Eber White Woods Report

By

Robert ~~C.~~ A. Farrington

1207 Packard Street
Ann Arbor, Michigan
May 26, 1939

Professor L. J. Young
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Ann Arbor, Michigan

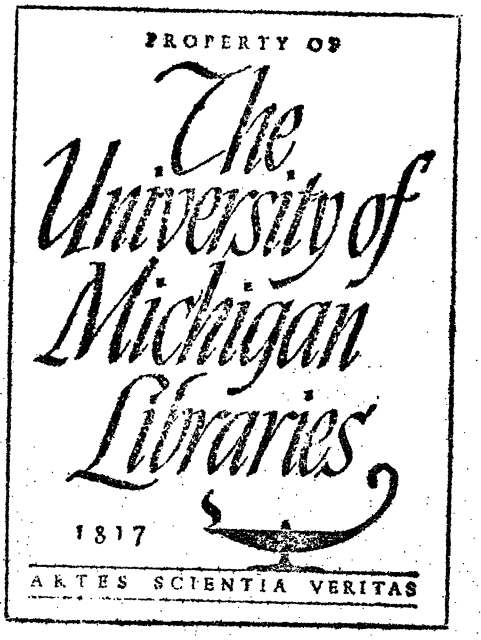
Dear Sir:

Attached is my report entitled "The Results of Twenty Years of Management of the Eber White Woodlot."

I trust that I have given you the information that you expected.

Respectfully submitted,

ROBERT A. FARRINGTON



THE RESULTS OF TWENTY YEARS OF MANAGEMENT OF THE EBER WHITE WOODLOT

By

Robert A. Farrington

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FOREWORD

During the past few years there has been an increasing recognition by the U. S. Forest Service and other forestry agencies that the woodlots in the United States are an important forest resource. The Soil Conservation Service and other "New Deal" agencies have brought the problems of this type of forest management into the present day conservation activities in a more active form than heretofore.

As soon as actual work was attempted in the field, it became apparent that the existing data were not adequate basis for management of the woodlot. Although a great deal of work has been accomplished during the last three or four years, there are few records covering more than 10 years of past management.

The Eber White Woodlot, a property of the University of Michigan, School of Forestry and Conservation, Ann Arbor, Michigan, offers an opportunity to study the results of woodlot management as it has been practiced by the School of Forestry and Conservation during the past twenty-two years.

It is the purpose of this paper to report the silvicultural and financial results of this period of management.

SUMMARY

The Eber White Woodlot has been managed by the School of Forestry and Conservation, University of Michigan, Ann Arbor, Michigan, since 1917. The 43 acre woodlot has been divided into 10 compartments of 4.3 acres each. Two plots are cut each year and the entire area covered every 5 years.

This area is a typical woodlot of Southern Michigan. Previous to the University's acquisition in 1915 it had not been mistreated by fire or grazing and has not been so treated since. The stand is composed chiefly of oak and hickory with smaller volumes of hard maple, basswood, black walnut, ash, cherry, elm, and ironwood. There are a number of big "wolf" trees 30 inches and over scattered through the stand. In general the stand is understocked, but thrifty.

The stand has been treated primarily by a modified single tree selection cuttings, with an aim to improving the stand as to species and diameter distribution. The "wolf" trees, over-mature trees, and defective trees are being removed as rapidly as possible with due regard to maintaining and improving forest conditions for the best possible growth and reproduction.

The tables and graphs presented in this report show that:

1. The height growth decreases materially at about 20 inches d.b.h.

2. The merchantable height indicates that there is an old stand of 30 inches and above and a much younger stand from 1 to 30 inches.

3. A diameter of about 26 inches is indicated as the cutting limit.

4. The species during the past 22 years have decreased in numbers, mostly in least desirable species, while the more desirable oaks and hickories have increased in numbers and volume.

5. Reproduction is adequate, and has been stimulated due to cutting practices.

6. Older veterans have also been stimulated in growth to some extent.

7. It is indicated that production of 100 board feet per acre per year and 1/4 cords per acre per year can be maintained.

8. In general the financial returns have not been profitable, but hearing in mind that unskilled, soft-muscled labor is used at $.40 per hour, it seems probable that a farmer could make a profit of about $142.00 per year exclusive of interest, taxes, or other costs.

This paper has also opened some questions as to how much good is done by removing material with no merchantable value; what part sprout reproduction plays and the possibilities of more detailed studies during cutting as to height, cull, and age,

THE RESULTS OF TWENTY YEARS OF MANAGEMENT OF THE EBER WHITE WOODLOT[1]

INTRODUCTORY

Historical

The Eber White Woodlot of 43 acres was acquired by the School of Forestry and Conservation in 1915. Prior to that time, it had been cut over to some extent, probably for the better species, as indicated by stumps present at the time of acquisition.[2] As far as can be ascertained, fire and grazing had not been a practice before 1915, and certainly has not been allowed since.

Site Description

Location. The area is located in the SE 1/4, SE 1/4, Section 30, T. 2 S., R. 6 E., Michigan P. M. In regard to the City of Ann Arbor, it is adjacent to the western boundary of the city limits, and south of and adjacent to West Liberty Street. Soule Avenue extends to the gate on the eastern end. (See Figure 1).

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1. A property of the University of Michigan, School of Forestry and Conservation, Ann Arbor, Michigan.

2. The condition of the stumps also indicated that previous cutting had been done many years before.

3. Veatch, S. O. U. S. Bureau of Chemistery and Soils, 1934.

Soil. The soil is classified in the Detailed Soil Survey of Washtenaw County[3] as a "Miami silt loam." According to the same report, this type is representative of well drained clay soils of the uplands. In general it is a moraninal soil found on more or less rolling terrain. The moisture conditions are usually good and other factors make this a desirable and productive soil for farming purposes. It is a good forest soil, local drainage being an important factor affecting the species and growth.

The profile is described as follows: 0-5 inches, a gray-brown silt loam; 5-10 inches, a grayish yellow, more or less leached layer; 10-24 inches, yellow-brown, more clayey, plastic and impervious when wet, coarsely granular when dry; parent material a blue-gray clay, massive, compact, moderately stony and gritty.

Although the soil survey of the County has called this a silt loam, three samples given a mechanical analysis in the soils laboratory at the University of Michigan indicate a "sandy loam" texture. The following is a summary of the analysis:

	Top soil a sandy loam;		Top soil a muck phase of a clay loam:
Clay and silt	30%	26%	34%
Sands	60%	63%	45%
Coarser material	10%	11%	21%

Stand Description

The stand is typical of many Southern Michigan woodlots on this site. It is composed chiefly of oaks and hickories, with smaller volumes of ash, hard maple, walnut, ironwood, basswood, elm, and cherry. Douglas fir, Scotch pine, and white pine have been planted on the north side of the western half of the woodlot where there were some open areas with but scant means of getting natural reproduction.

In addition to the main timber stand there is a moderately heavy herbacesous cover. In the more open spots grasses are found. Weeds and flowers such as bloodroot, adder's tongue, hepatica, and trillium are abundant. Some raspberry, blackberry, and gooseberry are found, and grapevines and green brier vines have been removed in spots where it was becoming detrimental to the timber trees or their reproduction.

In general, the tree canopy is well closed, although enough light comes through the openings to maintain reproduction. Tables I, II, and III show the actual timber stand condition in more detail, and will be further discussed in later pages.

Stand Treatment

The original plan of stand treatment was based upon a ten year cutting period. At the end of 5 years, after compartments 1 through 5

had been cut once, it was decided to change to a 5 year cutting period. Because of this change, the last half of the area, compartments 6 through 10, were receiving their first cutting while compartments 1 through 5 were receiving their second cutting.

The fundamental philosophy underlying the treatment of the stand are:[4]

1. The encouragement of desirable species and exclusion of weed or undesirable species.

2. The improvement of the quality of the trees, both as to cleaning of the boles and the elimination of overmature, diseased, and mechanically defective trees.

3. The maintenance of forest conditions adventageours to growth and natural reproduction.

4. The maximum production of forest products.

The treatment of the stand is based primarily upon the single tree selection method.[5] The past cuttings have used this method combined with improvement cutting. At the present time there has been no diameter limit set, but according to d.b.h.--height relationships shown in figures 2 and 3, about 26 inches is indicated. Slash has been lopped and scattered.

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4. This policy was not entirely carried out while Professor Roth was in charge of the cuttings, as his policy was to retain the old mature trees, partly for aesthetic reasons, as long as possible.

5. Hawley, R. C. The Practice of Silviculture. New York: John Wiley and Sons, Inc., 1939, pp. 89-90.

Records and Computations

The area of 43 acres was divided into 10 compartments of 4.3 acres each. Under the present plan two compartments are cut each year. Except for 1917-18-19, a diameter tally[6] was taken of trees "cut" and "left." Except for these same years, there has been little done in the way of height or age measurements. There are two plots of two square rods each, established for reproduction counts, but according to the available records have been but spasmodically examined.

The data taken have been computed at more or less irregular intervals due to the press of other work. The stand data were summarized by the number of trees and basal area cut and left and by species and 1 inch diameter classes (1.0 inches and up). The height and age data had been summarized by species and inch classes also. The repoduction data had been translated from field tallies to numerals and totaled by species.

Upon attempting to assemble these data taken during the past 22 years, random checks on the summaries disclosed that there were errors in the mathematics and in the translation from the

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6. Diameter breast high (4.5 feet above the ground) to the nearest inch (limits of .6 and .5 e. g., the 6 inch class would include actual diameters ranging from 5.6 to 6.5 inches, o.b.).

dot and dash field tallies; and that the age and height data taken had been segregated on 1 inch classes using different limits than had the other data. In view of these conditions, it seemed necessary to recompute all data from the beginning. This was done, and at the present time there are available in the files summaries for each cutting of each compartment as to the number of trees "before cutting" "cut" and "after cutting," by 1 inch diameter classes and species. Any questionable field data has been translated by Professor L. J. Young, and all mathematical work has been checked by cross addition. It is felt that these data to date have been accurately computed and summarized.[7]

The final computations and summaries are based upon two 21.5 acre areas comprising compartments 1 through 5, and 6 through 10 respectively. It was considered best to present the data in this manner inasmuch as compartments 6 through 10 were receiving their first treatment when the others were receiving their second, as has been explained on a previous page.

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7. Computations and field data are filed in Professor Young's office at the School of Forestry and Conservation.

SILVICULTURAL RESULTS

The first consideration is the results of the silvicultural treatment, because if management cannot control the silviculture of the stand, no one need bother about the financial considerations. The tables presented in this report are self-explanatory. A few of the outstanding points will be discussed in the following pages.

Diameter Breast High--Height Data

Inasmuch as diameter figures were the only measurements of the stand available, and all conversion to cubic foot, board foot volumes would have to be done by means of a combination of diameters and heights, the first work was to take enough total and merchantable height data to construct a d.b.h.--height curve.

These data were taken with a steel diameter tape and a Forest Service hypsometer. Most heights were taken by using a 50 foot distance from the tree and taking half of the hypsometer reading. Beginning at the east gate, measurements were taken on about every tree as it was encountered, covering the bulk of the south half of the area from east to west, as well as some representation from the western half. In this way, the natural representation of the species as well as the size of species were fairly distributed.

A two-man crew was used, one man taking the total and merchantable[8] heights, the other man taking the d.b.h. and making all recordings. The distance from the tree to the height observer was measured each time with a steel tape.

It was first planned to make a curve for each species, but inasmuch as many species such as walnut and cherry were not represented sufficiently to make good curves, it was finally decided to use a composite volume table which was available through the Lake States Forest Experiment Station.[9] Both merchantable board foot volume based upon the merchantable height and a total cubic foot volume based upon the total height were available and seemed reliable. Accordingly, two composite d.b.h.--height curves based on total and merchantable heights respectively were constructed.

Figure 2 shows the d.b.h.--total height relationship. The chief item of note is the sharp decrease in height development at about 20 inches.

Figure 3 shows the d.b.h.--merchantable height relationship. This curve of average values is very interesting. When first plotting this curve, the present trend was indicated, and upon taking

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8. Merchantable height limits are to an 8 inch top, or to the highest clear length (exclusive of small limbs not injuring the log value), or as limited by obvious defect.

9. Based upon forest Survey data from this region.

additional data on merchantable heights of trees 20 inches and over, the average points came into line even more strongly, proving conclusively that this is the actual condition in the stand. In short, there seem to be two age groups comprising the stand. One is made up mostly of white oak from 30 inches and up, many of which are over 300 years of age as indicated by stump rings. This rather spares, old stand is composed of "wolf trees" having heavy side branches at low height, causing a very low board foot or merchantable volume in comparison to their diameters. The trees from 10 to 30 inches represent a younger stand averaging close to 110 years of age or better, which has developed in a denser stand and consequently show more clear length. This conclusion also seems to be apparent even from an ocular examination.

Cubic Volume Table

Having established average total heights, the cubic foot volume table (Table IV) for mixed hardwoods was altered to formulate a local volume table. This was accomplished by interpolating volumes according to the total height read from the d.b.h.--total height curve. These values were plotted, and the final volumes read from this curve. (See Table VI, and figures 2 and 4).

Board Foot Volume Table

The board foot volume table was made up in much the same manner except that final values were interpolated rather than read from a curve. Merchantable heights were used instead of total height, and due to the exceptionally large diameters (to 45 inches) it was necessary to extend the original table data by means of a curve. (Fig 5). The adjusted table is given in table VI.

Basal Area

Basal area was computed by applying a basal area table based upon the formula: The area in square feet equals $.00545D^2$, when D is the diameter in inches.

Construction of Final Tables

Having constructed local volume tables as indicated above, it was only necessary to apply these values to the proper diameter class. It does not seem pertinent to reproduce those detailed tables in this report. The data contained therein are summarized in Table I of this report, showing the number and percentage of trees before treatment in 1917 and after treatment in 1937, both for all trees and those 10 inches and over; and in Tables II and III showing the basal area, cubic foot volume and board foot volume by size classes.[10]

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10. Size classes: Reproduction 1-3 inches; Small Poles 4-7 inches; Large Poles 8-11 inches; Standards 12-22 inches; Veterans 23 inches and over.

Discussion of "change of Species Data" (Table I)

The most prominent points of interest from the data presented in this table is the difference in numbers and percentages of trees 10 inches and over in comparison with the total number of trees 1 inch and over. Ironwood which heads the list of total trees has not enough trees 10 inches and over to be able to compute the percentages. The oaks and hickories comprise the bulk of the trees 10 inches and over. In compartments 1-5 the total number of trees has decreased over a 20 year period, the less desirable species such as ironwood being included in this decrease, while the more desirable oak, hickory and black walnut have increased. The number of trees over 10 inches have increased by about 7.6 percent. In compartment 6-10 the total number of trees has increased over a 15 year period, mostly with less desirable species, while oak, hickory and other desirable species have actually decreased. The actual number of trees over 10 inches have increased a negligible amount also in the less desirable species, and the percentage has decreased.

Discussion of "Stand Data" (Table II and III)

There has been a gradual decrease in the number of trees cut in compartment 1-5, as well as a gradual decrease in the total number of trees. This seems to be indicative that this area is responding to the treatment given it. The area comprising

compartments 6-10 also shows a constant decrease in the number of trees cut, and a gradual increase in the total number of trees, showing that there has been some regeneration of the stand (no artificial reforestation species were included) although this increase is not composed of the most desirable species. However, it seems hopeful that this area will restock in time to desirable trees, and in the meantime, less desirable trees will furnish a cover for the area, increase the organic matter which will improve soil conditions, and in general pay for their own place in the stand. As far as the total woodlot is concerned, it is probably slightly understocked, although it should be borne in mind that the wolf trees on the western half especially, cover an area usually occupied by two or three normal trees. In general compartments 1-5 are better stocked than compartments 6-10, although compartments 9 and 10 are most poorly stocked and pull the average down considerably.

The basal area cut has decreased slightly from the first cuttings through the fourth cutting of compartments 1-5; while in compartments 6-10 there has been a sharp decrease from 9.3 square feet in the first cut to 4.4 square feet in the

second and 5.6 in the third. There has been a steady increase in the amount cut of standards and veterans, thus pointing to the removal of "wolf" trees and a more satisfactory distribution of smaller stock.

The large pole class is not as well stocked as the other classes, and cutting has been lighter as should be expected. In spite of the cutting, the standards and veterans have held their original basal area and in most cases have increased, especially the standards, indicating a satisfactory feed in from below, a good growth rate, and no over cutting. The smaller classes have remained fairly constant.

Both cubic foot volume and board foot volume (trees 10 inches and over) point to a decrease in volume of the veterans and an increase in the standard class. This condition seems very desirable, as it again points to the removal of "wolf" trees and a satisfactory growth and feeding in from below in the standard class. Just what influence the deficiency in large poles will have in the future is a conjecture, but by careful cutting to favor this class, it may be possible to maintain as good growth as in the past, if not better.

It should be noted that heavier cutting, especially in the veteran class was begun in the fifth cuts made on compartments 1 and 6, and 2 and 7 in 1937 and 1938 respectively. Although it seems like good business to harvest the larger trees before their cull gets too large, there will undoubtedly be a drop in the next cut until the effects of the shock of a heavier cut are outgrown. A slight effect of this sort was reflected in the second cuts after the initial treatment which began in 1917.

Growth

Table VII gives the growth data based upon the stand data in tables II and III. Basal area and cubic foot volumes are very comparable as would be expected. In general cutting has stimulated the lower and upper classes as evidenced by the increases in growth percentages. The stimulation of reproduction is more marked in compartments 6-10. There was a marked increase in all parts of the woodlot during the second period of growth (first period for compartments 6-10), which was probably due to a favorable combination of climatic conditions (this has not been verified).

The deficiency in the large poles is again apparent, and in the light of growth percentages, it presents a more formidiable detriment to the future stand. When board foot volumes are examined, a more optomistic note is sounded, as the old, overmature trees have been stimulated and the standards have been making about 3 percent per year growth. When the "wolf" trees are replaced by thrifty standards production will increase. The whole stand averages close to 10 percent over a 5 year period or about 2 percent compound interest mean annual growth. Both growth percentages figured as simple increases or compounded are given in table VII, and for such a short growth period, there is no appreciable difference between the methods.

The reproduction quadrats in compartment 3 indicate that there were close to 6000 seedlings per acre of acceptable species (less than 3 feet high) in 1929. The stand data also indicate plentiful "reproduction" 1-3 inches d.b.h.

Production from 1917 through 1938

The preceding discussions and tables have demonstrated the changes and results of the silvicultural treatment given this woodlot. The

figures as given are gross values. In a stand of this type, containing many overmature trees, it would be expected that a large cull percentage would have to be taken into account. Based upon the author's experience and opinions voiced by Mr. Murray of the School of Forestry and Conservation, 20 percent cull seems like a conservative figure for sawlogs.

On this basis, the net volume per acre at the present time would be 4881 board feet (Scribner). Murray's strip cruise of January, 1936 showed 4690 board feet per acre. In 1932, 6 M board feet were reported as cut. The estimate according to this data would have predicted 6431 board feet gross volume. There was no record as to whether the 6 M reported cut was a gross figure, or what rule was used. In 1937 the estimate was for 5246 board feet net, the actual amount recorded was 2850 board feet. It is noted that this year was an extremely high cull year. Again in 1938 a net volume of 4131 board feet was predicted. The actual volume scaled was 4220 board feet. It is not possible to check the total volume of material removed during the past 22 years as the data are not complete. Total gross production from 1917 through 1938 could have been 81 M, or a net production of 64.8 M, amounting to a

production of approximately 70 board feet per acre per year. According to my interpretation of the growth data in Table VII, it seems conservative to expect to maintain at least 100 board feet per acre per year or an annual cut of about 4.5 M per year.

A cull percentage should also be applied to cubic volume, as this amount is lost due to rotten wood, wood left on the ground, and not utilizing to the 2 inch limit that the cubic foot table is based upon. After the 10 percent cull factor has been applied, it has been found that a factor of 66 is satisfactory to convert cubic feet to cords.[11] The converting factor to convert board feet to cubic feet is 6, i.e., there are about 6 board feet in a cubic foot.

On this basis the actual recording of 20.5 cords cut in 1937 was predicted as 18.9, and the actual cordage of 1938 of 13.5 standard cords would be predicted as 13.6.[12]

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11. Also suggested by Gevorkiantz of the Lake States Forest Experiment Station.

12. The computations for the 1937 and 1938 data are given:

	1937		1938	
Gross volume, bd. ft.	5154		6558	
20 percent cull	1031		1312	
Net bd. ft. vol.	4123		5246	
Gross cubic ft. vol.	1684		2263	
Cubic feet of bd. ft.	687		879	
10 percent cull	100		138	
Net Cubic vol.	897		1246	
Cords (divide by 66)		13.6		18.9

For the whole area from 1917 through 1937, the gross cubic foot volume of peeled wood 4 inches and over (d.b.h., o.b.) is 22691 cubic feet. Following the procedures outlined above, this area would have theoretically produced 162 cords of wood and 64.8 of logs.

Actually, there have not been many logs removed for lumber due to high cull and difficulties of marketing such small quantities, whereas the market for cordwood is usually good. As far as can be ascertained, there is no record of the actual production of products for the entire period. If the results of the past few years were taken as indicative of the whole period the cordwood production would be much too low and the timber production too high, as some years no timber has been taken out. Conservatively, the cordwood taken out will average 15 cords per year, and over the period from 1917 through 1937 would give a net volume of 255 standard cords and 24 M. The most difficult problem when estimating volumes is the cull percent of any one cutting. It is hoped that the 20 percent cull will prove a good average, as it is known that some years it is high and others it is low.

FINANCIAL RESULTS

There is not a great deal that can be said as to financial results. According to a record of the 1932 cuttings of compartments 1 and 6, it cost $132.44 to produce 11.5 standard cords of wood, and $110.00 were realized, plainly a loss of $22.44. It was claimed that 6 M of logs were cut in this year, the cost of which was included in the cordwood costs except $13.65 for log hauling. The return was $180.00 or $30.00 per M. This aggregated the income to $290.00, with costs of $146.09, showing a net profit of $43.91 or $5.10 per acre. It is not known whether the return for the logs was estimated or whether the case was actually received. In any event, $30.00 seems like a high price. This year $15.00 per M at the landing was received.

The record of the 1938 cut is as follows. The total costs to produce 13.5 standard cords of wood and 3950 board feet of logs was $241.20. Returns from cordwood at $11.25 per standard cord and logs at $15.00 per M aggregated $194.63, causing a loss of approximately $42.75, or $4.97 per acre.

It should be remembered that the costs of these products include all cultural work done such as cutting out many trees below 4 inches which have no monetary value. The labor used is unskilled, physically soft students for most part, paid at the rate of $.40 per hour. Undoubtedly, a farmer who knows his business could produce the same products at about one-third to one-half as much or about $3.00 per standard cord and $5.50 per M.

What would have happened under more normal conditions is pretty much conjecture, but assuming the production of 162 long cords of wood and 64.8 M of logs over a 20 year period with a sale price of $11.25 per cord and $15.00 per M, the gross return would have been $2794.50. Assuming costs of $3.00 per cord and $5.50 per M, total cost of production would be $842.40. Net income with no deductions for taxes, interest, or protection would be $97.61 per year or $2.27 per acre per year.

Assuming a 255 cord production and 24 M, the total income would have been $3228.75. Total cost of production would be $807.00. Net income without other expenses taken out would be $2421.75 or $121.09 per year and $3.82 per acre per year.

It seems reasonable to expect that as soon as the stand reaches a stable regulation, higher production can be maintained. If a production of 100 board feet and 1/4 cord per acre per year can be maintained, and it seems possible after studying Tables II, III, and VII, the net income exclusive of taxes, interest, and protection, will be $3.31 per acre per year, or $142.33 per year. Should the market for cordwood and logs stay in the same relationship as the present time, it would be most profitable to use all material for cordwood.

CONCLUSIONS

The summarization of the number of trees cut and left during the past 22 years is reliable in so far as the field data are reliable. The basal area figures are reliable in so far as the arithmetic is not in error. The cubic foot volumes compare favorably with basal area in percentages, and both cubic and board foot values are influenced by the nature of the original volume table used.

Time permitting, there are a number of questions which this paper brings up. There should be closer study made of height at time of cuttings, cull in various size and age trees, and a volume table built up for this stand. (Measurements taken on a percentage of the area by hypsometer

are always open to question for such a small area). More concrete study should be made as to the extent of seed and sprout reproduction. Inasmuch as so much time is expended upon the cutting of very small material, a further study might be made as to the need of doing this, i.e., whether conditions for germination and growth of reproduction would not be favored by the leaving of the smaller material which will die naturally in the course of time.

It is felt that the data as presented are reasonably accurate and will prove of interest to those who are interested enough to compare and apply them to their own problems. The financial hypothesis will probably be reworked in many different ways by various people using their own figures. The figures presented here are a basis from which to work, however, and should not be entirely worthless.

Finally it seems conclusive to say that the farm woodlot is worth a great deal to the farmer and that he should be taught to the best of our ability, how to manage his forest property.

LIST OF SPECIES MENTIONED

Common Name	Scientific Name
Adder's tongue	Erythronium americana
Ash, white	Fraxinus americana
Ash, black	" nigra
Basswood	Tilia americana
Beech, blue	Carpinus caroliniana
Blackberry	Rubus spp.
Bloodroot	Sanguinaria canadensis
Butternut	Juglans cinerea
Cherry, black	Prunus serotina
Dogwood	Cornus florida and others
Douglas fir	Pseudo-tsuga-taxifolia
Elm, american	Ulmus americana
Gooseberry	Ribes spp.
Green brier	Smilax hispida
Hepatica	Hepatica triloba
Hickory	Carya spp.
Ironwood	Ostrya virginiana
Maple, hard	Acer saccharum
Maple, red or soft	Acer rubrum
Oak, black	Quercus velutina
Oak, northern red	Quercus borealis
Oake, white	Quercus alba
Pine, Scotch	Pinus sylvestris
Pine, white	Pinus Strobus
Raspberry	Rubus spp.
Walnut, black	Juglans nigra

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APPENDIX CONTENTS

Table I

Distribution of Species Data
(Based on Total Number of Trees)

Species	Compartments 1-5 All trees 1917 Number	1917 Percent	1937 Number	1937 Percent	(21.5A) Trees 10"+ 1917 Number	1917 Percent	1937 Number	1937 Percent
Ironwood[1]	9323	54.2	5043	37.4	3	-	0	-
Red Oaks[2]	272	4.5	703	5.2	445	2.6	457	3.4
White Oak	364	2.1	423	3.2	104	.6	126	.9
Hickory	1090	6.3	839	6.2	112	.6	151	1.1
Basswood	1984	11.5	1902	14.1	36	.2	27	.2
Elm	1578	9.2	983	7.3	23	.1	20	.1
Black Wal.	58	0.3	63	0.5	23	.1	27	.2
Ash[3]	934	5.4	1991	14.8	40	.2	40	.3
Hard Maple	433	2.5	1051	7.8	58	.3	53	.4
Cherry	112	0.7	104	1.2	6	.1	6	.1
Others[4]	560	3.3	516	2.3	5	.1	5	.1
Total	17,205	100.0	15,478	100.0	850	4.9	912	6.8
	16,706							

Species	Compartments 6-10 All trees 1917 Number	1917 Percent	1937 Number	1937 Percent	(21.5A) Trees 10"+ 1917 Number	1917 Percent	1937 Number	1937 Percent
Ironwood[1]	1882	23.1	2509	25.2	1	-	12	.1
Red Oaks[2]	838	10.3	813	8.2	493	6.2	497	5.0
White Oak	508	5.8	500	5.0	79	1.0	101	1.0
Hickory	800	9.8	659	6.6	203	2.5	206	2.1
Basswood	1448	17.8	1874	18.8	26	.3	12	.1
Elm	786	9.7	849	8.5	23	.3	31	.3
Black Wal.	94	1.1	122	1.2	17	.2	14	.1
Ash[3]	498	6.1	1222	12.2	35	.4	24	.2
Hard Maple	259	3.2	366	3.7	78	.9	67	.7
Cherry	461	5.7	846	8.5	7	.1	5	.1
Others[4]	765	9.4	408	4.1	15	.2	12	.1
Total	8139	100.0	9968	100.0	976	12.0	981	9.8

1/ Includes some elm perhaps.

2/ Includes red and black oak.

3/ Includes black and white ash

4/ Includes soft maple, butternut, aspen, and some dogwood, but excludes any artificial plantings.

Table II

Stand Data Summary

Size Class 1/	No. Trees (Per Acre) Cut	Leave	Total	Basal Area (Per Acre) Cut	Leave	Total	Cubic Ft. 2/ (Per Acre) Cut	Leave	Total	Board Ft. 2/ (Per Acre) Cut	Leave	Total
					Compartments 1-6							
					First Cut (1917 - 1921)							
Reproduction	147.5	521.8	669.1	3.219	8.686	11.905	68.3	180.9	249.2			3/
Small Poles	18.5	55.6	74.1	2.449	8.000	10.449	45.4	145.0	190.4			
Large Poles	2.3	27.1	29.4	.997	13.024	14.021	22.1	299.0	321.1	24	467	491
Standards	.3	23.5	23.8	.476	28.294	28.770	14.5	835.4	849.9	52	2837	2889
Veterans	.1	3.8	3.9	.580	17.125	17.705	20.0	597.4	617.4	82	2471	2552
Total	168.5	631.8	800.3	7.721	75.127	82.848	170.3	2057.7	2228.0	158	5775	5933
					Second Cut (1922 - 1926)							
Reproduction	135.0	411.0	544.0	1.743	7.722	9.465	55.8	161.9	197.7			
Small Poles	5.5	53.6	59.1	.717	7.690	8.407	13.5	139.8	153.3			
Large Poles	.7	25.8	26.5	.297	12.433	12.730	6.7	285.6	292.3	8	441	449
Standards	.7	25.2	25.9	.825	50.602	51.427	24.5	904.7	929.2	86	3082	3168
Veterans	.6	3.2	3.8	2.679	14.663	17.342	95.2	512.9	608.1	338	2174	2508
Total	140.5	518.8	659.3	6.261	73.110	79.371	175.7	2004.9	2178.6	426	5697	6123
					Third Cut (1927 - 1931)							
Reproduction	75.8	573.1	648.9	1.335	9.576	10.911	27.7	197.8	225.5			
Small Poles	4.2	70.6	74.8	.551	9.123	9.674	10.2	167.8	178.0			
Large Poles	.7	25.2	25.9	.529	12.175	12.504	7.3	280.1	287.4	9	454	463
Standards	1.2	28.1	29.3	1.569	34.000	35.569	67.2	1011.9	1059.1	167	3508	3675
Veterans	.6	3.4	4.0	3.054	12.604	15.658	136.4	452.0	588.4	482	1802	2284
Total	80.5	694.4	774.9	6.838	77.478	84.316	200.8	2107.6	2308.4	658	5764	5402
					Fourth Cut (1932 - 1936)							
Reproduction	26.0	495.5	521.5	.678	9.486	10.164	14.3	198.1	212.4			
Small Poles	5.6	75.6	81.2	.773	10.437	11.210	14.5	191.5	206.0			
Large Poles	1.4	25.3	26.7	.579	12.413	12.992	12.8	286.6	299.4	12	481	493
Standards	.7	28.0	28.7	1.124	36.981	38.105	34.1	1109.3	1143.4	125	3902	4027
Veterans	.5	2.7	3.2	2.739	10.960	13.699	97.9	376.6	474.5	414	1550	1964
Total	34.2	626.9	661.1	5.893	80.277	86.170	173.6	2162.1	2335.7	551	5933	6484

1/ Reproduction 1-3 inches; Small Poles 4-7 inches; Large Poles 8-11 inches; Standards 12-22 inches; Veterans 22 inches and up.
2/ From Forest Survey Data, Lake States Forest Experiment Station.
3/ Trees 10 inches and up.

Table III

Stand Data Summary

Compartment 6-10
(Per Acre)

Size Class 1/	Number Trees			Basal Area			Cubic Ft. 2/			Board Ft. 2/		
	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total	Cut	Leave	Total
First Cut (1922 - 1926)												3/
Reproduction	69.8	196.2	266.0	1.239	2.907	4.146	25.9	59.6	85.5			
Small Poles	17.7	33.2	50.9	2.488	5.769	8.257	44.9	99.2	144.1			
Large Poles	3.0	28.4	31.4	1.353	14.165	15.518	29.1	329.4	358.5	39	576	615
Standards	1.8	25.9	27.7	2.741	31.707	34.448	84.0	941.1	1025.1	314	3183	3497
Veterans	.3	3.3	3.6	1.456	14.252	15.708	50.6	506.7	555.3	207	2072	2279
Total	92.6	286.0	378.6	9.277	68.800	78.077	234.5	1936.0	2166.5	560	5831	6391
Second Cut (1927 - 1931)												
Reproduction	55.8	300.9	356.2	.693	4.511	5.204	14.1	193.0	107.1			
Small Poles	5.8	36.2	59.8	.534	5.818	6.352	8.5	103.1	112.6			
Large Poles	.6	28.0	28.6	.298	13.956	14.254	7.1	323.7	330.8	18	331	377
Standards	.5	29.6	29.2	.772	35.196	35.965	23.8	1043.4	1067.0	98	3580	3686
Veterans	.5	3.6	4.1	2.004	14.286	16.350	71.9	490.9	561.9	291	2010	2301
Total	80.6	397.3	457.9	4.368	73.787	78.155	125.2	2053.2	2179.4	395	6151	3544
Third Cut (1932 - 1936)												
Reproduction	16.0	366.7	380.7	.317	5.853	6.170	6.7	121.1	127.8			
Small Poles	3.4	39.5	42.9	.529	6.093	6.622	9.5	108.9	118.2			
Large Poles	1.5	27.1	28.4	.569	13.450	14.019	12.8	313.2	326.0	14	548	562
Standards	1.1	29.0	30.1	1.495	35.789	37.284	45.2	1060.6	1105.8	162	3638	3800
Veterans	.6	3.3	3.9	2.753	13.479	16.212	95.0	462.9	557.9	396	1886	2282
Total	22.6	485.6	486.0	5.643	74.644	80.237	185.0	2065.7	2234.7	572	6070	6642

1/ Reproduction 1-3 inches; Small Poles 4-7 inches; Large Poles 8-11 inches; Standards 12-22 inches; Veterans 22 inches and up.

2/ From Forest Survey Data, Lake States Forest Experiment Station.

3/ Trees 10 inches and up.

Table IV

Mixed Hardwoods

Gevorkiantz

Total cubic-foot volumes[1/] of hardwood trees, by total-height and d.b.h. class

D. B. H.	20-foot trees	40-foot trees	60-foot trees	80-foot trees	100-foot trees	120-foot trees
Inches			Cubic feet			
6	1	3	4	5		
8	4	6	8	10		
10	7	10	14	17		
12	13	16	20	25	31	
14	19	22	28	36	44	
16		29	37	47	58	
18		37	46	59	75	92
20		45	57	73	93	115
22		54	69	89	113	143
24		65	82	106	136	172
26		76	98	126	163	205
28		90	115	149	191	239
30		104	133	173	221	276
32		119	152	198	252	316
34		135	171	224	286	358

1/ Volume is that of stem, top, and branches, inside bark, between stump and a top diameter of 2 inches. Stump height is 1 foot for trees up to 18 inches in d.b.h., 2 feet for trees 18 inches and larger.

Table V

Board-foot volumes[1] of hardwood trees

by merchantable[2] height and d.b.h. class

(S. R. Gevorkiantz)

DBH	½-log trees	1-log trees	2-log trees	3-log trees
Inches	Bd.Ft.	Bd.Ft.	Bd.Ft.	Bd.Ft.
10	18	30	50	
12	29	45	80	100
14	42	70	115	150
16	58	90	155	210
18	75	120	210	280
20	95	155	275	365
22	118	195	340	455
24	142	240	415	555
26	169	290	495	665
28	198	340	585	775
30	230	390	675	895
32	263	445	775	1025
34	299	500	875	1155
35			930	1225
36			980	1295

1/ Scribner scale.

2/ Merchantable height is expressed in 16.3-foot logs. Stump height is 1 foot for trees up to 18 inches in d.b.h., 2 feet for trees 18 inches and larger

Values from extended curves

D.B.H.	2 logs	3 logs
37	1030	1370
38	1090	1445
39	1140	1520
40	1200	1600
41	1265	1680
42	1325	1765
43	1390	1850
44	1450	1935
45	1520	2010
46	1590	2115

Table VI
Adjusted Volume Table 1/

D.B.H. (o.b.)	Total Cu. Ft. 2/ Volume (i.b.)	Board Foot 2/ Volume Scribner Rule)
1	0.1	
2	0.5	
3	1.0	
4	2.0	
5	2.3	
6	3.0	
7	4.5	
8	7.0	
9	9.9	
10	13.0	35
11	16.5	47
12	21.0	59
13	26.0	78
14	31.0	97
15	36.1	120
16	42.0	143
17	48.0	175
18	55.0	204
19	62.0	248
20	70.0	286
21	77.5	326
22	86.0	365
23	94.5	406
24	103.0	446
25	114.5	484
26	125.0	522
27	136.0	557
28	147.0	591
29	160.0	622
30	173.0	658
31	186.5	706
32	201.0	755
33	214.0	825
34	227.0	910
35	242.0	995
36	256.5	1088
37	276.0	1179
38	289.0	1279
39	303.0	1366
40	319.0	1462
41	335.0	1551
42	352.0	1581
43	369.0	1735
44	386.0	1814
45	405.0	1903

1/ From Forest Survey Volume Tables, Lake States Forest Experiment Station. Adjusted as indicated by average heights of area to be used on.

2/ These values applied directly to number of trees.

Table VII

Growth Data (Total for 5 years)
(Per Acre)

Size Classes[1]	Compartments 1-5 Basal Area Growth	Basal Area Percent[2]	Cubic Volume Growth	Cubic Volume Percent[2]	Bd. Ft. Volume Growth	Bd. Ft. Volume Percent[2]	Compartments 6-10 Basal Area Growth	Basal Area Percent[2]	Cubic Volume Growth	Cubic Volume Percent[2]	Bd. Ft. Volume growth	Bd. Ft. Volume percent[2]
Between first and Second Cuts												
Reproduction	.779	9.0	16.8	9.3		[3]						
Small Poles	.407	5.1	8.3	5.7								
Large Poles	-.294	-2.2	- 6.7	-2.2	- 18	-3.8						
Standards	3.133	11.1	93.8	11.2	331	11.5						
Veterans	.217	1.3	8.7	1.5	35	1.4						
Total (Annual)	4.244	5.7	120.9	5.9	348	6.0						
Mean Annual[4]		1.0		1.0		1.2						
	Between first and Second Cuts						**Between first and Second Cuts**					
Reproduction	5.189	41.3	65.6	39.4		[3]	2.297	76.9	47.5	71.3		[3]
Small Poles	1.985	25.8	38.2	27.3			.583	10.1	13.4	13.5		
Large Poles	.071	.6	1.8	.6	22	5.0	.069	.5	1.4	.4	1	0
Standards	4.967	16.2	154.4	17.1	593	19.2	4.258	13.5	125.9	13.4	483	15.1
Veterans	.995	6.8	45.5	8.9	90	4.1	2.098	14.7	57.2	11.5	229	11.1
Total	11.206	15.3	305.5	15.2	705	12.4	9.305	13.5	245.4	12.7	718	12.2
Mean Annual[4]		2.8		2.8		2.5		2.3		2.6		2.3
	Between third and Fourth cuts						**Between second and third cuts**					
Reproduction	0.588	6.9	14.6	7.4		[3]	1.659	56.7	34.8	37.4		[3]
Small Poles	2.087	22.9	58.2	22.8			.804	1.4	15.1	1.4		
Large Poles	.817	6.7	19.5	6.9	39	8.6	.085	.6	1.3	.4	- 1	0
Standards	4.105	12.1	131.5	12.8	519	14.8	2.078	5.9	62.4	6.0	220	6.1
Veterans	1.095	8.7	24.5	5.4	162	9.0	1.926	13.5	67.9	13.8	272	13.5
Total	8.692	11.2	228.1	10.7	720	12.5	6.550	8.9	181.5	8.8	491	8.0
Mean Annual[4]		2.2		2.2		2.4		1.7		1.7		1.5

1/ Reproduction 1-3 inches; Small Poles 4-7 inches; Large Poles 8-11 inches; Standards 12-22 inches; Veterans 23 inches and up.
2/ The percentage is Based upon the volume left after cutting, e.g. if 500 feet is left after cutting and 750 feet is found at the end of 5 years the growth is 250 feet or 50% (of the original 500 feet.)
3/ 10" and up.
4/ Based on Compound interest 1.0 p^n = $\frac{V \text{ now}}{V \text{ 5 years ago}}$

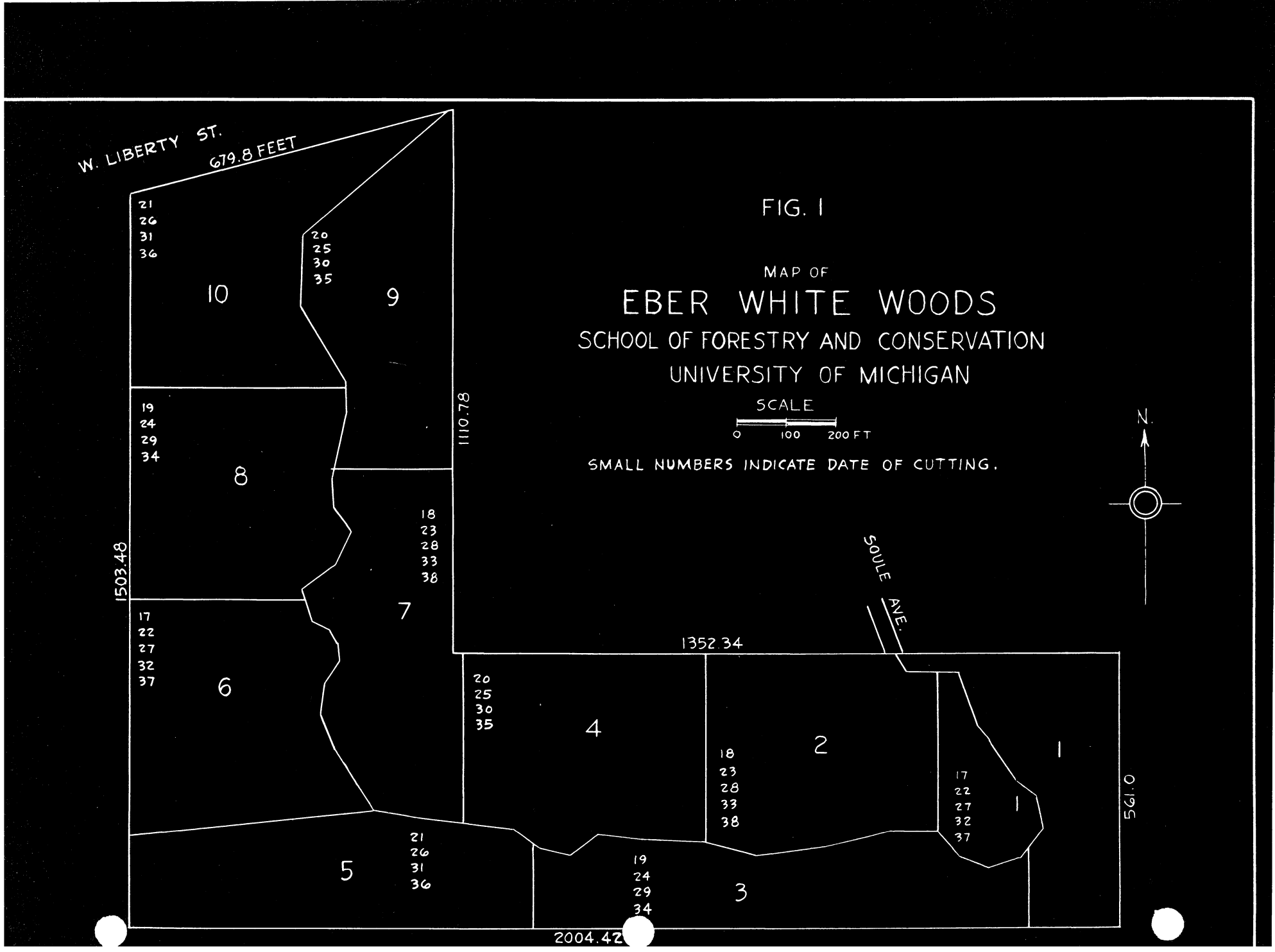
W. LIBERTY ST.
679.8 FEET
FIG. 1
MAP OF
EBER WHITE WOODS
SCHOOL OF FORESTRY AND CONSERVATION
UNIVERSITY OF MICHIGAN
SCALE
0 100 200 FT
SMALL NUMBERS INDICATE DATE OF CUTTING.
N.
SOULE AVE.
1110.78
1503.48
1352.34
561.0
2004.42
10
21 26 31 36
9
20 25 30 35
8
19 24 29 34
7
18 23 28 33 38
6
17 22 27 32 37
5
21 26 31 36
4
20 25 30 35
3
19 24 29 34
2
18 23 28 33 38
1
17 22 27 32 37
1

FIG. 2

COMPOSITE D.B.H. - TOTAL HEIGHT CURVE

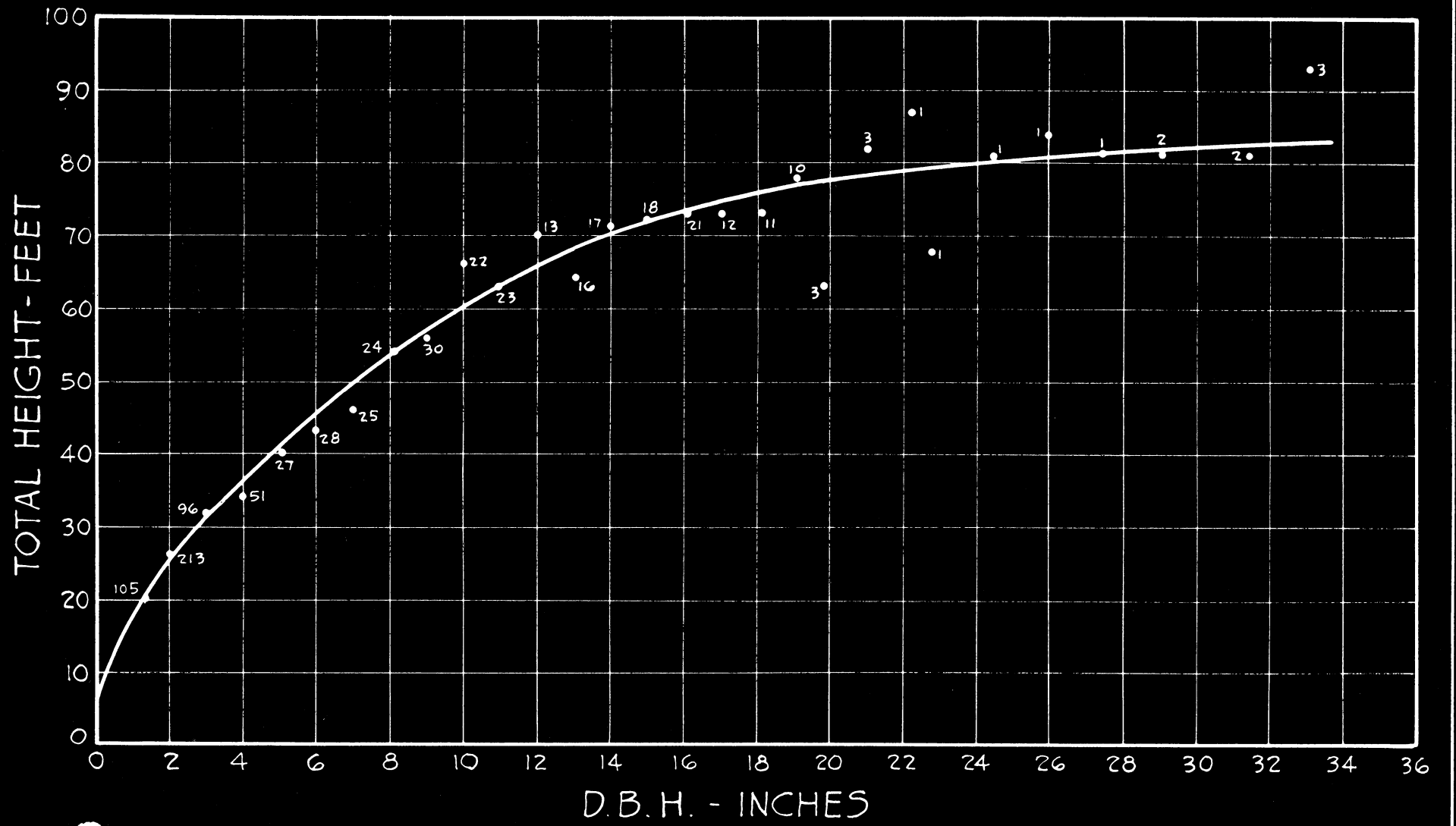

FIG. 3

COMPOSITE D.B.H. - MERCHANTABLE HEIGHT CURVE

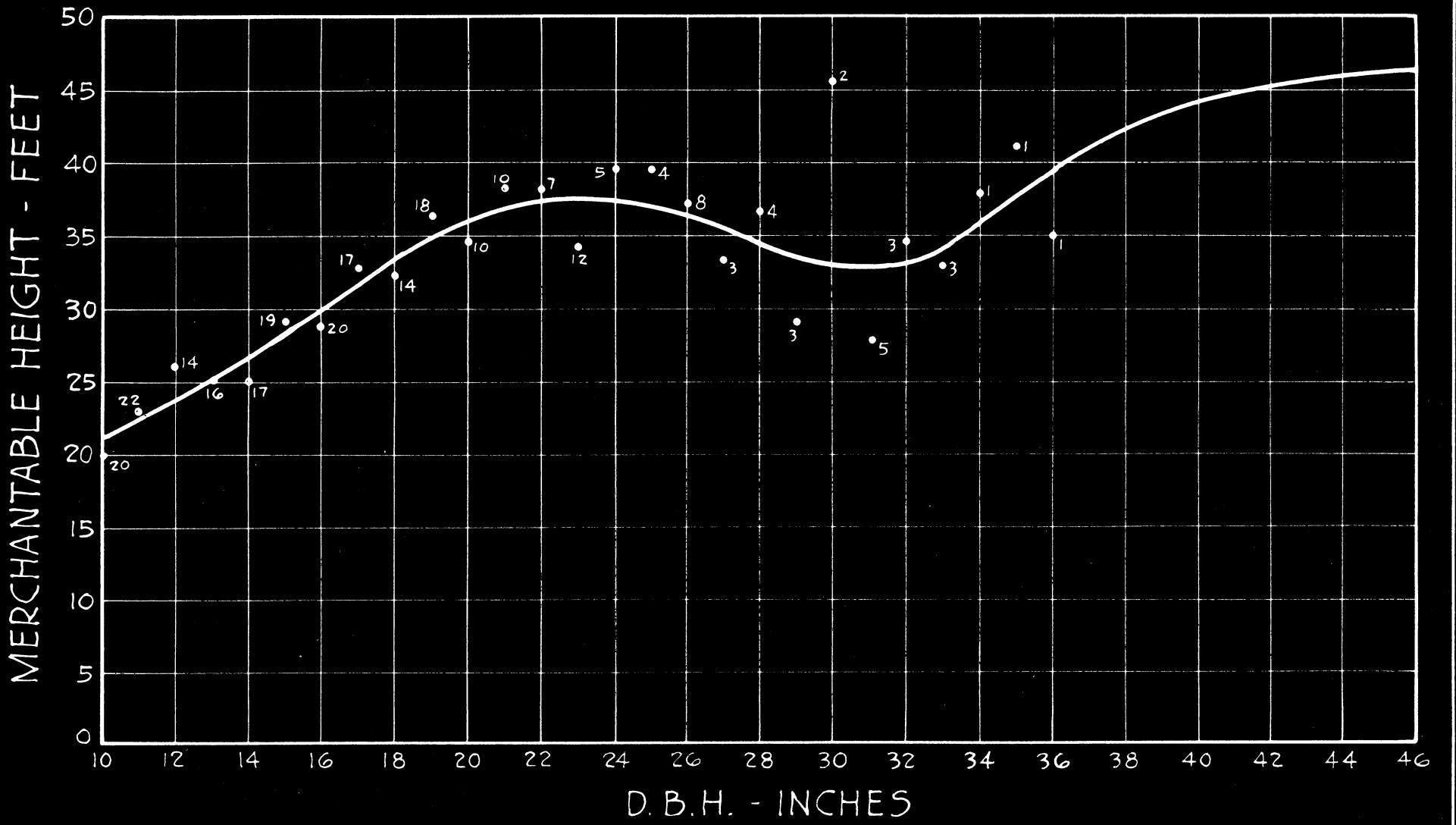

FIG 4

EXTENSION OF BOARD FOOT VOLUME CURVE