IMPACT OF PRODUCT MIX AND MARKETS ON THE ECONOMIC FEASIBILITY OF HARDWOOD THINNING[1]

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Abstract.--Results demonstrate how the economic feasibility of commercial hardwood thinning is impacted by tree diameter, product mix, and primary product markets. These results indicate that multi-product harvesting can increase revenues by $0.01/ft^3 to $0.32/ft^3; and that small shifts in price levels or haul distance can postpone commercial thinning approximately 10 years.

INTRODUCTION

The economic scarcity of quality sawtimber is evidence by increasing real prices for ash, oak, and cherry (Kingsley and DeBald 1986). Even species such as yellow-poplar or sugar maple that show no real price gains exhibit significant price differentials by log size and quality (Ohio Agr. Stat. Serv. 1987). Hardwood sawmills also report added haul costs of as much as $100/mbf resulting from the greater haul distances required to obtain adequate supplies of grade 1 and 2 sawlogs (Kronrad 1986).

To increase production of high-quality sawtimber, periodic thinning and improvement cutting is needed to maintain stocking at levels associated with maximum board-foot volume growth, and to concentrate growth on the most desirable trees. Results from thinning studies in upland oak stands show improved sawtimber yields and reduced time to grow large-diameter trees (Gingrich 1971). Although definitive results are not available regarding impacts of thinning on tree quality, Herrick and Morse (1968) project a twofold-to-threefold increase in the proportion of grade 1 butt logs resulting from intensive management of Appalachian hardwood stands.

Whereas viable opportunities exist for investing in hardwood management (Risbrudt and Pitcher 1986), nonindustrial private forest-land owners are reluctant to make these investments. These owners control 70 percent of the Nations' hardwood growing stock (USDA Forest Service 1982). Ownership surveys in Ohio and West Virginia (Birch 1982, Birch and Kingsley 1978) indicate that timber production is seldom the primary reason for owning timberland, yet owners of two-thirds of the nonindustrial private forest land plan to harvest timber. These owners also rank timber prices and the need for money well above cultural treatments as reasons for harvesting timber. Accordingly, commercial thinning may afford the best opportunity for improved hardwood management. Commercial thinning requires no investment, provides the required immediate cash flow, and provides periodic cash flows to bolster economic returns and continued interest in forest management.

Opportunities for commercial thinning are constrained by harvest revenue that must exceed harvesting costs. Product mix and available markets, factors that affect thinning revenues, are the focus of this paper. Harvesting cost for alternative logging technologies is the focus of another paper in this same proceedings volume (LeDoux and Baumgras 1989).

PRODUCT MIX

Revenue from thinning is a function of product mix and product markets. Product mix can be defined as the volume of wood available in alternative primary products. These volumes are affected by tree size, species, quality, and total volume harvested. Species and quality require site-specific assessments. However, evaluating product mix as a function of tree diameter can demonstrate very important trends in thinning revenue.

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The four types of primary products included in this analysis include only bolewood ≥ 4.0 inches diameter outside bark (dob) from trees ≥ 5.0 inches diameter at breast height (dbh). Product definitions and specifications include:

Large Sawlogs: USDA Forest Service factory grade 3 or better, scaling diameter ≥ 10 inches.

Small Sawlogs: USDA Forest Service factory grade 3 or better, 10 inches > scaling diameter ≥ 8 inches.

Sawbolts: Sawable roundwood > 6.0 inches dob, suitable for manufacturing wooden pallets or other low-quality sawn products. Because of size and/or quality, will not make a factory grade 3 sawlog.

Pulpwood-fuelwood: Bolewood ≥ 4.0 inches dob that will not make sawlogs or sawbolts due to crook, sweep, defect, or diameter constraints.

Total merchantable volume and volume by product type shown in figure 1 represent results from the analysis of 1,770 trees cut from 113 sample thinning plots in overstocked poletimber and small-sawtimber stands of Appalachian hardwood. These even-aged 50- to 70-year-old stands included upland oaks, cove hardwoods, and northern hardwoods growing on medium to good hardwood sites. These stands were thinned from below, removing dominant or codominant trees only if they were of poor quality, or to attain the desired spacing (Baumgras 1984).

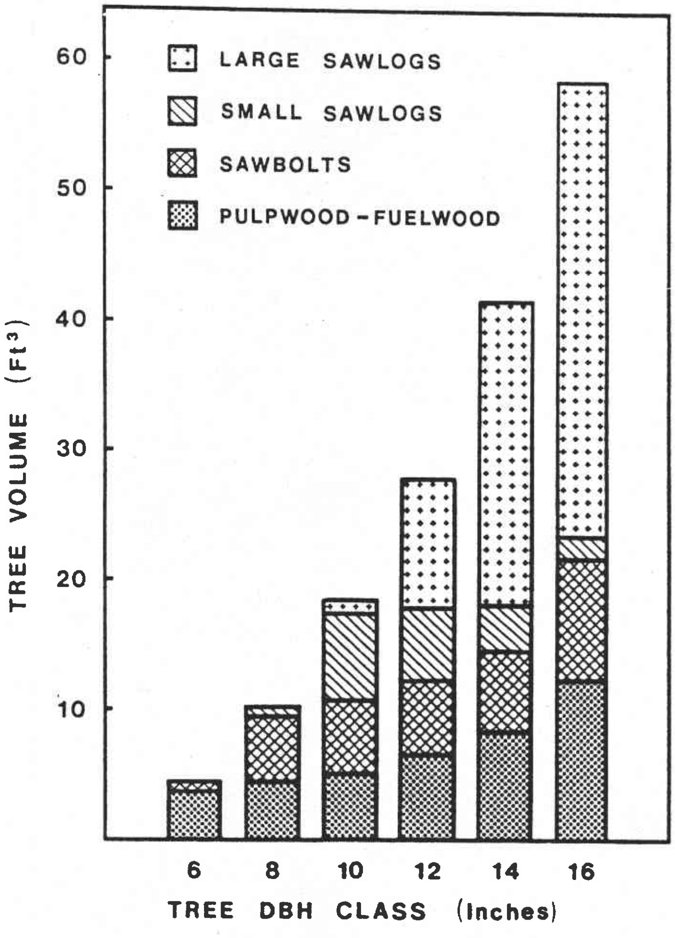

Figure 1.--Average total merchantable volume and product volume per tree by tree dbh class.

The most significant product mix trend is the increase in large-sawlog volume with increasing tree dbh class; from zero at 8 inches to 35 cubic feet at 16 inches dbh (fig. 1). For trees in the smaller dbh classes most likely to be removed in thinning, large sawlogs are not the major component. Small sawlogs and sawbolts represent 40 to 70 percent of the merchantable volume in the 8- to 12-inch dbh classes. This roundwood is often marketed as pulpwood or fuelwood. If markets are available for small sawlogs and sawbolts, these products afford an opportunity to upgrade the product mix and increase thinning revenue throughout the diameter classes shown in figure 1.

PRODUCT MARKETS AND MULTIPRODUCT HARVESTING

The array of products available and the need to increase thinning revenue identifies a very important role for multiproduct harvesting. Blinn and others (1983) reported a 25 percent gain in delivered product prices from multiproduct harvesting versus pulpwood-only harvests in Lake States hardwoods. Upgrading roundwood values through multiproduct harvesting could prove essential to intensive hardwood management and the required commercial thinnings.

To demonstrate the impact of multiproduct harvesting on thinning revenue, the APTHIN computer program (Baumgras and Yandle 1986) was used to obtain revenue estimates for three product marketing alternatives. The APTHIN program utilizes product volume and weight equations (Baumgras 1984, 1988) to estimate product yields and revenue for thinnings in Appalachian hardwoods. Inputs include the basal area removed by tree dbh classes and product prices. To show thinning revenue as a function of the mean diameter of merchantable trees removed, the required basal area removals were obtained by sorting the data from 113 sample thinning-plots according to the average dbh of trees ≥ 5.0 inches dbh removed from each plot. These same plots were used to develop the results shown in figure 1 and to develop the yield equations incorporated in APTHIN. For this application, the sample plot data are used only to define the relationship between average diameter of merchantable trees and basal area removed by tree dbh class.

The product prices included in this analysis represent a range of prices surveyed from published hardwood forest products price bulletins (Engalichev 1985, Ohio Agr. Stat. Serv. 1987, Univ. Wisc. 1986).

Input prices by product classification and relative price level are:

		High	Medium	Low
Large sawlogs	$/Mbf[a]	175	150	120
Small sawlogs	$/Mbf	120	105	90
Sawbolts	$/Mbf	115	100	85
Pulpwood	$/100 ft^3	55	44	33

[a] International 1/4-inch log scale.

The average unit revenue curves in figure 2 contrast three product marketing alternatives; (1) pulpwood only, (2) pulpwood - large sawlogs, and (3) pulpwood - sawbolts - small sawlogs - large sawlogs. To demonstrate maximum revenue gains from multiproduct harvesting, high relative prices are assumed for sawlogs and sawbolts, with low relative prices for pulpwood. The slope of the two multiproduct curves reflects the product price differentials and the product mix that changes with the average dbh of trees harvested. The vertical distance between curves represents revenue gains from product sorting. Gains from large sawlogs exceed those from small sawlogs and sawbolts when cut trees average 8.5 inches dbh or larger. Large sawlog volume and revenue gains, the distance between the sawlog-pulpwood curve and the pulpwood curve, continue to increase with dbh. Revenue gains from sorting large sawlogs range from $0.01/ft^3 at 7 inches, to $0.27/ft^3 at 12 inches. Gains from sawbolts and small sawlogs remain relatively constant at $0.03/ft^3 to $0.06/ft^3 (fig. 2).

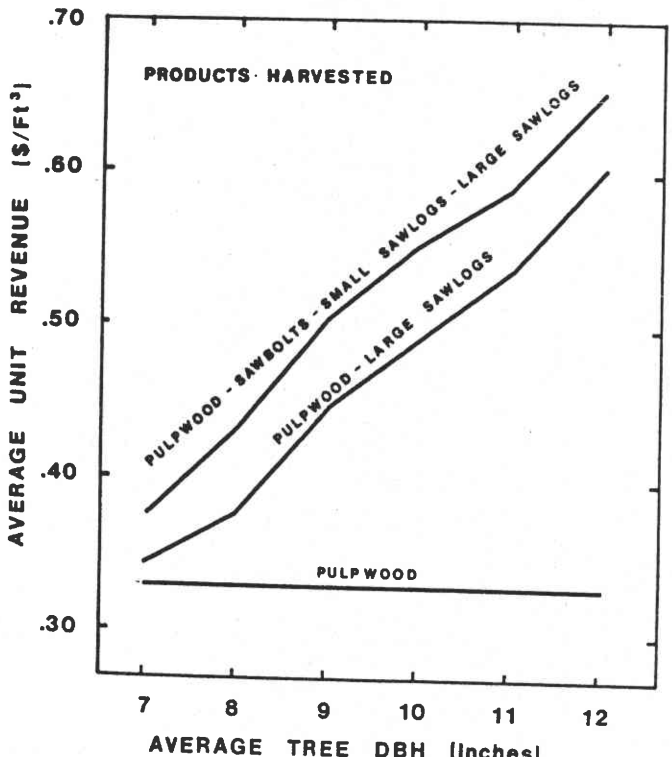

Figure 2.--Average unit revenue by average dbh of trees harvested and products harvested.

At the lower end of the diameter range associated with early thinning, small sawlogs and sawbolts provide a potentially important source of revenue to promote commercial thinning. However, either higher prices for pulpwood, or lower prices for small sawlogs and sawbolts, would diminish gains from sorting those two products. The resulting revenue curve would approach that of the pulpwood-large sawlog mix. Consequently, strong markets for material of the size and quality of sawbolt and small sawlogs would significantly improve prospects for early commercial thinnings. These markets also can provide needed outlets for small roundwood in the absence of pulpwood or fuelwood markets.

ECONOMIC FEASIBILITY

Evaluating the economic feasibility of commercial thinnings requires estimates of both costs and revenues. The variability of unit costs and revenues and the resulting shifts in feasibility are demonstrated in figure 3. The three stump-to-mill cost curves were developed from the ECOST computer program, and assume chainsaw felling and skidding with a JD-540B rubber-tired skidder (LeDoux 1988). ECOST estimates the stump-to-mill cost of cable or ground-based logging eastern hardwoods. Detailed estimates are available for felling, bucking, yarding or skidding, loading, and hauling. The computer program summarizes results from selected time and motion studies that have been generalized using computer simulation methods.

The slope of the cost curves show changes occurring with increasing tree diameter and harvested volume/acre. The vertical distance between cost curves represents differences in one-way haul distance: 20 miles, 40 miles, and 60 miles. Haul cost assumptions include a tractor-trailer combination averaging 25 miles per hour. Including haul distance and cost enables market location as well as price to enter the feasibility analysis. For the sake of simplicity, it is assumed that all primary products are hauled the same distance.

The three revenue curves assume multiproduct harvesting when product price differentials increase average unit revenue. For simplicity, it is also assumed that all four products are priced at the same relative level: high, medium, or low. Although numerous combinations could exist for product prices and market locations, the upper and lower cost and revenue curves essentially bound these possibilities.

With three levels each for cost and revenue, there are nine possible intersections. Each intersection represents the lower limits of feasibility with respect to the average dbh that can be commercially thinned under the stated assumptions. Under the best case scenario, a short haul with high prices, thinning is feasible at approximately 8.2 inches average dbh (fig. 3).

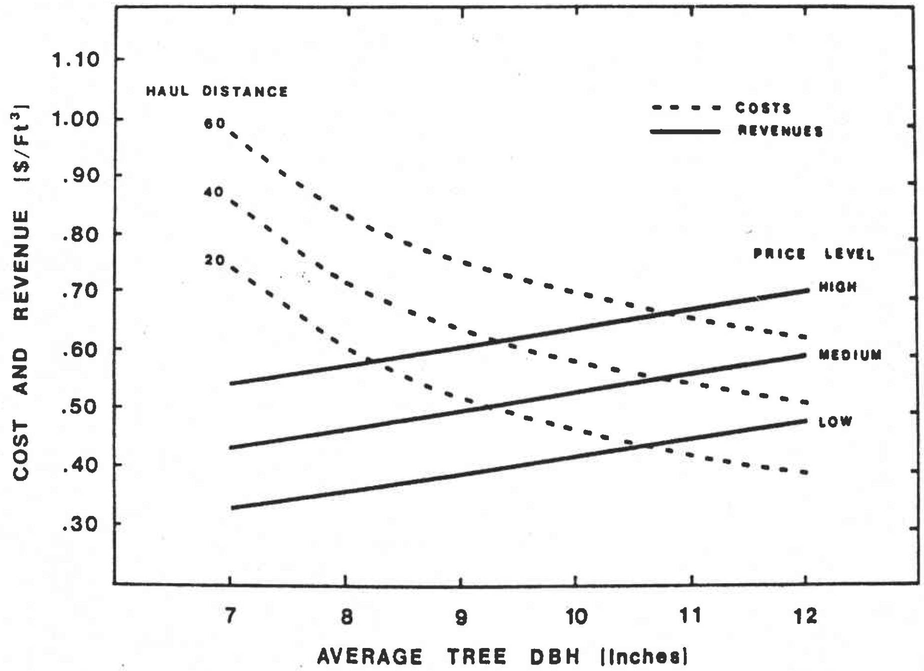

Figure 3.--Simulated cost and revenue per unit by the average dbh of trees harvested, haul distances, and relative price levels.

The minimum average dbh increases to approximately 9.2 inches when prices are reduced to medium levels or haul distance is increased by 20 miles. On the basis of diameter growth results reported for upland oaks by Gingrich (1971), this shift would postpone thinning about 10 years. At 60 miles, both medium- and low-price levels prove infeasible up to 12 inches average dbh.

The impact of price levels and haul distance demonstrates the trade-offs between these two important variables. In this analysis, a shift between relative price levels is roughly equivalent to a shift of 20 miles in haul distance. With smaller trucks or poorer roads, the impact of distance could be much greater. These results indicate that market location and resultant haul distances are as important to commercial thinning as product price levels. Alternative harvesting technology may also reduce stump-to-truck costs and thereby improve prospects for early thinning.

DISCUSSION

The constraints imposed by forest land ownership and landowner objectives seem to directly link prospects for improved hardwood management to the economic feasibility of commercial thinning. Accordingly, these results should help forest managers and planners recognize the product mix available from hardwood thinning, and to understand the important roles of multiproduct harvesting, product prices, and market locations. These variables affect revenue required to initiate thinning and the timing of commercial thinnings. Also affected are resultant growth and quality response. These variables should therefore be included in the development of forest management plans.

Many forest managers are acutely aware that poor markets often limit opportunities for commercial thinning. Although current markets may not favor commercial thinning, ongoing shifts in hardwood utilization and projected hardwood demand levels are encouraging. Important utilization trends include the increased production of composite wood products such as waferboard, oriented strand board, and medium density fiberboard; products that provide markets for thinning material (Kallio 1986). New processes for manufacturing sawn products from small logs should likewise improve hardwood markets (Reynolds and Kallio 1986). The growing demand for wooden pallets also can be satisfied with the large volume of small sawlogs and sawbolts available from thinning (Anderson 1987).

Long-term projections also show large increases in the Nation's total demand for hardwood roundwood increasing from 3.0 billion cubic feet in 1976, to 9.6 billion cubic feet in 2030 (USDA For. Serv. 1982). These projections include a threefold increase in pulpwood and fuelwood demand, with much of the pulpwood going to panel and board products. A 1.2-billion-cubic-foot increase is projected for hardwood sawlogs. Appropriately 55 percent of sawlog volume will go into shipping products such as wooden pallets.

To identify opportunities for commercial thinning, forest managers and forest industries must periodically update their feasibility analyses to reflect the ongoing developments in harvesting technology and product markets, as well as tree growth and the resulting changes in timber stand attributes. This process could be automated by using a computer to link forest inventory data bases and growth models with harvesting cost and revenue models such as ECOST (LeDoux 1985, 1988) and APTHIN. The required cost and revenue analyses could then be applied to each candidate stand in the forest inventory file. Resulting output could list economically feasible thinning sites, acres of feasible thinning sites, or product volume available from commercial thinning. Such results would identify marketing and utilization opportunities and help update forest management plans.

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