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Rate of Value Change in Pennsylvania Timber Stands

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Abstract

Data from remeasured Pennsylvania forest inventory plots revealed that during a 13-year period the compound rate of value change in uncut hardwood forest stands averaged 4.7 percent, and ranged from −5.5 to 18.8 percent. No well-defined means for predicting a stand's rate of value change could be identified. However, some measures of initial stand condition can be used to get a general indication of what to expect in stands with management potential. For example, stands with the highest rates of value change (averaging 7.5 percent) have (1) Tree of average basal area less than 5 inches in diameter; (2) less than 10 percent of their basal area in large sawtimber-size trees; and (3) some yellow-poplar, northern red oak, and/or black oak.

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Investigations into the rate at which timber increases in value generally have recognized the benefits of concentrating timber investment capital in well-stocked stands of pole- and small sawtimber-size northern hardwoods. Additional guidelines that indicate what rates of value change to expect of various stands of timber would aid people who have to make decisions about managing forest land.

An *expectation index* such as average rate of value change for forest stands could be useful in comparing timber stands and rating prospective stand management options. This paper reports results from analyses of statewide forest inventory measurements that quantify value change in hardwood timber stands, and provide further understanding of the link between timber stand characteristics and prospective value change.

Background

Given available markets for the species, tree value is influenced by diameter, merchantable height, and quality. The rate of change in tree value generally is based on estimates of prospective change in these attributes applied in the compound interest expression:

$$r = \left[\frac{V_n - V_o}{V_o} + 1\right]^{\frac{1}{n}} - 1$$

where r is the compound interest rate of value change, n is the period of time considered (often 10 years), V_n is the value of the tree n years hence, and V_o is its current value.

Generalized results from a series of studies (Leak et al. 1968; Mendel 1969; Mendel and Trimble 1969; Trimble and Mendel 1969; Grisez and Mendel 1972; Mendel et al. 1973) that have used the expression cited to evaluate projections of hardwood tree value can be summarized as follows:

- Rate of value increase is inversely related to initial tree diameter (assuming initial diameter meets minimum merchantability specifications).
- High-vigor trees (greatest diameter growth rate) have higher rates of value increase than trees of low vigor.
- Improvement in tree quality results in much higher rates of value increase than increases due to growth alone.
- Trees that increase in merchantable height usually show greater rates of value increase than trees that add no merchantable height.

The unique characteristics of a timber stand can be captured in rate of value change calculations by aggregating the value of individual trees and their potential development. Evaluations of silvicultural treatment possibilities for the stand often are handled similarly, making projections of the growth and value of trees in the future stand and focusing treatment results within a relatively short planning period.

The Study

More than *estimates* of growth and value are needed to develop expectation indexes that can serve as benchmarks of average rate of value change for timber stands. The rate of value change over a time period is determined by initial stand value and the relationship between the values at the beginning and end of the time period. Accordingly, the foundation for an index or average rate of value change is a record of actual timber stand change registered over an interval between measurements.

The USDA Forest Service updates statewide timber resource information approximately every 10 years. Part of the updating process includes remeasuring a network of permanent forest inventory plots in each state. Pennsylvania was remeasured during 1978 (Considine and Powell 1980) and 331 plots from that inventory are the basis for this analysis of rate of value change in hardwood forests between the 1965 and 1978 surveys.

Tree merchantable height, diameter (d.b.h.), and tree grade (based on butt-log grade measures) were converted to board-foot and cubic-foot volumes (Scott 1979, 1981). The volumes were then translated into dollar values to express the rate of value change on each forest inventory plot between 1965 and 1978. The dollar values are based on tree-value conversion standards (Mendel et al. 1976; DeBald and Mendel 1976). These standards reflect a tree's net worth as 4/4-inch lumber and/or pulpwood, allowing for the cost of conversion. The same (current) dollar-value standards were applied to both 1965 and 1978 survey measurements to evaluate the stand's development and not allow valuation items that are irrelevant to biological change to get in the way. This use of constant value standards avoids effects of inflation and changes in timber prices that occurred during the period.

Timber stand characteristics thought to correlate with the rate of value change were used as predictor variables to analyze rate of change. These variables are measures of:

Site class
Physiographic class
Timber stand age
Average tree diameter
Tree species composition (%)
Forest type
Trees/acre
Basal area (BA)/acre
Diameter of tree of average BA
Timber stocking (%)

Timber volume:
- Board feet/acre
- Cubic feet/acre

Timber quality:
- % Growing-stock trees
- % Sawtimber in each tree grade

Timber stand-size composition:
- % Sapling-size trees
- % Pole-size trees
- % Small sawtimber trees
- % Large sawtimber trees (15 inches +)
- % 4-inch diameter-class trees
- % Softwood species

Timber value:
- Average tree value
- Initial stand value
- % High-value species ($80+/Mbf)
- % Medium-value species ($50-$80/Mbf)
- % Low-value species ($50/Mbf)

The timber stand variables were screened as potential predictors of rate of value change using stagewise multivariate procedures including automatic interaction detection (AID).

Results

Between 1965 and 1978, inventory plots in the hardwood forests of Pennsylvania had a 3.7 percent average rate of value change. Tree cutting took place in one-fourth of these hardwood stands. When I include only the forest stands that had no timber cutting activity between surveys, the average rate of value change was 4.7 percent. These rates of change ranged from −5.5 to 18.8 percent (Fig. 1).

Despite the wide variety of potential predictors, analyses failed to identify associations between rates of value change and timber stand characteristics that would be useful in a predictive sense. Only loosely defined patterns of relationship showed up between characteristics representing initial timber stand conditions and the resulting rates of value change.

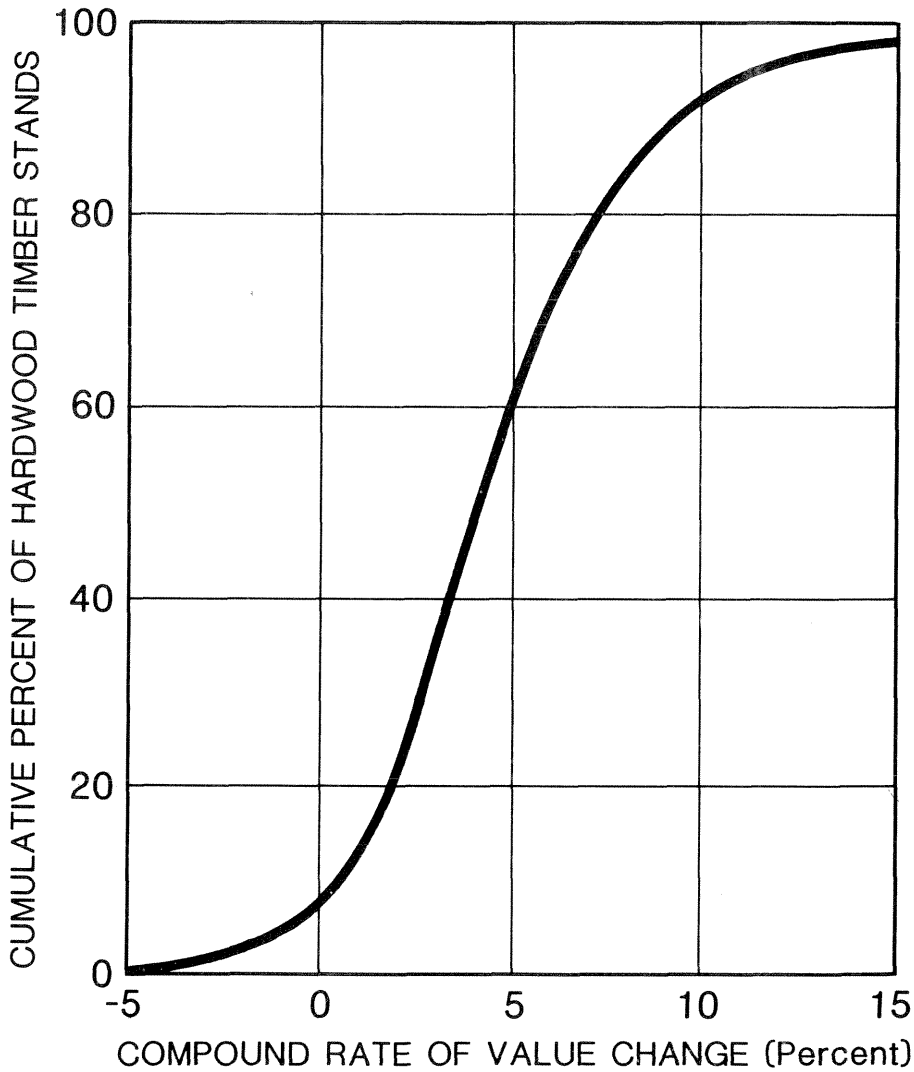

Figure 1.—Compound rate of change in timber value for hardwood forests in Pennsylvania, 1965-78.

Analyses were then concentrated on a subset of the data that included only plots from timber stands with adequate potential to achieve acceptable utilization of the site. That is, the initial stand condition was above the C-line that most stocking guides use to represent a position where 10 years of growth will achieve the lowest limit of acceptable stocking (Gingrich 1967). Stands below the C-line definitely are understocked and ordinarily would not be candidates for decisions requiring a rate of value change index.

This subset of timber stands with "management potential" had rates of value change that ranged from −3.0 to 11.9 percent, and a 4.3 percent average. Again, no useful predictive relationship was evident between initial timber stand characteristics and subsequent rates of value change. Results from AID analysis only loosely defined the structural pattern using initial stand condition measures of tree size, density, species composition, and quality (Fig. 2). For example, stands with the highest rates of value change in these hardwood forests have:

- Tree of average basal area less than 5 inches in diameter,
- Less than 10 percent of their basal area in large sawtimber size trees.
- Some yellow-poplar, northern red oak, and/or black oak.

These conditions identify them as members of Group 9, where rates of value change average 7.5 percent. In addition to this highest rate group, five others (Groups 8, 13, 17, 18, and 19) fell at or above the 4.3-percent statewide average rate of value change for these above C-level stands.

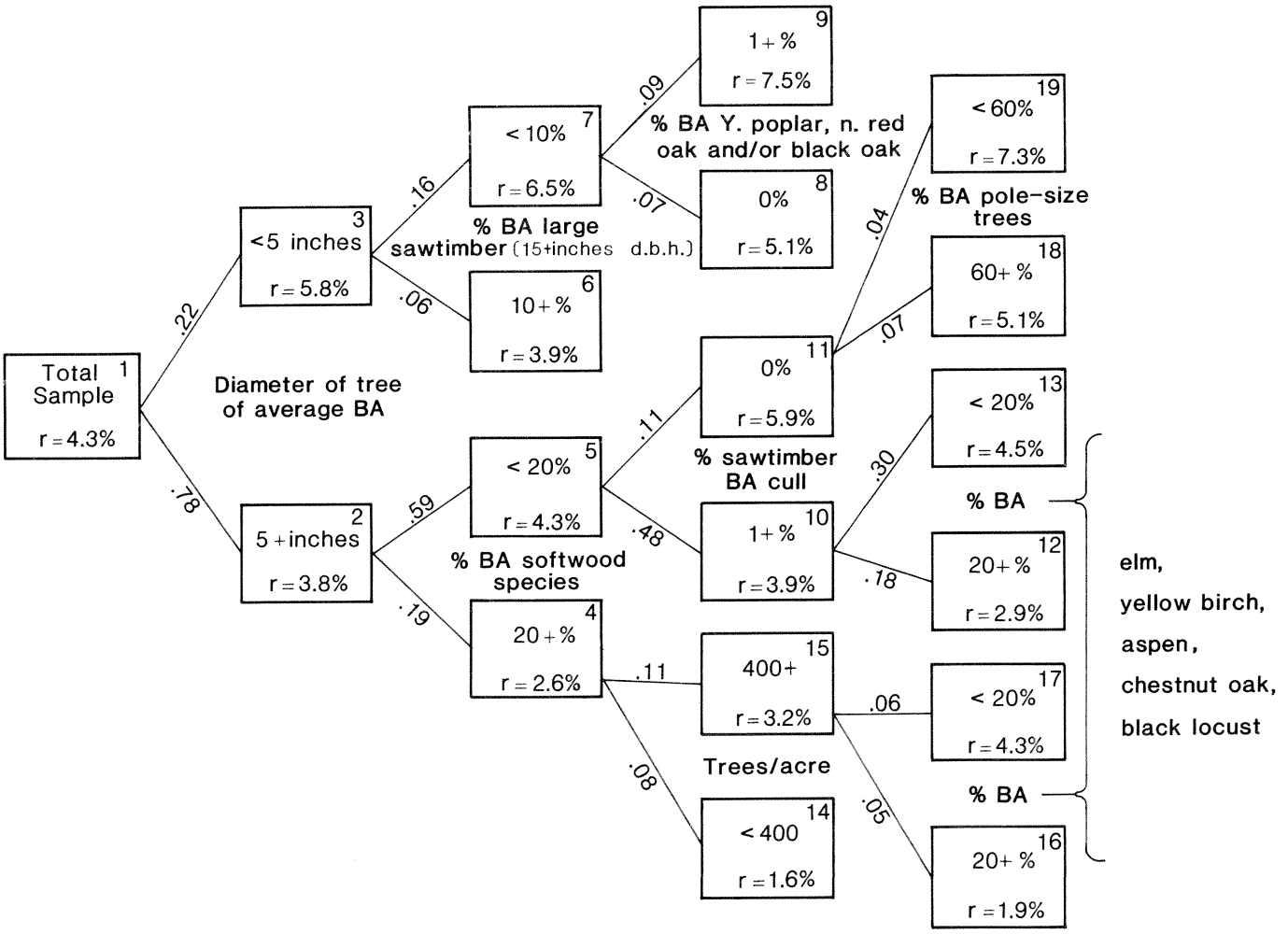

Figure 2.—Guide for estimating rates of value change in hardwood forests. A timber stand is assigned to a value-change group on the basis of characteristics of the stand. The average rate of value change 1965 to 1978 is shown for each group. Decimal fractions on each leg show the portion of the Pennsylvania sample in that group.

Conclusion

It has been said before (Mendel et al. 1973) but it's worth repeating: *dollar value* increase reflects the change in value of trees resulting from increases in diameter, merchantable height, or improvement in quality. A *rate of value* increase, on the other hand, accounts for the initial investment in capital (the value of the trees at the beginning of the period) that must be made to attain the dollar-value increase (added value by the end of the period). The rate of return on the investment (rate of value change) over the period is determined by the initial value and the relationship between the values at the beginning and end of the time period. Consider the following example:

Initial value (V_o)	*Ending value* (V_n)	*Change in value*	*No. of years*	*Rate of value change*
Dollars				*Percent*
10.00	15.00	5.00	10	4.14
50.00	55.00	5.00	10	0.96

In both cases there was a $5.00 change in value. But in the first case, its smaller investment in capital ($10 versus $50) clearly has a greater impact on the resulting rate of value change over the 10 years.

It is the timberland owner who determines the financial objectives of his or her ownership. On the basis of the definitions mentioned, will it be dollar-value increase regardless of the amount of capital investment? Or will it be a prescribed rate of return on the capital investment?

From a financial standpoint, the responsibility for choosing a proper course of action for handling a particular stand of timber rests with the owner, too. Once financial objectives are sorted out—dollar-value increase or rate of return on investment—it remains to determine the value-growth status of the timber stand. I looked at recently remeasured forest inventory plots in Pennsylvania to determine rates of value change in hardwood forests. The plots indicate that uncut hardwood timber stands in Pennsylvania are increasing in value at a rate of 4.7 percent, on average. But wide variation was evident in the rates of change during the 13-year period between inventories—from −5.5 to 18.8 percent. These results are appropriate where gross change estimates are desired. However, the results are limited as a management tool for foresters and landowners. The comprehensive analyses of these data yielded no well-defined predictive relationships between site characteristics or initial timber stand conditions and subsequent rates of value change.

A predictor or expectation index of rate of value change would be most useful. But only general notions seem possible when judging potential rate of value change in hardwood timber stands. Measures of tree size, stand density, species composition and quality can help. They represent key characteristics of initial timber stand conditions that can be used to pigeonhole stands with management potential into very loosely defined rate of value-change groups. These groups, with average rates of value change ranging from 1.6 to 7.5 percent, can serve as useful baselines for comparing timber stands and prospective stand management options.

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