Ten-Year Earnings from Two Small Woodlands

by Wilfred C. Mitchell
and Henry H. Webster

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RALPH W. MARQUIS, DIRECTOR

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Introduction

TEN years ago, management was started on two 30-acre demonstration woodlots on the Fernow Experimental Forest near Parsons, West Virginia. These were designated as Farm Woodlots, on the assumption that there was something significantly different between management incentives and opportunities for small holdings owned by farmers and for those owned by non-farmers.

The distinction was based on the belief that the farmer-owner would have the skills and the equipment to do his own logging; that he would have leisure time in the winter months when he would cut and skid logs; that he would make considerable use of the products from his woodlot for fuel, posts, and custom-milled lumber; and that he would want fairly regular annual returns, such as he got from his crops.

On the basis of these assumptions it seemed reasonable to report returns to the owner on the basis of wages per man-hour worked. But these "wages" sometimes included stumpage values, many times made no allowance for equipment

depreciation, and in some cases failed to disclose what was happening to the timber stand. Reports on "farm woods" issued by the Northeastern Forest Experiment Station have been as deficient as any others in this respect.

We are learning that these assumed differences are more fancied than real. Many of today's farmers would be as clumsy with an ax or a chain saw as would a banker or a school teacher. Their specialized equipment is not always adaptable to woods work. They no longer cut fuelwood: they burn gas, oil, or coal for heat, or slabs delivered from a mill. They don't have the assumed urge to put in every daylight hour at hard labor. In fact, so far as woods operations are concerned, they are pretty much like other people. And wages per man-hour mean as little to them as to others who are not going to put in these man-hours.

In this analysis of 10 years of management we assume that economic return will be important to most owners of small woodland properties, though we also recognize the importance of other considerations in motivating an owner to improve his management practices. We assume there will be a considerable variation among owners or prospective owners as to their desire or ability to do their own logging or cull removal. There will also be differences in their desire or opportunity to take advantage of Agricultural Conservation Program (ACP) payments for accepted cultural practices. So our analysis covers four different possible situations:

- An owner who already owned the land when management began, and did his own logging and cull killing.
- An owner who already owned the land, and hired logging done, but did his own cull killing.
- An owner who already owned the land, and who hired both logging and cull killing done.
- An owner who purchased the land when management began and hired logging and cull killing done.

This analysis of the results of 10 years of management on these two holdings does not purport to establish the economic return that might be expected from any other properties. It is strictly a case study. Other owners will have different species, different markets, different growing conditions, different stocking. But the methods used here may be helpful in aiding other owners to evaluate their opportunities in managing small holdings for quality timber products.

--RALPH W. MARQUIS
Director

The Areas Studied

The two 30-acre areas chosen for this study are fairly typical of topography and stand conditions in the northern Appalachian region, though they represent two different stages in the recovery of cut-over, burned-over forest land. Both areas have sites ranging from dry ridge tops to moist stream bottoms. The average site index on each area is in the vicinity of 70 to 75 feet at 50 years for dominant and codominant red oak. A mixture of Appalachian hardwoods is found on both areas. In general the oaks tend to predominate on the ridge tops and drier slopes. Sugar maple, beech, cherry, yellow-poplar, and red oak are found in the coves and on the moist slopes.

Both areas had been cut for sawlogs about 40 years before this study was begun. At the time of cutting, defective trees and unmerchantable species were left. So the present stand is made up of two distinct groups of trees: the old growth left from the original logging, and the second growth that came in after cutting. Cutting was followed by fire on both areas.

But there the resemblances between the two areas cease. The stand conditions on the two areas were quite different at the time the study was begun.

Area 1 had a stand of about 4,600 board-feet[1] per acre. Fewer large trees had been left on this area than on Area 2, and fires had done more damage. Area 1 had 56 percent of its volume in so-called high-value species,[2] and only 17 percent of its volume in the top two log grades.[3] Of trees over 5.0 inches d.b.h., 6.5 square feet of basal area per acre was classed as cull. The volume and quality of the stand was below the average of lands being operated by the Monongahela National Forest (of which these areas are a part).

The stand on Area 2 was much better. It ran just over 9,200 board-feet per acre, with larger and better trees.

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[1] In trees over 11.0 inches d.b.h. to an 8-inch top, International ¼-inch rule.

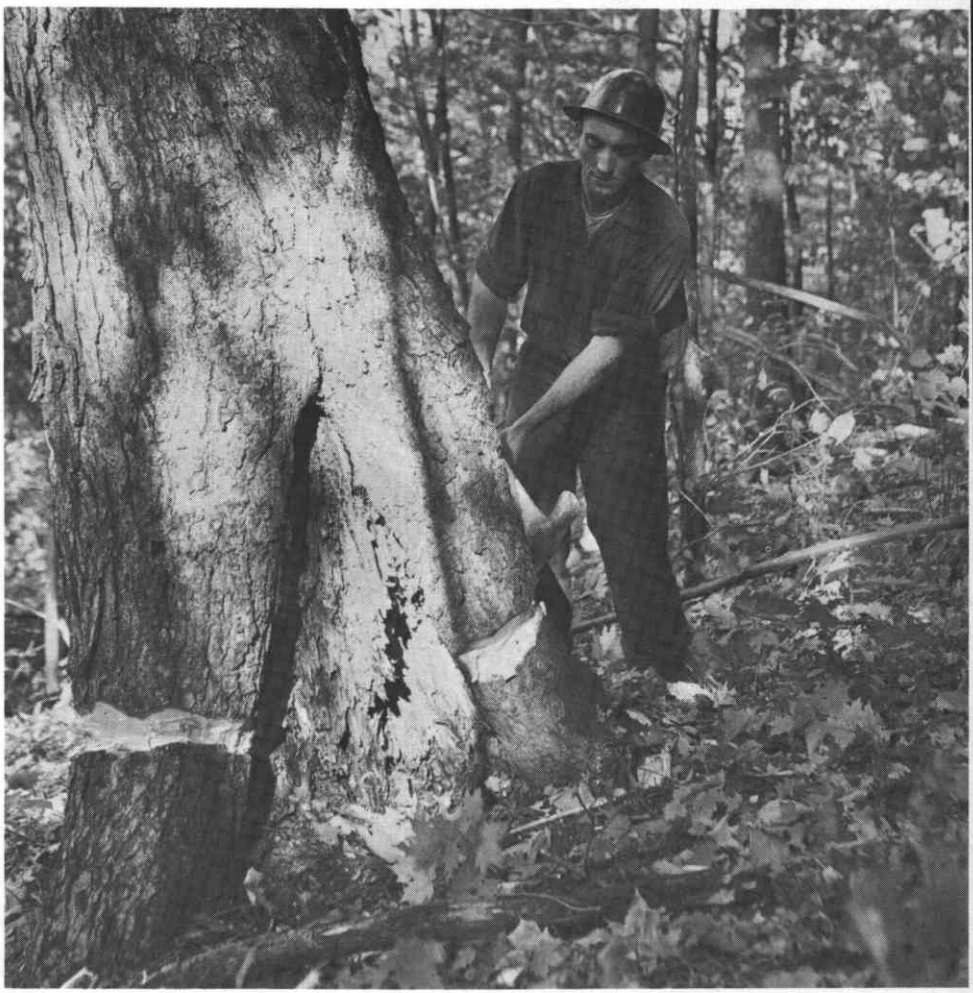
[2] White ash, black cherry, locust, sugar maple, red maple, red oak, white oak, basswood, cucumber, and yellow-poplar.

[3] U. S. Forest Products Laboratory. Hardwood log grades for standard lumber. Proposals and results. U.S. Forest Prod. Lab. Rpt. D1737. 1949.

Sixty-nine percent of the sawtimber volume was in high-value species. Thirty-two percent of the volume was in the two top log grades. Basal area in cull trees was 10 square feet per acre.

In summary, the stands differed as follows:

	Merchantable volume per acre (bd.-ft.)	*In high-value species (percent)*	*In log grades I and II (percent)*	*Basal area in cull (sq. ft.)*
Area 1	4,600	56	17	6.5
Area 2	9,200	69	32	10.0



Management Program

The management given these two small woodland properties was the best the manager could conceive to achieve the established goals, and the management plan was changed whenever experience or new knowledge pointed the way to better management.

The goals of management were to increase growth, improve quality, improve species composition, reduce cull volume, maintain or build up the growing stock, establish enough reproduction to renew the stand, and at the same time provide a return that would at least cover cost of logging. These were, of course, short-term goals established to put the properties in condition to produce larger net returns in the future.

At the start of management, all cull trees were girdled on both woodlots. Culls that have developed since that time have been girdled each year in areas where logging was carried on.

Annual harvest cuts were made, but each year only a portion of each area was logged. All of the timber removed in the annual harvests was marked before cutting. Trees to be cut were selected on the basis of species, quality, and vigor of individual trees. The marking was done by a professional forester. Keeping in mind the goals of management, he selected for removal a volume approximately equal to the expected annual growth for each area. Thus the original growing-stock volumes were maintained while the quality of the stands was being improved (table 1). All logging was done in accordance with soil and water-conservation principles.

After 10 years of management, there appears to be sufficient reproduction of commercial species to renew the stands (table 2). Sugar maple and beech, two very tolerant species, are the most abundant. Many of these stems were present before cutting. Wherever openings have been made in the canopy, some reproduction of intolerant species can be found.

Figure 1.--*Culls like this were eliminated in the first years of management, leaving more space for crop trees to grow.*

Table 1.--Inventory volumes, material removed (tree scale)[1], and periodic annual growth

(In board-feet per acre)

Item	Area 1	Area 2
Original stand	4,611	9,227
Removed in first 5-year period	1,143	1,728
5-year stand	4,605	9,968
Removed in second 5-year period	862	2,019
10-year stand	4,882	9,501
Annual growth for 10-year period	228	402

[1] In trees over 11.0 inches d.b.h. to an 8-inch top, International ¼-inch rule.

Table 2.--Number of stems of commercial species per acre after 10 years

Area	1 foot high to 1.0 inch d.b.h.	1.01 to 5 inches d.b.h.
Area 1	3,854	312
Area 2	4,948	388

During the first 10 years of management the goals related to the physical response of the stands have been realized. It is time now to consider the economic goal. That goal was to provide a return to cover the cost of logging.

Figure 2.--*Even after 10 years of management, small trees constitute an appreciable part of the stand in Area 1. However, sawtimber trees of good species and form are beginning to stand out.*

Cash Earnings

The owner or purchaser of a forest property who places it under systematic management may look for earnings in two forms: in cash from the sale of products, and in an increase in the capital value of his property. This section deals with cash earnings only.

Data collected in the course of managing the two woodland areas make it possible to show gross cash income and management costs under several possible situations, depending on the management decisions an owner might have made.

FIRST SITUATION

The first situation assumed was that of an individual who already owned the forest land, who decided to put it under management, and who did his own logging and killing of cull trees. His products were sold as logs at roadside. The values shown in table 3, rounded to the nearest dollar, are records of actual receipts and costs.

Out of the gross cash income the owner would have had certain costs and expenses. It is assumed that the typical owner in this situation would not be qualified to mark timber for cutting in a manner to accomplish the established goals. The annual $8 charge for marking was estimated by a local consulting forester as the current cost for this service. The machinery costs reported are the actual costs for felling and skidding equipment--power saws and a TD-9 tractor. Property taxes are not included as an additional cost attributed to the decision to manage the property; they would have had to be paid even if the property had been held in its former unmanaged condition.

The owner in this situation might have increased his net income by $80 for the 10-year period if he had been qualified to mark his own timber. He might have increased it by an additional $24 on Area 1 or $41 on Area 2 if he had collected ACP payments for the improvement work he did in killing cull trees (80 percent of cost in this situation).

It is apparent that the economic goal has not been met on Area 1 during the first 10 years. The return has not been great enough to meet the cost of logging.

But this does not mean that the economic goal cannot be met in 15 or 20 years. As the next section will show, the stand on Area 1 has been greatly improved, and the logs

cut from this stand during the next 5 or 10 years will be better logs and will bring higher prices than those cut during the past 10 years while the stand was being conditioned.

Table 3.--Net cash returns from managing woodland properties

FIRST SITUATION:
OWNER DID OWN LOGGING AND CULL TREE REMOVAL

Year of management	Gross receipts from sale of logs at roadside	Expenses		Net receipts	Man-hours worked	
		Marking costs	Machinery costs		Logging, road construction and maintenance	Killing culls
			AREA 1			
1	$164	$8	$31	$125	297	20
2	141	8	62	71	152	--
3	195	8	50	137	81	--
4	100	8	41	51	49	--
5	212	8	70	134	99	--
6	182	8	37	137	60	--
7	67	8	21	38	26	4
8	48	8	18	22	37	3
9	157	8	32	117	32	--
10	76	8	27	41	32	--
Total	$1,342	$80	$389	$873	865	27
			AREA 2			
1	$199	$8	$82	$109	283	22
2	157	8	55	94	128	--
3	365	8	42	315	73	--
4	183	8	38	137	74	--
5	225	8	42	175	62	6
6	318	8	58	252	81	2
7	148	8	44	96	50	6
8	274	8	77	189	72	10
9	453	8	49	396	56	--
10	204	8	55	141	50	--
Total	$2,526	$80	$542	$1,904	929	46

Considering only the cash position of the owner, it is reasonable to conclude that the owner of this tract, making his management decisions, would have had to face the alternatives during the first 10 years of making a capital investment to improve the property rapidly, or of cutting more valuable timber and so postponing stand improvement in order to operate on a break-even or cash-income basis.

Figure 3.--*Much of Area 2 is now composed of well-formed trees of good species like these.*

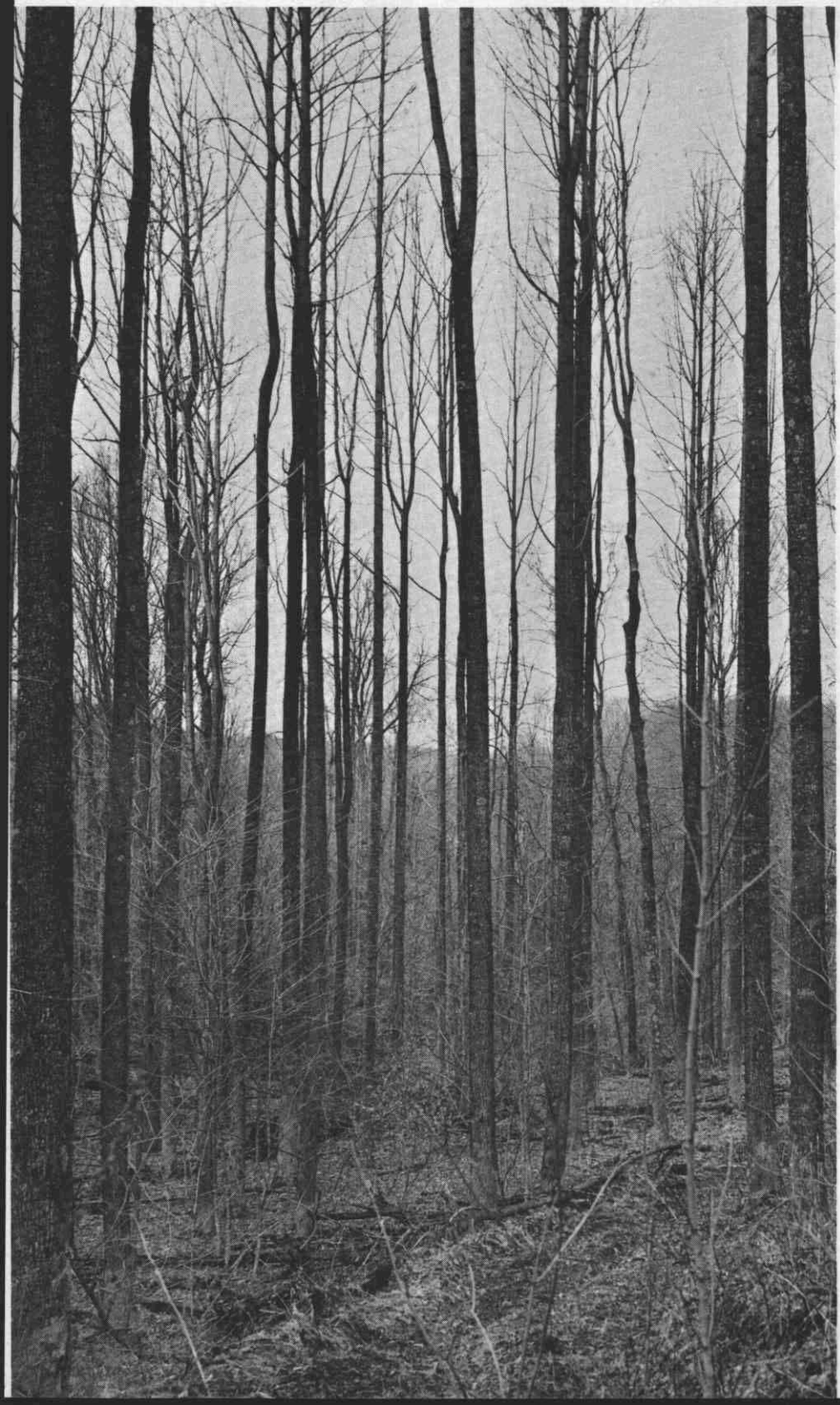


Figure 4.--*Trees like this--containing logs of good quality--make up an increasingly large part of the volume in both woodlands.*

Figure 5.--*Mine props and pulpwood cut from Area 1.*

The economic goal has been met on Area 2. Net cash receipts per man-hour worked in logging were $2.05. It is likely that many owners interested in doing their own logging would have considered this a satisfactory return.

SECOND SITUATION

The second situation assumed was that of an individual who already owned the forest land, who decided to put it under management, who hired his logging done, and who killed his own cull trees. As in the first situation, he sold his logs at roadside.

Labor costs were the actual wages paid to the logging crew operating these areas (table 4). These wages were adjusted annually to make them correspond to comparable rates paid in the logging industry, so they are representative of industrial logging labor costs.

The owner of Area 1 would have had to invest $80 cash and 27 man-hours of labor during the first 10 years of operation to maintain his stand volume and increase the quality of his stand (table 4). He could have operated on a break-even basis had he been qualified to mark his timber for cut-

Table 4.--Net cash returns from managing woodland properties

SECOND SITUATION:
OWNER HIRED LOGGING DONE, BUT DID OWN CULL TREE REMOVAL

Year of management	Gross receipts	Logging costs				Net cash	
		Marking	Machinery	Labor	Total	Loss	Gain
			AREA 1				
1	$164	$8	$31	$284	$323	$159	--
2	141	8	62	149	219	78	--
3	195	8	50	89	147	--	$48
4	100	8	41	55	104	4	--
5	212	8	70	116	194	--	18
6	182	8	37	77	122	--	60
7	67	8	21	34	63	--	4
8	48	8	18	49	75	27	--
9	157	8	32	50	90	--	67
10	76	8	27	50	85	9	--
Total	$1,342	$80	$389	$953	$1,422	$277	$197
			AREA 2				
1	$199	$8	$82	$271	$361	$162	--
2	157	8	55	132	195	38	--
3	365	8	42	79	129	--	$236
4	183	8	38	82	128	--	55
5	225	8	42	72	122	--	103
6	318	8	58	102	168	--	150
7	148	8	44	61	113	--	35
8	274	8	77	94	179	--	95
9	453	8	49	84	141	--	312
10	204	8	55	80	143	--	61
Total	$2,526	$80	$542	$1,057	$1,679	$200	$1,047

ting, and could have shown a cash income if he had also received $24 from ACP payments for stand improvement.

The owner of Area 2 ended the 10 years with net cash receipts of $847. He too could have increased his income if he had been able to do his own marking and had accepted ACP payments.

THIRD SITUATION

This was the same as the second situation except that the owner is assumed to have hired labor to kill cull trees. (The man-hours required for this are shown in table 3). The additional cost, at an average rate of $1.10 an hour, would be $30 for Area 1 and $51 for Area 2. Cash returns for the two areas as shown for the second situation would be reduced by these amounts.

This third situation might be typical of the absentee owner of a forest property.

FOURTH SITUATION

The fourth situation was that of an individual who purchased forest land for the purpose of putting it under management, who hired logging and killing culls done, and who sold logs at roadside. He differs from the individual in the third situation only in that his decisions required the purchase of land and timber. But in doing this he incurred an additional cost: annual property taxes on his new holdings.

It is difficult to estimate what taxes might have been, but in the taxing jurisdiction where the two properties are located they would not have been very high. The tax rate is 75 cents per $100, and property is assessed at 50 percent of full value. The assessed valuation is the doubtful figure, but even if the assessor had appraised the stumpage at full conversion value, the annual tax bill would not have exceeded $4 for Area 1 and $7 for Area 2 (see Appendix C). If assessment were based on sale prices for comparable tracts or on a fixed wildland value they would have been much lower.

The fact remains that a prospective purchaser must consider the cost of property taxes. In some situations these taxes might be so high that they would absorb any possible cash receipts from operation. This is unlikely for properties like Area 2, where net cash receipts were 12 times the $7 highest probable tax; but it is distinctly possible for properties such as Area 1, where cash receipts are small because of the poor quality of the stand. If this were the case, the prospective buyer would need some motivation other than net cash receipts before he would buy forest land. These other motivating factors may be non-economic in nature.

One factor other than net cash receipts might be the prospect of increasing the value of the property acquired. Then too, this prospect might also be a management incentive for owners already holding woodland properties. The next section considers this prospect for the two study areas.

Increase in Property Value

The second type of earning from managing a forest property is the increase in capital value. These earnings do not take the form of cash income until the investment is liquidated, in whole or in part. In a sense they are forced savings. But they are earnings in a real sense, similar to the earnings on a Series E Government bond, which accumulate for years without yielding a cash income.

As already told, the two small woodland properties have been improved through the removal of culls and the harvest of the lowest quality material. The percentage of the merchantable volume in high value species has been increased, and the grade of this volume has been improved. After 10 years of management the stands on the two areas have been changed as follows:

	Merchantable volume per acre (bd.-ft.)	*In high-value species (percent)*	*In log grades I and II (percent)*	*Basal area in cull (sq. ft.)*
Area 1				
1949	4,600	56	17	6.5
1959	4,880	76	43	1.7
Area 2				
1949	9,200	69	32	10.0
1959	9,500	76	58	1.8

It is apparent from this tabulation that the value of the two stands, disregarding price changes, has increased in three ways:

- Through a small increase in merchantable volume.
- Through a change in species composition, with more volume in high-value species.
- Through an improvement in quality (grade).

A fourth factor that resulted in an increase in value was the circumstance that stumpage prices rose during the 10-year management period. A part of this rise was real, but some of it was simply a result of inflation--all prices

rose. To measure increases in value meaningfully, values are expressed in terms of 1949 prices.

A SMALL INCREASE IN MERCHANTABLE VOLUME AND CHANGED SPECIES COMPOSITION

In 1949 the average stumpage prices for sawtimber in high-value species, for sawtimber in low-value species, and for pulpwood and similar products, as computed from National Forest standard stumpage prices, were as follows:

High-value species	$9 per M board-feet
Low-value species	$4.50 per M board-feet
Pulpwood	$1.00 per 5-foot cord
Charcoal wood	$0.50 per 4-foot cord

These prices are used in computing the values of both the 1949 and 1959 stands to avoid the influence of rising stumpage prices.

It was found necessary, however, to modify the $9 average for the high-value species, because the quality in the high-value species on the two study areas was much lower

Table 5.--Increases in value from increased merchantable volume and changed species composition, 1949-59

(In terms of 1949 dollars)

Item	1949	1959
AREA 1		
Land	$ 201	$ 201
Sawtimber:		
High-value species	287	461
Low-value species	240	155
Products:		
Pulpwood	164	154
Charcoal wood	101	94
Total	$ 993	$1,065
Increase	--	$ 72
AREA 2		
Land	$ 204	$ 204
Sawtimber:		
High-value species	$1,057	$1,341
Low-value species	345	307
Products:		
Pulpwood	111	98
Charcoal wood	68	60
Total	$1,785	$2,010
Increase	--	$225

than that of the National Forest timber on which the averages were based. Area 1 had only 9.2 percent of its volume in Grade I and 8.3 percent in Grade II. Area 2 was somewhat better, but still below average. The computations by which average stumpage values were reduced to account for this low quality are shown in the Appendix (A) as are the other computations of value (Appendix B and D). The summaries are in table 5.

At first glance it may seem paradoxical to assign a stumpage value of $792 to Area 1 at the start of management when management of the property failed to meet logging costs. The explanation is that the timber given this stumpage value is not the same material that was harvested and sold. The good timber was held to add growth and value; the poorer timber was cut.

A SMALL INCREASE IN MERCHANTABLE VOLUME AND CHANGES IN BOTH SPECIES AND QUALITY

The analysis of changes in value attributed to improvement in grade is subject to several risks:

1. The technique of measuring quality in standing sawtimber has not been perfected. The grades used in this study were the Forest Products Laboratory standard hardwood log grades. Tree grades were based on the grade of the butt log. Because the same standards and techniques were used in grading the timber at the start of management and after 10 years, non-compensating errors should not be great.

2. At the start of management no logs in this area were sold on grade, and no established prices by grade were available. It is necessary to assume that the relative values of different log grades at present are not significantly different from the relation that existed 10 years ago. On this assumption the present ratios can be applied to 1949 grades and prices.

3. Although logs from these woodland areas and from other areas of the Fernow Experimental Forest are now being sold on grade, the prices paid are not determined in a competitive market. They are appraised values based on the value of grade lumber that can be cut from them, less manufacturing costs. Lumber grade prices are established in a competitive market. Manufacturing costs are known. The appraised values should be close to those that would be established through competition.

4. Though the logs from the study areas have an assured market for graded products, there is no certainty that other owners in the area could sell on grade. The values are there, but how will they be shared between the landowner and the timber buyer? It is reasonable to assume that the landowner would not realize them in a lump-sum stumpage sale. But timber on a managed forest property will not be sold all at once. It will be sold, instead, a little at a time, either as sawlogs or as stumpage. Most of the sawmills in West Virginia, except the very smallest, now grade their lumber and sell on grade. As log buyers, they recognize the quality in logs that will yield high-grade lumber. It is the opinion of consultants and operators in West Virginia that most, if not all, the value in high-grade sawlogs will be recognized in the prices paid in an increasingly competitive market.

Despite these risks, an analysis of value by grade has been made. To leave it out would be to ignore one of the greatest potential advantages of placing an unmanaged stand under management.

Stumpage values by grade were computed from the appraised value of graded logs at roadside, minus logging and skidding costs. In 1959 log and stumpage values were as follows:

Log grade	*Roadside value*	*Stumpage value*
I	$55	$34
II	38	17
III	24	3
IV & V	19	0

It is impossible to reconstruct stumpage values by grade for 1949. Though logging costs could be estimated, there is no means of approximating roadside log values by grade. However, the relation of the value of a stand in 1949 to the value of a stand in 1959 can be estimated through the construction of a weighted aggregate index. This will show the relative values of 1,000 board-feet of stumpage of the high-value species--the only ones where grade has an influence on value.

Per thousand board-feet, the upper grades contribute more to tree and stand value than do the lower grades. For example, by present value relationships, 1,000 board-feet of Grade I is worth twice as much as the same volume of Grade II, and eleven times as much as Grade III. To take these value differences into account, the volume in each grade was

weighted by its relative value, with Grade I given a weight of 1.00, Grade II a weight of 0.50, and Grade III a weight of 0.09. Using these weights, the relative values of 1,000 board-feet typical of the stands before and after 10 years of management were computed (table 6).

The combined effect of increased merchantable volume and changes in both species composition and grade of the high-value species is readily found by multiplying the 1959 values for the high-value species (table 5) by the appropriate index of relative value (Appendix E). Table 7 shows these values.

The $80 investment (table 4) that the owner of Area 1 would have to make to improve his stand would just about be realized from the small increase in merchantable volumes and the increase in high-value species (table 5). The improvement of quality in these species, if realized by the landowner, would add another $576 to his earnings. His net earnings over the 10-year period would then be $568.

The owner of Area 2 would make out even better. In addition to his net cash return of $847, the small increase in merchantable volume and improvement in species would add

Table 6.--Computation of relative values of 1,000 board-feet before and after treatment

1949				1959			
Grade	Bd.-ft. in grade	Weight	Product	Grade	Bd.-ft. in grade	Weight	Product
			AREA 1				
I	92	x 1.00 =	92.00	I	257	x 1.00 =	257.00
II	83	x .50 =	41.50	II	171	x .50 =	85.50
III	371	x .09 =	33.39	III	357	x .09 =	32.13
IV & V	454	x .00 =	.00	IV & V	215	x .00 =	.00
Total	1,000	--	166.89	Total	1,000	--	374.63
			Relative value 1959/1949 = 2.25				
			AREA 2				
I	108	x 1.00 =	108.00	I	366	x 1.00 =	366.00
II	210	x .50 =	105.00	II	215	x .50 =	107.50
III	363	x .09 =	32.67	III	300	x .09 =	27.00
IV & V	319	x .00 =	.00	IV & V	119	x .00 =	.00
Total	1,000	--	245.67	Total	1,000	--	500.50
			Relative value 1959/1949 = $2.04				

Table 7.--Increases in value from increased merchantable volume and from changed species composition and changed grade distribution in the high-value species, 1949-59

Item	1949	1959
AREA 1		
Land	$ 201	$ 201
Sawtimber:		
High-value species	287	1,037
Low-value species	240	155
Products:		
Pulpwood	164	154
Charcoal wood	101	94
Total	$ 993	$1,641
Increase	--	$ 648
AREA 2		
Land	$ 204	$ 204
Sawtimber:		
High-value species	1,057	$2,735
Low-value species	345	307
Products:		
Pulpwood	111	98
Charcoal wood	68	60
Total	$1,785	$3,404
Increase	--	$1,619

$225 to his earnings, and the rise in grade would add another $1,394. His total earnings would then be $2,466.

The situation that would bring the smallest net earnings is that of a purchaser who acquires property tax liability, who hires his marking, logging, and cull killing done, and who does not receive ACP payments (the fourth situation). If this set of conditions would provide net earnings, each of the other situations assuredly would.

Timber quality improvement is important in the early years of managing stands that have been high-graded and allowed to regenerate naturally (table 8). On Area 1 the improvement in quality, if realized by the landowner, would change it from a losing to a profitable operation. On Area 2 the earnings attributed to quality improvement ($1,619-$225) were more than half the total earnings.

This element of quality improvement is one of the least understood and most neglected aspects in past analyses of small woodland operations. To demonstrate its importance in the first stages of management we need only compare the rates of return on investment to a purchaser when quality changes are ignored or considered in the analysis.

RATE OF RETURN ON INVESTMENT

In computing the rate of return on investment it is desirable to eliminate the effects of a changing purchasing power of the dollar. This was done in the following analysis by using 1949 stumpage prices in computing 1959 values (table 8), and by expressing operating costs and receipts for sale of logs (table 4) in 1949 dollars.

Table 8.--10-year total earnings

FOURTH SITUATION

Item	Area 1	Area 2
Cash receipts:		
Gross	$1,342	$2,526
Costs:		
Logging	1,422	1,679
Taxes	37	67
Cull killing	30	51
Total	$1,489	$1,797
Net cash earnings	$ -147	$ +729
Increase in capital value--		
(a) From increased merchantable volume and improvement in species	$ 72	$ 225
Net total earnings	$ -75	$ +954
(b) From increased merchantable volume and improvement in both species and grade	$ 648	$1,619
Net total earnings	$ 501	$2,348

It is also necessary, when a time period of more than 1 year is considered, to discount costs and returns to a base year. In our analysis the increase in the value of the stand was assumed to have accrued in the tenth year, and was discounted to 1949.

In some analyses of return on investment the practice is to assume an appropriate interest rate on investment and carry interest as a cost. It is also common practice to use the assumed interest rate in discounting costs and returns to the base year. The objection to this is that no assumed rate of interest will meet the individual time preferences of all owners or prospective managers of forest land; nor can any one rate cover the varying degrees of risk under all conditions.

A solution is to compute the internal rate of return; that is, to discount all costs and returns at a rate that will bring the sum of the component discounted values to an amount equal to the initial value of the property. Determining this rate can be done only by a series of approximations, or by trial and error. If the first rate tried gives a discounted value greater than the original value of the enterprise, the rate chosen is too low. If another gives a discounted value less than the initial property value, it is too high. But a series of calculations will eventually bring the two values into equilibrium. This, then, is the rate of return on initial investment.

Following are rates calculated for the fourth situation, that is, for an owner who purchased the woodland properties 10 years ago, hired logging and cull-tree killing, and in addition did not receive ACP payments for killing cull trees (Appendix F):

	Rate of return	
Assumption:	*Area 1 (percent)*	*Area 2 (percent)*
1. That the landowner realizes nothing from improved timber quality	--	4.0
2. That full benefit of improved timber quality is received by the landowner.	3.4	8.5

If these rates of return are less than a prospective purchaser thinks he should receive, considering risks involved and alternate investment returns, he presumably will not be induced by economic reasons alone to acquire and put such properties under this type of management. If they are higher than the minimum rate he will accept, any economic deterrent to management will have been removed.

The rates of return for the two areas have been influenced by the stand conditions at the time management was started. Area 2--the better stand in terms of merchantable volume, species composition, and timber quality--was the more profitable investment during the first 10 years of management. The rates of return have also been influenced by recognizing quality improvement and the assumed realization of its value by the landowner.

Further stand improvement may be more difficult on Area 2 than on Area 1, and this will tend to reduce the difference in rates of return for the two areas over a longer period. But for the prospective purchaser seeking a fairly quick return, the 10-year comparison is significant.

A Look Ahead

Ten thousand board-feet per acre has tentatively been set as the desirable growing-stock volume for both areas. Unless there is reason to change this estimate of optimum growing stock, future management will provide for cutting only a part of growth until this level is reached. The marking of trees to be cut will continue to favor retention of the high-value species and trees that will develop logs in the two top grades. Trees below sawtimber size, if their removal is desirable, will be cut for pulpwood, charcoal wood, and other bulk products. Increased emphasis will be given to obtaining a distribution of tree sizes favorable for orderly stand removal.

Because the two stands are so different at present it may be well to consider the future management and prospects for the two areas individually.

AREA 1

Although the stand on this area has been greatly improved in species composition and quality, it still has a long way to go before stand volume will reach the prescribed level. The periodic annual growth for the past 10 years has been 228 board-feet per acre; at this rate it would take 20 years with no cutting to reach optimum stocking. But board-foot growth should accelerate. A large number of trees just below sawtimber size are ready to come into the sawtimber class. Growth during the next 10 years could well average 300 board-feet per acre, and for the following decade 350 feet may be a reasonable estimate.

If we cut half the growth until the 10,000-foot level is reached, and if we continue to improve species composition and quality, the stand may develop as follows:

	Merchantable volume per acre (bd.-ft.)	*In high-value species (percent)*	*In log grades I and II (percent)*
1959	4,880	76	43
1969	6,400	80	50
1979	8,100	80	58
1989	10,000	80	65

The economic returns will continue to result from cash sales and from an increase in the value of the property.

The increase in property value may not be so great as in the past 10 years, but the timber cut will be of greater unit value than it has been. The annual cut per acre will average 150, 175, and 160 feet for the next three decades, and then stabilize at around 400 board-feet per acre after 1989.

AREA 2

The stand on Area 2 lacks only 500 board-feet per acre of the level prescribed, and will reach this level in the next 10-year period. Species composition and tree quality are also approaching what may tentatively be considered optimum levels: These levels should also be reached by 1969:

	Merchantable volume per acre (bd.-ft.)	*In high-value species (percent)*	*In log grades I and II (percent)*
1959	9,500	76	58
1969	10,000	80	65

There will be little increase in property values from now on. Earnings will come mainly from the sale of logs. The annual cut will average 350 board-feet per acre for the next 10 years and then become stabilized at the predicted growth rate of 400 board-feet per acre. The cut of sawlogs from now on will come largely from the high-value species, and 60-65 percent of it will produce logs in the two top grades.

Appendix

A

CALCULATION OF 1949 STUMPAGE VALUES FOR HIGH-VALUE SPECIES

1. Average National Forest stumpage sale prices:

1949	$ 9.00 per M
1959	$12.00 per M

2. Prices by grade:

Grade	*1959*	*1949 (estimated at 9/12 of 1959)*
I	$34.00	$25.50
II	17.00	12.75
III	3.00	2.25
IV & V	.00	.00

3. Value per M feet in 1949, based on composition of an average M feet at estimated 1949 prices.

	Area 1			*Area 2*		
Grade	*Feet/M ft.*	*Value/M*	*Value*	*Feet/M ft.*	*Value/M*	*Value*
I	92	$25.50	$2.35	108	$25.50	$2.75
II	83	12.75	1.06	210	12.75	2.68
III	371	2.25	.83	363	2.25	.82
IV & V	454	.00	.00	319	.00	.00
Total	1,000	--	$4.24	1,000	--	$6.25

4. Value of the 1949 stand (high-value species)

Area 1

30.86 acres
x 2,195 feet (net volume/acre)
x $4.24/M feet
= $287.

Area 2

31.33 acres
x 5,398 feet (net volume/acre)
x $6.25/M feet
= $1,057.

5. Value of the 1959 stand at 1949 prices.

Area 1	*Area 2*
30.86 acres	31.33 acres
x 3,525 feet/acre	x 6,848 feet/acre
x $4.24	x $6.25
= $461.	= $1,341.

Note: The net volumes per acre used here and in Appendices B, D, and E are gross volumes, as shown in table 1, reduced by appropriate percentages for cull material.

C

CALCULATION OF PROPERTY TAXES BASED ON VALUE AT START OF MANAGEMENT

	Area 1	*Area 2*
Value of land and timber	$993	$1,785
Assessment at 50 percent of value	$497	$ 892
Annual tax at $0.75 per $100 of assessment	$3.73	$ 6.69

CALCULATION OF STAND VALUE AT START OF MANAGEMENT (1949)

	Area 1	*Area 2*
Land	30.86 acre x $6.50/acre = $201	31.33 acre x $6.50/acre = $204
Sawtimber		
High-value species	30.86 acre x 2,195 bd.-ft./acre x $4.24/M bd.-ft. = $287	31.33 acre x 5,398 bd.-ft./acre x $6.25/M bd.-ft. = $1,057
Low-value species	30.86 acre x 1,728 bd.-ft./acre x $4.50/M bd.-ft. = $240	31.33 acre x 2,445 bd.-ft./acre x $4.50/M bd.-ft. = $345
Products		
Pulpwood	30.86 acre x 5.31 cords/acre x $1/cord = $164	31.33 acre x 3.54 cords/acre x $1/cord = $111
Charcoal wood	30.86 acre x 6.55 cords/acre x $0.50/cord = $101	31.33 acre x 4.37 cords/acre x $0.50/cord = $68
Value of land and timber	$993	$1,785

CALCULATION OF STAND VALUE AFTER 10 YEARS OF MANAGEMENT (1959) ASSUMING THE LANDOWNER REALIZES NOTHING FROM IMPROVED TIMBER QUALITY

	Area 1	*Area 2*
Land	30.86 acre x $6.50/acre = $201	31.33 acre x $6.50/acre = $204
Sawtimber		
High-value species	30.86 acre x 3,524 bd.-ft./acre x $4.24/M bd.- ft. = $461	31.33 acre x 6,848 bd.-ft./acre x $6.25/M bd.ft. = $1,341
Low-value species	30.86 acre x 1,114 bd.-ft./acre x $4.50/M bd.-ft. = $155	31.33 acre x 2,178 bd.-ft./acre x $4.50/M bd.-ft. = $307
Products		
Pulpwood	30.86 acre x 4.99 cords/acre x $1/cord = $154	31.33 acre x 3.13 cords/acre x $1/cord = $98
Charcoal wood	30.86 acre x 6.12 cords/acre x $0.50/cord = $94	31.33 acre x 3.86 cords/acre x $0.50/cord = $60
Value of land and timber	$1,065	$2,010

CALCULATION OF STAND VALUE AFTER 10 YEARS OF MANAGEMENT (1959), ASSUMING THAT FULL BENEFIT OF IMPROVED TIMBER QUALITY IS RECEIVED BY THE LANDOWNER

	Area 1	*Area 2*
Land	30.86 acre x $6.50 = $201	31.33 acre x $6.50/acre = $204
Sawtimber		
High-value species	30.86 acre x 3,524 bd.-ft./acre x ($4.24/M bd.-ft. x 2.25 value relative for quality improvement) = $1,037	31.33 acre x 6,848 bd.-ft./acre x ($6.25/M bd.-ft. x $2.04 value relative for quality improvement) = $2,735
Low-value species	30.86 acre x 1,114 bd.-ft./acre x $4.50/M bd.-ft. = $155	31.33 acre x 2,178 bd.-ft./acre x $4.50/M bd.-ft. = $307
Products		
Pulpwood	30.86 acre x 4.99 cords/acre x $1/cord = $154	31.33 acre x 3.13 cords/acre x $1/cord = $98
Charcoal wood	30.86 acre x 6.12 cords/acre x $0.50/cord = $94	31.33 acre x 3.86 cords/acre x $0.50/cord = $60
Value of land and timber	$1,641	$3,404

F

SAMPLE CALCULATION OF INTERNAL RATE OF RETURN FOR AREA 2, ASSUMING THAT THE LANDOWNER REALIZES NOTHING FROM IMPROVED TIMBER QUALITY

Data:

1. Value of stand at start of management = $1,785.
2. Value of stand after 10 years of management = $2,010.
3. Net cash receipts during particular years (negative items are net cash outlays).

Year	*Amount*	*Year*	*Amount*
1	- $192	6	$ 126
2	- 43	7	18
3	197	8	64
4	42	9	256
5	79	10	43

4. Discount factors from compound interest table.

Discount period (years)	*Discount factors for--*	
	4%	*3.9%*
1	1.040	1.039
2	1.082	1.080
3	1.125	1.122
4	1.170	1.165
5	1.217	1.211
6	1.265	1.258
7	1.316	1,307
8	1.369	1.358
9	1.423	1.411
10	1.480	1.466

Calculations:

1. Assume 4% internal rate of return

Stand value at start of management — Net cash receipts and stand value after 10 years of management discounted to start of management period.

$$\$1{,}785 - \frac{\$192}{1.040} - \frac{\$43}{1.082} + \frac{\$197}{1.125} + \frac{\$42}{1.170} + \frac{\$79}{1.217} +$$

$$\frac{\$126}{1.265} + \frac{\$18}{1.316} + \frac{\$64}{1.369} + \frac{\$256}{1.423} + \frac{\$43}{1.480} + \frac{\$2010}{1.480}$$

$$\$1{,}785 < \$1{,}778.65$$

4% rate more than discounted net cash receipts and stand value after 10 years of management to equality with stand value at start of management. Therefore the internal rate of return is less than 4.0%

2. Assume 3.9% internal rate of return

$$\$1{,}785 - \frac{\$192}{1.039} - \frac{\$43}{1.080} + \frac{\$197}{1.122} + \frac{\$42}{1.165} + \frac{\$79}{1.211} +$$

$$\frac{\$126}{1.258} + \frac{\$18}{1.307} + \frac{\$64}{1.358} + \frac{\$256}{1.411} + \frac{\$43}{1.466} + \frac{\$2010}{1.466}$$

$$\$1{,}785 > \$1{,}791.17$$

3.9% rate failed to discount net cash receipts and stand value after 10 years of management to equality with stand value at start of management.

Conclusion:

It is apparent that the internal rate of return is between 3.9% and 4%, somewhat nearer the latter. Therefore it will be taken to be 4%.