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Rate of Value Change in New England Timber Stands

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Abstract

Analyses of remeasured plot data show that between the last two forest inventories of New England, compound rates of value change in timber stands averaged 4.2 percent and ranged from −26 to +43 percent. Three key characteristics of stand condition (species composition, tree size, and stocking) can be used to estimate economic growth. For example, stands with (1) more than 10 square feet of basal area per acre in softwood species; (2) tree of average basal area less than 7 inches in diameter; and (3) more than 50 percent of total basal area in white pine have a 14.7-percent average rate of value change.

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Introduction

How much growth in value can we expect from various stands of timber? The answer holds important implications for people wanting to make rational judgments about the economic potential of forest land. For example, a forest-land owner with a stand of timber growing at an annual rate of 1 or 2 percent, while assured market rates at local banks are averaging between 8 and 9 percent, might want to consider some options, e.g., thinning, cull tree removal, or regeneration.

Growth in value is not the only item considered in timber management decisions. Protecting and enhancing nontimber resources such as water, wildlife, and esthetics are extremely critical to many. Likewise, a person's age, wealth, and financial obligations come into play. And we can't forget the importance of things like changing timber markets and tax structures. Throw in the unpredictable effects of insects, disease, and even weather and it adds up to an extremely complex matter. But the rate of change in timber value continues to be an important piece of the puzzle.

Unfortunately, growth in value can vary greatly from stand to stand. For example, a recent study shows that compound annual rates of change in value for forest stands in Maine between 1971 and 1982 ranged from –12 to +43 percent.[1]

With such wide variation in value growth, we can use all the help we can get in determining financial rates of return for woodlands. This analysis of forest inventory measurements quantifies value change for forest stands in New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont). Our findings provide a better understanding of the link between timber-stand characteristics and prospective value change.

Approach

Data

The USDA Forest Service updates statewide timber resource informaton approximately every 10 years. Part of the updating process includes remeasuring a network of permanent forest-inventory plots in each state. Plots (0.1 to 0.2 acre) that were previously measured in New England during the early 1970's were remeasured from 1982 through 1985 (Powell and Dickson 1984; Frieswyk and Malley 1985a,b; Dickson and McAfee 1988a,b,c). Data from more than 1,100 of these plots were used to analyze value growth. We included only those plots that remained relatively undisturbed, i.e., had less than 15 percent of their original basal area removed between inventories. These plots accounted for more than three-fourths of the total area sampled. The analysis incorporated more than 27,000 trees that were alive and 5.0 inches or larger in d.b.h. (diameter at breast height measured 4½ feet above the ground) at the time of the initial inventory, plus another 20,000 trees that grew to more than 5.0 inches in d.b.h. between inventories.

Analysis

Rates of change in stand value were based on measured changes in tree diameter, merchantable height, and quality. Compound annual rates of value change (r) were obtained using the expression:

$$r = (V_n/V_o)^{1/n} - 1$$

where n is the number of years between measurements, V_n is the value of a stand after n years. and V_o is its initial value.

Dollar values for hardwood sawtimber trees were based on tree-value conversion standards.[2] These standards represent consistent regional measures of a standing tree's net value (marginal value product or shadow price) in the production of 4/4-inch lumber, allowing for the cost of conversion. They account for a tree's species, diameter, merchantable height, and tree grade (based on butt-log grade measures). For example, a 16-inch-diameter red oak with a grade 2 butt log and merchantable height of 2 logs was valued at $29. For trees other than hardwood sawtimber, merchantable height, d.b.h., and cull estimates were converted to net volumes (Scott 1981) and assigned value based on recent local stumpage price reports. For example, white pine sawtimber stumpage averages about $70 per thousand board feet and spruce and fir pulpwood averages about $10 per cord.

The same dollar-value standards were applied to both initial and current measurements to evaluate stand development, thereby eliminating valuation items that are irrelevant to biological change. This ignores unpredictable effects of inflation and changes in timber prices and markets, but does account for the value of biological change in tree diameter, merchantable height, and tree grade. The few trees that were harvested between inventories were assigned the same value for both occasions.

The combined influence of tree and stand characteristics on rates of change in timber stand value was studied by Automatic Interaction Detection (AID) (Songuist et al. 1973). More than 40 variables thought to be related to value change were analyzed. These variables are measures of:

[1]Gansner, David A.; Arner, Stanford L.; Zarnoch, Stanley J. Timber value growth rates in Maine. Submitted to Northern Journal of Applied Forestry.

[2]DeBald, Paul S. Tree value conversion standards revisited. Research Paper, Northeastern Forest Experiment Station. In preparation.

- Species composition
- Tree size
- Stocking
- Site productivity
- Physiographic class
- Timber volume
- Tree quality
- Timber value

The AID technique searched these characteristics of the trees and timber stands for the best predictors of value change. Starting with the entire sample of stands in one group, the stands were partitioned through successive two-way splits into a series of subgroups. The splits occur so that at each step, the chosen predictor variable forms two new groups that cause the greatest reduction of variance in the dependent variable (value change). The result is a best set of predictors selected by the AID algorithm, and presented as a branching diagram that details the rate of value change configuration for individual stands as they responded to timber stand dynamics between the New England forest surveys.

Results

Rates of Value Change

Between the last two forest inventories, compound annual rates of value change for sample plots representing timberland in New England ranged from −26 to +43 percent and averaged 4.2 percent, reflecting the great amount of variability in value change for forest stands in the region.

About 8 percent of the forest had enough mortality and degrade to register negative rates of growth (Fig. 1). These stands show evidence of the detrimental effects of spruce budworm, gypsy moth and other destructive agents at work during the 1970's and the early 1980's. But most of the other woodland fared relatively well. One-fourth of all stands recorded rate increases of 6 percent or more; one-eighth of them earned better than 8 percent. Such rates are impressive when you consider they are for forest land that had virtually no human disturbance or improvement cutting between inventories.

Predicting Rates of Change

Automatic interaction detection analysis of the rate of value change for our sample plots generated 14 mutually exclusive final groups (No. 9, 10, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25, 26, and 27) and an average rate of value change for each group (Fig. 2). Each plot is a member of one of the groups. Only three of many elements of timber-stand condition analyzed as predictor variables were retained in this value growth-rate classification system: species composition, tree size, and stocking. Their inclusion makes good intuitive sense.

Rates of value change for the 14 groups ranged from 2.1 to 15.1 percent. Stands in the group with the highest average rate have:

- Less than 10 square feet of basal area per acre in softwood species.
- Less than 20 square feet per acre of total basal area.
- Tree of average basal area less than 6 inches in diameter.

These conditions identify them as members of group 15. Stands like this included two percent of our sample. Ranking right up there with stands in group 15 were those in group 19 (14.7 percent). They have:

- More than 10 square feet of basal area per acre of softwood species.
- Tree of average basal area less than 7 inches in diameter.
- More than 50 percent of total basal area in white pine.

At the other end of the scale are stands in group 16, where rates of value change average only 2.1 percent. Stands in this group represent one-fifth of New England's timberland. Six other final groups (10, 14, 18, 23, 25, and 27) fall above the regionwide average rate of 4.2 percent.

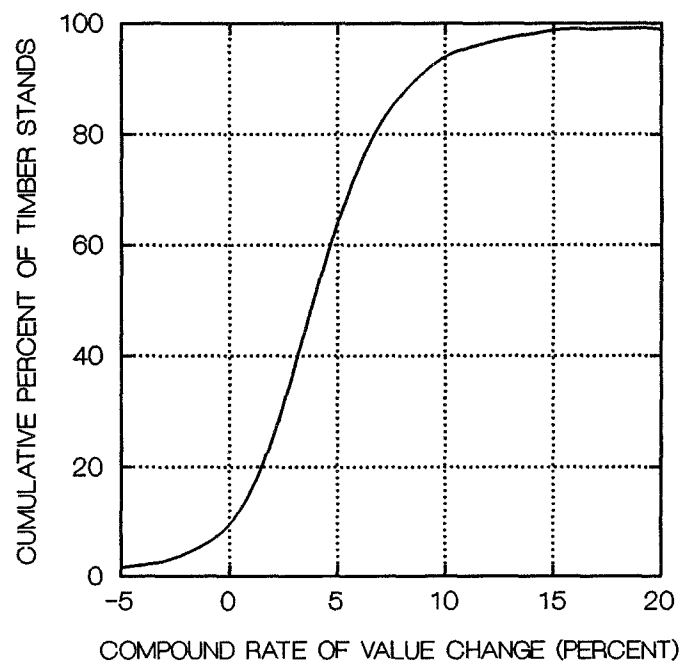

Figure 1.—Compound rate of change in timber value for New England forests.

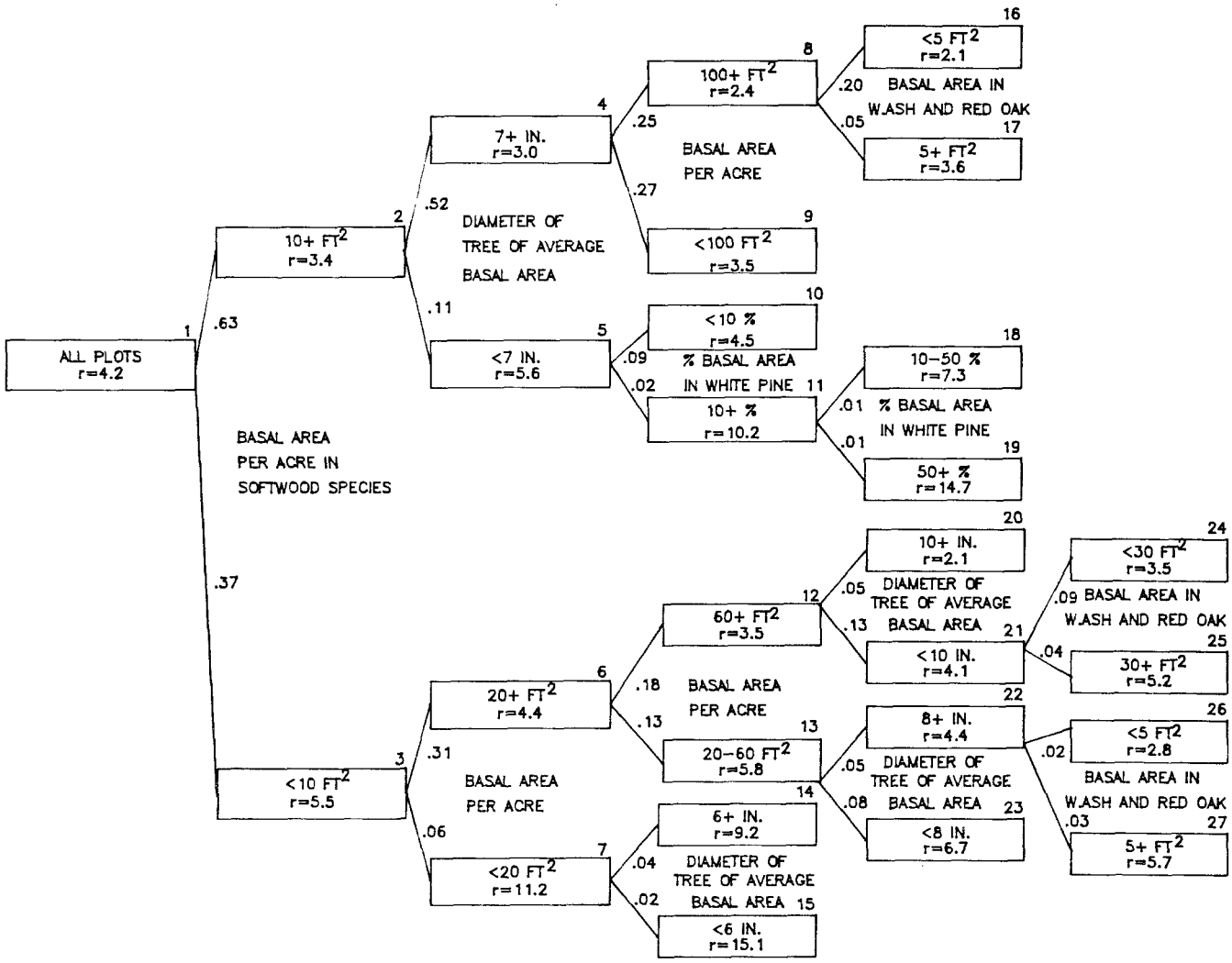

Figure 2.—Guide for estimating rates of value change for New England forests. A timber stand is assigned to a value-change group on the basis of characteristics of the stand. The average compound rate of value change (r) is shown for each group. Decimal fractions on each leg show the portion of the New England sample in that group.

The base or initial value of trees is important to the relative differences in their rate of change in value. Consider for example:

Initial value (V_o)	*End value* (V_n)	*Value change*	*No. of years*	*Rate of value change* (percent)
---------- *(Dollars)* ----------				
1.00	2.00	1.00	10	7.2
5.00	6.00	1.00	10	1.8

In both examples, value increased by $1. But the smaller initial value in the first example ($1 versus $5) yields a much greater rate of value change over the 10 years.

Summary

Timberland owners and others in the Northeast can use all the help they can get in determining the economic potential of the region's woodlands. Presented here is a simple guide for estimating rates of value change for timber stands in New England. Measures of species composition, tree size, and stocking are key characteristics of initial timber-stand condition that can be used to separate stands into 14 mutually exclusive value-change groups. Average rates of value change for the groups range from 2.1 to 15.1 percent.

These estimates provide useful baseline indexes for comparing the economic potential of timber stands and prospective stand management options. Further analyses will focus on rates of value growth in other areas of the Northeast. Our prime purpose is to gain a better understanding of the relationship between timber-stand characteristics and value change so as to develop improved methods for predicting rates of value growth for forest stands in the region.

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