

AN EXPERIMENT ON THE EFFECT OF ROOT  
PRUNING AND TWO DIFFERENT PLANTING  
METHODS ON CONIFEROUS STOCK  
and  
A STUDY OF NATURAL HARDWOOD  
REPRODUCTION IN STITCHFIELD WOODS  
by  
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PART A  
A STUDY OF  
NATURAL HARDWOOD REPRODUCTION  
IN  
STINCHFIELD WOODS  
and

PART B  
AN EXPERIMENT  
ON  
THE EFFECT OF ROOT PRUNING  
AND  
TWO DIFFERENT PLANTING METHODS  
ON  
CONIFEROUS STOCK

By Clayton Schooley

May 1949

DEDICATED

TO

MY WIFE, DOROTHY

Without whose encouragement,  
prodding, and very great  
assistance, this report may  
never have been completed.

PART A  
A STUDY OF  
NATURAL HARDWOOD REPRODUCTION  
IN  
STINCHFIELD WOODS

<sup>E</sup>  
FORWARD

These two reports are submitted as partial requirements for a Degree of Master of Forestry from the University of Michigan. The work was done under Leigh J. Young, Professor of Silviculture of the School of Forestry and Conservation, to whom I am indebted for the suggestion of this problem.

May 1949

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## INTRODUCTION

As the amount of virgin timber decreases it becomes increasingly important that farm woodlots as a source of timber supply be properly managed. Over 20% of the forest land in the United States is in farm woodlots (15). Most of this tremendous acreage is scattered among thousands of individual owners with small isolated tracts rarely over forty acres in size. These owners are frequently unaware of the economic importance of their woodlands to themselves and to the community as a whole.

If these areas are to take their proper place in the timber supply picture it is necessary that they be managed so as to show a return in financial profit or in raw materials for the farmer's own use which will justify cost in taxes, time and labor expended to keep them productive.

In considering the future management of his woodlands, the farmer will be confronted immediately by two questions. First, is the woods in its present condition worth maintaining and improving for the primary purpose of producing forest products? Second, if so, what plan of management shall be followed to bring it to its highest productiveness (11).

It is the attempt of studies such as this to answer such questions. The owner must know what will happen



when he excludes his stock from the woodlot or he isn't likely to do it.

The problem in this study is comparable to that facing most woodlot owners. The area was poorly stocked with trees mostly of coppice origin indicating a very heavy cut in the past. Sheep grazing had kept natural reproduction from coming in to the extent that the stand looked like an open park according to Frank Murray, Forest Manager for the University of Michigan. The area was more or less completely covered with sod. With conditions like this, the study is trying to determine the kind, character and amount of vegetation that would become established naturally and the length of time required for this to take place under the various conditions existing in the area.

The plots, originally eight, were first set up and measured in 1932, but according to Towell (A) the individual trees weren't tagged until 1936 when the plots were measured again. In 1937 they were remeasured and two new plots were added. Since then measurements have been made in 1938, 1939, 1940 and 1946.

This year, 1949, plot 8A was dropped from the study. This plot is located in a pine plantation and during a cleaning operation in this plantation the seedlings in the plot were inadvertently cut, leaving only one sassafras which was apparently spared because it was

close to the sign identifying the plot making it difficult to get at it with a brush hook. Many of the seedlings have sprouted but are of little value for the purposes of this study.

## REVIEW OF LITERATURE

There have been several very good studies conducted on what can be expected to happen in farm woodlots, after grazing is stopped. The principal work in this line has been done by the Purdue Agricultural Experiment Station in cooperation with the Central States Forest Experiment Station, USDA. (11) The work was conducted in Northern Indiana where 70 one half acre plots were established in previously grazed woodlots from which cattle had been excluded.

In their earlier studies they found that:

1. The removal of livestock from farm woodlots is the first step toward the accomplishment of adequate forestry.
2. Because of the extreme environmental changes which have taken place through years of continuous overgrazing, these woodlands are largely incapable of speedy natural recovery to productive forest conditions.
3. The principle factors controlling germination, establishment, survival and future growth of these areas appear to be:
  - a. The presence or absence of a tight sod cover at the time of the removal of the livestock.

- b. The density of the crown canopy of the overhead stand.
4. In the transition from well timbered areas to open pasture, grazed woodlands pass through four stages which are:
  - a. Early stage - Sod cover absent; crown density 80 per cent or more; no trees below 4-6 inches in diameter; development of a grazing line; elimination of shrubby undergrowth except unpalatable species.
  - b. Transition stage - Start of a sod cover; crown density less than 80 per cent; distinct opening of crown; definite scarcity of tree reproduction.
  - c. Open park stage - Complete sod cover; crown density of 50 per cent or more; no reproduction; frequent stagheadedness.
  - d. Final stage - Complete sod cover; crown density less than 50 per cent.
5. The regenerative capacity of grazed woodlands appears to be closely correlated with the stage in this transition in which the area falls at the time of the removal of livestock.
6. The increasingly unfavorable site conditions found in these successive stages is reflected in:
  - a. A decreasing amount of reproduction per acre.

- b. An increased length of time required to secure full stocking.
- c. A decreasing percentage of reproduction of valuable species.
- d. An increasing percentage of weed tree species.
- e. A decreasing percentage of survival following germination and establishment.
- f. A decreasing percentage of growth rate on established seedlings.

7. In woodlands which have not passed beyond the early stage, natural reproduction can be depended upon to assure the satisfactory regeneration of the area. The new stand will normally be of the same species as the overhead stand and they will usually be present in approximately the same percentages. No cultural treatment will be necessary, other than that dictated by good woodland management, to bring such stands back to a productive condition.

8. Farmwoods representative of the transition stage will normally regenerate naturally in sufficient amounts to assure a full stocking at maturity. However, the composition of the new stand may be materially different from that of the overhead stand. A few simple precautionary measures are recommended which will assist

in controlling the composition of the new stand.

9. The sod cover present in the open park stage effectively prevents natural reproduction as long as it remains. Under natural conditions, therefore, satisfactory regeneration is seriously delayed. Lack of seed trees of desirable species and the open character of these stands together with the slow growth rate of resulting reproduction, renders it extremely doubtful if satisfactory regeneration can be obtained within a reasonable length of time without considerable cultural treatment. Several economical measures are suggested as a means of creating conditions more favorable for germination and survival of tree reproduction.

10. The final stage represents the condition in which a large percentage of the grazed woodlands are to be found. Under natural conditions the tight sod cover will persist for many years, effectively preventing the material establishment of any tree species. Satisfactory regeneration of desirable species by natural means is impossible and planting is not recommended. Usually such areas will have a higher value if converted to permanent pasture.

A second study, DenUyl, Diller and Day (14) examined

in detail the natural succession which had taken place over a five year period in woodlands of the transition and open park stages and determined and appraised in each stage the factors principally responsible for the success or failure of natural reproduction.

In the oak-hickory type they found that while 80 to 95 per cent of the seed trees are type species only 5 or 6 per cent of the seedlings are type species. White ash, elm and black cherry seedlings comprised 70 per cent of the seedlings even though they constitute less than 1 per cent of the overhead stand.

The beech-maple and wet upland types show a much larger percent of type species in the reproduction but in the open park stages the distribution is often very poor.

The environmental conditions found to be most important in establishment, survival and growth of tree reproduction were:

1. Soil moisture
2. Leaf litter
3. Light influences
4. Wind movement
5. Ground cover

Of these soil moisture was found to be most important limiting factor. Soil moisture in the upper nine inches of soil woodlands during drought period drops

below the minimum point at which seedlings can survive. These critical soil moisture conditions are brought about by the high transpiration rate of the overhead stand and of the sod cover, the removal of leaf litter, higher light <sup>intensities</sup> ~~interstices~~, and greater wind movement.

They also made considerable progress in establishing the length of time required to bring grazed woodlands back to a productive condition.

In a study on the economics of the problem (13) they conducted a stock feeding experiment. Steers were turned loose in three different plots in which the grazing ~~interstices~~ were two, four and six acra per animal unit. The experiment was conducted for three years with a six months grazing season. In each instance the animals were unable to maintain their weights, carrying capacities of the woodlots was further reduced through elimination of the better forage plants, and the timber producing capacity was gradually destroyed through elimination of tree reproduction.

Another study on comparative values of grazed and ungrazed woodlots was conducted by Damback (9,10) in Northeastern Ohio. He found that there was a marked difference in production of maple sap in two adjoining woodlots one of which was protected from grazing. The difference amounted to about \$10.00 per acre even considering the forage value of the grazed woodlot. The



apparent reasons for better sap production on the ungrazed woodlot were the better moisture conditions and the fact that the soil wasn't frozen to the extent that it was on the grazed woodlot.

Other findings of this ten year ecological study were:

1. The grazed woodlot lost 0.3 trees per year while the ungrazed woodlot gained 4.2 trees per year.
2. It took 3 years to establish seedlings after stock was excluded and 6 years for herbs and shrubs.
3. At the end of 10 years seedlings averaged 50,000 per acre on the ungrazed woodlot.
4. Leaf litter and snow were evenly distributed and stable in the ungrazed condition.
5. Animal life was much more abundant.

A study conducted in the South-west (23) indicates that the value of a continuous timber supply is about three times the value of the forage that can be obtained in the forests, forage at expense of ponderosa pine reproduction which is difficult to get in the first place.

Other studies concluding that grazing is detrimental to forest reproduction have been conducted in New Mexico (22), Wisconsin (27) and Missouri(19). The New Mexico

study was conducted in the spruce barrens. Loveridge concluded that some sheep grazing could be permitted if held off until the grass was developed.

The Wisconsin bulletin is one of general recommendations written in terms that the farmer understands and has value if for that reason alone.

The Missouri study admitted the detrimental effect of grazing but because of local custom and economic pressure on those whose livelihood depended on grazing in the Ozarks very little was likely to be accomplished until the sociological problem of what to do with this submarginal occupation was solved. In the meantime recommendations are made to improve the pasture. These recommendations amounted to the death warrant for any forest so treated.

The problem of <sup>stopping</sup> grazing in the woods is a big one and it isn't simple. Most people who have given it any thought agree that it is detrimental to continued production of forest products. Even many of the land owners who graze their woods know this but when the farmer compares a lush looking woodlot to a burned up pasture he is going to turn his stock into the woodlot (14). While it is true that economic factors have lead to the wide spread practice of woodland grazing, the most serious factor in decadence of farm woodlots has been the lack of a definite management plan applied to the other parts

of the farm.

In answer to this problem in the realm of farm planning, the Soil Conservation Service with the Soil Conservation Districts has made great strides. In their plans they recommend, if possible, a fence between the pasture and the woodlot but no fence between the woodlot and cropped fields. If this recommendation is carried out it very effectively prevents grazing in woodlots. The rest of the plan tries to take care of the rest of the farm so it will carry the stock needed by the farmer.

In the West and South the problem is materially different. There the forests are open range. In the West the Forest Service knows it is bad practice to graze the forest but it can't arbitrarily stop issuing permits because of the hardship it would create among those who need the range for their cattle. The Forest Service is trying to reduce the number of head gradually to the carrying capacity but the pressure is great.

In the Southern Appalachian region (17) the amount of grazing in the forest is decreasing because of the demand for better cattle than can be produced on forest browse. The increase of fence laws may have some effect on this reduction, however.

Other reproduction studies have been of a purely mensurational nature. One of the most popular is the stocked quadrat method (8,18) of determining the com-

pletness of the reproduction stand. This method has lead to a great deal of discussion on what is the proper size of quadrat but it is often determined from yield tables. One tree per square is taken to indicate full stocking and in some studies no more than eleven seedlings per quadrat are recorded. The disadvantage is that it doesn't take into account seedling mortality due to various causes but it has the great advantage of showing distribution which a mere statement of the number of seedlings per acre fails to do. In Cowlin's sampling of Douglas fir reproduction his results checked very closely with a silviculturists' estimation<sup>e</sup> of the degree of stocking.

Dr. S.A. Graham of the University of Michigan uses a method similar to this in some of his ecological studies. His quadrats are only a milacre in size which is much smaller than that used in the West. His number of seedlings per quadrat never exceeds nine. This is an adaptation required to meet space requirements on IBM cards on which his data <sup>are</sup> ~~is~~ recorded.

There have been a good many environmental studies. Boerker (4) showed soil moisture to be the most important limiting factor in germination. Several studies (21) have dealt with the effect of root competition as determined in trenching experiments.

Korstian (20) did considerable work on the factors

controlling the germination and early survival in oaks. His work seems conclusive and is borne out by the work of others.

Most of the work has been done with what happens under forest conditions. This is hardly the case in this study. When sod covers an area forest conditions no longer exist. Several (1) mention the fact that oaks germinate better if covered by the litter but if there is no litter to start with a very important limiting factor enters the situation. Several studies mentioned a forester in India who stated that the oaks germinate well in grass cover. Conditions must be radically different there for all evidence from work in this country in diametrically opposed to this.

The conditions given by DenUy, Diller and Day mentioned earlier seem most important under conditions existing in Stinchfield Woods.

A study that may be of future interest to men working on this problem is now (1949) in the process of establishment at the George Reserve. Dr. S. A. Graham is setting up ten exclosures against the deer on this area. Careful data has been taken on the size, amount and condition of all vegetation to be included in the exclosures and on the adjacent check plots.

The over population of deer on this fenced area has lead to a condition similar to that caused by the

grazing of domestic cattle with the exception that deer  
are even less selective in their browsing.

## DESCRIPTION OF THE EXPERIMENTAL SITUATION

### LOCATION:

The experimental plots are located in the lots 2, 3, 9 and 10 of the University of Michigan property known as Stinchfield Woods. The woods is located in sections 11, 12, and 14; R. 4E., T. 1. S., M.P.M. of Dexter Township, Washtenaw County, Michigan. This land is approximately six miles northwest of Dexter, Michigan on the Portage Lake Road.

### COMPOSITION OF THE STAND:

The original Stinchfield Woods was approximately 320 acres, acquired in 1924. About one third of this was in hardwood forest which consisted mostly of oaks and hickories with a few ash, cherry and elm. There has been some under planting of sugar maple but there is none in the overstory. The stand had been grazed for many years so there is a considerable gap between the 10-12 inch size classes and the reproduction. Stocking is below normal and many of the trees are of sprout origin indicating that it had been cut heavily at one time. It was probably what Day and DenUyl would have classed as the transition stage with some of it in the open park stage of deterioration. The sod cover at that time was fairly complete.

### TOPOGRAPHY:

The terrain for the most part is gently rolling

on each side of the main moraine which runs East and West but there are some very steep slopes leading into some glacial potholes on the area. The elevation is about 1000 feet above sea level.

SOIL:

The soil is Bellefontaine sandy loam of glacial origin. The glacial till varies from 125 to 200 feet deep in this area. It is described in the "Soil Survey of Washtenaw County" (Veach et al) as follows:

The plow soil of Bellefontaine sandy loam, to a depth of 6 or 7 inches is grayish-brown friable, or loosely coherent, sandy loam or fine sandy loam. Beneath this and extending to a depth ranging from 3 to 4 feet the soil material is somewhat red, is sandy, and in places coarse gravelly or coherent and compact. The substratum or parent drift material, is a confused mass of sand, sandy clay, gravel and boulders. The virgin soil contains only a small quantity of organic material, but enough to give it a light brown color. The organic matter is not so durable in the heavier soils. The surface soils are loose and pervious, but the subsurface soil contains sufficient clay and the structure is sufficiently tight to check the free downward movement of water. The soil is only moderately retentive, but holds enough moisture to carry crops



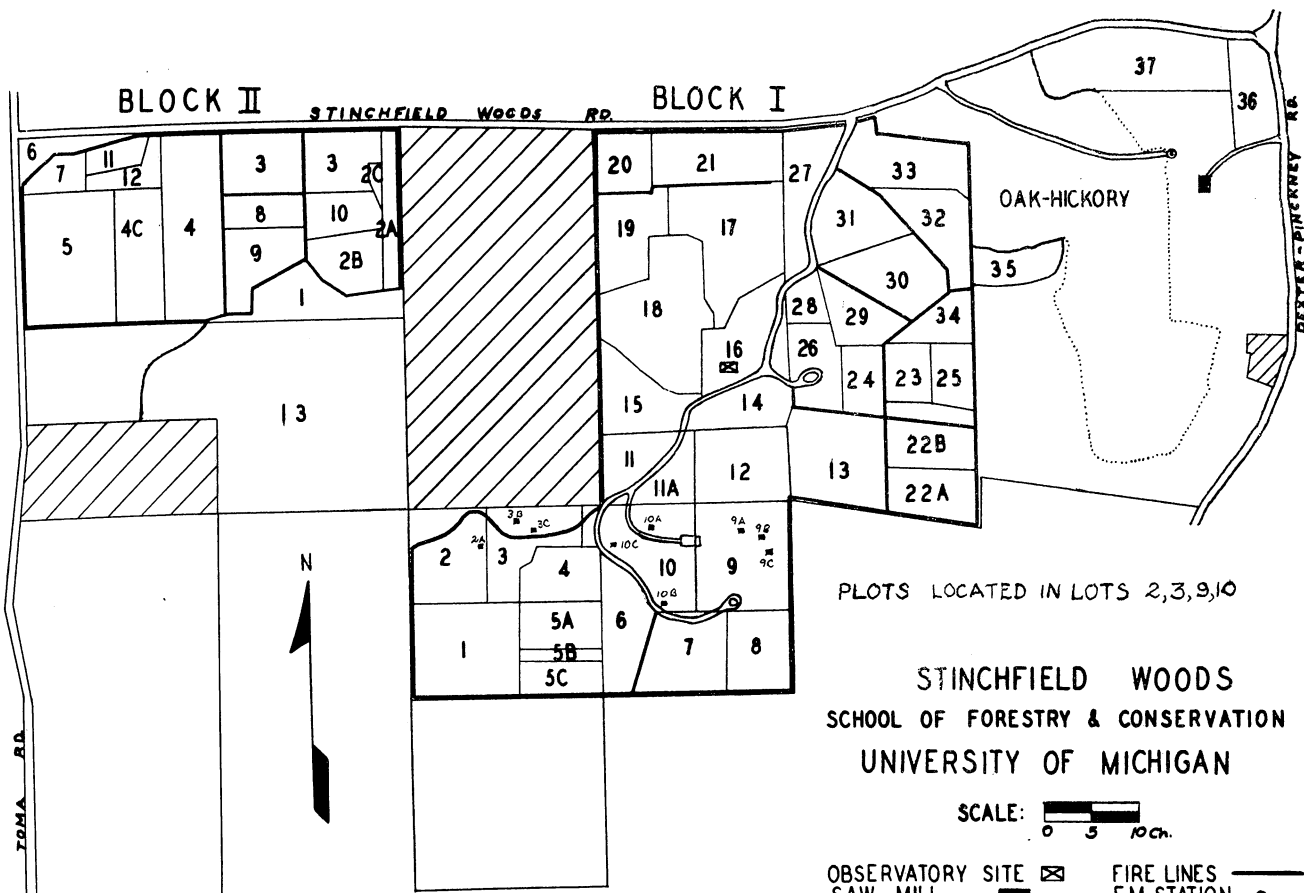
through ordinary periods of dry weather. The surface soil generally exhibits medium acidity, but below a depth of 2 or 3 feet the reaction is less acid and the substratum commonly contains enough lime to react with acid or to give an alkaline reaction.

Bellefontaine sandy loam occurs in fairly large areas which are characterized by knobs, hills and gentle to steep slopes. The gradient of most of the slopes is from 5 to 10 feet to one hundred. Very little of the land is so excessively steep as to be nonarable, but slopes exceeding 10 percent are susceptible to gullying and destructive erosion when placed under cultivation. In practically all the areas shown on the map, local variations occur in the soil of cultivated land according to topographic position. The normal soil occurs on more level areas. On steep slopes there is considerable erosion, resulting in a loss of the surface soil and exposure of the underlying clay, or even of the limy sand and gravel. At the faces of slopes or in depressions the soil is either deepened and enriched or covered with coarse unproductive wash. Because of their small size, areas consisting of spots of deep sand or of clay, and depressions containing peat or muck, are not included in the

mapping. The variation in surface relief and the association with muck swamps and lakes are unfavorable for the successful extensive use of the land for general farming, although in small fields high yields may be obtained. It is estimated that about 15 percent of the land is now in permanent pasture or has been abandoned for cultivated crops. About 10 to 12 percent remains in original forest or in second growth woodlots.

WEATHER CONDITIONS:

The climate has cool winters and mild summers with a mean average temperature of 47.4 degrees Fahrenheit and an average frost free season from May 2nd to October 13th. The mean annual precipitation is 31.37 inches, including snow. There is a tendency toward short droughts during the summer. The prevailing winds are westerly.



PLOTS LOCATED IN LOTS 2,3,9,10

STINCHFIELD WOODS  
SCHOOL OF FORESTRY & CONSERVATION  
UNIVERSITY OF MICHIGAN

SCALE: 0 5 10 ch.

OBSERVATORY SITE FIRE LINES   
SAW MILL F.M. STATION   
ALIEN LAND

**BLOCK I**

LOT	SPECIES	DATE	ACRES	LOT	SPECIES	DATE	ACRES	LOT	SPECIES	DATE	ACRES	LOT	SPECIES	DATE	ACRES
1	CORSICAN PINE	'29	9.9	13	OAK-HICKORY		9.5	32	NORWAY PINE	'37	5.6	9	CORSICAN PINE	'36	4.7
2	OAK-HICKORY		6.9	14	OAK-HICKORY		5.7	33	WHITE PINE	'37	6.9	10	NORWAY PINE	'39	3.0
3	OAK-HICKORY		7.2	15	OAK-HICKORY		6.1	34	JACK PINE	'40	3.4		" SPRUCE	'39	
4	NORWAY SPRUCE	'28	4.9	16	OAK-HICKORY		7.7	35	WHITE PINE	'46		11	AUSTRIAN PINE	'37	2.2
	CORSICAN PINE	'34		17	SCOTCH PINE	'29	11.2		NORWAY SPRUCE	'47			W.YELLOW	"	'35
5A	WHITE PINE	'26	4.5	18	SCOTCH PINE	'27	12.0	36	W.YELLOW PINE	'47		12	WHITE PINE	'47	2.0
	NORWAY PINE	'31		19	SCOTCH PINE	'25	5.2		NORWAY SPRUCE	'47			NORWAY SPRUCE	'47	
5B	W.YELLOW PINE	'28	1.5	20	NORWAY PINE	'25	3.5	37	WHITE PINE	'48		13	OAK-HICKORY		
5C	AUSTRIAN PINE	'28	2.9	21	NORWAY PINE	'29	9.2		W.YELLOW	"	'48				
6	OAK-HICKORY		6.3	22A	SCOTCH PINE	'29	4.0		JACK	"	'48				
	WHITE PINE	'38		22B	SCOTCH PINE	'30	5.9		NORWAY SPRUCE	'48					
	NORWAY	"	'39												
	AUSTRIAN	"	'42												
7	OAK-HICKORY		6.6												
	WHITE PINE	'39													
8	OAK-HICKORY		5.9												
	CORSICAN PINE	'38													
	W.YELLOW	"	'38												
	NORWAY	"	'42												
	WHITE	"	'38												
9	OAK-HICKORY		12.0												
	NORWAY PINE	'40													
	WHITE	"	'40												
10	OAK-HICKORY		9.0												
11	OAK-HICKORY		3.1												
11A	OAK-HICKORY		2.9												
12	OAK-HICKORY		7.5												
	WHITE	"	'38												
	WHITE	"	'38												

**BLOCK II**

### DESCRIPTION OF THE PLOTS

Plot 2A is located at the top of the glacial moraine at the edge of Lot #2. The crown cover is about 90 percent complete. The overtopping species are all oak, one a small white oak is included in the plot itself. There is a 6.5 inch stump on the plot which has sprouted and these sprouts should exert considerable influence in the future. These sprouts are now about 6 or 7 years old. The sod cover is complete with a patchy leaf litter. The A horizon is 3 to 4 inches deep or the depth of the sod influence. Below this is a yellowish clay with some sand and a little gravel in mixture.

Plot 3A is at the bottom of a glacial pothole. It is a short distance northwest of a large ash tree which furnished the seed for the stocking of this plot. There are four large oaks with canopies covering about 75 percent of the plot. One tree was cut at the edge, ? releasing the seedling somewhat. The leaf litter is 3 to 4 inches deep so there is no longer a sod cover on the plot itself. The A horizon is about 4 inches deep and is underlain by a grey clay loam B horizon. Site conditions are good judging from the form and height of the overhead stand. No measurements were made but the trees appear to be taller here than at the higher elevations. Water stands in a slightly lower part of

pot hole at least in the spring of the year indicating that the water table is close to the surface and that moisture conditions should be good even in dry periods. The possibility of frost is the only deterring factor present.

Plot 3B is also located in Lot #3. It was established in 1937 to study ash reproduction. It is at the top of the moraine extending east and west through this part of the woods. Seven trees were cut around the plot so there is now no direct overhead cover. The seed source is mainly from the same large ash mentioned for plot 3A. There is a fairly good leaf litter of 1 to 3 inches so there is no sod remaining. The A horizon is about 4 inches deep or to the depth of the influence of the former sod cover. The B horizon is a dense yellow clay extending at least three feet. Clay that close to the surface in an area that is supposed to be sandy loam might indicate that considerable erosion took place when it was in a cutover and heavily grazed condition.

Plot 9A is on the northern slope of a glacial pot-hole in Lot #9. It has a patchy grass cover but no leaf litter because of the steepness of the grade. Crown cover over the plot is only about 10 percent but the maples on the plot are getting to a size where they will influence vegetation under them by the density of

their shade. These sugar maples were planted. A large elm nearby accounts for the elm seedlings on the plot. The A horizon doesn't exceed 3 inches and blends into a very gravelly B horizon. It appears to have a very low water retaining capacity which would make establishment of seedlings in a dry year very doubtful.

Plot 9B is located near the bottom of the glacial pothole mentioned above. It has a slight slope with a western aspect. Tree canopies cover only about 10 percent of the plot but vines have become established thickly over the plot causing considerable mortality of the seedlings. The leaf litter is one to two inches deep with very little grass on the plot itself. The A horizon is about 3 inches deep and the B horizon has a good loamy texture. The oaks here, while not dense, have good form and much better than average height growth which indicates that it is a good site. Frost danger is probably high however.

Plot 9C has a steep northern aspect on the southern slope of the same pothole. It is immediately surrounded by five large oaks which overtop about 90 percent of the plot. There is very little leaf litter and what there is, is held in place by the seedlings on the plot. The A horizon is very shallow and underlain by a gravelly sand B horizon. Erosion at one time was probably severe. The coppice origin of most of the

trees indicates that this steep slope was clear cut at one time, leaving very little protection against washing. In cases like this it is indeed fortunate that oaks sprout as well as they do because some cover comes back on the slope with no cultural treatment. Conditions for growth appear to be poor, because of poor moisture conditions in the shallow soil.

Plot 10A is located on the flat top of the glacial moraine. There are a small hickory and oak on the plot itself and three other trees close by that give almost complete crown cover over the plot. There is a patchy sod that is slowly being eliminated by the shade and the leaf litter of one to two inches deep. The soil here has a good loamy texture which should make it a fairly good site.

Plot 10B has much the same situation as 10A. The plot is level with about the same type of soil. There have been several trees cut around the edge of the plot but the crown canopy is still 80 percent complete. The leaf litter is one to three inches deep so there is very little grass. There are several fair sized black cherries near by that furnish much of the source of the abundant cherry reproduction on the plot.

Plot 10C is the other of the two plots established in 1937 to study ash reproduction. There is an 18 inch ash about a chain to the west which is the source of the

reproduction. The plot is on the same moraine as the other two plots in Lot #10. The overhead crown cover is approximately 30 percent. The ground has a slight slope with a northern aspect. The leaf litter is about 2 inches deep and there is no grass on the plot. The A horizon is about 5 inches deep over a B horizon with a yellow clay content which bears a close resemblance to that found on the other ash plot set up in 1937, 3B. On both of these plots the dominant ash has made very good growth so moisture conditions must be fairly good on this site considering the higher moisture requirements of this tree.



#### PROCEDURE IN OBTAINING PLOT DATA

Before taking any data the plot corners were checked. If any were missing the corner was reestablished as closely as possible. To facilitate taking data the plots were divided into four strips running from north to south. This was done by stretching strings between stakes set on the northern and southern boundaries. This procedure insured a more accurate count by reducing the width of area to be examined.

Each tree was examined to determine if it had been tagged. This often required considerable digging in the litter as the tags were often buried under several inches of leaves. Several times, quite by accident, trees were found to have two numbers. Apparently after the first number was attached the seedling was bent down to the ground and finally sent down roots above the point where the tag had been attached. The next observer naturally assumed that it was a new seedling and attached his own number to it. If the tree had no number a new one was attached.

Each tree was listed as to species and the height taken to the nearest tenth of an inch.

EXPLANATION OF TABLES I TO IX

Each table represents one plot.

The first column lists the tag numbers on the individual seedlings. In a few cases there is a second number in parenthesis. This indicates that the tree had lost its number and a new one was attached. The old number is in parenthesis.

The remaining columns are double. The first number indicates the present height of the tree. The second number records the growth made since the last measurement, three years ago.

Each table has two sections; the first section records the trees on the plot when last measured and the second section records those trees which have become established since that time.

If there is no growth given for a tree it indicates that no record of the tree was made when the plot was last measured.

The letter "R" following a number indicates severe rabbit damage to the seedling causing a negative growth. Other causes of negative growth are not listed but in the main it is caused by the dying back of the seedling.

TABLE I

PLOT 2A  
Height in inches

Number	Cherry	Hickory	Sassafrass	Oak
1			61.7	-4.3
5	67.3	8.5		
18			12.0	4.8
20			14.3	4.7
22			158.0	13.2
23		16.2	6.6	
2784		16.0	4.0	
2789		9.0	-0.6 R	
2796		12.7	4.3	
2798		11.0	-10.6	
2803		17.5	7.9	
2832				13.8 1.8
2833	38.3	3.5		
2834	25.2	7.2		
2835	21.8	3.8		
2836	18.7	1.9		
2839	18.8			
2840				8.7 2.7
Totals	6	6	4	2

NEW REPRODUCTION

Number	Cherry	Sassafrass	Ash
701	5.0		
702	16.3		
703	4.5		
704			12.8
705		6.0	
706	6.7		
707		12.7	
Totals	4	2	1

TABLE II

## PLOT 3A

*Height in inches*

Number	Ash		Cherry	
6			105.5	1.5
7	28.4	-5.1		
10	25.0	1.0		
15	47.0	1.0		
16	91.5	-1.5		
17	162.0			
20	44.0			
23			39.5	-16.5
25	96.5	7.5		
26	79.2	-0.8		
27	73.5	-1.5		
28	45.6	5.6		
30	114.5	4.5		
31	124.0	2.0		
32	174.0	7.0		
34	87.2	5.2		
35	55.2	-1.8		
37	56.0	-3.0		
38	121.0	11.0		
39	41.0	1.0		
40	183.0	38.0		
41	62.4	-3.6		
42	31.2	-1.8		
43	42.0	-0.5		
44	108.5	5.5		
45	225.0	54.0		
46	43.4	0.9		
48	48.5	-1.5		
51	90.5	-2.5		
55	38.5	4.5		
57	28.9	-5.1		
59	204.0	46.0		
61	35.5	-1.0		
64	60.0			
65	34.5	-19.5		
67	84.0	6.0		
68	198.0	56.0		
69	92.4	-9.6		
70	154.0	19.0		
71	158.0	32.0		
72	39.6	-25.4		
73	33.0	-11.0		
74	19.5	-4.5		
75	108.0	18.0		

TABLE II

PLOT 3A (Cont'd.)

Height in inches

Number	Ash	Cherry
77		177.0 7.0
78	122.0	6.0
79	145.4	32.4
80	73.0	8.0
81	49.0	-6.0
82	40.8	-1.2
83	7.5	-20.5 R
84	40.2	0.2
85	33.4	5.4
87	34.5	-5.5
91	86.4	5.4
92	27.6	-6.9
93	195.0	38.0
94	109.0	11.0
95	35.5	4.5
96	102.0	-2.0
97	150.0	13.0
98	35.5	-1.5
101	60.0	-13.0
104	85.0	
105	43.0	14.0
107	196.0	51.0
109	36.0	
110	44.5	-5.5
111	154.0	24.0
112	34.0	-24.0
114	131.0	21.0
115	68.4	-0.6
117	147.0	27.0
119	14.5	-5.5
122	40.5	-1.5
123	41.5	0.5
124	190.0	20.0
125	110.0	8.0
126	71.0	9.5
127	87.5	16.5
133	26.2	4.2
274	13.5	0.5
277	17.5	2.0
280	30.2	10.2
283	48.0	-1.0
287	16.8	-0.2
289	14.5	-1.5
290	17.0	2.0

TABLE II

## PLOT 3A (Cont'd.)

Height in inches

Number	Ash	Cherry
300	10.8	-0.2
307	8.4	-0.6
309	16.5	4.5
310	17.2	1.2
317	12.0	-1.0
321	16.7	0.2
329	15.8	-1.2
336	25.2	5.2
1770	12.5	-3.5
1772	23.7	-3.3
1773	27.6	-0.4
1774	25.2	-0.8
1782	17.0	1.0
1785	84.0	2.0
1789	34.5	4.5
1792	19.5	
2812	18.0	0.5
2819	36.0	1.0
2820	18.5	1.5
2827	13.5	
2829	11.5	-0.5
2832	13.2	1.2
2831	24.5	
2844	39.5	12.0
2845	20.4	1.9
2848	26.4	0.9
2855	13.0	2.0
2857	6.0	
2858	46.0	
2861	28.5	1.0
2863	14.5	-0.5
2865	21.2	
2867	26.5	
2872	10.5	-11.5
2874	30.0	
2880	33.8	-2.4
2883	26.4	0.4
2886	26.4	-4.6
2891	26.5	-0.5
2893	84.0	5.0
2896	69.6	4.6
2897	32.5	2.5
2898	60.0	0.5
2899	41.5	

TABLE II

PLOT 3A (Cont'd.)

Height in inches

Number	Ash	Cherry
2900	54.3	-0.7
2901	24.0	1.0
2902	74.2	-0.3
2904	38.0	4.0
2907	7.4	-6.6
2909	31.2	2.7

NEW REPRODUCTION

Number	Ash	Cherry
715		17.2
716	24.0	
717	19.5	
718	12.5	
719	21.6	
720	9.6	
721	10.8	

Total 141. 4

TABLE III

PLOT 3B

Height in inches

Number	Ash	Cherry	Sassafrass	Hickory
25			234.0	102.0
26	48.0	7.2		
28	51.0	9.0		
29	50.0			
30	87.0	46.2		
31	28.0	-32.0		
32	30.0	10.8		
34	115.0	53.8		
35	162.0	52.8		
36	34.0	6.4		
38			204.0	92.4
39	70.0	24.4		
41	17.0	2.6		
43	37.0			
45	99.0	34.0		
47	37.0	11.8		
50	58.0	23.2		
51	99.0	52.2		
1446	51.5			
1467	73.0	31.0		
1471	47.0			
1476				36.0
1479	47.0	11.0		
2760	34.0	5.0		
2770	24.0	17.0		
3109	246.0	104.5		
3119	83.0	17.0		
3120	44.5	8.5		
3122	97.0			
3123	108.0	36.0		
3125	56.0	14.0		
3127	168.0	78.0		
3131	132.0	56.5		
3136	18.0	3.5		
3138	32.5	12.5		
3140	67.0	16.5		
3144	159.0	82.0		
3145	97.0	40.5		
3150			168.0	69.5
3151	121.0	73.0		
3152	54.0	37.0		
3155	115.0	75.0		
3156	180.0	79.0		
3159	107.0	43.5		



TABLE III

PLOT 3B (Cont'd.)

Number	Ash	Cherry	Sassafrass	Hickory
3160	32.0	3.0		
3166	75.0	29.5		
3172	120.0	57.5		
3173	168.0	93.5		
3176	171.0	96.5		
3179	52.0	6.5		
3182	30.0	1.0		
3184	62.0	33.0		
3188	35.0	2.5		
3189	47.0	6.0		
3190	116.0	62.0		
3193	51.0			
3195	78.0	33.5		
3201	156.0	80.5		
3204	88.0	37.5		
3211	144.0	84.0		
3212	22.0	3.0		
3214	82.0			
3215	119.0	52.0		
3218	90.0	42.0		
3220	49.0	3.5		
3221	131.0	10.0		
3223	217.0	96.0		
3225	98.0	27.0		
3232	63.0	14.0		
3234	174.0	56.5		
3235	186.0	68.5		
3237	198.0	86.5		
3239	186.0	66.0		
3240	36.0			
3242	86.0	16.5		
3243	96.0	24.0		
3246	220.0	88.0		
3247	218.0	76.5		
3249	91.0	33.5		
3250	213.0	93.0		
3252	30.0	5.0		
3254	44.0	13.0		
3257	24.0	5.0		
3259	77.0	42.0		
3260	73.0			
3261	90.0	44.5		
3263	73.0	31.0		
3266	138.0	96.0		

TABLE III

PLOT 3B (Cont'd.)

Number	Ash	Cherry	Sassafrass	Hickory
3267	83.0	43.5		
3269	53.0	17.0		
3275	41.0	14.5		
3276	121.0	52.5		
3282	170.0	87.0		
3286	46.0	21.0		
3287	162.0	75.5		
3290	48.0	12.0		
3292	47.0	16.0		
3293	42.0	11.0		
3295	168.0	72.0		
3296	108.0	38.5		
3297	162.0	92.5		
3299	251.0	119.0		
3304			37.5	-7.0
3305	40.5	3.5		
3307	192.0	84.0		
3308	228.0	120.0		
3309	46.0	10.0		

NEW PRODUCTION

Number	Ash			
708	43.0			
709	23.0			
710	37.0			
711	32.0			
712	90.0			
713	34.0			
714	144.0			
Total	109	2	<u>2</u>	1

TABLE IV

## PLOT 9A

Height in inches

Number	Cherry	Hickory	Maple	Elm	Oak
103		9.0	1.0		
107					50.0 9.0
113		82.0			
167					204.0 50.0
168	19.5	-38.5			
169	16.0	-6.0			
173		127.0	19.0		
178	74.0	9.0			
179					62.8 11.8
184				156.0	15.0
186		79.6	34.6		
192			221.0	68.0	
195			242.0	35.0	
197					93.6 9.6
198					98.5 2.5
199			268.0	57.0	
200				144.0	13.0
201		66.0	-3.0		
202					102.0
203					58.0 8.0
205		96.0	20.0		
207				107.0	-52.0
209					138.0 51.5
213				122.0	14.0
214					103.0 7.0
217		57.5	8.5		
218					44.5 1.5
219					31.0 -4.0
220					3.0 R
228					50.4 2.4
231				70.5	5.5
239	126.0	49.0			
281					94.5
1122	31.0	-2.0			
2601		85.5	8.5		
2602	24.0	-1.0			
2936				48.5	
Total	6	8	3	6	14

TABLE IV

PLOT 9A (Cont'd.)

NEW REPRODUCTION

Number	Hickory	Maple	Oak
776		34.5	
779		282.0	
781	23.0		
780			8.0 R
782			19.2

TABLE V

PLOT 9B

*Height in inches*

Number	Cherry	Oak
60		10.8 4.8
61	23.5 -6.5	
67	37.0 14.0	
70	13.5 -9.5	
77	15.5 5.5	
82	38.5	
16	12.0	
84	11.0 -14.0	
100	19.5 -11.5	
116	30.0	
118		12.0 2.0
122	7.2 -3.8	
123	14.5 0.5	
126	14.4 -0.6	
128		8.5 1.0
131		8.4 -0.6 R
147	11.5 -6.5	
149	9.0 -4.0	
150		9.5 1.5
154	98.0 26.0	
155	17.0 -15.0	
157	18.0 -3.0	
158	26.2	
163	19.5 -12.5	
166	13.3	
169	31.0 12.0	
174	20.5 3.5	
175	4.0 -12.0	
187	31.2 2.2	
188	6.0 -23.0	
198	12.0 -1.0	
199	23.5 9.5	
200	18.0 9.0	
202	24.2 21.2	
205	15.8 4.8	
210	11.5 -16.5	
212	17.5 9.5	
218	27.2 18.2	
224	180.0 61.5	
229	31.0 16.0	
230	74.0 12.0	
232	34.5 -5.5	
233	53.5 -18.5	
237	32.4	
239	79.0 -4.0	

TABLE V

PLOT 9B (Cont'd.)

Number	Cherry	Maple	Hickory
240	110.5	27.5	
244	75.0	9.0	
248	41.5	-7.5	
255	21.5	-4.5	
257	76.5	8.5	
258	144.0	1.0	
260	48.5	12.5	
263	96.0	3.0	
264	114.0	18.0	
265	41.5	-36.5	
267	15.5	-28.5	
272	14.4	-27.6	
277	86.5	4.5	
283	124.0	22.0	
284	44.0	-22.0	
285	101.0	7.0	
287	77.0		
288	43.0	-24.0	
289	67.5	14.5	
290	27.6	-13.4	
291	60.0	-12.0	
292	18.5	-16.5	
294	13.2		
299		174.0	42.0
302	12.0	-28.0	
307	19.5		
309	49.5	-7.5	
312	39.5	4.5	
314	78.0	11.0	
315	37.0	4.0	
317	20.4	-11.4	
320	6.0	-2.0	
322			68.4 5.4
326	9.6	-19.4	
327	66.0	11.0	
329	51.6	-11.4	
333	162.0	58.0	
335	13.0	-7.0	
339	84.0	4.0	
341	24.0	-5.0	
342	27.8		
345	24.0	-23.0	
347	25.0	-27.0	
348	24.0	-18.0	

TABLE V

PLOT 9B (Cont'd.)

Number	Cherry	Sassafrass	Oak	Hickory
351	53.5	-2.5		
353	81.0			
354	62.5	0.5		
356	89.0	11.0		
360	23.5	2.5		
364	36.0	-15.0		
365	150.0	138.3		
368	24.0	-36.0		
376	35.0	6.0		
377	38.4	7.4		
1176	12.0			
1178	24.5	-11.5		
1186	70.0	5.0		
1187	42.0	-1.0		
1406	12.5	0.5		
1410	23.0	-3.0		
2938	60.0	17.0		
2943	12.0	-7.0		
2946				118.0 22.0
2953			49.5 3.5	
2958			23.0 1.0	
2974 ✓	14.5	-13.5		
2982		112.0 36.0		
2996	82.0	10.0		
2997			17.0 4.0	
3004	19.2	5.2		
3006	15.5			
3016	23.0	2.0		
2625	80.0	13.0		
2981	13.4			
1131	22.0			

Total 108

1

8

2

NEW REPRODUCTION

Number	Cherry	Maple	Elm
784	69.6		
783		118.0	
785	19.5		
787		2	78.0

1

TABLE VI

PLOT 9C  
Height in inches

Number	Maple	Oak	Cherry	Hickory
9			38.0 13.0	
63		24.0 7.0		
76		16.5		
85		17.5		
87		3.0 -4.0		
88		13.3 4.3		
94		21.6 6.6		
114		37.3 17.3		
226		24.0 10.0		
230		15.5 3.5		
234		19.6 5.6		
259		14.4 2.4		
334		23.6 9.6		
373				32.3 11.3
382			16.5 4.5	
388	97.0 20.0			
389	60.0 18.0			
394	141.0 39.0			
397	129.0 42.0			
402			24.0 2.0	
405			50.4 2.4	
406	98.5 33.5			
408				13.3 1.3
1183	14.2 0.2			
1419			15.2	
1420			18.0 -3.0	
1422				21.6 5.6
1423		29.0		
1424			40.5 10.5	
1427		23.0 10.0		
1428		13.5 2.5		
2652		13.0 1.0		
2655		16.0 8.0		
2658		35.5 6.5		
2659	84.0 37.0			
2660		27.5 5.5		
2894		29.0 8.0		
2971			68.4 32.4	
2991		7.0 1.0		
2666			18.0	
3023		18.0 5.0		
3024		21.5 7.5		
3029			43.0 25.0	
3030		19.3		



TABLE VI

PLOT 9C (Cont'd.)

Number	Maple	Oak	Cherry	Hickory
3032				13.5 -0.5
3034			29.5 -0.5	
3036			31.0 6.0	
3037	146.0 51.0			
3038		14.5 0.5		
3042	67.5 35.5			
3044		31.3 5.3		
3045			56.4 16.4	

NEW REPRODUCTION

Number	Maple	Oak	Cherry	Hickory
378				9.5
788		6.2		
789				7.2
790	9.6			
791		13.0		
792	13.4			
793				9.6
794			14.5	
795			44.0	
796				20.4
797		8.5		
798				8.0
799	13.4			
800	45.5			
Total	13	29	15	9

TABLE VII

PLOT 10A  
Height in inches

Number	Cherry	Sassafras	Ash	Oak	Maple
6	48.5				
129	44.4	17.4			
131	34.4	5.4			
132	23.2	3.2			
134	58.5	0.5			
135			65.5	29.5	
136	50.4	-1.6			
138	19.5	6.5			
147	102.0	22.0			
148	45.0	-2.0			
149	11.0	2.0			
150	51.6	19.6			
151	60.0	28.0			
152	57.6	6.6			
154	25.2	-4.8			
155	43.2	-0.8			
156	30.0	-4.0			
158	47.6	7.6			
159	24.5	-8.5			
162	19.2	-13.8			
164	82.0	24.0			
166	107.0	-17.0			
161	33.6				
240	19.6				
242	35.5				
246	6.0				
250	19.2				
251	24.0				
253		26.4			
254		24.0			
258				19.2	
257					9.6
260		8.4			
263	54.0				
266	26.4				
267			21.6		
276	22.6				
273			29.5		
278	22.5				
285	17.5				
299		9.5			
1484					
1486	23.5	4.5			
1489					18.0
1491					19.2 -6.2

TABLE VII

PLOT 10A

NEW REPRODUCTION

Number	Cherry	Sassafrass	Ash	Maple	
771		13.2			
772			8.4		
774	10.0				
775				8.4	
777	14.4 Elm				
778	90.0				
Total	<del>37</del> 35	5	4	4	1 oak

TABLE VIII

PLOT 10B  
Height in inches

Number	Cherry	Oak	Sassafrass	Hickory
117	9.6	5.1		
165	17.5	3.5		
171	15.6	9.6		
179	15.6	3.6		
181	52.8	20.5		
185	5.5	0.5		
189	21.6	6.6		
195	19.0	5.0		
218	36.0			
220	23.5	5.5		
226	8.0	3.0		
227	31.0	4.0		
235	8.4	1.4		
236	16.5	2.5		
245	19.5	10.5		
249	6.2	1.2		
258	5.5	1.5		
264	4.8	0.8		
266	7.5	0.5		
274	6.0	1.0		
275	14.4	3.4		
286	7.2	0.2		
290	13.4	3.4		
312	20.4	6.4		
327	11.0	5.0		
332	21.6	3.6		
347	9.6	0.4		
353	6.2	2.2		
367	48.8	11.1		
374	46.6	41.6		
376	12.2	-1.8		
378	13.5	1.5		
384	9.6	-2.4		
425	17.5	-0.5		
432	23.5	-2.5		
433	17.5			
434	30.0			
435	19.2			
439	24.6	6.6		
440	26.3	9.3		
446	27.0	6.0		
447	18.0	-2.0		
451	20.5			
453	55.5			
455	17.5	3.5		

TABLE VIII

PLOT 10B (Cont'd.)

Number	Cherry	Oak	Sassafrass	Hickory
456	21.0	4.0		
462	38.4	14.4		
463	38.5	13.5		
465	15.6	-10.4		
467	31.2	5.2		
472	43.0			
474	25.5			
475	48.0	11.0		
478	42.5	0.5		
482	31.4	9.4		
484	25.0	1.0		
487	29.0	2.0		
496	39.6	10.6		
501	50.5	10.5		
509	63.6	22.6		
511	75.5	26.5		
515	36.4	1.4		
518	18.4	-5.6		
521	37.0	3.0		
522	47.5	25.5		
523	49.6	5.6		
530	19.4	2.6		
532	10.5			
533	37.5	5.5		
538	20.4	-5.6		
539	11.0	-18.0		
545	76.8	28.8		
549	31.2	3.2		
552	15.6	-0.4		
553	30.0			
557	15.6	-12.4		
558	26.4			
559	9.6			
561	18.0	-8.0		
564	33.6	9.6		
565	18.5			
572	51.6			
573	16.8	2.8		
577	61.0	12.0		
579	33.2	-2.8		
580	31.0			
582	14.4			
583	23.5	-3.5		
586	44.6	13.6		
589	20.4	-2.6		

TABLE VIII

PLOT 10B (Cont'd.)

Number	Cherry	Oak	Sassafrass	Hickory
593	50.4	-7.6		
594	116.4	17.4		
601	23.5	5.5		
602	12.0	-2.0		
605	20.4	2.4		
610	33.6	3.6		
615	30.5	1.5		
616	27.3	6.3		
620	43.5	-5.5		
621	35.0	15.0		
623	37.6	-12.4		
624	48.5	6.5		
625	25.2	5.2		
629	15.0			
631	25.0			
632	55.2	12.2		
633	59.0	32.0		
635	44.4	18.4		
636				10.8
637	60.5			
1496	8.0			
1498	7.2			
1746	11.5	-7.5		
1747	18.5	5.5		
1750	29.2	0.2		
1751	15.0	-3.0		
1752	7.2			
1760	18.5			
1767	12.0			
1785	7.0			
2456	6.0			
2463	8.4			
2465	18.0	24.0		
2467	14.4			
2472	19.2			
2476	13.2	0.2		
2477	26.2	2.2		
2482	10.8			
2483	43.2			
2493	16.8			
2495	36.0			
2496	22.8	4.8		
2497	8.2	-3.8		
2683	26.5			
2684		14.4		

TABLE VIII

PLOT 10B (Cont'd.)

Number	Cherry	Oak	Sassafrass	Hickory
2693	27.6			
2697	9.5			
2698	6.0			
2701	13.5	3.5		
2705	36.0	8.0		
3076	12.0			
3077	31.2	13.2		
3078			66.0	
3082	13.2	-0.8		
3086	13.2			
3094	34.4	8.4		
3095	31.0	7.0		
3096			92.6	-3.4
3101			110.4	7.4
3105	24.0			

TABLE VIII

PLOT 10B

NEW REPRODUCTION

Number	Cherry	Oak	Sassafrass
722	4.8		
723	8.4		
724	15.6		
725	8.4		
726	4.8		
727	31.5		
728	33.5		
729		4.5	
730	8.4		
731	9.6		
732	13.0		
733	9.0		
734	19.2		
735	5.5		
736	17.5		
737	9.6		
738	5.2		
739	6.0		
740	4.8		
741	4.0		
742			8.2
743		8.4	
744	19.5		
745	13.0		
746		9.6	
747	27.4		
748	13.3		
749	25.2		
750	23.5		
751	9.6		
752	46.8		
753	18.0		
754	15.6		
755	8.4		
756	10.8		
757	11.0		
758	6.5		
759	9.6		
760	6.2		
761	7.2		
762	53.4		
763	26.4		
764	11.0		
765			11.0

Total 184

4

5

1 hickory



TABLE IX

PLOT 10C  
Height in inches

Number	Ash	Cherry
1	104.0	
3	218.0	58.0
4	110.0	-8.0
6	144.0	
7	234.0	48.0
10	24.0	
17	269.0	41.0
2733		12.0
2734		14.5
2743		12.5
3311		15.6
768(3312)	216.0	32.0
3313	83.0	9.8
3315	96.0	
3316	109.0	19.0
3317	78.6	9.0
3318	93.0	17.4
3320	54.5	-0.7
3321	73.0	-0.2
3322	234.0	66.0
3324	56.5	3.7
3325	170.4	44.4
3326	128.0	14.0
3329	78.5	6.5
3330	8.5	-9.1
3336	190.0	34.0
3338	198.0	57.2
3339	60.5	0.5
3341	78.5	7.3
766(3342)	108.0	36.0
3343	156.0	12.0
3345	46.5	4.5
3346	59.2	11.2
3348	54.0	-9.5
3349	96.0	2.5
3350	192.0	24.5
3351	125.0	5.0
3352	204.0	36.0
3355	320.0	73.0
3356	156.0	12.0
3357	126.0	20.5
3360	69.0	-0.5
770(3361)	281.0	85.5
3362	83.0	7.5
3363	91.5	10.0

TABLE IX

PLOT 10C (Cont'd.)

Number	Ash	Cherry
3364	75.6	20.6
3365	300.0	70.5
3366		25.5 -5.5
3367	27.5	1.0
3368	204.0	18.0
3370	51.5	1.0
3371	288.0	72.0
3372	66.0	2.5
3373	48.0	
3374	47.5	2.5
3375	281.0	
3377	86.5	-3.5
3378	234.0	49.5
3379	104.0	-4.0
3380	264.0	68.5
3381	95.0	1.5
3383	161.0	-1.0
3384	90.0	2.5
3385	30.5	1.7
3386	121.0	7.0
3387	79.5	-2.0
3388	286.0	
3389		13.5 -8.1
3390	42.0	
3391	77.0	2.5
3392	45.5	2.5
3393	91.0	7.5
3396		258.0 26.5
3398	277.0	85.0
3400	158.0	2.0
3401	275.0	59.0
3403	218.0	56.0
3404	36.0	-1.5
3405	324.0	84.0
3406	24.0	
3407	174.0	
3410	42.0	-54.0
3411	170.0	4.5
3414	111.0	-6.5
3415	168.0	
3417	89.5	4.5
3418	48.0	
3419	210.0	
3421	31.0	-9.0
3423	30.5	-5.5

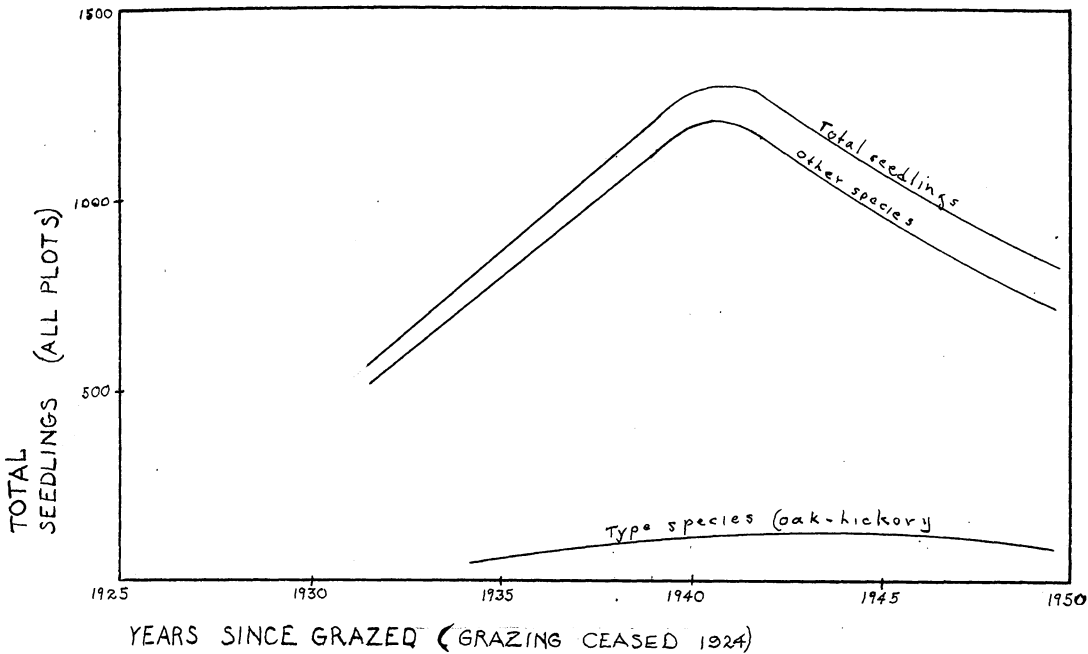
TABLE IX

PLOT 10C

NEW REPRODUCTION

Number	Cherry
767	9.6
769	14.4
773	18.0
Total 83 ash	10

FIGURE 1



This graph represents the total number of seedlings of all species on all nine plots.

As can be seen from the graph, the total number of seedlings is decreasing, showing the results of suppression by the dominant trees in the reproduction.

An interesting trend can be observed in the fact that although the number of seedlings is decreasing, the percentage of oaks and hickories in the total reproduction is increasing.

The graph's reliability is decreased by the fact that the plots were not selected at random and the results are prejudiced by the ash plots to some extent.

## SUMMARY AND CONCLUSIONS

After twenty five years with no grazing, fire or other catastrophe, definite trends should be established. It appears from examination of data that the hardwood areas at Stinchfield Woods are undergoing a type conversion.

White ash, cherry and red maple are much more numerous in the reproduction than are the oak and hickory. This is not only true on the plots themselves but on the area in general. These trees, except the cherry, seem to be doing well and enough will probably survive to stock the area. This probably isn't a permanent conversion but one that will last at least one tree generation. When these trees grow up and close the canopy reestablishing true forest conditions, the oaks will have a chance if there are seed trees left on the area. Oaks are trees that need certain conditions to become established. These apparently are, 1. a good leaf litter of several inches for protection during germinations, 2. they need a good seed year to enable them to have a surplus over those acorns used by the rodents and insects and, 3. they need a wet season following the good seed year. When these three conditions are satisfied there should be a sharp up turn in the number of oak seedlings. The second two are mostly a matter of chance but will happen eventually. The first condition is

being steadily improved by the lighter seeded trees taking over. For this reason alone the cherry is of great value to the woods. It may seed in and grow for a few years only to die back and sprout anew but the dense thickets of the small trees and sprouts slow the wind through the woods and cause an accumulation of leaves which is the start of a good humus layer. This leaf layer will be there to protect the acorns when they fall and will keep them moist for germination and the establishment of seedlings.

The oaks and hickories are not tolerant trees but they should be able to compete with most of reproduction now in the woods. This leads me to believe that oak and hickory reproduction will come back eventually if a seed source is maintained. The areas where hard maple has been planted will eventually contain more maple than the present type species because of its much greater tolerance. This, of course is only true if the site will support maple. Indications are that hard maple will do fairly well. In spots where it has been placed in openings it has made very good growth. The maple on plot 9A was planted and is making very good growth although the site appears to be very poor and gravelly. With the dense shade these four trees will throw on the plot the chance of other reproduction coming in and surviving to tree sizes is very poor. The fact that

these maples have been growing at a rate of better than twenty inches a year for the last 10 years puts them far ahead of anything else on the plot.

On the plots 3A, 3B and 10C the ash is making very good growth which accounts for the reduction in the numbers of trees on these plots. The reduction will continue because the dominants are starting to close their canopies. These plots have very little new reproduction and practically all the growth is on the dominants. The smaller seedlings have made practically no growth in the last three years and the next few years should see their removal from the stand.

The lack of growth for the oaks and hickories is rather strange. Most of the seedlings are practically standing still. There is only one oak seedling that is doing well and that is on plot 9A. The reasons for it's better growth appear to be the facts that there is very little shade from the overhead, and very little competition from grass. The site, if anything, appears much poorer than that of the other plots. When examining the other oak seedlings in the light of this information it seems to be the grass competition that is holding them back because in most cases the overhead cover isn't too dense. Root competition with the larger trees may be a factor however. The apparent answer is that oak is a slow growing tree except under the most favor-

able circumstances.

This slow growth gives the white ash an excellent opportunity. The fact that the ash is slowly spreading out from the seed trees is born out by the new ash on plot 2A several hundred yards from the nearest seed tree and that one is not in the direction of the prevailing winds. This lone ash can not be over three years old and yet it has equalled the growth of oaks and hickories that have been there at least ten years.

Indications are that the new stand will have a heavy representation of ash, some cherry, maple, elm, oak and hickory. To maintain the oaks and hickories they will have to be favored in any cutting done on the area.



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PART B

AN EXPERIMENT  
ON

THE EFFECT OF ROOT PRUNING,  
AND

TWO DIFFERENT PLANTING METHODS  
ON

CONIFEROUS STOCK

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## INTRODUCTION

This report is a continuation of an experiment started in 1937. It concerns a planting made in Lot 8 of Stinchfield Woods and was first written up by C. F. Coffman Jr. in that year. Additions have since been made by William E. Towell in 1938, Robert L. Metzger in 1939, Robert E. Leeson in 1940, G. David Bauch in 1942 and Ivor N. Jenkins in 1946. All of these papers may be found in the Forestry School Library.

The object of the experiment as stated by Coffman (A) was to have a periodic check to determine:

1. The effect of various degrees of root pruning on survival and growth of both roots and tops of 2-0 Western yellow pine stock.
2. The same for 2-2 Austrian pine stock.
3. The effect of slit planting as opposed to center hole planting on survival and growth.

Towell (B) enlarged this to "include a study of subsequent development of the root systems as affected by planting coniferous stock with roots in one vertical plane, as is done in slit or dibble planting.

This last part has been omitted in this study as some trees are to be reserved for future observations; because, as Rudolf (11) has observed, the full effects of planting methods may not be evident for some time.

The results of this experiment, whether of a positive

or negative nature, will add to the expanding body of knowledge which is necessary for the successful establishment and management of forests where trees should, but do not now grow.

## REVIEW OF LITERATURE

Root pruning is done in the nursery or in the field to improve the planting stock's root system or to facilitate planting. Root pruning is supposed to increase the growth of new laterals (16) and fine root hairs (8) to aid in the absorption of water and nutrients.

The seedling's roots are often pruned or trimmed when they are transplanted to remove injured or diseased roots (2) or to reduce the necessity of digging deeper trenches to receive the longer roots (13).

Often, due to lack of man power, or to reduce expenses, the seedlings are root pruned in their beds to reduce the necessity of transplanting (7) and to force the plant to develop a more compact root system. To accomplish this a long sharp blade is passed beneath the seed bed at the required depth, (7, 5). This blade, usually mounted on a tractor, is drawn the length of the seed bed and cuts all the roots at the same depth. The bed is then sprinkled to settle the seedlings back in place (14).

It is noted that a sharp blade is usually specified. How this is maintained while dragging it through the soil is not explained. While I have never witnessed this operation, Young (17) states that he has observed that the roots are not sheared off, merely bent over and skinned. This, according to Baxter (3), greatly increases



the danger of fungus infection because it takes much longer to heal a skinned place or a ragged torn cut than it does a sharp cut. As far as I can determine no mention of this effect has been made in the various reports on this method of root pruning. It stands to reason, however, that the cut can not be cleanly made as the reports imply. Pulling an instrument that can not be very sharp against a fibrous root in a yielding medium such as loose nursery soil would seem to be like trying to cut a piece of string on a sand pile with the back of a knife.

This discussion has little to do with root pruning as it was done in this experiment. The pruning in the nursery as discussed is a long way from that done in the field or after the seedlings have been removed from the nursery. In the nursery they get the best of care after their root systems have been reduced. They can be watered at will to keep the soil moist during the period of adjustment so that loss is not important. Consequently anything done in the nursery to produce the right kind of seedlings required for the field conditions in the locality is important to the success of the planting operation.

There have been a number of root pruning studies made. Stoeckler, in a letter to Jenkins (F) stated that at the Lake States Forest Experiment Station the

roots of spruce and pine transplants were always cut back to a length of six to eight inches with a machete or knife. This was done to speed up planting and to keep roots from being curled in the hole.

The effects of careless planting has often been given as a reason for mortality in planted trees. In order to examine this assumption, Cheyney (4) conducted an interesting experiment. He took white pine, white cedar and black spruce, rolled their roots into compact balls and planted them at a spacing of six inches in rows two feet apart. He set the controls in rows alternating with the test plants. These controls were planted with their roots well spread.

After four years growth, all plants were lifted and the roots inspected. He found that while the effect of the balling was still visible, subsequent root development had about equalled that of the control plants.

The average height of the controls was slightly higher, being 41.5 inches as compared with 38.7 inches for the test plants.

Young, from his examinations of plantings along the Hurnon River, reported to a class in Seeding and Planting at the University of Michigan, that seedlings of ~~Scotch~~<sup>white</sup> pine had survived with roots doubled back to the extent that the tips<sup>almost</sup> protruded from the ground. These roots ~~turned back~~<sup>grew downward</sup> into the soil and survived

with a horizontal 'S' curve in them. This is a striking example of the geotropic tendency of the roots of trees.

German experiments (9) with oblique planting, where the slit is made with a mattock slanting away from the worker, have given no apparent differences or height growth. The examination was made after 18 years growth.

A root pruning experiment in Delaware (1) on one year old peach and apple trees gave a definite advantage to the unpruned trees. Two pruning methods were used, one method was to remove broken roots, thin them out and shorten to six inches. The other was to remove all the roots except the main stem. The controls showed the best height and diameter growth, the severest pruning the least.

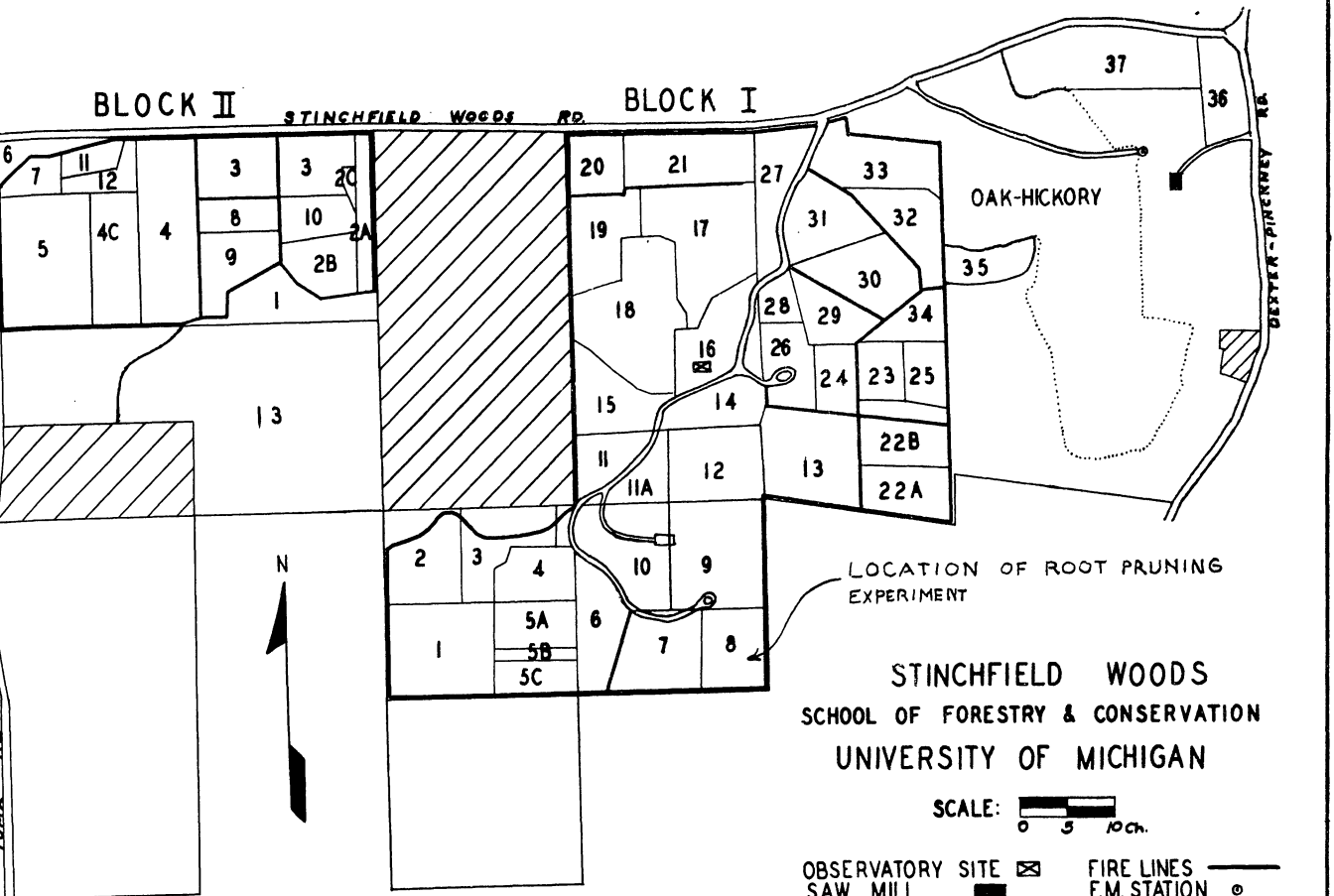
Smith (12), in an experiment on root pruning of hardwoods found that effects varied with the tree species. He took hardy catalpa, green ash, hackberry, black locust and american elm and pruned the roots. He used four degrees of severity, ten inches, eight inches, six inches and four inches with controls unpruned. The experiment showed no effect on the growth of hardy catalpa, green ash or black locust. With the hackberry and elm, however, growth decreased as the severity of the pruning increased.

There has been little conclusive work done on the

relative merits and long time effects of the different methods of field planting. The center hole method is usually held to be best because the roots are spread naturally and allowed to develop in all directions. The slit method compresses the roots in one plane and Turner (15) believes that any distortion of the roots during planting is retained indefinitely.

Koodsma's (6) experiments with planting methods indicated that the slit method decreases survival and growth. Only thirty percent showed good root distribution after slit planting. He discounts records of successful plantations established by the slit method until they reach maturity which is the ultimate test of any method.

Much of the planting done in this country has been done by the slit method. This is because it is cheap and fast. Initial cost is very important so the trees are planted and the planter hopes for the best.

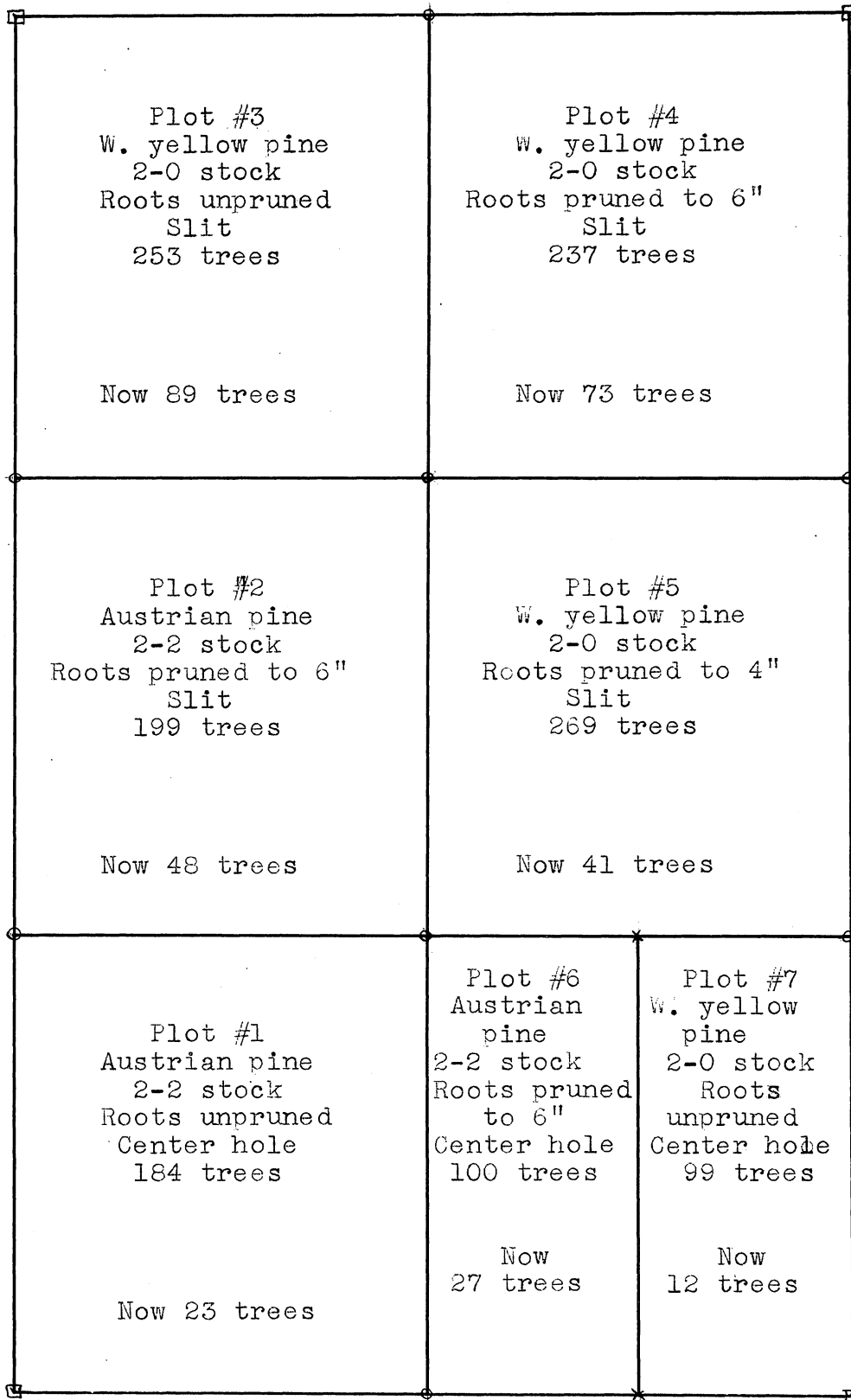


STINCHFIELD WOODS  
SCHOOL OF FORESTRY & CONSERVATION  
UNIVERSITY OF MICHIGAN

SCALE: 0 5 10 ch.

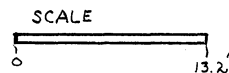
OBSERVATORY SITE FIRE LINES   
SAW MILL F.M. STATION   
ALIEN LAND

BLOCK I				BLOCK I				BLOCK I				BLOCK II			
LOT	SPECIES	DATE	ACRES	LOT	SPECIES	DATE	ACRES	LOT	SPECIES	DATE	ACRES	LOT	SPECIES	DATE	ACRES
1	CORSICAN PINE	'29	9.9	13	OAK-HICKORY		9.5	32	NORWAY PINE	'37	5.6	9	CORSICAN PINE	'36	4.7
2	OAK-HICKORY		6.9	14	OAK-HICKORY		5.7	33	WHITE PINE	'37	6.9	10	NORWAY PINE	'39	3.0
3	OAK-HICKORY		7.2	15	OAK-HICKORY		6.1	34	JACK PINE	'40	3.4		SPRUCE	'39	
4	NORWAY SPRUCE	'28	4.9	16	OAK-HICKORY		7.7	35	WHITE PINE	'46		11	AUSTRIAN PINE	'37	2.2
5	CORSICAN PINE	'34		17	SCOTCH PINE	'29	11.2		NORWAY SPRUCE	'47			W.YELLOW	"	'35
6	WHITE PINE	'26	4.5	18	SCOTCH PINE	'27	12.0	36	W.YELLOW PINE	'47			WHITE	"	'32
7	NORWAY PINE	'31		19	SCOTCH PINE	'25	5.2		NORWAY SPRUCE	'47		12	WHITE PINE	'47	2.0
8	W.YELLOW PINE	'28	1.5	20	NORWAY PINE	'25	3.5						NORWAY SPRUCE	'47	
9	AUSTRIAN PINE	'28	2.9	21	NORWAY PINE	'29	9.2	37	WHITE PINE	'48		13	OAK-HICKORY		
10	OAK-HICKORY		6.3	22A	SCOTCH PINE	'29	4.0		W.YELLOW	"	'48				
11	WHITE PINE	'38		22B	SCOTCH PINE	'30	5.9		JACK	"	'48				
12	NORWAY	"	'39						NORWAY SPRUCE	'48					
13	AUSTRIAN	"	'42												
14	OAK-HICKORY		6.6												
15	WHITE PINE	'39													
16	OAK-HICKORY		5.9												
17	CORSICAN PINE	'38													
18	W.YELLOW	"	'38												
19	NORWAY	"	'42												
20	WHITE	"	'38												
21	OAK-HICKORY		12.0												
22	NORWAY PINE	'40													
23	OAK-HICKORY		9.0												
24	OAK-HICKORY		3.1												
25	OAK-HICKORY		2.9												
26	OAK-HICKORY		7.5												
27	WHITE	"	'38												
28	WHITE	"	'38												
29	WHITE	"	'38												
30	WHITE	"	'38												
31	WHITE	"	'38												
32	WHITE	"	'38												
33	WHITE	"	'38												
34	WHITE	"	'38												
35	WHITE	"	'38												
36	WHITE	"	'38												
37	WHITE	"	'38												



EXPERIMENTAL PLANTING PLOT  
Part of Lot #8, Stinchfield Woods

- 3x3 stakes
- 2x2 stakes
- x Small pile of stones



## DESCRIPTION OF THE EXPERIMENTAL PLOT

### Location

The experiment on root pruning is located on Lot #8 of Stinchfield Woods. This woods covers parts of Sections 11, 12 and 14, R.4 E., T.1 S., M.P.M of Dexter Township, Washtenaw County, Michigan. This location is about six miles northwest of Dexter, Michigan.

The experimental plot is 66 feet by 108 feet, the <sup>long axis</sup> ~~length~~ running north and south. The four corners are marked by three by three oak stakes originally painted black and white. The two southern corner stakes have since fallen over and need replacement. This main plot is divided into seven sub-plots, the corners of which are marked by two by two unpainted stakes with the exception of the boundary between Plots 6 and 7, which is marked by small piles of stones at each end. The most positive distinction, however, is the difference in tree species on each side of the line.

### Soil

The soil is Bellefontaine sandy loam of glacial origin. The underlying till ranges from 125 to 200 feet deep and varies from clay loam to sand and gravel. A complete description taken from Veatch's soil survey can be found in Part A of this report under Soils.

Topography

The elevation of the plot is about 1000 feet above sea level. The northwestern corner slopes steeply, giving the plot a southeastern aspect. The remainder of the plot has a gently sloping to nearly level terrain toward the southeastern corner. (A)

Cover

Originally the area was oak-hickory forest. The land around the plot is now planted in various species of pine. The plot itself was clear cut in the winter of 1936-37 (A). There is now a cover of grass and some blackberries where the trees haven't shaded them out.

Weather

The weather at the time of planting was mild and it was an unusually wet year.



### DESCRIPTION OF EXPERIMENTAL SITUATION (A)

The plot was divided as shown in Map III. The entire plot was furrowed in preparation for the planting, the furrows being spaced between two and three feet apart. Several stumps interfered with an exact, regular spacing.

The number of plants in each subdivision should have been equal but the discrepancies that occurred were probably due to psychological reasons. The fact that the Austrian pine was larger caused the planting crew to place the trees a little farther apart than the proposed two feet. There were three men doing the work and each did about an equal amount to equalize any differences due to a personal factor.

The pruning was done with a large knife or cleaver. As many trees as could be grasped in one hand were pruned with a single stroke of the instrument. The seedlings were then planted.

The speed with which trees can be planted with a planting bar was the reason for the use of this method. It would have been difficult to plant 2-2 stock by this method without pruning because of the size of the root system so only pruned trees were slit planted.

The stock used on May 8th had been heeled in during the week of May 1st to May 8th.

Samples of the stock (B) used in each subdivision

were air dried and roots and tops were weighed separately to determine top-root ratios. This ratio is determined by dividing the total weight of the tops by the weight of the roots.

## DATA FROM EXAMINATIONS

### First Examination

Towell (B) made the first examination in 1938. He examined each dead seedling to determine the cause of death from which he was able to get the percentages of mortality due to planting, pruning or other causes.

He found that death due to planting had the highest percentages in the slit method with unpruned stock. Second highest was the unpruned stock using the hole method of planting. Both of these were yellow pine stock, which being smaller, should have been easier to plant and consequently planted better than the larger Austrian pine.

The height growth was measured to the nearest one quarter inch and the heights were averaged for each plot. With the yellow pine it was found that both the center hole unpruned plot and the slit method pruned to four inches plot practically stood still. While the seedlings on unpruned and slit planted did best. The unpruned, center hole plot for Austrian pine did best while there was no significant difference between the two pruned plots.

When the trees were lifted it was found that the roots of the slit planted trees were all in one plane.

### Second Examination

This examination was made by Metzger (C) in 1939. He found that the unpruned Austrian pine led all plots in growth, closely followed by the other center hole plot that had been pruned to six inches.

The biggest change in the Western yellow pine was the unpruned, center hole plot that went from last place in 1938 to the tallest average in 1939. The seedlings pruned to four inches made the next best growth but were still behind all the other plots because of slower growth the first year. They had apparently recovered from the shock of the severe pruning.

### Third Examination

The third examination was done by Leeson (D) in 1940. In the Austrian pine plots the center hole, unpruned plot was still ahead but it made practically the same growth as the center hole pruned plot. The pruned, slit planted plot was a little behind but the difference was hardly significant.

The western yellow pine in the center hole, unpruned plot continued to improve over the other plots. Plot IV, pruned to six inches, slit planted, made almost enough growth to overtake Plot III, planted the same way but unpruned. The trees pruned to four inches still lagged behind.

### Fourth Examination

Bauch (E) made the fourth examination in 1942. As shown by Table X, the unpruned, center hole Austrian pine was still in the lead and grew 1.4 inches more than the pruned plot planted by the same method which was close behind. The slit planted plot grew the least and so was still behind both center hole plots.

The yellow pine showed considerable changes in position. The center hole, unpruned plot was still in the lead but surprisingly enough, Plot V, pruned to four inches, grew as much as the unpruned Plot VII and passed both Plots III and IV to take second place. Plot IV, pruned to six inches continued to grow a little more than the unpruned Plot III and passed it.

#### Fifth Examination

The examination was made by Jenkins (F) in 1946. The Austrian pine was growing well. The unpruned center hole plot still led, but the pruned, slit planted plot had grown practically the same amount, about 68 inches, to pass the pruned, center hole plot. Jenkins explained this by saying that the slit planted plot (Plot II) was a better site than the center hole plot (Plot VI). This seems hard to explain when the map of the plot is studied. Plot VI is sandwiched between Plot I which has the best Austrian pine growth, and Plot VII, which has the best Western yellow pine growth. All three plots were planted by the center hole method, the only difference being

that Plot VI was pruned to six inches.

As mentioned above Plot VII continued to have the best growth for the yellow pine. Plot V, which was pruned to four inches was still second but Plot III which was unpruned made the most growth for the yellow pine passing Plot IV which was pruned to six inches. This can not be explained by the death of smaller trees because Plot III lost fewer than did the other two slit planted Western yellow pine plots.

In examining the roots of the trees, Jenkins found that all the slit planted trees had a strong tendency to grow in one plane except for one tree which had developed in all directions after its initial start in one plane. It might be interesting to note that this tree was about two feet taller than the other slit planted trees that he dug. One tree isn't enough for a definite conclusion but it might suggest that after a tree gets larger the roots may develop more naturally.

#### Sixth Examination

The sixth examination was made in the spring of 1949 by the author.

As can be seen from Table X, the unpruned, center hole Austrian pine leads all others and is increasing at a more rapid rate. Plot II, slit planted and pruned to six inches increased its lead over the other center hole plot. For the Austrian pine the maximum and

minimum for each plot were: Plot I, 20.0 feet and 12.4 feet; Plot II, 18.5 feet and 9.9 feet; Plot VI, 17.5 feet and 8.0 feet. In each case the smallest trees were gradually being suppressed. There was no mortality for the Austrian pine during the last three years.

With the yellow pine as the Austrian pine, the center hole, unpruned plot still led. It will be noted, however, that Plot III, also unpruned but slit planted, grew 42 inches to take second place. Plot VII maintained its lead, not so much by growth but by the loss of four small trees. This was a mortality of 25 percent. Of these trees, one died of suppression, one was choked by vines, one in the open died from undetermined causes, while the fourth disappeared. In contrast, Plot III had no mortality but has a number of small suppressed trees that are holding down the average and which will probably die soon, as the crowns close.

All the slit planted plots are fairly close in height growth. The spacing is irregular due to removal of trees for study, planting failures, rodent girdling and the like. In some parts of each plot the trees are very closely spaced and the death of a few suppressed individuals in any plot could raise the average height in that plot over that of its neighbor. For example, if only nine trees which are definitely suppressed and lacking in vigor were removed from Plot IV, the average

would be less than one half an inch less than Plot V which has about 40 percent fewer trees on it.

The maximum and minimum for the Western yellow pine plots are: Plot III, 15.7 feet and 3.3 feet; Plot IV, 13.0 feet and 3.4 feet; Plot V, 12.8 feet and 4.1 feet; Plot VII, 13.9 feet and 3.1 feet.

Mortality has been low since the last examination. No trees died on Plots I, II, III and VI. Four trees died of suppression on Plot IV. On Plot V two definitely died of suppression and a third disappeared. The four dead on Plot VII have been discussed.

Totals for each plot are now: Plot I - 23 trees, Plot II - 48 trees, Plot III - 89 trees, Plot IV - 73 trees, Plot V - 41 trees, Plot VI - 27 trees, Plot VII - 12 trees.



TABLE X

## AVERAGE HEIGHTS (INCHES)

PLOT	I	II	III	IV	V	VI	VII
SPECIES	AUST. PINE	AUST. PINE	W.YEL. PINE	W.YEL. PINE	W.YEL. PINE	AUST. PINE	W.YEL. PINE
STOCK AGE	2-2	2-2	2-0	2-0	2-0	2-2	2-0
METHOD OF PLANTING	CENTER HOLE	SLIT	SLIT	SLIT	SLIT	CENTER HOLE	CENTER HOLE
TREATMENT	UN- PRUNED	PRUNED TO 6"	UN- PRUNED	PRUNED TO 6"	PRUNED TO 4"	PRUNED TO 6"	UN- PRUNED
1937	5.	5.	2.	2.	2.	5.	2.
1938	9.31	8.40	3.39	3.17	2.60	8.44	2.36
1939	18.84	15.26	6.12	5.76	5.59	17.16	7.22
1940	26.9	21.5	9.6	9.5	8.4	25.0	11.4
1942	51.3	41.6	22.19	23.44	26.75	48.0	29.82
1946	119.57	109.46	60.59	58.91	62.11	107.38	80.86
1949	190.8	174.2	102.6	91.4	96.8	162.8	109.2

## CONCLUSION

I believe that one thing this study brings out is that it is not so much the method of planting that counts but the care that is exercised in using that method. When Towell (B) examined for causes of mortality he found that planting had caused 2 percent mortality in unpruned, hole planted yellow pine and 2.3 percent mortality in the unpruned slit planted yellow pine. With a difference like that it would hardly pay to use the more expensive, time consuming method if initial survival is the important reason for using it.

One thing this experiment is trying to establish is whether or not planting methods such as the slit method will retard subsequent growth. An examination of Table X quickly shows that the best average heights for both species was made on center hole plots. Further examination of two Austrian pine plots shows that the one that was slit planted has the best average growth being nearly a foot taller. Both plots were pruned to six inches before planting. With the yellow pine, Plot VII shows the greatest height and it was center hole planted. It is 6.6 inches higher than Plot III which was slit planted but in the last three years the slit planted plot grew 42 inches compared to 28.3 inches for the center hole planted plot. This trend has been in

evidence for the last seven years and if it continues the slit planted plot will soon be ahead. Both of these plots were unpruned.

Here we have evidence that is conflicting but apparently on this particular site, slit planting does not retard growth. In fact if present trends continue it would appear that slit planted trees will eventually make better growth than center hole planted trees. Some of the other investigators have used site as an explanation for differences. The quality of some plots has varied with the year and the investigator depending on how the trees happened to be doing. The trees made a few embarrassing shifts in the speed with which they grew. The quality of the ground should not vary a great deal in a plot of this size.

Wind firmness is another of the effects to be studied in the future. The roots held in one plane by slit planting is believed to make a tree less wind firm. However, from personal observations, the position of the tree seems more important. A tree on the edge of the forest is windfirm ordinarily, while those on the interior of the stand are less so. An example is a plantation planted near Negaunee, Michigan by the Cleveland Cliffs Iron and Coal Co.. This is an area of about 35 acres planted to Scotch pine, red pine and Norway spruce. It was furrowed and the trees were

presumably put in with spades at six by six spacing. This plantation is in an open position but has withstood winds from Lake Superior from 1903 to 1947. In the latter year they decided to thin the plantation. A contractor was hired to do the job and contrary to instructions, put his road in from the windward side. In a few days there was considerable windfall fanning out within the stand from this small opening. All of these trees were planted alike, yet those on the edge were windfirm, those on the interior were not. I would think that much the same condition would be true no matter how the trees were planted.

In a discussion of degrees of pruning, this experiment points out the fact that seedlings will take a terrific beating and survive if they have a good growing year when they are planted.

Table X shows that the unpruned trees have all made better growth than those pruned, regardless of the degree of pruning or the method of planting. Apparently the fact that the roots may be doubled up in the hole or slit is not as important as having all the roots there to give the plant the necessary absorbing surface. If this experiment is reliable, it is an argument against root pruning.

Root pruning is done to make planting easier, yet Towell (B) in his mortality determination ascribed 1.5

percent mortality due to planting on those trees pruned to four inches. These trees should have been the easiest to plant and so planted best, yet 1.5 percent was the highest mortality due to planting of any of the pruned trees.

Mortality was seen to be highest on the unpruned trees but in all cases mortality due to other causes was about twice that of mortality caused by planting. There would hardly seem to be a correlation between root treatment and susceptability to grub damage, mechanical injury or rodent damage so it must have been due to chance.

It must be remembered in all mortality determinations on this plot that the year of planting was exceptionally good for survival of seedlings. This fact undoubtedly obscures results that would have been more positive if the season had been near normal.

The effect of degrees of root pruning is also obscured by the good growing year. Once the trees pruned to four inches became established they did very well. They now rank with the other pruned yellow pines that were slit planted. In fact they are a few inches ahead of them but as pointed out earlier, this may be due to the greater number of suppressed trees on the other plots which are more densely populated.

One point that may be accidentally brought out is

that various treatments affect different species differently. There are two Scotch pine on the plot, one in Plot V and the other on Plot III. Presumably, these trees received the same treatment as the others in their respective plots. Plot III was unpruned, Plot V pruned to four inches, yet both of these Scotch pine are over 17 feet high and are within three inches of each other in spite of the drastically different treatment. This would seem to bear out Smith's observation that some trees are affected by pruning, others are not. They are, incidentally, at least five feet taller than any of the other trees on their plots.

In the light of the literature on the subject, it is evident that root pruning will continue as a forestry practice. If it is to be done, probably the best place to do it is in the nursery where conditions can be controlled to give the seedling a chance to recover. If, because of the pruning, the seedling develops a better root system, a great gain has been made toward insuring survival in the field.

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