BIOMASS UTILIZATION FOR FOREST HEALTH AND COMMUNITY DEVELOPMENT

Susan L. LeVan
Assistant Director

USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin 53705-2398

ABSTRACT

Rural communities in forested areas and Federal forest managers are facing new challenges to provide treatments for forests to achieve improved ecosystem outcomes and to provide jobs and income for rural, forest-based communities. Forest ecosystem management seeks to maintain ecosystem functions and processes while providing products and services for economic benefits within the capabilities of ecosystems. To restore forested ecosystems to a more natural distribution of biological features and restore natural cycles of fire disturbance will require treatment of millions of aces, which include vast numbers of small-diameter trees and forest biomass. There is a key problem in establishing organizations and industries to utilize all parts of this resource for its highest value to enable the byproducts of ecosystem management to support these rural communities in these forested areas. This paper is a discussion of the ongoing activities at the USDA Forest Service, Forest Products Laboratory, directed towards developing partnerships between rural communities, public agencies, and small local forest products industries to use the forest biomass that needs to be removed for improving or restoring forest ecosystems, thereby providing jobs and income to rural, forest-based communities.

Keywords: rural communities, ecosystem management, forest-based, small diameter, forest biomass

INTRODUCTION

Many communities rely on adjacent forest lands for their economic health. However, past practices of high lumber grading and changes in forest policies are placing these communities in situations where they need to adapt to a different type of forest resource. This different forest resource is characterized by small-diameter, mixed species and grades, and generally of lower value than traditionally used. But many forest-based communities lack the technical, marketing, and financial resources to make this shift.

At the same time, there is a critical need to remove forest biomass material from both U.S. Western and Eastern forests. In the West, dense, overstocked stands are at risk from infestation by insects and disease and catastrophic wildfires. In the East, reliance on non-industrial private forest lands is increasing the need for good forest management

practices. In both the West and East, forest material removal offers one management treatment but it is expensive, particularly for this lower valued resource.

During the past several years, changes in forest policy have caused undue hardships on forest-based communities. In addition, timber sales consisting of this different forest resource were going without bids because the value of the material did not cover the costs of harvesting and transporting. When the available forest resource changes, local businesses and community groups have little knowledge on (1) the amount of available resource, (2) the raw material properties and what markets might be best suited for a particular set of properties, (3) how to most efficiently and economically harvest material, (4) how to add value, and (5) how to put this information into a successful business plan.

Healthy forests and healthy local communities are inextricably linked. As forest conditions have declined or access to the forest resource base has changed, big industry has moved on, taking with it a significant segment of the economic pie and leaving small, rural communities in a downward spiral of economic and social problems. The recurring question heard in rural communities across the country, who have historically depended on local forest resources to drive their economies is "How can we develop value-added forest products businesses that will help diversity our economies and use local forest resources in a manner that will help restore healthy and sustainable forests?"

The question is multifaceted and so are the solutions. The following are three of the major problems: (1) Rural communities and rural forest product businesses are isolated and often lack connections to outside information sources and assistance. (2) Even if assistance is available (e.g., university extension), problems encountered in these rural situations, especially those related to underutilized species and diameter classes, often require a much wider range of skills and resources than what can be realistically provided. (3) There is a serious lack of coordination and contacts between forest product technical assistance networks and information sources.

RESOURCE PROBLEMS

Fundamental elements exist that are common to all U.S. geographical locations and involve both the forest resource and the ability of the community to achieve economic benefits from this resource. To more easily describe the problems and needs, we categorized the forest resource/forest-based community issues into three primary groups: Western Forests, Eastern Forests, and Southeast Alaska.

Western Forests

Timber harvests on public western forests have decreased, and millions of these forest acres are at risk from wildfire, disease, and insect attack as a result of densely overstocked, small-diameter trees. In the West, about 62% of the forested land base is in the public domain (Table 1). Much of this at risk material needs to be removed to restore these forests, but the low value of small-diameter timber makes thinning uneconomical, thereby limiting restoration activities (Sampson 1997; Covington et al. 1997). Therefore, there needs to be some economic incentive achieved through value-added use of the

thinnings and removals so that restoration can be achieved without totally relying on Federal dollars (Dahms and Geils 1997).

Table 1—U.S. Forest Lands by Region and Ownership (thousands of acres)

			Private land	
Region	All forests	Public (Federal & State) land	Industrial	Non-industrial
North	157,799	30,306 (19%)	16,198 (10%)	111,294 (71%)
South	199,309	20,502 (10%)	39,026 (20%)	139,782 (70%)
Rocky Mountains	62,628	43.389 (69%)	2,918 (4%)	17,322 (27%)
Pacific Coast	54,751	29,414 (54%)	12,314 (22%)	19,209 (35%)
Alaska	15,068	8,883 (59%)	0 (0%)	6,185 (41%)

Forest-based communities have traditionally relied on large-diameter timber and generated revenues through primary sawmilling. However, the kinds and quality of the material that needs to be removed poses severe challenges to these communities. The reduction in size and grade of these logs increases manufacturing costs with decreased wood product market values relative to large-diameter trees. The mix and grade of species are typically different from what has historically been used. The size of the material is smaller, and in many cases, forest-based communities lack the appropriate technology necessary to achieve the highest value. Therefore, for forest-based communities in our Western Forests to return to financial viability, new value-added uses must be found for the available, small-diameter forest resource. These forest-based communities are aware of the full potential of this resource and have the motivation to return their forests to healthy conditions but need assistance in developing value-added uses. An example of one such community follows.

Hayfork Adaptive Management Area

Trinity County, California, is located within the Hayfork Adaptive Management Area. Trinity County is rural (population 13,063), historically timber-based, and has a 16.6% unemployment rate. More than 80% of the land base is in public ownership. The county has experienced a severe decline in timber supply as a result of the Northern Spotted Owl decisions. The Northwest Record of Decision replaced a timber-driven management plan with a new ecosystem management plan aimed at preserving and increasing old-growth habitat. Management activities in these forests are focused on restoration forestry. Small-diameter thinnings have been identified as a means to reduce fire risk, improve forest health, and move the forest towards old-growth form and function. At present, small-diameter thinnings are not economical, but they do present the largest opportunity for economic activity in Trinity County.

The economic status of this community has changed because the timber supply has decreased by about 80%. One of the most telling statistics regarding the economic status of Trinity County is the change in the number of school children who must rely upon the "Free and Reduced Lunch Program." In 1990, 54% of Trinity County school children participated in this program. Today, that figure is 84%. Economic opportunity is almost non-existent.

The proposed site-specific project in Trinity County is to identify the best potential for the integrated use of the small-diameter thinnings from the forest lands in and around the Hayfork Adaptive Management Area. The project will be part of a larger effort, which is to provide multiple sites for pilot utilization projects for small-diameter material throughout California. The goal of this site-specific project would be to reduce extraction and processing costs while increasing product value through local value-added activities. The needs of this project include but are not limited to the following:

- Characterize the forest resource for product opportunities
- Develop process technologies that are appropriately scaled
- Identify markets and market opportunities
- Integrate use of all raw materials, including waste products
- Assist with business planning
- Disseminate information through workshops

Eastern Forests

America's private forests increased 11 million acres from 1977 to 1992, as a result of abandoned farm land reverting to forests. Development pressure is causing fragmentation of these lands into smaller and numerous parcels. Compared with public lands, greater challenges exist to bring private forests under a sustainable forestry philosophy. The demand for hardwoods and softwoods is increasing, with the demand for hardwoods anticipated to increase 83% between 1992 and 2040. This demand will need to be met from non-industrial private lands. However, small, non-industrial forest landowners lack the knowledge of the full potential of their resource and the ability to obtain the best use of this material. There needs to be some mechanism for providing information that allows the forest landowner to achieve the highest and best use of the resource under sustainable forestry practices.

Much of the forest lands in the East consist of lower valued hardwoods. Two-thirds of the hardwood sawtimber volume is in lower value Grade 3 and 4 logs. Sustainable forest management concerns associated with Eastern hardwood forests are (a) maintaining forest health and vigor with the increased demand (b) maintaining and regenerating oak species, (c) maintaining diversity of tree species, and (d) minimizing residual damage from forest operations (NRC 1997; Forest Service 1993). An example of the needs of forest-based communities in the Eastern forests follows.

Menominee Tribal Enterprises

Menominee Tribal Enterprises (MTE), located in Neopit, Wisconsin, is responsible for the management of some 224,000 acres of reservation forest lands, with a total of more than 1.7 billion board feet of standing timber. Although MTE has demonstrated excellence in forest management practices, their integrated wood products manufacturing operation lags behind in production technology, new product development, and marketing efforts. Menominee county is one of the poorest of Wisconsin's 72 counties, suffering an unemployment rate of more than 12%. Nearly 25% of the county's workforce is forest based. Between woods workers, forestry operations, wood products manufacturing, and administration, MTE currently employs 400 people (MTE 1997).

Today, MTE is a wholesaler of truckloads of primary lumber products, boltwood, pulpwood, and byproducts. These primary product lines generate only small profits from Menominee's high quality certified hardwood and softwood species. To decrease the pressure on pushing the annual allowable cut levels to produce additional profits, optimize operations, create additional jobs and economic diversity, and obtain the highest and best use of the tribal sustainable forest resource, MTE needs to achieve the following:

- Evolve into downstream value-added product development (e.g., cutstock, edge-glued, and fingerjointed product lines)
- Process maximum levels of small-diameter logs currently shipped out
- Develop whole log chipping capabilities
- Expand marketing efforts for certified wood products and proprietary grade development
- Enhance and sustain operating efficiencies in primary operations that will feed subsequent value-added and secondary operations

Needs that would facilitate the successful implementation and optimization of the MTE Revitalization and Value-Added Expansion Project include the following:

- Mentoring: Mentoring provides an opportunity to work closely with experts knowledgeable in value-added processing and manufacturing, business, new technologies, and marketing.
- Technical Assistance: Value-added processing and marketing require specific technical assistance, such as in the development and marketing of proprietary lumber grading systems.
- Training: Training that provides hands-on experience for business/management representatives and processing/manufacturing operators.
- Technology Transfer/Networking: Gaining access to a national network of experienced forest management and wood product manufacturing specialists for a wide variety of technical assistance is critical to foster two-way exchange of information, research, and assistance.
- Forest Management/Products Manufacturing Databases: Gaining access to information both published and unpublished.
- Forecasting Assistance: Developing access to advanced market trend and financial/statistical analyses to assist in improving the accuracy of marketing forecasting.
- Financial Resources: Anticipated financial costs of expanding into value-added forest products are estimated to be more than $6 million. Obtaining access to information and potential sources of funding.

Southeast Alaska

The closure of two pulp mills in Southeast Alaska has had a large impact on the economic health of rural communities in Alaska. In response to these closures, the USDA Forest Service, Forest Products Laboratory (FPL), reviewed issues related to management, utilization, and economic recovery, and provided six recommendations:

- Convert the resource into higher valued products other than pulp.
- Add value through kiln drying lumber.

- Maximize use of salvageable timber
- Provide technical assistance to improve recovery, increase efficiency, and achieve value-added products.
- Improve ways of sorting logs to obtain highest and best use of material.
- Revamp infrastructure capability to promote value-added manufacturing.

In addition to the impact on the economic health of rural communities, the closure of the mills removed an outlet for lower grade logs. Approximately 30% of the material that is included in the Tongass Land Management Plan contains considerable volumes of lower western hemlock log grades. About 65% of yellow-cedar trees on more than 500,000 acres of forest are dead. This dead material creates an extreme fire hazard.

In response to these problems, FPL conducted research that demonstrated the strength and durability of dead, Alaska yellow-cedar (McDonald et al. 1997). Material that had been standing dead for up to 100 years had equivalent strength to that of coastal Douglas-fir. The current use of this material was for firewood. Potential uses for this material include decking, bridges over sensitive aquatic areas, boardwalks, and playground equipment. Even though value-added opportunities are one way to use the lower quality logs that currently have no use and to create jobs, Alaska lacks the necessary infrastructure to optimize the economic value of its forest resources and needs technical, marketing, and financial assistance to realize its full potential (LeVan 1995; Dramm and Smyrski 1997). Studies on the lower grade hemlock logs demonstrated that high-quality structural lumber could be produced from material that had previously only been considered as pulpwood (Green 1998).Therefore, specific needs for Southeast Alaska are as follows:

- A marketing program for Alaska yellow-cedar as well as technical assistance to sawyers to maximize value from dead logs.
- Technical assistance to maximize recovery and increase revenue from all the forest resources. Technical assistance for sawmill operators to maximize the value from lower grade western hemlock logs as well as a marketing study to determine the best uses of this dimension lumber, and a marketing plan to help sell these western hemlock products.

COMMUNITY NEEDS

In all these communities, various groups and individuals have come together to focus efforts, resolve differences, and develop strategic plans on how to achieve their objectives. In some communities, the major focus is on community-based forest stewardship to restore healthy forests and provide jobs. In other cases, the major community objective is to provide jobs and restore economic vitality to economically depressed communities. In either case, the level of community involvement and commitment is extremely strong and is a prerequisite for developing a successful value-added venture. The activities, objectives, and motivations for each community recognize and highlight the cultural and fundamental core values within that community. However, several common elements stand out from all these descriptions and include the following:

Local Resources and Local Value-Added Opportunities: All these communities have the common goal of wanting to use the local forest resources to enhance economic opportunities within their communities. These communities have expressed a strong desire to build economic vitality from within the community, without having to rely on large forest industries.

Similar Needs: Similar needs emerge from the previous descriptions and are summarized in Table 2. This table demonstrates the need for a cross-discipline, coordinated approach.

Table 2. Summary of Rural Community and Business Value-Added Forest Product Needs

Needs	Community or Partnership						
	Monroe County (KY)	Menominee Tribal (WI)	SE Alaska	Ponderosa Pine Partnership (CO)	Grand Canyon Forest Trust (AZ)	Hayfork AMA (CA)	Applegate AMA (OR)
Resource inventory & interpretation	X		X	X	X	X	X
Economical & harvest systems			X	X	X	X	X
Financially & legally feasible timber sale arrangements			X	X	X	X	X
Shared log sort yards			X	X	X	X	X
Raw material characterization-product processing & market research	X	X	X	X	X	X	X
ID & develop appropriately-scaled processing technologies	X	X	X	X	X	X	X
Market research & market feasibility studies & trials	X	X	X	X	X	X	X
Market forecasts	X	X	X		X	X	X
Mill residue utilization	X	X	X	X	X	X	X
Mentoring/hands-on training	X	X	X				
Develop & market proprietary and/or new lumber grades	X	X	X	X	X	X	X
Access & partner with national networks & communities	X	X	X	X	X	X	X
Access published/ unpublished info	X	X	X	X	X		X
Sawmill optimization assistance	X	X	X		X		
Workshops & info dissemination	X		X	X	X	X	X
Business planning	X	X	X	X	X	X	X
Financing	X	X	X				

FPL'S RESEARCH ACTIVITIES

The purpose of research is to provide the basis for value-added opportunities for forest-based communities. Research needed includes characterizing the physical and mechanical properties of the resource, identifying available or new technologies that can provide value-added opportunities, resolving technical or economic barriers, and developing appropriately-scaled technologies for ensuring sustainable value-added forest products from sustainable local resources. The following are examples of FPL research activities.

Properties of Small-Diameter Inland West Species of Importance in Truss Design

Problems associated with small-diameter densely stocked stands are common in the Intermountain West. Production of structural lumber for use in metal plate wooden trusses is an attractive option for some material; however, little data are available on the mechanical properties of this material.

A study was initiated to evaluate the yield of structurally graded 2 by 4's. Species included ponderosa and lodgepole pine, white fir, grand fir, and Douglas-fir where available. Sampling locations included central Idaho/northern Montana, Four Corners region of the Southwest, Flagstaff area, and locations in New Mexico. Initial results indicate that excellent yields of visually graded structural lumber may be obtained with lodgepole pine and grand fir. Ponderosa pine thinnings show little potential for direct use as structural lumber. However, this material may have potential as core material in glue-laminated beams. Mechanical grading of lodgepole pine and grand fir offered even better grade yield of structural products than did visual grades (Erickson 1997).

Structural Uses for Small-Diameter Round Timbers

Another opportunity for using small-diameter material is in the round form. However, expanding the market for structural uses of roundwood is not simply a matter of demonstrating a direct substitution. Conventional construction methods and materials have evolved to require structural wood components in rectangular shape and standard dimensions. Therefore, expanding such a market requires development of design standards and quality assurance procedures, connections, systems, and aesthetics that are unique to the structural use of roundwood.

The strength of round wood is less variable than that of lumber, but its round form is not directly amenable to nails, screwed or bolted lap joints. Reductions in section properties from one end to the other are accompanied by reductions in strength and elasticity. Finally, the natural taper requires some surface modification or special connection detail to mimic the parallel and plumb vertical surfaces of conventional construction.

A study is being initiated to evaluate the material properties of roundwood. Species being evaluated include ponderosa pine, lodgepole pine, white fir, grand fir, and Douglas-fir where available. Sampling locations include central Idaho/northern Montana, Four Corners region of the Southwest, Flagstaff area, and New Mexico. The goal is to establish a basis for derivation of design stresses and for judging capacity of individual round timbers to safely perform at the level assumed by that derivation.

Demonstration of Value-Added Opportunities With Character Grade Products

Appearance products manufactured from hardwoods are predominantly made from clear cuttings. Therefore, appearance grading rules for hardwoods place a greater value on logs, lumber, and veneer that exhibit little variation and yield the highest volume of "clear" wood. Thus, consumers expect hardwood furniture to be defect free, although they readily accept similarly styled products in knotty pine. If consumers would accept naturally occurring features such as knots, mineral streaks, and grain and color variation, then this would potentially increase the value of lower grade hardwood products. Previous research indicates yield savings of 3% to 5% through acceptance of small (<0.25 in.) tight knots. Market studies revealed that utilization savings were important but creating a unique product that was acceptable in the market place was most important.

An exploratory study using hard maple from MTE demonstrated the potential for character grade products and consumer acceptance. Since the market price for hard maple lumber is dependent on color, bright white hard maple sells for two to three times that of non-white or brown maple. If color variation and tradition are barriers to value-added products from brown maple, there may be an opportunity to create value-added products from brown maple by sorting into similar "brown" standard categories. An exploratory market study to evaluate the potential of sorting into similar "brown" standard categories was conducted by West (1997). Several edge-glued panels were created from brown maple. Twelve panels were shown at a regional woodworking trade fair, typically attended by furniture and cabinet manufacturers. Analysis of the panel rankings by randomly selected attendees revealed strong preferences for panels without mineral streak and natural finishes and that color consistency, not brightness, is more important. Panel ratings revealed that color-sorted brown maple without mineral streak was suitable for use in products produced by at least 60% of all respondents.

Use of Lower-Quality Hardwoods for Structural Applications

There is increasing interest in using lower quality hardwoods in structural applications. Previous research resulted in the approval of the use of machine stress rated grading system for 2-in.-thick lumber made from oak, the first time applied to hardwoods. Results indicated that most lumber that only made lower grades by the visual grading system in fact had properties equivalent to Select Structural visual grades. Several research studies are expanding this previous work into other hardwood species to lay the foundation for routine structural grading of lower quality hardwoods and exploring the use of hardwoods as structural components in trusses and I-joists.

Wood Utilization Under Ecosystem Management Practices

With the advent of implementing ecosystem management and concepts of sustainability on National Forest Service (NFS) lands, a fundamental barrier is the economics involved in removing the woody material that needs to be removed from overstocked dense stands. Because tens of millions of acres of NFS lands require varying levels of restoration and treatment, the appropriated funds available are generally insufficient to make significant inroads or achieve desired forest conditions in a timely manner. A national research project was initiated to provide methods to evaluate the economic feasibility of different silvicultural treatments, different harvesting methods, and current and future product options for woody materials removed from forests maintained under an ecosystem approach. This is a Multidisciplinary research (Wood Utilization Options for Ecosystem, Management—WUEM project) projected to develop alternative utilization options and management decision models to aid National forests in treating specific ecosystem conditions in the U.S. South, West, and Northeast regions. Research is linking options for silvicultural treatments with forest operations, with impacts on current and a future wood qualities, and with options for current and future wood products. Economic evaluation tools are being developed to help managers evaluate the economic feasibility of various silvicultural treatments, forest operations, and wood products.

CONCLUDING REMARKS

In summary, the three major needs are as follow: First, for the 62% of the forest lands in the public domain in the West, there is the need to create economic incentives that will facilitate forest restoration practices under ecosystem management principles. Second, for the 70% of the forest lands that are under non-industrial private ownership in the East, there is a need to provide economic incentives for sustainable forest management. One way to provide that economic incentive is through the highest and best use of the resource in value-added forest products. Third, there is a need to provide economic opportunities that will provide jobs and enhance the quality of life in forest-based communities. The Forest Products Laboratory research efforts are directed at developing the basis for value-added opportunities for small, forest-based rural communities.

REFERENCES

1. Covington, W. Wallace; Fule, Peter Z; Moore, Margaret, et al. 1997. Restoring ecosystem health in ponderosa pine forests of the Southwest. Journal of forestry. April. p. 23-29.
2. Dahms, Cathy W.; Geils, Brian W., eds. 1997. An assessment of forest ecosystem health in the Southwest. RM-GTR-295. Forest Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.
3. Dramm, John; Smyrski, Rose, comp. 1997. Workshops on opportunities for forest products in Southeast Alaska. U.S. Department of Agriculture, Forest Service, Region 10, Alaska Region, Pacific Northwest Research Station. 50 p.
4. Erickson, R.G. 1997. Mechanical grading opportunities for lumber sawn from small-diameter logs. M.S. thesis. University of Idaho, Mosco, ID.
5. Forest Service. 1993. Forest health assessment for the Northeastern Area. NA-TP-01-95. U.S. Department of Agriculture, Forest Service, Northeastern Area and Northeastern Forest Research Experiment Station. 61 p.
6. Green, David W. 1998. Status report: Grade recovery from Alaskan hemlock pulp logs. Internal report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.
7. Forest Products Laboratory. 1995. Region/FPL Charting a Course for sustainable development in southeast Alaska. Unpublished Trip report. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 25 p.
8. McDonald, Kent A.; Hennon, Paul E.; Stevens, John H. et al. 1997. Mechanical properties of salvaged dead yellow-cedar in southeast Alaska. Phase I. FPL-RP-565. Madison, WI: USDA, Forest Service, Forest Products Laboratory.
9. MTE. 1997. The Menominee forest management tradition: History, principles and practices. Menominee Tribal Enterprises, Neopit, WI. 57 p.
10. NRC. 1997. Forested landscapes in perspective: Prospects and opportunities for sustainable management of America's nonfederal forests. Republication copy. Committee on prospects and opportunities for sustainable management of America's nonfederal forests. National Research Council, Board of Agriculture. National Academy Press. Washington, DC.

11. Sampson, R. Neil. 1997. Forest management, wildfire and climate change policy issues in the 11 Western states. Office of Economy and Environment, Environmental Protection Agency, and Forest Policy Center American Forests. CR-820-797-01-0.
12. West, Cynthia D. 1997. Demonstration of value added opportunities with character grade products. Princeton, WV: U.S. Department of Agriculture, Forest Service, Forestry Sciences Laboratory.