DETERMINING THE RATE OF VALUE INCREASE FOR OAKS

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ABSTRACT. A method used to develop rate of value increase is described as an aid to management decision-making. Regional rates of value increase and financial maturity diameters for ten species common to the oak-hickory type are outlined, and the economic principles involved are explained to show how they apply to either individual trees or stands.

AN IMPORTANT objective in forestry is to earn an acceptable return on capital invested in growing timber. Once he has decided on the level of return he considers acceptable, a timber grower needs a way to measure his success in attaining it. Rate of value increase (RVI) provides him with a way to measure his success and, when used with proper silvicultural methods, helps him to attain it.

Rate of value increase is, simply, the rate at which trees or stands increase in value. But it is also a lot of other things. To those in the timber-growing business it is a means for attaching a dollar sign to the results of all the complex and interacting biological factors that make up tree growth; a crosswalk between silvicultural and economic principles; a basis for deciding which trees or stands to cut and when to cut them. Even if a timber owner chooses not to cut his timber, he can use rate of value increase to judge his preferred objectives in terms of the timber returns he has elected to forego.

A method used to compute the rates of value increase and to determine the financial maturity diameters for several species commonly associated with the oak-hickory type is described here. It is based largely on research work previously reported in Northeastern Forest Experiment Station Research Papers *(Trimble and Mendel 1969; Mendel and Trimble 1969).* Our effort here is concerned primarily with the application of these results to individual trees and stands of timber.

METHODOLOGY

Computation of the rate of value increase is based on the relationship between the present value and the prospective value 10 years hence, as indicated in the compound interest formula

$$(1 + r)^n = \frac{V_n}{V_o}$$

where r is the rate of interest, n is the time period, V_n is the prospective tree value or stand value, and V_o is the present tree value or stand value.

Say we had a 3-log 20-inch red oak that had a grade 2 butt log. Its present

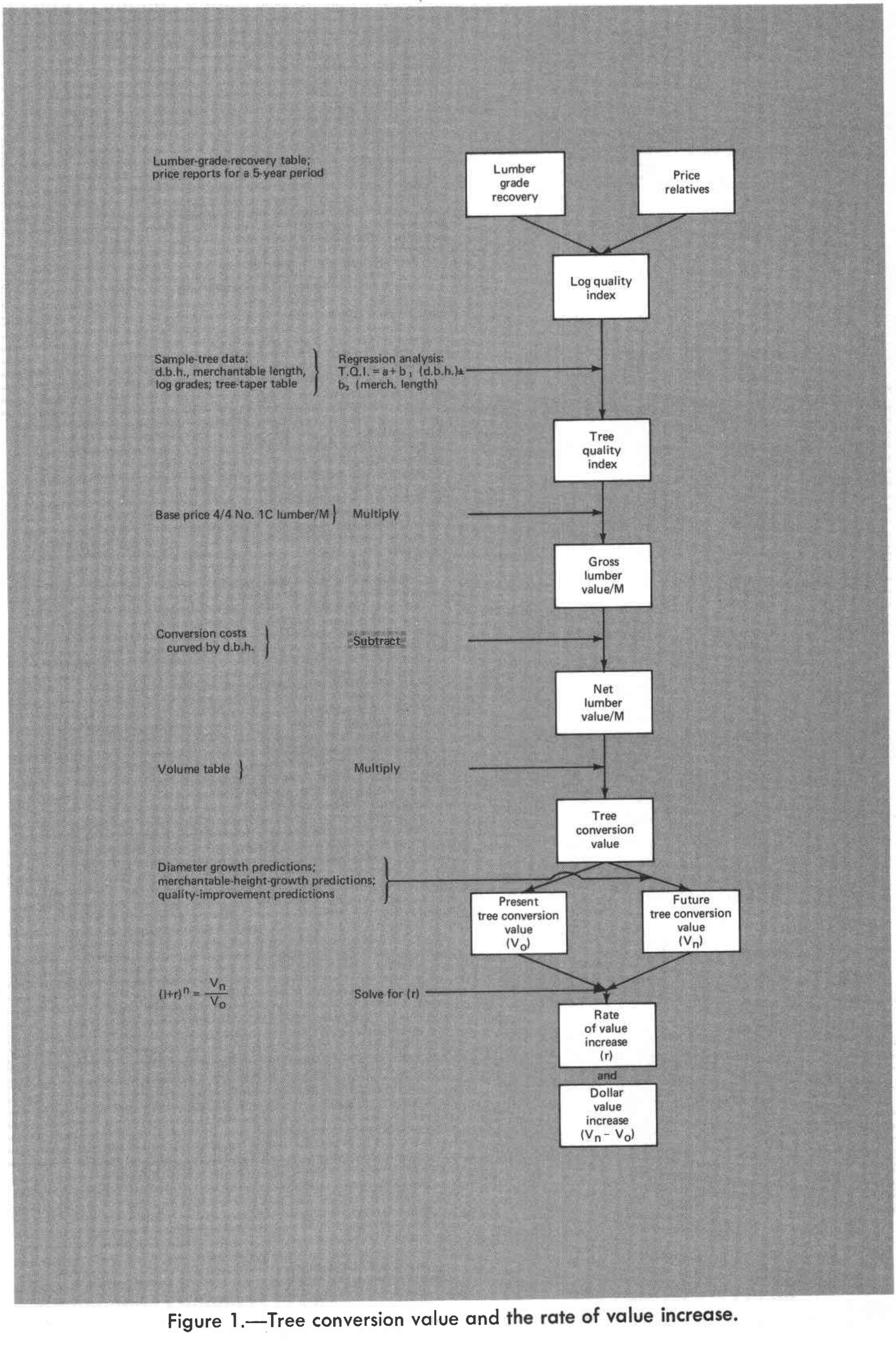

Figure 1.—Tree conversion value and the rate of value increase.

value would be $5.87. If, during the next 10 years, it grows 2 inches in diameter without increasing in sawlog height or improving in grade, its future value would be $11.37. The tree's V_n/V_o ratio would thus be $11.37/$5.87 or 1.938. Looking up 1.938 at 10 years in a compound-interest table, we find the tree's rate of value increase to be 6.8 percent.

On the surface, computing rate of value increase seems easy enough. The big part of the job is assembling tree-value data.

We employed the quality index (Q.I.) approach in developing tree values based on sawing logs into 4/4-inch lumber (fig. 1). Lumber-grade-recovery data and price relatives were used to develop log-quality index data, which were transformed into tree-quality index by regression analysis of sample-tree data, which provided information about the grade of the upper logs of the tree.

Gross lumber value was found by multiplying tree Q.I. by the existing price of 4/4 No. 1 Common lumber.

Net lumber value was determined by subtracting from the gross value all of the conversion costs involved in harvesting, transporting, and processing the tree into 4/4 lumber.

All of the values previously mentioned were on a 1,000-board-foot basis. Net lumber value when multiplied by the volume in the tree is the tree-conversion value or, more understandably, tree stumpage value.

The values obtained as above indicate a tree's net worth as 4/4 inch lumber, a consistent measure for a product common to most sawlog species. We can use the same set for both present and future values, if we are willing to assume that lumber prices and conversion costs will remain constant. And this has some merit, for its allows us to find the return that is directly attributable to a tree's development. We would be guessing at future lumber prices and conversion costs, anyhow.

All we need at this point is to estimate the changes in diameter, merchantable height, and log grade that are likely to occur during the growth period—10 years is a commonly used management period. We can also assume various combinations of changes in each, say by tree vigor class, and find the resulting future values. That is, we can determine the future value of a given tree if it does not increase in sawlog height or improve in log grade, if both height and grade increase, and if either height or grade increase during the 10-year period.

RESULTS

Basing our rate of value increase computations on all the possible future values for a single tree gives us a vast amount of detailed information (table 1). For convenience we can construct more generalized tables to show ranges in rates of value increase, reflecting differences in sawlog height and grade.

Table 2 shows the rates of value increase that we can expect, regionally, from 10 species common to the oak-hickory type. Keep in mind that rates of value increase are based on existing trees and their projected value increase over the next 10 years. Costs of growing the trees to sawtimber size are not considered. Nor are the fixed costs of taxes, protection, etc. These sunk and fixed costs will be the same regardless of the timber-cutting alternative the forest owner selects, or if he just chooses to let the trees grow.

Note the high portions of the ranges in rates. They are due largely to low-grade trees that have a low present value and thus produce a relatively high rate of value increase when considered in the ratio V_n/V_o. This is especially true in the estimates "due to growth and quality increase" for the smaller diameters, where we have grade 3 trees improving to grade 2. While those kinds of trees show high rates of return, they add little in the way of actual dollar value to a stand.

Note also that the rates decrease in the larger diameter classes. Again, this has to do with our V_n/V_o ratio. The larger trees usually have a big increase in dollar value, but their initial value is relatively large too. So the resulting V_n/V_o ratio gives a low rate of increase.

Another way to reduce our mass of detailed data is to develop financial maturity guides—tables showing the diameters at which trees cease to earn various levels of interest rates that a forest owner might deem acceptable (table 3). The diameters presented are based on value increases due to growth alone and must be adjusted upward where potential log-grade increase is involved. Dashes in the table show the vigor classes that fail to meet the indicated interest rates.

HOW RVI WORKS FOR INDIVIDUAL TREES

Before we can apply the rate of value increase or financial maturity concepts, we must know the rate of return we expect our timber to earn. That is, we must be aware of the forest owner's alternative rate of return—the interest rate that he expects for the use of his capital. This rate is peculiar to each owner's appraisal of his circumstances *(Duerr, Fedkiw, and Guttenberg 1956)*. And it is subject to change. The rate may be low, say 2 percent in cases where timber-growing is one of multiple use objectives. It may be the 4 percent foresters have seemingly adopted as classical. Or it may be 6 percent or higher, reflecting the current lower limits for alternate investments.

Alternative rate of return serves as a financial yardstick against which we can compare the rate of value increase for trees or stands. As such it gives us an economic basis for making cut-leave decisions. If a tree's rate of value increase is greater than our alternative rate of return, it is earning us more than we could get from selling the tree and investing its sale price. If the two rates are equal, we are equally well off if

Table 1.—*Determination of rate of value increase for 16-inch d.b.h. red oak, vigor 1, site index 80**

Present				Future						
D.b.h. inches) (1)	Butt-log grade (2)	Log height (feet) (3)	Tree value (dollars) (4)	D.b.h. inches) (5)	Butt-log grade (6)	Log height (feet) (7)	Tree value (dollars) (8)	Ratio V_n/V_o (9)	Rate of value increase (percent) (10)	Ten-year value increase (dollars) (11)
16	1	16	3.01	18.7	1	16	6.57	2.183	8.1	3.56
16	2	16	.90	18.7	2	16	2.83	3.144	12.1	1.93
16	2	16	.90	18.7	1	16	6.57	7.300	22.0	5.67
16	1	24	3.75	18.7	1	24	8.52	2.272	8.6	4.77
16	1	24	3.75	18.7	1	32	9.46	2.523	9.7	5.71
16	1	24	3.75	18.7	1	40	9.75	2.600	10.0	6.00
16	2	24	.96	18.7	2	24	3.55	3.698	14.0	2.59
16	2	24	.96	18.7	2	32	3.77	3.927	14.7	2.81
16	2	24	.96	18.7	2	40	3.66	3.813	14.3	2.70
16	2	24	.96	18.7	1	24	8.52	8.875	24.4	7.56
16	2	24	.96	18.7	1	32	9.46	9.854	25.7	8.50
16	2	24	.96	18.7	1	40	9.75	10.156	26.1	8.79
16	1	32	4.05	18.7	1	32	9.46	2.336	8.9	5.41
16	1	32	4.05	18.7	1	40	9.75	2.407	9.2	5.70
16	1	32	4.05	18.7	1	48	9.73	2.402	9.2	5.68
16	2	32	.77	18.7	2	32	3.77	4.896	17.2	3.00
16	2	32	.77	18.7	2	40	3.66	4.753	16.9	2.89
16	2	32	.77	18.7	2	48	3.34	4.338	15.8	2.57
16	2	32	.77	18.7	1	32	9.46	12.286	28.5	8.69
16	2	32	.77	18.7	1	40	9.75	12.662	28.9	8.98
16	2	32	.77	18.7	1	48	9.73	12.636	28.9	8.96
16	1	40	3.77	18.7	1	40	9.75	2.586	10.0	5.98
16	1	40	3.77	18.7	1	48	9.73	2.581	9.9	5.96
16	2	40	.35	18.7	2	40	3.66	10.457	26.4	3.31
16	2	40	.35	18.7	2	48	3.34	9.543	25.3	2.99
16	2	40	.35	18.7	1	40	9.75	27.857	39.5	9.40
16	2	40	.35	18.7	1	48	9.73	27.800	39.4	9.38

*No computations are shown for trees with negative present or future stumpage values as in the case of trees with a butt-log grade of 3 or local-use and and construction grade.

Table 2.—*Expected rate of value increase for tree species common to the oak-hickory type**

(In percent)

D.b.h. (inches)	Due to growth only			Due to growth & quality increase		
	Vigor I	Vigor II	Vigor III	Vigor I	Vigor II	Vigor III
			RED OAK			
16	7-25	5-22	3-16	20-39	20-36	16-33
18	5-12	4- 9	2- 6	15-21	13-20	12-18
20	4- 8	3- 6	1- 4	12-16	11-15	9-13
22	3- 7	2- 4	1- 3	10-13	10-12	8-10
24	3- 7	1- 4	1- 2	9-12	8-10	7- 8
26	1- 5	1- 4	0- 2	8-10	7- 9	7- 8
28	1- 3	1- 3	0- 2	7- 9	7- 8	7- 8
30	1- 2	0- 2	0- 1	7- 8	7- 8	6- 7
			WHITE OAK			
16	4-24	3-21	2-18	15-38	13-36	12-35
18	3-21	2-19	2-14	13-31	12-29	11-28
20	2-11	2- 9	1- 7	8-15	7-14	6-13
22	2- 5	1- 5	1- 3	4-13	3-12	2-11
24	1- 3	1- 3	0- 2	2-12	2-11	2-11
26	1- 2	0- 2	0- 1	2-12	1-11	1-11
28	0- 2	0- 1	0- 1	2-12	1-11	1-11
30	0- 1	0- 1	0- 1	1-12	1-11	1-11
			BLACK OAK			
16	7-51	5-45	3-33	23-58	21-53	18-46
18	6-19	4-15	2-10	18-21	14-18	12-15
20	5-16	4-14	2- 9	12-20	9-16	7-15
22	4-13	3-11	2- 7	7-18	6-16	4-13
24	3-11	2-10	2- 3	5-16	3-15	2-12
26	3- 5	2- 4	1- 3	3-10	2- 9	2- 8
28	2- 5	2- 3	1- 2	—	—	—
30	2- 4	2- 3	1- 2	—	—	—
			CHESTNUT OAK			
16	3-10	2- 9	1- 6	19-24	18-23	17-21
18	2-14	2-12	1-10	14-23	13-24	12-22
20	2- 8	1- 7	1- 5	9-14	8-13	7-12
22	1- 5	1- 4	0- 3	6-10	5-10	5- 9
24	1- 2	0- 2	0- 1	5- 8	5- 8	4- 7
26	0- 2	0- 1	0- 1	4- 7	4- 7	3- 7
28	0- 1	0- 1	0- 1	3- 6	3- 6	3- 6
30	0- 1	0- 1	0- 1	3- 6	3- 6	2- 6
			HICKORY			
18	6-30	4-23	1-12	30-47	27-43	24-39
20	4-19	3-13	1- 6	19-31	16-28	14-24
22	4-13	2-10	1- 3	14-23	12-20	10-17
24	3- 7	1- 5	1- 2	11-15	10-14	8-11
26	2- 7	1- 5	0- 2	—	—	—
28	2- 4	1- 3	0- 1	—	—	—
30	2- 3	1- 2	0- 1	—	—	—
			YELLOW-POPLAR			
16	5-11	4- 8	2- 6	7-17	5-15	4-14
18	4- 8	3- 6	2- 5	6-13	5-11	3-10
20	3- 7	2- 5	1- 4	5-11	4-10	3- 8
22	3- 7	2- 5	1- 3	5-10	4- 9	3- 8
24	2- 4	1- 3	1- 3	4- 9	3- 8	3- 7
26	2- 3	1- 2	0- 2	4- 8	3- 7	3- 6
28	1- 2	1- 2	0- 1	—	—	—
30	1- 2	0- 2	0- 1	—	—	—
			ELM			
16	6-29	4-23	2-14	16-37	13-33	10-27
18	5-18	3-15	2- 9	11-24	9-21	8-17
20	4-15	3-12	1- 7	9-19	7-17	5-13
22	3-12	2-11	1- 6	7-16	5-15	3-11
24	3-10	2- 9	1- 5	5-14	4-13	3- 9
26	2- 4	1- 3	0- 2	4- 8	3- 7	2- 6
28	2- 4	1- 3	0- 2	—	—	—
30	2- 3	1- 2	0- 1	—	—	—

Table 2.—*Continued*

D.b.h. (inches)	Due to growth only			Due to growth & quality increase		
	Vigor I	Vigor II	Vigor III	Vigor I	Vigor II	Vigor III
			SUGAR MAPLE			
16	4-12	3- 9	2- 7	9-20	8-18	7-15
18	3- 8	2- 7	2- 5	6-15	7-13	5-12
20	3- 6	2- 5	1- 4	6-13	5-12	4-11
22	2- 5	1- 4	1- 3	5-11	4-10	4-10
24	1- 4	1- 3	1- 3	5- 9	4- 8	3- 8
26	1- 3	1- 2	0- 2	4- 7	3- 7	3- 6
28	1- 2	0- 2	0- 1	—	—	—
30	0- 2	0- 1	0- 1	—	—	—
			RED MAPLE			
16	4-12	3- 9	2- 7	6-16	5-13	4-12
18	4-11	3- 8	2- 6	5-14	4-11	3-10
20	3-11	3- 7	1- 5	4-13	4-10	2- 8
22	3- 8	2- 6	1- 4	3-10	3- 8	2- 6
24	2- 7	2- 4	0- 3	3- 8	2- 6	1- 4
26	2- 5	1- 4	0- 2	2- 6	2- 5	0- 3
28	2- 3	1- 3	0- 1	—	—	—
30	1- 2	1- 2	0- 1	—	—	—
			WHITE ASH			
16	4-39	3-36	2-33	7-58	6-54	4-52
18	4-23	3-15	2-14	7-32	4-27	3-26
20	3-18	2-12	1-10	5-26	4-22	3-21
22	3-13	2- 8	1- 7	4-18	3-15	2-14
24	2-10	2- 6	1- 5	3-14	3-13	2-13
26	2- 8	1- 5	1- 4	3-13	2-12	2-12
28	2- 3	1- 2	1- 2	—	—	—
30	2- 3	1- 2	1- 2	—	—	—

*Based on 4/4 factory-grade lumber recovery. These rates can have a variation of 2 to 4 percent due to differences in location, volume estimates, and quality estimates.

we sell the tree or keep it. But, if the tree's rate of value increase is less than our alternative rate, we would be better off, financially, to sell the tree and invest its value at our higher alternative rate.

Let's say that our alternative rate of return is 4 percent. Recall the 20-inch red oak we used in an earlier example (tree A). As it grows during the 10 year period, the tree will increase in value $5.50, or at a compound rate of 6.8 percent. If we sell the tree and invest its present value ($5.87) at our 4-percent alternative rate, we would expect to earn only $2.64. Thus we would be $2.86 ahead by letting the tree grow.

Suppose we had another red oak (tree B) similar to the first one, but about 2 inches larger:

	Tree A	*Tree B*
D.b.h. (inches)	20	22
Vigor class	I	I
Log grade	2	2
No. logs	3	3
Present value (V_o)	$ 5.87	$11.08
Future value (V_n)	$11.37	$17.26
Value increase	$ 5.50	$ 6.18
Rate of value increase	6.8%	4.5%

Note that tree B is increasing in value at a lower rate than tree A. But as long as we keep our 4-percent alternative rate, we would be wise to let tree B grow, too, since it is returning more than 4 percent.

But suppose our alternative rate of return is 6 percent. In this case tree A is still a good bet to leave. Not so with tree B. Let's look at the cutting options we have, cutting either tree, both trees, or neither one:

	Options			
	(1) Cut Tree A	*(2) Cut Tree B*	*(3) Cut both*	*(4) Cut neither*
Value of tree cut, invested at 6 percent compound, earns in 10 years:	$ 4.64	$ 8.75	$13.39	—
Value increase of tree left:				
Tree A	—	5.50	—	5.50
Tree B	6.18	—	—	6.18
Total value added in 10 years	$10.82	$14.25	$13.39	$11.68
Rate of value increase	5.1%	6.3%	6.0%	5.4%

Table 3.—*Financial-maturity diameters based on value increase determined by growth alone*

Vigor class	Alternative rate of return		
	2 percent	4 percent	6 percent
	RED OAK		
I	25	21	18
II	23	19	16
III	19	16	—
	WHITE OAK		
I	23	17	15
II	21	15	14
III	19	14	—
	BLACK OAK		
I	30+	23	19
II	30	21	16
III	25	16	15
	CHESTNUT OAK		
I	21	16	15
II	19	15	—
III	16	15	—
	HICKORY		
I	30+	22	18
II	23	19	—
III	17	—	—
	YELLOW-POPLAR		
I	27	20	15
II	23	17	13
III	19	13	12
	ELM		
I	30+	22	17
II	25	17	15
III	19	15	—
	SUGAR MAPLE		
I	24	17	15
II	22	16	—
III	19	13	—
	RED MAPLE		
I	29	19	14
II	26	16	13
III	19	14	12
	WHITE ASH		
I	30+	19	15
II	25	16	13
III	20	13	—

The first option is our poorest one. We lose by cutting tree A and investing its value at 6 percent. Allowed to grow it would earn 6.8 percent. We lose by not cutting tree B. It is returning only 4.5 percent in the woods, and its value could be earning our alternative 6 percent elsewhere.

The second option gives the highest possible return. We take advantage of tree A's earning power by letting it grow. We also take advantage of our alternative rate of return by investing tree B's value at the higher 6-percent rate instead of letting it grow at the lower 4.5-percent rate.

The third option satisfies our 6-percent requirement. We can obviously get the rate of return we want by cutting both trees and investing their value at that rate. In doing so we sacrifice some of tree A's earning power while effectively using tree B's cash value at our higher alternative rate.

The fourth option shows the net return from letting both trees grow. We get an acceptable return from tree A, but not from tree B. As a result, their combined value increase is not enough to give us the 6-percent return we want.

SOME ECONOMIC PRINCIPLES

The above examples point out some principles that are important in applying the rate of value increase concept.

1. The financial maturity idea.—When a tree first reaches sawtimber size, it usually has a negative or low stumpage value, but it increases in value rapidly. Then its rate of value increase gradually diminishes until it falls below the forest owner's alternative rate of return. The diameter at which this occurs is the point of financial maturity.

The two trees in our example illustrate the financial maturity idea. At 20 inches tree A has a rate of value increase that exceeds the net return possible from selling the tree and using its cash value elsewhere. At 22 inches tree B—similar to tree A, but larger—no longer pays its own way. Expecting a 6-percent return in our invested capital, we would consider tree B financially mature.

2. *The let-it-grow option.*—The forest owner may set an objective of meeting his alternative rate of return. To judge his success as a timber grower, he needs to know whether or not his trees are earning him his required rate. He can find out by looking at the rates of return he can expect if he lets them grow. Option 4, his let-it-grow option, illustrates this.

3. *The principle of maximum net return.*—The forest owner, like any other businessman, would enjoy earning the highest net return from his invested capital. To achieve the maximum net return from his timber growth, he should maintain in his stands the greatest possible value in trees that are growing at or above his alternative rate, and liquidate those trees that are growing below (or never will meet) that rate.

HOW RVI WORKS FOR STANDS OF TREES

We can place a value on a stand by summing the values of the trees that make up the stand, both now and in the future. Again, the big job is determining tree values. But we already have them from our tree rate computations—an added benefit from our work. Thus, we can apply tree values to our present stand tables, grow the trees for 10 years, and apply values to the resulting future stand tables. The rate of value increase for the stand would then be based on the ratio V_n/V_o.

Unfortunately, we will have to limit ourselves to sawtimber stands or to the sawtimber portions of stands, since we have not developed RVI data for other products. When data are developed for other products or product mixes, we can enlarge the scope of our stand valuations to include most (if not all) of the trees in a stand. And the economic principles behind the rate of value increase concept would still apply—the same principles that we discussed for individual trees.

Take, for example, a typical acre of oak-hickory sawtimber in southeastern Ohio. Its basal area is made up as follows:

Sawtimber trees	63 square feet
Poletimber trees	24 square feet
Cull trees	9 square feet
Total	96 square feet

After applying values to the sawtimber trees in the stand, we can break them down further into:

Trees with positive value	25.1 square feet
Trees with negative value:	
11 to 16 inches d.b.h.	32.8 square feet
16 inches + d.b.h.	5.1 square feet
Total	63.0 square feet

The trees with positive values are as follows:

D.b.h. (inches)	*Vigor*	*Basal area (sq. ft.)*	*Log grade*	*Present value ($)*	*Future value ($)*	*10-year value increase ($)*	*Rate of value increase (%)*
16	1	1.2	1	3.75	7.90	4.15	7.7
	1	1.3	1	3.75	8.72	4.97	8.8
	1	1.3	1	4.05	8.72	4.67	8.0
	1	1.3	1	4.05	8.95	4.90	8.2
	1	1.3	1	4.05	8.85	4.80	8.1
	2	1.4	2	.35	2.33	1.98	21.0
	2	1.4	1	3.75	6.60	2.85	5.8
	2	1.4	2	.35	2.33	1.98	21.0
	3	1.5	1	3.75	5.43	1.68	3.8
	3	1.5	1	4.05	5.89	1.84	3.8
18	2	1.6	1	7.92	12.36	4.44	4.6
	2	1.7	1	7.92	12.58	4.66	4.7
	2	1.8	2	2.61	5.18	2.57	7.1
22	1	2.5	1	21.32	30.40	9.08	3.6
26	2	3.9	2	20.10	23.60	3.50	1.6
Total		25.1		91.77	149.84	58.07	5.0

Note the detailed value data in the four right-hand columns. We can derive such data only if we know each tree's butt-log grade. Unfortunately, quality information is often neglected in management inventory work.

Note, too, the variation in individual tree rates from 1.6 to 21.0 percent and their overall 5.0 percent rate of value increase. The acceptability of these rates depends on the owner's alternative return requirements and on whether he expects the sawtimber portion of the stand or each sawtimber tree to meet that requirement. This portion of the stand obviously meets a 2- or 4-percent requirement, but not a 6-percent requirement. If the owner wanted his stand to earn him 2 or 4 percent he might well be content to let the trees grow.

But if he wanted a 2 or 4 percent return from each tree, we would have to cut those growing below those rates and invest their value at the higher alternative rate. The same would apply for a 6-percent return expectation, as far as individual trees are concerned. If the owner wanted 6 percent from his stand, the sawtimber portion would be, in a sense, financially mature. But unlike individual trees, we would not have to cut the entire stand. We can meet his requirement by cutting only the poor earners and investing their cash value at 6 percent while leaving the good earners grow at better than 6 percent.

Actually, when we expect each tree in a stand to earn at least our acceptable rate of return—either through growth or through liquidation and reinvestment—we are insisting on obtaining a maximum net return on our capital investment. If we pursued this principle in our example, we would get the following results:

Requirement (Pct.)	*Remove BA/A (Sq. ft.)*	V_o	V_n	*Value increase*	*RVI (Pct.)*
2	3.9	91.77	150.74	$58.97	5.1
4	9.4	91.77	157.36	$65.59	5.5
6	14.1	91.77	176.15	$84.38	6.7

The basal area removed in each case is the total basal area in trees that do not meet our alternative rate of return. The reinvested cash value of these financially mature trees, plus the value increase of the trees left to grow, equals the stand's future value (V_n).

In each case we would raise the net return above what we could expect by letting all the trees grow—our let-it-grow option. For each of the requirement levels the value increase represents the maximum net return possible.

Let's say now that, in addition to our investment requirements, we had a silvicultural requirement to reduce the overall stand basal area to 70 square feet. How would this affect our cut-leave decisions? First, we would probably kill our 9 feet of basal area in cull trees. These will never add value to our stand. Then we would take out the 5 feet of negatively valued trees over 16 inches d.b.h. These are grade 3 or tie-and-timber quality trees that are unlikely to add any value to the stand. This would leave us 81 square feet of basal area. If we now remove the financially mature sawtimber trees, the basal areas would be, in square feet:

	Alternative return		
	2%	*4%*	*6%*
Remaining	81	81	81
Remove	3.9	9.4	14.1
Residual	76.1	71.6	66.9

Our residual basal area at the 2- and 4-percent interest levels would still exceed our 70-square-foot requirement. We can still remove about 6 more feet with our 2-percent requirement and about 2 square feet with our 4-percent requirement. These trees might be sawtimber trees under 16 inches d.b.h. that show no promise of improving in log grade, or they might be poletimber trees of low vigor. But with our 6-percent requirement we would dip under our 70-square-foot basal area requirement. We would thus have to decide on which of the two objectives we wanted to meet.

In either case we could determine the cost involved. Chances are we would be likely to assume that 67 square feet is close enough to 70. But what if we needed to earn an 8-percent return on our capital investment? Again, we would have a choice to make, weighing long range silvicultural principles against shorter range economic ones.

The final decision, of course, would rest on the forest owner's policies. However, with our rate of value increase information, we would be able to advise him as to the business aspects involved—the cost of following a silvicultural recommendation or the return that could result from rejecting it. In either case the owner would be in a better position to decide on which course to follow.

CONCLUSIONS

We have introduced a logical method for evaluating trees, projecting that valuation over a 10-year period, and determining the rate of value increase. This method is useful not only for evaluating an individual tree, but also for evaluating future diameter growth, increase in merchantable height, and improvement in tree quality. Further, it is complementary to forest-management techniques whether it be selection or even-aged management, in that it places a dollar valuation on the product as it develops to maturity. Its applicability to stand valuation has been demonstrated, and the need for information about quality of the product is duly noted.

But, most noteworthy of all, it is a calculable measure of the financial maturity of the end product, and we no longer need to accept the tacit reckoning of when to cut. The rate of value increase is the measure that, combined with basal-area requirements of silviculturists, will also provide a more adequate base from which to determine what to cut.

Literature Cited

Duerr, William A., John Fedkiw, and Sam Guttenberg.
1956. FINANCIAL MATURITY: A GUIDE TO PROFITABLE TIMBER GROWING. USDA Tech. Bull. 1146. 74 pp., illus.

Mendel, Joseph J., and George R. Trimble, Jr.
1969. THE RATE OF VALUE INCREASE FOR YELLOW-POPLAR AND BEECH. USDA Forest Serv. Res. Paper NE-140. 27 pp. NE. Forest Exp. Sta.

Trimble, George R., Jr., and Joseph J. Mendel.
1969. THE RATE OF VALUE INCREASE FOR NORTHERN RED OAK, WHITE OAK, AND CHESTNUT OAK. USDA Forest Serv. Res. Paper NE-129. 29 pp. NE. Forest Exp. Sta.

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