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Management plan for
a mixed hardwood forest
in the lake states.
1946

A CRITICAL ANALYSIS
OF A
MANAGEMENT PLAN FOR A MIXED HARDWOOD FOREST
IN THE LAKE STATES

by
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INTRODUCTION

In 1938 the United States Forest Service completed a report entitled "Timber Management and Financial Plans for the Goodman Working Circle." It was prepared with the co-operation of Mr. R. B. Goodman, president of the Goodman Lumber Company.

Briefly, this report presented five separate plans of management for consideration with regard to 151 ,910 acres of mixed hardwood forests in northern Wisconsin, and considered specifically 24,093 acres of virgin timber, area A, and 17,515 acres, area B, that had been selectively cut from 1926 to 1936. Three of the five plans were sustained yield plans and two were liquidation plans. Of the sustained yield plans, the plan entitled, A Selective Cutting and Sustained Operation of Timber and Mill With the Annual Cut Equalling the Annual Growth Ten Years Hence, showed the largest net return and present worth value. This plan did not show a net return or present worth value greater than the plan entitled, Clear Cutting and Liquidation in Ten Years. It did, however, show a return on the investment of 6% which is probably as good a return as can be realized in any business today over a period of years.

The recommendation by the Forest Service with regard to these two areas was that the Goodman Company convert to

the selective cutting and sustained operation plan. Their further proposals were to cut on area A from 1936 to 1946, then to cut on area B from 1946 to 1956. In 1956 the company should then return to Area A and cut until 1966. At this time the two areas would be combined into a single management unit operated on a 20 year cutting cycle.

After intensive study of this report, it is believed that a better plan of management could have been proposed for the 24,093 acre tract; one that would have given a greater net return and present worth value from the first cut and which would have left a stand that shows possibilities of a greater volume cut in the more valuable size classes at the beginning of the next cutting cycle. Such a plan should then, when put on a financial basis, show a greater present worth value than the Forest Service's best sustained yield plan.

This paper attempts a critical analysis of the Forest Service plan by comparing the results of that plan with the results of the one composed herein. No alterations have been made in the basic data presented in the Goodman Report. They serve as a foundation of both plans.

Part I of the paper contains those tables and schedules necessary to show the cuts and returns when the 24,093 acres are managed under the Forest Service's best sustained yield plan. Some tables were lifted directly from the Goodman Report. Only the pertinent portions of other tables are presented as many of the tables contain data that are not

necessary to use in the analysis. Each table is preceded by explanatory data where necessary.

Part II contains those tables and schedules necessary to show cuts and returns when the 24,093 acres are managed under the alternative plan. For ease in comparison of tables of the proposed plan with the Forest Service plan, the tables in both parts will have the same number and those in Part II will also have a letter added to the number. For example, in Part I, Table I is the Stand and Stock Table of the 24,093 acres showing the average stocking of all timber combined on a cut and leave basis. Table IA in part II is the same table showing the average stocking of all timber combined on a cut and leave basis as proposed by the alternate plan. These tables also carry explanatory data.

Part III presents a discussion of both plans and the conclusions that can be drawn from the material presented in Parts I and II.

The writer expresses his appreciation to Professor D. M. Matthews of the School of Forestry & Conservation of the University of Michigan for the use of some materials in his text, Management of American Forests, and for his helpful suggestions in the preparation and organization of this paper. The writer is further indebted to his fellow students for their helpful criticisms and discussion of this problem while the work was in progress.

PART I

TABLE I

Table I represents the Stand and Stock Table of the 24,093 acres, showing the average stocking of all sawtimber combined. This table shows the timber recommended to be cut, and left, separately. In the Report, the Forest Service explains, "characteristics of the stands and species involved indicate the individual tree selection method to be the most desirable silvicultural system of cutting," and further, "the all age character of the virgin stands will be retained by selective cutting----this is accomplished by cutting trees in all age classes and of all diameters on the basis of their present condition and environment."

TABLE I

STOCK AND STAND TABLE
REMAINING UNCUT SAW
Volumes in
24,093 Acres

DBH	Sugar Maple: No. of Trees	Sugar Maple: Net Vol.	E. Hemlock: No. of Trees	E. Hemlock: Net Vol.	Y. Birch: No. of Trees	Y. Birch: Net Vol.	Basswood: No. of Trees	Basswood: Net Vol.	Elm: No. of Trees	Elm: Net Vol.	Red Maple: No. of Trees	Red Maple: Net Vol.
PROPOSED												
10	.02		1.39	25	.09	2	.03	1	.02			
12	.30	14	1.06	43	.29	10	.15	8	.05	3	.02	1
14	.24	20	.92	73	.60	41	.06	6	.05	5	.06	4
16	.59	78	.51	59	.77	81	.14	20	.03	4	.05	6
18	1.02	196	.51	88	.87	129	.17	35	.08	15	.06	10
20	1.02	261	.37	89	.54	109	.13	36	.08	20	.03	7
22	.82	260	.34	104	.46	126	.20	68	.08	27	.02	6
24	.71	268	.43	169	.33	115	.15	62	.19	85		
26	.48	218	.27	131	.18	76	.11	53	.12	63		
28	.11	58	.29	168	.08	40	.06	34	.05	33		
30	.07	44	.11	75	.02	11	.05	34	.05	39		
32	.03	22	.03	22	.02	12	.02	15	.03	27		
34	.02	16	.02	16					.02	20		
Total	5.43	1455	6.25	1062	4.25	752	1.27	372	.85	341	.24	34
PROPOSED												
2	48.65		2.34		4.02		3.30		4.62		2.40	
4	9.67		6.97		2.70		1.86		1.98		.84	
6	4.38		8.05		2.46		.90		1.14		.30	
8	2.51		7.78		1.86		.69		.74		.18	
Total	65.21		25.14		11.04		6.75				3.72	
10	2.84	65	6.03	121	2.21	44	.39	9	.90	21	.15	3
12	2.22	122	4.09	192	2.15	88	.51	28	.96	52	.05	2
14	2.19	221	3.10	285	1.92	156	.42	40	.66	65	.11	9
16	1.76	289	1.67	230	1.46	184	.42	64	.56	78	.02	3
18	1.25	308	1.04	220	.81	146	.29	63	.30	60		
20	.75	248	.26	78	.30	74	.22	65	.24	67		
22	.39	163	.12	47	.09	31	.06	22	.09	33		
24					.02	9	.02	9				
Total	11.40	1416	16.31	1173	8.96	732	2.33	300	3.71	376	.33	17
Net Cut and Leave	16.83	2871	22.56	2235	13.21	1484	3.60	672	4.56	717	.57	51

FOR THE AVERAGE ACRE
TIMBER TYPES COMBINED
Board Feet
Goodman Report-1936

Ash		Northern W. Cedar		Balsam Fir		Northern White Pine		Black and W. Spruce		Aspen		Total	
No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.
CUT													
		1.40	17	.62	6			.06	1	.06	1	3.68	53
.05	3	2.16	41	.44	11	.02	1	.11	6	.12	4	4.77	145
.11	10	1.74	75	.06	3	.03	3	.08	9	.09	6	4.04	255
.05	7	.72	51	.08	6	.02	3	.06	10	.02	2	3.04	327
.03	6	.57	50					.07	18			3.38	547
		.35	59			.02	7	.05	17			2.59	595
		.09	17									2.01	608
		.03	7									1.84	706
		.02	5									1.18	546
												.59	333
						.02	20					.32	223
												.13	98
						.02	25					.06	77
.23	26	7.08	312	1.20	26	.13	59	.43	61	.28	13	27.65	4513
LEAVE													
7.57		10.63		29.61				.96		.18		122.51	
1.56		8.23		13.33		.12		.42		.06		51.58	
.66		7.81		6.37		.06		.18				33.69	
.65		5.74		2.63		.08		.44		.02		23.61	
10.44		32.41		51.94		.26		2.00		.26		231.39	
.44	13	4.19	59	.78	8	.12	4	.21	3			18.26	350
.36	24			.13	3	.06	2	.23	13			12.32	560
	19	1.56	34	.02	1	.15	14	.18	20			9.63	866
.17	9	.71	36			.06	10	.06	10			6.34	898
.05	9	.26	21			.06	15					3.80	817
		.05	5			.05	18					1.82	550
						.02	9					.77	305
						.02	13					.06	31
1.02	65	6.77	155	.93	12	.54	85	.68	46			52.98	4377
1.26	91	13.85	467	2.13	38	.67	144	1.11	107	.28		~~13.80~~ 80.63	8890

TABLE II

Table II has been drawn up from Table I and shows the Stand and Stock Table of the average acre by diameter classes only, with the addition of columns showing the proposed cut and leave and Basal Area in square feet by diameter classes.

TABLE II

STAND AND STOCK TABLE - 24,093 ACRES
1936

DBH	No.of Trees	B. A., Sq. Ft.	Volume ft.b.m.	Proposed Cut: No.of Trees	Proposed Cut: Volume ft.b.m.	Proposed Leave: No.of Trees	Proposed Leave: Volume ft.b.m.
10	21.94	11.94	403	3.68	53	18.26	350
12	17.09	13.42	705	4.77	145	12.32	560
14	13.67	14.60	1121	4.04	255	9.63	866
16	9.36	13.08	1225	3.04	327	6.32	898
18	7.18	12.69	1364	3.38	547	3.80	817
20	4.41	9.63	1145	2.59	595	1.82	550
22	2.78	7.33	913	2.01	608	.77	305
24+	4.20	15.64	2014	4.14	1983	.06	31
Total	80.63	98.30	8890	27.65	4513	52.98	4377

The total basal area cut per acre was 46.68 square feet, leaving a basal area of 51.62 square feet in the residual stand.

TABLE III

Table III represents the Stock and Stand Table for the average acre of the 24,093 acres in 1957 or time of the next cut. Ten percent of the trees of the residual stand have been deducted to allow for mortality and the volumes have been projected twenty years into the future in the following manner: If the 8 inch diameter class tree would grow to become 11 inches in 20 years, the number of 8 inch trees today would be multiplied by the volume of an 11 inch tree. This calculation gives the volume of the present 8 inch trees 20 years hence.

This volume increase is based on an average growth rate of about 0.15 inches per year. "This assumption was made necessary due to the lack of more intensive information," the report states, "but preliminary studies on this point indicate the increase in diameter by inches is remarkably close for all diameter classes after selective cutting."

TABLE III

STOCK AND STAND TABLE FOR THE AVERAGE ACRE
PROPOSED SELECTIVELY CUT STANDS-20 YEARS HENCE

Volumes in Board Feet
24,093 acres Goodman Report-1936

DBH Today	Sugar Maple No. of Trees	Sugar Maple Net Vol.	E. Hemlock No. of Trees	E. Hemlock Net Vol.	Y. Birch No. of Trees	Y. Birch Net Vol.	Basswood No. of Trees	Basswood Net Vol.	Elm No. of Trees	Elm Net Vol.	Red Maple No. of Trees	Red Maple Net Vol.
					Estimated Stand							
8	2.26	90	7.00	238	1.67	37	.62	35	.67	19	.16	4
10	2.56	205	5.43	391	1.99	100	.35	34	.81	49	.14	9
12	2.00	270	3.68	423	1.94	176	.46	71	.86	89	.05	6
14	1.97	404	2.79	502	1.73	239	.38	84	.59	89	.10	19
16	1.58	458	1.50	390	1.31	252	.38	117	.50	105	.02	6
18	1.13	424	.94	329	.73	197	.26	102	.27	79		
20	.68	309	.23	105	.27	97	.20	89	.22	86		
22	.35	192	.11	66	.08	37	.05	30	.08	42		
24					.02	11	.08	14				
Total	12.43	2352	21.68	2444	9.79	1145	2.72	583	4.00	558	.47	44

TABLE III--Continued

Ash		Northern W. Cedar		Balsam Fir		Northern White Pine		Black and W. Spruce		Aspen		Total	
No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Volu	No.of Trees	Net Vol.
						Per Acre							
.59	29	5.17	98	2.37	52	.07	3	.40	20	.02		21.26	636
.40	37	3.77	151	.70	34	.11	9	.19	30			16.45	1039
.32	47	1.40	101	.12	10	.05	8	.21	33			11.09	1253
.15	31	.64	61	.02	3	.14	32	.16	38			8.67	1502
.05	14	.23	35			.05	17	.05	17			5.67	1411
		.05	11			.05	23					3.43	1165
						.05	30					1.65	725
						.02	15					.69	382
						.02	18					.06	43
1.51	158	11.26	457	3.21	99	.56	155	1.01	128	.02		68.91	8156

TABLE IV

Table IV has been drawn up from Table III and shows the Stand and Stock Table of the average acre by diameter classes only. The additional columns show Basal Area in square feet by diameter classes and the estimated DBH in 20 years.

The Forest Service states that a 50% cut or a volume of 4,221 ft., b. m. can be made on this stand.

Note that the total Basal Area is 83.30 square feet. This is a reduction of 15.00 square feet per acre over the original stand that carried 98.3 square feet of Basal Area.

TABLE IV

STAND AND STOCK TABLE OF AVERAGE ACRE
24,093 ACRES - 20 YEARS HENCE

DBH Today	No. of Trees	B. A., Sq. Ft.	Volume ft.b.m. 20 yrs.	Est. DBH 20 yrs.
8	21.26	14.05	636	11
10	16.45	15.19	1039	13
12	11.09	13.60	1233	15
14	8.67	13.68	1502	17
16	5.67	11.18	1411	19
18	3.43	8.25	1165	21
20	1.65	4.76	725	23
22	.69	2.35	382	25
24	.06	.24	45	27
Total	68.97	83.30	8136	

SCHEDULE I

Schedule I is the tabulated results of the dry lumber values per acre of trees by species and diameters, and the total cost per acre by species as derived by the Forest Service. The difference between the values per acre and cost of production per acre is the gross realization per acre (before taxes and depletion.)

These figures for each species were derived in the same manner as those in Form III, Part II. See explanatory data to Form III.

SCHEDULE I

DRY LUMBER VALUES PER ACRE OF TREES BY SPECIES AND DIAMETERS

DBH	Maple	Eastern Hemlock	Yellow Birch	Basswood	Soft Elm	Red Maple
10		1.22	.09	.03		
12	.46	1.96	.57	.36	.11	.03
14	.70	3.11	1.69	.30	.17	.15
16	2.83	2.36	3.41	.95	.15	.22
18	7.83	3.35	5.62	1.67	.54	.36
20	10.17	3.23	4.84	1.75	.73	.27
22	10.45	3.64	5.80	3.36	1.00	.25
24	11.07	5.78	5.50	3.19	3.19	
26	9.30	4.41	3.77	2.78	2.46	
28	2.58	5.54	2.07	1.86	1.31	
30	2.02	2.46	.56	1.88	1.55	
32	1.02	.71	.65	.87	1.11	
34	.77	.49			.84	
Total 10"up	58.70	38.26	34.37	19.00	13.16	1.28
Cost 10" up	44.82	34.67	22.59	11.38	9.97	1.13

SCHEDULE I-Continued

Ash	N.White Cedar	Balsam Fir	N.White Pine	Spruce	Aspen	Grand Total	DBH
	.81	.31		.06	.03	2.55	10
.12	1.87	.49	.08	.27	.16	6.28	12
.36	3.17	.13	.18	.38	.22	10.56	14
.28	2.02	.25	.18	.38	.06	13.09	16
.23	1.86			.71		21.67	18
	1.77		.36	.62		23.74	20
	.59					25.09	22
	.25					28.98	24
	.19					22.91	26
						13.36	28
			1.06			9.53	30
						4.36	32
			1.37			3.47	34
.99	12.53	1.18	3.23	2.42	.47	185.59	
.96	12.12	1.19	1.77	2.28	.45	143.35	

GROSS REALIZATION PER ACRE (Before Taxes and Depletion) 42.26

SCHEDULE II

Schedule II shows the net income per MBM before land and timber taxes and forestry expenses are deducted. The 'Source of Data' column shows how the figures in column two were derived. The figures for taxes, social security, etc. are taken directly from pages of the Report; hence where 'Report' appears it means that the data came from a table in the Report which does not appear in this paper.

SCHEDULE II

Derivation of Net Income per MBM
Before Land and Timber Taxes and Forestry
Expenses are deducted.

ITEM		Source of Data
A. Total Value removed per acre	$185.59	Schedule I
B. Cost of Production	143.33	Schedule I
C. Gross realization on Lumber per acre	42.26	A-B
D. Volume-mill scale per acre	5,239	Report
E. Increased revenue per acre	23.58	$4.50 x D
F. Total gross realization per acre	65.84	C + E
G. Charge for depletion of stumpage ($6.50 x Vol. cut per acre, log scale)	29.33	$6.50 x 4513 bd.ft
H. Net realization per acre. (before any taxes)	36.51	F -G
I. Total net income before taxes	87,953	H x 2409 acres
J. Less taxes on land and timber	15,000	Report
K. Less social security and excise tax 11,160	11,610	3% of $372,000
L. Total net taxable income	61,793	I - J and K
M. Federal normal tax	8,109	13% of L
N. Adjusted and undistributed net income	53,684	L - M
O. Federal tax on capital tax	1,200	0.1 x $1,200,000
P. State normal tax	3,708	6% of L
Q. State surtax (1/6 of normal tax)	618	1/6 of P
R. Total federal and state taxes	13,635	M + O + P + Q
S. Total income after income and stock taxes	48,158	L - R
T. Total net income less 2% state tax on dividends or net cash dividends availabel to stockholders	47,195	S - 2%
U. Total net income per MBM, log scale	3.93	T ÷ annual cut
V. Total net income per acre	17.74	U x Volumbe cut 1.S.
W. Annual taxes on land and timber	15,000	J above
X. Forestry and marking expense	8,040	12,000 MBM x $.67
Y. Total annual charge	23,040	W + X
Z. Charge per MBM, log scale	1.92	Y ÷ amount cut
AA. Net income per MBM before land and timber taxes and forestry expense are deducted.	5.85	U + Z

SCHEDULE III

Schedule III shows the derivation of total revenue per M, Mill Scale and total operating costs per M, Mill Scale. The difference between the revenue and cost gives gross realization per M. These figures are taken directly from the Report but arranged in a little different manner than the tables from which they were taken.

SCHEDULE III

TOTAL REVENUE AND OPERATING COSTS PER M, MILL SCALE

Total revenue per acre - Lumber only	$185.59	
Increase revenue due to veneer:		
$4.50 per M x 5,239 ft., b.m., mill scale	23.58	
Total	$209.17	
Revenue per M, Mill Scale:		
$209.17 ÷ 5,239		$39.93
Direct Costs, per M that vary with the size of the tree.		
Felling and bucking	$ 2.62	
Skidding and swamping	1.78	
Loading and unloading	.74	
Hauling (Operation and Maintenance)	3.43	
Total	$8.57	
Indirect logging costs per M that vary with the volume cut per acre.		
Supervision - woods work	$ 0.54	
Woods - general expense	.80	
Forester's salary and expense	.67	
Total	2.01	
Total logging cost, Log Scale	$10.58	
Overrun at 16.1%, therefore		
Total logging cost, Mill Scale	$ 9.11	
Total direct milling costs per M that vary with the size of trees cut.	$ 2.76	
Total general indirect milling costs per M that vary slightly with the size of trees cut.	$3.48	
Total indirect milling costs per M that are fairly constant per M	$6.03	
Total indirect milling costs per M that vary most with the total annual cut.	$5.28	
Operating costs per M, Mill Scale		25.66
Gross realization per M		$14.27

SCHEDULE IV

Schedule IV shows the results of the financial calculations in determining the present worth values of the first cycle and all subsequent cycles. The figures used to develop item L, Total net realization annually, are taken from Schedule II. Total revenue per M and total current operating costs per M were derived in Schedule III.

The following explanation relates how the Forest Service determined the present worth value of the future incomes under their best sustained yield plan. It is quoted directly from the Goodman Report:

"The present worth values are determined on the basis of a risk-free rate of interest of 3 per cent, and also on the rate of interest indicated by discount for hazard of 30 per cent.

It is believed that a 3 per cent risk-free rate of interest is conservative. The results obtained by using 4 per cent as the basic rate of interest would not differ radically from those obtained. Governments bonds, for example, have earned 3 to 4 percent annually over the course of the last 50 years, and it does not seem likely that present economic conditions will alter these earnings for some time in the future.

If the business of holding and cutting timber and

of manufacturing lumber had no hazards the values indicated under the 3 per cent rate would be reliable. To allow for the actual hazards of operation some provision must be made for risk. In an attempt to reach a reasonable discount for these hazards the following risks are listed, and an effort made to appraise how much each might affect the average annual net realizations.

Accuracy of timber estimate	-	10%
Losses from fire, insects and disease	-	1
Possible changes in cost of logging and milling	-	2
Possible increase in taxes	-	2
Average fluctuation of markets and prices	-	15
		30%

When one attempts to appraise the present value of future incomes, it is necessary to make use of present worth factors. If, for example, one wishes to arrive at the present value of ten annual payments of $1 each to be received during the next 10 years, one can consult present worth tables in text books on valuation and find that these ten future payments are worth $8.53, if 3 per cent is assumed as a safe rate of interest. In other words, $8.53 would, if now placed in a bank or investment yielding 3 per cent annually, produce enough interest to increase the value of the original deposit in 10 years to a sum that equals the ten annual payments and interest on them during the same period.

Since it was decided that this plan has an average annual hazard of about 30 per cent of the net realization, the present worth values have been determined by using the rates

of interest indicated in Grimes and Craige's curves on Page 152 of their book "Principles of Valuation." These curves indicate the rate of interest that one should use to secure a specific factor of safety (the complement of discount for hazard secured by subtracting the latter from 100) in analyzing present worth values. If the present worth of ten annual payments of $1 is $8.53 at 3 per cent and $8.11 at 4 per cent, the factor of safety between these two appraisals of value is obtained by dividing the value of the lower by that of the higher value as follows:

$$\frac{\$8.11}{8.53} = .95 \text{ or } 95\% \text{ factor of safety}$$
(100% - 95% = 5% discount for hazard)

Grimes and Craige express their factors of safety in decimals - as .95 for 95 per cent shown above. To take the ten annual payments of $1 each and learn what rate of interest should be used to allow a discount of 30 per cent for hazard (or factor of safety of 70 per cent) the following is necessary.

First : Take the value shown by the safe rate of interest (3 per cent) and multiply it by the factor of safety: $8.53 x .70 = $5.97.

Second : Refer to Table IX (Page 235) of Grimes and Craige, and see what rate of interest would indicate the closest value to $5.97 in ten years. This will be found to be 11 per cent.

Third : Refer to the curve for factor of safety of .70 on Page 152 of Grimes and Craige, and it will be found that it also indicates 11 per cent for a ten-year period. Under Table IX the present worth factor under 11 per cent indicates $5.98 as the value of ten annual payments of $1 each, when the factor of safety is about .70.

The first two steps indicate how the curves are built

up; the third step is all that is necessary now to determine the rates that should be used to secure values in line with a factor of safety of .70. In the manner indicated by the third step the rates of interest were obtained and new present worth factors secured from Table IX, page 235, of Grimes and Craige.

This detailed explanation is shown, to give the foundation for the use of the present worth factors shown in the plan. In this plan the following factors are used:

Present Worth Factors for Series of Equal Annual Payments
(Compound interest annuity valuation formula)

No. of Years	Using 3% as a risk-free rate of interest	Using rate of interest indicated by Grimes & Craige curves-hazard 30%
10	8.530	5.889 (11%)
perpetuity	3% capitalization rate	3.9 capitalization rate

Discount Factors for Single Payments
(Compound interest deferment valuation formula)

10	1.344	1.967 (7%)

Sinking Fund Factor:

10	.087231
20	.037216

The Present Worth Factors for series of Equal Annual Payments were identified in the manner as described above with the exception of the 3.9% capitalization rates in perpetuity when allowing a discount for hazard of 30%.

It is believed that this figure is in error. The factor is based on the compound interest annuity premise, and when the time is perpetuity, it can be calculated by the following formula:

$$\text{Factor of safety} = \frac{\text{Risk free rate of interest}}{\text{Rate of interest allowing a discount for hazard.}}$$

or $FS = \frac{.0s}{op}$

By substitution in this formula of the known values we can solve for .op, the capitalization rate in perpetuity when allowing a discount for hazard of 30%.

FS = 100% - 30% = 70%

Risk free rate of interest = .03

Therefore $.70 = \frac{.03}{.op}$ and

$.70 \times .op = .03$ whereby

$.op = \frac{.03}{.70}$ or

$.op = 4.3\%$

This correction necessitated recalculating the financial calculations in Schedule IV from item R through item U to get values that can be compared with the alternate plan proposed herein.

These new values are shown on page 27, in Schedule IV.

SCHEDULE IV

Selective Cutting and Sustained Operation of Timber and Mill With the annual Cut Equalling the Annual Growth 10 years Hence.

Basic Data

A. Annual Cut - 13,932 MBM, mill scale
12,000 MBM, log scale
In this plan it is recommended that 1,674 MBM of the annual cut be purchased annually.

B. Present Volume - 308,838 MBM, log scale

C. Period of conversion to sustained yield - 10 years

Average Net Returns During Period of Conversion

D.	Total revenue per M, all products	$39.93 mill scale	
E.	Total current operating costs per M	25.66 " "	
F.	Gross realization per M (D - E)	$14.27 " "	
G.	Total annual gross realization for period of 10 years before depletion, depreciation and income taxes (A x F)		$198,810
	-Less cost of purchases stumpage of 1,674 MBM at an assumed cost of $6.50 per M log scale.		10,881
			$187,929
H.	Federal and state income and capital stock taxes.		$ 13,635
I.	Social Security tax.		11,160
J.	Estimated losses from obsolescence, etc.		4,000
K.	Total reductions of annual gross realization (H,I,J)		28,795
L.	Total net realization annually.		159,134

Present Worth Value of All Future Net Realizations

		Using 3% as a risk-free rate of interest	Using rate of interest indicated by discount of 30% for hazard
M.	Present worth of 10 annual incomes of $1 each.	$8.530	$5.889

	Using 3% as a risk-free rate of interest	Using rate of interest indicated by discount of 30% for hazard
N. Present worth of net realizations of the next 10 years (L x M)	$1,357,415	$937,140
O. Average annual cut, log scale, after next 10 years	10,000 MBM	10,000 MBM
P. Estimated average net return per M, Log scale (First 10 years it is $13.26 per M, log scale, and although a slight reduction of the annual cut is provided for it is believed the net realization per MBM would be maintained)	$13.36	$13.26
Q. Average net return after next 10 years	$132,600	$132,600
R. Capitalized value of average net return of $132,600 on a continuous basis at 3% and 3.9% respectively	$4,420,000.	$3,400,000
S. Value of $1 at compound interest in 10 years	$1.344	$1.967
T. Present value of realizations after the next 30 years	$3,288,690	$1,726,521
U. Present worth value of all future net realizations	$4,646,103	$2,665,661

Sinking Fund Required Annually - First 10 Years

1/4 of $2,771,128 = $692,782

$692,782 x .087231	$60,432
200,000 x .037215	7,443 (To replace plant every 20 years)
Total sinking fund	$67,875

Rate Earned - First 10 Years

Net realization	$159,134
Sinking fund	67,875
	$ 91,259

$\frac{91,259}{2,771,128} \times 100 = 3.3$ per cent.

Rate Earned - After 10 years

3/4 of $2,771,128	$2,078,346

Net realization	$132,600	
Sinking fund	7,443	(To replace plant every 20 years)
	$125,157	

$\frac{125,157}{2,078,346} \times 100 = 6.0$ per cent.

Calculations of present worth values, item Q thru U, based on the correct capitalization rate in perpetuity when allowing for a hazard of 30%.

Q.	Average net return after net 10 years.	$ 132,600
R.	Capitalized value of average net return of $132,600 on a continuous basis at 4.3%. Q ÷ 4.3%	3,081,000
S.	Value of $1 at compound interest in 10 years.	1.967
T.	Present value of realizations after next 30 years. r ÷ S	1,567,000
U.	Present worth value of all future net realizations. T + N	2,504,140

PART II

THE THEORY OF THE BASAL AREA METHOD OF CONTROL TO DETERMINE HARVEST CUTS

"Normal yield tables present data with regard to yield, number of stems, and basal area per acre to be expected in even age fully stocked stands at different ages throughout the life of a forest from youth to old age. Our all age forests, as nature or previous logging operations present them to us for management carry various grouping of different aged trees all on one acre, and the comparison of the data presented by the ordinary stock and stand table for an all age forest with that contained in a yield table for the same species will get us nowhere ---- What we require for comparison with the all age stand and stock table is data for the same or similar species on the all age arrangement, which is normal. Such data can rarely, if ever, be found and measured in natural stands, but we can prepare such an arrangement of data from ordinary yield tables."[1]

When the Basal Area Method of Control is to be used as a management tool, the only data necessary to take from a normal yield table are the Basal Area figures. These figures then arranged in predetermined cyclic age groups become applicable as a control table for use in classifying

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[1]Matthews, Professor D.M., Management of American Forests, (McGraw Hill, 1935)

the stand and stock table of the actual all age forest. Such an arrangement is justified when we see that the basal area percentages of age groups in all age normal yield tables as constructed by Matthews show that species of similar habit and growth have approximately the same percentage distribution of basal area for a definite cutting cycle regardless of what site conditions or total basal area may be.

TABLE —COMPARISON OF ALL-AGE CONTROL TABLES FOR OAK IN EUROPE AND MIXED HARDWOODS IN NEW ENGLAND
Rotation 80 years; cutting cycle, 10 years

Age group, years	Mixed hardwoods, New England[1]						Oak (after Schwappach, Prussia)[2]					
	B.A., sq. ft.	% of total B.A.	Vol., cu. ft.	% of total vol.	Diameter range, in.	No. of trees per acre	B.A., sq. ft.	% of total B.A.	Vol., cu. ft.	% of total vol.	Diameter range, in.	No. of trees per acre
	Site Class I						Site Class I					
0–10	.....	.....	....	.....	.....	...	....	....	....	.....	.....	....
10–20	.....	.....	....	.....	.....	...	....	....	....	.....	.....	....
20–30	10.8	*10.2*	199	7.0	3.1–4.4	141	6.8	*10.8*	84	4.5	1.7–2.8	280
30–40	14.8	*14.0*	326	11.4	4.4–5.5	113	8.6	*13.8*	169	9.0	2.8–4.4	134
40–50	17.3	*16.4*	435	15.2	5.5–6.7	88	10.1	*16.2*	266	14.2	4.4–6.3	69
50–60	19.3	*18.2*	535	18.7	6.7–8.1	66	11.3	*18.0*	364	19.4	6.3–8.3	40
60–70	21.0	*19.8*	634	22.2	8.1–9.7	49	12.4	*19.8*	454	24.3	8.3–10.2	27
70–80	22.6	*21.4*	728	25.5	9.7–11.2	38	13.4	*21.4*	535	28.6	10.2–12.2	20
Total.	105.8	100.0	2,857	100.0		495	62.6	100.0	1872	100.0		570
	Site Class II						Site Class III					
0–10	.....	.....	....	.....	.....	...	....	.....	....	.....	.....	....
10–20	.....	.....	....	.....	.....	...	....	.....	....	.....	.....	....
20–30	8.4	*9.9*	111	5.5	...–3.4	172	5.6	*10.3*	11	1.6	...–1.4	565
30–40	11.2	*13.2*	222	11.1	3.4–4.2	141	7.2	*13.3*	38	5.5	1.4–2.3	416
40–50	13.7	*16.2*	312	15.5	4.2–4.9	118	8.7	*16.0*	76	11.0	2.3–3.6	198
50–60	15.6	*18.4*	388	19.4	4.9–5.8	97	9.9	*18.3*	125	18.2	3.6–5.0	103
60–70	17.1	*20.2*	454	22.7	5.8–6.8	85	11.0	*20.2*	185	26.9	5.0–6.5	64
70–80	18.7	*22.1*	517	25.8	6.8–8.0	63	11.9	*21.9*	253	36.8	6.5–7.9	44
Total.	84.7	100.0	2,004	100.0		676	54.3	100.0	688	100.0		1,390

[1] Compiled from Table II, *Harvard Forest Bull.* 2, Growth Study and Normal Yield Tables for Second-growth Hardwood Stands in Central New England by Spaeth.

[2] Compiled from Table in Appendix II, p. 244, of "The Economics of Forestry" by W. E. Hiley.

FORM I

A control Table has been prepared using the Basal Area figures from S. R. Gevorkiantz and William A. Duerr's "Yield Table For Average Well Stocked Stands of Northern Hardwoods in the Lake States".[1]

As the forest to be classified is of medium site, the medium site table was used in the calculations though the basal area figures of either of the other two site tables could have been applied as well.

The steps to set up the Control Table are as follows:

1. Draw a curve of basal area over average stand diameter from medium site yield table. (see Graph 1). Graph 1 was prepared from the above mentioned yield Table.

2. Determine the growth rate, mean annual increment, in inches to be expected for the acutal forest. As the Forest Service in the Goodman Rep ort determined this as 0.15 inches a year, this growth rate has been used.

3. Decide what the probable maximum size timber to be produced in the regulated forest will be. This size has been set at 22 inches with an average of about 20 inches. The Forest Service proposed cutting clear to 24 inches, but it is believed that the interest return on keeping trees beyond 22 inches does not cover the cost of carrying them.

4. Decide upon the cutting cycle for the actual forest. The 20 year cutting cycle has been used as that is the aim of the p lan proposed by the Forest Service.

5. Determine the limit of cruise. This has been set at 10 inches, the lower limit of merchantibility. There is an adequate growing stock below this limit to assure the success of a sustained yield program.

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[1]Published in Journal of Forestry, (June, 1937)

From the data of 2,3,4, and 5 above, the number of cyclic age groups into which the total basal area of the Control Table will be arranged, and after, the stand and stock table, can be determined by the following formula:

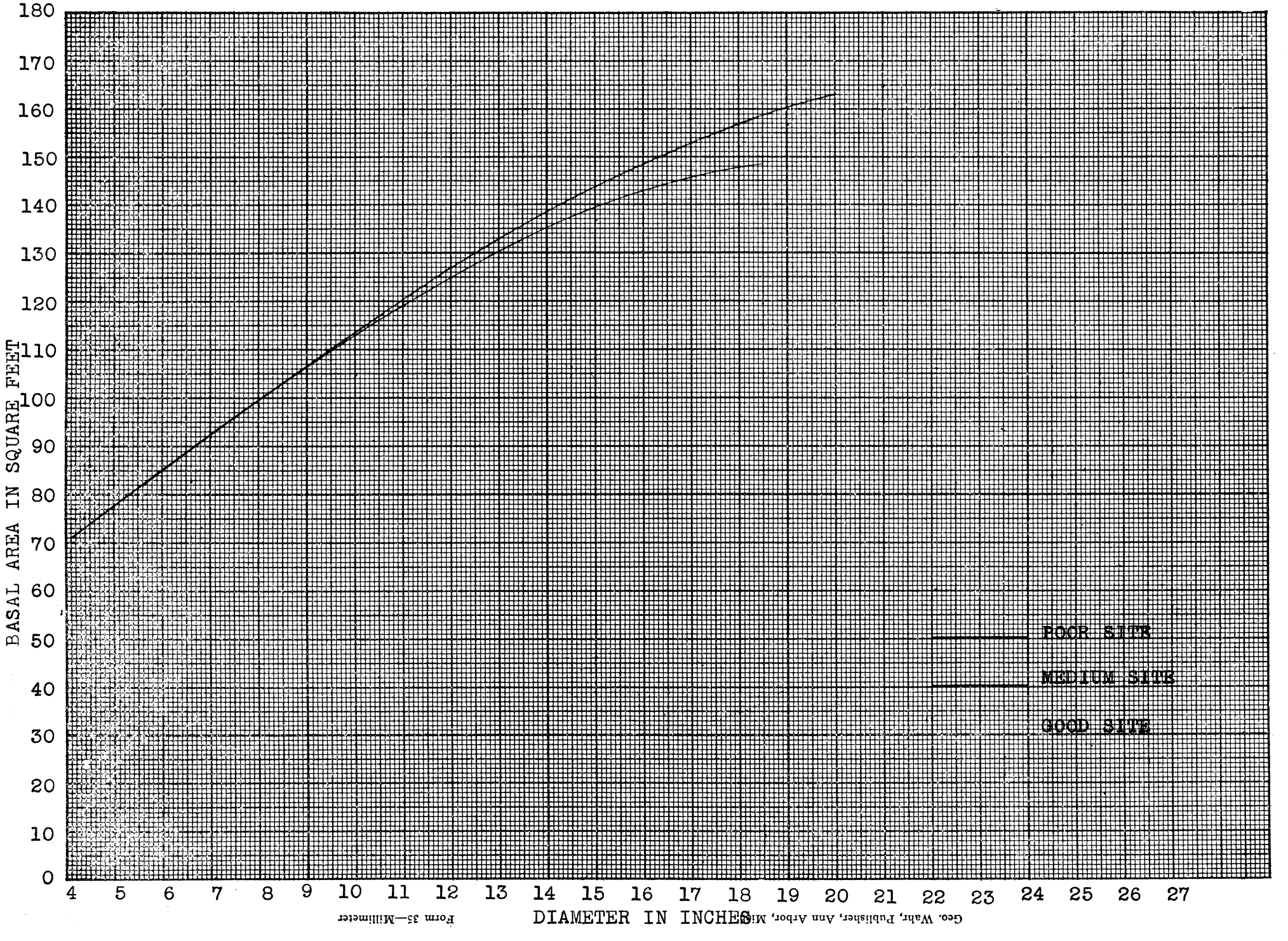
$$\frac{\text{maximum size timber to be expected - lower limit of cruise}}{\text{cutting cycle x MAI in inches}}$$

equals $\frac{22" - 10"}{20 \times 0.15}$ equals $\frac{12}{3}$ equals 4 cyclic age groups.

6. The probable average diameter of trees within each age group is determined. For the four age groups the diameter range is from 22 inches down to 10 inches or a range of 12 inches. Therefore each group will have a diameter range of 3 inches, i.e., Group I will range from 10" to 13",-- and Group IV from 19" to 22". The averages of these groups are then calculated being 11.5" for Group I, 14.5" for Group II, 17.5" for Group III and 20.5" for Group IV. The quantity of basal area in square feet which one fully stocked acre of these average diameters would carry is then read from the Basal Area curve in Graph I.

The preceding data are tabulated in Form I and the percentage of basal area which should be allocated to each age group is determined by dividing the basal area of each age group by the total basal area of all groups. These percentages of basal area per age group can now be used as a control in classifying the stand and stock table of the actual forest.

GRAPH I



Geo. Wahr, Publisher, Ann Arbor, Mich. Form 33—Millimeter

FORM I

CONTROL TABLE - DETERMINED FROM YIELD TABLE

Age Group	DBH Range	Average Diameter	Basal Area Sq. Feet	Basal Area Per Cent
I	10 - 13	11.5	123	21.9
II	13 - 16	14.5	141	24.6
III	16 - 19	17.5	155	26.3
IV	19 - 22	20.5	164	27.2
Total			583	100.0

FORM II

Form II shows the stand and stock table of the actual forest as classified into age groups under the Basal Area Method of Control. The following discussion explains how it was classified.

The total square feet of basal area of the stand and stock table of the actual forest is 98.3 square feet. From the Control Table we see that Group IV should carry 27.2% of this total basal area or 26.7 square feet. Adding up from the bottom of the basal area column of the Stand and Stock Table of the actual forest, we see that the basal area 22" and up totals 22.97 square feet. As a cut of 26.7 is allowable, 26.7 minus 22.97 or 3.73 square feet can come from the 20" class. The 20" class contains 9.63 square feet of basal area, 4.41 trees and 1145 ft.,b.m. Therefore, 3.73 ÷ 9.63 or 38.8% of the basal area, number of trees and volume in the 20" class will be included in Group IV. Similar calculations are done for each group and are shown in total on page 37. The totals of the number of trees and volumes in each group as calculated are then tabulated into the classified stand and stock table.(Form II)

The Estimation of the Possible Cut

From the calculations to classify the stand and stock table and the classified table itself an estimation of the annual possible cut can now be made.

We can take all of Group IV, plus any thinnings in the other age groups over and above the number of trees that

are necessary to leave to carry forward for the next cut, and which should have the basal areas as shown in the classified stock and stand table. The present stand is about 86% stocked as determined by the Forest Service. To help bring the stand up towards full stocking no thinnings were considered in Groups I and II. Unless there were defective trees in these groups that would not carry through to the next cycle these two groups would remain as they are. A thinning was made in Group III and is calculated in the following manner:

The average diameter of trees in Group III is 17.7". In 20 years, the time of the next cut, they should average 20.7" (MAI 0.15" per year) and should carry 26.7 square feet of basal area. The number of trees in Group III to carry forward then:

$$\frac{\text{Basal Area in square feet of Group IV}}{\text{Basal Area of a 20.7" tree}}$$

equals $\frac{26.7}{2.337}$ equals 11.42 trees

As there are 15.05 trees in Group III now, 15.05-11.42 or 3.63 trees can be taken as a thinning along with Group IV for the harvest cut. The thinning should take trees of poorest form or trees of the smallest diameter class in the Group which in this case are the 16" trees. The volume, figured by species was calculated at 402 feet, b.m.

The total cut then is:

	Trees	Volume, ft.,b.m.
Group Iv	8.69	3,371
Group III	3.63	402
	12.32	3,773

These data are tabulated by diameter classes in Table IIA.

STOCK AND STAND TABLE - 24,093 ACRES
1936

DBH	No.of Trees	B. A., Sq. Ft.	Volume, ft.,b.m.
10	21.94	11.94	403
12	17.09	13.42	705
14	13.67	14.60	1121
16	9.56	13.08	1225
18	7.18	12.69	1364
20	4.41	9.63	1145
22	2.78	7.33	913
24	4.20	15.64	2014
Total	80.63	98.33	8890

CALCULATIONS TO CLASSIFY STOCK AND STAND TABLE

Group IV		B. A.	No. Trees	Volume
B. A. required		26.70		
through 22"	22.97	22.97	6.98	2927
Balance from 20" class		3.73		
% BA from 20" class	3.73 ÷ 9.63 = 38.8%			
No. trees 20" class	4.41 x .388		1.71	
Volume 20" class	1145 x .388			444
	TOTAL		8.69	3371
Group III				
B. A. required		25.80		
Balance from 20" class BA 9.63 - 3.75 =	5.90		2.70	701
18" class	12.69	18.59	7.18	1363
Balance from 16" class		7.21		
% BA from 16" class	7.21 ÷ 13.08=55.2%			
No. trees 16" class	9.36 x .552		5.17	
Volume 16" class	1225 x .552			676
	TOTAL		15.05	2741
Group II				
B. A. required		24.20		
Balance from 16" class BA 13.08 - 7.21 =	5.87		4.19	549
14" Class	14.60	20.47	13.67	1121
Balance from 12" class	TOTAL	3.73		
% BA from 12" class	3.73 ÷ 13.42= 27.8%			
No. trees 12" class	17.09 x .278		4.74	
Volume 12" class	705 x .278			195
	TOTAL		22.60	1865
Group I				
B. A. required		21.60		
Balance 12" class BA 13.42 - 3.73 =	9.69		12.55	510
10" Class	11.94	21.63	21.94	405
	TOTAL	0.00+	34.29	915

FORM II

CLASSIFIED STOCK AND STAND TABLE - 24,093 ACRES
-BASAL AREA METHOD OF CONTROL-

Size Group	B. A. %	Actual B. A., Sq. Ft.	No. Trees	Volume	B. A. Per Tree	Ave. DBH	Diameter Range
I	21.9	21.6	34.29	915	.630	10.75	10-12
II	24.6	24.2	22.69	1865	1.070	14.00	12-16
III	26.3	25.8	15.05	2741	1.715	17.70	16-20
IV	27.2	26.7	8.69	3371	3.078	23.75	20+
TOTAL	100.0	98.3	80.63	8892			

TABLE IA

Table IA represents the stand and stock table of the 24,093 acres, showing the average stocking of all timber combined. This table shows the timber to be cut and left, separately, when determined by the Basal Area Method of Control.

In determining what number of trees of each species in the 16" and 20" classes should be cut it was decided to cut in the same percentage as was calculated by the Forest Service in their plan. For example, using Sugar Maple as an illustration, .59 trees were recommended to be cut out of a total of 3.04 trees in the 16" class, or 19.4%. To keep the percentage cut comparable in the Basal Method of Control plan where a total of 3.63 trees were to be cut in the 16" class, 19.4% of 3.63 or .70 trees in Sugar Maple were cut.

This procedure was followed for all other species in the 16" and 20" classes. The volume to be cut in these classes was then calculated on the basis of this number of trees.

TABLE IA

STOCK AND STAND TABLE FOR THE AVERAGE ACRE
REMAINING UNCUT SAW-TIMBER TYPES COMBINED

DBH	Sugar Maple: No. of Trees	Sugar Maple: Net Vol.	E. Hemlock: No. of Trees	E. Hemlock: Net Vol.	Y. Birch: No. of Trees	Y. Birch: Net Vol.	Basswood: No. of Trees	Basswood: Net Vol.	Elm: No. of Trees	Elm: Net Vol.	Red Maple: No. of Trees	Red Maple: Net Vol.
PROPOSED												
16:	.70:	96:	.61:	73:	.93:	101:	.17:	25 :	.04:	5:	.06:	7:
20:	.67:	195:	.25:	67:	.35:	82:	.08:	27 :	.05:	15:	.02:	5:
22:	1.21:	423:	.46:	151:	.55:	157:	.26:	90 :	.17:	60:	.02:	6:
24:	.71:	268:	.43:	169:	.35:	124:	.17:	71 :	.19:	85:	:	:
26:	.48:	218:	.27:	131:	.18:	76:	.11:	53 :	.12:	63:	:	:
28:	.11:	58:	.29:	168:	.08:	40:	.06:	34 :	.05:	33:	:	:
30:	.07:	44:	.11:	75:	.02:	11:	.05:	34 :	.05:	39:	:	:
32:	.03:	22:	.03:	22:	.02:	12:	.02:	15 :	.03:	27:	:	:
34:	.02:	16:	.02:	16:	:	:	:	:	.02:	20:	:	:
TOTAL	4.00	1340:	2.47	872:	2.48	603:	.98	349 :	.72	347:	.10	18:
PROPOSED												
2:	48.65:	:	2.34:	:	4.02:	:	3.30:	:	4.62:	:	2.40	:
4:	9.67:	:	6.97:	:	2.70:	:	1.86:	:	1.98:	:	.84:	:
6:	4.38:	:	8.05:	:	2.45:	:	.90:	:	1.14:	:	.30:	:
8:	2.51:	:	7.78:	:	1.86:	:	.69:	:	.74:	:	.18:	:
TOTAL	65.21		25.14		11.04		6.75		8.48		3.72	
10:	2.86:	65:	7.42:	146:	2.30:	46:	.42:	10 :	.92:	21:	.15:	3:
12:	2.52:	136:	5.15:	235:	2.44:	98:	.66:	36 :	1.01:	55:	.07:	3:
14:	2.43:	241:	4.02:	358:	2.52:	197:	.48:	46 :	.71:	70:	.17:	13:
16:	1.65:	271:	1.57:	216:	1.30:	164:	.39:	59 :	.55:	77:	.01:	2:
18:	2.27:	504:	1.55:	308:	1.68:	275:	.46:	98 :	.38:	75:	.06:	10:
20:	1.10:	314:	.38:	100:	.49:	101:	.27:	74 :	.27:	72	.01:	2:
TOTAL	12.83	1531:	19.99	1363:	10.73	881:	2.68	323 :	3.84	370:	.47	33:
Net Cut and Leave	16.83	2871:	22.56	2235	13.21	1484:	3.60	672 :	4.56	717:	.57	51:

TABLE IA-Continued

Ash		Northern W. Cedar		Balsam Fir		Northern White Pine		Black and W. Spruce		Aspen		Total	
No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.
							CUT						
.07	10	.86	62	.08	6	.02	3	.07	12	.02	2	3.63	402
		.24	36			.01	5	.04	12			1.71	444
		.09	17			.02	9					2.78	913
		.03	7			.02	13					1.90	737
		.02	5									1.18	546
												.59	333
						.02	20					.32	223
												.13	98
						.02	25					.08	77
.07	10	1.24	127	.08	6	.11	75	.11	24	.02	2	12.32	3773
							LEAVE						
7.57		10.63		29.61				.96		.18		122.51	
1.56		8.23		13.33		.12		.42		.06		51.58	
.66		7.81		6.37		.06		.18				33.69	
.65		5.74		2.63		.08		.44		.02		23.61	
10.44		32.41		51.94		.26		2.00		.26		231.39	
.44	13	5.59	76	1.40	14	.12	4	.27	4	.05	1	21.94	403
.41	27	3.72	75	.57	14	.08	3	.34	19	.12	4	17.09	705
.28	29	2.45	111	.08	4	.18	17	.26	29	.09	6	13.67	1121
.03	6	.12	10			.06	10	.05	8			5.73	823
.03	6	.62	55			.06	15	.07	18			7.18	1364
		.11	13			.06	20	.01	5			2.70	701
1.19	81	12.61	340	2.05	32	.56	69	1.00	83	.26	11	68.31	5117
1.26	91	13.85	467	2.13	38	.67	144	1.11	107	.28	13	80.63	8890

TABLE IIA

Table IIA has been drawn up from Table IA and shows the stand and stock table of the average acre by diameter classes with the addition of columns showing the proposed cut and leave, and square feet of Basal Area by diameter classes.

TABLE IIA

STOCK AND STAND TABLE - 24,093 ACRES
1936

DBH	No.of Trees	B. A., Sq. Ft.	Volume ft.b.m.	Proposed Cut		Proposed Leave	
				No.of Trees	Volume ft.b.m.	No.of Trees	Volume ft.b.m.
10	21.94	11.94	403	none		21.94	403
12	17.09	13.42	705	unless		17.09	705
14	13.67	14.60	1121	defective		13.67	1121
16	9.36	13.08	1225	3.63	402	5.73	823
18	7.18	12.69	1364			7.18	1364
20	4.41	9.63	1145	1.71	444	2.70	701
22	2.78	7.33	913	2.78	913		
24	4.20	15.64	2014	4.20	2014		
TOTAL	80.63	98.33	8890	12.32	3773	68.31	5117

The total basal area cut per acre is 31.76 square feet leaving a basal area of 66.54 square feet per acre in the residual stand.

TABLE IIIA

Table III represents the Stock and Stand Table for the average acre of the 24,093 acres in 1957 or time of the next cut. The number of trees in the residual stand as found in the proposed leave in Table IA was reduced 10% to allow for mortality and the volumes of the trees left projected ahead 20 years in the same manner as described in the explanatory data of Table III, Part I.

TABLE IIIA

STOCK AND STAND TABLE FOR THE AVERAGE ACRE
PROPOSED SELECTIVELY CUT STANDS-20 YEARS HENCE

DBH Today	Sugar Maple No. of Trees	Sugar Maple Net Vol.	E. Hemlock No. of Trees	E. Hemlock Net Vol.	Y. Birch No. of Trees	Y. Birch Net Vol.	Basswood No. of Trees	Basswood Net Vol.	Elm No. of Trees	Elm Net Vol.	Red Maple No. of Trees	Red Maple Net Vol.
					Estimated Stand							
8	2.26	90	7.00	238	1.68	37	.62	33	.67	19	.16	4
10	2.58	200	5.68	462	2.07	127	.38	28	.81	63	.14	8
12	2.27	300	4.64	533	2.20	229	.60	73	.91	108	.06	7
14	2.19	447	3.62	634	2.27	348	.43	80	.64	109	.15	29
16	1.49	430	1.41	353	1.17	252	.35	90	.50	119	.01	3
18	2.05	761	1.40	482	1.51	447	.41	139	.34	111	.05	21
20	1.00	452	.34	155	.44	173	.24	103	.24	108	.01	4
Total	13.84	2680	25.09	2857	11.34	1613	3.03	546	4.11	637	.58	76

TABLE IIIA-Continued

Ash		Northern W. Cedar		Balsam Fir		Northern White Pine		Black and W. Spruce		Aspen		Total	
No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.	No.of Trees	Net Vol.
Per Acre													
.59	29	5.17	98	2.37	52	.07	3	.40	20	.02		21.01	623
.40	35	5.03	191	1.26	45	.11	7	.24	20	.05	1	19.75	1187
.37	52	3.35	221	.51	32	.07	9	.31	43	.11	5	15.40	1612
.25	52	2.21	205	.07	7	.16	34	.23	50	.08	8	12.30	2003
.03	8	.11	15			.06	18	.05	15			5.18	1303
.03	12	.56	115			.06	25	.06	24			6.47	2137
		.10	26			.05	30	.01	5			2.43	1056
1.67	188	16.53	871	4.21	136	.58	126	1.30	177	.26	14	82.54	9921

TABLE IVA

Table IVA has been drawn up from Table IIIA and shows the Stand and Stock Table of the average acre by diameter classes only, with additional columns showing Basal Area in s quare feet by diameter classes, estimated DBH in 20 years and estimated cut and leave at time of the next cut.

The cut and leave columns necessitate further explanation. The results as tabulated must be an estimation inasmuch as they are derived from a table that is an estimation itself of what is going to be the situation twenty years in the future. However, based on all the data available it does approximate what can be taken from this stand at the time of the next cut when calculated under the Basal Area Method of Control.

By reference to the table it is seen that the total Basal Area is 103.13 square feet. This is an increase over the original stand of almost five square feet. This figure is significent in that it shows that the cut in the first cycle left a stand that not only recovered to its former stocking but increased about 5%.

To arrive at the figures in the cut and leave columns, it was first necessary to classify the Stock and Stand Table (first four columns of Table IVA) with this new Basal Area. The same procedure was used as outlined in the explanatory data for

Form II. From the results, which are shown on the following two pages, the estimation of the cut was calculated in the same manner as for the orginal stand. That is, the cut will be:

In Group IV, 11.66 trees with a volume of 3,888 ft.,b.m.

In Group III: The average diameter of trees in Group III now is 17.1". At the time of the next cut these trees should average 20.1" (MAI of 0.15") and should carry 28 square feet of Basal Area. The number of trees to carry forward then:

$$\frac{\text{Basal Area in square feet in Group IV}}{\text{Basal Area of a 20.1" Tree}}$$

equals $\frac{28.00}{2.204}$ equals 12.70

As there are 17.13 trees in Group III now, 17.13-12.70 or 4.43 trees can be taken as a thinning along with Group IV for the harvest cut. The thinning again will be trees of poorest form or in the smallest diameter classes of the Group. As 15" trees are included in the Group, they are taken plus enough other in the 17" class to make up the 4.43 trees. In total, the thinning will be:

	No.of Trees	Volume(ft.b.m.)
15" Class	2.41	252
17" Class	2.02	330
	4.43	582

The Total Cut is:

	No.of Trees	Volume(ft.b.m.)
Group IV	11.66	3888
Group III	4.43	582
	16.09	4470

These data are tabulated by diameter classes in Table IVA.

CALCULATIONS TO CLASSIFY THE STAND AND STOCK TABLE-1957

Class IV-Harvest		B. A.	No. Trees	Volume
BA required		28.00		
Thru 21" class	22.57	22.57	8.90	3193
Bal. from 19" Class		5.43		
%BA from 19" Class= 5.43 / 10.20 = 53.3%				
No. Trees 19" Class = 5.18 x.533			2.76	
Vol. 19" Class = 1303 x .533				695
	TOTAL		11.66	3888
Class III				
BA required		25.80		
Bal. from 19" Class BA 10.20-5.43 = 4.77			2.42	608
17" Class	19.38	24.15	12.30	2003
Bal. from 15" Class		2.95		
%BA from 15" Class 2.95 / 18.90 = 15.81%				
No. trees 15" Class = 15.40 x .1581			2.41	
Vol. 15" Class = 1612 x .1581				256
	TOTAL		17.13	2867
Class IIA				
BA required		25.40		
Bal. from 15" Class = 18.90 - 2.95 = 15.95		15.95	12.99	1356
Bal. from 13" Class		9.45		
%BA from 13" 9.45 / 18.21 = 51.9%				
No. trees 13" Class = 19.75 x .519			10.23	
Vol. 13" Class = 1187 x .519				615
	TOTAL		23.22	1971
Class I				
BA required		22.60		
Bal. from 13" Class 18.21 - 9.45 =	8.76		9.52	672
11" Class	13.57	22.63	21.01	623
	TOTAL		30.53	1195

CLASSIFIED STANDARD STOCK TABLE FOR TABLE IVA

Age Group	% B.A.	Actual B.A.	No. of Trees	Volume ft., b.m.	B.A. per Tree	Ave. DBH	Diameter Range
I	21.9	22.6	30.53	1195	.741	11.65	11-13
II	24.6	25.4	23.22	1971	1.096	14.20	13-15
III	26.3	27.1	17.13	2867	1.590	17.10	15-19
IV	27.2	28.0	11.66	3888	2.381	20.9	19+
TOTAL	100.0	103.1	82.54	9921			

TABLE IVA

STAND AND STOCK TABLE IN 20 YEARS-24,093 ACRES
-BASAL AREA METHOD OF CONTROL-

DBH Today	No.of Trees	B. A., Sq. ft.	Volume ft.,b.m.	Est.DBH 20 years	Estimated Cut		Estimated Leave	
					Trees	Volume	Trees	Volume
8	21.01	13.87	623	11			21.01	623
10	19.75	18.21	1187	13			19.75	1187
12	15.40	18.90	1612	15	2.41	252	12.99	1360
14	12.30	19.38	2003	17	2.02	330	10.28	1673
16	5.18	10.20	1303	19	2.76	695	2.42	608
18	6.47	15.56	2137	21	6.47	2137		
20	2.43	7.01	1056	23	2.43	1056		
TOTAL	82.54	103.13	9921		16.09	4470	66.45	5451

SCHEDULE IA

Schedule IA shows the dry lumber value per acre and the cost of production per acre by species of the proposed cut in the original stand,(1936).

The derivation of these values are explained by the use of Form III. Form III goes into the details of obtaining the dry lumber values per acre for the sugar maple volume as given in the stock and stand table for the orginal 24,093 acres. The results are carried over to Schedule IA. This practice was repeated for each species in the stand until the Schedule was complete. The following detailed notes explain the column heading in Form III:

Column 1 - Diameter class of tree, based on breast height measurements.

Column 2 - Obtained from the Stand and Stock Table.

Column 3 - Overrun factors obtained from USDA Technical Bulletin #164 entitled "Selective Logging in the Lake States." The overrun factors, by diameter classes, for the three main species-sugar,maple, yellow birch, and eastern hemlock-were used as the basic data on overrun for all the other species. Since these three species represent 74 percent of the volume in the stand, the overrun used in this report should be fairly representative of the entire stand. Whether these overrun factors apply to the sawing done by the Goodman Lumber Company will depend again on the average thicknesses and widths sawed, the general methods and efficiency of manufacture, and the practice followed by the company in scaling its lots. The Scribner Decimal C log Rule is used throughout the report, and this rule is also used by the Goodman Lumber Company.

Column 4 - Represents the products of Column (2), times Column (3).

Column 5 - Indicates the volume left after applying a 5 percent shrinkage factor for air drying. For the lumber which is kiln dried, a higher shrinkage factor would be required at this point and higher values per M board feet would have to be used in basic prices.

Column 6 - Is obtained from the Goodman Report. The values are based on prevailing 1936 market prices and grade outturns by diameter classes.

Column 7 - Is the product of Column (6), times Column (4).

Column 8 - The value of by-products at $1.50 per M is multiplied by the volume in Column (5). This by-product value is an assumption representing an average for all species. There is no doubt that this varies by species and other factors but not having a true measure of this variation by species it is believed that the average used will be close to correct for the entire stand. The increased returns from veneer and small dimension are considered as a separate item in another table.

Column 9 - Is the sum of Columns (7) and (8).

Column 10 - Is obtained by dividing Column (9) by Column (4).

Columns 11 and 12 are concerned with the cost of production and are referred to under the financial calculations.

The same procedure was followed to arrive at the dry lumber values in Schedule I, Part I.

FORM III

DERIVATION OF DRY LUMBER VALUE AND COST OF PRODUCTION PER ACRE, USING SUGAR MAPLE AS AN EXAMPLE

1. DBH	2. Net Vol. Log Scale	3. Overrun Factor	4. Net Vol. Mill Scale	5. Vol.after Shrinkage 5%	6. Dry Lbr. Price Per M
16	96	1.228	118	112	$29.57
20	195	1.160	226	215	33.81
22	423	1.134	480	456	35.82
24	268	1.110	297	282	37.77
26	218	1.093	238	226	39.65
28	58	1.080	63	60	41.44
30	44	1.060	47	45	43.27
32	22	1.048	23	22	44.91
34	16	1.037	17	16	46.60
TOTAL	1340		1509	1434	

FORM III-Continued

7. Dry Lumber Value	8. By-Products @$1.50 Per M	9. Total Dry Lbr.Value	10. Mill Scale Value	11. Cost of Production Per M by Diam.	12. Cost of Production For Each Diameter Per Acre
$ 3.31	$0.17	$ 3.48	$ 31.10	$ 28.69	$ 3.41
7.26	0.32	7.58	35.30	27.35	5.87
16.53	0.68	17.01	35.40	26.[illegible]	12.94
10.65	0.42	11.07	37.27	26.59	7.90
8.96	0.34	9.30	39.08	26.25	6.25
2.49	0.09	2.58	40.95	25.95	1.63
1.95	0.07	2.02	42.98	25.86	1.22
.99	0.03	1.02	44.35	25.78	.59
.75	0.02	.77	45.29	25.53	.43
			351.67	238.96	
			9	9	
$52.69	$2.14	$54.83	$39.07	$26.55	$40.24

SCHEDULE IA

DRY LUMBER VALUES PER ACRE OF TREES BY SPECIES AND DIAMETERS

DBH	Sugar Maple	Eastern Hemlock	Yellow Birch	Basswood	Soft Elm	Red Maple
16	$ 3.48	2.86	4.42	1.14	0.15	0.26
20	7.58	2.35	3.81	1.27	0.53	0.18
22	17.01	5.29	7.20	4.47	2.21	0.25
24	11.07	5.78	5.98	3.68	3.19	
26	9.30	4.41	3.77	2.78	2.46	
28	2.58	5.54	2.07	1.86	1.31	
30	2.02	2.46	.56	1.88	1.55	
32	1.02	.71	.65	.87	1.11	
34	.77	.49			.84	
Total 10"up	$54.83	29.89	28.46	17.95	13.35	.69
Cost 10"up	$40.24	25.97	18.47	10.41	9.80	.61

SCHEDULE 4A-Continued

Ash	N.White Cedar	Balsam Fir	N.White Pine	Spruce	Aspen	Grand Total	DBH
0.35	2.27	0.25	0.18	0.42	0.06	15.84	16
	1.77		0.27	0.43		18.19	20
	.59		0.42			37.44	22
	.25		0.62			30.57	24
	.19					22.91	26
						13.36	28
			1.06			9.53	30
						4.36	32
			1.37			3.47	34
.35	5.07	.25	3.92	.85	.06	155.67	
.34	4.18	.20	2.13	.71	.04	113.10	

GROSS REALIZATION PER ACRE 42.57
(Before Taxes and Depletion)

SCHEDULE IIA

Schedule IIA shows the net income per MBM before land and timber taxes and forestry expenses on deducted under the alternate plan as proposed. The "Source of Data" column shows how or where the figures in column two were derived. It is self explanatory.

SCHEDULE IIA

Derivation of Net Income per MBM
Before Land and Timber Taxes and Forestry
Expenses are deducted.

ITEM		Source of Data
A. Total Value removed per acre	$ 155.67	Schedule 1A
B. Cost of Production	113.10	Schedule 1A
C. Gross Realization on Lumber per acre	42.57	a-b
D. Volume Cut-Mill Scale	4,234	Form III
E. Increased Revenue per acre	19.00	$4.50 x D
F. Total Gross Revenue per acre	61.62	C + E
G. Depletion charge per acre	24.52	$6.50 x 3.773M
H. Net Realization before taxes	37.10	F - G
I. Total Net Income before taxes	89,373.90	H x 2,409 acres
J. Taxes on Land and Timber	15,000	Goodman Report
K. Social Security and excise tax	10,227.60	3% of $28.41 x 12,000M
L. Total net taxable Income	64,146.30	I -(J+K)
M. Federal Normal Tax	8,339	13% of L
N. Adjusted and undistributed Income	55,707.30	L - M
O. Federal Tax on Capital Tax	1,200	0.1 x $1,200,000
P. State Normal Tax	3,848.78	6% of L
Q. State Surtax	641.46	1/6 of P
R. Total Federal and State Taxes	14,019.24	N + O + P + Q
S. Total Income after Taxes	50,127.06	L - R
T. Total net Income less 2% state taxes on dividends on net cash dividends	49,124.50	S-2% of S
U. Total Net Income for M, Log Scale	4.09	T ÷ annual cut
V. Total Net Income per acre	15.43	U x volume cut, log scale
W. Annual Taxes on Land and Timber	15,000	Goodman Report
X. Forestry and Marking expense	8,040	Goodman Report
Y. Total Annual Charge	23,040	W + x
Z. Charge per MBM, log scale	1.92	Y ÷ annual cut
AA. Net Income per MBM before land and timber taxes and forestry expense are deducted	6.01	Z + U

SCHEDULE IIIA

Schedule IIIA shows the derivation of total revenue per M, mill scale and total operating costs per M, mill scale under the alternate plan of management. The difference between the revenue and cost gives gross realization per M.

The total revenue per acre was carried over from Schedule IA.

The operating cost per M were derived from basic data in the Goodman Report, and are based on the annual cut and size classes cut under the alternate plan.

To illustrate, the Felling and Bucking costs per M were derived as follows:

DBH Classes Cut	Cost per M	Vol.per A.	Cost (class)
16	$3.12	402	$1.25
20	2.60	444	1.15
22	2.44	913	2.22
24	2.30	706	1.62
26	2.18	546	1.19
28	2.09	333	.70
30	2.02	223	.45
32	1.96	98	.19
34	1.95	77	.15
Total	....	3,773	$8.92

$$\frac{\text{Total Cost per acre}}{\text{Volume cut per acre}} = \frac{\$8.92}{3,773} = \$2.39$$

The above proceedure was followed to derive the costs that vary with the size of the tree both in logging and milling. The constant costs were quoted directly from the Goodman Report.

SCHEDULE III A

TOTAL REVENUE AND OPERATING COSTS PER M, MILL SCALE

Total revenue per acre - Lumber only	$155.67	
Increase revenue due to veneer:		
$4.50 per M x 4,234 ft., b.m. mill scale	19.05	
Total	$174.72	
Revenue per M, Mill Scale		
$174.72 ÷ 4,234		$41.30
Direct Cost, per M that vary with the size of the tree.		
Felling and bucking	$ 2.39	
Skidding and swamping	1.47	
Loading and unloading	.64	
Hauling (Operation and Maintenance)	3.30	
Total	$7.80	
Indirect logging costs per M that vary with the volume cut per acre.		
Supervision - woods work	$ 0.54	
Woods - general expense	.80	
Forester's salary and expense	.67	
Total	$ 2.01	
Total logging cost, Log Scale	$ 9.81	
Overrun at 18.2%, therefore		
Total logging cost, Mill Scale	$ 8.73	
Total direct milling costs per M that vary with the size of trees cut.	$ 2.29	
Total general indirect milling costs per M that vary slightly with the size of trees cut.	$ 2.18	
Total indirect milling costs per M that are fairly constant per M	$ 6.03	
Total indirect milling costs per M that vary most with the total annual cut.	$ 5.28	
Operating costs per M, Mill Scale		24.51
Gross realization per M		$16.79

SCHEDULE IVA

Schedule IVA shows the results of the financial calculations in determining the present worth values of the first cycle and all subsequent cycles. The figures used to develop item K are developed from Schedule IIA. Total revenue per M and total current operating costs per M were derived in Schedule IIIA.

The present worth values were derived by using the same factors as used by the Forest Service in determining their values with the exception of the rate of interest indicated by a discount for hazard of 30% in perpetuity. The correct rate of 43% as developed and shown in the explanatory data of Schedule IV was used.

SCHEDULE IVA

Selective Cutting and Sustained Operation of Timber and Mill With the Annual Cut Equalling the Annual Growth 10 Years Hence.

Basic Data

A. Annual Cut -13,464 MBM, mill scale
12,000 MBM, log scale

In this plan it is recommended that 2,911 MBM of the annual cut be purchased annually.

B. Period of conversion to sustained yield - 10 years.

Average Net Returns During Period of Conversion

C.	Total Revenue per M, all products	$41.30 mill scale	
D.	Total current operating costs per M	24.51 " "	
E.	Gross realization per M (C - D)	$16.79 " "	
F.	Total annual gross realization for period of 10 years before depletion, depreciation and income taxes (A x E)		$226,061
	-Less cost of purchases stumage of 2,911 MBM at an assumed cost of $6.50 per M, log scale.		18,921
			$207,140
G.	Federal and state income and capital stock taxes.		14,150
H.	Social Security tax.		10,228
I.	Estimated losses from obsolescence, etc.		4,000
J.	Total reductions of annual gross realizations (G,H,I)		28,378
K.	Total net realization annually.		$178,762

Present Worth Value of All Future Net Realizations

		Using 3% as a risk-free rate of interest	Using rate of interest indicated by discount of 30% for hazard
L.	Present worth of 10 annual incomes of $1 each.	$8.530	$5.889

	Using 3% as a risk-free rate of interest	Using rate of interest indicated by discount of 30% for hazard.
M Present worth of net realizations of the next 10 years (K x L)	$1,524,876	$1,052,729
N. Average annual cut log scale, after next 10 years. 4.474 MBM x 2409	10,778 MBM	10,778 MBM
O. Estimated average net return per M, log scale. (First 10 years it is $178,762 ÷ 12,000 MBM or $14.90. It is believed that this net realization can be maintained for all subsequent cycles).	$14.90	$14.90
P. Average net return after next 10 years. 14.90 x 10,778	$160,000	160,000
Q. Capitalized value of average net return of $160,000 on a continuous basis at 3% and 4.3% respectively.	$5,333,330	$3,720,000
R. Value of $1 at compound interest in 10 years	$1.344	$1.967
S. Present value of realizations after the next 30 years.	$3,968,000	$1,892,000
T. Present worth value of all future net realizations (L + S)	$5,492,876	$2,944,729

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

In Part I are presented those Tables and Schedules necessary to show the Forest Service's best sustained plan of management.

In the first cycle, the proposed cut is 4,513 ft.,b.m. per acre. (Tables I and II) This volume is realized by the Individual Tree Selection method of marking for cut where some trees are taken in every diameter class. In their plan the Forest Service cut clear to 24 inches and took some trees in all the lower classes. This cut leaves a residual stand of such a structure that at the time of the next cutting cycle it is estimated that 4,221 ft.,b.m. per acre (50 percent of the total of 8,136 ft.,b.m. per acre) will be available for cut. The stocking of the stand at this time is 83.3 square feet of Basal Area, a reduction of 15 square feet over the original stand.(Table IV)

It appears that the failure of the stand to recover to it's original stocking is a result of overcutting in the first cycle, which cutting occurred in the lower diameter classes. Such cutting means not only taking trees that cost more to produce per M in relation to their value produced per M than in the larger diameter classes but that the fastest growing and most thrifty trees in the stand, the growing stock, is being destroyed.

The volume per acre available for cut is less in the second cutting cycle. In the Goodman Report the Forest Service states that the cut will have to be reduced somewhat further for two more cycles to allow stocking to begin to build up again.

In Schedule IV, the Forest Service states that the estimated average net return per MBM, log scale, for the first cycle is $13.26. Though the annual cut is reduced for several cycles thereafter, they believe that this return per MBM will be maintained in the future. As further shown in Schedule IV, the present worth value of the property is $2,665,661 under this plan.

The plan for clear cutting and liquidation in 10 years has a present worth value of $2,771,128 or $105,567 more than the sustained yield plan. Notwithstanding, the Forest Service recommends the sustained yield plan on the basis that besides giving a fair rate of return on the investment, the intangible values attaching to the plan would more than offset the difference in present worth values of the two plans. Any plan of management recommended to an owner to be put into effect on his property should show a greater present worth value on a dollar for dollar basis than any other similar plan possible. Even though intangible values do attach to a sustained yield plan of management, from a strict business and financial point of view the dollar value of the plan must be the convincing factor as far as an owner is concerned.

In Part II, the alternative plan is presented. The Basal Area Method of Control is used as a basis for the determination of the cut. The allowable cut was found to be 3,773 ft.,b.m. per acre for the first cycle. (Tables IA and IIA). Though the volume cut per acre is less, the net realization per acre and per year is higher than the Forest Service Plan (Schedule IA and IVA).

Table IVA shows that at the time of the next cutting cycle the allowable cut is 4,770 ft.,b.m. per acre and that the Basal Area in square feet has increased from 98.3 square feet to 103.13 square feet. On this increased cut per acre, and with the cut falling in the diameter classes as shown in Table IVA, it is believed that $14.90 per MBM, log scale, as an annual return in the second and subsequent cycles is reasonable. $14.90 per MBM is derived as shown in Schedule IVA. As further shown in Schedule IVA, the present worth value of the property under this plan is $2,994,729. This is a greater value than the Forest Service's best sustained yield plan and also the liquidation plan. It, further, need not rest its case on the intangible values resulting from a plan of sustained yield. The values, however, can be used as a basis for additional argument for the plan.

It must be remembered that the Basal Area Method of Control is but another guide or tool useful in setting up a plan of management. As such, the results obtained in Table IIA need not or undoubtedly would not be rigidly adhered

to. From those results it would be reasonable to say that on the average 12 to 13 trees 16 inches DBH and up with a volume of 3,500 to 4,000 ft.,b.m. per acre could be cut.

Basal Area Control shows on the average, for any given area, what the allowable cut should be in order to maintain an adequate growing stock for future yields and in what diameter classes the cut might fall.

With such data at hand as a guide the intelligent operator can proceed to mark his stand for cutting in such a manner that his volume and trees cut per acre will closely approximate that which he actually should take to assure him a forest business in perpetuity.