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SENIOR THESIS

THINNING DOUGLAS FIR ON THE McDONALD FOREST

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SPRING TERM, 1933

By

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THINNING DOUGLAS FIR ON THE McDONALD FOREST

OBJECT:

The present study is an analysis of the plots in a thinning experiment initiated by Prof. E. G. Mason.

HISTORY:

In the late winter of 1927, 7 plots were laid out at the Peavy Arboretum in a second growth stand of Douglas fir, 5 of one acre size and 2 of one-half acre size. Plots 1-A and 1-B, each one acre, lay close together; 2-A, B, and C, were somewhat scattered, but were intended to be in comparable stands; 3-A and B were side by side. The corners were marked with scribed and whitewashed stakes 4 feet high. Each tree was tagged at breast high with its serial number on a tin square, and its diameter and crown class recorded. Enough diameters and heights were taken from each plot to construct a height curve for each.

In the fall of 1927, a number of marked trees were felled on plots 1-B, 2-A, 2-C, and 3-A. Plots 1-A, 2-B, and 3-B were left untouched to act as checks on the growth of the thinned plots. A different percentage was removed from each plot to give different percentages of thinning. The trees thus felled were lopped and left lying where they were.

Measurements were taken for volume table data that fall and winter. Nothing was done then, except occasional casual observations of rot, until the winter and spring of 1932. In that period, J. W. Kimmey made a study of rot in the down trees, bucking up about 5 trees on each plot into 10 foot sections. During the same spring, before the growing season, the plots were remeasured, crown class again estimated, and heights taken on the same trees if they were still standing. The next activity will probably be the second remeasurement in 1937.

PLOT DESCRIPTION:

1-A and 1-B are in almost pure Douglas fir, which from increment borings taken this spring, 1933, appear to be nearly 57 years old at B.H. (breast high) which, allowing 7 years for the seedling to reach B.H., makes the stand 64 years old now and 59 years in 1927 when the plots were established. They are on opposite sides of a small creek. The check plot, 1-A, had in 1927, an average diameter of 15.4 inches. It has 160 trees evenly spaced over the acre. The average height of dominants and codominants is 110 feet which makes it a site III. The aspect is very slightly south, with not more than 3% slope. The thinned plot, 1-B, had in 1927 an average diameter of 14.8 inches with also 160 trees.

An old woods road runs through the SE and NE corners but does not affect it materially. The site is the same, however, it has a slight northern aspect with a slope not over 5%. Although there is no brush on 1-A, considerable has sprung up on 1-B since thinning.

Plots 2-A, B, and C, are the oldest of the series. They are 80 years old and were 75 at the time of cutting. 2-B is the unthinned one. It is located on the gently rounded crest of a ridge, thus on well drained soil. It had an average diameter of 18.7 inches in 1927 and 180 trees. The average height of dominants and codominants is 135 feet, and the site is a very good III or poor II. The trees are the most uniform in size of any of the plots. The ridge on which it is situated gives off to the north, east, and south. The greatest slope is 5-6% to the north.

Plot 2-A lies west up the ridge. It has a northern aspect with a slope up to 9%. There are 134 trees on the acre averaging 20.4 inches in diameter in 1927. The site is about the same, if anything, poorer. Trametes pini was encountered in one increment boring here. Plot 2-C has the best site of the 7 acres. It is site II, 150 feet at 75 years, located in a slight hollow on the south-east slope of the ridge below 2-B. The slope runs from 2-3% at the lower end up to 35% at the upper. The lower half of the plot is well stocked but the steep portion is very scantily covered with timber. This scarcity is evinced in the small number of trees, 91 to the acre. The diameter was 23.1 inches in 1927.

The last group, 3-A and 3-B, are located directly adjacent to each other. Each is ½ acre in size. They are long and narrow, stretched across a slope with perhaps 20-30 feet separating them. They are on a 20% slope with a directly eastern aspect. The age of the two is 66 years, allowing 7 years to reach B.H., and was 61 at the time of their establishment. The site is good III or poor II, the dominants and codominants being 120 feet high at 61 years. The average diameter of the thinned plot, 3-A, was 18.6 inches with 52 trees for the ½ acre. It has a trail running along the upper boundary which, however, affects its growth none. 3-B had a greater average B.A. (basal area), 19.4 inches, but only 46 trees.

Each of the thinned plots was supplied with a control strip of a half chain in width around it, in which the same degree of thinning was practiced as on the plot. It appears from the records that a low or "German" method was used in marking the trees, those of the lower diameters and crown classes being removed. Each received a different percentage of thinning, 2-A the least, then 1-B, 2-C and 3-A, which received the heaviest.

Some mention of moisture conditions might be indicated by the study of rot in felled timber carried on in the winter and spring of 1932 by J. W. Kimmey.

The rot figures seem to show a general gradation from north to east to south. The rot thickness increases with that change. It would seem that the northern slope has the greatest moisture content, then east, then south. The table follows:

Plot	Double rot Thick.	Aspect.
2-A	2.61"	N
3-B	3.03"	E
1-B	3.24"	N.E.
2-C	3.81"	S.E.

A map of the plot locations is given on chart I.

RESULTS:

INCREMENT OF TREES - The first object of this paper is to make a study of the individual increment of thinned trees. I took increment borings on an average of 7 trees from each thinned plot and 5 from each check plot, a total of 28 thinned and 16 check borings. The trees were selected at random to get all sizes of trees and all distances of stumps. In the office, I counted back 5 years (1927), marked the core with indelible pencil, counted back 10 more years (1917) and marked the core, and finally counted 10 more years (1907) and marked it. Using a grooved block to hold the cores, I measured the 1907-27 radial growth, the 1917-27 growth and the 1927-32 growth. I next figured the 1927-32 radial increment as a percentage of the 1917-27 and of the 1907-27 increases. These were then grouped and averaged two ways: by distance to the nearest stump, and by crown classes. The object was to determine the effect of release of light, moisture, and nutrients on the adjacent tree. Also to test the importance of crown class in the response to these changed conditions.

The results of the first analysis are in the following table. The values are plotted on chart III.

Page 5 not supplied

Release distance	0'-5'	6'-10'	11'-15'	16'-20'	Check Plot
1927-1932 % of 1917-1927 gfowth	76	75	62	67	54
1927-1932 % of 1907-1927 growth	30.5	28.5	18	27	19
Number of trees	6	13	3	6	16
Average release distance	4	8	14	19	--

It would appear from the preceding that radial growth is greatly stimulated when adjacent trees are removed. The effect is apparently exercised even when the nearest trees removed is 20 feet distant. As I had no data above that, I can set no limit to the distance release is effective. The curious drop in the curve for the 11'-15' class is to be accounted for to some extent by the small number of trees which determined the average. With a larger number of samples in this group, the curve would undoubtedly become smoother through that space.

The classification by crown class is given in the following table, and its plotted values in chart II.

Crown Class	Thinned		Check		
	Dom.	Cod.	Dom.	Cod.	Int.
1927-1932 as a % of 1917-1927 growth	74	67.9	58.2	43.5	57.5
1927-1932 as a % of 1907-1927 growth	28.4	25.1	22.6	12	19

According to these figures, the codominant trees on a thinned plot are stimulated more in growth than the dominants. The actual percent growth based on the preceding 10 years is higher in the dominant trees, both on thinned and unthinned stands; but the relative pickup is greater comparing the codominants with their unmutilated brethern than comparing the dominants with their corresponding virgin mates. A possible explanation for this occurred to me. I make no claims as to its authenticity,

Page 7 not supplied

it is merely a possibility. A dominant tree has the needed light, and because of its probable dominancy below ground, a lion's share of the moisture and nutrients. When some of these factors are released by thinning, the tree has no excessive capacity to use them. However, the codominant tree, because of its subordinant crown and probably root status, is handicapped in nourishing itself. When release of the moisture, nutrient, and light supplies occur, this tree has a greater capacity to utilize them. This hypothesis would explain the figures. I should like to have data on the behaviour of intermediate trees. It would seem that somewhere the crown would be so reduced, that the trees would not be capable of utilizing the available increase in growth needs. Whether that point occurs in the intermediate class or not, my samples do not show.

INCREMENT OF STANDS - The second goal of this paper was to test influence of thinning on the increment of second growth Douglas fir stands. I realize that 7 plots are a pitifully small number of samples to work with, and that 5 years is a very short time over which to base any conclusions, but I am making this preliminary summary with the knowledge that later remeasurements will give more reliable data.

The first consideration is the reliability of the data to be used. There is quite a variation of site, age, and stocking, between the three groups. So the question presents itself: Is it possible to compare the results of thinning in a given stand with those of a stand of a different age, site, and stocking? As there is no criterion by which to test the safe limits of variation in these indices, I have taken the data as it is and compared it.

There is, however, another important point to be answered. Are the thinning and check plots representative of the same stand, or are they taken from different conditions of timber? It is easily seen that one could not compare the increment of a thinning plot originally fully stocked, with that of a check plot of three-quarter stocking, or a thinned plot of 2 foot trees with a check plot of 3 foot trees. There is in this case a criterion by which to ascertain whether or not the 2 plots are from the same stand. I added up the basal areas of all trees on the plot and divided by the number of trees to determine the average B.A. Then by a process, given in the following table, I determined the standard deviation, σ, and the standard deviation of the mean, σ_m, as shown.

Limits	x	u	f	uf	u^2f
.38- .62	.50	-6	3	-18	108
.63- .87	.75	-5	15	-75	375
.88-1.12	1.00	-4	8	-32	128
1.13-1.37	1.25	-3	23	-69	207
1.38-1.62	1.50	-2	21	-42	84
1.63-1.87	1.75	-1	23	-23	23
1.88-2.12	2.00	0	25	00	00
2.13-2.37	2.25	1	12	12	12
2.38-2.62	2.50	2	18	36	72
2.63-2.87	2.75	3	12	36	108
2.88-3.12	3.00	4	6	24	96
3.13-3.37	3.25	5	5	25	125
3.38-3.62	3.50	6	3	18	108
3.36-3.87	3.75	7	5	35	245
3.88-4.12	4.00	8	1	8	64
Totals			180	-259	1755
				+194	
				- 65	

$$\frac{-65}{180} = -.3611 \qquad -.3611 \times .25 = -.0903$$

$$2.00 - .090 = \underline{1.910} \text{ (Mean)}$$

$$\sqrt{\frac{1755}{180-1} = \frac{180}{180-1}(.3611)^2} = 3.113$$

$$3.113 \times .25 = \underline{.778}\ (\sigma)$$

$$\sqrt{\frac{.778}{180}} = \underline{.058}\ (\sigma_m)$$

If the correct indices of the stand were known, the difference of the average of the sample from that of the stand would be tested by the σ of the stand. But in this case, we have two samples taken from close localities. Neither is perfectly representative, but it is desired to find out if they come from the same stand. Canadian bulletin #77* gives a method for determining this. The unit of dispersion is σ_{diff} computed as $\sqrt{\sigma_{m_1}^2 + \sigma_{m_2}^2}$ The difference between the average B.A. of the two stands is divided by σ_{diff}. The resulting figure is the value of x on the normal curve of distribution. The formula for the curve is $P = \frac{2}{\sqrt{2\pi}} \int e^{-\frac{x^2}{2}}$ Tables are easily found to look up "P". "P" gives the probability that these two samples are drawn from the same universe. The figures for each plot are given in the following table.

Plot	Av.B.A.	σ	n	$\sigma/\sqrt{n}$	B.A.-B.A.	σ_{diff}	x	P
1-A	1.337	1.137	160	.090	.148	.1166	1.27	.2040
1-B	1.191	.935	160	.074				
2-A	2.269	1.107	134	.096	.357	.112	3.18	.0015
2-B	1.912	.778	180	.058	.987	.177	5.57	.00000003
2-C	2.899	1.421	91	.149				
3-A	1.884	.972	52	.135	.170	.217	.78	.4354
3-B	2.054	1.150	46	.170				

Plots 1-A and 1-B are evidently from the same stand, as are also 3-A and 3-B. The criterion ordinarily taken as the outside possibility of similarity is 3 σ or a value for "P" of .0027. It appears from this that neither 2-A nor 2-C are established in a stand comparable with their check plot, 2-B.

In analyzing the volumes on the acres then, it is safe to compare the thinnings with the checks on the 1 and 3 groups, but in the 2 groups, it must be remembered that the check plot is not representative of the thinnings and is not safely used. However, as there is no better

*Statistical Methods in Forest Investigative Work. Dept. Interior.

criterion, I shall have to use it.

Following is the procedure used in computing the volumes. From the few heights taken, I constructed a height over diameter curve for each group. One curve for 1-A and 1-B, one for 2-A and 2-B, one for 2-C, and one for 3-A and 3-B. It was necessary also to construct one for 1927 and one for 1932 in each of these groups. Using these height curves. I read off 8 local volume tables in cubic feet from the Douglas fir tables in McArdle's bulletin, 4 for 1927 and 4 for 1932. Following that, I took off 8 more readings in board feet, Scribner rule, trees 12 inches and up. Using these tables, I recorded the volume of each tree on the form prepared by Prof. Mason. A copy is included at the end of this paper. On the occurrence of .5, I threw it up from uneven digits and down to even ones. Thus: 8.5 goes down to 8 inches and 9.5 goes up to 10 inches. Having completed this operation, I added the volumes for each plot and prepared the tables given below. I have grouped these data into the tables and have prepared charts IV, V, and VI: growth as a percentage of original stand over percentage thinned; growth as a percentage of reserved stand over percentage thinned; and, growth as a percentage of check growth over percentage thinned.

CUBIC FOOT VOLUME

Plot	Area Acres	1927	Thinned	Reserve 1927	1932	Growth
1-B	1	7,257	1,651	5,606	6,341	735
1-A	1	8,166	---	8,166	8,787	621
2-A	1	13,229	2,316	10,913	12,210	1,297
2-B	1	16,161	---	16,161	17,442	1,281
2-C	1	12,502	3,248	9,253	10,696	1,441
3-A	1/2	3,930	1,741	2,189	2,565	376
3-B	1/2	3,712	---	3,712	4,151	439

BOARD FOOT VOLUME

Plot	1927	Thinned	1927 Reserve	1932	Growth
1-B	30,918	6,566	24,352	28,342	3,990
1-A	35,166	----	35,166	38,263	3,097
2-A	65,578	10,333	55,245	64,763	9,518
2-B	79,938	----	79,938	87,557	7,619
2-C	66,812	16,291	50,521	60,083	9,562
3-A	18,221	7,921	10,300	12,421	2,121
3-B	17,214	----	17,214	19,948	2,734

COMPARISON OF GROWTHS

			B.F. GROWTH		
Plot	% Thinned	% Reserved	% of reserve volume	% of orig. volume	% of growth of check
1-B	21	79	16	13	129
1-A	00	100	9	9	100
2-A	16	84	17	14.5	125
2-B	00	100	9.5	9.5	100
2-C	24	76	19	14.5	126
3-A	44	56	20-5	11.5	78
3-B	00	100	16	16	100

The first curve indicates that thinning up to 16-24% increases the actual growth. Thinnings of heavier grade reduce the actual growth.

The second curve shows that the growth, relative to volume reserved after thinning, increases steadily with increased degree of thinning. My data carries it only up to a 44% thinning. What the curve does beyond that point cannot be told. However, I would surmise that it leveled off, but did not drop. There would come a point beyond which the stand could not utilize all the growth factors. There the curve would become horizontal, but it would not decline.

The third curve, indicates the same as the first, that the actual growth increases up to a given degree of thinning, then drops, but the curve is more regular. The maximum increment comes around 20% thinning. Beyond that, additional thinnings so reduce the growing stock that even the incfeased growth rate cannot make up the deficit. This is shown especially well in the 44% thinning.

CONCLUSION:

These figures show that thinning could be advantageous. On the better older stands, an increased increment of 2000 feet per acre per year was gained in the 5 years by thinning. Not only that, but this increased volume is being layed on fewer boles and is thus more valuable than that on the unthinned plots.

The financial advisability of thinning of course depends on the market, but the volumetric argument is unquestionable.

NOTE:

It would be well to reestablish the corner posts as some of them are badly rotted and a couple even down. Some of the tag nails were driven into the wood so that the bark is growing over the tags. Such trees should be retagged, care being taken to drive only into the bark so the tags will not be overgrown.

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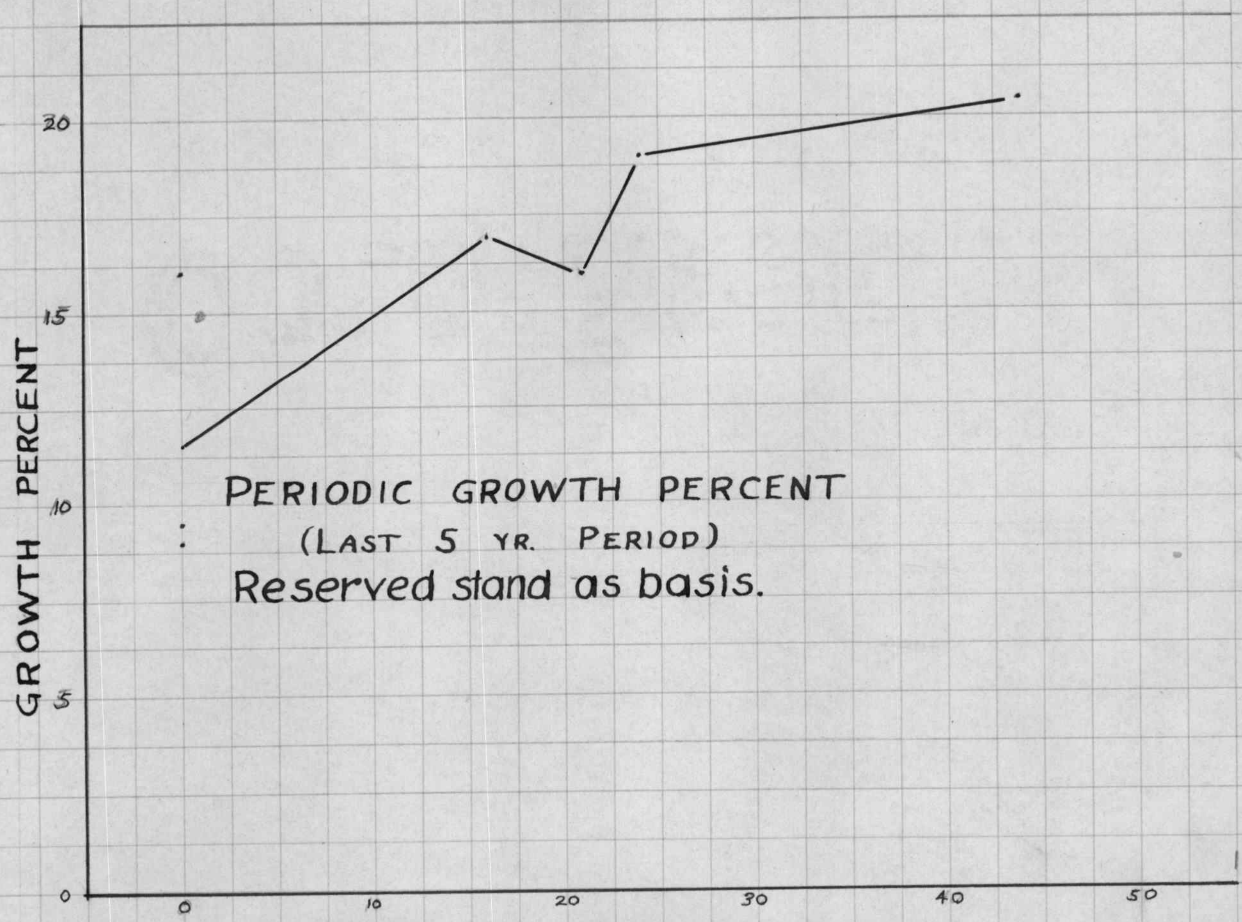
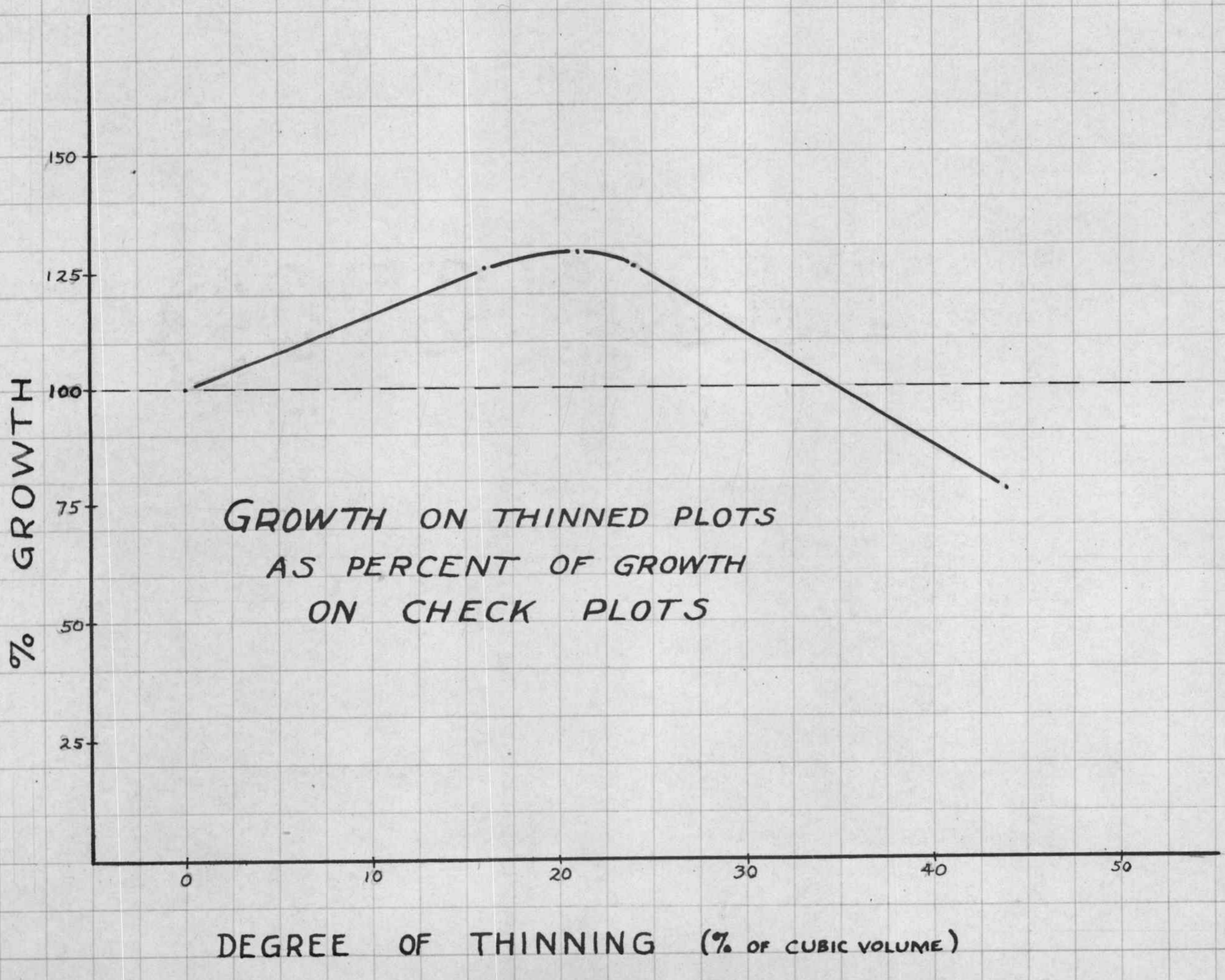


DEGREE OF THINNING (% OF CUBIC VOLUME)



150
125
100
75
50
25
% GROWTH
0
10
20
30
40
50
GROWTH ON THINNED PLOTS
AS PERCENT OF GROWTH
ON CHECK PLOTS
DEGREE OF THINNING (% OF CUBIC VOLUME)

From Nettleton's Old Files
J. Meier

WORKING PLAN FOR ESTABLISHING AND MEASURING SAMPLE

PLOTS FOR THINNING EXPERIMENT ON ~~PEAVY ARBORETUM~~ Forest
" Plots in Second Growth D. Fir

PURPOSE

To study the effect of thinnings in second growth Douglas fir on the Peavy Arboretum.

FIELD WORK

Procedure:

1. Lay out sample plots in pairs consisting of:

   (a) Check plot, upon which no thinnings will be made.
   (b) One or more thinning plots, upon which will be made fairly heavy thinnings, based on opening up the canopy to favor the thrifty trees. A complete inventory of these plots before thinning is essential.

2. Remeasure plots every five years and compute amount of change. Every measurement shall be taken in the spring before the growing season has started.

Location

1. There shall be 3 units of sample plots, each unit ~~to~~ should consist of two one-acre plots, except where two thinning plots and one check plot will be feasible.

2. Two units will be situated in the stands in 40's No's. 5 and 6 and one unit in 40 No. 10, of section 36.

3. Each plot will be completely surrounded by a border strip 50 feet wide.

Laying out Plots

1. Make each plot as nearly square as feasible. Have no sharp angles.

2. Survey boundaries with compass and tape, using horizontal measurement. Sufficient measurements should be recorded so that the area could be computed on a basis of a slope measurement if later desired.

SECTION 36

T10S, R5W, W.M.

SCALE 8" = 1 MILE