Building Partnerships to Evaluate Wood Utilization Options for Improving Forest Health

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Abstract.—Silvicultural practices used on national forests are changing as a result of the shift to ecosystem management. As a result, the species mix, size, quality, and quantity of woody material that may be removed are changing. In a combined, multidisciplinary effort, Forest Service research units at the Forest Products Laboratory, Pacific Northwest and Southern Research Stations, Northeastern Forest Experiment Station, and national forests in Regions 6, 8, and 9 have been identifying wood utilization options for managing specific ecosystems. Teams have been focusing research on three conditions: dense small-diameter stands in the West, uneven-aged pine/mixed hardwood stands in the South, and central Appalachian hardwood forests in the Northeast. The teams are evaluating alternatives for silvicultural treatments, forest operations, and wood products, as well as the economic feasibility of these alternatives. The project objective is to provide information and methods for evaluating opportunities for current and future products from woody materials that may be removed from the forests.

INTRODUCTION

Forest Service research units at the Forest Products Laboratory, Pacific Northwest and Southern Research Stations, Northeast Forest Experiment Station; and national forests in Regions 6, 8, and 9 are completing the first year of research of the Wood Utilization for Ecosystem Management Project. The project involves many types of studies aimed at developing methods to identify and evaluate utilization options for managing specific ecosystem conditions.

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The research is coordinated by a national steering committee and conducted by three teams. Each team has been focusing on a particular ecosystem condition: (1) dense small-diameter stands in the West, (2) uneven-aged pine/mixed hardwood stands in the Piedmont region of the South, and (3) central Appalachian hardwoods in the Northeast. Using an ecosystem approach to management, land managers in these areas are seeking workable silvicultural practices to achieve many interrelated outcomes:

- restoring the natural range of variation in disturbance patterns
- restoring wildlife habitat
- maintaining healthy and aesthetically desirable forests
- mitigating the impact of insects and diseases
- reducing the risk of catastrophic fire
- restoring a mix of vegetation within the natural range of variation

Treatments needed to achieve these outcomes may require removal of woody material, as with

traditional practices, but there may be differences in the species mix, size, quality, and quantity of materials to be removed when compared to traditional practices.

The overall objective of this project is to provide information and methods needed to evaluate current and future product opportunities for woody materials that may be removed from forests maintained under ecosystem management regimes. By combining expertise in silviculture, forest operations, wood utilization, and economic feasibility evaluation, this project provides scientific and technical knowledge relevant to planning and implementing ecosystem management for specific ecosystem conditions.

To financially support the removal of woody materials on national forests and to aid local economies we need to obtain the highest value products possible from these materials at the lowest operating cost. The information from this research may also help community leaders to determine where wood utilization proposals can realistically provide jobs and income.

APPROACH

Regional research teams are studying widespread ecosystem conditions. Team members on the national forests identify the outcomes needed for the ecosystems and work with scientists to identify possible alternative silvicultural treatments. The research teams (1) collect information that links possible treatments to characteristics of wood to be removed and to possible products and product qualities, (2) evaluate woody material for use in alternative high value products, (3) evaluate alternative forest operations for removing woody material, and (4) evaluate the economic feasibility of alternatives. Utilization options are being evaluated for woody material to be removed both now and in the future.

DENSE SMALL-DIAMETER STANDS IN THE WEST

Dense, small-diameter stands are widespread in the West. To improve ecosystem health and biological diversity will require thinning and other silvicultural treatments. The research objectives for this ecosystem condition are (1) to evaluate the effect of alternative silvicultural treatments on forest conditions, (2) to evaluate logging costs, product yield, and price of alternative forest operations, (3) to examine alternative high value products, and (4) to prepare a tool for analyzing the economic feasibility of alternative products.

Current Forest Conditions

Fire suppression has resulted in the development of small-diameter, densely stocked stands throughout the interior West. These stands typically lack vegetative and structural diversity and exhibit an increased susceptibility to attack from insects and disease. Mortality from competition, insects, or disease leads to an increase in fuel materials (fuel loading) and consequent increased risk of catastrophic fires.

Under a program known as Creating Opportunities (CROP), the Colville National Forest (NF) surveyed 110,000 acres (44,516 ha) of densely stocked small-diameter stands (4–7 inches [102–178 mm] dbh, 1300–2000 stems/acre) (USDA FS 1994a). Natural development has led to stands commonly consisting of fire-origin lodgepole pine (*Pinus contorta* var. *latifolia*), western larch (*Larix occidentalis*), and Douglas-fir (*Pseudotsuga menziesii* var. *glauca*). These stand conditions are common in northeast Washington, northern Idaho, and northwest Montana. A heavy western redcedar (*Thuja placata*) understory is also present in many stands on the east side of the Colville NF.

Average stem size varies in the Colville stands, but at least half the trees fall below the minimum size required for conventional lumber utilization at local mills. The Rocky timber sale area, which encompasses 5,600 acres (2,266 ha), has been selected for studying how active management can produce a range of ecosystem characteristics.

Desired Forest Ecosystem Conditions

The desired outcome for Colville stands is to create healthy, vigorous stands that contain structural components (age, species) within the historic range of variation for the region and that support

wildlife. The reference for variation is the pattern and abundance of structural stages within watersheds in the region during the 19th century (USDA FS 1994b). To achieve this outcome requires creating a higher proportion of late successional forest structure as quickly as possible. The objective is to improve wildlife habitat, forest health, and forest aesthetics. Standards and guidelines for managing these stands are contained in the Colville NF Plan (USDA FS 1988), as amended by the Regional Forester's Interim Management Direction for Eastside National Forests.

Alternative Silvicultural Treatments

To evaluate silvicultural alternatives for the Colville NF, Dr. Steven Tesch and David Ryland[8] of Oregon State University have simulated four silvicultural prescriptions and a no treatment scenario for a range of stand types using the Inland Empire variant of the Forest Vegetation Simulator (FVS) (Wykoff 1986, Wykoff et al. 1982). The alternatives are thinning, a small clearcut with green tree retention, group selection, and single tree selection. The last two are treatments for uneven-aged management. For thinning, the objectives are to remove trees with poor form or vigor, remove trees that pose a health risk, reduce competition, and increase growing space to develop larger trees. For the clearcut, 12 to 15 green trees per acre are retained after the harvest, larch seedings are planted at a density of 360 seedings per acre, and other species regenerate naturally. Group selection is used for western larch/Douglas-fir stands—0.75-acre (0.3-ha) areas are harvested on a 30-year cycle; one-fourth of the area is harvested each 30 years, resulting in a 120-year rotation. Single tree selection is limited to western redcedar stands where a majority of understory and overstory species are shade tolerant. Treatments are scheduled every 30 years and leave no more than 150 ft^2/acre (35 m^2/ha) in size distribution, characterized by a reverse J-shaped distribution with a diminution quotient of 1.3.

The FVS projections suggest that without intervention the Colville NF will not meet the desired future conditions for these dense, small-diameter stands. The projections show that for the no treatment option, stands will develop slowly and it is unlikely they will ever reach the tree size or species objectives. Simulations show greater success for growing stands with the desired tree size and species diversity through the small clearcut with green tree retention, thinning, and uneven-aged management options.

Alternative Forest Operations

Actual thinning operations on the Rocky timber sale area were studied to determine the relationship of stand characteristics (tree size, density) to harvest costs and product volume–value recovery under current local mill utilization standards (Barbour et al. 1995).

Stands were marked to remove trees attacked by *Armillaria* and mistletoe, to release understory trees, to reduce potential fire risk, to create winter browse sites, and to move stands toward a late successional stage. Harvesting equipment included one rubber-tired harvester, three tracked harvesters, and two rubber-tired forwarders.

Costs for harvesting were developed along with estimated volume and value of dimension lumber and chips that could be produced in local mills. Estimated harvesting costs and value of recovered products were highly sensitive to differences in average diameter of trees harvested. For dense stands with mean tree dbh of 5–10 inches (127–254 mm), harvest costs increased and traditional product revenue declined sharply with even slight decreases in mean tree dbh. A stand averaging a few tenths of an inch smaller in average diameter provided a third less lumber per unit volume of logs harvested.

Alternative Wood Products

Some small trees that will be removed under ecosystem management are large enough to produce structural lumber. Stud-grade 2x4s would be a traditional choice for some mills.[9] However, some of the larger logs might be made into machine-

[8] *Ryland, David B. Evaluating the impact of four silvicultural prescriptions on stand growth and structure in North East Washington—a modeling approach. Submitted to Western Journal of Applied Forestry.*

[9] *2x4 refers to nominal 2- by 4-inch lumber (standard 38 by 89 mm).*

stress-rated lumber (MSR) or laminated veneer lumber (LVL). MSR and LVL lumber are worth from 20 to 400 percent more than Stud-grade lumber. However, the grade of MSR and LVL is determined by nondestructive testing of wood properties in addition to visual assessment of growth characteristics, such as knots. Current grading procedures for logs are based solely on visual assessment of log characteristics. Identification of logs most likely to produce high quality MSR lumber or veneer for LVL lumber could help get the maximum value from small-diameter logs.

The Forest Products Laboratory (FPL) is evaluating a nondestructive method to test logs for stiffness and link test results to mechanical properties of lumber or other products made from the logs. Results of initial studies on red oak, balsam fir, and eastern spruce indicate that longitudinal stress wave techniques may be used to relate log properties to lumber properties.[10] A cooperative study between the FPL and the Pacific Northwest Forest and Range Experiment Station is using this stress-wave technique with small-diameter Douglas-fir and Hem–Fir logs. The objectives of the study are to establish a relationship between log and lumber properties and to combine visual measurements of growth knots with the nondestructive measurement of log properties to predict the yield of MSR lumber from the logs.

The FPL and the University of Washington are conducting mechanical and chemical pulping trials, respectively, of small-diameter trees from the Colville NF. These trees may contain large concentrations of juvenile wood, compression wood, bark, and extractives that could be detrimental to both pulping processes and pulp and paper characteristics. Tests are examining fiber quality differences associated with different tree characteristics. Mechanical pulping is done by thermomechanical and chemithermomechanical pulping procedures; electrical energy consumption during pulping is a primary concern. The kraft pulping procedure is used for chemical pulping, where the primary concerns are cooking conditions and pulp yield. Pulp characteristics will be identified for each processing method. Paper made from the resultant pulp is tested for strength and optical properties.

Washington State University is conducting research on the relationship between characteristics of wood from the Colville NF and options for composite products.

Evaluation of Economic Feasibility

A simulation tool will be developed to conduct sensitivity analysis of economic feasibility of alternative treatments of dense small-diameter stands. The tool will show how costs and revenues for particular silvicultural treatments change with changes in stand conditions (size, density, species), available alternative products, efficiency of conversion to products, manufacturing costs, and product prices. The analysis will help identify the conditions where silvicultural treatments, forest operations, and utilization options combine to achieve ecological objectives economically.

UNEVEN-AGED MIXED-SPECIES FORESTS IN PIEDMONT REGION

The Piedmont physiographic region is located east and south of the Appalachian Mountains and west and north of the fall-line of the Coastal Plain in the Southeast. The Piedmont contains about 21 million acres (8,500 thousand hectares).

Before European settlers arrived in the Piedmont, nearly one-half of the area was probably occupied by pine–mixed hardwood stands and the other half by predominantly hardwood stands. The rolling hills of the Piedmont, among the most fertile in the South, had been extensively cleared for cotton and other row crop production by 1860. By the 1930s, most top soil had eroded away and further productive cultivation was difficult because of large gullies and poor soils. Subsequent abandonment of agriculture and the reforestation of vast areas stabilized the land, and by 1990 only a small percentage of the Piedmont was still row cropped. Most agricultural land has been converted to pasture, naturally seeded to pine forests, or planted to pine plantations.

[10] *Ross, R.; Green, D.; McDonald, K; Schad, K. Stress wave nondestructive evaluation of logs to predict structrual product quality. In preparation as a journal report. Schad, K.; Kretschmann, D.; McDonald, K.; Ross, R.;Green, D. Stress wave techniques for determining quality of red oak switch ties. In preparation as a FPL Technical Note.*

Current Forest Conditions

Based on the latest forest inventory data, the Piedmont contains 31 billion ft^3 (8.78×10^8 m^3) of growing stock—44 percent pine, 1 percent other softwoods, 26 percent soft hardwoods, and 29 percent hard hardwoods. The NF land in the Piedmont region was purchased by the Federal government in the 1930s; prior to that time, it was private agricultural land. At present, Piedmont national forests contain 58 percent of growing stock in pine, 3 percent in other softwoods, 18 percent in soft hardwoods, and 21 percent in hard hardwoods. The NF lands account for only 2 percent of all timberland in the Piedmont. The majority of stands are natural even-aged pine or pine/hardwood on abandoned agricultural lands.

Desired Forest Ecosystem Conditions

Forest soils are in a highly depleted condition. In many cases, centuries of careful management will be needed to restore the soils to a condition similar to their original fertility. Nevertheless, the general health of Piedmont forests is good, except for problems with fusiform rust and small outbreaks of southern pine beetle.

The NF lands have been managed under the multiple-use concept since the 1960s. Under this concept, timber management objectives were to improve the health, quality, and volume of pine stands. Older pine stands were often clear cut and replanted with pine or harvested using seedtree cuts to regenerate pine. Younger stands were thinned using various partial-cut management systems to stimulate pine sawtimber growth.

Under ecosystem management objectives, pine and pine/hardwood stands on national forests in the Piedmont are sometimes converted from even-age to uneven-age stand management for pine and mixed species stands. Other practices include traditional even-age, modified even-age, and modified uneven-age methods and systems.

The research objective for the Piedmont region is to identify the implications of various ecosystem management strategies and resultant silvicultural treatments on species composition, tree growth, tree survival, wood properties, and product quality.

Alternative Silvicultural Treatments

A series of study plots with histories representative of a range of ecosystem management practices is being established, measured, and retained for future monitoring in pine and mixed pine/hardwood stands in the Piedmont. Forest practices represented are seed tree, group selection, partial cuts, and reserved.

Plots are located on the Oconee NF and Piedmont Wildlife Refuge in Georgia, the Sumter NF and Savannah River Forest Station in South Carolina, and the Uwharrie NF in North Carolina. Study plots will be inventoried every 5 years, after any natural disturbance, and prior to and following harvest treatments. Selected study plots are relatively even-aged, representing five 20-year age classes (1, 20, 40, 60, and 80 years) and two broad site-index (SI) classes (SI < 80 and SI > 80).

On each study plot, three 1/5-acre (0.081-ha) circular permanent subplots are being established. Trees > 5.0-inch (> 127 mm) dbh are being inventoried by individual species, diameter at breast height, total height, merchantable height, crown class, tree grade, and defect indicators. Rate of growth and wood properties will be estimated from increment cores collected from a sample of trees from each subplot. Five 1/300-acre (0.001-ha) subplots are being installed in each plot to measure reproduction and trees 1.0 to 4.9 inches (25.4 to 124.5 mm) dbh.

Alternative Wood Products

Wood properties and tree characteristics will be linked to lumber and veneer yield by grade. Equations will be developed that link tree characteristics to product yield by grade. Using the equations and field measurements of tree characteristics, total product potential by grade will be determined for trees and stands managed under various ecosystem management regimes.

In a cooperative study, the FPL and the Southern Station are evaluating the use of longitudinal stress wave techniques to relate log properties to properties of MSR lumber. Southern Pine logs from both plantation and natural stands under uneven-age management schemes will be used to assess the

techniques. Preliminary results indicate a useful correlation between log and lumber properties.

Alternative Forest Operations

Implementing intermediate cuts under uneven-age regimes and for stand improvements is difficult and costly in the southern United States. Higher costs are associated with harvesting low volumes and scattered trees, as well as an increased risk of residual tree damage, especially when protecting the hardwood component in mixed species stands. Current harvesting systems are designed for large volume, large area operations and are not conducive to intermediate cutting activities. Recent studies have shown that harvesting costs and residual tree damage increase inversely with cutting volumes and that site disturbance increases directly with cutting volumes for conventional chainsaw/skidder systems. New technologies and techniques are needed to improve harvesting efficiency, to reduce site impacts and residual tree damage, and to optimize wood recovery.

Forest operations need to be completed in a way that minimizes residual tree damage, soil surface disturbance, and impact to the physical properties of the soil. Multiple entries into the stand may lead to cumulative impacts and potential growth loss unless the operations are managed carefully, using improved technologies. Current research is assessing the costs and impacts associated with different technologies in implementing various intermediate stand cuts and in identifying improved methods and alternatives, such as cut-to-length systems and smaller machines. The scientific and technical knowledge from such research will aid the development of new technologies and operating guidelines that will benefit the forest manager in implementing partial cuts.

Evaluation of Economic Feasibility

Prediction models will be developed to estimate potential timber product yields for various stand conditions and treatment regimes. The models will estimate current and predicted yields of total biomass and timber products per acre for pine and hardwoods. The predicted yields will be based on stand variables, including species mix, stand age, basal area, trees per acre, and site index. A model is being developed to project growth and yield for uneven-aged loblolly pine stands in the South. An optimization model will also be developed to work with the growth yield model to evaluate the economic return and stand species and size diversity for alternative silvicultural treatments. The optimization model will use information about potential products from stands grown under different treatment regimes.

CENTRAL APPALACHIAN HARDWOOD FORESTS

The initial phase of research in the Northeast is focusing on central Appalachian hardwood stands on the Monongahela NF. Innovative silvicultural practices are being evaluated as a means for meeting ecosystem objectives for a wide variety of forest types and stand conditions. No single forest type, age class, or species association is being targeted.

Current Forest Conditions

According to a 1989 Forest Service inventory, 79 percent of West Virginia is forested, with 12.1 million acres (1,270 thousand ha) of forest land (DiGiovanni 1990). Two-thirds of this forestland is fully stocked or overstocked. Survey results also indicate that sawtimber stands predominate, which indicates the maturing of the central Appalachian forest resource. One-third of the timberland has sawtimber volumes exceeding 6000 board feet per acre.[11] However, a problem common to much of the eastern hardwood region is that two-thirds of the sawtimber volume is in low-value grades 3 and 4 logs. Although oak/hickory and northern hardwood forest types dominate, species composition on a single treatment area can be extremely variable, given variation in elevation, aspect, and stand history. Thus, the timber resource for ecosystem management treatments is very diverse.

Desired Forest Ecosystem Conditions

The ecosystem management concerns associated with the central Appalachian hardwood forests are

[11] *1 board foot = 0.0024 m³.*

(1) maintaining forest health and vigor, (2) maintaining diversity of tree species, (3) maintaining and regenerating oak species, and (4) minimizing residual stand damage from forest operations.

Given the relatively high proportion of sawtimber stands and fully or overstocked stands, maintaining forest health and vigor will require the regeneration of maturing sawtimber stands and intermediate cuts in other fully stocked and overstocked stands.

Intolerant species such as yellow-poplar and black cherry cannot be adequately regenerated with the light partial cuts or diameter-limit cuts common on private lands, and clearcutting is seldom an option on NF lands. These shade-intolerant species are very important to wildlife and the forest industry. Many wildlife species also require tree height or crown structure diversity.

Oak species are essential to several species of wildlife and are very important to the forest industry. Frequently, light cutting on mesic sites does not regenerate oak species; with heavy cutting, the oak regeneration cannot compete with intolerant species. Preliminary research indicates that removing the understory without creating canopy openings may be the key to regenerating oaks on mesic sites. Relying on commercial harvesting operations to remove the understory would pose a significant challenge for harvesting and utilization research. Timber stands with an oak component are also threatened by gypsy moth defoliation. Silvicultural treatments are needed to reduce susceptibility of these stands to defoliation and their vulnerability to mortality.

Residual stand damage resulting from intermediate partial cuts that may occur over longer rotations will need to be minimized. Several partial cuts also increase the likelihood that logging damage will result in significant losses to decay and reduction in quality. Cable yarding on steep slopes creates an additional challenge to moderating residual stand damage.

Alternative Silvicultural Treatments

Innovative silvicultural systems or treatments required to implement ecosystem management and address forest health issues include two-age management, crop tree release, and thinning to reduce the susceptibility and vulnerabillity of stands threatened by gypsy moth defoliation. These treatments and systems were identified in meetings with managers on the Monongahela NF.

Two-age management can regenerate intolerant tree species without the adverse impact on esthetic (visual) quality associated with clearcutting (Smith and others 1989). Two-age harvest cuts conducted thus far have left 20 to 30 ft^2 (1.9 to 2.8 m^2) of basal area in sawtimber-size trees. Even though two-age management is now being implemented, information is lacking on the effects of pretreatment stand and residual tree characteristics on residual stand growth, quality, and vigor. We also need to determine the effect of site quality and the composition, density, and crown expansion of the residual overstory on the subsequent species composition and quality of reproduction. Future wood utilization options will be determined by the growth and quality of residual trees and the species composition of the regeneration. Research is being planned to address these issues.

Crop tree release is thinning that provides crown release for designated crop trees (Perkey and others 1994). With lengthening rotations and increasing reliance on intermediate cuts, crop tree release can become an important management tool. Crop tree release can also be applied to the management of non-timber resources. For example, selecting desired mast-bearing species for release can improve wildlife habitat. Unlike a two-aged cut, which is primarily a regeneration tool applied to mature stands, crop tree release can be applied to a much wider range of stand conditions—from poletimber to large-diameter sawtimber stands.

Presalvage thinnings or sanitation thinnings can be used to treat immature timber stands at risk from gypsy moth attacks. Presalvage thinnings remove vulnerable trees and increase the vigor of residual trees. Sanitation thinnings eliminate trees that are prospective targets of infestation (Gottschalk 1993). Since stands with a heavy oak component are the most susceptible to gypsy moth and are important to wildlife, maintaining a viable oak component is very important.

Alternative Forest Operations

One objective of research on harvesting will be to obtain information required to model harvesting

system production and to estimate harvesting costs as a function of cut stand attributes and wood utilization options. These cost estimates are needed for economic analysis of treatment/harvesting/utilization alternatives. Harvesting systems will include conventional ground-based systems employing rubber-tired skidders and skyline yarding. Cut stand attributes will be determined by initial stand conditions and the prescribed silvicultural treatments. For two-age cuts, which remove larger volumes and larger trees, research will focus on the relationship between wood utilization limitations (minimum merchantable tree dbh and minimum stem dib) and harvesting costs. For thinnings and crop tree release, which remove smaller trees, research will focus on the relationship between cut stand attributes and harvesting costs.

Research will also consider the environmental impact of harvesting operations, including soil disturbance, visual quality, and residual stand damage. Skyline yarding has generally been limited to large clearcut units, and there is concern about residual stand damage when this technology is applied to the partial cuts now required on NF lands. Skyline yarding is also expected to increase harvesting costs, which could limit applications when low-value stands are to be treated.

Research plans include a study of cable yarding and ground-based skidding on a timber sale that includes two-age cuts, crop tree release cuts, and thinnings in stands threatened by the gypsy moth. Variables of interest include production rates, cost, stand damage, soil disturbance, and effects of soil disturbance on revegetation and regeneration. A study has been completed on thinnings of cable yarding, two-age cuts, and shelterwood cuts. This case study was conducted in cooperation with national forests in North Carolina to assess the cost, production, and environmental impact of cable yarding partial cuts (Baumgras and LeDoux 1995). Results indicate that light thinnings and shelterwood cuts removing only 30 percent of basal area produce very little net revenue. Heavy thinnings, two-age cuts, and shelterwood cuts removing more than 50 percent of basal area all showed excellent economic returns. The two-age and shelterwood cuts destroyed or heavily damaged 30 percent of the residual basal area, indicating that residual stand damage can be a serious concern when cable yarding technology is applied to partial cuts in Appalachian hardwoods.

Alternative Wood Products

Research will identify types of primary products that can be harvested from specific treatments and develop methods of estimating product yields from the cut stand attributes. This information is essential for estimating the marketability of wood harvested, identifying methods of allocating roundwood to the most valuable end-uses, and determining the extent to which new products or processes could expand the merchantability of wood products available from ecosystem management activities or forest health treatments.

Research is underway to estimate potential roundwood product yields, given tree attributes (such as species, diameter, total and merchantable heights) and bole quality attributes. This information will be used to develop equations required to estimate potential product yields from tree attributes for a wide array of products—factory-grade logs, local use logs, sawbolts or pallet bolts, LVL, oriented strandboard, rails, posts, pulpwood, and fuelwood. Research is also planned to validate the product yield models, measuring actual product yields from harvested trees.

A cooperative study between the FPL and the Northeastern Station will evaluate using longitudinal stress-wave techniques to relate log properties to veneer properties. These techniques have been used to sort veneer into "grades" for commercial production of LVL. Traditionally, LVL has been produced using only Southern Pine and Douglas-fir. Recently, however, Trus Joist MacMillian has begun production of LVL using yellow-poplar, and there is interest in the potential for using other species as well. If successful, this log testing approach could help foster the use of smaller diameter logs of underutilized Appalachian species for higher valued LVL lumber. Initial studies will probably focus on yellow-poplar and red maple.

Evaluation of Economic Feasibility

Research will be aimed at determining how the economic feasibility of a silvicultural treatment and

associated harvesting operations is affected by alternative market conditions for products. For specific sets of harvesting and marketing conditions (defined by a set of cut stand attributes, potential product yields, markets, and prices), economic feasibility will be determined by deducting harvesting and transportation costs from the value of wood delivered to mills (value of processed wood minus conversion costs). Additional research will also establish values and conversion costs for the production of lumber, veneer, oriented strandboard, and LVL, given tree species, log quality, and log dimensions. The results will link future stand conditions to the value of the available roundwood.

Because many variables in the economic analyses cannot be estimated with precision, sensitivity analyses will be conducted to determine the effects of markets on net revenue from specific management activities. These results will indicate combinations of price levels, market locations, and initial stand attributes required to implement specific ecosystem management activities.

CONCLUSION

We expect that the combined efforts of a multidisciplinary group of researchers and forest managers will increase the likelihood of finding viable and economical wood utilization options for improving forest health. By coordinating and evaluating research on several specific ecosystem conditions, we can identify common elements of solutions that may be applied to a wider range of ecosystem conditions. Future work under consideration includes expanding outreach efforts to communicate results to forest managers, studying additional ecosystem conditions, and expanding our capability to evaluate various species and qualities of wood for composite panel products.

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