MEASURED AND PREDICTED GROWTH
IN
WHITE PINE AT SAGINAW FOREST

W. E. Roberts January, 1935

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The purpose of this paper is to check the accuracy of growth predictions against measured growth records from a white pine plantation in Saginaw Forest; and in addition, to tie in with the results brought forth in another report on growth in hardwoods at Stinchfield Woods entitled A Study of Several Methods of Predicting Growth for a Stand of Timber.

Procedure.

The data used were obtained from two plots in Block I, Lot 2b, a control plot and a thinned area. A sample of every third tree was taken from the 1925 measurements and the growth during the 1920-'25 period recorded against the 1920 diameters. Diagrams of growth based on 1920 diameters were then constructed according to Gneson's, Reynolds' and the "Step-up" theories. Applying the growth

rates derived from figures 1, 2, 3, 4, and 5 to the 1925 tally of trees, the forecasted 1930 stand tables appearing in Table I* were built-up. To secure the predicted basal areas for 1930, the figures in these stand tables were multiplied by basal area relatives.

Mortality Reduction:- No mortality reduction was made for the thinned plot. It is unnecessary to consider such an an area where the slower growing and suppressed trees will be removed in the cuttings. On the control plot, however, mortality must be regarded because this area is left in its natural condition and an overestimate would be obtained otherwise. An attempt was made to correlate mortality with the rate of growth — those trees growing the slowest representing those that would drop out of the stand during the period.

The trees in the sample that were plotted on the diagrams were refered by number to the 1930 records to see how many still lived. Those that

* Table and figure references in appendix.

had died were noted on their 1920 diameters along with the growth they made during the 1920 - 1925 period. A percentage for mortality was then calculated for each diameter class of the year 1920. These percentages were plotted on the percentage movement diagram of Arneson's as shown in Figure 2 and a curve balanced through the points. In this way, an estimate of mortality during the future period based on past growth is determined the same way that growth itself is forecasted.

Figures 6 and 7 were constructed to see how closely the mortality in another plot corresponded with that in Lot 2b. Here all the trees were plotted instead of taking just a sample. The predicted mortality curve for the 1925-1930 period is similar to that in Lot 2b.

When trying to arrive at mortality by this method for an area where no records can be obtained, the forester would first have to have some means of telling what growth rate in each diameter class might prove to be an index

of mortality. This would depend on the species, the site, and various factors influencing the condition of the stand such as its age, density, and distribution of diameter classes that effect the dispersion in growth rates. Hence, to put in use, the method would require complete notes on every tree in the sample.

Probably mortality could be disregarded in many cases when using Meyer's system of forecasting growth. Where the growth in a stand is rapid, the percenteges that remain in the same diameter classes could be substituted for a reduction percentage. However, in slow growing stands, an overestimate of mortality would be obtained by doing this.

Explanation of Results.

A large overestimate of growth in both the thinned and the control plots by all methods was the result as will be noticed upon referring to Table I. Since these calculations were made only to test the relative accuracy of

growth predictions by the several methods, the purpose was lost by such results. Accordingly, to check the mathematical theory underlying the methods, an estimate of growth for the 1920-1925 period, based on the growth that the sample trees used in constructing the diagrams made during that period, was computed. The predicted basal areas by the three methods compare very closely with the measured basal area in 1925, Smeaton being the nearest as will be seen upon referring to Table II.

There appears to be only one reason for the overestimate and that is that the growth rate of the stand is decreasing. This does not show up in comparing average diameters at the end of each period so well. On the control plot the average diameter in 1920 was 2.7 inches and in 1925, 3.55 inches giving a growth of 0.85 inches for the period. On 1930 the average diameter was 4.4 inches or again a growth of 0.85 inches. The thinned plot showed a little falling-off in comparing average diameters. The average dia-

meter after thinning in 1920 was 3.2 inches, and in 1925 before thinning 3.95 inches, a growth of 0.72 inches. The average diameter after thinning in 1925 was 4.5 inches and that before thinning in 1930 was 5.1, a growth of 0.60 inches or a slight decrease in growth rate. When the measured basal area growth for the period of 1920 to 1925, upon which the growth predictions rest, however, is compared with the measured basal area growth for 1925 to 1930, a decided falling-off is noted for both plots. Furthermore, the measured growth for the 1920 to the 1925 period is very close to the predicted growth for the 1925 to 1930 period. The predicted growth from 1925 to 1930 exceeds the measured growth from 1920 to 1925 for two reasons. First, growth is taking place on a larger growing stock during the later period and if the growth rate remains the same as assumed it does, the proportional increase in basal area will be the same as that of the past; but the actual increment will be somewhat larger. Secondly, when the curves were extended to larger diameters they were not flattened as much as they should have been. This

is especially true of Reynolds' growth curve and may be the reason why the estimate by his method is so much larger than that by the other two.

Conclusions:

The rate of growth in the stand, therefore, must be decreasing. The three methods of predicting growth are reliable only when the stand grows at the same rate during the future period as it did during the past period. Chesom's is probably the most accurate method when this required condition is met, and will probably give much more accurate results than the other two when a great dispersion of growth rates are present in a stand of timber. Growth of young stands where the growth rates are changing rapidly will have to be figured upon some other basis in order to get a close estimate.

Appendix

Diagrams

Tables

Ineson's "Scatter Diagram" & Reynolds' Growth Curve

Saginaw Forest Lot 2b White Pine Control - Basis - 98 Trees

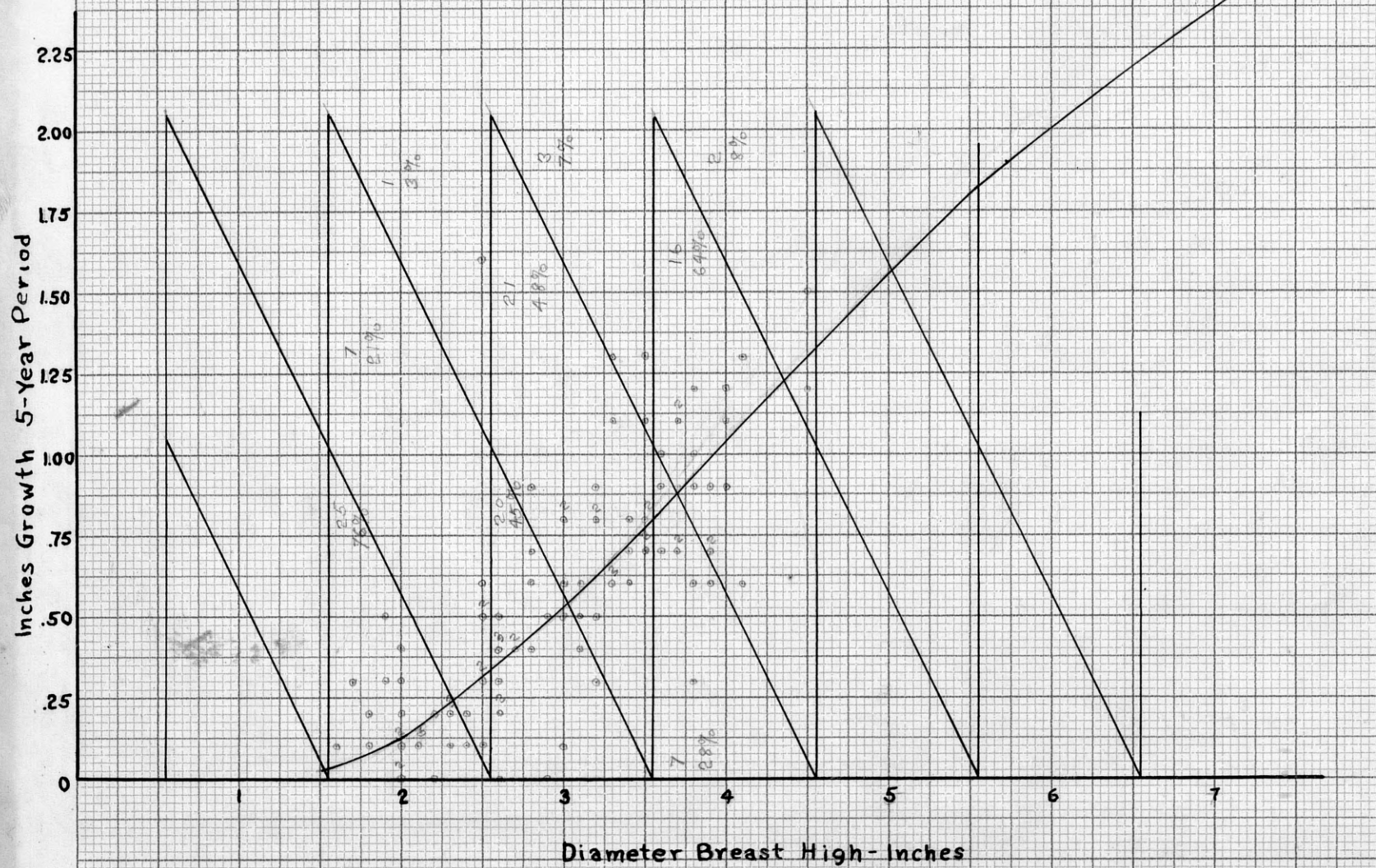


Figure 1

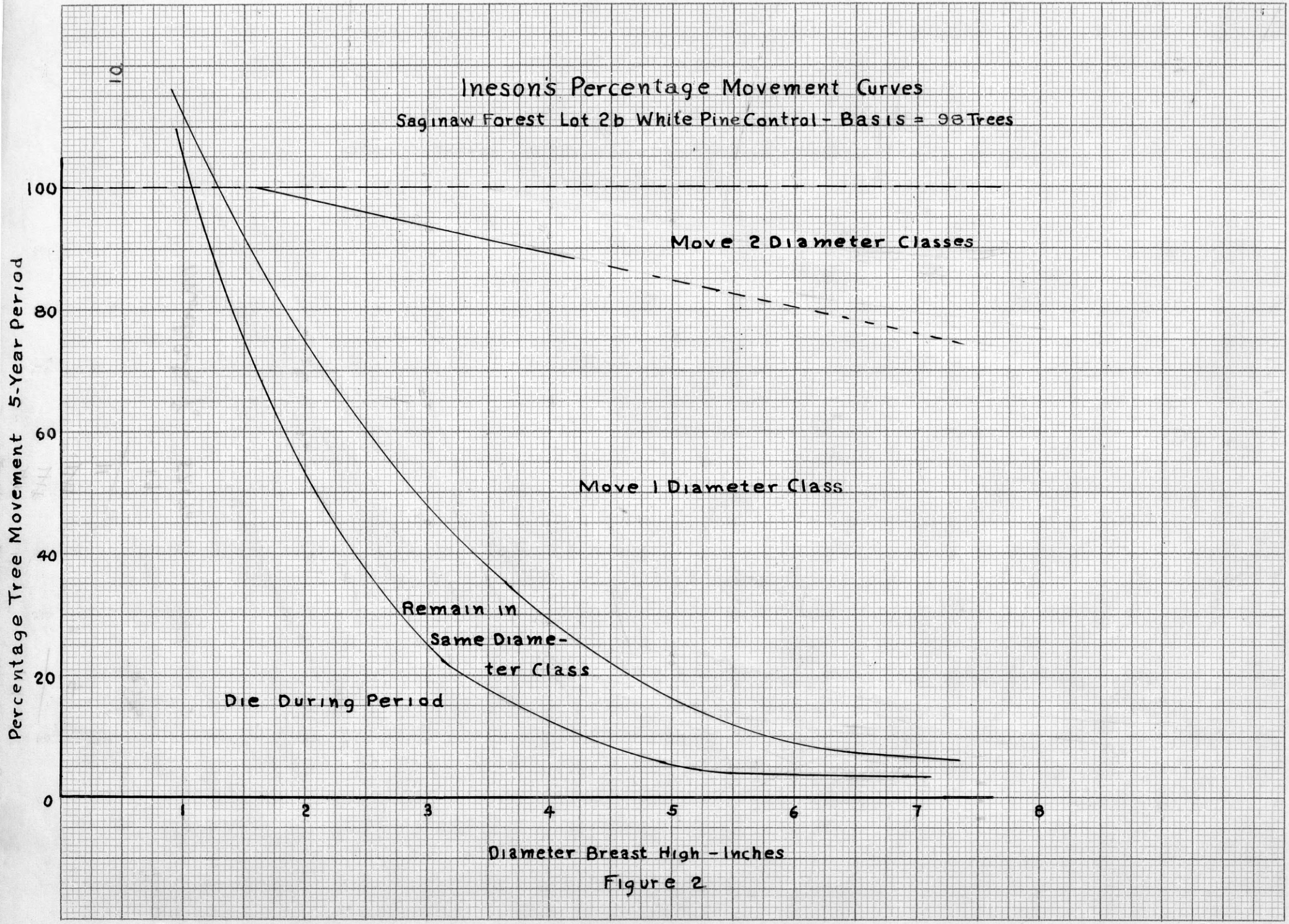

Ineson's Percentage Movement Curves
Saginaw Forest Lot 2b White Pine Control - Basis = 98 Trees
Percentage Tree Movement 5-Year Period
100
80
60
40
20
0
Move 2 Diameter Classes
Move 1 Diameter Class
Remain in Same Diameter Class
Die During Period
1
2
3
4
5
6
7
8
Diameter Breast High - Inches

Figure 2

11

Ineson's "Scatter Diagram" & Reynolds' Growth Curve

Saginaw Forest Lot 2b White Pine Thinned - Basis 92 Trees

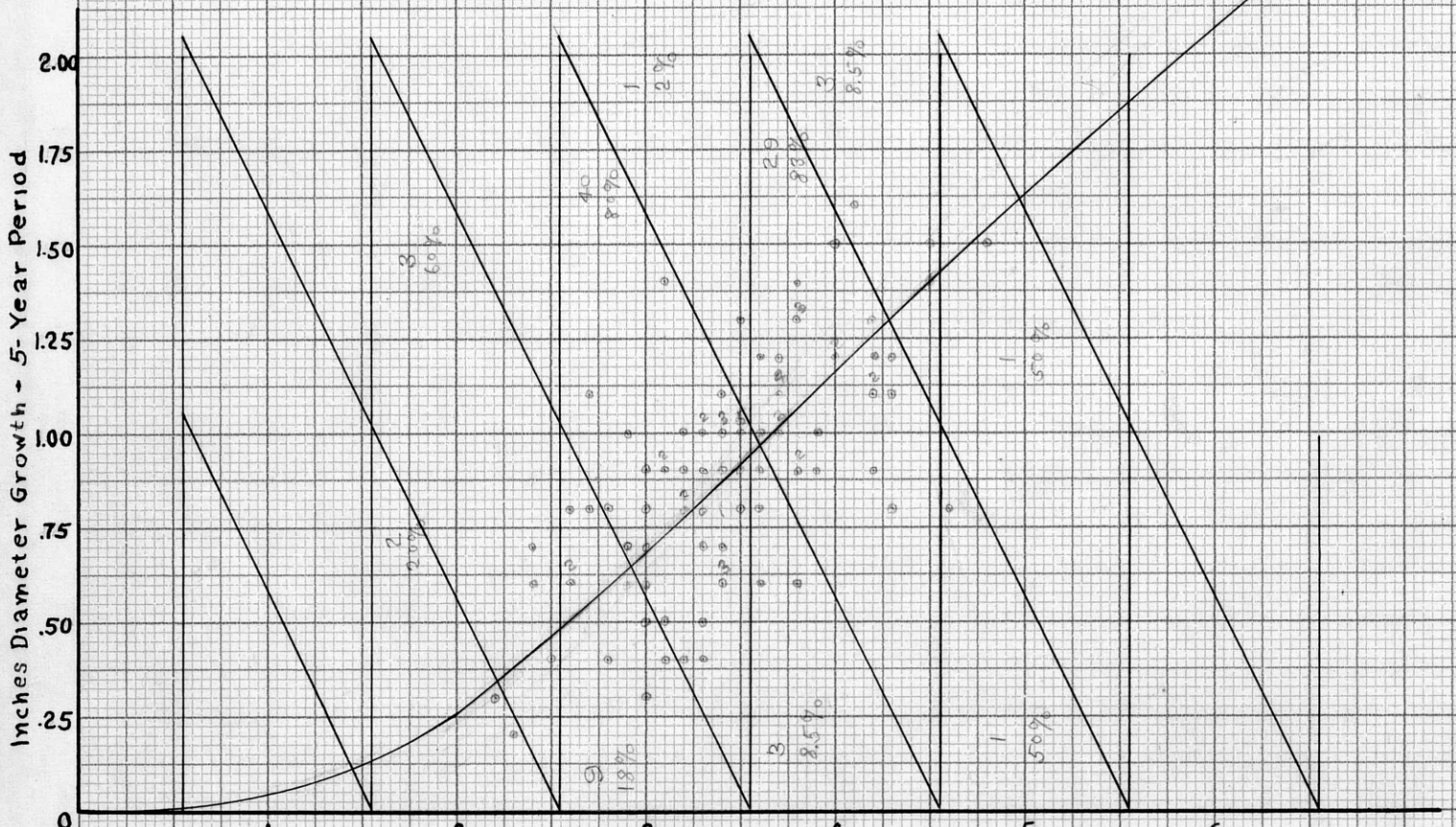


Figure 3

Ineson's Percentage Movement Curves

Saginaw Forest - Lot 2b White Pine Thinned - Basis = 92 Trees

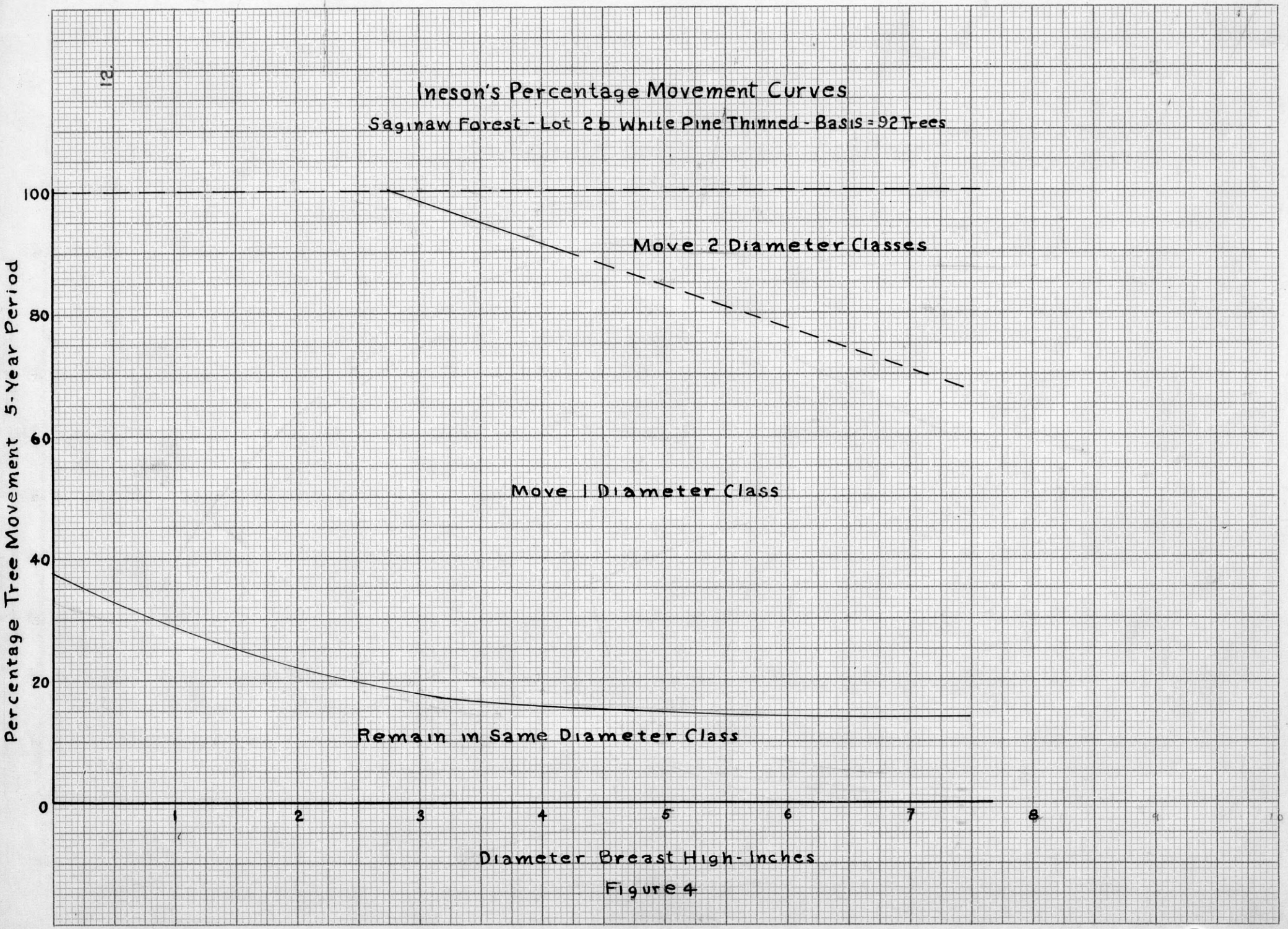


Figure 4

Average Diameter Growth

Saginaw Forest Lot 2b White Pine

Control - 98 Trees

Thinned - 92 Trees

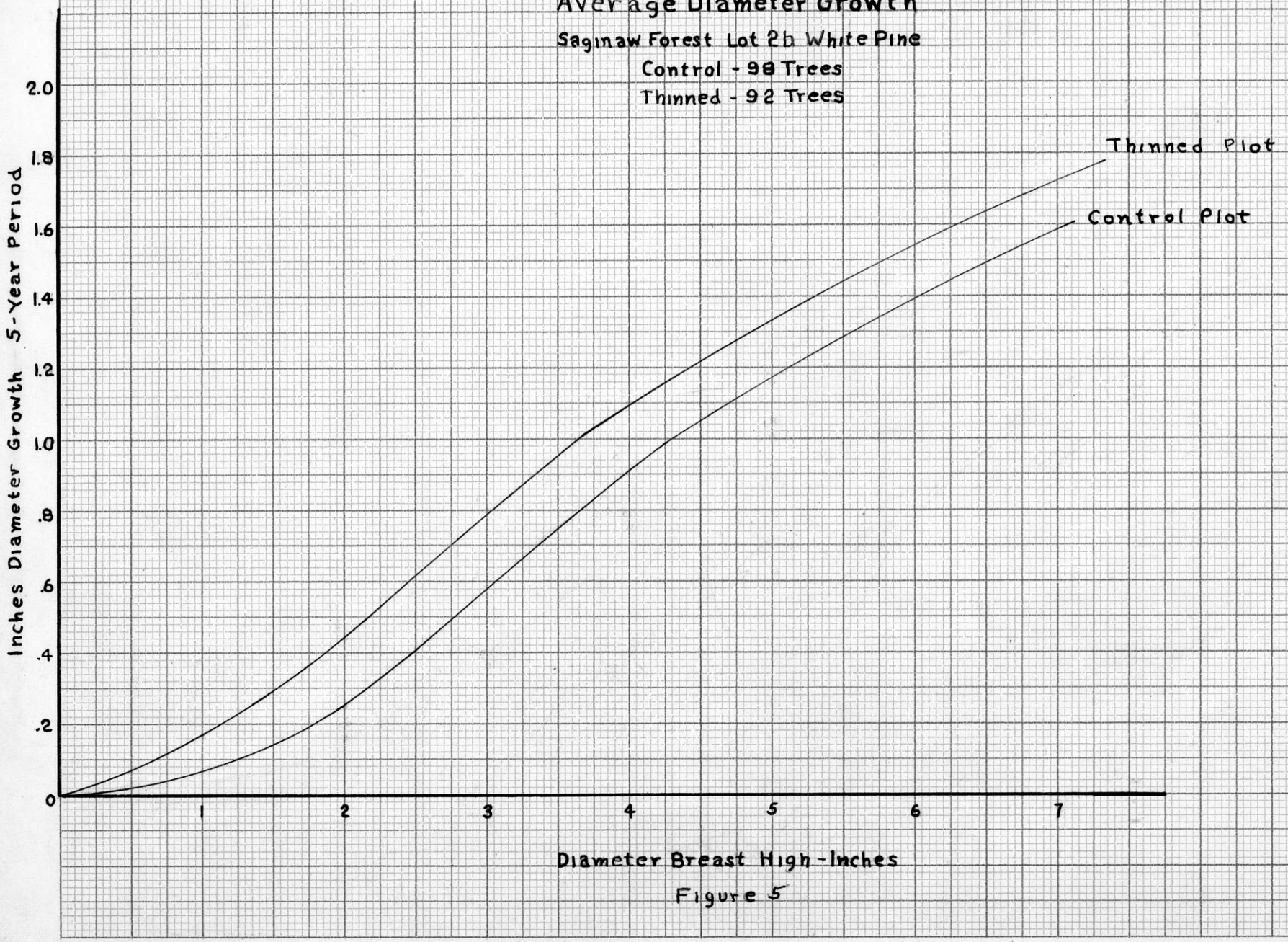


Figure 5

Ineson's "Scatter Diagram"

Saginaw Forest Lot 2C White Pine Control - Basis = Trees

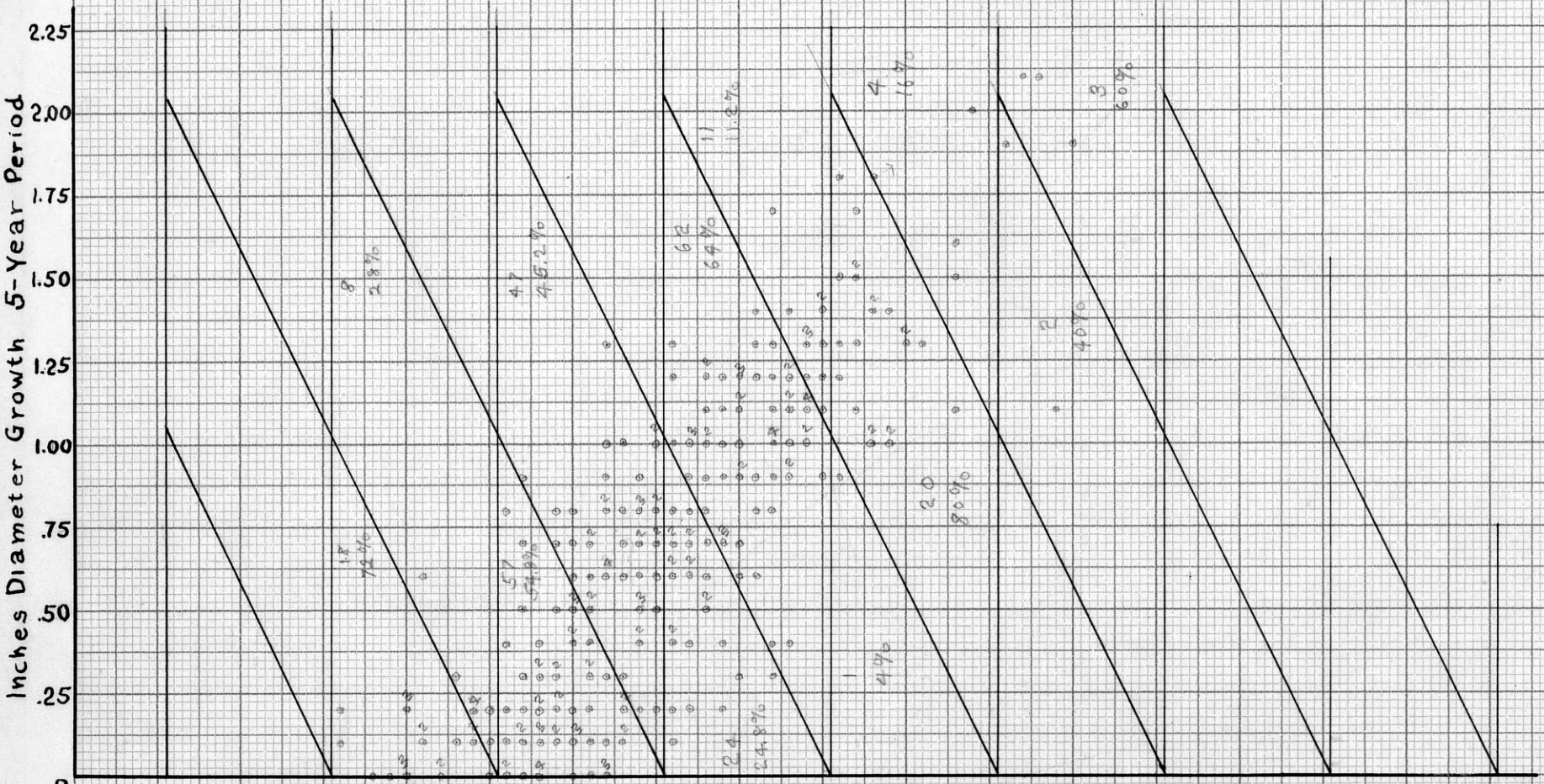


Figure 6

Ineson's Percentage Movement Curves

Saginaw Forest - Lot 2C White Pine Control Basis = Trees

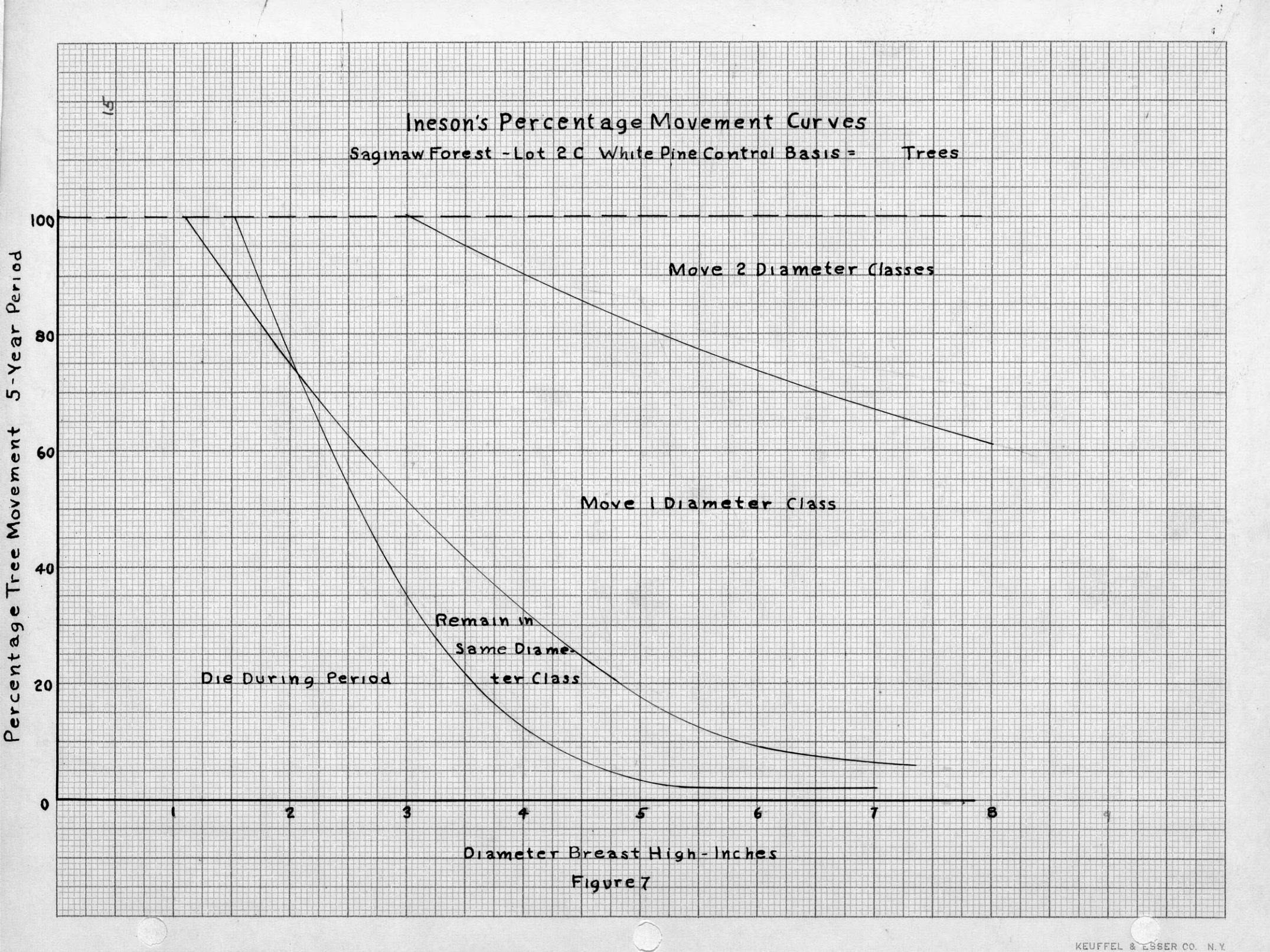


Figure 7

Table I

Growth Measured & Predicted
White Pine at Saginaw Forest

Block 1-Control Plot- Lot 2b

D.B.H. Inches	No. Trees 1925	Ineson's Method: Growth Period = 5 yrs. % Mortality	% Remain Same D.B.H.Cl.	Percent Moving 1 Cl.	Percent Moving 2 Cls	Mortality Reduction	Trees Remain. Same Class	Trees Moving 1 Cl.	Trees Moving 2 Cls.	No. Trees 1930	Basal Area 1930	Reynolds' Method: No. Trees After Mortality Reduction	Ave. Gr. Inches	Trees Remain Same Class	Trees Moving 1 Cl.	Trees Moving 2 Cls.	Trees Moving 3 Cls.	No. Trees 1930	Basal Area 1930	"Step-Up" Method: No. Trees 1930	Ave. Gr. Inches	Ave. Dia. 1930 Inches	Basal Area 1930
1	1	100				1.0							0.03								0.06	1.1	
2	113	53	21	24	2	60.0	23.7	27.0	2.3	23.7	0.521	53.0	0.13	46.1	6.9			46.1	1.014	53.0	0.25	2.2	1.378
3	157	25	23	46	6	39.2	36.2	72.2	9.4	63.2	3.097	119.8	0.52	57.5	62.3			64.4	3.156	119.8	0.58	3.6	8.506
4	139	12	17	61	10	16.7	23.6	84.8	13.9	98.1	8.535	122.3	1.04		117.4	4.9		62.3	5.420	122.3	0.92	4.9	16.021
5	58	5	11	69	15	2.9	6.4	40.0	8.7	100.6	13.682	55.1	1.55		24.8	30.3		117.4	15.966	55.1	1.17	6.2	11.571
6	13	4	5	70	21	0.5	0.7	9.1	2.7	54.6	10.702	12.5	2.00			12.5		29.7	5.821	12.5	1.38	7.4	3.787
7	1	3	3	70	24			0.7	0.3	17.8	4.753	1.0	2.37			0.6	0.4	30.3	8.090	1.0	1.58	8.6	0.403
8										3.4	1.187							12.5	4.362				
9										0.3	0.133							0.6	0.265				
10																		0.4	0.218				
											42.610								44.312				41.616

Predicted Basal Area for 1930 — 42.610 sq. ft. | 44.312 sq. ft. | 41.616 sq. ft.
Measured Basal Area for 1930 — 36.969 " "
Predicted Basal Area Growth (1925-'30) — 8.967 " " | 10.669 " " | 7.973 " "
Measured Basal Area Growth (1925-'30) — 3.326 " "
Measured Basal Area Growth (1920-'25) — 7.518 " "

Block 1- Thinned Plot- Lot 2b

1		28	72									0.07									0.16	1.2	
2	3	22	78			0.7	2.3		0.7	0.015		0.25	2.2	0.8				2.2	0.048	3	0.44	2.4	0.091
3	42	17	81	2		7.1	34.0	0.9	9.4	0.461		0.68	13.4	28.6				14.2	0.696	42	0.79	3.8	3.318
4	126	16	75	9		20.2	94.5	11.3	54.2	4.715		1.16		105.8	20.2			28.6	2.488	126	1.10	5.1	17.892
5	95	15	69	16		14.2	65.6	15.2	109.6	14.906		1.62		36.1	58.9			105.8	14.389	95	1.33	6.3	20.520
6	18	14	63	23		2.5	11.3	4.2	39.4	17.522		2.07			16.7		1.3	56.3	11.035	18	1.54	7.5	5.526
7									26.5	7.075								58.9	15.726				
8									4.2	1.466								16.7	5.828				
9																		1.3	0.576				
											46.140								50.785				47.347

Predicted Basal Area for 1930 — 46.140 sq. ft. | 50.785 sq. ft. | 47.347 sq. ft.
Measured Basal Area for 1930 — 40.417 " "
Predicted Basal Area Growth (1925-'30) — 15.351 " " | 19.896 " " | 16.458 " "
Measured Basal Area Growth (1925-'30) — 9.528 " "
Measured Basal Area Growth (1920-'25) — 14.033 " "

Table II
Growth Measured & Predicted
White Pine at Saginaw Forest
Block I - Control Plot - Lot 2b

Ineson's Method

Growth Period - 1920 - '25

D.B.H. Inches	No. Trees 1920	Actual Mortality Reduction	No. Trees Living 1925	% Remain Same D.B.H. Cl.	Percent Moving 1 Cl.	Percent Moving 2 Cls.	Trees Remain Same Class	Trees Moving 1 Cl.	Trees Moving 2 Cls.	No. Trees 1925	Basal Area 1925
1	56	45	11	100			11.0			11.0	0.066
2	267	99	168	74	24	2	124.3	40.3	3.4	124.3	2.736
3	231	1	230	48	4.6	6	110.4	105.9	13.7	150.7	7.380
4	76		76	29	6.1	10	22.0	46.4	7.6	131.3	11.420
5	10		10	16	69	15	1.6	6.9	1.5	61.7	8.400
6										14.5	2.840
7										1.5	0.400
8											

Predicted Basal Area 1925 — 33.242

Measured B.A. 1925 = 33.643 sq ft.

Reynolds' Method

Growth Period - 1920 - '25

No. Trees Living 1925	Ave. Gr. Inches	Trees Remain Same Class	Trees Moving 1 Cl.	Trees Moving 2 Cls.	No. Trees 1925	Basal Area 1925
11	0.03	10.7	0.3		10.7	0.064
168	0.13	146.0	22.0		146.3	3.220
230	0.52	110.4	119.5		132.4	6.500
76	1.04		73.0	3.0	119.6	10.400
10	1.55		4.5	5.5	73.0	9.930
					7.5	1.470
					5.5	1.470

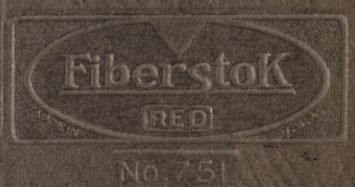
33.054

"Step-Up" Method

Growth Period - 1920 - '25

No. Trees Living 1925	Ave. Gr. Inches	Ave. Dia. 1925 Inches	Basal Area 1925
11	0.06	1.1	0.077
168	0.25	2.2	4.365
230	0.58	3.6	16.320
76	0.92	4.9	9.950
10	1.17	6.2	2.100

32.812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