.... Farm Woodland Management Plans in the Loblolly-Shortleaf-Hardwood Region of the United States

by

J. Edwin Corathers

1941

NATURAL SCIENCE LIBRARY

NATURAL SCIENCE LIBRARY

DEVELOPMENT AND APPLICATION OF FARM WOODLAND MANAGEMENT PLANS IN THE LOBLOLLY-SHORTLEAF-HARDWOOD REGION OF THE UNITED STATES

by

J. Edwin Corathers

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Forestry in the University of Michigan.

Ann Arbor, Michigan February, 1941

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to Prof. Donald M. Matthews, under whose direction this work was done, and to Miss Ina Rankin, Mrs. Lily S. Corathers, Miss Zella Fiester, Sylvan Nelken and Robert E. Wilder for the help that they have given.

TABLE OF CONTENTS

Page

INTRODUCTION

This thesis may be helpful to foresters in developing and applying sound, simple and flexible farm woodland management to relatively small areas of forests in the general loblolly-shortleaf-hardwood region of the south and southeastern United States. Mistakes of technic in collecting data and in the interpretation of that data are common. To merely make a guess, for example, as to the amount of board feet, units of pulpwood, or cords of fuelwood to cut from a stand of timber may result in serious error.

Some forest managers have recommended cuts for sawlogs to a specific diameter limit, for example 16 or 18 inches at breast height for pine and 18 or 20 inches for merchantable hardwood. Thus, many defective, badly crooked, or otherwise undesirable trees of larger or smaller diameters have been left. Many of these trees would pay their way out of the woods, particularly as fuelwood or posts for farm use.

Cuts among larger size trees to the amount equal to the total growth for the stand is erroneous, as much of the growth (basal area or volume) on the sapling to pole size timber never reaches maturity. If the total growth is cut, much of it should be taken as a thinning. As farmers in the south and southeast usually need fuelwood and posts, part of the cut should come from the misshapen, defective or undesirable species of the smaller sizes.

Little consideration has been given in this thesis to the managing of loblolly-shortleaf-hardwood stands for pulpwood, as the present value of the stumpage is relatively low and marketing and cutting practices need to be improved. If thinnings of the otherwise worthless trees can be sold as pulpwood for enough to pay the farmer for his labor, then a limited amount might be justified.

The methods of collecting data and the technic in developing and applying them must not be considered as "iron-bound", as each acre of woods must receive individual treatment as needed; sound figures are merely a guide to good judgement. Then, too, the ability and interest of the farmer or landowner may determine how the forester will proceed. Improvements in the methods set forth will necessarily follow in the future.

SOCIAL AND ECONOMIC ASPECTS OF THE REGION

General Picture Today:

The farmers throughout the loblolly-shortleaf-hardwood forest type of the south and southeastern United States (Fig. 1) need adequate woodland management plans and sound advice as to carrying out forestry practices. This need for managing the woodland as an integral part of the farm operation on the highly potential productive timber lands of the South is well known among foresters and agriculturists. As approximately 37 per cent of the forest land of the eight lower southern states, for example, is on farms and as the return per acre is usually far below what could be expected,[1] there should be more and more interest in forest resources on the part of farmers, communities, civic organizations and forest industries. About one half million people in the lower South are now depending on the woods for at least a major part of their employment.[1] (These figures do not include Virginia, North Carolina and South Carolina.) After some

[1] Demmon, E. L., Annual report. U. S. Department of Agriculture, Southern Forest Experiment Station, New Orleans, Louisiana, p. 3, 1939.

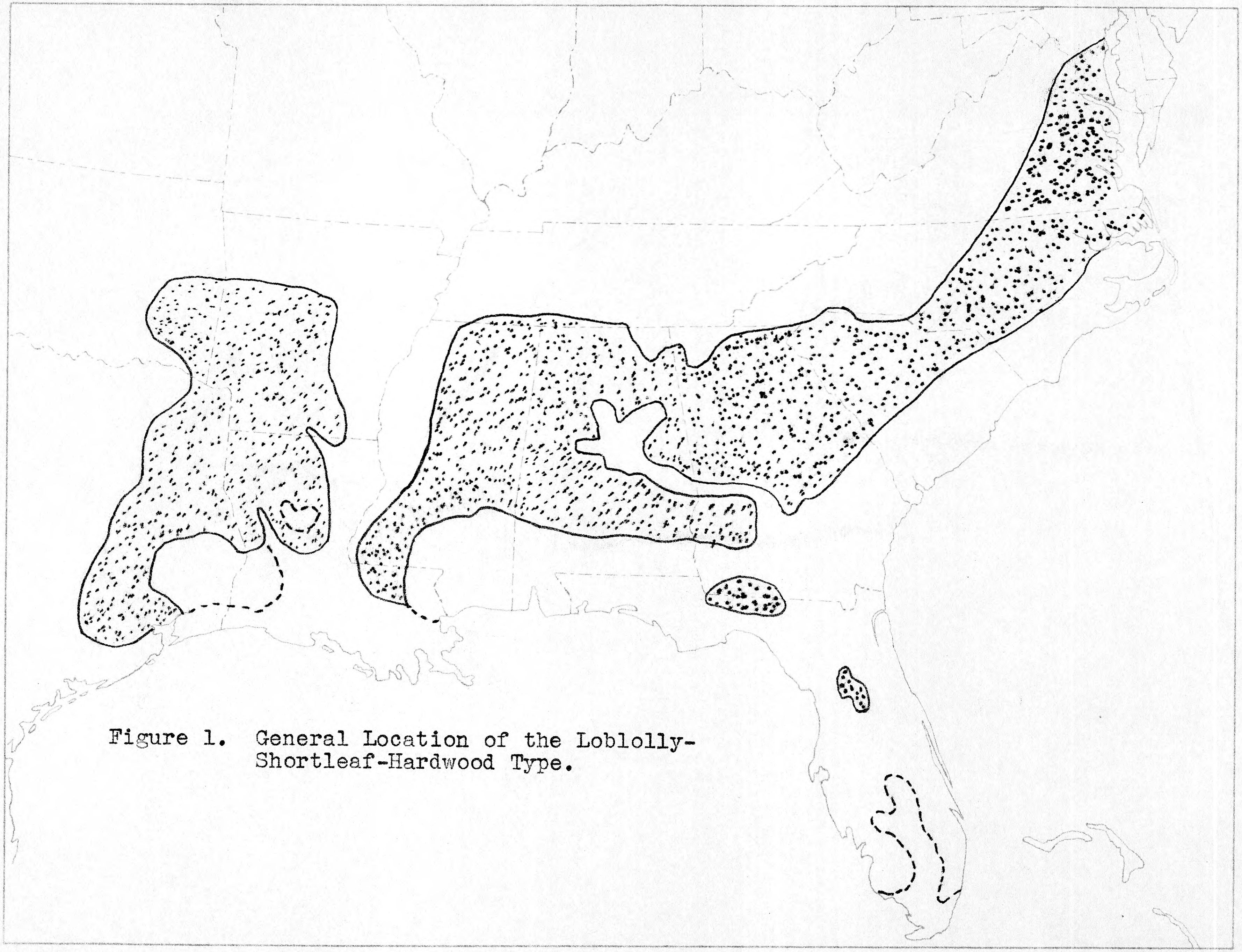

Figure 1. General Location of the Loblolly-Shortleaf-Hardwood Type.

decades of proper protection and management, these forests could support almost double the present number.[1]

The interrelation of the pressing social and economic conditions of the South are causing the farmers to realize the importance of caring for, improving and maintaining their forests. The cotton crashes of 1914, of 1920, and of 1929 have brought more attention to the woods as a possible source of income. The large foreign cotton market is at least temporarily lost; cultivated land is badly eroded and large parts have been abandoned; the lack of phosphorus and lime, plus small areas in pastures, lack of roughage, and the inherent quality of the soils throughout the loblolly-shortleaf-hardwood region, has somewhat limited the development of extensive beef cattle production, as well as discouraged large scale dairy operations. Dairy products are not available, in many instances, for home use. The per cent of farms under mortgage in the South is not as high as in the United States in general.[2] Yet

---

[1] Demmon, E. L., Annual Report. U. S. Department of Agriculture, Southern Forest Experiment Station, New Orleans, Louisiana, p. 3, 1939.

[2] Odum, Howard W., Southern regions of the U. S., the University of North Carolina Press, Chapel Hill, North Carolina, p. 427, 1936.

a single southeastern federal land bank did own 1,100,000 acres of land and operated more than 4,000 farms in three states only.[1] Present farm product prices make payments of interest and reduction of principal rather hard. Then, the desire for an automobile or other modern conveniences is usually present. The population of the rural areas has been increasing and the size of farms becoming smaller. Migration to the cities has increased. The National Resources Comittee[2] reports that if the South is to enjoy prosperity equal to that which can be achieved in other parts of the United States the probability is that the population living in the southeast must be reduced.

The South, then, is a land of declining agriculture[3] where farming, largely cotton, has been the main source of income to the rural people. This decline is particularly true of the loblolly-shortleaf-hardwood region, as the better agricultural soils of the southeastern United States are largely confined to the alluvial deposits along streams.

---

1 Odum, Howard W., Southern regions of the U. S., the University of North Carolina Press, Chapel Hill, North Carolina, p. 427, 1936.

2 National Resources Comittee, the problem of a changing population, U. S. Gov't Printing Office, Washington, D. C., p. 114, May, 1939.

3 Demmon, E. L., Annual Report, U. S. Department of Agriculture, Southern Forest Experiment Station, New Orleans, Louisiana, pp. 3-4, 1939.

The decadence in agriculture emphasises the need for developing the forest resources. Such utilization of the land will provide permanency for communities and industries, continuous employment of labor, more prosperous utilities, a broader and more stable tax base and an increase in purchasing power.[1] This does not mean that the farmer should give up all his cultivated land or pasture but, rather, that he should seek a wise and profitable use of the soil.

---

[1] Demmon, E. L., Annual report, U. S. Department of Agriculture, Southern Forest Experiment Station, New Orleans, Louisiana, pp. 3-4, 1939.

Complex Problems of the Region:

The farmer in the loblolly-shortleaf-hardwood type is confronted with various problems and practices that are hindrances to good woodland management. Fire is still a major cause of widespread destruction. Demmon[1] (1939) in his Annual Report of the Southern Forest Experiment Station estimates that for the eight deep southern states about 20 per cent of the forest area burns annually and that less than 40 per cent is under any kind of fire protection system.

Grazing of woods is common throughout the South. A concentration of livestock, for example one cow to five acres, will injure the young trees, particularly. As hardwood browse is preferred by most animals, pines are favored when grown in a mixture of pines and hardwoods.[2] However, trampling destroys many pine seedlings and, also, renders the surface layers of the soil more compact and less easily penetrated by rain, insects and roots. Growth rates are retarded when the soil is compacted.

---

[1] Demmon, E. L., Annual Report, U. S. Department of Agriculture, Southern Forest Experiment Station, New Orleans, Louisiana, p. 2, 1939.

[2] Wahlenberg, W. G., Journal of Forestry 35(6): Society of Americal Foresters, Washington, D. C., pp. 550-556, June, 1937.

The financial status and the living standard of the landowner in the region are usually not relatively high. The tendency, therefore, is to liquidate the woods as quickly and as often as possible. This leads to improper cutting practices, poor utilization and inefficient and wasteful marketing methods. The sawmill operator, or the logging contractor, for example, buys timber on the stump at a definite sum for the tract and removes all the sawlogs, even though many of these logs may be too small to pay their way to and through the mill. Then, too, the farmer usually trusts the buyer as to the amount of timber he has.

The portable sawmill operator (portable sawmills usually have a capacity of under 20,000 board feet daily) is normally not interested in forestry or conservation of any kind. He offers the farmer a quick and ready market for his logs but does little to encourage timber growing. The portable mill man pays minimum wages and minimum prices and contributes to the current overproduction of low quality lumber. Demmon states that the operator of the transient plant is apparently impervious to all efforts to interest him in better forest and utilization practices.[1]

Wood for fuel is quite important throughout the southeastern United States. Winters[2] estimates that for the forest region of the eight southern states the drain upon the forest growing stock is 8.9 million cords, or 20 per cent of the total drain. Many land owners, or more often tenants, when cutting firewood or stovewood remove the straight, high quality trees and leave the defective, crooked or otherwise inferior trees in the woods. This practice seems to prevail because the better trees split easily.

Besides the custom of selling sawlogs in the "bulk" probably for much less than the timber is worth, the farmer is now confronted with the pulpwood contractor or buyer who is using the same tactics of "bulk" buying. The pulpman usually damages the woods much more than the logger, as he takes all pine that will make a 4 inch diameter stick of wood 4½ to 5 feet long. Much of the stand that is taken for pulpwood will have reached or is

---

1 Demmon, E. L., Annual report, U. S. Department of Agriculture, Southern Forest Experiment Station, New Orleans, Louisiana, p. 3, 1939.

2 Winters, R. K., Fuel wood consumption in the lower South, Journal of Forestry 37(6): Society of American Foresters, Washington, D. C., pp. 445-448, June, 1939.

approaching pole, piling and sawlog size for which the farmer could usually receive a better price.

Many farmers are interested in improving their woodlots, but their interest seems to have developed after the woodlots were practically destroyed. These men do act as leaders, however, and are now influencing their neighbors to a better appreciation of the forests.

In general, the farmer in the loblolly-shortleaf-hardwood region does not know how to care for his woods. He is either not aware of the possibilities of his forest or does not have the information or ability to manage it.

Another great problem is the system of land ownership and management. The South has 48 per cent of all the tenants of the United States. In some states more than two thirds of the farmers are renters.[1] Tenancy leads to a shiftless attitude toward the land. The average tenant moves every two or three years or oftener. The effect on schools, community life, credit and income, neighborhood status, personal character, recreation, health, working conditions, diet, housing and art is serious

[1] Ely, R. T., and Wehrwein, G. S., Land economics, The Macmillian Co., N. Y. City, pp. 202-206, 1940.

if not disasterous.[1]

Possibly 22,000,000 acres of rural land (forest and non-forest) in the eight states from Georgia and Florida to eastern Oklahoma and Texas are now in default of tax payments for two or more years. This is about 10 per cent of the gross land area.[2] Such a condition raises a serious problem in governmental finance, in land utilization and, most important, in the economic stability and welfare of the citizens of the South.[2] The farmer or landowner who is confronted with the delinquency problem tends to neglect his property. If he is about to lose it or if he can not meet his tax payment, he does not have the incentive to keep up fences, improve his house, protect his woodland or improve his crop land. Then, too, he is likely to liquidate his woods as a last effort to avert the loss of his property. The more land that becomes delinquent, the higher the taxes are likely to become on property that is not delinquent. Thus, even the landowner who does pay his taxes is confronted with a seeming dilemma.

---

[1] National Resources Committee, The problem of a changing population, U. S. Gov't Printing Office, Washington, D. C., pp. 225-226, May, 1938.

[2] Craig, Ronald B., The forest tax delinquency problem in the South, Southern Economic Journal 6(2): Southern Economic Ass'n and the Univ. of North Carolina, Chapel Hill, N. C., p.145, October, 1939.

COLLECTION OF DATA

Sampling and Estimating:

In general a strip or a circular-plot survey should be used when sampling and estimating timber, unless an 100 per cent tally is needed for small areas of valuable timber. Strip cruises usually consist of strips 66 feet wide that run parallel and at approximately right angles to the streams (Fig. 2). Circular-plot surveys are a series of one-fifth or of one-quarter acre plots and they may run in parallel lines as convenient (Fig. 3). One-fifth acre plots have a radius of 52.7 feet and one-quarter acre plots have a radius of 58.9 feet. The percentage of estimate in relation to spacing of circular plots is shown in Table 1.

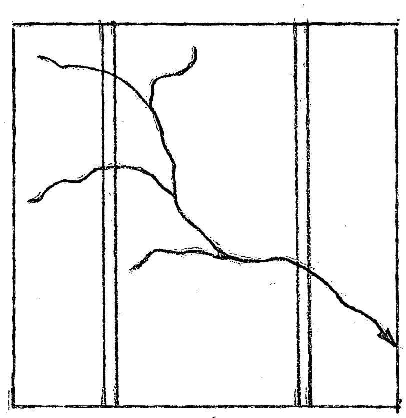

Figure 2. Ten per cent strip survey of 40 acres.

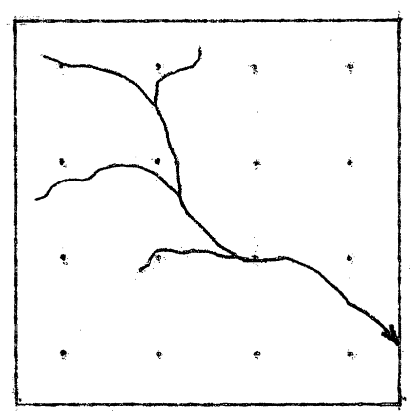

Figure 3. Ten per cent circular-plot ($\frac{1}{4}$ acre) survey of 40 acres.

Table 1. Percentage of Estimate in Relation to Spacing of Circular Plots

Per cent of Estimate	1/4 acre circular plot		1/5 acre circular plot	
	Between lines, chains	Between plots, chains	Between lines, chains	Between plots, chains
$2\frac{1}{2}$	10	10		
	20	5	20	4
5	5	10	5	8
	10	5	10	4
10	5	5	5	4
	10	$2\frac{1}{2}$	10	2
20				
			5	2

The per cent of sampling will vary with the size of forest area, the value of the timber, the time available in relation to cost and the objectives of management. The forester must determine these factors in the field. On areas of 10 to 30 acres if the trees are of merchantable size, perhaps a 20 per cent estimate should be made. For similar woodland areas of 40 to 100 acres, a 10 per cent survey should be sufficient. A $2\frac{1}{2}$ to 5 per cent cruise will usually be adequate for extensive areas. (For detailed discussion about sampling, see Bruce and Schumacher[1].) Sampling may be modified to suit the objectives of management or the value of the timber.

[1] Bruce, Donald, and Francis Schumacher, Forest Mensuration, pp. 109-114, McGraw-Hill Book Co., Inc., New York and London, 1935.

If the farmer or landowner is going to do his own marking, felling and hauling, a "rough" estimate of the sawlog volume may be all that is needed. If the timber is being sold "in bulk", a more accurate figure would be desirable. Sapling or pole size timber would require less sampling, unless an immediate pulpwood thinning or clear cut were wanted.

If aerial photographs are available, the forester may omit boundry surveys (described in Guise[1] and in Chapman and Demerritt[2]). Such photographs give the estimator a reasonably accurate map of the area and they are valuable for fire control work and for determining road spacing, length of truck haul and the quality of roads for minimum costs.

The practical and experienced estimator will likely use a box compass and will measure distances by pacing. If greater accuracy is desired, a Jacob-staff compass and a "trailer" steel tape should be used. This tape should usually be 132 feet in length, plus the "trailer" for slope correction. Compasses

---

1 Guise, Cedric H., The management of farm woodlands, McGraw-Hill Book Co., Inc., New York and London, pp. 118-125, 1939.

2 Chapman, Herman H., and Dwight B. Demerritt, Elements of forest mensuration, J. B. Lyon Co., Albany, N. Y., pp. 124-126, 1932.

should be adjusted for magnetic declination.[1,2]

Forest cover changes should be shown on a base map. (See Guise[3] for a detailed description of estimating and mapping.) Such changes should denote the area in pine-hardwood with variations of distinct age groups or of differently stocked localities, bottomland hardwood regions, pure pine stands, reproduction or open areas, streams, bodies of water, burns, roads and other improvements. If the topography is rolling or rough, an Abney level should be used to make a contour map. The contour lines should be drawn on the base with the forest cover changes. When the relationship between cover changes and topography is available, the planning of roads and of marking and cutting areas will be more efficient.[1]

---

1 Chapman, Herman H., and Dwight B. Demerritt, Elements of forest mensuration, J. B. Lyon Co., Albany, N. Y., pp. 164-166, 278-279, 1932.

2 Buchard, Harry, Surveying, International Textbook Co., Scranton, Penna, pp. 135-137, 1935.

3 Guise, Cedric H., The management of farm woodlands, McGraw-Hill Book Co., Inc., New York and London, pp. 136-145, 1939.

The cruise data should include a stand tally by one inch diameter classes for reserve crop and for desirable to cut trees by species, as shown in Form 1. As the timber of the loblolly-shortleaf-hardwood type is relatively small, two inch diameter classes should not be used. Unless a reliable table of diameter-log lengths has been made previously for the various sites of the locality, an estimate of logs by top diameters should be made. Such an estimate will be more accurate and valuable data will be acquired toward a local volume table.

As general volume tables can not cover all the various local conditions, such as merchantability, form of tree and grade of product, local tables will be desirable.

Information as to possible growth of the timber is necessary under the management practices to be set up. Several crop trees, or potential crop trees, should be bored with an increment borer and diameter growth for a ten year period recorded (Form 2). The trees that are bored should be quality trees in which no mortality would be expected for a cutting cycle of 5 to 10 years. If the stand is below normal normal stocking, and if the trees are receiving plenty of sunlight, the crop trees should

Form 1.

ESTIMATE SHEET*

Owner ____________________, Address ____________________ Date __________

Compartment No. and Location ____

Est. by ________________, Type or type variation ________________________

Plots tallied ____________________________________Applies to ________ acres

	RESERVE CROP TREES											DESIRABLE TO CUT TREES										
D.B.H.	Pine			W. O.		R. O.		P. O.		Mis.		Pine			W. O.		R. O.		P. O.		Mis.	
9																						
10	1	2	3	1	2	1	2	1	2	1	2	1	2	3	1	2	1	2	1	2	1	2
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						

Notes ____

* Estimate sheet should be made large enough to accomodate 6 to 28 inch timber.

Form 2 Sheet ________ of _____

INCREMENT DATA SHEET

Owner ______________________ Address ____________________

Compartment and Location _________________________ Date _____

Type or Type Variation _________________________________

Present D.B.H. inches and tenths	D.B.H. 10 years ago inches and tenths	10 year's diam. gth. inches and tenths	Present D.B.H. inches and tenths	D.B.H. 10 years ago inches and tenths	10 year's diam. gth. inches and tenths

continue to grow at approximately the same growth rate after a cut is made.[1] If the stand is approaching a fully stocked or overstocked condition, the trees to be bored should be selected in relatively open spots which have similar conditions to those that will be set up after a thinning or after a harvest cut. Growth data are usually not taken on hardwoods. The average growth by diameter classes should be summarized and averaged by diameter classes (Form 3) and plotted and curved on a graph.

A few large trees should be bored to the center so as to determine the rotation age under wild conditions. If the stand is placed under management, however, this age will likely be lowered to a "financial" rotation age and can be estimated in accordance with the predicted growth rate.

If a pine stand is overstocked, a pulpwood thinning of the worst trees might be desirable. The estimator should tally the reserve crop and the desirable to cut trees by one inch classes, as has been described for sawtimber. Merchantable height (usually to a 4 inch top) should be taken of a few trees of each diameter class of both the reserve

[1]Matthews, Donald M., Management of American forests, McGraw-Hill Book Co., Inc., New York and London, p. 162, 1935.

Form 3.

GROWTH SUMMARY SHEET

Owner ____________________, Address ____________________; Compiled by ________ Date __________

Type or type variation ______________; Compartment number and location ____________________

D - D.B.H. Start of growing period; G - Diameter growth during period.																			
10		11		12		13		14		15		16		17		18		19	
9.6-10.5		10.6-11.5		11.6-12.5		12.6-13.5		13.6-14.5		14.6-15.5		15.6-16.5		16.6-17.5		17.6-18.5		18.6-	
D	G	D	G	D	G	D	G	D	G	D	G	D	G	D	G	D	G	D	G
Total																			

crop and the desirable to cut trees. After the average merchantable height and the average diameter at one-half the merchantable height is determined for each diameter class, the cubic volume of the proposed cut and of the reserve stand can be computed.

APPLICATION OF DATA

Volume and Basal Area Summary:

The cruise data should be summarized by compartments and sites and a stand and stock table made for a typical acre. Table 2[1] gives an example of such a summary but does not distinguish between reserve crop and desirable to cut trees; hardwood trees were also omitted. One of the first aims of management in the loblolly-shortleaf-hardwood region should be to eliminate the competitive, low value hardwoods.

The graphic presentation of volume in feet board measure per square foot of basal area by diameter classes is shown in Figure 4. This graphic method is a simple and easy way of determining a possible diameter cutting limit for crop trees. In this instance the diameter limit lies between 18 and 20 inches. If overmature timber is present, the curve will fall sharply at the diameter where

[1] Matthews, Donald M., Management of American forests, McGraw-Hill Book Co, Inc., New York and London, p. 155, 1935. Compiled from Garver, R. D., and others, Publication 43, Virginia Forest Service, Table 22, 1931.

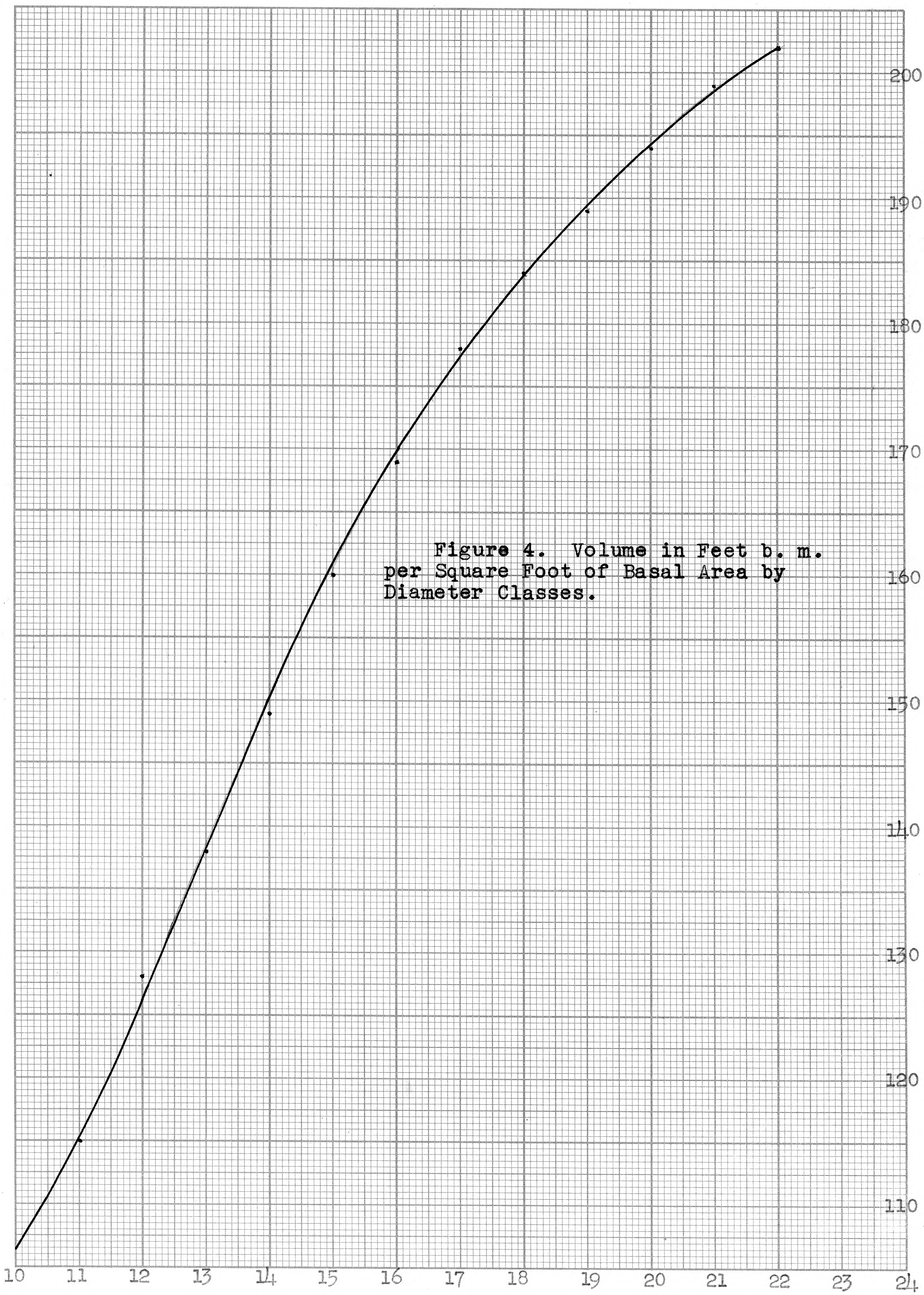

Figure 4. Volume in Feet b. m. per Square Foot of Basal Area by Diameter Classes.

physical overmaturity begins. If the stand has not yet reached a diameter where the board foot volume per square foot of basal area has begun to slow down, the stand will likely be open or understocked or the crop trees will not have reached the desirable diameter cutting limit. A high percentage of farm woodlots of the loblolly-shortleaf-hardwood region will likely be understocked and will not have crop trees above the diameter cutting limit. However, the numerous desirable to cut trees of larger or smaller diameters should be cut when markets and farm needs permit. (Diameter cutting limits for crop trees will be discussed further).

Table 2. Stand and Stock Table, Loblolly Pine Forest, Atlantic Coastal Plain, Typical Acre

D.B.H. in inches	No. of trees	B. A., sq. ft.	Vol. ft. b.m. mill tally	Per cent vol. per diam. class	Vol., ft. b. m. per sq. ft. B. A.
6	4.0	0.78	.....	.....	.....
7	5.5	1.47	104	0.7	71
8	10.6	3.70	386	2.7	104
9	10.3	4.55	422	2.9	93
10	11.0	5.99	628	4.35	105
11	9.3	6.14	706	4.9	115
12	10.1	7.93	1,010	7.0	128
13	9.5	8.75	1,206	8.4	138
14	8.9	9.50	1,415	9.8	149
15	6.5	7.97	1,274	8.8	160
16	5.7	7.95	1,345	9.3	169
17	4.2	6.62	1,176	8.15	178
18	4.6	8.11	1,495	10.4	184
19	2.1	4.14	784	5.4	189
20	1.2	2.62	508	3.5	194
21	0.9	2.16	429	3.0	199
22	0.7	1.85	373	2.6	202
23	0.3	0.85	177	1.2	208
24	0.4	1.26	261	1.8	207
25	0.3	1.02	215	1.5	211
26	0.2	0.74	156	1.1	211
27	0.2	0.79	170	1.2	215
28	0.1	0.42	92	0.6	219
29	0.1	0.46	99	0.7	216
Totals	106.7	95.77	14,431	100.	...

Interpretation of Growth Data:

Diameter growth in inches for a 10 year period should be taken from the curved growth data collected in the woods and further inspected as to financial possibilities. An example from the Atlantic Coastal Plain[1,2] (Table 3) shows the diameter and value growth for an average acre of loblolly pine, site index 90, for a 10 year period. As can be seen from column 5 of this table and from Figure 5, the trees of 19 inches and up in diameter have little value growth. Although the value growth will likely be speeded up when a cut is made because of increase in growth rate, such figures are a guide to a possible diameter cutting limit for crop trees. If growth data are available for an open stand of a similar site or, if the stand is relatively open and no increased growth rate is expected, a diameter cutting limit for crop trees may be easily determined.

A further interpretation of the stand and stock

---

[1] Matthews, Donald M., Diameter and value growth of loblolly pine during a 10 year period, Mimeo. for forest management class, School of Forestry and Conservation, Univ. of Michigan, 1940-41, and interpretated from

[2] Garver, R. D., and others, Selective logging in the loblolly pine-hardwood forests of the Middle Atlantic Coastal Plain, Va. Forest Service, Pub. 43, p. 47, 1931.

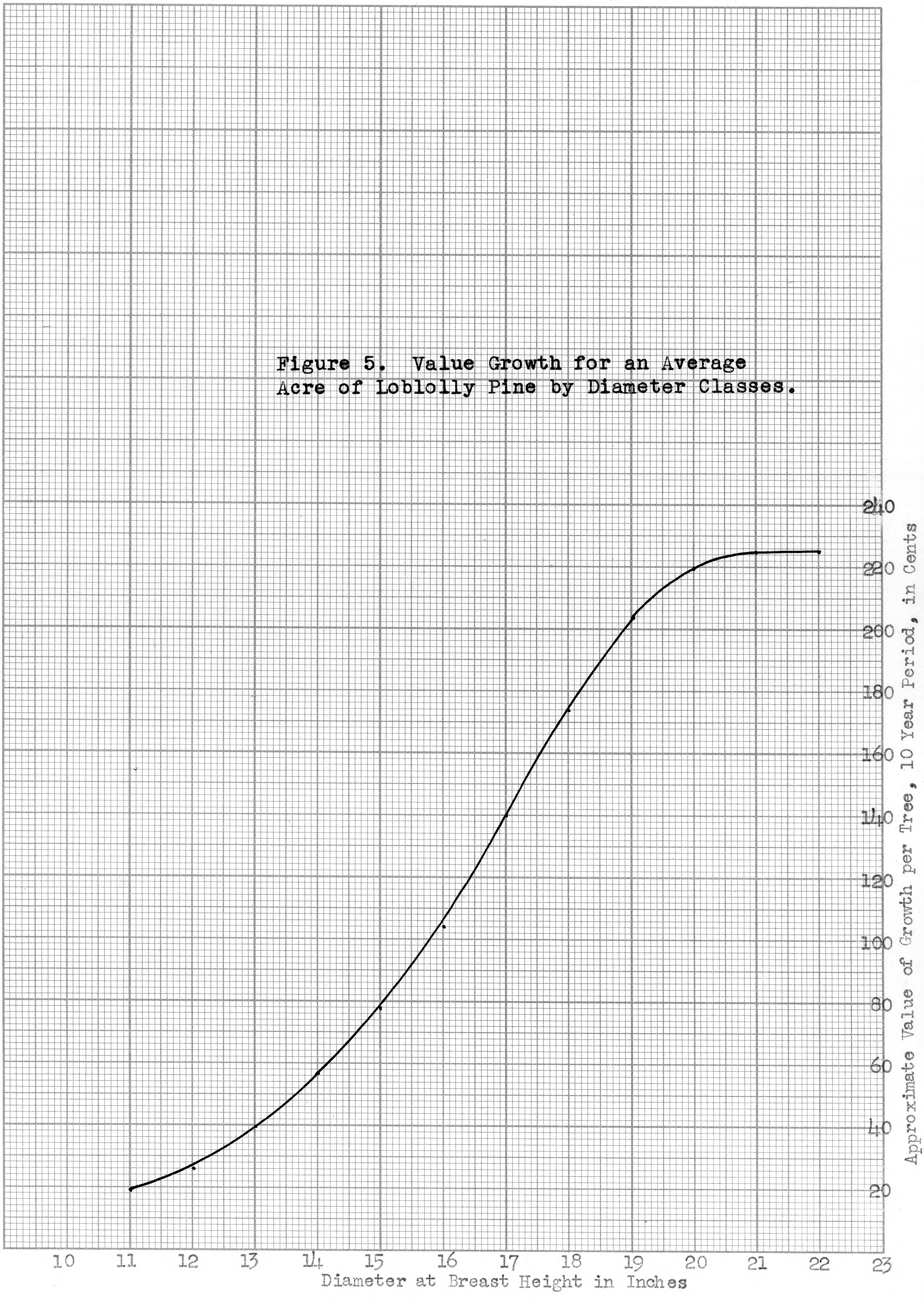

Figure 5. Value Growth for an Average Acre of Loblolly Pine by Diameter Classes.

table of Table 2 and Table 3 can be shown by Figures 6 and 7. Figure 6 shows the curved value per tree. Such a curve would be of value in showing the farmer or landowner that small trees are of little value and should not be cut. The diameter limit at which cutting of quality trees should be restricted can be supported by graphs similar to Figure 7 which shows the annual per cent of value growth by diameter classes for an average of 10 years. Thus, at 19 inches the annual return is 8 per cent on the value of the investment. If money can be loaned at 8 per cent, then 19 inches should be the diameter cutting limit. Figure 7 also supports the desirability of a 19 inch cutting limit for crop trees as previously determined in Figures 4 and 5. Therefore, under present growth rates and market prices, 19 inches in diameter at breast height is the proper diameter cutting limit for this stand. A diameter limit, however, is merely a guide to silviculture and should not be followed slavishly.

If markets or local wood consumption permit, thinnings should be taken from the desirable to cut

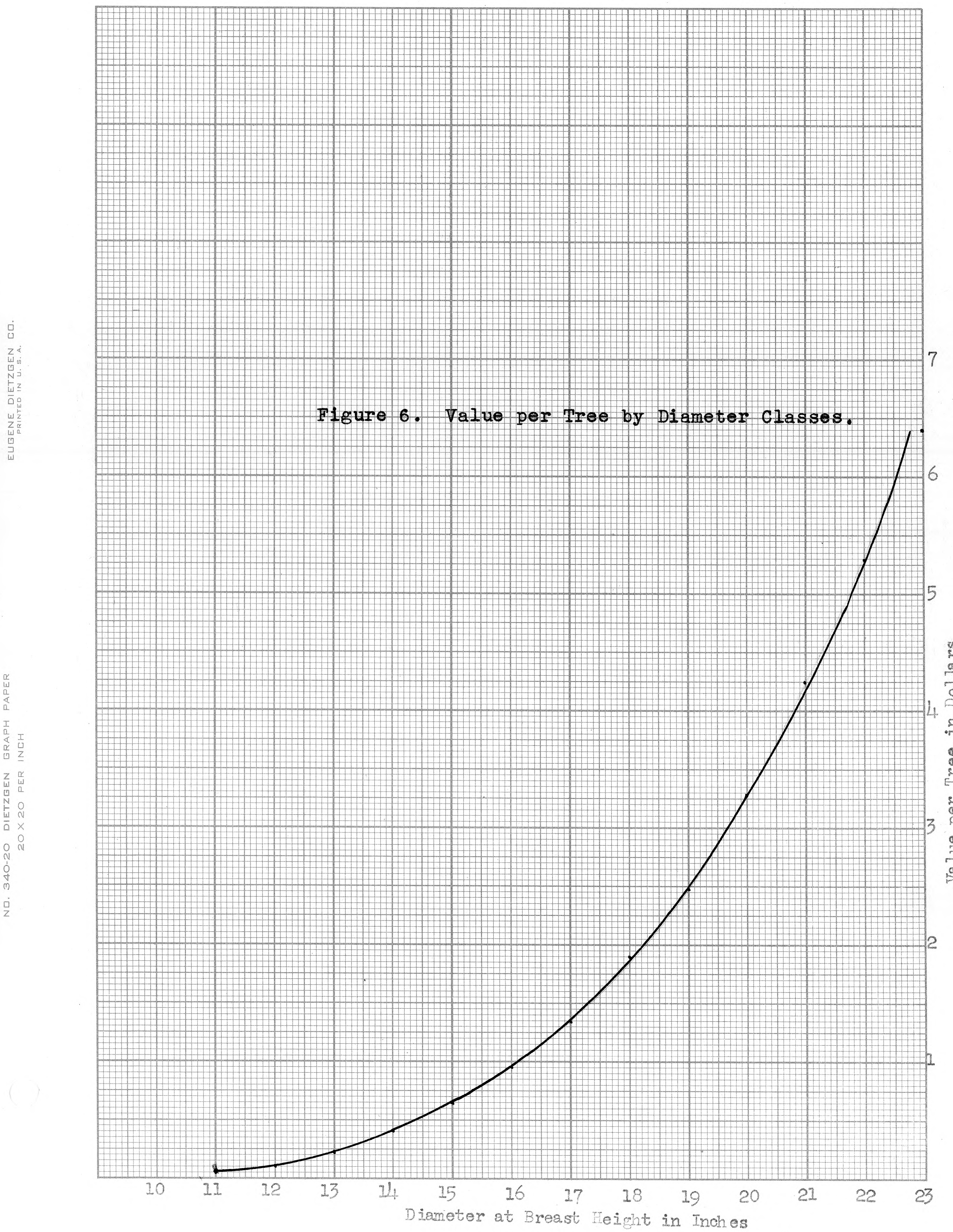
Figure 6. Value per Tree by Diameter Classes.
Value per Tree in Dollars
1
2
3
4
5
6
7
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Diameter at Breast Height in Inches
EUGENE DIETZGEN CO.
PRINTED IN U. S. A.
NO. 340-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH

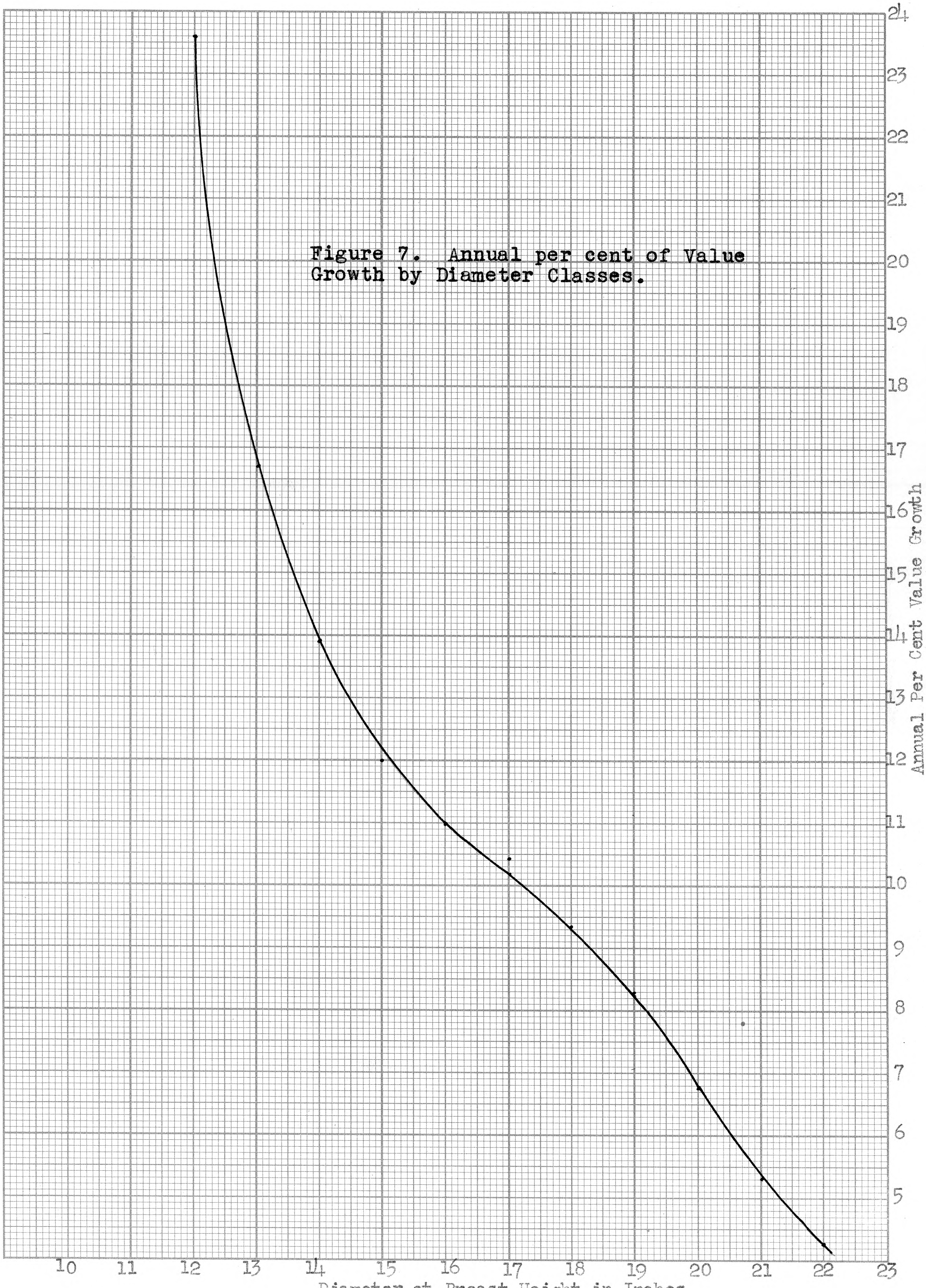
Figure 7. Annual per cent of Value
Growth by Diameter Classes.
Annual Per Cent Value Growth
Diameter at Breast Height in Inches
10
11
12
13
14
15
16
17
18
19
20
21
22
23
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Table 3. Diameter and Value Growth of Loblolly Pine During a 10 Year Period. (Based on Table 2).

D.B.H. in inches	No. of trees	Diam. growth 10 year period, inches	Value per tree, dollars	Approximate value growth per tree, 10 year period, dollars
6	4.0	1.14		
7	5.5	1.22		
8	10.6	1.3		
9	10.3	1.4		
10	11.0	1.5		
11	9.3	1.64	0.06	0.19
12	10.1	1.78	0.11	0.26
13	9.5	1.92	0.24	0.40
14	8.9	2.07	0.41	0.57
15	6.5	2.21	0.65	0.78
16	5.7	2.31	0.95	1.04
17	4.2	2.35	1.34	1.40
18	4.6	2.34	1.87	1.74
19	2.1	2.29	2.49	2.06
20	1.2	2.18	3.28	2.20
21	0.9	2.05	4.25	2.25
22	0.7	1.92	5.28	2.25
23	0.3	1.8	6.40	2.25
24	0.4		7.60	2.25
25	0.3		8.88	2.25
26	0.2		10.10	2.25
27	0.2		11.40	2.25
28	0.1		13.00	2.25
29	0.1		14.30	2.25

trees of lower diameters and from the poor quality trees of larger diameters, such as "wolf" trees. As the growth data should be collected on the crop trees or potential crop trees only, the undesirable portion of the stand should not be considered as a part of the future growing stock. Therefore, growth data should be applied only to the reserve crop timber.

After the financial diameter cutting limit has been established, the cut in board feet can be determined from the merchantable desirable to cut trees, plus the crop trees above the diameter limit. Once the present cut is known, an estimate of the cut at the end of the first cutting cycle should be made. If no cut is advisable at present because the timber is small or the stand is open and understocked, the crop trees might be predicted forward for 5 years or 10 years to determine when cutting should be done and the approximate volume to remove at that time. No growth should be estimated for those trees that are to be removed or for the poor quality, desirable to cut trees.

An easy and reasonably accurate method of growth prediction has been developed by R. R. Reynolds of the Crossett Experiment Station, Crossett, Arkansas. This method predicts trees forward by diameter classes as those that "remain" in the class, those that "move one" or more classes, and the per cent of each that remain or move. For example, assume that 6 crop trees of the 15 inch diameter class grow at the rate of 2.2 inches for a 10 year period. The figure "2" before the decimal point indicates that the entire class of 6 trees could be expected to move two classes and become 17 inch trees at least and that 6 x .2, or 1.2, would become 18 inch trees. Thus, 6 - 1.2, or 4.8, trees would be in the 17 inch class. If the growth rate were .9 inch in a 10 year period, 6 x .9, or 5.4, trees would move one class and become 16 inch trees and .6 tree would remain in the present class. Table 4 gives an example of Reynolds' growth prediction of the stand from Table 2 and Table 3 for five and ten year periods after a cut has been made. If data are collected for a 10 year period and growth were wanted for a 5 year period, the error would be small if the growth for 10 years were divided by 2.

A prediction today of the cut at the end of the second cutting cycle, also shown in Table 4, can be determined in a similar way by predicting forward the trees that are shown to be left after the cut of the first cycle.

The interpretation of the data in Table 3 showed that the financial diameter limit was approximately 19 inches and that the cut today should take the merchantable desirable to cut trees and those crop trees above 19 inches. This limit was held to a higher diameter of 20 inches in Table 4a, however, for the first cut when a 5 year cycle was to be used.

The actual growth should be checked from the cruise data at the end of each cutting cycle to determine the accuracy of the prediction. New growth figures may need to be used, if any appreciable change is found under the method of management.

Once the amount of timber to cut per acre for the different cycles has been found, the capital value of the property by each cycle should determine which cycle is the best. If the woodland is relatively small and can be cut over in one year or less, value per acre will be higher than for a large area that will cut $\frac{area}{CC}$ acres each year. If a return

Table 4. Prediction for 19 Inch Diameter Limit, 10 Year Cutting Cycle.

First cut: 4.4 trees per acre; 2480 ft. b. m. (mill tally).

Diam. in Inches	No. of Trs.	Growth in 10 Years	No. Trs. 10 Years Hense	M_1	M_2	M_3	Vol. per Tr. ft. b. m., mill tally	Total Vol. ft. b. m., mill tally
6	4.0	1.14		3.44	.56			
7	5.5	1.22	3.44	4.29	1.21			
8	10.6	1.30	4.85	7.42	3.18			
9	10.3	1.40	8.63	6.18	4.12			
10	11.0	1.50	9.36	5.50	5.50			
11	9.3	1.64	9.62	3.35	5.95			
12	10.1	1.78	8.85	2.22	7.88			
13	9.5	1.92	7.17	.75	8.75			
14	8.9	2.07	8.63		8.28	.62		
15	6.5	2.21	8.75		5.13	1.37		
16	5.7	2.31	8.28		3.93	1.77	236	
17	4.2	2.35	5.75		2.73	1.47	280	
18	4.6	2.34	5.30		3.04	1.56	325	
19	2.1	2.29	4.50		1.49	.61	373	
20			4.51				424	1910
21			3.05				478	1460
22			.61				533	325
			8.17		Second Cut	....		3695

Prediction for 19 Inch Diameter Limit, 10 Year Cutting Cycle, Third Cut.

Diam. in Inches	No. of Trs.	Growth in 10 Years	No. Trs. 10 Years Hense	M_1	M_2	M_3	Vol. per Tr. ft. b. m., mill tally	Total Vol. ft. b. m., mill tally
16	8.28	2.31			5.75	2.53		
17	5.75	2.35			3.74	2.01		
18	5.30	2.34			3.50	1.80		
19	4.50	2.29			3.20	1.30		
20			5.51				424	2337
21			5.00				478	2390
22			1.3				533	693
			11.8		Third Cut	....		5420

Table 4a. Prediction for 19 Inch Diameter Limit, 5 Year Cutting Cycle.

First Cut: 3.2 trees per acre to 20 inch diameter limit; 1972 ft. b. m. (mill tally).

Diam. in Inches	No. of Trs.	Growth in 5 Years	No. Trs. 5 Years Hense	M_1	M_2	Vol. per Tr. ft. b. m., mill tally	Total Vol. ft. b. m. mill tally
15	6.5	1.11	8.63	5.78	.72		
16	5.7	1.15	6.05	4.85	.85		
17	4.2	1.18	5.57	3.44	.76		
18	4.6	1.17	4.29	3.82	.78		
19	2.1	1.14	4.58	1.81	.29		
20	1.2	1.09	2.59	1.09	.11	424	1100
21			1.38			478	660
22			.11			533	58
			4.08		Second Cut	....	1818

Prediction for 19 Inch Diameter Limit, 5 Year Cutting Cycle, Third Cut.

Diam. in Inches	No. of Trs.	Growth in 5 Years	No. Trs. 5 Years Hense	M_1	M_2	Vol. per Tr. ft. b. m., mill tally	Total Vol. ft. b. m. mill tally
15	8.6						
16	6.1						
17	5.6	1.18			1.01		
18	4.3	1.17		3.57	.73		
19	4.6	1.14	4.58	3.96	.64		
20			4.69			424	1980
21			.64			478	306
			5.33		Third Cut	....	2286

today of "a" dollars per acre and of "b" dollars per acre at the end of each cutting cycle thereafter is expected from a small forest area, the following formula will apply: $C_O = a + \frac{b}{(1.0p^{cc}-1)} - \frac{e}{.0p}$, where "$C_O$" is the present capital value of the property per acre, "a" is the return today, "b" is the expected return at the end of each cutting cycle to come, "cc" equals years in the cutting cycle, ".0p" is the interest rate charged against the investment and "e" is the average annual expense. The expression "$1.0p^{cc}$" will be found in compound interest tables. If no return is expected from a small woodland for "cc" years but it will yield "b" dollars per acre for each cut comming every "cc" years thereafter, the formula should be modified to read $C_O = \frac{b}{(1.0p^{cc}-1)} - \frac{e}{.0p}$. If an increase in cut were predicted at the end of the second cutting cycle and would remain practically constant for each cut thereafter, the formlua should read $C_O = a + \frac{b}{(1.0p^{cc})} + \frac{c}{(1.0p^{cc}-1)(1.0p^{cc})} - \frac{e}{.0p}$, when "c" is the cut at the end of the second cycle and for following cycles.

If the forest property is extensive (farm forests are seldom extensive) and only $\frac{area}{cc}$ acres will be cut each year, the present capital value formula changes. If a cut of "a" dollars per acre is expected throughout the first cutting cycle and further cuts of "b" dollars per acre is predicted for the cycles that follow, the formula should read $C_o = \dfrac{\dfrac{(a - (e \times cc))(1.0p^{cc}-1)}{.0p \times 1.0p^{cc}} + \dfrac{b - (e \times cc)}{.0p \times 1.0p^{cc}}}{c.c.}$.

This formula reduces the value to a per acre basis and can be compared to the per acre value of the small area that is cut once a cutting cycle. If a cut of "a" dollars is expected today, a cut of "b" dollars at the end of the first cutting cycle and further cuts of "c" dollars for each cycle thereafter, the formula should be modified to read

$$C_o \text{ (per acre)} = \frac{\dfrac{(a-(e \times cc))(1.0p^{cc}-1)}{0p. \times 1.0p^{cc}} + \dfrac{(b-(e \times cc)(1.0p^{cc}-1}{.0p \times 1.0p^{2cc}}}{c.c.}$$

$$+ \frac{\dfrac{c - (e \times cc)}{.0p \times 1.0p^{2cc}}}{c.c.}.$$

Application of compound interest formulae at a reasonable interest rate is the really "acid test" for any proposed plan of management.[1]

Problems 1, 2, 3 and 4 give an example of the use of compound interest formulae to determine the

---

[1] For a further use of compound interest formulae, see Matthews, Donald M., Management of American Forests, McGraw-Hill Book Co., Inc., New York and London, 1935.

the present value of the stand from Table 2. This stand has been predicted forward by Reynolds' method (Table 4 and 4a) for 3 cuts.

Problem 1

Small Woodland: Periodic cuts every 5 years, or a 5 year cutting cycle.

1972 ft. b. m. -- First cut to 20 inch diameter limit.
1818 ft. b. m. -- Second cut to 19 inch diameter limit.
2286 ft. b. m. -- Third cut to 19 inch diameter limit.

If the value of stumpage is assumed to be \$5 per M b. m., expenses 20 cents per acre per year, and interest is charged at 4 per cent, what is the per acre value of the property today?

$$C_o = a + \frac{b}{1.0p^{cc}} + \frac{c}{(1.0p^{cc}-1)(1.0p^{cc})} - \frac{e}{.0p}$$

$$= 9.86 + \frac{9.09}{1.04^5} + \frac{11.43}{(1.04^5-1)(1.04^5)} - \frac{.20}{.04}$$

$$= 9.86 + \frac{9.09}{1.217} + \frac{11.43}{(.217)(1.217)} - 5.00$$

$$= 9.86 + 7.48 + 43.40 - 5.00$$

$= \$55.74$ per acre, value just before first cut.

$\$55.74 - 9.86 = \$45.88$ per acre, value just after first cut.

Problem 2

Small Woodland: Periodic cuts every 10 years to a 19 inch diameter limit.

2480 ft. b. m. -- First cut per acre.
3695 ft. b. m. -- Second cut per acre.
5420 ft. b. m. -- Third cut per acre and for following cuts.

If the value of stumpage is $5 per M b. m., expenses 20 cents per acre per year, and interest is charged at 4 per cent, what is the present value per acre of the property?

$$C_o = a + \frac{b}{1.0p^{cc}} + \frac{c}{(1.0p^{cc}-1)(1.0p^{cc})} - \frac{e}{.0p}$$

$$= 12.40 + \frac{18.48}{(1.04^{10})} + \frac{27.10}{(1.04^{10}-1)(1.04^{10})} - \frac{.20}{.04}$$

$$= 12.40 + \frac{18.48}{1.48} + \frac{27.10}{(.48)(1.48)} - 5.00$$

$$= 12.40 + 12.40 + 38.10 - 5.00$$

= $62.90 per acre, value just before first cut.

$62.90 - 12.40 = $50.50 per acre, value just after first cut.

Problem 3

Extensive Property: Annual cuts of $\frac{\text{area of property}}{\text{cutting cycle}}$.

If the cutting cycle is 10 years, 10 acres can be used as a typical sample. Interest is charged at 4 per cent; annual expenses for the first cutting cycle = 20 cents, for the second cutting cycle = 25 cents, for the third and following cycles = 30 cents per acre.

2480 ft. b. m. -- Cut per acre first c.c. to 19 inch diameter limit.
2695 ft. b. m. -- Cut per acre second c.c. to 19 inch diameter limit.
5420 ft. b. m. -- Cut third cycle. No increase is expected for future cycles.

C_o (per acre) =

$$\frac{\dfrac{(a - (e \times cc))(1.0p^{cc}-1)}{.0p \times 1.0p^{cc}} + \dfrac{(b - (e' \times cc))(1.0p^{cc}-1)}{.0p \times 1.0p^{2cc}}}{c.\ c.}$$

$$+ \frac{\dfrac{c - (e'' \times cc)}{.0p \times 1.0p^{2cc}}}{c.c}$$

$$\frac{\dfrac{(12.40-(.20\times10))(1.04^{10}-1)}{.04 \times 1.04^{10}} + \dfrac{(18.48-(.25\times10))(1.04^{10}-1)}{.04 \times 1.04^{20}}}{10}$$

$$+ \frac{\dfrac{27.10 - (.30 \times 10)}{.04 \times 1.04^{20}}}{10}$$

$$= \frac{(10.40)(8.111) + \dfrac{(15.98)(.48)}{.04 \times 2.191} + \dfrac{24.10}{.04 \times 2.191}}{10}$$

$$= \frac{84.35 + 87.30 + 275.11}{10} =$$ \$44.69 per acre, first cut coming throughout present year.

Problem 4

Extensive Property: Annual cuts of $\frac{\text{area of property}}{\text{cutting cycle}}$.

If the cutting cycle is 5 years, 5 acres can be used as a typical sample. Interest is charged at 4 per cent; annual expenses per acre for the first cutting cycle = 20 cents, for the second cycle = 22 cents and for the third cycle = 25 cents.

1972 ft. b. m. -- Cut per acre first c. c. to 20 inch diameter limit.
1818 ft. b. m. -- Cut per acre second c.c. to 19 inch diameter limit.
2286 ft. b. m. -- Cut third cycle. No increase is expected for future cycles.

C_o (per acre) =

$$\frac{\frac{(a - (e \times cc)(1.0p^{cc}-1)}{.0p \times 1.0p^{cc}} + \frac{(b - (e' \times cc))(1.0p^{cc}-1)}{.0p \times 1.0p^{2cc}}}{c.\ c.}$$

$$+ \frac{\frac{c - (e'' \times cc)}{.0p \times 1.0p^{2cc}}}{c.\ c.}$$

$$\frac{\frac{(9.86-(.20\times5))(1.04^5-1)}{.04 \times 1.04^5} + \frac{(9.09-(.22\times5))(1.04^5-1)}{.04 \times 1.04^{10}}}{5}$$

$$+ \frac{\frac{11.43 -(5 \times .25)}{.04 \times 1.04^{10}}}{5}$$

$$= \frac{8.86 \times 4.452 + \frac{7.99(.217)}{.04 \times 1.48} + \frac{10.18}{.04 \times 1.48}}{5}$$

$$= \frac{39.40 + \frac{1.734}{.0592} + 171.96}{5}$$

$$= \frac{240.67}{5} = \$48.13$$ Best cycle for extensive property if twice area of 10 year cycle can be covered; will give better silviculture.

Cost of Extracting Timber (Small Areas):

The cost of extracting timber from small areas of less than 100 acres is largely dependent on the distance of haul and the service standard of the external road. As the distance of haul becomes greater, the total cost of delivered product will be higher and, as the road standard is improved, the hauling cost will be lowered. The standard of external road to build has been discussed under Detailed Extraction of Timber (Large Areas). Small woodlands of less than 100 acres in the loblolly-shortleaf-hardwood region will usually not support a timber cut that will be large enough to justify large expenditures for improving roads or for purchasing and operating modern logging equipment.

Detailed Extraction of Timber (Large Areas):

Forest managers and forest owners of 100 acres or more of woodland should be interested in harvesting the timber crop as economically and efficiently as possible. Cost should be measured in terms of result.[1]

Total expense figures must usually be broken down into "fixed" or "overhead" costs and "direct" or "variable" costs. Fixed costs are those which are fixed in their aggregate amount and vary per unit result with output. Variable costs are fixed per unit result and vary in their aggregate amount with output.[1] For example, if a team or tractor is skidding logs directly to woods roads proir to loading, fixed costs could be estimated by determining the time used in yarding or bunching, turn-around, delay, hook and unhook. Idle time because of bad planning or lost time because of mechanical failure should not be included as a part of fixed cost as they can be corrected. Variable costs of pre-haul (normally thought of as skidding) vary with the ground conditions and slopes but can be estimated for any given locality

[1]Matthews, Donald M., Principles of forest industry economy, School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, mimeographed, p. 2, 1940.

by determining speed of travel, distance and delays while skidding, such as would be expected if tongs or choker slipped. All costs that deal with logs should be reduced to costs per thousand board feet.

Fixed and variable costs serve as a basis for comparing different types of pre-haul equipment. A team will have a low fixed cost, for example, and a high variable, while a tractor will usually have a high fixed cost and a low variable. Thus, at a certain distance from roads and/ or loading point, the tractor will become more economical than the team. This distance can be determined by the formula $\frac{F' - F}{C - C'}$, when F' is the fixed cost for a tractor, F equals the fixed cost for a team, C is the variable cost for a team and C' equals the variable cost for a tractor. If F' equals 90¢ per M b. m., F is 70¢, C equals 14¢ and C' is 10¢, the "break even" point can be determined by the use of the formula or graphically by plotting the variable costs per M b. m. per 100 feet for each machine (Figure 8).

After the most economical machine has been found for various skidding or pre-haul distances, a determination of the economic spacing of spur roads for this type of equipment will be necessary.[1] As

---

[1] Matthews, Donald M., Principles of forest industry economy, School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, p. 59, mimeographed, 1940.

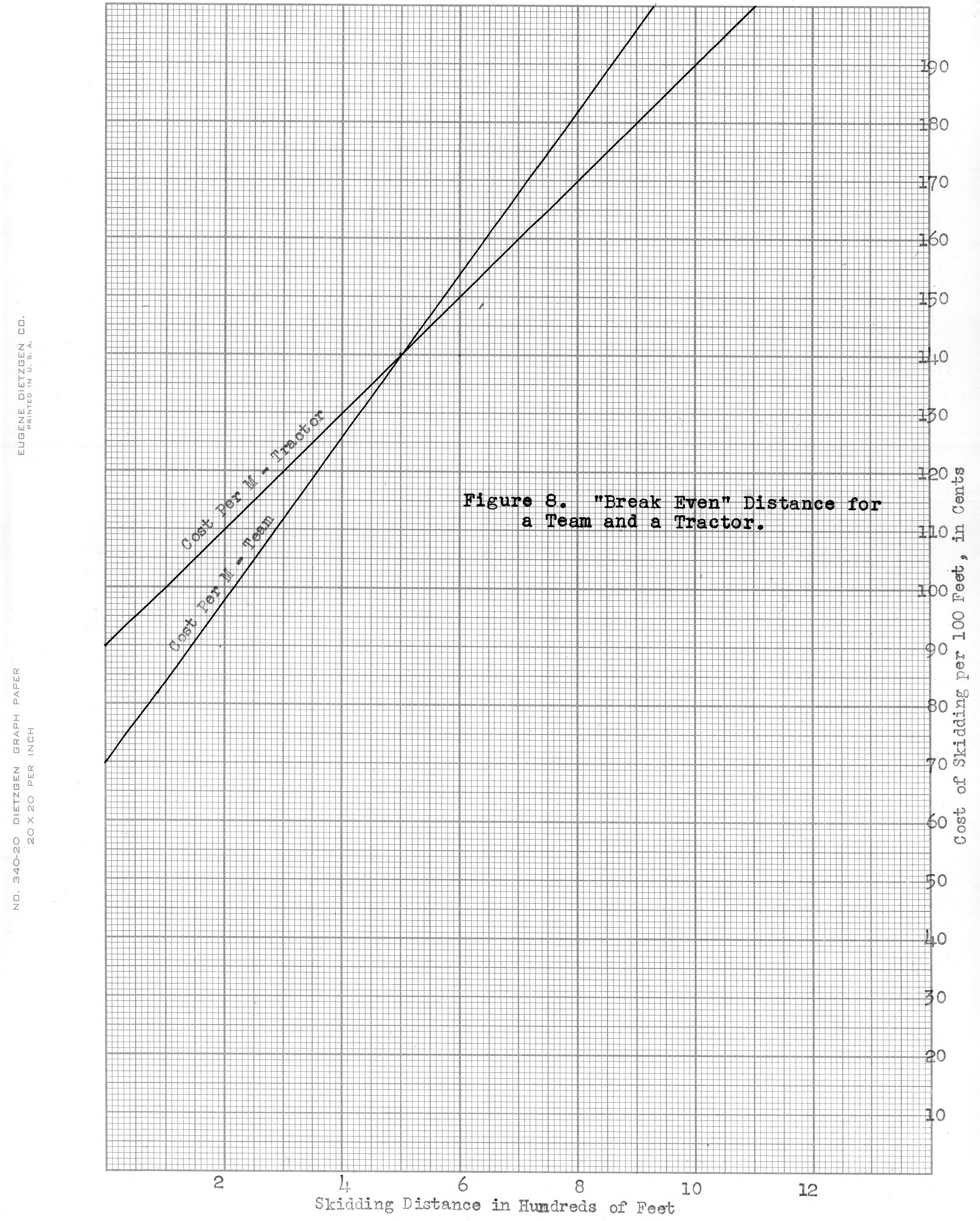

Figure 8. "Break Even" Distance for a Team and a Tractor.

spacing is increased and the cost of roads per sale unit of product is lowered, the cost of moving the product to the road in the pre-haul operation increases.[1] Thus, road construction per mile, pre-haul per 100 feet and volume of timber to be cut per acre must be balanced. This balance can be obtained for direct skidding by the formula $S = \sqrt{\frac{.33\ R}{VC}}$ when S represents spacing of roads in hundreds of feet, R equals cost of road construction per mile, V is the volume of cut per acre and C represents pre-haul cost per 100 feet per M board feet. If R is measured in cost per 100 feet (r), the formula should read $S = \sqrt{\frac{17.4\ r}{VC}}$. These formulae are not applicable if landings are used.

Total cost of sale unit delivered at a main line road can be found by the formula $F + \frac{CS}{4} + \frac{\frac{R}{12.1}}{VS} + F' + \frac{HD}{2}$ when F represents fixed cost of pre-haul, C is the variable cost of pre-haul per 100 feet per M board feet, S equals road spacing in hundreds of feet, R represents road construction costs per mile, V is the volume of cut per acre, F' is the fixed cost of interior hauling (usually by truck) and H equals the cost of hauling per M per 100 feet.

---

[1] Matthews, Donald M., Principles of forest industry economy, School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, p. 59, mimeograhped, 1940.

The standard of logging road to build is an important factor in harvesting timber in the South. Hauling costs will vary greatly with the quality of the road. If cost construction estimates are obtainable for different classes of roads for any given topography, soil, construction methods and equipment available and if the cost of operating a truck on these different classes of roads is known, the most economical road can be determined for any timber volume and distance of haul for similar conditions. The standard of external road to build can be found by a direct cost comparison. For example, a total stand of timber is estimated to be 8,000 M b. m. Hourly cost of operating (fixed plus variable costs) is 130¢per hour for a truck that hauls 2M per load. Cost of fuel per round trip mile equals 6¢. What standard of road would be most economical if other data are available as follows:

Road Class	Speed in mph*	Road Construction costs per mile
II	4	$200
III	7	400
IV	12	600
V	18	1400

* Speed in mph should be the speed per round trip mile and can be determined as follows:

$$\frac{2 \times (\text{high rate of speed} \times \text{low rate of speed})}{\text{high rate plus low rate}}$$

Solution of the problem:

Road Class	Speed in mph	Hauling Cost per Mile $\frac{130¢ \times 2}{mph \times 2M} + \frac{6¢}{2M}$	Road Cost per M b.m. $\frac{Cost/mi.}{8000\ M}$	Total Cost per M b.m. per Mile
II	4	32.5 + 3 = 35.5¢	2.5¢	38¢
III	7	18.5 + 3 = 21.5	5.0	26.5
IV	12	10.8 + 3 = 13.8	7.5	21.2
V	18	7.2 + 3 = 10.2	17.5	27.7

Thus, Class IV road is seen to be the most efficient road to use. The above calculation shows that if the hauling costs and road costs were equal the total cost would be at a minimum.

Interior main logging roads are not always constructed to adequate standards, as the volume moved over any length of road is not constant for the entire length but decreases as the road penetrates the area to be logged.[1] The tendancy has been to lower the standard of the road too quickly as the road enters the operating area.[1] This is not justified until the road is approaching the remote portions of the tract. The interior line can be of higher standard than the branch or spur roads but will usually not equal that of the exterior road.

Service standards for branch or spur roads

---

[1] Matthews, Donald M., Principles of forest industry economy, School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, pp. 77-78, mimeographed, 1940.

should be compared by direct cost comparison. As has been shown in comparing costs of road construction and hauling costs for external roads, the minimum total cost is found when road construction and hauling costs are equal. The standard may be limited, however, by the type of skidding equipment that is available. For example, if teams are used, the spacing of roads should be relatively close together so that the "break even" distance for the teams versus small tractors will equal $\frac{S}{2}$, or one half the spacing. As spacing of roads varies inversely with the volume of timber to be cut per acre (from formula $S = \sqrt{\frac{.33\ R}{VC}}$) as well as with the variable cost of operating a certain type of skidding equipment, the amount and size of timber to be logged may determine whether teams, small tractors or larger tractors should be used. An example of determining spur spacing for direct skidding to the spurs is as follows:

A township that has an average stand of 7M board feet per acre is to be logged. The topography is level to gently rolling. Although the topography is not rough, ground conditions in the woods are not suitable for trucks; therefore, spur roads are necessary. Timber will be skidded directly to these spurs. Road construction costs are estimated as follows:

Construction to a 20 mph standard --- $1,000 per mile
Construction to a 15 mph standard 600 per mile
Construction to a 10 mph standard 400 per mile

Trucks can carry loads of 2.5M board feet on the average. The machine rate for these trucks has been calculated as follows:

Fixed cost per hour	$1.20
Variable cost per hour	1.60
	$2.80

The trucks will require 10 minutes per M to load and 4 minutes per M to unload.

D_4 tractors are to be used for skidding and the machine rate is figured at $2.10 per hour. The average load of these machines is estimated at 400 ft. b. m. Fixed time for skidding is estimated at 10 minutes per turn; travel time (variable) is found to be 1 minute per 100 feet of round trip distance.

If a main line interior road is planned to run through the center of the township, plan the most efficient road lay-out.

Solution of the problem:

Machine rate for tractor = 210¢ per hour.

$$\frac{210}{60} = 3.5\text{¢ per minute}$$

Fixed cost of tractor per turn = 10 x 3.5 = 35¢

$$\frac{35}{.4M} = 87\text{¢ per M.}$$

Variable cost of tractor per turn = 1 x 3.5 = 3.5¢

$$\frac{3.5}{.4M} = 8.7\text{¢ per M per 100 feet.}$$

Road Speed mph	Construction cost per mile	Hauling Cost* per mile
20	$1,000	11.24¢
15	600	19.90
10	400	22.40

* Hauling cost per mile is developed from the formula that has been given, when

$$\frac{\text{Hauling cost per hour} \times 2}{\text{mph} \times \text{Load}} \text{ plus } \frac{\text{fuel}}{\text{Load}}$$; fuel may not be important enough to consider, as in this instance.

Road spacing for different road classes:

$$S = \sqrt{\frac{.33\ R}{VC}}$$

$$S_{20} = \sqrt{\frac{.33 \times 100000}{7 \times 8.7}} = 23.4 \text{ hundred feet}$$

$$S_{15} = \sqrt{\frac{.33 \times 60000}{7 \times 8.7}} = 18 \text{ hundred feet}$$

$$S_{10} = \sqrt{\frac{.33 \times 40000}{7 \times 8.7}} = 15.1 \text{ hundred feet}$$

Total of variable costs will give the most efficient road to use and can be expressed as

$\frac{2CS}{4} + \frac{HD}{2}$ when C is the variable cost of skidding, S is the road spacing, H is the variable cost of operating the truck per mile and D is the maximum trucking distance on spur roads.

$$S_{20} = 2 \times 8.7 \times \frac{23.4}{4} = 117.4¢$$

$$S_{15} = 2 \times 8.7 \times \frac{18}{4} = 100¢$$

$$S_{10} = 2 \times 8.7 \times \frac{15.1}{4} = 98.5¢$$

Class S_{10} shows the lowest cost, but as the difference between S_{10} and S_{15} is so small, S_{15} would likely be used.

Therefore, if Class 15 mph roads can be used for spurs, the main line road can certainly be constructed to Class 20 mph, as the volume of timber to move over it will be greater than for the spurs.

If two types of skidding devices are used on the same logging operation, road spacing will vary only slightly from that found by $\sqrt{\frac{.33\ R}{VC}}$, if the value for C is that of the high fixed cost machine. As this formula is easy to use, it is recommended. If the "break even" distance or maximum haul for teams, for example, is one fourth the road spacing, the greatest saving per M board feet will result for two skidding devices (perhaps tractors and teams) working together. If the spacing of roads is four times or more the break even distance or less than one and one half the break even distance, no reduction in costs will result.[1]

---

[1] Matthews, Donald M., Principles of forest industry economy, School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, p. 100, mimeographed, 1940.

Timber Marketing:

The farmer or landowner may sell his timber and land, or just the timber, for a given sum for the tract--or "bulk" selling. Such a practice should be discouraged. The purchaser, if he is interested in sawlogs, usually takes every pine that will make a log with an eight inch diameter top. If the purchaser is a pulpwood buyer, he will normally cut all the pine 4 inches and up in diameter. Thus, little growing stock is left on the ground to insure future cuts or the landowner may lose the land itself.

Another method of sale is to sell at an agreed amount per M board feet for the standing trees. Thus, the buyer may take the best logs and leave many that should be cut. The farmer may receive but a fraction of the value of his timber by "bulk" selling or by this method.

Perhaps the best procedure is for the farmer to cut his own trees (under the supervision of a forester, if possible). Thus, he can remove those trees that should be cut and he will usually not damage the trees that are to remain. The farmer will generally have to contract the hauling. He should not sell the logs to the contractor but directly to the mill at a specified amount per M board feet for a definite log scale, such as the Doyle scale. The farmer should have a log scale stick similar to the one used by the mill operator. Thus, the farmer will be able to check the buyer's scale. Of perticular importance is a contract between the logging operator and the farmer. A sample contract is shown in Appendix A.

If the farmer does his own timber cutting, better silvicultural practices and closer utilization will usually result.[1]

No rigid standards have been set-up for evaluating log grades in the South. When this is done, the farmer or landowner will have a further incentive for operating on short cutting cycles which take the larger, premium trees.

---

[1] See Appendix B for general principles of cutting.

Methods of Organization for Production:

As government foresters are rarely able to give close attention to woodlands on individual farms and as farm woodlots are not large enough to justify the services of a full time forester, the development of farm forest cooperatives is certainly worth consideration as a means of managing the small productive forests of the Coastal Plains. Solin[1] has summarized the development of farm woodland cooperatives in the United States to March, 1940. Apparently government supervision has been closely connected with their growth. If the cooperative is to stand on its own merits, however, private interests and capital must do the major part of the developing.

A cooperative in the loblolly-shortleaf-hardwood type should likely have the objectives of woodland improvement and protection, marketing of rough forest products, education and cooperation with state and federal forest and agriculture agencies. Then, if the organization were successful, milling and marketing of finished products might be attempted.

[1] Solin, Lawrence, A study of farm woodland cooperatives in the United States, Tech. Bul. No. 48, The New York State College of Forestry, Syracuse University, Syracuse, New York, vol 8 (2), March, 1940.

In order to insure desirable membership in such an association and in order that membership might be maintained and increased, rigid requirements for elegibility should be included in the constitution and by-laws. If members drop out of the cooperative on the slightest excuse, no forestry program could be successful.

The cooperative manager, preferably an experienced forester, should have a good understanding of business management and of local conditions of sociology, economics, farming practices, forest management and forest cost accounting, marketing conditions and marketing problems.

Further information as to the development, problems, and constitutions and by-laws of cooperatives is available in Solin's bulletin.

Recommendations to the Farmer:

The farmer is likely to remain the protector and manager of his woods, even though a cooperative organization or a government agency may relieve him of part of his responsibility. The cooperative forester, or government forester, may have to accomplish much of the woodland management by working with and educating the farmer. The farmer would need to know something as to the value and condition of his forest, the best cutting cycle to use, the amount and date of the first cut, the rate of growth and expected return under management and the general cutting and silvicultural recommendations.[1] A brief, simple, written statement of these points should be of help to both the farmer and the manager. Education can be furthered by personal interviews--which is probably the best method, newspaper articles, bulletins and publications, and by talks at group meetings--perhaps in cooperation with the county agent.

---

[1] See Appendix B for general principles of cutting.

SUMMARY AND CONCLUSIONS

The general social and economic conditions in the loblolly-shortleaf-hardwood region are quite pressing. The problems of fire and grazing, income and credit, wood utilization and marketing practices, soil erosion, farm tenancy and taxes present a seemingly dark future. The development of the forest resources, however, should be an important factor in increasing the purchasing power and in the improving of living standards.

If forest management is to be successful, sound methods of data collection and interpretation are necessary.

The application of the woodland data should give the farmer or landowner a simple picture of his forest and suggestions as to how he can improve and manage it for the greatest return. Perhaps this application can be extensively carried out by woodland cooperatives.

Appendix A

Sample Timber Logging Contract:

LOGGING CONTRACT

Agreement entered into this _____ day of _______________, 194___, between ______________________, of Coushatta, Louisiana, hereinafter called the owner, and ____________________________, of Ringgold, Louisiana, hereinafter called the logging contractor.

Witnesseth:

ARTICLE 1. The owner agrees to pay the logging contractor, for cutting and hauling, upon the terms and conditions hereinafter stated, all the marked or designated living pine timber that is merchantable for sawlogs on a certain tract of land, approximately _______ acres, situated in Section _______, Township 12 North, Range 10 West, Parish of Red River, State of Louisiana, and approximately ________ miles north of Coushatta, Louisiana, on U. S. Highway 71.

ARTICLE 2. The owner agrees to pay the logging contractor at the rate of __________ ($________) per thousand board feet, Doyle scale, for the cutting and hauling of the marked and designated living pine described above. Payment of __________ ($___________) per thousand board feet, Doyle scale, will be made when seventy five per cent (75%), approximately, of the timber has been delivered and full settlement will be made when all the timber has been delivered at the designated point.

ARTICLE 3. The logging contractor further agrees to cut and haul said timber in strict accordance with the following conditions:

1. Unless extension of time is granted by the owner, all timber shall be cut and hauled on or before ____________________, 194____.

2. Saw timber shall be scaled by the Doyle log rule, and measured at the small end along the average diameter, taking one edge of the bark and leaving one, to the nearest inch.

3. The maximum scaling length of logs shall be 20 feet; greater lengths shall be scaled as two or more logs. Upon all logs, four (4) inches shall be allowed for trimming.

4. No other timber except the marked or designated merchantable sawlog pine shall be cut and hauled.

5. Stumps shall be cut so as to cause the

least possible waste--approximately 12 inches or less above the ground.

6. All trees shall be utilized in their tops to the lowest possible diameter for commercially salable logs.

7. Young trees shall be protected against unnecessary injury; only dead trees and other worthless trees, such as defective post oak, red oak, hickory, or gum, may be used in connection with the logging operation. Care shall be used not to damage remaining trees that are not marked or designated to be cut.

8. No pine wood or pine tops shall be left against another living pine; no pine shall be sawed and left suspended, or lodged, against another living pine.

9. Care shall be exercised at all times by the logging contractor and his employees against starting and spread of fire.

ARTICLE 4. It is mutually understood and agreed by and between the parties hereto as follows:

1. All timber included in this agreement shall remain the property of the present owner.

2. In event of dispute over the terms of this contract, final decision shall rest with a reputable, disinterested person to be mutually agreed upon by the parties of this contract; in event of further disagreement, with an arbitration board of three disinterested persons, one to be selected by each party to this contract and the third to agreed upon by the first two.

In witness whereof the parties hereto have hereunto set their hands this ________day of ____________________, 194_____.

Witnesses:

________________________ (Owner) ________________________

________________________ (Contractor) ________________________

Appendix B

General Principles of Cutting:

1. Cut the poorest trees that will meet the specific need; leave the best.

2. Try to leave a good pine of average reserve diameter every 12 to 20 feet.

3. Mark every tree that is to be cut. This practice will save many good trees.

4. Protect woods from uncontrolled fire and grazing.

5. Use care when felling trees and skidding logs so as not to damage those trees that are to remain.

6. Green pine tops or pine wood should not be allowed to remain against another living pine or bark beetles are likely to pass from the cut wood into the standing tree.

7. Stumps should be kept low. Wood in the tops should be utilized where practicable.

8. Shrubs and vines should be favored, especially along woodland borders, so as to furnish food and cover for wildlife. An occasional den tree is desirable.

9. Competitive, low value hardwoods should

usually be eliminated if financially feasable.

10. Logs should be removed from the woods as soon as possible after they are cut.

11. Merchantable pines that show evidence of heartrot by the presence of "punk" knots should usually be cut during the first logging operation.