diameter softwood logs.

Results The BOF has proven itself to be an effective aid in sawmill efficiency and forest conservation. This FPL-developed technology has aided the automation of West Coast sawmills since the 1970s. Industries incorporated BOF algorithms into computerized optical log scanners and sawing systems to maximize recovery of softwood dimension lumber. The BOF and related sawmill computer automation helped prevent industry collapse in the 1970s and 1980s as sawmills shifted from old-growth to small-diameter second-growth timber supplies in the Pacific Northwest. In addition to being adopted by industry, BOF provided the basis for State and Private Forestry's national Sawmill Improvement Program (SIP).

A vast portion of softwood dimension production in the United States and Canada is manufactured today with the help of BOF-based technology. The SIP has improved sawmill efficiency by about 3½%, which equates to annual conservation of 1 billion board feet of lumber. This is enough lumber to build all the houses in Madison, Wisconsin.

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Sustaining Rural Communities Through Improving Quality of Forest Products

Location Nationwide and international

Approach Rural America has been experiencing high unemployment and a declining tax base as forest products firms close their doors in response to the changing structure and availability of timber supply on public lands. To overcome these problems, the forest products industry has made improved quality, productivity, and efficiency key objectives. Quality improvement is particularly important because it has effects on productivity, competitiveness, and business survival. Improved quality results in lower costs because of less scrap and rework, fewer mistakes and delays, and better use of machines and materials. Productivity increases in response to lower costs, which allows a company to capture the market with better quality at a lower price. Capturing the market improves competitive position and helps companies stay in business, retaining jobs and providing for economic growth. In addition to the economic benefits, quality improvement promotes better utilization and conversion efficiency, which helps to conserve and extend timber resources and to mitigate impacts on water quality, endangered species, and biodiversity.

Forest Service efforts are helping industry reach their objectives and adapt to the increasing supply of small-diameter and underutilized material by implementing quality improvement technology. Quality and productivity are improved through informed decision-making provided by the adoption of tools such as Statistical Process Control (SPC). Documented case studies where SPC has been implemented have demonstrated positive results in controlling lumber size variation and improving manufacturing efficiency, quality, and productivity.

Status The project has been completed. Although no further development is planned, technology transfer continues through conferences, clinics, and workshops.

Results Quality improvement technology is improving industry's competitive position and helping to sustain rural communities by retaining jobs based on the forest industry. In one example, the use of SPC technology helped a sawmill owner in the Upper Midwest gain a competitive position in the hardwood market by controlling lumber size variation and reducing target lumber sizes. The size reduction resulted in improved lumber recovery and annual savings of $250,000. The properly adjusted target sizes allowed for greater lumber dry kiln capacity and shorter drying times that brought an additional $500,000 in energy savings and increased productivity. In another example, the use of SPC helped a sawmill in the Intermountain West stay in business by identifying and correcting processing problems and bringing lumber size variation under control. These changes lowered cost per unit of output and allowed the mill to purchase logs and continue operating, retaining 80 jobs that otherwise would have been lost.

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Wood Utilization for Ecosystem Management: The Colville Study

Location Colville National Forest, Washington

Approach The Colville Study was initiated in 1994 to identify and evaluate management options for achieving ecosystem objectives in dense stands of small-diameter trees with the aid of removing some wood for products. Dense stands of small-diameter trees are common in the forests of the Intermountain West and east of the crest of the Cascade Range in Oregon and Washington. The Colville National Forest (NF) selected the Rocky II timber sale as an example of the type of stand that needs management to achieve late successional forest structure, decrease forest health risk from fire, insects, and disease, improve wildlife habitat, and improve aesthetics. A series of research studies were conducted to aid managers in understanding how stands may be treated and how products are used. Research was conducted on silviculture and ecology, forest operations, timber conversion, and economics.

Status Studies are complete and results are being transferred to National Forests of Region 6. Some results are in the form of a software program called Financial Evaluation of Ecosystem Management Activities (FEEMA) to aid in management decisions.

Results Silvicultural simulations confirm that dense small-diameter stands are unlikely to meet desired conditions without treatment. The cost of harvesting is very sensitive to the average diameter of stems and is a key influence on overall economic return from the manufacture of various products. Strength properties of small-diameter wood were tested for the production of lumber, veneer, composite products, mechanical pulp, and chemical pulp; strength was found to be adequate, with some variation by species. Summaries of studies on the pulp quality of small-diameter trees from the Rocky II timber sale and the economic return for various small-diameter processing options can be found on subsequent pages. FEEMA is used to evaluate the potential return (stumpage prices) possible for given treatments of given small-diameter stands, which are presumed to be made into specified products. This program can aid in evaluating the combinations of stems offered for sale that should obtain given prices for stumpage. FEEMA is being adopted by National Forests in Region 6 to aid in planning management treatments.

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Economic Feasibility of Small-Diameter Timber

Location Colville National Forest, Washington

Approach An economic analysis was conducted on various industrial processes that use small-diameter timber to manufacture products, some of which were produced from large-diameter trees in the past. The products were pulp, oriented strandboard (OSB), and dimension, stud, machine-stress-rated, and veneer laminated lumber. Each technology was analyzed in terms of standard industrial-scale operations and its per-unit operating and capital costs, along with unit operating revenues at prevailing product prices. Researchers calculated the timber inputs required to feed such operations and a return-to-wood figure for each operation, which was expressed as the difference between gross operating revenues and costs divided by timber requirements. These calculations set benchmarks for what such operations could afford to pay for delivered timber of the type generated by the thinning operations, or, alternatively, what the forests could expect to recoup for the expense of undertaking these treatments.

Status The project was completed in May 1996.

Results Researchers conclude that pulping, followed by veneer laminated lumber and OSB, provides the highest returns to wood, \$2.23 to \$1.24/ft^3 (\$78.72 to \$43.77/m^3). The lumber options provide lower returns of \$1.24 to \$1.10/ft^3 (\$43.77 to \$38.83/m^3). For all options, considerable capital investments were found to be required to achieve these rates of return to wood. This implies that industrial concerns would need to be assured of dependable supplies of wood before committing the large sums required.

Publication Spelter, H.; Wang, R.; Ince, P. 1996. Economic feasibility of products from Inland West small-diameter timber. Gen. Tech. Rep. FPL–GTR–92. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 17 p.

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Quality of Pulp From Small-Diameter Trees

Location Colville National Forest, Washington

Approach A research study is evaluating the chemical and mechanical pulping of small-diameter resources harvested on the Colville National Forest. Raw materials assessed in these pulping trials include sawmill residue chips, submerchantable logs, and small trees from Douglas-fir, western larch, and lodgepole pine. Vaagen Bros. Lumber (Colville, Washington) supplied the sawmill residue chips and submerchantable logs. The small trees were obtained directly from the Colville National Forest. All roundwood was shipped to Forest Products Laboratory (FPL), where it was peeled, chipped, and screened. Chip samples were sent to the University of Washington, Seattle, for chemical (kraft) pulping research. The FPL used the remaining chips for mechanical pulping research by thermomechanical pulping (TMP) and chemithermomechanical pulping (CTMP) processes.

Status Researchers have completed all kraft, TMP, and CTMP trials.

Results The results of the kraft pulping trials showed that all small trees and submerchantable logs can be used as potential raw materials in kraft pulp mills. These wood sources (except Douglas-fir submerchantable logs) produce pulps with a kappa number comparable to that of pulps from sawmill residue chips. (Kappa number indicates the extent of delignification during pulp processing.) Pulping large quantities of Douglas-fir submerchantable logs with sawmill residue chips produces pulp with inherent chemical nonuniformity. Pulping small trees raw materials with sawmill residue chips in linerboard mills (70 to 100 kappa number range) may produce pulp with significant chemical nonuniformity. All western larch raw materials had low kraft pulp yields.

The results show that four of the evaluated resources were equal to or better than corresponding sawmill residue chips in TMP trials. Lodgepole pine and Douglas-fir small trees produced a better quality pulp, and the quality of Douglas-fir and western larch submerchantable logs pulp was the same as that of sawmill residue chip pulp. Lodgepole pine submerchantable logs and western larch small trees produced a lower quality TMP pulp than that obtained from sawmill residue chips.

In the initial CTMP trials, which used a higher concentration of sodium sulphite liquor, the quality of Douglas-fir small trees and submerchantable logs pulp and lodgepole pine small trees pulp was better than that of sawmill residue chips pulp; the quality of lodgepole pine submerchantable logs pulp was comparable to that of sawmill residue chips pulp. Western larch submerchantable logs and small trees and lodgepole pine submerchantable logs were damaged during pulp preparation and thus produced a lower quality pulp than that obtained from sawmill residue chips. In the second CTMP trial, which used a lower concentration of sodium sulphite liquor, the quality of Douglas-fir submerchantable logs and western larch small trees pulp was better than that of sawmill residue chips pulp; the quality of Douglas-fir small trees pulp was comparable to that of sawmill residue chips pulp.

The same fiberization and refining conditions were used for all raw materials in both TMP and CTMP processes. Optimizing these processes for each species would probably improve pulp and paper quality.

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Biopulping of Small-Diameter Material

Location Forest Products Laboratory, Madison, Wisconsin

Approach Biopulping, the fungal treatment of wood chips prior to mechanical pulping, decreases energy consumption by a minimum of 30% and significantly increases paper strength properties. Its commercial feasibility has been demonstrated by large-scale trials. Currently, biopulping technology tends to use specialized equipment within or near a mechanical pulping mill to steam, inoculate, and aerate chips from a common pulpwood species. Biopulping of small-diameter material presents unique challenges because it would involve alternative wood species and, in most cases, shipping to distant mills.

The Colville Study found that mechanical and chemical pulping were suitable uses for small-diameter timber, but it did not include biopulping in its investigation. In a two-phase project, Forest Products Laboratory researchers are studying the use of biopulping on small-diameter materials from the Colville National Forest. First, laboratory experiments are identifying efficient biopulping strains suitable for a variety of wood species. Biopulping of nonsterile chips with reduced aeration are being evaluated. In the second phase, biopulping trials will be scaled up under field conditions. Results will contribute to the development of biomechanical pulping processes for small-diameter timber.

Status The project is in the first phase. Comparative analyses of fungal strains have revealed substantial physiological adaptations to changes in wood species. A genetically altered fungal strain has been isolated, and laboratory experiments have demonstrated significantly increased energy savings for wood chips derived from small-diameter material.

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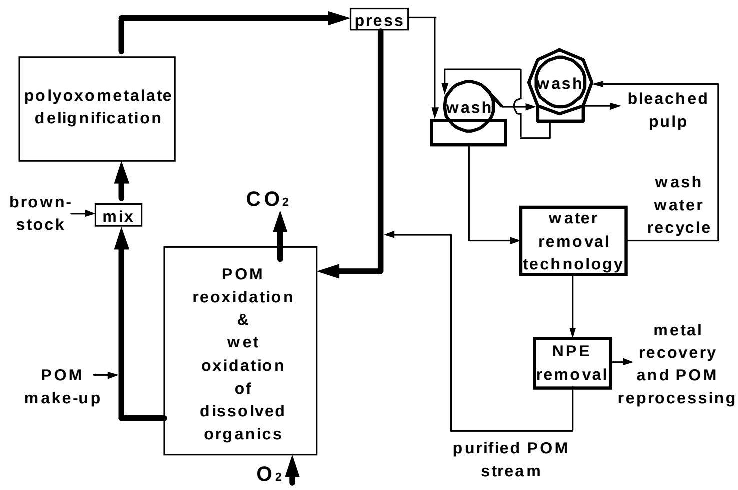
Polyoxometalates for Pulping and Bleaching of Mixed Species

Location Forest Products Laboratory, Madison, Wisconsin

Approach Pulping for papermaking provides a potential market for small-diameter mixed species timber. However, conventional pulping is not feasible for small-diameter mixed species because chemical pulping rates are not uniform. Some species are more difficult to delignify than are others, so they cannot be pulped together; easy-to-delignify species would be overcooked, while hard-to-delignify species would be undercooked. This kind of pulping would result in a pulp with inferior properties.



This project investigates the use of polyoxometalates (POMs) in the pulping and bleaching of small-diameter mixed species. POMs, a class of nontoxic, environmentally friendly chemical compounds, mimic the action of enzymes used by naturally occurring white-rot fungi to metabolize wood components. These systems are selective—they remove lignin without damaging the cellulose. POMs have an advantage over fungi because they are inorganic and can be used at elevated temperatures to speed up the reaction rates to commercially feasible levels. POMs produce no environmentally troublesome byproducts in either pulping or bleaching. Researchers are pulping and bleaching small-diameter mixed species with POMs to determine the advantages of these chemical compounds over other delignifying techniques that are not as selective.

Status Phase 1 of the study has been completed. Phase 1 was a small-scale study that investigated the feasibility of using POMs to delignify small-diameter mixed species. Phase 2 will be conducted on a larger scale to allow more comprehensive testing of pulp properties.

Results Exploratory work has shown that POM-based systems are effective at pulping and bleaching small-diameter mixed species.

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Structural Use of Small-Diameter Round Timbers

Location Intermountain West, particularly Flagstaff, Arizona, and selected sites in New Mexico

Approach Developing value-added structural uses for round timber will significantly improve the efficient use of forest resources. Such uses include space frames, trusses, and segmental arches for roof assemblies, beam–column elements for post-frame building systems, and pile foundations for residential structures in flood- or surge-prone areas. Increasing the value of this material could provide an incentive to increase selective thinning. Eliminating the need for added processing and generating low-value materials, such as chips, slabs, and sawdust, will reduce the unit cost of producing structural elements.

Compared with lumber and sawn timbers, small-diameter logs have the advantage for a variety of structural applications. The strength of roundwood has been shown to be less variable than that of sawn timber, giving a potential advantage in the derivation of allowable stresses. Fiber continuity on the surface of a log is less likely to produce splinters than does the “diving” grain common to sawn lumber, giving some advantage in applications involving repeated human contact (for example, playground equipment). The natural taper of roundwood makes it appropriate for use in column applications where moments and axial force increase from tip to butt. With respect to the presence of juvenile and mature wood, the symmetry of roundwood makes it less susceptible to warp, more dimensionally stable, and stronger than most lumber sawn from it. The round section is better suited to applications where members must carry axial loads in combination with multidirectional bending moments. These advantages, coupled with the low processing cost, make small-diameter logs an attractive alternative to sawn lumber for many applications.

Status Researchers have completed pilot studies and identified connections as the aspect of roundwood structural use most in need of further investigation. To encourage structural applications of round timbers, connectors must be inexpensive, be easy to apply, and provide consistent, reliable strength and stiffness. These characteristics rely on details of the connector as well as moisture conditions and quality of the material at the site of attachment. Current research projects are therefore focused on connection performance, air drying, and material properties of roundwood. Another important issue is the lack of information about roundwood use in structures. A major obstacle to acceptance of this material centers on necessary deviation from conventional construction practice. Consequently, demonstrations of small-diameter round timber in structural assemblies are being planned. Summaries of these projects can be found in this report. Future efforts will focus on developing span tables as well as design guidelines and connection details for this type of timber.

Results This study has demonstrated the potential for roundwood use as an alternative to sawn dimension lumber. Mean strength and modulus of elasticity of small-diameter timber are comparable to published values from tests on clear wood. Strength variability for a given species is low enough to make incremental stress grades unnecessary. Using the full section of roundwood reduces processing costs and waste. Load-carrying capacities of small-diameter timber elements are three to six times that of any prismatic sawn timber that could be obtained from them. These findings suggest that it is more efficient to use small-diameter timber as roundwood than as sawn dimension lumber.

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Air-Drying of Small-Diameter Round Timbers

Location Vallecitos and Glenwood, New Mexico; Eagar, Flagstaff, Holbrook, Tombstone, and Winslow, Arizona

Approach Structural applications of small-diameter timber rely heavily on the performance and predictability of connections. To optimize the design of small-diameter connections, the timber should be dried in a manner that minimizes drying degrade, especially in the region of the connection. The drying of round small-diameter timber presents different challenges than those found in the drying of sawn lumber. The symmetry of juvenile wood in small-diameter logs means that they are less likely to warp compared with lumber cut from these logs. Nevertheless, roundwood is more difficult to dry because it has a lower surface to volume ratio, has less exposed end-grain compared with sawn lumber, and is more prone to splitting. Some kiln-drying has been used to lower the weight of roundwood poles and piles. Nevertheless, the market for round timber is too small for kiln-drying to be an economical option. Air-drying of roundwood requires less energy cost than does kiln-drying, but it takes more time and space. A number of air-drying test sites have been established in the arid U.S. Southwest to assess the viability of air-drying small-diameter timber. Cooperators monitoring these sites include a lumber company, a university, and a community cooperative. These air-drying studies are considering the effects of shading cloths, end coatings, machining on timber ends, and log size on the time needed for drying, the rate of drying, and the degrade of the round timbers.

Status Three drying studies have been completed and two will be initiated in the fall of 2000. The University of Idaho and the Rogue Institute in southwestern Oregon have expressed interest in this project, but economic constraints have kept them from participating. Researchers would like to expand the project into Idaho and southwestern Oregon because they could then study the effects of a different climate on air-drying small-diameter timber. Whereas some mills in the southwest might need to slow down the drying process to minimize splitting, mills in the northwest might need to accelerate the process. Results of this study will form the basis of a published guideline for assessing the feasibility of air drying as a means of producing a stable small-diameter timber product of acceptable quality for structural applications.

Results The primary purpose of air drying logs is to reduce transportation hauling weight. On average, peeled logs lose moisture at a rate of roughly 2.5% per day until they reach the fiber saturation point, where wood moisture content equilibrates at 8%. Drying below the fiber saturation point proceeds at a slower rate; wood moisture content drops from 35% to 15% over a period of 2 months. Unpeeled logs dry at about 1/10 the drying rate of peeled logs. Therefore, air drying unpeeled logs is probably not effective.

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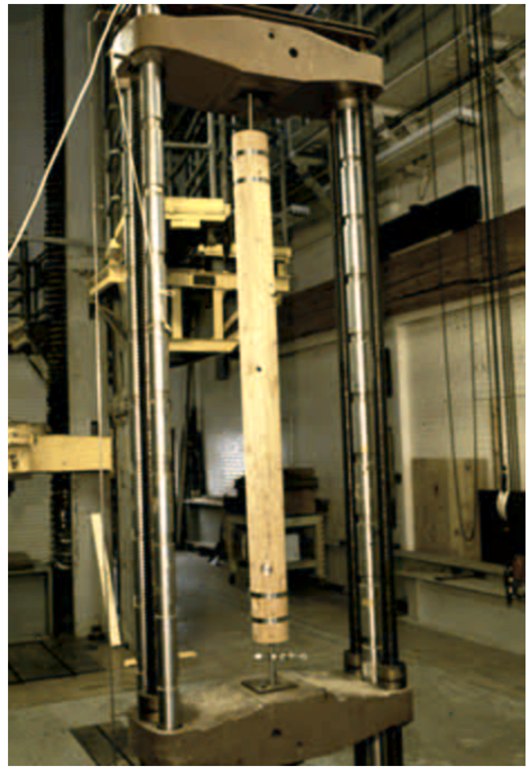
Connectors for Roundwood Structural Applications

Location Forest Products Laboratory, Madison, Wisconsin

Approach Previous research on the structural applications of small-diameter round timber showed that available connectors control the use of this resource in most structural applications. Most commercial connectors are intended for use with sawn lumber. Two types of connectors are made specifically for round timber: connectors used for utility poles and those used in custom-built structures. The former are not suitable for small-diameter timber, and the latter are designed on the basis of proprietary information. Published information about small-diameter timber connectors is limited. Any connectors developed for this kind of resource will have to be able to transfer axial bending and/or shear loads, be economically feasible, demonstrate a preference for ductile failure over brittle failure, and compete against conventional construction.



This project involves pilot testing a variety of connection details to determine relative capacities and material costs. The connectors tested include dowel-nut connectors, finger joints, nailed metal plates, wood shear keys, and threaded dowel rods. Dowel-nut connectors were adapted from the furniture industry and finger joints were modeled after the glulam industry. Metal plates have been used for heavy timber. The threaded dowel rod is an adaptation of the concrete post tensioning rod. Forest Products Laboratory researchers are selecting the most promising details to develop a data base for deriving design values that will be applied in demonstration structures.

Status The dowel-nut connector has been evaluated for use with Douglas-fir peeler cores as well as small-diameter round ponderosa pine. A combination of peeler core and dowel-nut was used to construct a 60-ft- (18-m-) span space-frame roof system in Ferndale, Washington. Preliminary results show that the performance of the dowel-nut connection in ponderosa pine round timber is superior to that in the peeler core. Flitch and gusset plate connections fabricated using power-driven nails show potential as a low-cost connection that exhibits a very ductile failure mode.

Shear keys performed as expected and can be designed for a shear parallel-to-grain failure mode following guidelines in the *National Design Specification for Wood Construction*. The finger joints have not been tested to date.

Results At present, test connections show design capacities in the range of 10,000 to 30,000 lb (44.5 to 133.5 kN) for 5- to 7-in.- (127- to 178-mm-) diameter round timbers.

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Measurement of Roundwood Material Properties

Location South Dakota, southern Colorado, New Mexico, and Arizona

Approach Limited knowledge of the strength and stiffness of small-diameter timber presents an obstacle to its acceptance as a structural component. Existing data from test results for small clear specimens, full-size lumber, and utility poles do not adequately represent the proportion of juvenile wood likely to be found in most small-diameter round timber. There is also some question as to how well the existing data base applies to suppressed-growth small-diameter timber, in which the portion of juvenile wood is not a major consideration.

This project seeks to obtain data needed to characterize the strength and stiffness of small-diameter round timber for use in design. A mobile test machine has been designed specifically for this purpose. The machine is being used to test logs shortly after harvest to characterize strength and stiffness distributions, including variations in these values along the stem length. Because the influence of juvenile wood is likely to be most obvious for axial stiffness and strength, the machine was designed to test log sections in axial compression. It has a half-million-pound (2.2 MN) load capacity, enough to test a 10-in.- (25-cm-) diameter Douglas-fir timber to failure.

The primary reason for building a mobile test machine was to minimize the influence of moisture variations on timber strength. Wood tested at or above the fiber saturation point, roughly 35% moisture content, should exhibit little variability as a result of moisture. As moisture drops below this point, however, wood strength and stiffness increase. Until the log section reaches a uniform equilibrium moisture content, moisture gradients will add to the variability. The time required to dry small-diameter timber to a uniform equilibrium moisture content therefore makes it preferable to test in the green condition and then derive a dry-use adjustment. Testing in the green condition, shortly after harvest, will eliminate the variable influence of moisture and expedite data collection.

Log samples are being collected for laboratory testing in bending and compression as a check on correlation and calibration. These results will be compared to the results of field tests on end-matched specimens. The bending and compression results should offer a basis for checking the correlation between compression and bending as well as a basis for moisture adjustment and mobile test machine calibration.

Results obtained from this project will be used to develop standards for deriving design stresses for small-diameter round timber. These values will also be incorporated in the design of experimental structures used to demonstrate the capabilities for round timber use in construction.

Status The mobile test machine has been calibrated and used twice in field tests. The first test was conducted in the Black Hills of South Dakota, close to the eastern limit of the range of ponderosa pine, and in New Mexico. Future tests will be conducted in Arizona, Oregon, and Idaho.

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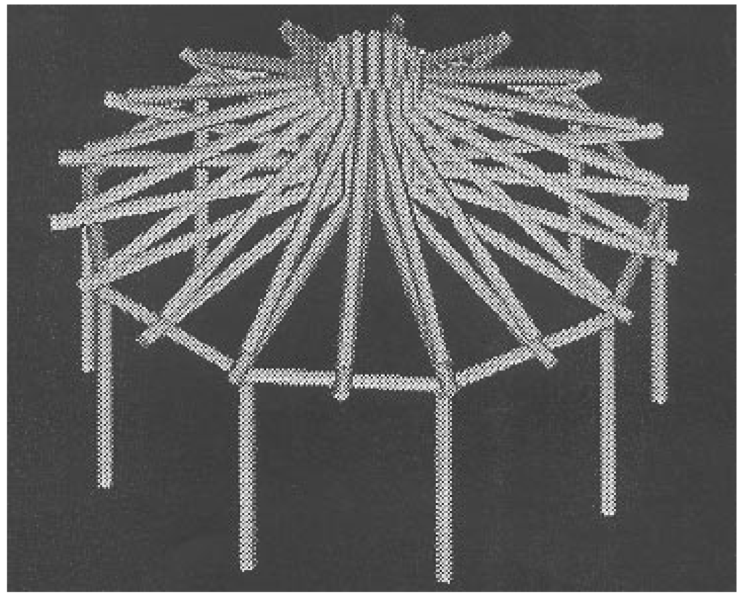
Use of Roundwood in a Demonstration Structure

Location Forest Products Laboratory, Madison, Wisconsin

Approach A lack of familiarity with the use of small-diameter round timber in structures and a lack of information on drying processes, wood properties, and connectors for this material present an obstacle to the acceptance of roundwood in structures. The construction of a demonstration structure shows the potential of roundwood to provide strength and stability as well as the creative possibilities that the shape of this resource bring to wood structures. The objective of this study is to demonstrate potential applications of structural components made from small-diameter round timber. Such applications provide value-added markets that could help small businesses profit from processing this "low value" resource.



For this project, the Forest Products Laboratory (FPL) constructed a demonstration structure framed with posts, beams, and trusses made from small-diameter ponderosa pine. Five types of roundwood connectors were used. In addition to demonstrating the structural uses of round timber, this structure provides a basis for comparing various applications of wood shingles. Researchers detailed the types of connections, treatments, and materials. This experimental structure demonstrates the practical applications of many findings from studies on connectors and material properties.

Researchers are monitoring the performance of the demonstration structure. The structure serves as a demonstration of the benefits of wood research for FPL visitors. It also provides a basis for the development of construction guidelines for working with this resource and for making architects and contractors more aware of the possibilities for small-diameter roundwood use in structures.

Status The structure was completed in July 2000. The FPL is providing some technical guidelines to cooperators who want to use small-diameter round timber in structures. Examples include roofs for a school gym, a log barn, and a Navaho dwelling (hogan).

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Use of Sound to Evaluate Standing Timber

Location Alaska, Arizona, Idaho, Michigan, Minnesota, and Washington

Approach Differences in genetics, the environment, and responses to human intervention create a wide variability in wood as a material. Consequently, manufacturers and users of wood products become frustrated by processing difficulties and performance variability in finished products. Nondestructive evaluation (NDE) technologies have contributed significantly towards eliminating the cause of these frustrations. NDE is the science of identifying the physical and mechanical properties of a material without altering its end-use capabilities and using this information to make decisions on appropriate applications. In the forest products industry, NDE technologies are currently used in lumber and veneer grading programs and result in engineered materials with well-defined performance characteristics.

NDE includes various technologies, such as x-rays, chemical analyses, vibration properties, and sound wave transmission. The use of sound wave transmission characteristics has received considerable attention because of its potential to evaluate the quality of wood in standing timber. Two properties commonly measured by sound wave NDE are speed-of-sound transmission and sound wave attenuation, the rate at which a wave loses energy as it travels through wood. Speed-of-sound transmission depends on fiber (grain) angle and is significantly influenced by the presence of certain types of decay or deterioration. Previous research has found that sound travels at a lower speed through deteriorated stems. Sound wave attenuation correlates with wood properties such as modulus of elasticity (MOE). Better knowledge of the properties of standing small-diameter timber will help identify more value-added uses for this resource.

The USDA Forest Service has initiated a series of studies with various cooperators to investigate NDE technologies for standing timber. The studies represent a wide range of species as well as forest ecosystems. Wood is evaluated for the presence of decay as well as MOE. To detect the presence of decay, researchers measure speed-of-sound transmission across the diameter of the tree stem. To determine MOE, they place accelerometers approximately 1.6 ft (0.5 m) apart along the tree stem, with the upper accelerometer 3.3 ft (1.0 m) above the groundline. They then use an impact hammer to strike a nail inserted into the stem to induce a stress wave into the stem. The characteristics of the resulting wave are related to the mechanical properties of lumber obtained from the tree.

Status The studies are in their beginning phases.

Results Preliminary results are encouraging. Researchers have observed a very good correlation between sound transmission characteristics and the presence of decay in small-diameter balsam fir trees. Results from studies on Douglas-fir trees indicate a relationship between sound transmission characteristics and the mechanical properties (MOE) of structural lumber obtained from these trees.

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Veneer Recovery From Small-Diameter Stands in Southwestern Oregon

Location Applegate Watershed, southwestern Oregon

Approach The Applegate Watershed consists of dense, overstocked stands of ponderosa pine, Douglas-fir, white fir, and Shasta red fir. By finding economical and value-added uses for this material, foresters can offset management costs.

The USDA Forest Service, Pacific Northwest Experiment and Range Research Station, with cooperation from both the Forest Products Laboratory and State and Private Forestry in Region 6, examined the relationship between nondestructive evaluation of small-diameter timber in the Applegate Watershed and wood product quality. Researchers also examined the potential of producing veneer from this resource. They concluded that the properties of this veneer make it suitable for the manufacture of engineered wood products, such as laminated veneer lumber (LVL).

Collaborators selected sample sites and 25 sample trees of each of three species (ponderosa pine, Douglas-fir, and white fir). The sound wave characteristics of both tree-length and short logs were nondestructively measured. The logs were then taken to a mill where they were cut into veneer and processed into LVL. The quality of the veneer, as determined by ultrasonic grading, was compared to the quality of the logs from which the veneer was made.

Status The ponderosa pine portion of the study has been completed. Data analysis for Douglas-fir and white fir is in progress.

Results Information to date indicates that the quality of the veneer produced from small-diameter trees is similar to the quality of veneer produced from old growth. Measurements from both short and tree-length logs correlate strongly to comparable measurements made on veneer obtained from those logs. These findings suggest that small-diameter timber is suitable for the manufacture of LVL. In addition, the collaborators have shown that the quality of logs can be assessed more accurately before they are processed into veneer. This results in more efficient use of the resource and a cost savings to LVL manufacturers.

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Nontraditional and Underutilized Species for Timber Bridge Design

Location Nationwide

Approach The transportation infrastructure in the United States is in disrepair. Approximately 50% of highway bridges are structurally deficient or functionally obsolete. The majority of these bridges are located on rural roads where local economies depend heavily on the highway system.

Timber bridges have proven their durability, and many bridges more than 50 years old are still in service. Forest Service efforts during the past decade have done much to advance the acceptance and use of timber bridges, and the potential for improved wood utilization in bridge applications continues to grow.

Many timber highway bridges are currently being constructed from glued-laminated timber (glulam), which is manufactured by gluing together relatively small sawn lumber members to form large structural components. Small-diameter material is especially suited to the construction of glulam stress-laminated decks and deck panels. Stress-laminated bridge decks are constructed from a series of small glulam beams manufactured from nominal 2- by 4-in. (standard 38- by 89-mm) lumber. By placing the beams side by side and connecting them with tensioned steel bars, bridges can be built with spans up to 50 ft (15 m). Glulam deck panels are typically placed on top of glulam or steel beams to form a bridge deck. Nominal 6- or 8-in. (standard 140- or 184-mm) material is required for these panels; nominal 6-in. (standard 140-mm) material is used in most cases. Some species, such as ponderosa pine, are excellent for glulam bridge applications because the material is easily glued and treated with wood preservatives. These applications are also well suited for low-strength material, which is typical of several small-diameter species.

Status The Forest Products Laboratory has been involved in developing timber bridge systems for secondary wood species for more than a decade. Many stress-laminated bridges have been built using red pine glulam, and extensive field evaluations have been completed. Five bridges have been built from new designs using cottonwood glulam deck panels: four bridges have cottonwood decks on steel stringers, and one is a cottonwood girder bridge with a cottonwood glulam deck. Several more bridges will be built using cottonwood during the next 2 years. Two ponderosa pine bridges were built on the Tonto National Forest in Arizona.

Much basic research has been directed toward adapting these bridge designs to other small-diameter species. Future work will include the development of economical standardized designs using small-diameter species.

Results Red pine glulam bridges have shown good performance in field evaluations, as have demonstration structures built with small-diameter material. Efficient manufacture of glulam from combinations of yellow-poplar, red oak, and red maple lumber has led to a revision of industry standards.

Publications

Ritter, M.A.; Duwadi, S.R. 1998. Research accomplishments for wood transportation structures based on a national research needs assessment. Gen. Tech. Rep. FPL–GTR–105. Madison, WI: USDA Forest Service, Forest Products Laboratory. 30 p.

Ritter, M.A.; Wacker, J.P.; Duwadi, S.R. 1995. Field performance of stress-laminated timber bridges on low-volume roads. In: Proceedings, 6th international conference on low-volume roads, 1995 June 25–29, Minneapolis, MN. Washington, DC: National Academy Press; Vol. 2: 347–356.

Ritter, M.A.; Wacker, J.P.; Tice, E.D. 1995. Field performance of timber bridges. 2. Cooper Creek stress-laminated deck bridge. Res. Pap. FPL–RP–536. Madison, WI: USDA Forest Service, Forest Products Laboratory. 17 p.

Wacker, J.P.; Ritter, M.A. 1992. Field performance of timber bridges. 1. Teal River stress-laminated deck bridge. Res. Pap. FPL–RP–515. Madison, WI: USDA Forest Service, Forest Products Laboratory. 19 p.

For a list of additional publications on this topic, visit the FPL Wood Transportation Structures Research Publications website (http://www.fpl.fs.fed.us/wit/pubs.htm).

Contact

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Lumber Recovery From Ponderosa Pine

Location Flagstaff, Arizona; Forest Products Laboratory, Madison, Wisconsin

Approach More than 5.5 million acres (2.23 million hectares) of densely stocked ponderosa pine are in the southwest. Thinning these stands would improve forest health and reduce the risk of catastrophic wildfire. The cost of such management is high, but cost could be defrayed by converting the removed wood into products. Past research to evaluate product recovery from small-diameter ponderosa pine trees has generally not been specific to suppressed stands and has been limited to a few grading options.

Approximately 150 ponderosa pine trees were selected from a stand near Flagstaff, Arizona. The trees were about 100 years old and 6 to 16 in. (15 to 41 cm) diameter at breast height. The forest management objectives were to return these dense overstocked stands to stock levels similar to presettlement conditions. The trees were measured and cut into logs. Half of each log was sawn into appearance grade lumber and the other half into nominal 2- by 4-, 2- by 6-, and 2- by 8-in. lumber (standard 38- by 89-, 38- by 140-, and 38- by 184-mm lumber). A total of 14,000 board feet (33 m^3) of lumber was processed. The structural lumber was graded into structural light framing, machine stress rated, and lamstock grades.

Results The cubic volume (percentage of gross cubic log volume) of dried and surfaced lumber increased with log diameter. The recovery of dimension lumber was slightly higher than that of appearance grade lumber. The recovery of No. 2 Common and better appearance-grade lumber was about 25%, with a majority of lumber (66%) graded as No. 3 Common. A previous study showed that the value of No. 3 Common lumber can be improved with further processing as cut stock.

Preliminary analysis of the data by visual grade for the Structural Light Framing grading system showed that about 50% of the lumber is No. 2 or better grade. However, very little lumber is Select Structural (the highest grade), and very little is below No. 3 (Economy) grade. Value recovery depends upon both the volume and grade of the lumber recovered from the log. The value of both appearance-grade and dimension lumber increased with log diameter. Even though logs of equal size sawn for appearance grade had similar volume recovery to those sawn for dimension lumber, the logs sawn for appearance grades would be worth more than those sawn for dimension lumber (based on 1999 Western Wood Products Association year-to-date prices).

Wane on the edges of the pieces and warp caused by drying degrade were the two most common grade-limiting factors for the dimension lumber. The grade of about half the pieces was limited by drying degrade. The top loading used to weigh down half the dimension lumber did not reduce warp. To better understand this anomalous result and to investigate other drying alternatives, an independent study on the drying of small-diameter ponderosa pine has been initiated at the Forest Products Laboratory.

Status Testing and evaluation are almost complete.

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Properties of Small-Diameter Inland Species Important for Truss Design

Location Idaho, western Montana, Four Corners region of Arizona and New Mexico, Flagstaff area of northern Arizona

Approach A research study is in progress to evaluate the yield of structurally graded nominal 2- by 4-in. (standard 38- by 89-mm) lumber (2 by 4) from several locations in the Inland West. Species being evaluated include ponderosa pine, lodgepole pine, white fir, and grand fir, where available. Small-diameter trees are sawn into 2 by 4s for each location. Researchers then determine the grade of the wood using mechanical and visual grading systems. Some lumber is used to determine the properties of manufactured metal-plate connections when used with small-diameter timber. Production of structural lumber for use in metal-plate-connected wood trusses is an attractive option for using lumber from small-diameter trees. However, little information is available on the mechanical properties of this material. The information obtained in this study, when combined with historical data and independent studies on other uses, is helping to define utilization options for wood from small-diameter trees in the Inland West.

Status Results from the Idaho and Montana locations indicate that excellent yields of visually graded structural lumber can be obtained from lodgepole pine and grand fir. Ponderosa pine thinnings show little potential for direct use as structural lumber, since these trees grow below the canopy and the wood has many knots. Additional ponderosa pine samples obtained from co-dominant trees are expected to produce better yields. Mechanical grading of lodgepole pine and grand fir offered even better grade yield of structural products than did visual grading. Machine–stress-rated (MSR) lumber can produce an estimated $27 per thousand board feet (\$11.44/m^3) premium over the value of visually graded lumber for lodgepole pine and a \$15 per thousand board feet (\$6.36/m^3) premium for grand fir. Testing and analysis of material from Colorado and Arizona are in progress.

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Mechanical Grading of Structural Logs for Log Homes

Location Idaho, Montana

Approach In the West, 80% to 90% of the logs used to make log homes come from standing dead trees, primarily trees killed during wildfires. Dead trees that are left in the forest contribute to fire risk and often have little value in traditional markets. Log homes provide a high-value use for such material as well as employment opportunities for local communities.

Current structural grading methods for logs to be used in log homes are based solely on visual methods. Property assignments with this process are not very precise and are probably overconservative. Previous Forest Products Laboratory research on structural timbers demonstrated that a mechanical grading system based on a combination of visual grading and nondestructive testing is more precise than standard structural grading methods and can lead to more efficient use of the available resource. Such a grading system for structural logs can potentially allow the use of small-diameter members in log homes and thus increase the use of dead timber. In this two-phase study, a mechanical grading system is being developed for logs from dead trees.

Status Phase I of the study is nearing completion. Logs with a uniform diameter of 9 in. (23 cm) were obtained from dead subalpine fir and lodgepole pine trees. To provide the modulus of rupture to modulus of elasticity relationship needed to develop grade boundaries for mechanical sorting, 60 logs were tested at the University of Montana in third-point bending. To determine the relationship between compression and bending, an additional 60 logs are being tested as short columns at the Forest Products Laboratory. Analysis of these bending tests is in progress. In Phase II, researchers will sort logs into one or more mechanical grades, then subject the logs to bending tests to assess the accuracy of the property assignments.

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Utilization Options for Suppressed Douglas-fir

Location Shasta–Trinity National Forest, California; Forest Products Laboratory, Madison, Wisconsin

Approach Problems associated with densely stocked small-diameter stands are common in the West. Such stands cannot resist drought and insect attack, and the buildup of woody debris increases the risk of catastrophic wildfire. The stands must be thinned to maintain or improve forest health and to reduce the risk of wildfire. Historically, small-diameter trees have been considered nonmerchantable and treated as waste. To help pay the estimated $150 to $500 per acre ($375 to $1,250 per hectare) associated with thinning, economical uses must be found for these trees. Douglas-fir (*Pseudotsuga menziesii*) is the most important commercial species in western United States and a major component in many stands of suppressed trees. Although there are extensive data on expected yields of lumber products from large Douglas-fir trees and from intensively managed plantations, little information is available on properties and grade yield from suppressed trees.

Trees were selected from a 67-acre (26.8-hectare) stand of even-aged Douglas-fir on the Shasta–Trinity National Forest that was being thinned to reduce ladder fuels and to maintain forest health. Most trees sampled were 60 to 80 years old, with diameter at breast height ranging from 4 to 10 in. (10.2 to 25.4 cm). The average size of the worst knot in butt and middle logs was 0.2 to 0.3 in. (0.5 to 0.8 cm). Generally, the logs had less taper than might be expected in small-diameter trees and a low occurrence of juvenile wood in the butt logs. The logs were cut into nominal 2- by 4-in. (standard 38- by 89-mm) and nominal 2- by 6-in. (standard 38- by 140-mm) lumber and dried in a dehumidification kiln. Some lumber was scanned to estimate the recovery of clear cuttings. The rest of the lumber was graded as Structural Light Framing, Light Framing, or LamStock (Stud grade).

Results The results of visual grading are shown in the following table. Based on visual characteristics, 82% of the lumber might qualify for the highest machine-stress-rated grades and 30% for tension lamination grades of glulam. Mechanical testing must be completed before final grade assignments can be made for these grading systems. Some lumber is also being finger jointed for determining finger-joint strength for glulam beams.

Results of visual grading

Grade and rejects	Yield (%)
Structural Light Framing	
Select Structural	68
No. 1	7
No. 2	17
No. 3	5
Rejects	3
Light Framing	
Construction	74
Standard	17
Utility	5
Rejects	4
Stud	
Grade	88
Rejects	11

Status Mechanical testing and evaluation of results are nearing completion.

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Debarking of Softwood With Fungi to Improve Marketing Options

Location Rocky Mountain Region

Approach One barrier to using small-diameter, slow-growth timber is the lack of a practical, economical way to remove the bark. Removing the bark of dormant or slow-growing timber is very difficult because the cambial layer, which lies just under the bark, is resistant to shearing. Since the cambial layer is very thin and susceptible to microbial degradation, it is possible to harness the use of natural fungi to aid in debarking. Fungi debark timber biologically by attacking the cambial layer and loosening the bark. Some fungi are detrimental because they discolor the wood (sapstain). Other fungi can debark timber and prevent the incursion of detrimental fungi.

To investigate the potential of fungi for debarking small-diameter timber, fungi that naturally colonize the cambial layer will be isolated from felled and exposed logs. The fungi will be identified and used to inoculate new logs in the cambial region. Various treatments will be tested that might facilitate growth of the fungi, such as wetting the log or sealing the exposed ends. After appropriate incubation times, the bark will be removed mechanically and the amount of energy required for debarking will be measured.

Researchers will investigate several variables: species of fungi and tree, age and growth rate of wood, type and method of inoculation, incubation time required, and season of harvest. Sampling for new fungi and analysis of fungal application will be conducted on a quarterly basis for approximately 2 years. Researchers hope to identify the most efficient fungi for debarking and the optimum conditions for inoculation and colonization. The final product will be a biological debarking process that is suitable for commercial use. This project will increase forest health and productivity by lowering the cost of removing bark from slow-growing, overcrowded small-diameter timber, thus making this resource more commercially desirable.

Status The project is in progress.

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Composting of Wood Waste

Location Ketchikan, Alaska

Approach The disposal of woody residues, whether from thinning overstocked small-diameter stands or from the forest product industry, has become a costly problem. In the past, this material was burned or allowed to accumulate in huge piles on low-value land behind mills or within the forest. Tighter environmental regulations designed to reduce the runoff of organic residues into groundwater supplies have necessitated the development of different disposal systems. Composting transforms wood waste into a value-added product. It is a microbial process that converts carbonaceous and nitrogenous materials into a stable, often nutrient-rich, organic soil supplement that can be sold to consumers or returned to the forest to increase soil fertility and improve forest health.

Large-scale, commercial composting operations require substantial amounts of capital investment. The small-scale producer of forest products residues cannot afford this type of investment. The Forest Service is therefore exploring smaller-scale alternatives that will be efficient at compost production but do not require a large investment of capital. Increasing the efficiency of composting woody materials would also decrease costs by allowing faster turnover of woody residues. Passive aeration of compost piles and windrows does not require investment in large air-handling systems and is one possibility for reducing costs. This system has not yet been thoroughly evaluated for the composting of forestry residues.

The objective of this study is to develop cost-effective and efficient composting technologies for the materials and conditions found in southeastern Alaska that have universal applications and can be used throughout the United States. Specific objectives include the following:

- Determining whether passive aeration composting is as effective as active aeration for composting a variety of forestry residues
- Determining how much residue from decay-resistant wood species, such as cedar, can be incorporated into compost without decreasing its quality
- Determining whether the addition of wood-decay fungi or commercially available bacterial preparations to the curing stage of composting will accelerate the decomposition of recalcitrant woody materials

Status The study is in its initial phase, the construction of passively aerated compost windrows.

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Wood Fiber–Plastic Composites From Underutilized Species

Location Albuquerque and Mountainair, New Mexico; Phoenix, Arizona; northern California

Approach Utilization research on composite materials conducted at the Forest Products Laboratory (FPL) is helping to justify and provide a return for removal of the present biomass buildup. The technology used to assemble composites from small pieces of wood is adaptable to a changing resource base. Composites can be made from a variety of wood and wood-based raw materials, including fibers, particles, flakes, and strands. Current research focuses on developing wood fiber–plastic composites from blends of thermoplastics and various species of wood fibers (pinyon pine, juniper, insect-killed white fir, and guayule wood). More than 3.4×10^9 lb (1.5×10^9 kg) of filled thermo- plastic composite materials are used annually in the United States to produce a wide range of products. Fillers improve the stiffness, strength, and dimensional stability of thermoplastics. At FPL, wood fiber is being used as a filler in wood–plastic composites. The benefits to using this technology include reducing the overall amount of material used through better engineering, increasing the strength and life of the product, and reducing the weight of the product.

Status One study is exploring the properties of thermoplastics filled with wood fibers from small-diameter and insect-killed white fir. Fibers from insect-killed white fir have slightly better notched impact, tensile, and flexural properties than that of commercially available wood flour fillers. Other small-diameter species are being investigated.

Another study centers on expanding the potential uses of juniper and developing technology for industrial application of juniper fiber materials. This study focuses on determining current environmental management needs for juniper rangelands, improving rural community economic sustainability, and providing a competitive and efficient alternative for a high-value durable exterior panel products. The goal is to develop and demonstrate the technical and market feasibility for a juniper–polymer material system engineered for highway signage. Prototype signs were made from whole juniper trees and others from juniper stems. Samples from these sign panels are being tested for stiffness, strength, durability, fastener performance, and puncture resistance. Samples have also been installed at various Forest Service sites in New Mexico. After 12 months of exposure, the samples will be evaluated for weatherability, animal damage, and general evidence of continued serviceability. Mixing juniper fiber with a controlled blend of waste plastics will allow FPL scientists to create a material with the needed mechanical properties and weather resistance for the sign industry.

A third study involves expanding the potential uses of wood fiber–thermoplastic composites to a host of exterior applications by incorporating a naturally occurring preservative and termicide into the composites. Limited research data indicate that when the naturally occurring resin of guayule (*Parthenium argentatum*) combines with wood in a composite, it provides protection against termites, molluscan borers, and fungi. The objective of this research is to use guayule as a natural wood preservative in wood fiber–plastic composites. Termite tests are ongoing in Arizona, and the University of Illinois is conducting decay tests. This research and development should lead to many markets for durable exterior materials.

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Development of Businesses for Utilizing Small-Diameter Material

Location Nationwide

Approach Attempts to find ways to support proactive management of underutilized and undervalued timber have previously focused on large industries, which require a high amount of capital and infrastructure compared to the value returned by the products. Recent efforts by the State & Private Forestry Technology Marketing Unit at the Forest Products Laboratory focus on rural community-based approaches to generate small businesses that can serve local markets with lower costs. Information is being developed for small forest-dependent communities to evaluate the uses of small-diameter material in various markets and their economic feasibility.

This work is being developed and tested within the Intermountain West and Southwest. These regions consists of many dense stands of overstocked small-diameter material that are at risk from insect infestation and catastrophic wildfire. Although current efforts focus on this particular region, the results are applicable to any available forest biomass; they are specifically targeted to a community-based approach to generating market pull to remove excess biomass. The results from this work will be applicable to areas with forest-based communities and undervalued overstocked timber.

Status A bibliography of information relevant to utilization of small-diameter and underutilized material is available. Computerized software programs are under development that will estimate capitalization, labor, and raw material requirements for appropriate combinations of harvesting and processing systems and associated product markets. Model outputs will be based on available resource characteristics and supplies. This software assesses the economic feasibility of new investments and develops detailed business pro-forma statements. Various investment feasibility scenarios are also under development, representing technologies that could contribute to the complete and economic use of small-diameter and underutilized material.

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Log-Sort Yards

Location Nationwide

Approach In the past 10 years, the amount and type of Federal timber available for the traditional forest products industry has changed dramatically. As a result, many large timber firms have shut down, causing unemployment problems in several forest-dependent rural communities. The establishment of log-sort yards in these areas would provide an opportunity to improve the marketing of small-diameter timber by offering a location where purchasers could bring small quantities of timber for sorting for the best market niche. Improved marketing of this resource could improve rural economies.

Log-sort yards are heterogeneous and have different functions. Some manufacture value-added products such as debarked logs and utility poles, and others simply sort logs according to different grades and species. In general, log-sort yards manufacture and sort logs into higher-value products and broker them to the best market. They thus provide a market for large and small timber producers and for supply firms with raw materials. Successful log-sort yards are self-sufficient and have a good business plan, well-established markets, a steady supply of wood, and adequate capital.

This project investigates the log-sort yard as a feasible outlet for small-diameter timber utilization and marketing by determining how to plan, develop, and operate such a yard successfully. Many aspects of these enterprises are being studied, including design, technology, grading and scaling procedures, and markets. This analysis will provide knowledge about the business planning and management skills needed to operate a small-diameter processing center. A good business plan is particularly important for obtaining financing and increasing the odds of success.

After reviewing current information on log-sort yards, project team members visited existing and planned log-sort yards in the United States that represent a variety of management situations; some log-sort yards were commercially owned, and others were run by the community or government. The aim of the project is to produce a log-sort yard guidebook applicable to both small-diameter softwoods in the West and underutilized material in forests nationwide. Developing successful log-sort yards promotes better utilization and improved value recovery of available timber resources.

Status Team members are currently analyzing the information collected and preparing the guidebook.

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