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Selection Cuttings for the Small Forest Owner

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SELECTION CUTTINGS FOR THE SMALL FOREST OWNER

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A Note to Readers
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FOREWORD

THE purpose of this publication is to indicate to owners of small forests methods of harvesting wood and timber and developing future timber crops which are likely to prove more profitable than those followed in the past. Cutting practices here described have been applied for some years in the Eli Whitney Forest, New Haven, Conn., where forest areas in various stages of treatment can be seen.

In presenting the subject technical terms, so far as possible, have been avoided.

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SELECTION CUTTINGS FOR THE SMALL FOREST OWNER

INTRODUCTION

A LARGE part of the forest land in Connecticut is held in connection with farms or country homes. Such properties usually contain from a few to two or three hundred acres of woodland. While there are in the State solid blocks of forest, often covering several thousand acres, such extensive holdings are not considered in this publication. Large blocks of forest ultimately should go to the State to be incorporated within its forest system, or to the occasional landowner who desires a relatively large forest property.

The problem of the small forest landowner is here discussed. His wooded area is an essential part of the holding, either because it is interspersed among the arable fields or because it is needed to round out an otherwise irregular boundary or to give the desired setting for the homestead. In fact, unless he confines himself to house lots, the owner of rural property will find possession of forest land well-nigh unescapable. This situation is a distinct advantage of rural life, although it creates responsibility for intelligent use of forest areas. In the past, to the detriment of the owner's best interests, the forest has been too often totally neglected or improperly handled.

A variety of causes have contributed to this result. No one remedy for improving conditions can be found. Unquestionably there must be attained on the part of the forest landowner appreciation as to what his forest may mean to him, both as a tangible and as an intangible asset. In addition, he should have adequate knowledge of simple but correct methods of managing small forest properties.

The forest presents, to the alert owner, many possibilities capable of realization. It can supply timber and other wood products, it is rich in æsthetic and recreational values, it protects not only the land covered but indirectly adjacent areas, and it serves in the conservation and management of wild life.

Usually too narrow a view is taken with reference to the purpose of the

forest. To one man production of timber appears paramount, to another the æsthetic values obtainable from the forest are of primary importance, while in a third case protection against soil erosion may be the feature for which the forest is maintained. When fully understood it will be found that most purposes—timber production, development of æsthetic values, the protective function of the forest as well as other additional functions—can be fulfilled on the same area. It is essentially a question of management. In unsettled regions often the forest may be of chief use as a source of timber supply. Recreational uses and the protective functions of the forest are fully as, if not more, important than production of timber in densely populated regions like Connecticut. For the average case a method of management should be practiced that will satisfy at least these three purposes.

Connecticut forests have been badly abused and heavily cut. Oftentimes nothing is left except small trees and defective larger individuals. The regenerative power of the forest is excellent throughout Connecticut, and there are promising trees of the younger ages in nearly every forest area. The full recovery of the forest from its past abuse and heavily cut-over condition must be brought about principally through protection and the passage of time which allows the forest to grow.

Skillful cuttings can assist greatly in the process of restoration and often can increase the income while improving the value of the forest. Unfortunately past abuse and cuttings have reduced the forest to stands of such young trees that relatively little material is of the most profitable size to cut. This restricts the opportunities for skillful cuttings which are now open to the owner. In spite of this general situation many forest areas exist on which cuttings to improve conditions can be made at an immediate financial profit. Owners living near their forest areas are in a particularly good position to initiate intelligent cutting practices.

Clearcutting for timber products and particularly for cordwood should seldom be made. Only rarely are such operations justified. Fuelwood should be secured either by partial cuttings, made especially for this product, which remove the crowded and least promising trees, or by utilizing for fuelwood only the tops of trees cut for saw logs and other major products. When harvesting older timber the biggest trees should be cut for lumber and the poorest trees for fuel, leaving the thrifty and middle-aged trees to grow to more profitable sizes.

This policy consistently pursued furnishes the quickest, safest, and cheapest method of building up Connecticut's forest areas to the point where they will again not only produce valuable timber crops, but also function ade-

quately as protection forests and provide satisfactory resthetic and recreational values.

It is planned to elaborate this policy in some detail and to describe how under one set of conditions the process of improvement may be carried forward. While details are drawn from specific tracts in southern Connecticut, the practices advocated should find application over several million acres of forest land in the densely populated portions of the northeastern states.

A SOUND CUTTING POLICY

SETTLEMENT by the white man ,vas begun in southern Connecticut about three hundred years ago. Expansion of agriculture and industrial development have resulted in the complete disappearance of the original forest. Most of the forest area has been cut over several times. The method of cutting commonly used during the last 80 years has been clearcutting, which takes larger trees for lumber products and smaller trees for cordwood. Practically all the forest area in southern Connecticut has been cut over under this method within the last 80 years, most of it within the last 40 years and a great deal of the area within the last 20 years.

The forest as the o\vner finds it to-day is made up of young evenaged stands. An evenaged stand may be defined as one in which the individual trees are all of approximately the same age, giving an appearance of uniformity, particularly as regards the crowns of the trees. These form a compaiativelylevel-topped, thick canopy relatively monotonous in appearance. As the owner inspects these stands he soon realizes that few of them contain trees large enough for the more valuable forest products. The occasional stands 40 years or more in age which do contain larger trees are apt to have such trees as scattered individuals, while most of the trees in the stand are too small for anything but cordwood.

CLEARCUTTING NOT ADVISABLE

In considering the possibilities for immediate profit from his forest the owner may ask: "Why cannot I go ahead on the system used in the past and cut clear my older stands (40 years or more in age), putting the larger trees into lumber products and the rest of the stand into cordwood?"

There are several reasons why he cannot or should not continue the old style of clearcutting.

S.ELECTION CUTTINGS FOR THE SMALL FOREST OWNER

In the first place such a policy will produce a larger supply of cordwood than can be absorbed by the market. Industrial demands for cordwood are only a small fraction of what they were even 20 years ago when brick yards, brass mills, and lime kilns required large quantities of cordword in their manufacturing processes. The substitution of other fuels has permanently reduced the industrial demand for cordwood. So, likewise, has the increasing use of oil, coal, gas, and electricity for heating and cooking in both urban and rural communities caused a substantial and permanent reduction in the quantity of cordwood consumed by householders. It is impossible, as a practical method of operation over the whole territory, to continue the past policy of clearcutting stands which contain large volumes of cordwood and relatively small quantities of timber products.

In individual cases where the owner is able to find a market, the possibility exists of clearcutting such stands, but for any large number of owners it would be impossible.

Old stands (80 to 100 years or more in age) which can be manufactured chiefly into timber products with only a relatively small output of cordwood could still be handled on a clearcutting method so far as selling the product is concerned, though there may be other reasons for not clearcuttinge The clearcutting method if systematically followed as a cutting policy will require carrying forward all young and middle-aged stands until they are more than 80 years of age. For the average forest owner this may mean waiting 20 to 60 years before any lumber products can be cut. This would be unfortunate.

A second reason for not continuing the past system of clearcutting is that this method, while providing satisfactorily for production of timber, does not develop the best protection forest or the highest æsthetic and recreational values.

At this point, as a preliminary step toward establishing the truth of the last statement, it will be advisable to suggest a cutting policy which might be adopted instead of clearcutting. .

THE SELECTION METHOD

The policy suggested for the small forest owner may be termed the selection method of cutting. It involves the cutting of the largest trees in the stand and leaving most of the remainder for further growth. Removal of these larger trees creates small openings in the forest canopy. Tree seedlings start under these small openings. In 10 to 15 years another cutting is

made in the same stand, again taking out the larger trees. Every succeeding 10 to IS years a similar cutting is made.

This process applied in a stand eventually causes a radical change with respect to the manner in ,vhich trees of different ages from seedlings on up to the oldest individuals are arranged with respect to one another. In the evenaged stand (produced by clearcutting) all trees are approximately of the same age. In a stand managed under the selection method of cutting trees of a great range of ages will be found. This results because of the repeated partial cuttings, each of which takes out only a few of the larger trees and causes their replacement by seedlings. Such a stand containing trees of many different ages may be termed unevenaged. It presents an irregular appearance with a broken profile in sharp contrast to the monotonous, level-topped uniformity of the evenaged stand. Because the partial cuttings remove only SOlne of the larger trees, the ground is never completely bared of trees as in the clearcutting method.

This difference in form of stand (unevenaged versus evenaged), produced by the selection method of cutting as contrasted to clearcutting, furnishes the key to the relative efficiency of the two cutting methods in developing and maintaining the protective, æsthetic, and recreational functions of the forest.

COMPARATIVE ADVANTAGES OF THE TWO METHODS OF CUTTING

Within the region considered the principal protective influence of the forest is its effect upon stream flow. Among minor influences may be mentioned prevention of erosion, maintenance of the forest soil in productive condition, and effect as a windbreak. Upon stream flow the forest exerts a regulating influence tending to equalize flow between different portions of the year. This is accomplished through maintenance of a porous, spongy layer of decomposing leaves and litter, which helps in carrying into the ground a larger part of the rainfall than so enters on bare ground. Surface run-off in periods of heavy precipitation is thereby decreased. Stream flow in the drier periods of the year may be increased from the water stored in the ground which gradually comes out in springs. Snow melts off more slowly in the forest than in the open. The forest has also a purifying influence on the water supply since the tendency is to change surface run-off to underground flow.

These advantages of the forest over bare areas are well recognized. Less well recognized is the fact that the unevenaged form of forest exerts a

higher degree of effectiveness than the evenaged in regulating stream flow. The irregular profile of the unevenaged stand is better adapted for allowing rain and snow to reach the ground rather than to be intercepted by the tree tops. The unevenaged stand furnishes continuous protection, whereas the young age classes (1 to 20 years) of the evenaged form may be so open in density and so low in height as to furnish comparatively little protection to the ground.

In affording protection against erosion and injury to the productive power of the soil there is relatively little difference between unevenaged and evenaged stands. What difference there is favors the unevenaged form. This is because of the relatively complete exposure of the area for the first few years after evenaged stands are clearcut.

The best resthetic effects come through variation and irregularity rather than through uniformity over considerable areas. Within the forest this can best be secured by the unevenaged stand. To what extent the recreational values of the forest are distinct from those of an resthetic nature may be open to discussion. In any case it is likely that the unevenaged forest will prove to be the most interesting to those seeking recreation.

The selection system maintains the most effective protection forest and the best resthetic values while at the same time adequately providing for timber production. Indeed, the selection type of cutting, since it requires the removal of large trees only, is better suited to existing conditions than is clearcutting, which requires the cutting and sale of relatively large quantities of cordwood. Under selection cuttings this class of material, for which there will probably be a restricted demand in the future, can be kept at a minimum.

Another advantage of selection cutting is that the forest owner may be able to start immediately in the harvesting of timber products because he can select the larger trees in stands principally composed of unmerchantable individuals; whereas if he employs clearcutting he must wait until most of the trees in the stand have grown to sizes suitable for lumber products. An additional advantage to some owners is that the selection system maintains in the stand a reserve of merchantable timber which is available as security for mortgage loans.

The foregoing pages lead to the conclusion that clearcutting, while useful in the past, cannot be so profitably employed in the future and fails to accomplish so satisfactorily as the selection system of cutting any of the several purposes, with the possible exception of timber production, for which the small forest owner may manage his tract.

A SOUND CUTTING POLICY

WHY CUT AT ALL?

It is evident that selection cuttings will be the best type for the forest owner ,vhether the purpose of timber production, protection, or æsthetic effect is paramount. If either protection or æsthetic effect is of primary importance, he perhaps may ask: "Should any cuttings at all be made or will my purposes not be better satisfied by leaving the forest untouched?"

While some owners believe that such would be the case, as a matter of fact cuttings should improve the value of a forest from both the protection and æsthetic standpoints. This is true particularly for forests on drier situations.

Competition between individuals becomes destructive when no cuttings are made. Cuttings reduce the number of trees, thereby lessening competition and allowing the reserved trees to remain healthy and to develop more as individuals in their characteristic form. Unless such a reduction in number is accomplished artificially by cuttings, it will inevitably take place by death of weaker individuals. On dry situations this dying off sometimes occurs ina wholesale fashion, affecting all trees on areas up to at least an eighth of an acre in size. Cutting is the tool by means of which the forest is kept in a healthy, vigorous condition without expense.

Trees attacked by insects and fungi and those most susceptible to such attacks can be removed in the cuttings. A healthy forest in which some of the trees are allowed opportunity to develop as individuals without excessive crowding, showing a wide range in size, age, and height of the trees, is resthetically more satisfying than an area of untouched woods. An unevenaged forest of this character can be created and maintained by skillfully made selection cuttings.

The protective value of the managed selection forest is also better than that of the more densely crowded stand untouched by cuttings.

One purpose for which forests may be maintained, that has as yet been only mentioned, is the conservation and management of wild life. It may be the chief object with some owners. Others may consider wild life as ope of the features which assists in building up the recreational values of the forest. Conservation and management of wild life is a complicated problem as yet not completely solved for this region. Experience indicates that the unevenaged stand with its irregularity and change within short distances is superior to the unbroken uniformity of the evenaged stand; and further that a forest in which cuttings are made at intervals will support a more varied fauna than dense stands in which no cuttings are ever made.

Cuttings should therefore be initiated and systematically made even in forest areas where timber production is not the object, but where instead maintenance of the best protective and recreational values is the goal.

SELECTION CUTTINGS IN OPERATION

TO serve as an illustration of the selection cutting policy applied in practice, a 21-acre tract already operated once under this method has been taken. The work on this tract will be explained and some of the difficulties and advantages of the plan brought out and discussed as they are reached in the operations.

Location and Character of the Sample Tract

The tract chosen to serve as an example is a part of the Eli Whitney Forest, owned by the New Haven Water Company and managed by the Yale School of Forestry. It is located in the town of Madison, Conn., west of the state highway from Durham to North Madison and a mile south of the village of Rockland.

The woodlot was selected to represent average conditions for the region so far as topography, soil, character of forest, and location with respect to markets are concerned. It does not represent the relatively small part of the region which is in swamp or which on the upland is covered with pine, hemlock, or cedar.

An excellent system of state highways provides facilities for transportation to neighboring cities, such as New Haven, Meriden, and Hartford, all within a radius of 25 miles. Motor trucking will be the most satisfactory means of moving raw or semimanufactured forest products to these markets, although a railroad siding is within 9 miles of the tract.

The average elevation above sea level is approximately 350 feet, with a range of 100 feet on the area. The topography furnishes examples of both level and irregular country. The underlying rock is gneiss with frequent ledges and rock outcrops at the higher elevations. Although nearly all aspects are represented, the tract slopes in a general southerly direction. Loose rocks are neither large nor abundant enough to interfere with logging.

Access to the property is made easy by a system of woods roads leading south and southeast to the Goat Lot road, so arranged on either side of the

main ridge that no uphill haul is necessary in removing material. Such an arrangement makes logging comparatively simple.

The soil is a stony, sandy loam, glacially deposited, thin on the hilltops and steep slopes,and deeper in local pockets or swales. Soils of good, medium, and poor quality for forest growth are found interspersed over the area in a way typical of the region, except that no sample of swamp is included. On the average the soil may be classed as of medium quality.

The forest is composed of a variety of broad-leaved trees (usually termed hardwood trees). White ash, basswood, yellow poplar, and red oak make up the major part of the stand on the best soils (about 15 per cent of the area). A mixture of various oaks, hickories, black birch, and red maple predominates on the medium soils, covering about 46 per cent of the area. On the poorer sites, which include hilltops and steeper slopes, chestnut oak forms practically the entire stand. Growth and health of the stand are best on the good soils, becoming progressively poorer with decreasing soil depth and quality.

Table I shows in detail the composition of the stand and distribution of sizes in 1928, just before the selection cutting policy was put into operation. Evidently there was a wide range in size among the trees on the tract, yet most of these trees were around 75 years in age. The stand in 1928 was evenaged in form, with small openings (now stocked with younger trees), which had been created by death of the chestnut in the period 1911 to 1920. Definite records as to cuttings in the past could not be obtained. The evidence on the ground indicates that most of the area was clearcut about 75 years ago. Since then the forest had grown without any cutting of consequence.

THE FIRST SELECTION CUTTING

The tract was purchased as part of a larger property in 1925 by the New Haven Water Company. In the winter of 1928-29 a selection cutting was made as the initial step in putting this system into practice.

In making this selection cutting the tract was first inspected and a choice made of the trees which should be cut. These trees were blazed with an axe at breast high and also at a point close to the ground. A distinctive symbol was stamped, with the back of the marking axe, on each of the lower blazes. After the cutting the lower blaze with its stamp remains and serves as a check to control the purchaser in his logging operation. The larger trees and some of the middle-sized merchantable trees were marked for cutting.

TABLE I

TOTAL NUMBER OF TREES ARRANGED BY SPECIES AND DIAMETER CLASSES STANDING ON 21 ACRES IN THE FALL OF 1928 BEFORE THE FIRST SELECTION CUTTING

Diameter breast high inches*	*White and chestnut oaks*	*Red and black oaks*	*Scarlet oak*	*Others*	*Cedar*	*Chestnut (dead)*	*Ash*	*Basswood*	*Yellow poplar*	*Total*
				Number of trees						
2	372	27	6	502	4	..	13	6	..	930
3	366	42	15	393	17	8	10	10	..	861
4	408	54	21	378	31	25	8	6	..	931
5	270	44	19	213	25	27	10	4	2	614
6	276	75	29	169	23	33	10	..	..	615
7	282	56	61	134	6	36	8	2	..	585
8	215	65	67	107	6	38	4	..	..	502
9	230	86	50	61	4	56	..	4	..	491
10	155	42	21	52	..	46	..	6	4	326
11	136	46	38	29	2	27	..	2	4	284
12	86	33	23	15	..	17	..	..	..	174
13	46	31	4	8	..	10	..	..	..	99
14	29	17	6	17	..	13	..	..	..	82
15	10	10	8	2	..	6	..	..	..	36
16	2	2	..	..	..	2	..	..	..	6
17	4	4	..	..	..	..	..	..	2	10
18	2	4	..	2	..	..	..	..	..	8
19	4	2	..	..	..	..	..	..	..	6
20	2	..	..	..	..	..	..	..	..	2
21	..	..	..	..	..	..	..	..	..	..
22	2	..	..	..	..	..	..	..	..	2
23	2	..	..	..	..	..	..	..	..	2
24	2	..	..	..	..	..	..	..	..	2
Totals	2,901	640	368	2,082	118	344	63	40	12	6,568

* Measured at 4½ feet from the ground.

SELECTION CUTTINGS IN OPERATION

When the marking was finished a prospective purchaser was taken over the area and shown the marked trees, which were eventually sold to him. The purchaser cut the marked trees and removed the portions containing lumber products. Those logs which were to be sawed were taken to his portable sawmill, set up on a lot nearby. The total volume contained in the marked trees amounted to 49,000 feet, board measure, or a little over 2,300 feet, board measure, per acre, while the total sale value was $476.

When the lumberman had finished his operation, the tops of the marked trees, left on the ground after removal of the timber, were cut into cordwood and later on sold to a wood dealer. This did not prove to be profitable, since the wood was cut when wages were high and had to be sold when selling prices were low. Receipts and expenditures on the cordwood operation practically balanced. Sixty cords were cut and sold. Even though no financial profit was made, the cordwood operation was worth while since it benefited the appearance and health of the forest and lessened the fire hazard.

The foregoing brief summary of the progress and results of the first selection cutting can well be amplified by further discussion of a number of points involved.

How much to mark

Since trees from 8 inches and up in diameter, breast high, are merchantable for lumber products, it would be possible to cut all trees of this size and larger. Such a cutting would be too heavy for a good selection cutting. Table II shows the number of trees of different sizes which were marked and cut. On comparing the figures in Table II with those in Table I it will be seen that all trees 19 inches and over in diameter breast high were cut. Trees 18 to 24 inches in diameter of various hardwood species may in this region be considered mature in the sense that they have reached most profitable cutting size. Logs from larger trees are expensive to manufacture on the small type of portable mill customarily employed, while those from smaller trees do not furnish a large enough percentage of high quality material to be profitable. Hence, practically all trees from 18 inches up should be marked.

From the 18 down to the 8-inch class only part of the trees were cut. The percentage decreased gradually from the 18-inch class until less than 10 per cent of the 8-inch class were marked. Below the 8-inch class no trees were marked. In the logging operation a few (2 per acre) of the trees below 8 inches in size were destroyed.

None of the ash, basswood, and yellow poplar were cut because these are among the most valuable species. The few trees now present should be retained to scatter seed over the area. Practically all of the dead chestnut was removed.

TABLE II

TOTAL NUMBER OF TREES ARRANGED BY SPECIES AND DIAMETER CLASSES MARKED FOR THE SELECTION CUTTING OF 1928–29

Diameter breast high inches	*Oaks*	*Others*	*Chestnut (dead)*	*Total*
		Number of trees		
8	23	8	29	60
9	46	13	56	115
10	36	21	46	103
11	54	19	27	100
12	42	10	17	69
13	31	8	10	49
14	23	13	13	49
15	6	2	6	14
16	2	..	2	4
17	6	..	..	6
18	2	2	..	4
19	6	..	..	6
20	2	..	..	2
21	..	..	..	..
22	2	..	..	2
23	2	..	..	2
24	2	..	..	2
Totals	285	96	206	587

All the larger trees were taken out. Such trees are likely to furnish the best quality material secured in a cutting. In addition to harvesting the big, valuable, mature trees, some of the trees in the smaller but yet merchantable size classes were marked. These were chosen with the object in view of leaving the stand in condition to produce quickly another cut of good timber. With this purpose the least promising trees were marked for

cutting. Such trees may be crowded individuals in thick groups, unhealthy trees, and individuals of the less valuable species.

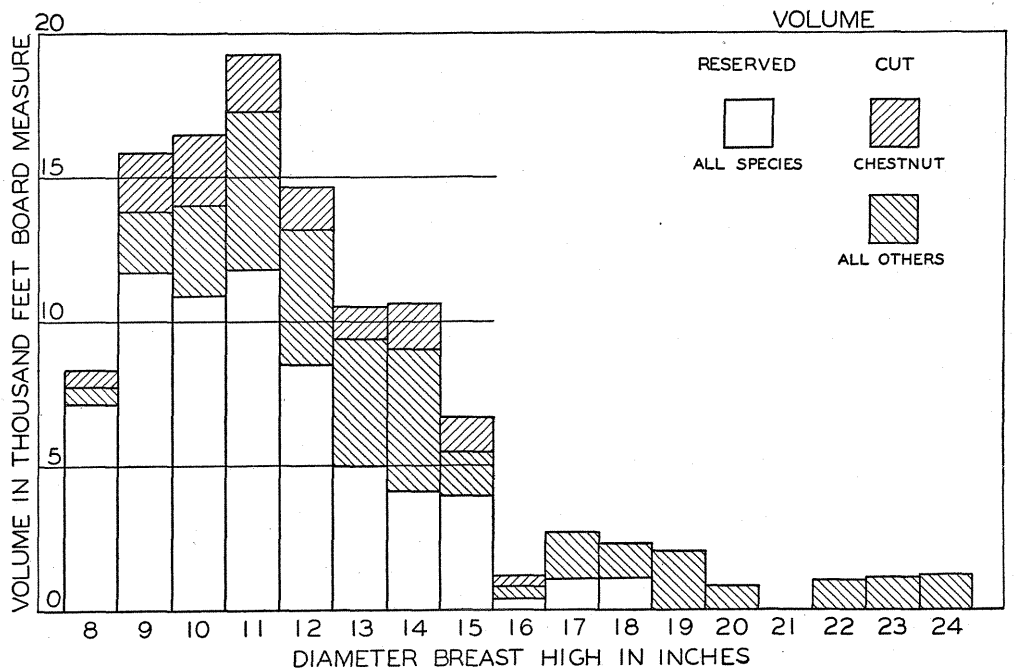
Actual selection of the trees to be marked depends then primarily upon the size, species, present condition, and position in the stand. Enough must be taken out to make possible a profitable logging operation. Any cut which removes more than 1,000 feet, board measure, per acre is likely to be economically feasible under prevailing conditions. If a mill has to be set up especially for the operation, a total volume equal to or exceeding the minimum necessary to justify a mill set-up must be marked for cutting. Discussion of this point is deferred to page 33.

TABLE III

VOLUME IN FEET, BOARD MEASURE, ON 21 ACRES BEFORE FIRST SELECTION CUTTING

Diameter breast high inches	*Total*	*Reserved*	*Removed in first selection cutting*		
			All species	*Chestnut*	*Species other than chestnut*
			Volume in feet, board measure		
8	8,300	7,100	1,200	600	600
9	15,800	11,700	4,100	2,000	2,100
10	16,500	10,900	5,600	2,500	3,100
11	19,300	11,800	7,500	2,000	5,500
12	14,700	8,500	6,200	1,500	4,700
13	10,500	5,000	5,500	1,100	4,400
14	10,600	4,100	6,500	1,600	4,900
15	6,700	4,000	2,700	1,200	1,500
16	1,200	400	800	400	400
17	2,700	1,100	1,600	...	1,600
18	2,300	1,100	1,200	...	1,200
19	2,000	...	2,000	...	2,000
20	800	...	800	...	800
22	1,000	...	1,000	...	1,000
23	1,100	...	1,100	...	1,100
24	1,200	...	1,200	...	1,200
Totals	114,700	65,700	49,000	12,900	36,100

FIGURE 1
VOLUME ON 21 ACRES BEFORE FIRST SELECTION CUTTING



SELECTION CUTTINGS IN OPERATION

Figure 1 and Table III show in graphic and tabular form, respectively, the volume distribution by diameter classes of the trees cut and reserved. Over one half of the volume cut consisted of trees below 13 inches in diameter. This is not the ideal arrangement in selection cuttings. It can be attributed to a shortage of volume in the larger diameter classes and to the large amount of dead chestnut in the lower diameter classes which had to be removed. In the second and subsequent selection cuttings a much larger proportion of the volume should come from the bigger trees and less from the 8 to 12-inch trees.

Out of a volume of 114,700 feet, board measure, on the 21-acre woodlot, 65,700 feet, board measure, of merchantable timber were reserved in the form of thrifty, middle-sized trees. The larger of these trees will furnish the basis for the second selection cutting.

Figure 1 shows how the reserved volume is concentrated in the 8 to 18-inch diameter groups. Note also that in passing from the higher to the lower diameter classes a decreasing percentage of the total volume in each class was cut in the first selection cutting.

SPECIAL CORDWOOD THINNING

As already indicated the manufacture into cordwood of the tops of the trees cut for lumber did not prove profitable in this instance, due partly to temporary drop in selling prices of cordwood, but due also to permanent shrinkage in demand. This illustrates one of the advantages indicated for selection cutting as contrasted to clearcutting. Under the former system a smaller amount of cordwood has to be placed on the market. In this illustration only 60 cords were cut. The same stand if clearcut would have yielded, in addition to timber products, approximately 200 cords of wood suitable only for cordwood. Of course it is possible to leave the tops on the ground unutilized, either after selection or clearcutting. Such action after selection cutting is quite feasible. After clearcutting, the tops, if left unutilized, constitute an eyesore and may hinder reproduction.

In cases where the forest owner can find a market for more cordwood than will be produced from tops of trees cut for lumber, a special cordwood thinning is proposed as a means of improving the condition of the stand. Such a thinning immediately following the selection cutting of 1928-29 was badly needed in our sample woodlot but could not be made, except at a financial loss, because there was no market for the cordwood. Since the need for a cordwood thinning is characteristic of unmanaged woodlots to-

day, and since there will be many cases where the operation is practicable, methods of making it will be discussed.

In any unmanaged stand there are likely to be many trees which are undesirable for anyone of a variety of reasons. Excessive competition, disease, insects, mechanical deformities, fire scars, and animals all contribute to render certain individuals undesirable. These trees compete with and impede the growth of more promising individuals. Where such undesirable trees are big enough and of suitable quality for timber products they can be marked and removed in the selection cutting. Most of the trees between 8 and 15 inches, inclusive, marked in the selection cutting were taken out because of their relative undesirability as compared to other trees which were left.

Unfortunately the worst individuals are either so defective as to be unmerchantable for products better than cordwood or else are too small in size to make anything but cordwood. Consequently, if they are to be removed at all, it must be by means of a special cordwood cutting.

To illustrate how the idea would work out in a concrete case, the stand on our sample tract was marked for a cordwood thinning and an estimate was made of the volume in cords which would be yielded by the cutting. Table IV shows the distribution of marked trees by diameter classes.

Ninety-eight trees 8 to 15 inches in diameter, large enough but too defective for timber products, were marked. In addition, 781 trees 2 to 7 inches in diameter, too small for timber products, also were marked. This marking removed a total volume of 30 cords or 1.4 cords per acre. This yield per acre is too small a cut to be chopped economically as a separate job. If the special cord\vood thinning is made, it is best combined with the operation of cutting up the tops of trees harvested for lumber.

The benefit of this type of thinning in giving promising trees a better chance to develop and in removing diseased trees can scarcely be overemphasized. It should be made wherever practicable following every selection cutting.

DISPOSAL OF SLASH

Any logging operation leaves some unused portions of the felled trees in the forest. This material usually is termed "slash" and consists principally of the upper stem and of branches which were too small for timber products or cordwood. Where cordwood is taken out of the tops, the remaining branches are 3 inches or less at their larger end. Where only timber products are removed, the whole top of the tree with branches attached may be left.

TABLE IV

TREES MARKED ON 21 ACRES FOR SPECIAL CORDWOOD THINNING TO FOLLOW SELECTION CUTTING OF 1928–29

Diameter breast high inches	*Oaks*	*Others*	*Cedar*	*Total*
		Number of trees		
2	17	27	..	44
3	77	81	4	162
4	129	129	13	271
5	66	69	15	150
6	58	37	10	105
7	38	9	2	49
8	33	7	2	42
9	19	4	2	25
10	6	2	..	8
11	13	2	..	15
12	2	..	..	2
13	2	..	..	2
14	2	..	..	2
15	2	..	..	2
Totals	464	367	48	879

Total volume marked: 30 cords.
Volume per acre marked: 1.4 cords.

Hardwood tops and single branches rot within a few years and do not increase appreciably the danger from fire, insects, fungi, or other enemies. As a result of its decay the slash aids in building up a better type of humus layer.

From the standpoint of timber production and protection to the site the slash is beneficial. Æsthetically the presence of large branchy tops or piles and windrows of smaller branches is unsightly. There may be instances where the æsthetic and recreational values of the forest can be enhanced by lopping off the branches on large tops so that they lie close to the ground, in scattering piles and windrows of single branches, and even in rare cases

gathering the slash into piles and burning it. The slash left after selection cuttings is not dense enough to prevent reproduction.

WHAT FOLLOWS THE FIRST SELECTION CUTTING

After the larger trees have been removed in the first selection cutting and after a special cordwood thinning is finished (provided such a thinning is practicable), no further cuttings are made in that stand for a period of 10 to 15 years. During this interval the trees will be growing and should increase in volume sufficiently so as to make possible another profitable cut of timber products by the end of the period. This procedure, a selection cutting followed by a 10 to Is-year period of growth, may be followed indefinitely. To insure adequate growth and make possible repeated cuts of timber, protection against forest fire, domestic animals, and other enemies of the forest must be continuously provided.

Two questions are likely to arise in the forest owner's mind. How long an interval should elapse between the first and second selection cuttings and how much material should be taken out in the second cutting? It is impossible, and unnecessary for the successful conduct of the plan, to answer either of these questions precisely. Answers accurate within reasonable limits are available.

The number of years which should elapse between the first and second cuttings depends principally on two factors: amount of the growth and condition of the stand.

If repeated cuttings are to be made, the amount removed should not exceed the growth added to the stand during the interval since the last cutting. Since this is the case, the minimum interval between cuttings should be set long enough to allow an accumulation of growth which will make a logging operation economically possible. In practice this restriction is likely to prevent cutting at such short intervals as 5 years, but usually will allow cutting as often as every 10 to 15 years.

On our sample tract an estimate of the growth was made. This amounted to 3,250 feet, board measure, per year. In the 15 years following the 1928-29 selection cutting the total growth should amount to approximately 49,000 feet, board measure, practically the same amount as that removed by the 1928-29 cutting.

Ten years after the first cutting the accumulated growth would be 32,500 feet, board measure. In this illustration, from the standpoint of a practicable logging operation, there would be adequate growth accumulated to justify a cut even at the end of a Io-year interval.

SELECTION CUTTINGS IN OPERATION

The condition of the stand should assist in determining how soon to make the second cut and whether to take out all the accumulated growth at that time. If the trees in the stand are becoming badly crowded or show signs of ill health for any reason or of slackening in their growth rate, there will be more reason for cutting earlier than if the reverse is the case. Careful observation of the stand is required to pass on this point. When the cutting is made, it may be best not to remove an amount equal to the accumulated growth since the last cutting. This will be the case particularly when there appears to be a shortage in the number of trees in the 12 to 24-inch classes. Most of the volume cut should be in these diameter classes. If the merchantable trees are relatively few in number, practically all of them may have to be removed to obtain the desired volume. Should this be done it may leave standing too few trees to provide the basis for another cut 10 to 15 years later. In such case it will be wiser to remove only a portion of the accumulated growth in the second cut.

Just this situation is believed to exist on our sample tract. Hence, it is estimated that only 35,000 feet, board measure, should be removed in the second selection cutting and that this second cutting should be tentatively placed at a 15-year interval from the 1928-29 cut or in 1943-44.

A CONTINUOUS CUT OF TIMBER

The selection cutting policy as outlined so far apparently provides for cutting timber on a property at intervals of 15 years. Where the forest is less than 40 acres in area this may have to be the case (although it should always be possible to go into the small woodlot and cut each year the fuelwood needed on the farm or an occasional timber tree to supply a small requirement for repair work).

If clearcutting were used, the intervals between the harvesting of timber crops would be a great deal longer than 15 years. The selection system enables the small owner to harvest timber from even a small area at relatively frequent intervals.

When the forest holding is 40 acres or more in extent, it may be divided into two or more portions of at least 20 acres each. Each portion can then be operated as a unit, a selection cutting being made on only one unit in a given year. For example, if the forest contains as much as 300 acres, 15 units of 20 acres each could be established. It would take 15 years to log over the 15 units in a first selection cutting at the rate of one unit per year. When finished it would be possible to start again and go over the series systematically with a second selection cutting. This particular forest owner

would then be able to place a small timber cut on the market each year. Continuous production in this way may be impracticable for many small owners and is not essential to the application of the selection policy of cutting.

What has been said in the preceding paragraphs applies particularly to cases where a sawmill must be brought in to saw the logs. Wherever small quantities of logs can be disposed of by hauling to a stationary mill, the small owner is in a position to cut every year if he wishes and to reduce the volume cut at anyone time. This is the ideal situation for the small owner, enabling him to cut and market each year the few trees maturing on his area. Some stationary mills are already in operation, and the number is likely to increase. Within a few years it is probable that enough of these mills will be established to care for the requirements of the slnall owner.

FOREST PROTECTION ESSENTIAL

IT has already been noted that one of the objects for which an owner may maintain and value a forest is its protective function in regulating stream flow. The term "forest protection" as employed in the title to this paragraph is used in a different sense. The forest itself needs protection against numerous injurious agencies, each capable of severely damaging or destroying the forest. No plan of managing a forest can be successful over a series of years which does not provide adequate protection to the forest against its enemies.

For the small forest owner either forest fires or domestic animals or both will be of paramount importance. If his tract is isolated from other forest areas and does not adjoin highways or railroads, then danger from fire is reduced to a minimum. Forest fire control for such an o\vner may consist in keeping trespassers out of the woods in dangerous seasons. Where the forested area is less isolated, control by the individual owner is more difficult and becomes a function best handled by the State with the cooperation of the owner. The latter should support his State Forest Fire organization and should demand that adequate means for controlling fires in his territory be provided.

Widespread and serious damage is caused by domestic animals in the hardwood forests of this region. In the openings created by the periodic removal of the larger trees seedlings become established and develop into young trees. If repeated cuts are to be made, these seedlings must be en-

couraged and allowed to grow into merchantable trees. The domestic animalsbrowse upon, deform, and destroy these seedlings. They compact the ground by trampling and thereby create soil conditions which hinder or prevent the establishment of seedlings. Domestic animals have no place within the hardwood forest handled under a selection cutting policy and must be excluded if the policy is to be successful.

There will always be present in every woodlot some insects and disease. Control of these pests is best secured by recognizing and removing affected and weakened individual trees when cuttings are made. Special operations such as spraying are not practicable or usually required in the forest except in occasional instances where æsthetic values are predominant.

SELLING FOREST PRODUCTS

ONE objection which many forest owners will raise against applying a selection cutting policy (or any other cutting policy) will be that the material they might wish to cut cannot be profitably sold. They will admit that the trees they wish to cut are of merchantable size but will contend that the sale value of the material will not pay the costs of its removal. This idea (which the authors consider incorrect) is so widespread as to warrant discussion of the selling problem.

The merchantable products coming from a hardwood forest in Connecticut may be classified into lumber, piles, ties, posts, and cordwood. In the previous pages the first four products have been combined under the name timber products. Trees 8 inches and over in diameter, breast high, are utilized so far as possible for timber products, while small trees and the tops of the large trees go into cordwood.

There is usually an option as to whether a tree 8 inches and over in diameter shall be cut into lumber, ties, or posts or sold as a stick of piling. Practice as to \vhich products are preferred varies with the individuallumberman, depending upon his avenues for sales. In general highest values per tree are secured from piling, next from lumber, and lastly from ties and posts. The market for poles is fluctuating and undependable. On the average best results will be obtained by cutting the biggest and clearest logs into thick lumber, while the smaller and knottier logs below 10 inches or less in top diameter are put into ties and posts.

The forest owner ready to sell the marked trees on a selection cutting unit (possibly totaling 40,000 feet, board measure) finds that his trees are

of a decidedly mixed character as to species, size, and clearness. Probably they contain some trees and logs suited for each of the four timber products.

TABLE V

INTERNATIONAL LOG RULE FOR SAWS CUTTING 1/8-INCH KERF*

Diameter inside bark at small end	*Length of log in feet*						
	8	*10*	*12*	*14*	*16*	*18*	*20*
	Contents in feet, board measure						
6	10	10	15	20	20	25	30
7	15	15	20	25	30	35	45
8	20	25	30	35	45	50	60
9	25	30	40	50	55	65	75
10	30	40	50	60	70	85	95
11	40	50	65	75	90	105	115
12	50	65	75	90	105	125	140
13	60	75	90	110	130	145	165
14	70	90	110	130	150	175	195
15	80	105	125	150	175	200	225
16	95	120	145	170	200	230	260
17	105	135	165	195	225	260	295
18	120	155	185	220	255	295	330
19	135	175	210	250	290	330	370
20	150	195	235	275	320	365	410
21	170	215	260	305	355	405	455
22	185	235	285	340	390	445	500
23	205	260	315	370	430	490	550
24	225	285	345	405	470	535	600
25	245	310	375	445	510	580	650
26	265	335	405	480	555	630	705
27	290	365	440	520	600	680	765
28	310	395	475	560	645	735	825

* Taken from *Forest Mensuration*, by H. H. Chapman, 2d Edition, Revised, 1924: 493.

The standing timber should be shown to several prospective purchasers. One man may not be interested at all, but usually one out of three or four shown the area will find the character of the material suited to his needs

and \vill be willing to buy the timber as it stands. Several methods of selling can be used. The timber may be sold for a lump sum. The trees may be measured after they are felled, the contents computed from a table sho\ving volurnes of logs of different sizes, and be paid for on the basis of this log scale. A log scale recommended for scaling hardwood logs is given in Table V. A third method of selling sometimes used is to have a tally made of the lumber and other products sa\vn at the mill and to base payment on this mill scale. Circumstances will dictate which of these three methods to employ in each case.

The timber on our sample tract was sold on the mill scale basis, the following prices being used:

Lumber	
Oak and chestnut	$10.00 per M ft., B.M.
Other species	8.00 per M ft., B.M.
Ties, 6 x 8 and 7 x 9 inch	0.25 apiece
Posts, chestnut 7 foot	0.10 apiece
Piles, 25 to 34 feet long	1.00 apiece
35 to 40 feet long	1.25 apiece

Undoubtedly the small forest owner in selling timber will at first need some help in fixing on the stumpage prices for the different timber products and in determining volumes contained in standing trees. The latter can be obtained approximately by measuring the diameter, breast high, and the total height of the tree and looking up the volume corresponding to these dimensions in Table VI. With the aid of this table an owner should be able to make an estimate of the marked timber which he has for sale. Stumpage prices vary so greatly with location of the woodlot and character of the timber and the year, that consultation with the State Extension Forester or other professional foresters is advisable.

Where a forest owner wishes to do the logging with his own men and teams, he may decide to fell the marked trees himself, cut them into logs, haul the logs to a designated point, and sell the logs so delivered to a millman. The advantage of this arrangement is that the owner is enabled to utilize his men and teams and the forest is likely to receive the minimum of injury from the logging when the work is done by the owner. Prospective purchasers have one valid objection to this plan. It is difficult to decide in advance just what products and log lengths will be taken out of a given tree. The millman may be sawing to order and does not like to have many logs cut in advance of the day's run. This difficulty should not prove in-

surmountable. Where water power or other stationary mills are available, the forest owner can often sell logs delivered to these mills.

TABLE VI

CONTENTS IN LUMBER OF HARDWOOD TREES OF DIFFERENT SIZES*

Form Class 0.65

Diameter breast high inches	*Total height in feet*						
	40	*50*	*60*	*70*	*80*	*90*	*100*
	Feet, board measure						
8	20	20	25	30	...	...	...
9	25	35	40	45	55	...	...
10	35	45	55	65	75	...	...
11	45	60	75	85	100	...	...
12	55	70	90	105	120	...	...
13	..	90	110	130	150	170	...
14	..	105	130	155	180	205	...
15	..	125	155	185	215	245	...
16	..	145	180	215	250	285	...
17	..	...	210	250	290	335	...
18	..	...	240	290	335	380	...
19	..	...	275	325	380	435	...
20	..	...	305	365	430	490	...
21	..	...	340	410	480	550	...
22	..	...	...	460	535	605	...
23	..	...	...	505	590	675	...
24	..	...	...	555	650	745	...
25	..	...	...	...	710	815	920
26	..	...	...	...	770	885	1,005
27	..	...	...	...	...	965	1,090
28	..	...	...	...	...	1,040	1,175

* Taken from Bulletin 17, Yale School of Forestry, 1926: 39.

The number of portable sawmill operators and timber buyers throughout the region has undergone a great reduction in the last 10 years. This is due to the shrinkage in the amount of timber available for sale, causing the

milhnen to move else\vhere or go out of business. Difficulty in finding prospective purchasers sometimes results from this cause.

The portable steam sa\vmill has practically disappeared, being replaced by gasoline tractor mills. These mills are inexpensive to move and set up and can afford to operate for as little as 3°,000 feet, board measure, in a single set-up. Where a stationary mill is established within trucking distance or a portable mill is operating on some lot near by, jobs involving smaller quantities of logs become practicable. There are enough tractor mills within the territory, together with stationary mills, to provide purchasers for the timber which is offered for sale.

During the present depression there should be no effort made to sell standing timber. In normal times the market should readily absorb all the standing timber offered for sale. On the whole there is usually too little rather than too much local timber on the market.

The small forest owner is in better position to market cordwood successfully than is the larger owner, because of the relatively small amount of this product which he needs to put on the market at anyone time. Oftentimes his own requirements for fuelwood will consume the small quantity which should be cut each year, while such help as he already employs may be sufficient to cut the wood. In other cases the local market will absorb a reasonable amount of fuelwood of good quality.

Cordwood may be sold on the stump just as in the case of timber products. Often the tops of trees utilized for timber products are sold as they lie on the ground. One of the most satisfactory methods is for the owner to have his cord\vood cut on a piecework basis and then sell the cordwood. either in the piles in the woods or hauled out beside some road where it can be picked up by trucks.

Stumpage prices for cordwood are likely to range all the way from $0.25 to $2.50 a cord, depending on the quality of the wood and its location. Chopping may cost from $1.50 to $3.00 per cord and hauling out of the woods from $1.00 to $2.00 per cord.

In sales of forest products misunderstanding and trouble may be avoided by having a simple contract in writing between the two parties. This contract may cover such points as products included in the sale, method of measurement, prices, terms of payment, location of mills, damage to the forest through logging or fire, and penalties for cutting trees not included in the sale.

ASSISTANCE TO FOREST OWNERS

THE small forest owner will probably find his knowledge of trees and their utilization inadequate to enable him, unassisted, to handle the technical details involved in putting a sound cutting policy into practice. He may feel that the size of his woodlot will not justify the expense of a consulting forestry expert.

Public sources of information are open to him. He may turn for advice and a limited amount of assistance to such agencies as Experiment Stations, Extension Foresters, and Forest Schools.

Eventually other facilities for supplying technical assistance to the small forest owner will be developed. Cooperative associations of forest landowners to supply the need for technical advice in planning operations, marking timber, and selling forest products already have been initiated on a small scale and promise to become one of the most important agencies in this field.

The establishment of stationary mills, .mentioned on page 28, which will buy at all times small quantities of logs will go far toward solving the marketing problem for the small owner. Where a community lacks such a mill, one should be established.

The simplest and cheapest stationary mill would be one which was equipped only to saw logs. From this as a beginning development into a plant equipped to manufacture the product more completely could be pushed as fast and as far as business warranted.

PLATE 1

SAMPLE TRACT AFTER FIRST SELECTION CUTTING

After the first selection cutting on the sample tract. The remaining stand is composed of black, white, red, and chestnut oaks, hard maple, white ash, beech, and black birch, from 2 to 15 inches in diameter and ranging up to 70 feet in height. The selection cutting in this spot removed approximately 4,200 feet, board measure, of lumber products and 3 cords of fuelwood per acre.

A special cordwood thinning was needed but could not be made because of economic conditions. Compare with Plate 3.

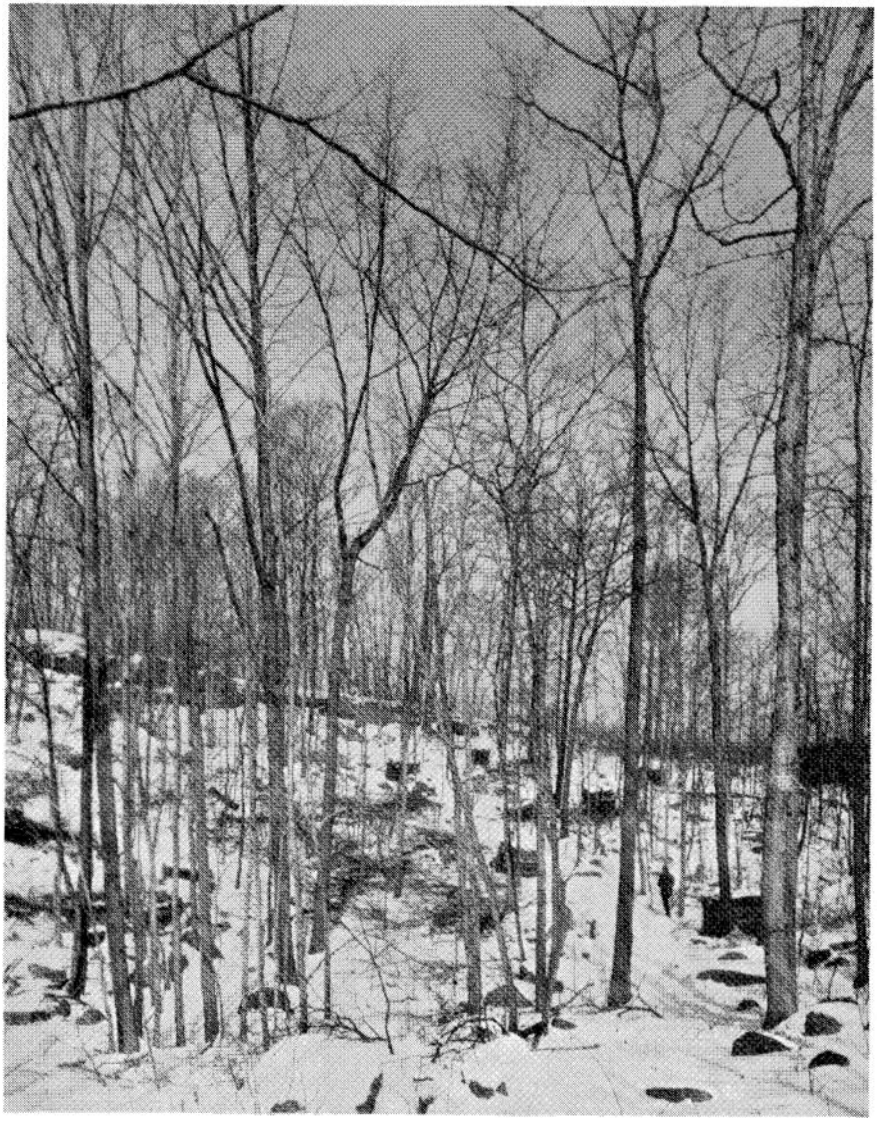


PLATE 2

STAND MARKED FOR SELECTION CUTTING

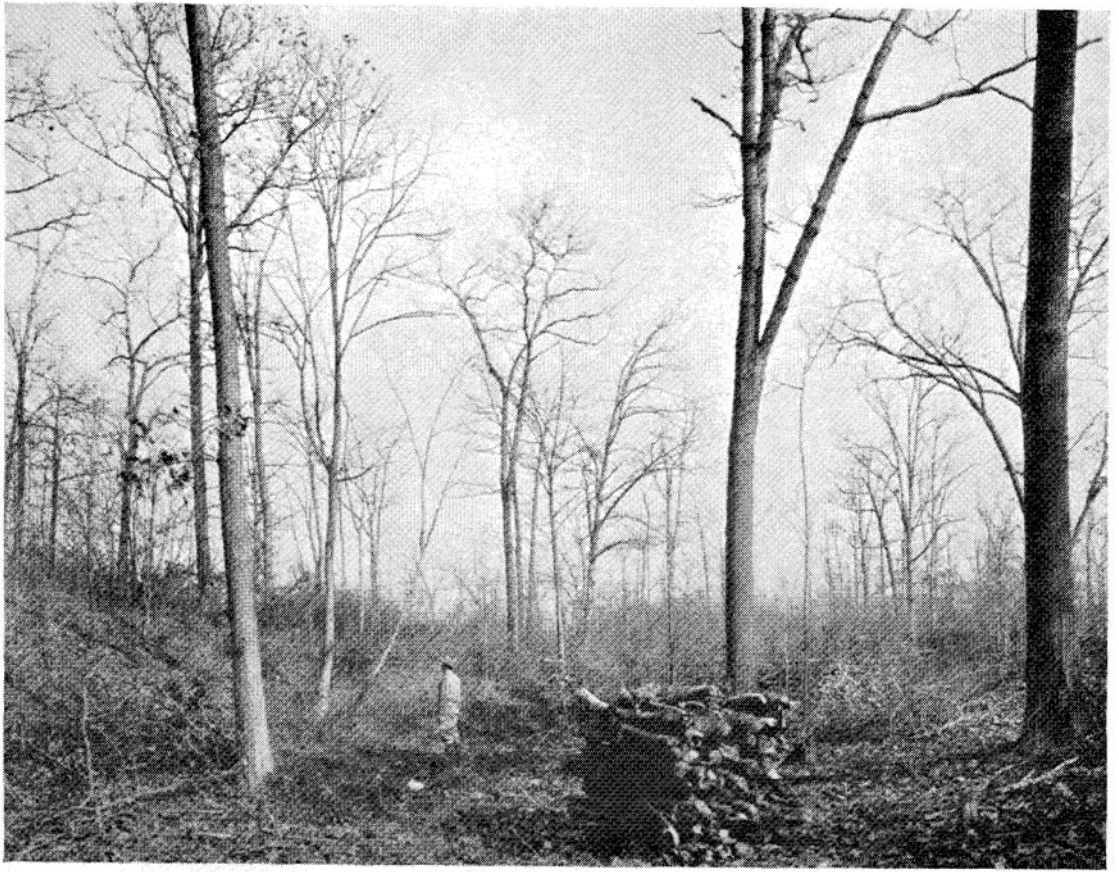
A hardwood stand marked for a first selection cutting. The blazed trees will be removed. This cutting removes sometimes a group of larger trees, as in this instance, and in other cases only single large trees. Before cutting the stand contained 6,000 feet, board measure, per acre and 2,500 feet, board measure, were marked. The oak in the middle foreground is 16 inches in diameter and 70 feet high. Compare with Plate 3.

PLATE 3

SAME STAND AS PLATE 2 AFTER SELECTION CUTTING

The same stand illustrated in Plate 2, but after the selection cutting has been made. The tops of trees utilized for lumber products have been cut into cordwood, and in addition a special cordwood thinning as described on page 23 has been completed.

Compare with the stand shown in Plate 1, where the cordwood thinning could not be made.



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