The "LET-IT-GROW" Treatment for timber

--Is it economically worthwhile?

by David P. Worley

U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-157
1970

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
RICHARD D. LANE, DIRECTOR

THE AUTHOR

DAVID P. WORLEY is a project leader in forest-economics research for the Northeastern Forest Experiment Station's unit at Columbus, Ohio. He received his bachelor of science degree in forestry from Syracuse University and his master of forestry degree from Duke University in 1947. Since joining the USDA Forest Service in 1957, Mr. Worley has conducted forest-products-marketing research at the Berea, Kentucky, unit and was responsible for designing and implementing the multiple-use evaluation being conducted on the Beaver Creek Pilot Watersheds near Flagstaff, Arizona. His present assignment is concerned with the economics of managing hardwood timber tracts in the Northeast.

The "LET-IT-GROW" Treatment for timber --Is it economically worthwhile?

CONTENTS

Let It Grow?

ONE WAY TO TREAT a timber stand is to ignore it—simply let it grow. This treatment will in time produce usable timber. And this is how many small woodlands in the Northeast are treated today. The question is: How well does this treatment work in returning a profit to the owner?

As a guide for forest managers, the Northeastern Forest Experiment Station has made an economic study of this let-it-grow treatment. We found that the profitability of this treatment depends mainly upon the age of the stand and the timber markets available.

Our analyses suggest that the forest manager should consider other ways to treat his timber. This report was prepared to provide a yardstick against which the manager can measure other management options to help him decide, for different situations, what treatment will be most profitable.

An economic evaluation is usually made for a specific time period. Long-run evaluations usually start with bare ground at the beginning of a rotation. However, private woodlands usually have a forest stand of some sort already on the ground, so evaluations beginning at different stages of forest development might be

more meaningful than those beginning with little or no timber. And because the tenure of most woodland owners is less than 20 years, it is clear that for most owners a rotation is too long a period on which to base an evaluation. Five, 10, or 15 years may be a more useful time horizon.

Our economic evaluation of the let-it-grow option is based on a 10-year period. It is built around several different analyses, and is presented as an array of the economic consequences of the let-timber-grow decision.

The economic measures used as a basis for evaluation include volume and value increments per acre and rates of return to the standing timber investment. Reasonable management goals are developed for each of these measures, and the evaluation is conducted by contrasting stand performance to management goals. Information from different economic points of view is thus provided to help forest land managers sharpen their judgment.

Even-aged fully stocked upland oak stands 20, 40, 60, 80, 100, and 120 years old growing on site indexes of 40, 60, and 80 are the forest situations evaluated. Timber values that depend on a single market, on changing markets, and on multiple markets are considered.

The Physical Basis

Stand tables for upland oak sites 40, 60, and 80 (from *Schnur 1937*) were used as a beginning. These tables, based on empirical data, take into account species compositions, and extend to 100 years. Most of these stands followed charcoal-wood operations in which stands were clearcut to 2 or 3 inches d.b.h. This is essentially the management procedure recommended by foresters today for hardwood stands to be used mainly for timber production.

Stand tables for site indexes 40 and 80 were extended to 120 years, while the stand table for site index 60 was extended to 130 years. The proportion of the trees living from ages 90 to 100 years was held constant in the extension. This amounted to between

90 to 95 percent of the trees at the beginning of each 10-year period. Living trees were moved to successive diameter classes during the 10-year period by the movement-factor method (*Meyer 1953*). This factor varied from 0.50 to 0.75, and the numbers of trees were rounded off to the nearest tree to conform to the original tables. Stand tables to 100 years appear in Schnur's well-known work (*Schnur 1937*), and the extensions are shown in table 1.

Table 1. — Stand-table extensions for selected sites and ages

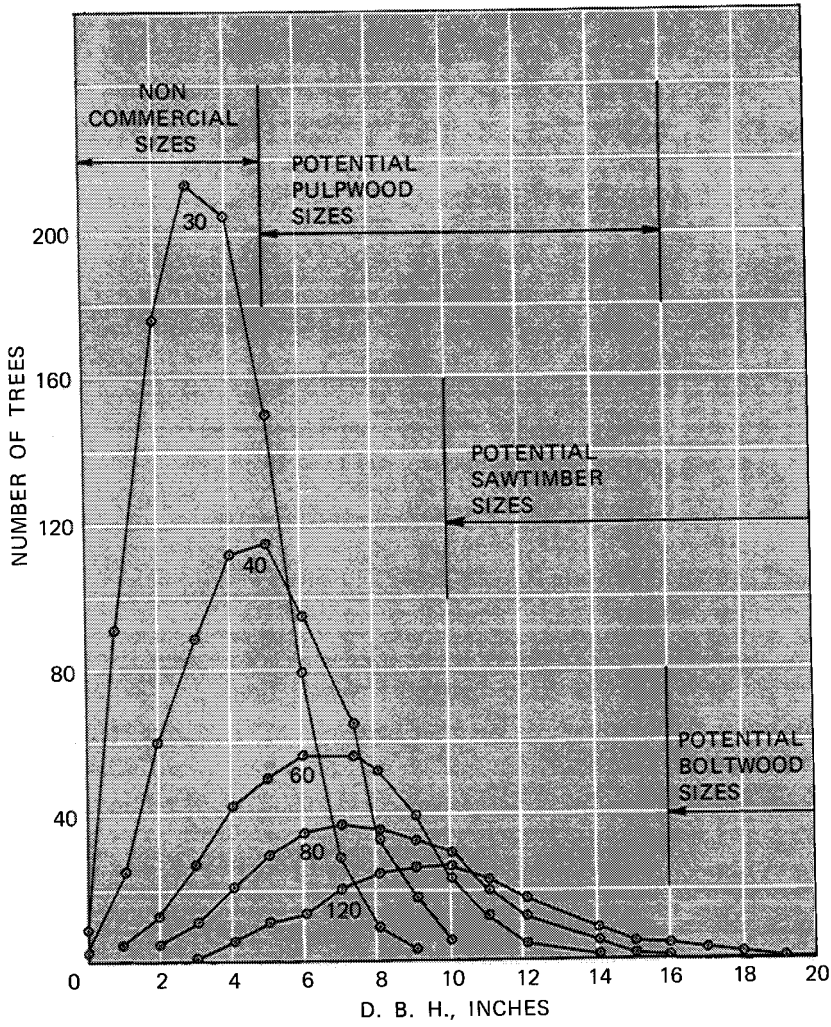
[Number of trees per acre]

D.b.h. (inches)	Stand age						
	110			120			130
	SI 40	SI 60	SI 80	SI 40	SI 60	SI 80	SI 60
0	—	—	—	—	—	—	—
1	3	—	—	1	—	—	—
2	9	—	—	7	—	—	—
3	22	4	—	15	2	—	—
4	34	9	3	25	6	1	6
5	49	13	3	39	12	3	9
6	54	20	7	47	14	5	11
7	56	24	9	50	20	6	15
8	52	28	9	49	24	8	22
9	39	27	12	41	26	9	23
10	27	25	11	30	23	11	21
11	17	22	11	20	22	10	18
12	10	16	11	12	17	9	16
13	3	16	11	6	14	11	14
14	2	9	12	3	10	11	10
15	1	6	9	1	6	10	8
16	—	5	7	1	5	7	5
17	—	3	6	—	5	5	5
18	—	1	6	—	1	6	3
19	—	—	3	—	1	5	1
20	—	—	2	—	—	3	1
21	—	—	2	—	—	2	—
22	—	—	1	—	—	1	—
23	—	—	1	—	—	1	—
24	—	—	—	—	—	1	—

The development of tree-size distributions is illustrated in figure 1 for site index 60 stands. Though species compositions are not shown in either table 1 or figure 1, they were used in the subsequent analyses.

Tree size limits the variety of wood products that can be made from a tree or stand. This is emphasized in figure 1. Pulpwood is

Figure 1. — Tree-size distributions for selected hardwood stand ages growing on site index 60 land.



the main product that younger stands—say age 40—can be expected to produce. Older timber stands can be used for other products in addition to pulpwood, and for combinations of products.

We are concerned only with the trees in the original stand and not with trees that might seed in later during the life of the stand. This limitation is not severe because, with fully stocked forest stands as dense as those studied, there will be little opportunity for seedlings to become established. Recent forest-survey reports for states in the oak region indicate that 40 to 50 percent of the commercial forest area has over 70 percent of full stocking. The quantitative results of this study may be directly applicable to many of these stands.

Stand volumes were estimated by multiplying the numbers of trees in each diameter class by the volumes for that class from an appropriate volume table. Board-foot volumes are based on the International 1/4-inch rule to an 8-inch top. Standard volume tables were localized by using Schnur's height-diameter curves as a basis for selecting proper tree volumes. The stand volumes resulting from this procedure are shown in table 2.

Table 2. — Decadal yield table for selected sites

[Stand volumes in board feet, International ¼-inch rule]

Age (years)	Stand volumes		
	SI 40	SI 60	SI 80
20	—	—	—
30	—	—	490
40	—	258	3,645
50	—	2,130	8,270
60	245	4,208	11,915
70	652	6,433	14,290
80	1,287	8,447	16,075
90	2,564	10,767	17,490
100	3,720	12,020	18,915
110	5,265	13,518	20,415
120	6,952	14,541	21,860
130	—	15,454	—

The validity of the evaluation depends on how reasonable these synthesized volumes are; so they were compared with independent data in the files of the Northeastern Forest Experiment Station.[1] The results of this comparison are shown in figure 2, in which the synthesized volumes for site index 60 are compared with the empirical data for site indexes 55 and 65. The minimum merchantable diameter of 8 inches in the synthesized work should give higher volumes than the empirical curves, which are based on a minimum merchantable diameter of 10 inches. The quantitative differences in figure 2 exhibit this relation, and the curve inflections are similar; so the synthesized data were judged satisfactory. The synthesized volumes were used for all lumber and bolt products.

[1] The author thanks Samuel F. Gingrich, mensurationist, Northeastern Forest Experiment Station, for guiding these reasonability checks.

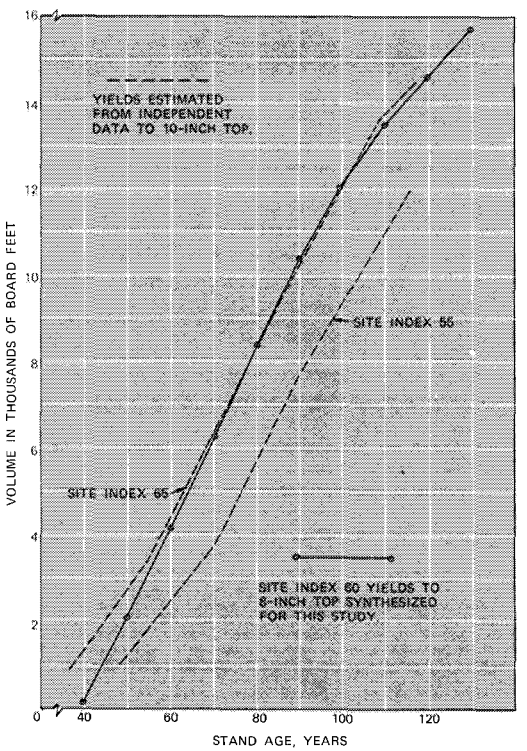


Figure 2. — Total product curve, in board feet, International ¼-inch rule, for site index 60 compared to independent checks.

Pulpwood volumes were calculated in the same manner, but were restricted to trees 5 to 16 inches d.b.h. When more than one wood product was considered, the multi-product principles and ratios adapted from Worley (*1958, 1963*) were used to prorate volumes to different products.

The Value Basis

Current stumpage values from Ohio, Kentucky, and Indiana price and market reports were used as a value basis. Unit values for pulpwood, sawtimber, and boltwood were developed to assess the importance of product alternatives to the economics of managing these stands. Since Schnur did not recognize tree quality in his work, certain quality assumptions were made, based on the work of Trimble (*1965*), who showed that tree quality increases with tree size. Since definitive information is lacking about the proportion of timber suitable for boltwood products, it was assumed that 50 percent of the volumes of trees that had logs with scaling diameters of 18 inches or larger were suitable for veneer, and that 50 percent of the volume of white oaks having a 16-inch d.b.h. could be included as stave-billet material in this market. Pulpwood is considered an alternative only for trees 16 inches d.b.h. and smaller.

Inspection of the price reports in light of these assumptions suggested a price schedule as follows:

Product used as a basis of value	*Minimum tree diameter specifications (inches d.b.h.)*	*Unit*	*Price (dollars)*
Pulpwood	All trees 5-16 inches	Cord	2.00
Sawtimber	Trees 10-12 inches	M ft. b.m.	10.00
	Trees 13-17 inches	M ft. b.m.	20.00
	Trees 18+ inches	M ft. b.m.	30.00
Stave bolts	White oak trees 16+ inches	M ft. b.m.	100.00
Other bolts	All trees 18+ inches	M ft. b.m.	100.00

In addition to a price schedule, a limit is needed on minimum merchantable quantities that operators ordinarily accept. For our purposes a minimum of 5 cords of pulpwood, or 2,500 board feet

of sawtimber, or 500 board feet of boltwood products per acre must be present for operability. We would use these limits then to say that a stand that has developed to the point where it contained 10 cords of pulpwood or 2,000 board feet of sawtimber would be valued only for pulpwood but not for sawtimber at that time. In 10 years, when it would contain say 18 cords of pulpwood and 3,500 board feet of sawtimber, it would be operable for either or both. When these values and market rules are applied to the physical data cited earlier, an array of values is produced at any particular age, as shown for site index 60 in figure 3.

Above age 60, stands have at least three values, depending upon the market context used. The dashed connecting lines (fig. 3) illustrate the lumpy nature of the total-value curve in the presence of all markets. Expanding market potential through either the introduction of new markets or the eligibility of the timber for higher valued products through increasing size, can have a dramatic effect on the desirability of a forest investment.

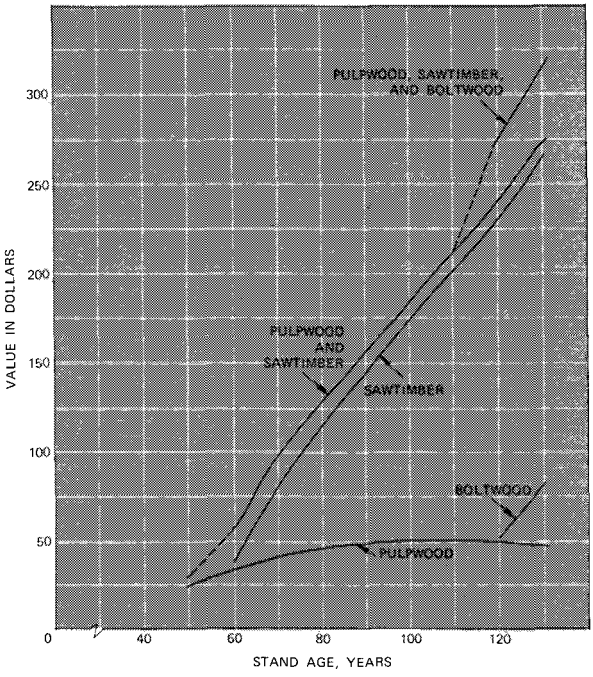


Figure 3. — Total-value curves, showing effects of individual products and potential product mixes on value for SI 60 stands.

Analysis of Volume and Volume Increments for Selected 10-Year Period

Physical product data were converted to volumes of commercial products (table 3), using the rules cited earlier. Table 3 shows that forest stands growing on good sites produce merchantable volumes very quickly, and that the spectrum of product alternatives is greatest for older stands on good sites.

Sawtimber is divided (table 3) into three classes based on size and potential quality. Class 1 represents small and generally low-quality timber; class 2 medium-size medium-quality timber; and class 3 large and generally high-quality timber. Although volume increments (sum of board feet for classes 1, 2, and 3) for ages 80 and 100 are very nearly the same for all three sites, the major differences are in the products produced. At these ages the greatest contribution to board-foot volume growth on poorer sites is made by ingrowth trees represented in class 1 while on the better sites most board-foot volume growth is put on larger and potentially more valuable trees specified as class 3.

For our purposes though, an analysis should show (1) whether the timber is marketable for particular products and (2) whether it is meeting reasonable production goals. The first indicates whether or not the forest manager has the option to cut available to him and the second sets up reasonable production goals against which he can exercise his option to cut it or let it grow. The merchantability quantities cited earlier (5 cords of pulpwood, 2,500 board feet of sawtimber, or 500 board feet of boltwood) suffice for the first part of the analysis. Acceptable production goals for a decade may be 5 cords per acre of pulpwood, 1,000 board feet of sawtimber, and 250 board feet of boltwood. Table 4 summarizes our estimated stand performance against these standards.

Table 4 shows that the option to cut is open for one product or another for all stands 60 years and older. Whether or not

Table 3. — Estimated volumes per acre of commercial products at selected ages and volume increments for 10 years

Age (years)	Timber product[1]		Beginning volumes			10-year increments		
			SI 40	SI 60	SI 80	SI 40	SI 60	SI 80
20	Cords		—	—	5.1	.8	4.7	7.9
	Logs, board feet	1	—	—	—	—	—	490
	" "	2	—	—	—	—	—	—
	" "	3	—	—	—	—	—	—
	Bolts, board feet		—	—	—	—	—	—
40	Cords		2.5	9.2	20.6	1.5	4.6	7.9
	Logs, board feet	1	—	258	3,315	—	1,760	2,530
	" "	2	—	—	330	—	112	2,095
	" "	3	—	—	—	—	—	—
	Bolts, board feet		—	—	—	—	—	—
60	Cords		5.6	17.3	31.1	1.2	3.5	—0.4
	Logs, board feet	1	245	3,717	6,085	407	1,113	—905
	" "	2	—	491	5,830	—	1,112	2,560
	" "	3	—	—	—	—	—	720
	Bolts, board feet		—	—	—	—	—	360
80	Cords		8.0	23.8	30.3	1.7	2.0	—1.6
	Logs, board feet	1	1,189	5,779	4,545	1,158	1,079	—555
	" "	2	98	2,668	9,920	119	1,241	500
	" "	3	—	—	1,610	—	—	1,470
	Bolts, board feet		—	—	950	—	—	880

100.....	Cords		11.0	27.0	27.5	1.6	—1.0	—2.0
	Logs, board feet	1	3,220	6,522	3,515	1,250	—100	—380
	" "	2	500	5,498	10,410	295	1,347	—100
	" "	3	—	—	4,990	—	251	1,980
	Bolts, board feet		—	—	2,820	—	238	1,190
120.....	Cords		14.0	25.2	23.8	—	—0.8	—
	Logs, board feet	1	5,414	6,498	2,820	—	—584	—
	" "	2	1,538	7,441	10,380	—	549	—
	" "	3	—	602	8,660	—	948	—
	Bolts, board feet		—	541	5,040	—	474	—

[1] Board-foot log products include cordwood from trees over 10 inches d.b.h. and boltwood products. Board-foot log products (1) from small trees, (2) from medium trees, and (3) from large trees then are additive.

Table 4. — The occurrence of merchantability and production alternatives for selected ages and sites of hardwood stands

Age (years)	Site index 40						Site index 60						Site index 80					
	Pulpwood		Sawtimber		Boltwood		Pulpwood		Sawtimber		Boltwood		Pulpwood		Sawtimber		Boltwood	
	M	*P*[1]	*M*	*P*	*M*	*P*	*M*	*P*	*M*	*P*	*M*	*P*	*M*	*P*	*M*	*P*	*M*	*P*
20	0	0	0	0	0	0	0	0	0	0	0	0	+	+	0	0	0	0
40	0	0	0	0	0	0	+	0	0	+	0	0	+	+	+	+	0	0
60	+	0	0	0	0	0	+	0	+	+	0	0	+	0	+	+	+	+
80	+	0	+	0	0	0	+	0	+	+	0	0	+	0	+	+	+	+
100	+	0	+	+	0	0	+	0	+	+	0	0	+	0	+	+	+	+
120	—	—	—	—	—	—	+	0	+	+	+	+	—	—	—	—	—	—

[1] + in the *M* (merchantable) column indicates the option to cut for that product is open. + in the *P* (production) column indicates that stand growth equals or exceeds growth criteria.

production goals are met depends upon the product, stand age, and site quality. Pulpwood production goals are made only by young stands on high sites. Sawtimber goals are met by stands 40 years and older on medium and high sites. Meeting boltwood goals requires older stands on the better sites. Table 4 forms a production-goal framework for deciding what to do in a single stand-site-market situation. Presumably, if the production goal is not met, and the stand is merchantable, the stand should be cut according to this yardstick.

Analysis of Value and Value Increments for Selected 10-Year Period

Value increments per acre may be a viable economic goal for many owners. Their reasoning may be: "I want to pay taxes, and/or other custodial charges, and/or return an average dollar rate per acre." This reasoning is worthwhile if they have other objectives for their timber holdings and want to add the benefits from several uses for additional economic evaluations, or if they are speculating on other values as land value and want assurances that timber alone will carry the out-of-pocket investment costs.

The value analysis began by multiplying the product volumes in table 4 by the appropriate values cited in the value-basis section. The estimated value and value increments appear in table 5.

It is evident (table 5) that market potential, present and prospective, plays a controlling role in the development of timber value. For our 60-year-old, site-index 60 stand, for example, the introduction of a pulpwood market, where only a sawtimber market existed before, increases the value increment from $44 to $60, a positive change of 36 percent. A positive market change can occur in two ways: (1) a new wood-using industry that requires a previously unmerchantable round-wood product as its raw material becomes established in an area; or (2) the timber stand develops to the point where it produces merchantable

Table 5. — Estimated per-acre values and 10-year value increments for timber of selected ages and markets, in dollars

Age (years)	Present market as basis for valuation		Present value per acre	Ten-year per-acre value increments for selected future markets[1]				
				(1)	(2)	(3)	(4)	(5)
			SITE INDEX 40					
20	Pulpwood	(1)	—	—	—	—	—	—
40	Pulpwood	(1)	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—
60	Pulpwood	(1)	11	2	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—
80	Pulpwood[2]	(1)	16	3	15	24	—	—
	Sawtimber	(2)	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—
100	Pulpwood	(1)	22	3	39	51	—	—
	Sawtimber	(2)	42	—	19	31	—	—
	Pulpwood & sawtimber	(3)	55	—	—	18	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—
120	Pulpwood	(1)	28	—	—	—	—	—
	Sawtimber	(2)	85	—	—	—	—	—
	Pulpwood & sawtimber	(3)	94	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—

SITE INDEX 60

20.....	Pulpwood	(1)	—	—	—	—	—	—
40.....	Pulpwood	(1)	18	9	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—
60.....	Pulpwood	(1)	35	7	46	62	—	—
	Sawtimber	(2)	37	—	44	60	—	—
	Pulpwood & sawtimber	(3)	57	—	—	40	—	—
80.....	Pulpwood[2]	(1)	48	4	103	116	—	—
	Sawtimber	(2)	111	—	36	49	—	—
	Pulpwood & sawtimber	(3)	126	—	—	34	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—
100.....	Pulpwood	(1)	54	—	155	165	—	—
	Sawtimber	(2)	175	—	34	44	—	—
	Pulpwood & sawtimber	(3)	186	—	—	33	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—
120.....	Pulpwood	(1)	50	—	215	224	294	—
	Sawtimber	(2)	232	—	33	42	112	—
	Pulpwood & sawtimber	(3)	241	—	—	33	103	—
	Pulp., saw., & bolt.	(4)	277	—	—	—	67	—
	Boltwood	(5)	54	—	—	—	—	47

SITE INDEX 80

20.....	Pulpwood	(1)	10	16	—	—	—	—
40.....	Pulpwood	(1)	41	16	63	83	—	—
	Sawtimber	(2)	33	—	71	91	—	—
	Pulpwood & sawtimber	(3)	58	—	—	66	—	—

CONTINUED

Table 5. — Continued

Age (years)	Present market as basis for valuation		Present value per acre	Ten-year per-acre value increments for selected future markets[1]				
				(1)	(2)	(3)	(4)	(5)
60	Pulpwood	(1)	62	—	179	190	—	—
	Sawtimber	(2)	177	—	64	75	—	—
	Pulpwood & sawtimber	(3)	191	—	—	61	—	—
80	Pulpwood[2]	(1)	61	—	280	287	356	—
	Sawtimber	(2)	292	—	49	50	125	—
	Pulpwood & sawtimber	(3)	301	—	—	47	116	—
	Pulp., saw., & bolt.	(4)	348	—	—	—	69	—
	Boltwood	(5)	95	—	—	—	—	88
100	Pulpwood	(1)	55	—	392	397	589	—
	Sawtimber	(2)	393	—	54	59	251	—
	Pulpwood & sawtimber	(3)	399	—	—	53	245	—
	Pulp., saw., & bolt.	(4)	532	—	—	—	112	—
	Boltwood	(5)	282	—	—	—	—	119
120	Pulpwood	(1)	48	—	—	—	—	—
	Sawtimber	(2)	496	—	—	—	—	—
	Pulpwood & sawtimber	(3)	500	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	744	—	—	—	—	—
	Boltwood	(5)	504	—	—	—	—	—

[1] Numbers in parentheses correspond to markets in column 2.

[2] An 80-year-old stand on site 40 land now merchantable for pulpwood may be expected to add $3.00, $15.00, or $25.00 in value in the next 10 years if the market then is for pulpwood, or sawtimber, or a combination of pulpwood and sawtimber, respectively, at that time.

quantities of a new wood product. A forest manager can speculate on market development in much the same way that stock, commodity, and real estate investors speculate on market changes for their products.

The performance standard or management goal used here for gaging the performances listed in table 5 is that the value increments must cover custodial costs and include additional cash returns. The costs of ownership are usually annual costs while the value increments in table 5 are for a decade. Our analysis needs to equate these in order to consider out-of-pocket costs realistically. This requires compounding annual costs at appropriate rates of interest for comparison with decadal value increments.

The formula for the future value of a terminable series of annual payments was used. It was altered to determine the value increment required to cover a series of annual costs.

$$V_i = a\left[\frac{(1+p)^n - 1}{p}\right]$$

Where V_i = Value increment.
a = Annual payments.
p = Interest rate.
n = Period of years: 10 years in our case.

We are asking, for example, the value increment to pay for say \$1.50 annual custodial charges at 4 percent in 10 years.

$$V_i = \$1.50\left[\frac{(1.48024) - 1}{0.04}\right] = \$18.00$$

Reference to table 6, which gives solutions to this equation for 4- and 6-percent interest rates, shows that a decadal value increment of \$18.00 (1 + 7 + 10 column 1) is equivalent to annual payments of \$1.49 (\$0.08 + \$0.58 + 0.83 column 2) for 10 years at 4-percent interest.

Table 6 can be used in two different ways. First, the annual costs covered by a value increase can be estimated for any given decadal value increment in table 5. Costs for one of the two interest rates are summed until they equal the estimated increment. For example, the 10-year sawtimber value increment for age 80

Table 6. — Decadal value increments required to pay for annual costs at 4- and 6-percent interest for a 10-year period[1]

Dollar decadal value increments (V_i)	Annual dollar cost (a)	
	p = 4 percent	p = 6 percent
1	0.08	0.07
2	.17	.15
4	.33	.31
7	.58	.53
10	.83	.76
20	1.66	1.51
40	3.33	3.03
70	5.84	5.31
100	8.33	7.59

[1] $V_i = a\left[\frac{(1+p)^n - 1}{p}\right]$

where V_i = value increments
a = annual cost
n = 10 years
p = interest rate

site index 80 is (from table 5) $49. The annual cost equivalent is obtained by adding individual annual costs (table 6) for decadal values of 40, 7, and 2. For 4 percent this amounts to $3.33 + 0.58 + 0.17 = $4.08 per year, and for 6 percent it amounts to $3.71 per year. If $3.50 per acre per year is judged to be an adequate return, this forest stand can be expected to make it during the next 10 years and can be let grow.

This procedure can be turned around so that, given a 4-percent annual value requirement of $3.50 as a goal, we can show what minimum decadal value increment is required. In this case $3.33 and $0.17 in the 4-percent annual column sum to $3.50 and are equivalent to 40 + 2 = $42.00 per decade value increment. Stands making less than this do not meet the goal and should be considered financially mature for cutting.

Taxes on forest land of $0.25 to $0.30 per acre are common. Total custodial charges including taxes of $0.50 to $0.75 per acre are often considered reasonable. These minimal annual charges, if they are to be met from timber growing, require decadal returns

Table 7. — The occurrence of stands meeting (A) $30 and (B) $100 per-acre-per-decade value performance standards

Age (years)	Present market as basis for valuation		Selected future markets[1] (1) A	(1) B	(2) A	(2) B	(3) A	(3) B	(4) A	(4) B	(5) A	(5) B
			SITE INDEX 40									
20	Pulpwood	(1)	—	—	—	—	—	—	—	—	—	—
40	Pulpwood	(1)	—	—	—	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—
60	Pulpwood	(1)	O[2]	—	—	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—
80	Pulpwood	(1)	O	—	O	—	O	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—
100	Pulpwood	(1)	O	—	+	O	+	O	—	—	—	—
	Sawtimber	(2)	—	—	O	—	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	O	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—

CONTINUED

Table 7. — Continued

Age (years)	Present market as basis for valuation		Selected future markets[1] (1) A	(1) B	(2) A	(2) B	(3) A	(3) B	(4) A	(4) B	(5) A	(5) B
			SITE INDEX 60									
20	Pulpwood	(1)	—	—	—	—	—	—	—	—	—	—
40	Pulpwood	(1)	O[2]	—	—	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—
60	Pulpwood	(1)	O	—	+	O	+	O	—	—	—	—
	Sawtimber	(2)	—	—	+	O	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	—	—	—	—
80	Pulpwood	(1)	O	—	+	+	+	+	—	—	—	—
	Sawtimber	(2)	—	—	+	O	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—
100	Pulpwood	(1)	—	—	+	+	+	+	—	—	—	—
	Sawtimber	(2)	—	—	+	O	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—
120	Pulpwood	(1)	—	—	+	+	+	+	+	+	—	—
	Sawtimber	(2)	—	—	+	O	+	O	+	+	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	+	+	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	+	O	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	+	O

SITE INDEX 80

20.....	Pulpwood	(1)	O [2]	—	—	—	—	—	—	—	—	—
40.....	Pulpwood	(1)	O	—	+	O	+	O	—	—	—	—
	Sawtimber	(2)	—	—	+	O	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	—	—	—	—
60.....	Pulpwood	(1)	—	—	+	+	+	+	—	—	—	—
	Sawtimber	(2)	—	—	+	O	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	—	—	—	—
80.....	Pulpwood	(1)	—	—	+	+	+	+	+	+	—	—
	Sawtimber	(2)	—	—	+	O	+	O	+	+	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	+	+	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	+	O	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	+	O
100.....	Pulpwood	(1)	—	—	+	+	+	+	+	+	—	—
	Sawtimber	(2)	—	—	+	O	+	O	+	+	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	+	O	+	+	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	+	+	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	+	+

[1] Numbers in parentheses correspond to markets in column 2.
[2] + indicates the value standard is attained while O shows it is not being met.

of $3.00 to $4.00 for taxes and $7.00 to $10.00 for all custodial charges, including taxes. A forest manager desiring to cover his custodial charges and return an average of $2.00 per acre per year then would expect his forest stand to return say $27 to $30 in value increment per decade. This could then become one goal to be tested for his forest and market conditions from data in table 5.

Table 7 shows which stands exceed $30 and $100 standards. The $30 standard was chosen as being an adequate gain for forests being exploited for several uses, with the timber use expected to cover owner costs and yield a modest return. The $100 standard is used as an example of what might be considered an attractive gain.

It is important to note that the older stands suitable for a variety of markets have a better opportunity of meeting the $30 and $100 per acre standards than younger stands. Stands for which there is an improving market are subject to better gains than those in a static market condition.

Those forest stands that do not show promise of meeting the decadal value increment goals should be cut. This forms another single-analysis framework for deciding what to do. The cut may liquidate all the stand, salable portions of it, or enough of it so that money is available for meeting the 10-year goal. If partial cutting is done by featuring properly located clearings, thinnings, and improvement cuttings, the residual timber may make improved value increments in the decade in question as well as in subsequent decades.

Analysis of 10-Year Rates of Return to the Timber Investment

The rate of return is a popular economic yardstick applied to timber as well as to other investments. The rate of return is calculated for a timber stand and compared to a standard to determine if the timber is "financially mature." Rate of return $(1+p)^n$ to the timber investment as used here is calculated as follows:

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

where p = Interest rate earned.

n = Period in years: 10 years in our case.

V_n = Timber value at the end of the period.

V_o = Timber value at the beginning of the period.

Rates of return for our timber situations appear in table 8.

The importance of timber-market development becomes apparent again in table 8. High rates of return result only in a rapidly expanding market due either to the improved product potential of the stand or to markets for new products. When a static market exists at both the beginning and end of the 10-year period, the rates of return to let-it-grow management are unattractive. The only exception to this are those periods when the timber moves in size or specifications into that market. For example, 40-year-old timber on site index 80 valued as sawtimber achieves a prospective 12.2-percent rate of return over the next 10 years. At ages 60, 80, and 100 years, however, the rate drops to 3.1, then 1.5, and 1.2 percent respectively.

The interpretation of this dropping rate of return in a static market needs to be made with care. The decline is fundamental, but the point at which the decline occurs, or its magnitude, depends entirely on minimum product quantities, product values, and tree size and quality distributions. Table 3 shows that the product increment increases quickly, remains stable for a number of years, and declines slowly. During the period of stable production, the value base (table 5) increases rapidly while the value increment holds steady, which accounts for the declining rate of return. Other forest-management practices that alter the skewness of the tree-size and -quality distributions can cause the decline to be delayed or accelerated, depending on the objective of the practice.

Three rate-of-return standards are selected as a basis for judging stand performance. A 2-percent rate was chosen as a suitable criterion for the forest manager interested in a variety of forest uses. The rates of return or rates of utility obtained from other

Table 8. — Rates of return to timber investment in 10-year periods, for selected markets

Age (years)	Present market as basis for valuation		Ten-year rate of return—percent—for selected future markets[1]				
			(1)	(2)	(3)	(4)	(5)
			SITE INDEX 40				
20	Pulpwood	(1)	—	—	—	—	—
40	Pulpwood	(1)	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—
60	Pulpwood	(1)	1.7	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—
80	Pulpwood[2]	(1)	1.7	6.8	9.6	—	—
	Sawtimber	(2)	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—
100	Pulpwood	(1)	1.3	6.8	12.7	—	—
	Sawtimber	(2)	—	3.8	5.6	—	—
	Pulpwood & sawtimber	(3)	—	—	2.8	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—
120	Pulpwood	(1)	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—

SITE INDEX 60

20.....	Pulpwood	(1)	—	—	—	—	—
40.....	Pulpwood	(1)	4.1	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—
60.....	Pulpwood	(1)	1.3	8.7	10.7	—	—
	Sawtimber	(2)	—	8.1	10.1	—	—
	Pulpwood & sawtimber	(3)	—	—	5.5	—	—
80.....	Pulpwood	(1)	0.9	12.8	13.8	—	—
	Sawtimber	(2)	—	2.8	3.7	—	—
	Pulpwood & sawtimber	(3)	—	—	2.4	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—
100.....	Pulpwood	(1)	neg.	14.5	15.0	—	—
	Sawtimber	(2)	—	1.8	2.3	—	—
	Pulpwood & sawtimber	(3)	—	—	1.6	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—
120.....	Pulpwood	(1)	neg.	18.2	18.6	21.3	—
	Sawtimber	(2)	—	1.3	1.7	4.0	—
	Pulpwood & sawtimber	(3)	—	—	1.2	3.6	—
	Pulp., saw., & bolt.	(4)	—	—	—	2.2	—
	Boltwood	(5)	—	—	—	—	3.7

SITE INDEX 80

20.....	Pulpwood	(1)	10.0	—	—	—	—
40.....	Pulpwood	(1)	3.3	9.8	11.7	—	—
	Sawtimber	(2)	—	12.2	14.1	—	—
	Pulpwood & sawtimber	(3)	—	—	7.9	—	—

CONTINUED

Table 8. — Continued

Age (years)	Present market as basis for valuation		Ten-year rate of return—percent—for selected future markets[1]				
			(1)	(2)	(3)	(4)	(5)
60.....	Pulpwood	(1)	neg.	14.4	15.0	—	—
	Sawtimber	(2)	—	3.1	3.6	—	—
	Pulpwood & sawtimber	(3)	—	—	2.7	—	—
80.....	Pulpwood[2]	(1)	neg.	18.8	19.0	21.2	—
	Sawtimber	(2)	—	1.5	1.8	3.6	—
	Pulpwood & sawtimber	(3)	—	—	1.4	3.3	—
	Pulp., saw., & bolt.	(4)	—	—	—	1.8	—
	Boltwood	(5)	—	—	—	—	15.9
100.....	Pulpwood	(1)	neg.	23.3	23.3	27.9	—
	Sawtimber	(2)	—	1.2	1.4	5.0	—
	Pulpwood & sawtimber	(3)	—	—	1.2	4.9	—
	Pulp., saw., & bolt.	(4)	—	—	—	1.9	—
	Boltwood	(5)	—	—	—	—	2.1
120.....	Pulpwood	(1)	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—

[1] Numbers in parentheses correspond to markets in column 2.

[2] An 80-year-old stand on site 40 land is now merchantable only for pulpwood. In 10 years it is suitable for 3 markets. Its rate of return depends upon these future markets. It will earn 1.7 percent in a pulpwood market, 6.8 percent in a sawtimber market, and 9.6 percent in the combination market.

uses should be enough to add to this modest timber return to make woodland ownership attractive. Four percent was chosen as a lower limit for investment alternatives, and 6 percent was selected to reflect a criterion for those who might seek alternative investments. Table 9 contrasts stand performance against these criteria.

A comparison of value-increase performance in table 7 with the rate-of-return performance in table 9 points up important differences between these two yardsticks. Important value increases are made by older stands while high rates of return are made by younger stands. Those stands that do not meet the appropriate decadal rate of return should be cut according to this yardstick. Again, as with the value-increase yardstick, partial cuttings are feasible. Trees that do not meet the rate-of-return criterion should be selected for cutting. Guides for financial maturity *(Trimble and Mendel 1968)* can be used to select these trees.

Table 9. — Estimated stand performance at 2-, 4-, and 6-percent rates of return criteria

Age (years)	Present market[1] as basis for valuation		Selected future markets[1]														
			(1)			(2)			(3)			(4)			(5)		
			2	4	6[2]	2	4	6[2]	2	4	6[2]	2	4	6[2]	2	4	6[2]
SITE INDEX 40																	
20	Pulpwood	(1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
40	Pulpwood	(1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60	Pulpwood	(1)	O	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
80	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
100	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	+	O	—	+	+	O	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	+	O	—	—	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

SITE INDEX 60

20	Pulpwood	(1)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
40	Pulpwood	(1)	+	+	O	—	—	—	—	—	—	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
60	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	+	+	+	+	+	+	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	+	+	O	—	—	—	—	—	—	—
80	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	+	O	—	+	O	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	+	O	—	—	—	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
100	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	—	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	O	—	—	+	O	—	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	O	—	—	—	—	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
120	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	+	+	+	—	—	—	—
	Sawtimber	(2)	—	—	—	O	—	—	O	—	—	+	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	O	—	—	+	O	—	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	+	O	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	+	O	—	—

CONTINUED

Table 9. — Continued

Age (years)	Present market[1] as basis for valuation		Selected future markets[1] (1) 2	(1) 4	(1) 6[2]	(2) 2	(2) 4	(2) 6[2]	(3) 2	(3) 4	(3) 6[2]	(4) 2	(4) 4	(4) 6[2]	(5) 2	(5) 4	(5) 6[2]
								SITE INDEX 80									
20	Pulpwood	(1)	+	+	+	—	—	—	—	—	—	—	—	—	—	—	—
40	Pulpwood	(1)	+	O	—	+	+	+	+	+	+	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	+	+	+	+	+	+	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	+	+	+	—	—	—	—	—	—
60	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	—	—	—	—	—	—
	Sawtimber	(2)	—	—	—	+	O	—	+	O	—	—	—	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	+	O	—	—	—	—	—	—	—
80	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	+	+	+	—	—	—
	Sawtimber	(2)	—	—	—	O	—	—	O	—	—	+	O	—	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	—	—	—	+	O	—	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	+	+	+
100	Pulpwood	(1)	O	—	—	+	+	+	+	+	+	+	+	+	—	—	—
	Sawtimber	(2)	—	—	—	O	—	—	O	—	—	+	+	O	—	—	—
	Pulpwood & sawtimber	(3)	—	—	—	—	—	—	O	—	—	+	+	O	—	—	—
	Pulp., saw., & bolt.	(4)	—	—	—	—	—	—	—	—	—	O	—	—	—	—	—
	Boltwood	(5)	—	—	—	—	—	—	—	—	—	—	—	—	+	O	—

[1] Numbers in parentheses correspond to markets in column 2.

[2] Column numbers 2, 4, 6 indicate rate-of-return standards. O indicates stand performance did not meet the standard while + indicates that the standard was equalled or exceeded.

The Effects of Custodial Charges and Land Values

The effects of custodial charges on value increments was discussed briefly in an earlier section. The effects of these charges and land values on the rate of return from letting timber grow can be understood more clearly by expanding the rate-of-return equation.

Let: ΔV = Timber value increase obtained by letting timber grow.

V_1 = Initial value of land, not including timber.

V_t = Initial value of timber growing stock.

C = Required decadal value increase needed to cover annual custodial charges.

Then: $$V_n = V_t + V_1 + \Delta V - C$$

V_o becomes $V_t + V_1$

and: $$(1+p)^n = \frac{V_t + V_1 + \Delta V - C}{V_t + V_1}$$

The effects of these charges and the addition of land value become apparent by considering the changes in $(1+p)^n$ wrought by different amounts of C and V_1.

1. If C exceeds ΔV, the rate of return disappears. Any value for C will reduce the rate of return to letting timber grow.
2. Introducing V_1 into the denominator as well as the numerator will reduce the rate of return but will not eliminate it. Its effect varies depending on the size of V_t and V_1.

The illustration provided by table 10 shows the effects of constant decadal charges of $20 and land value of $50 on the rates earned by a range of timber values common to our example.

For a constant value increment, a constant custodial charge will adversely affect the rate of return to high-value timber to a greater extent than low-value timber. The difference is entirely due to the value base. Our example in table 10 shows that 66 percent of the original rate was retained for a $50 timber investment while only 58 percent was retained for a $400 timber investment. For a constant land value, on the other hand, rates of return to timber alone will be reduced more for low-value stands

Table 10. — Effect of custodial charges and land values on the rate of return to investments in timber

Timber value			Decadal custodial charge			Land values			Combined charges and values			
				Rate of return			Rate of return		Amount		Rate of return	
Beginning value, dollars	10-year increase, dollars	Rate of return, int. rate	Amount (dollars)	Interest rate	Percent of timber rate	Amount (dollars)	Interest rate	Percent of timber rate	Charge, dollars	Value, dollars	Interest rate	Percent of timber rate
(V_t)	(ΔV_t)	(1)	(C)	(2)	(5)	(V_1)	(3)	(5)			(4)	(5)
50	50	7.2	20	4.8	66	50	4.2	58	20	50	2.7	37
100	50	4.2	20	2.7	64	50	2.9	69	20	50	1.8	43
200	50	2.3	20	1.4	61	50	1.8	78	20	50	1.1	47
400	50	1.2	20	.7	58	50	1.1	92	20	50	.6	50

[1] $(1+op)^{10} = \frac{V_t + \Delta V_t}{V_t}$ Rate of return to timber investment only.

[2] $(1+op)^{10} = \frac{V_t + \Delta V_t - C}{V_t}$ Rate of return to timber affected by annual custodial charges.

[3] $(1+op)^{10} = \frac{V_t + V_1 + \Delta V_t}{V_t + V_1}$ Rate of return to timber affected by introducing land values.

[4] $(1+op)^{10} = \frac{V_t + V_1 + \Delta V_t - C}{V_t + V_1}$ Rate of return to timber affected by both custodial charges and land values.

[5] $(1+p)^{10}$ Compares rate of return in preceding column as a percent of the rate of return to timber alone in column 3.

than for high-value stands. In table 10 the $400 timber investment retained 92 percent of its rate of return to timber alone while the $50 stand retained only 58 percent. The effects of the combined charges and values as treated here are the product of the two individual effects. They produce a general reduction in the rate of return to timber alone.

Evaluating the "Let-it-Grow" Alternative

Decisions are rarely made on the basis of a single factor. Usually a course of action is decided on after considering it from several points of view. Each single factor presented here represents a different economic point of view. A formal presentation of the outcomes of the let-it-grow alternative for all factors should sharpen the forest manager's judgment so he can make a better decision. This is done by example in table 11. A forest manager can follow this example to develop a similar array for his own situation. If his forest and markets conform to the situations described here, he can develop his evaluation from data in this publication. More than likely, though, he will have to trace out the stand-table projection methods and market synthesis described to develop his own basic data for evaluation.

These quantitative data can be generalized for the forest and market situation described in table 11 to provide management-decision information as follows:

1. The owner has the option to cut it all as well as let it grow according to the per-acre volume standards outlined in this paper. Also, he has enough volume of each individual product so that partial liquidation options are clearly open to him.

2. The per-acre sawtimber and boltwood growth standards will be met and exceeded while the pulpwood components of the stand exhibit negative production and do not meet the standard.

Table 11. — Evaluation array (10-year basis) for judging if the let-it-grow management option is worthwhile

1. Condition for evaluation:
   - Age of timber stand — 80 years
   - Site index of timberland — 80 feet
   - Existing market — Pulpwood & sawtimber (3)
   - Prospective markets — Pulpwood & sawtimber (3)
   - — Pulpwood, sawtimber & boltwood (4)
   - — Boltwood (5)

2. Basis for evaluation:

Item	Product	Measure	Estimated performance	Performance compared to acceptable standards[1]						
				Merchantability standards	Growth standards	Value increase standards		Rate of return on timber standards		
						$30	$100	2%	4%	6%
Present volumes (Table 3)[2]	— Pulpwood	— cords	30.3	+	—	—	—	—	—	—
	— Sawtimber	— ft. b. m.	16,075	+	—	—	—	—	—	—
(Table 4)	— Boltwood	— ft. b. m.	950	+	—	—	—	—	—	—
Volume increase	— Pulpwood	— cords	1.6	—	O	—	—	—	—	—
(Table 3)	— Sawtimber	— ft. b.m.	1,415	—	+	—	—	—	—	—
(Table 4)	— Boltwood	— ft. b. m.	880	—	+	—	—	—	—	—
Present value (Table 5)		— dollars	301	—	—	—	—	—	—	—

Value increase (Table 5) (Table 7)	— Pulpwood & sawtimber market	(3)	— dollars	47	—	—	+	O	—	—	—
	— Pulpwood, sawtimber & bolt market	(4)	— dollars	116	—	—	+	+	—	—	—
	— Boltwood market	(5)	— dollars	88	—	—	+	O	—	—	—
Rate of return on timber (Table 8) (Table 9)	— Pulpwood & sawtimber market	(3)	— percent	1.4	—	—	—	—	O	O	O
	— Pulpwood, sawtimber & bolt market	(4)	— percent	3.3	—	—	—	—	+	O	O
	— Boltwood market	(5)	— percent	2.6	—	—	—	—	+	O	O

[1] Performance meeting standards is indicated by +, not meeting standards by O.

[2] Tables 3, 5, and 8 are sources for estimated performance; tables 4, 7, and 9 are sources for the comparison with performance standards.

3. Per-acre value increases meet custodial charges for all potential market conditions. A boltwood market must be present for the stand to make attractive per-acre value increases.

4. Rates of return on the timber investment are low. In fact, a boltwood market must be present to make a 2-percent (multiple-use rate) rate of return on timber alone.

This type of evaluation provides the forest owner valuable economic background information to use in conjunction with his other responsibilities, commitments, and circumstances to help decide whether to cut it or let it grow. The first generalization suggests that he has other options open to him. Added considerations beyond the scope here need to be made to develop the similar information required for him to estimate whether partial liquidation or additional investments in forest-management practices would be advantageous to him.

■

Literature Cited

Meyer, H. Arthur.
1953. FOREST MENSURATION. 357 pp., illus. Penns Valley Publishers, Inc.

Schnur, Luther G.
1937. YIELD, STAND, AND VOLUME TABLES FOR EVEN-AGED UPLAND OAKS. U. S. Dep. Agr. Tech. Bull. 560, 87 pp., illus.

Trimble, George R.
1965. IMPROVEMENT IN BUTT-LOG GRADE WITH INCREASE IN TREE SIZE, FOR SIX HARDWOOD SPECIES. USDA Forest Serv. Res. Paper NE-31, 15 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.

Trimble, George R., and Mendel, Joseph J.
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., Upper Darby, Pa.

Worley, David P.
1958. PULPWOOD OR SAWLOGS FROM SMALL HARDWOOD TREES. USDA Forest Serv. Central States Forest Exp. Sta. Tech. Paper 156, 7 pp. Columbus, Ohio.

Worley, David P.
1963. CALCULATING OPTIMUM PRODUCT COMBINATIONS FROM STANDING TREES. USDA Forest Serv. Res. Paper CS-7, 17 pp., illus. Central States Forest Exp. Sta., Columbus, Ohio.

■

THE FOREST SERVICE of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.