COMPARATIVE GROWTH IN GRAZED AND UNGRAZED WOODLOTS AT PURDUE.

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The fact that grazing and the timberlot have nothing in common has been known to those of us who are interested in building up our woodlots, for a long time. That being the case, I shall not take time to argue the case. The many detrimental effects of grazing are too well known to need further argument here.

The opportunity has come to me during the last year or so, however, to study rather closely the growth on a few woodlots in the vicinity of Lafayette, some of them grazed and others not. This study is by no means complete but it has progressed far enough to disclose some features of interest.

I wish at this time to merely outline the method which I have selected somewhat arbitrarily for the comparison of these two types of woodlots. First, an attempt was made to select areas of unquestioned *site* 1 character, i.e., representing the most productive site class with reference to an area's forest producing power. Second, to select for comparative purposes areas similar in other characteristics except the matter of grazing. Age, silvicultural system or lack of same and distribution of species, were determining factors in the selection.

For the present comparison I have two areas each of the following characteristics. The first areas are both young second growth on land which was clear cut some 20 to 25 years ago and allowed to sprout. One has been rather severely grazed and the other not at all. The second type is an old stand on a selection method, one grazed and the other not.

The method on which the comparison is based is briefly as follows: 1. Preparation of stand tables. 2. The preparation of tables of basal areas for each of the tracts.

Such tables showing the basal areas of the total number of trees per acre in each diameter class form a remarkably good basis for comparison. I must confess, however, that I was somewhat disappointed in my first even-aged ungrazed selection, to find upon completion of the basal area table that the area seemed to fall in site 2 class rather than site 1. So far as basal area was concerned it practically coincided with the figure which Chapman gives for a similar mixture on site 2 in "Better Second-growth Hardwood Stands in Central New England." However, my heights, as I shall show later, were appreciably better than his for site 1. The low basal area on this tract may be accounted for by the fact that the farmer adjoining, across whose land the drainage would naturally flow, has been allowed to turn up several furrows along the fence and thus back up the water on the area, causing it to become stagnant thereon a portion of the year. As a result the mortality was appreciably increased. The following are the comparative results obtained.

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Tract 1	Tract 2
Young, even aged, ungrazed	Same as 1 except grazed
Age, 25	20
Trees per acre, 694	274
Basal area per acre, 54.344 sq. ft.	8.432
Average D. B. H., 3.78 in.	2.4

Tract 3	Tract 4
High forest, selection system, grazed	High forest, selection system, ungrazed
Trees per acre, 81	156
Basal area, per acre, 51.872 sq. ft.	75.17
Average diameter B. H., 8.78 in.	8.2
Reproduction under 6″, 25 per acre	106 per acre

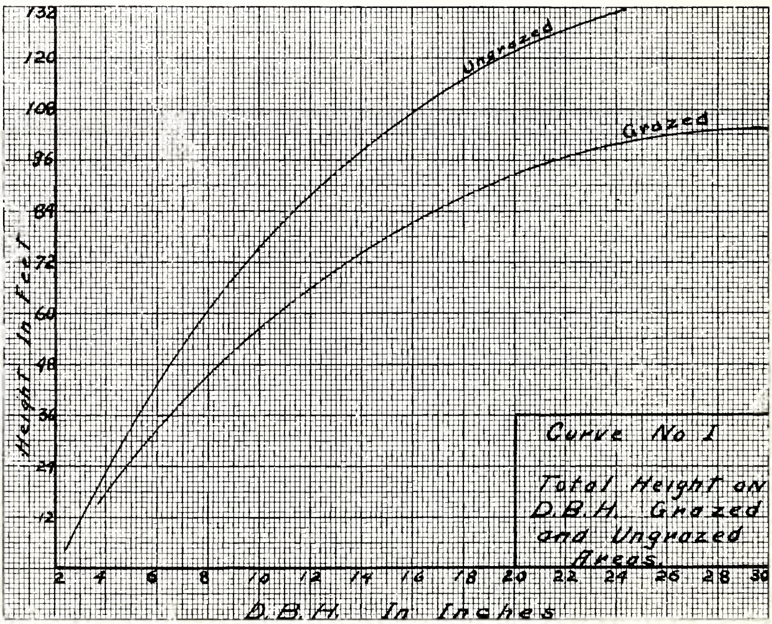

Fig. 1. Curves showing total height on D. B. H. grazed and ungrazed areas.

With reference to these comparative figures in D. B. H. it is interesting to note the difference in number of trees per acre and also the differences in height. Reference to the height curves drawn later shows the average heights for the eight and one-half inch trees on the grazed area to be 49 feet while that on the ungrazed area is 68 feet.

The next step in my comparison was the projection of growth for the next 20 years by diameter classes by means of the increment borer. Here I was confronted by the usual problem of growth prediction in mixed stands. Should I prepare yield tables for pure stands of each species and then determine the percentage of each species in the mixed stand or should I disregard percentage of mixture and proceed as though the stand were pure? I finally decided upon the latter course, and cite the following as justification of the decision. J. Nelson Spaeth gives as his conclusion in his bulletin on the Harvard Forest No. 1, Growth Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England, the following: "First, that in spite of wide variation in per cent of species in mixture, for a given age, site, and density, the volumes in board feet, cubic feet and cords were constant, and second, that the volumes of trees of given height and diameter in cords and cubic feet were the same regardless of species."

Inasmuch as the second of the sprout second growth woodlot types was cleared off shortly after the preliminary measurements were made on it a year ago, the comparison of the two woodlots of the first type could be carried no further. Therefore only the two of the latter type will be discussed further in the present paper.

The next steps were those leading to an actual comparison of volumes both present and future on each of the areas. Inasmuch as no volume tables were available, the trees were cubed by means of the Smalien formula, V equals $\frac{(B \text{ plus } b)\,h}{2}$. The basal areas at breast height and at the height of the limit of six inches in diameter in the top were secured by means of the Biltmore stick and Faustmann Hypsometer. I am convinced that these methods gave a rather high volume but inasmuch as my object was a comparison of values it did not vitiate the experiment. The following are the values for the present obtained as outlined above:

Grazed Woodlot Present Volume		Ungrazed Woodlot Present Volume	
Hickory	463.68 cu. ft.	Hickory	558.96 cu. ft.
White Oak	459.08 cu. ft.	White Oak	1,548.54 cu. ft.
Elm	14.13 cu. ft.	Red Oak	56.09 cu. ft.
Mulberry	11.23 cu. ft.	Maple	62.33 cu. ft.
Walnut	7.97 cu. ft.	Elm	22.54 cu. ft.
Hackberry	7.41 cu. ft.	Basswood	5.88 cu. ft.
Total	963.50 cu. ft.	Total	2,254.34 cu. ft.

The next step was the prediction of mortality or, in other words, the selection of the trees in each diameter class which would probably die within the next twenty years. This was done by a minute examination of each area by tree classes. Those falling into the lower half of the intermediate class and the entire suppressed and dead classes were thrown out. Tables 1 and 2 are a tabulation of the results. They show an average loss in all classes on the grazed tract of less than 0.3 per cent for the next 20 years, whereas the grazed tract, which is much more nearly fully stocked, shows a prospective loss for all classes of six inches D. B. H. and up, of 29 per cent. There was additional loss in classes below six inches which is reckoned in with the reproduction. In actual numbers the grazed area shows a loss of but two trees at present above six inches, leaving a total of 79 on which to predict growth. The ungrazed area has a loss in the same classes of 49 trees, leaving a balance of 107 on which to predict future increment.

TABLE 1. SHOWING MORTALITY IN D. B. H. AND TREE CLASSES ON GRAZED AREA.

	Living End of 20 Years								Dead End of 20 Years.					
	Species.								Species.					
D.B.H. Class	Aver. D.B.H.	Oak	Hickory	Elm	Walnut	Mulberry	Total		D.B.H.	Average	Oak	Total	Grand Total	% Loss
2									2					
4	5.0		1				1		4				1	
6	6.7	3	19			2	24		6	6.0	1	1	25	.42
8	8.3	6	11	3			20		8	8.0	1	1	21	.5
10	10.3	9	7		1	1	18						18	
12	12.4	3	5				8						8	
14	14.6	2	2				4						4	
16	16.0	2					2						2	
18	18.5	1					1						1	
20	20.0	1					1						1	
Totals							79					2	81	.05

TABLE 2. SHOWING MORTALITY IN D. B. H. AND TREE CLASSES ON UNGRAZED AREA.

Living at End of 20 Years.

D.B.H. Class	Aver. D.B.H.	Oak	Walnut	Hickory	Ash	Maple	Beech	Basswood	Elm	Iron	Total
2	2.3	.....	.....	.....	.....	3	.....	.....	.....	.....	3
4	4.2	.....	.....	2	.....	3	1	.....	.....	.....	6
6	6.7	1	.....	4	.....	3	1	1	1	1	12
8	8.5	6	.....	9	.....	3	1	1	.....	.....	20
10	10.2	6	.....	12	1	2	2	2	2	.....	26
12	12.2	12	1	2	.....	1	1	.....	.....	.....	17
14	14.2	8	1	3	.....	.....	.....	.....	1	.....	13
16	16.2	3	.....	.....	.....	.....	1	.....	1	.....	5
18	18.2	3	.....	.....	.....	.....	.....	.....	.....	.....	3
20	20.0	2	.....	.....	.....	.....	.....	.....	.....	.....	2
Average....	11.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	107

TABLE 2.—Continued.

Dead at End of 20 Years

D.B.H. Class	Aver. D.B.H.	Oak	Hickory	Maple	Beech	Elm	Basswood	Total	Grand Total	Percent Loss
2	2.6	.....	.....	8	.....	.....	.....	8	11	73
4	4.4	1	1	8	8	.....	.....	18	24	75
6	6.1	.....	9	2	.....	2	1	14	26	54
8	8.6	4	2	.....	1	.....	.....	7	27	25
10	9.6	1	1	.....	.....	.....	.....	2	28	7.1
12	.....	.....	.....	.....	.....	.....	.....	.....	17	.....
14	.....	.....	.....	.....	.....	.....	.....	.....	13	.....
16	.....	.....	.....	.....	.....	.....	.....	.....	5	.....
18	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
20	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
.....	6.26	.....	.....	.....	.....	.....	.....	49	156	46.8

TABLE No. 3. GRAZED AREA

Present D. B. H. Inches.	D. B. H. 20 years hence Inches.
3	5.8
4.1	6.8
5	7.6
5.8	8.2
6.8	9.2
7.6	10.2
8.8	11.3
9.8	12.1
10.7	13.1
11.7	14.3
12.3	15.3
13.3	16.2
14.6	17.2
15.8	18.4
16.8	18.5

TABLE No. 4. UNGRAZED AREA

Present D. B. H. Inches.	D. B. H. 20 years hence Inches.
2.0	4.2
3.2	5.5
4.1	6.7
6.1	9.2
7.1	10.1
8.3	11.2
9.0	12.0
10.1	13.5
11.7	14.6
13.0	16.6
15.0	18.1
16.5	19.6

TABLE No. 5. UNGRAZED

D. B. H. Inches.	Height in Feet.
6	24.0
7	27.5
8	31.0
9	34.0
10	37.0
11	40.0
12	42.5
13	45.0
14	47.5
15	49.5
16	52.0
17	54.0
18	56.0
19	58.0
20	59.9

TABLE No. 6. GRAZED

D. B. H. Inches.	Height in Inches.
6	20.0
7	23.0
8	26.0
9	29.0
10	32.0
11	34.9
12	37.2
13	39.9
14	42.0
15	44.5
16	46.5
17	49.2
18	51.5
19	53.9
20	56.0

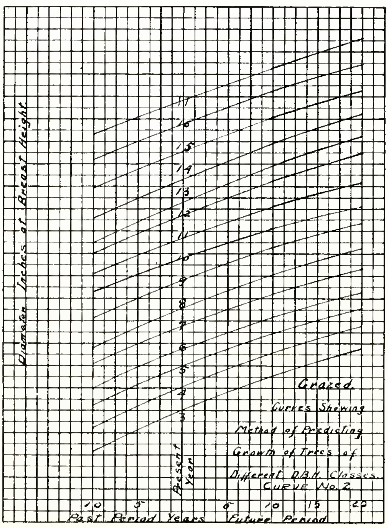

Fig. 2.

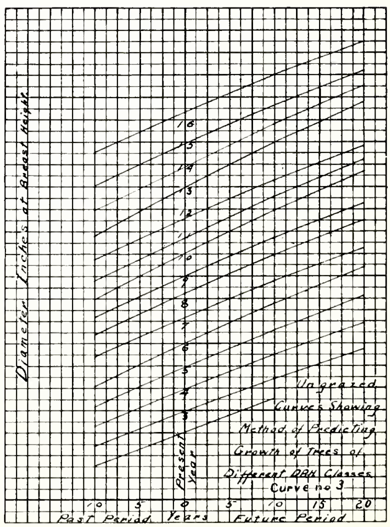

Fig. 3.

Fig. 2. Curves showing method of predicting growth of trees of different D. B. H. classes in grazed area.

Fig. 3. Curves showing method of predicting growth of trees of different D. B. H. classes in ungrazed area.

It is obvious that any study which is to predict growth of trees for a given period must reveal the size of the trees at the end of the period, the difference in volumes of the present and at the end of the period being the measure of the growth for the period. Our first step, then, looking toward the future, was to ascertain what the D. B. H. of the respective trees on each area would be at the end of the period. We could not of course cut any of the trees to find out what their past and present rates of growth were. So we substituted the use of the increment borer. With the borer we were able to find what the rates for the past 15 years had been. We plotted these rates on co-ordinate paper and projected them into the future for 20 years. (Figs. 2 and 3.) Tables 3 and 4 are taken from these curves.

Having found the D. B. H. of the trees at 20 years, we next proceeded to plot the heights to a six-inch limit for 20 years hence. Data obtained on trees of all heights represented on the tract for our present yield was used for the construction of a curve showing heights to a six inch limit of all trees represented. Figures 4 and 5 and tables 5

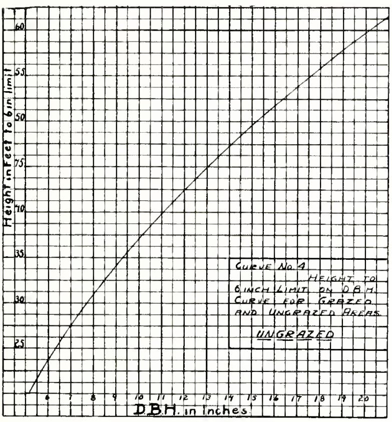

Fig. 4.

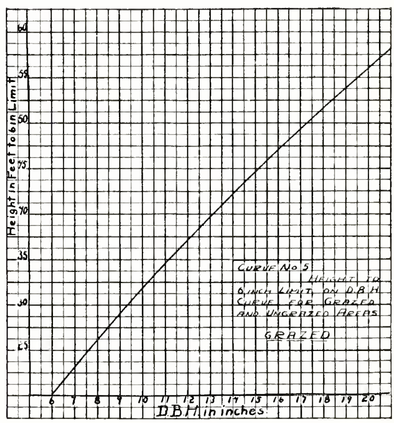

Fig. 5.

Fig. 4. Curve showing height to six-inch limit on D. B. H. curve for ungrazed area.
Fig. 5. Curve showing height to six-inch limit on D. B. H. curve for grazed area.

and 6 give the results obtained. It is of interest to note that the ungrazed area shows an average D. B. H. increase of 25 per cent as against a 14 per cent increase for the grazed area.

We are now ready to compute the volume of our tracts 20 years hence. Tables 7 and 8 show the contents of each stand by species and D. B. H. classes. A summary of these tables shows a volume on the ungrazed area at the end of 20 years of 3,826 cubic feet, and on the grazed area, 1,448 cubic feet. Subtracting in the first instance the volume of our present stand or 2,254 cubic feet and in the second instance, 968 cubic feet, we see that we have an increase in the first stand of approximately 70 per cent and in the second instance 50 per cent. Moreover, the base line on which the growth percentage is figured is two and one-half times as great in the ungrazed as in the grazed area.

In the above discussion of growth we have disregarded the reproduction. Before closing, mention should be made of the inherent differences in the two stands is this respect. On the grazed area, our stand tables show but 25 trees under the six-inch D. B. H. class, whereas the ungrazed area shows 86 trees in the same classes. By referring these trees to the D. B. H. increase curves for their respective areas and to the total height curves for the same areas and computing the resultant volumes, we find that the grazed area will have an increase in cubic volume in D. B. H. under six inches of from 63 to 107 cubic feet, or 44 cubic feet in 20 years. The ungrazed area in the same time on its 86 trees that are at present under six inches D. B. H. will have an increase of from 35 to 231 cubic feet, or an increase of 196 cubic feet. Of course this is supposing in each case that there will be no mortality, which is not scientifically true. What that mortality will be we have no present means of ascertaining. One fact may be of interest, that 41 out of the 86 trees on the ungrazed area that are below six inches are in the two-inch class. What has become of the trees in the other three classes? Probably the crowded condition in the stand makes the mortality in these classes high.

We may suggest the following salient points in conclusion:

1. Grazed areas show a lower number of species per acre, as compared to ungrazed areas.
2. Grazed areas show a lower number of stems per acre as compared with ungrazed areas.
3. Grazed areas show a greatly decreased height growth as compared to ungrazed areas.
4. Grazed areas show a greatly decreased diameter growth as compared to ungrazed areas.
5. The grazed area under consideration showed but 30 per cent of the growing stock of the ungrazed area, notwithstanding the fact that conditions of site were very similar.
6. Increment on the ungrazed area in 20 years was found to be 300 per cent greater than on the grazed area.
7. There were over three times the actual number of trees under six inches D. B. H. on the ungrazed area than on the grazed area with double the increase in volume in 20 years.