OAK MANAGEMENT FOR WOOD PRODUCTS

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ABSTRACT. A method is presented for analyzing oak management alternatives through comparisons of the present value of the net cash flow produced. Even-aged management without age-class regulation returned $72.60 of present value over a 40-year period. In the next 40 years the only expenses reduce the present value to $72.43. To regulate this stand into a forest with an equal number of acres in each age class, the present value is estimated to be $71.08, for a regulation cost of $1.35 per acre. The average acre, selectively cut to create an all-aged stand, returns a present value of $63.17. This is a cost per acre of $7.91 for this type of management compared to the regulated even-aged forest.

AS A WOODLAND MANAGER responsible for growing timber products for a pulpmill, sawmills, and a veneer mill—while maximizing a return on the forest investment—I am concerned with the analysis of different management alternatives. So I will present a method of comparing different courses of action to maximize the return on an oak forest investment.

The first step in the analysis is a field inventory showing diameter distribution, stand age and number of stems, and volume and basal area per acre. This acre supports an oak stand that is typical in form of a large area of the Appalachians. It contains trees from 5 inches d.bh. to 24 inches d.b.h., with an average d.b.h. of 9.7 inches and a mode d.b.h. of 8 inches. It contains 19.9 cords, 1,355 board feet Doyle, a basal area of 110.1 square feet, is 60 years old, and has never been managed.

The value of this stand is computed at $1.50 per cord and at a variable board-foot price depending on the lumber return and manufacturing costs from $22.00 per M board feet to $54.14 per M board feet, with a resulting total wood volume value of $72.18. The bare land value is assumed at $5. The total value is $77.18 for the typical acre.

This value becomes a base to work from. We can, if we wish, liquidate our investment now or continue to manage in the expectation that it will return an acceptable rate of interest on the investment. An acceptable interest return for this would be 9 percent compound interest after taxes.

The next step is to simulate a hypothetical situation where the present stand can grow, and where it can be managed so the resulting future forest-product yields can be calculated with some degree of accuracy. The hypothetical stand is growing at the rate of 15 rings per inch for stems 6 to 8 inches d.b.h., 10 rings per inch for stems 10 to 12 inches and 8 rings per inch for stems 14 inches and larger. After 15 years of management, it is assumed that stems of all diameter classes grow at 10 rings per inch. This stand is considered to be on a better-than-average site.

The next step is to compute the present value of future income created by the management method under consideration. To illustrate this procedure, two management alternatives will be considered. Alternative No. 1 will program the hypothetical acre to maximize profit through intensive even-aged management. Alternative No. 2 will maximize profit through intensive all-aged management.

ALTERNATIVE 1: MAXIMIZED PROFIT BY INTENSIVE EVEN-AGED MANAGEMENT

To maximize profit, it is important to maximize early cash flow (after tax net profit plus depletion), taking care not to destroy a future potential. Cash flow, as an economic concept to determine return on investment, has created controversy among economists for some time. The fact that it includes depletion and depreciation as income, when to accountants they are considered costs, is at the root of the conflict. I feel that cash flow is a sound logical concept for a forest land investment in that we are dealing with a factor that produces a product forever without repair or additional capital expenditures. Unlike a sawmill, which must be overhauled or replaced periodically, the forest factory can be productive forever, can return the original investment, and at the same time can hold more volume than when it was purchased.

The first cut will be made to remove the larger sawlog trees, which are, for the most part, defective holdovers. In addition, it is important to remove, as pulpwood or bolts, those stems that will never make sawlogs This includes defective stems, low-quality trees lacking the ability to reach sawlog grade 2 at 14 inches d.b.h., and those stems that because of crowding will need to be removed to allow the better trees to develop. In this example, a total of 95 trees are all that will reach sawlog size under even-aged management.

Our first cutting removes 49 percent of the sawlog volume, 37 percent of the pulp volume, and 46 percent of the value (table 1). The objective is to group the diameters

Table 1.—*Typical first thinning in a previously unmanaged stand under the maximated profit alternative*

D.b.h. (inches)	No. stems	Board feet	No. stems	Cords	Basal area
			CUT		
6	—	—	20.0	0.6	3.9
8	—	—	40.8	2.9	14.0
10	—	—	7.1	1.0	3.9
12	—	—	3.0	0.6	2.4
14	1.9	99	6.7	1.8	9.2
16	3.2	187	1.0	.3	5.9
18	1.2	132	.4	.2	2.8
20	.5	85	—	—	1.1
22	.5	101	—	—	1.3
24	.2	60	—	—	.6
Total	7.5	664	79.0	7.4	45.1
			LEAVE		
6	—	—	36.0	1.2	7.0
8	—	—	20.0	1.4	7.0
10	—	—	42.0	5.9	22.8
12	—	—	20.0	4.0	15.6
14	7.0	373	—	—	7.5
16	3.0	263	—	—	4.2
18	.5	55	—	—	.9
Total	10.5	691	118.0	12.5	65.0

as tightly as practical with approximately 60 trees per acre of the best and biggest trees. I have chosen those trees in the 8 to 12-inch classes for my final clearcut while removing as many 6-inch trees as is practical and the mature and defective trees. If this initial cut results in a remaining basal area below that that will create maximum growth, it is not important. Under utilization of the site is only temporary, and the growth lost is pulpwood which, in this stand, can only be grown as a byproduct. Pulpwood growth seldom gives an acceptable return on investment, although many trees return their maximum return in this form.

Branching may be a problem when a stand is cut this drastically. I feel that this is a real consideration, and an area where more research should be done. My somewhat limited experience in this kind of cutting has convinced me that a residual basal area as described above will create at least some branching, but mostly confined to suppressed trees and upper crowns of intermediates.

In fifteen years, the stand will be thinned again, returning $76.80 from 1,773 board feet and 3.6 cords. Dollar values are at today's prices. In 30 years, another thinning returns $111.20. This stand is clearcut in 40 years, returning $312.10.

The question is: How good an investment has this been? Assume property taxes at $0.30 per year, overhead at $1 per year, and timber depletion as an additional expense of $3 per cord equivalent. For this computation, board-foot volume is converted to cords at the rate of 3 cords per 1,000. Taxes are computed on the assumption that the business has ordinary income; that is, income other than that receiving a capital-gains treatment. The expenses are used to offset this ordinary income, creating a tax savings to the business equal to 50 percent of the expense. It is also assumed that the timber values sold qualify for capital-gains treatment. Future cash flows are discounted at 9 percent.

This total computaton shows a combined discounted cash flow of $72.64 (table 2). Since the theoretical acre cost $77.18, it might first appear that the investment did not return 9 percent, and we should sell the land now and invest our money elsewhere. This is not necessarily the case, however, because increasing stumpage and land values were not a part of the computation. I feel that the effects of inflation or changing supply and demand are quite speculative and are not needed in a comparative analysis. If the purpose of analysis is to justify a purchase, future values and costs must be considered.

Observations of this management method are made easily by watching the simulation model develop. The management shown did not create a sustained yield in that sawlogs

Table 2.—*Computation of the after-tax present values of future cash flow-maximum profit alternative*

Item	Years 0	10	15	20	30	40	Residual value
Pulpwood income	$11.10	—	$ 5.40	—	—	—	—
Sawlogs income	24.84	—	71.40	—	$111.20	$312.10	—
Total	35.94	—	76.80	—	111.20	312.10	—
Property tax & overhead	—	—	19.50	—	19.50	13.00	—
Post-tax expense	—	—	9.75	—	9.75	6.50	—
Depletion	28.20	—	26.70	—	16.28	—	—
Income less depletion	7.74	—	50.10	—	94.92	312.10	—
Post-tax income	5.80	—	37.58	—	71.19	234.08	—
Cash flow	34.00	—	54.53	—	77.72	227.58	$1.16
Discounted cash flow	34.00	—	23.04	—	6.96	8.60	.04
Total discounted cash flow	—	—	72.60	—	—	—	—
Bare land value	—	—	.04	—	—	—	—
Total	—	—	$72.64	—	—	—	—

are produced beginning at age 60 and increase in volume to a very heavy cut at maturity. Pulpwood is produced at ages 40 through 70 as a byproduct of sawlog production. Because a large percentage of the oak type being considered is approximately 60 years of age, to accomplish sustained yield in the forest an investment in age-class regulation will be necessary.

A calculation of present value, similar to the above but not clearcutting until 90 years from now, results in $69.52. The cost of regulation for a stand made up of our simulated acre would be somewhere between the difference of our maximized profit stand and clearcutting in 90 years; assuming that acre regulation is to take place with mature timber, rather than clearcuts in immature stands. The present value of a regulated even-aged forest is probably close to the average of the two simulations, or $71.08.

ALTERNATIVE 2: ALL-AGED STAND CONVERSION

This analysis is not based on observations or measurements of actual stands, because I have yet to see an all-aged stand. My hypothetical stand is the same as case study No. 1 and is cut to maximize profit while creating a new age class every 10 years. The new age class covers 1/9 acre (90 year rotation) and requires the allocation of 12 square feet of basal area. The stand simulation thins 757 board feet and 7.4 cords with a value of $38.71. This is a heavier cut than our first alternative because of the need to reduce the basal area sufficiently to create a new stand.

The acre is cut according to the individual selection system for 80 years, in which time the original stand is completely removed through nine cuttings designed to create nine age classes.

I question whether it is possible under any practical management to create more than a two-storied stand. I base this on the feeling that to create surviving reproduction in our stand, the basal area must be reduced to 40 to 50 square feet and not be allowed to increase above 60 to 70 square feet before cutting. An initial cut this heavy would not leave enough stems to make partial cuttings economic over the regulatory period. Also, the quality of trees grown in this way would be very poor. In short, the all-aged acre probably does not exist except as a mental concept, and individual selection belongs as an intermediate partial cutting tool and not as a management philosophy.

The simulation was programmed to attempt the creation of an all-aged forest in a way that has a practical field application. The present value of the acre is $63.24, which includes the value of the stand remaining at the end of the regulatory period. Sawlogs were produced in fairly equal amounts every 10 years on what could be considered a sustained-yield basis. Pulpwood was produced in the first, seventh, and ninth cuttings, producing less total pulpwood than any system, and certainly not on a sustained-yield basis. The problem with pulpwood appeared immediately in the program when low production of only a cord or two per cutting was considered to be uneconomical to harvest. It was removed in partial cuttings only when its volume reached 4 cords per acre which, along with the sawlog component, could then be produced economically.

All-aged management will create a steady flow of logs and an intermittent pulpwood cut. Compared to even-aged management you can expect higher logging costs, higher management expense, and less usable wood growth.

MANAGEMENT ALTERNATIVE COMPARISON

Forest investments involve considerations of payback times, dilution of earnings and, of course, return on investment. In order to show these factors in a form that can be used to compare alternatives, a *present value index* is computed, using a 9 percent return as the point of comparison (table 3). For this example land value is assumed to increase in value by 9 percent to eliminate it as a factor in the comparison.

The stand on the sample acre has been grown in an assumed economy without inflation or increases in sawlog or pulpwood values. This has been done to avoid confusion or distortions that might have existed under an assumed drastic change in sawlog values, as an example. It is probable that a decreasing price for logs would result in a shorter rotation and a poorer profit picture while a sharply increasing future price would have the opposite effect. Table 2 is designed to allow future unit value changes along with predicted changes in costs. Table 3 is designed to include the future land values along with its growing stock.

The culmination of all the economic factors shows "all-aged conversion" as the system that maximizes profit for the first 10 years (fig. 1). At 15 years "maximized income" and "even-aged acre regulation" take the lead with "maximized income" showing its economic dominance after 30 years.

It can be seen that a company accustomed to a 9-percent return will suffer a dilution of earnings for 40 years. It takes 15 years to pay back the original investment under "maximized income" while "all-aged conversion" returns all but $1.15 in 10 years.

The sample acre as an investment does not look good compared with the large variety of other uses money can be put to. Our jobs, as foresters, is to improve the picture through the principles of multiple use and a more concerned role in the development and sales of forest-based products. We need to predict increasing unit prices for the future and incomes from sources other than wood.

FUTURE TIMBERLAND POTENTIALS

Management in today's complex world requires a broader understanding of the

Table 3.—*Economic comparisons of management alternatives*

Item	Years				
	0	15	30	40	80
Maximum income:					
Original investment	$77.18	$77.18	$77.18	$77.18	$77.18
Less present value timber cash flow	34.00	57.04	64.00	72.60	72.43
Net land investment	43.18	20.14	13.18	4.58	4.75
Less present value of land	5.00	5.00	5.00	5.00	5.00
Net present value cash in (out)	(38.18)	(15.14)	(8.18)	.42	.25
Present value index*	.51	.80	.89	1.01	1.00
	Years				
	0	15	30	40 • • •	90
Even-aged acre regulation:					
Original investment	$77.18	$77.18	$77.18	$77.18	$77.18
Less present value timber cash flow	34.00	57.04	64.00	66.96	69.52
Net land investment	43.18	20.14	13.18	10.22	7.66
Less present value of land	5.00	5.00	5.00	5.00	5.00
Net present value cash in (out)	(38.18)	(15.14)	(8.18)	(5.22)	(2.66)
Present value index*	.51	.80	.89	.93	.96
	Years				
	0	10	20	30 • • •	80
All-aged conversion:					
Original investment	$77.18	$77.18	$77.18	$77.18	$77.18
Less present value timber cash flow	36.31	53.09	58.33	61.13	63.17
Net land investment	40.87	24.09	18.65	16.05	14.01
Less present value of land	5.00	5.00	5.00	5.00	5.00
Net present value cash in (out)	(35.87)	(19.09)	(13.65)	(11.05)	(9.01)
Present value index*	.54	.75	.82	.86	.88

$$\text{* Present value index} = \frac{\text{Present value timber cash flow \& present value of land}}{\text{Original investment}}$$

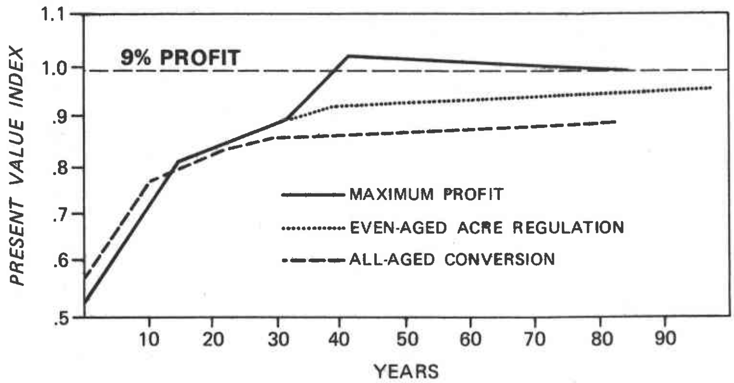

Figure 1.—A graphic comparison of the present value index created by management alternatives versus a 9-percent expected return on investment.

world around us than ever before. We are being asked to predict the future and, perhaps most important of all, to justify the existence of forest land as an investment with a fair return of wood products as a return on that investment.

The last 20 years has shown a phenomenal increase in the value of timberland (fig. 2). If this past performance continues into the future, profits from a forestry investment would seem to be assured, no matter how poorly we manage. However, maximized profits are realized by understanding this increase.

There are three major factors to be considered; bare-land value increase due to recreation demand, increase in stumpage values, and the movement of low-value pulpwood-size trees into the much higher value sawlog class. In the past 20 years, pulpwood stumpage values have not increased significantly, while sawlog values have increased 510 percent. The growth of pulpwood trees into sawlog trees has re-

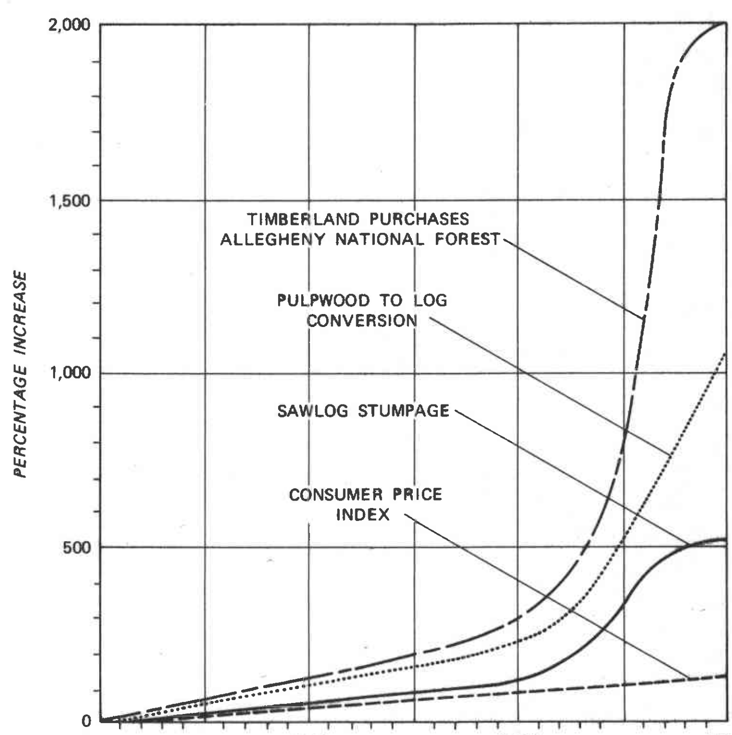

Figure 2.—Consumer price index compared with timberland appreciation.

sulted in 1,000 percent increase in value, leaving a comparatively meager 364 percent growth attributable to bare land values. I believe that the bare-land increase is deceiving in that recent years have introduced a buyer of timberland willing to pay about the same for a fully stocked acre as he will for a cut-over acre. So my figures are significant only in sales to forest-product-oriented buyers.

I feel that the stumpage-value increases will not be repeated in the next 20 years but will increase with lumber-value increases or at about the same rate as the cost of living. As forest managers, there isn't much we can do about this except to improve our marketing.

A manager's best opportunity to create maximum timber profits will be his management of potential sawlog trees. The sample acre, under maximized profit, shows increasing movement into sawlog sizes with value increases of this type ending in about 25 years.

The near future appears very favorable for timberland values, but they will not increase as much as would be indicated from a projection of the last 20 years. Also, much of the profit will be tied up in bare land and growing stock, which means that the investment will have to be liquidated to realize the profit. This is not always a feasible alternative for a wood-using industry.

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