

THE  
HARVARD FOREST  
MODELS



PETERSHAM, MASS.  
1941

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HARVARD COLLEGE

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To  
R. T. F.

## INTRODUCTION

**THE** Harvard Forest models were designed to portray, first, the history of the central New England forests, beginning with the first white settlement in Petersham; second, the silvicultural practices developed at the Harvard Forest for application to local forest conditions; and, third, certain allied functions of modern forestry. The last-mentioned include a model on wildlife management, another on the control of soil erosion, and two models on forest fires, to emphasize the wastefulness of developing forests only to have them destroyed through human carelessness. The large central model is a reproduction of a section of an old growth stand on the Harvard Forest and a portion of Harvard Pond,—a scene suggesting the great aesthetic and recreational value of forests.

The models in the Historical Series and the Silviculture Series were designed by the late R. T. Fisher, first director of the Harvard Forest, to whose memory the Museum is dedicated, and A. C. Cline, formerly assistant director and now director. The wildlife management model was designed by N. W. Hosley, formerly instructor in wildlife management at the Forest; and the soil erosion control model by Kirk Bryan of the Harvard Department of Geology, and P. R. Gast of the Harvard Forest staff. The forest fire models were constructed under the supervision of M. C. Hutchins, State Fire Warden, and John P. Crowe, Supervising Fire Warden, of Massachusetts.

Construction of the models was begun in 1931 in the studios of Guernsey and Pitman at Cambridge, Massachusetts, and completed in 1941 by Theodore B. Pitman and his associates.



No. 1. HISTORICAL SERIES

PRIMEVAL FOREST OF CENTRAL  
NEW ENGLAND

1700 A. D.

**THE** primeval forest of the Central New England region consisted in the main of mixtures of coniferous and broad-leaved trees. Further, there was an unusually large variety of species, owing to location within a zone where the Northern Forest and the Central Hardwood Forest overlap. The protected sites in the northern part of this transition zone favored the growth of a number of "northern" species, including hard maple, beech, yellow and paper birch, basswood, poplar, red spruce, Norway pine and balsam fir; while the more exposed sites to the south were better adapted to such "central" species as red, white, black, and scarlet oak, hickory, chestnut, tupelo, black birch, and pitch pine. Intermediate sites were characterized by an intermingling of both kinds and, in addition, by several other species which are not typically either "northern" or "central," among them white pine, hemlock, white ash, black cherry, and red maple.

Pure white pine formed a permanent type only on light, sandy soils, and a transient type on burns or blowdowns, where full exposure to light and a temporary reduction of competition with shade-enduring hardwoods and hemlock, which ordinarily predominated in the primeval forest, permitted an abundant reproduction of pine. It was observed in the Mt. Pisgah old growth forest, a tract belonging to the Harvard Forest, that white pine, both in pure stands and as an overstory in mixtures with hemlock and hardwoods, was essentially even-aged—proof of its origin under exposed conditions such as would result from fire or blowdown. Significantly enough, examination of the soil in the same forest disclosed the presence of charcoal beneath many years' accumulation of litter and duff. It is clearly evident that destructive fires occurred long before the white man came to America.

Thus, the primeval forest was not a stable community, unchanging in the representation of the various species; but, rather, one subject periodically to drastic alterations or setbacks in the natural successional trends in composition and form.



No. 2. HISTORICAL SERIES

A N E A R L Y S E T T L E R C L E A R S

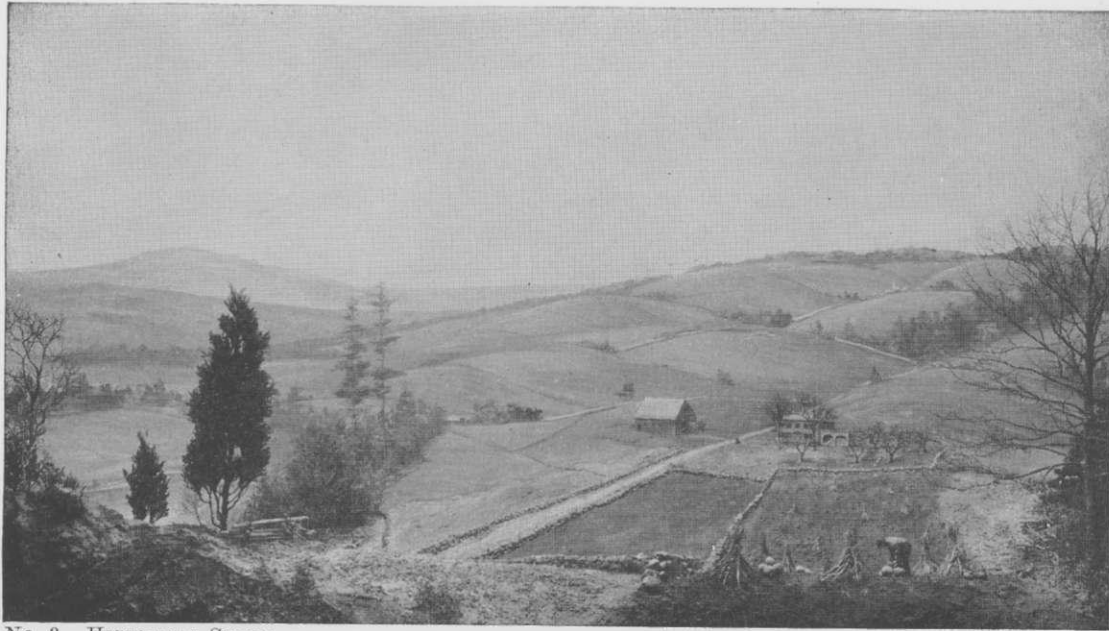
A H O M E S T E A D

1740

**THE** first recorded settlement of the town of Petersham, in which most of the Harvard Forest is situated, was in 1740 by proprietors whose claim for a grant was based on services rendered and hardships undergone in the Indian wars. Sixty families, or more, were required to be settled on the granted territory, of some 36 square miles, within three years. It is written that resident Indians claiming any rights or interests in these lands were paid by the proprietors to relinquish their claims. For the region as a whole, settlement took place chiefly between the years of 1700 and 1760, the date being progressively later from south to north.

The first settlers left their old homes in such "frontier" towns as Rutland, Lancaster, Lunenburg and Brookfield early in the spring in order to accomplish as much clearing as possible before winter set in. At least for the first year or two they traveled back and forth in season between their new clearings in the wilderness and their old homesteads in the towns to the east. For immediate shelter it is probable that small houses were built of logs, but it is interesting to note that provision was soon made for sawing lumber. Records state that a sawmill was established almost at the very beginning of the settlement, and that the mill owner supplied good pitch pine boards for 40 shillings per thousand board feet.

In clearing the land, the choicest timber trees were cut into logs and hauled to the sawmill for manufacture into boards and planks, or else hewn into timbers for frame construction. In addition, certain log structures were made from selected smaller trees, and it is certain that much material was split up for fuel. Even so, there is little doubt but that great quantities of wood for which there was no immediate use were piled and burned as the clearing progressed. There could have been little thought of conserving a resource which appeared to be inexhaustible.



No. 3. HISTORICAL SERIES

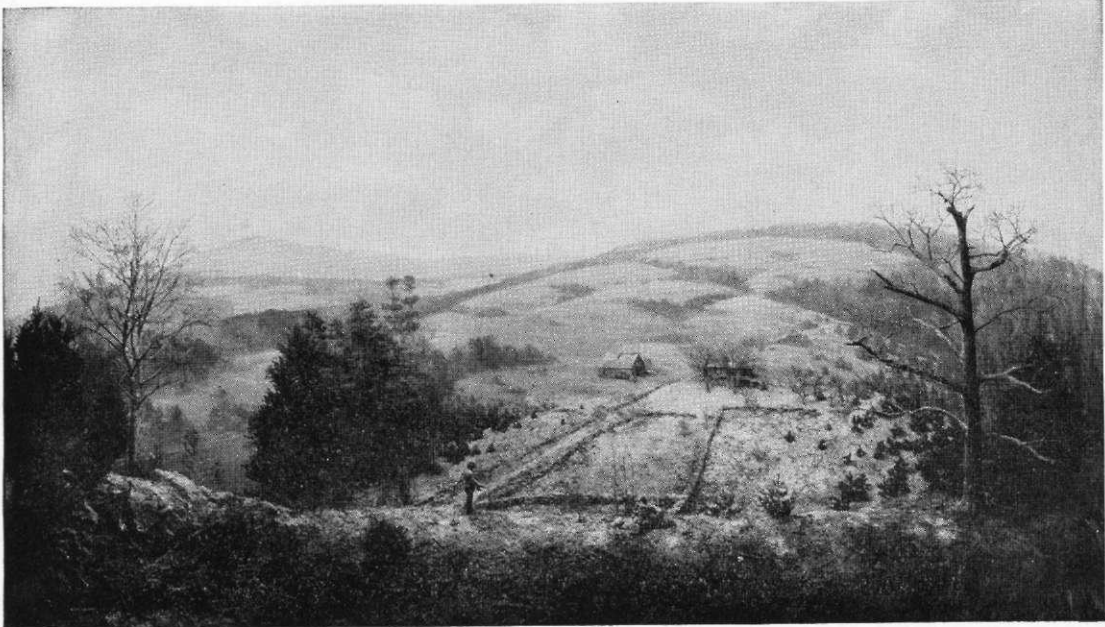
**HEIGHT OF CULTIVATION FOR  
FARM CROPS**

1830

**THE** height of cultivation, in point of land cleared and utilized for farm crops, was during the period between 1800 and 1850. In 1840 the population of the town of Petersham was 1775, the highest number in the town's history, and nearly two and one-half times that of the present day. The percentage of land cleared for tillage, pasturage, orchards, and building sites has been variously estimated at from 60 to 75. In some of the neighboring towns to the south, no less than 80 percent was cleared; while not far distant to the north the percentage was considerably less. For the region taken as a unit, probably fully 65 percent of the land area was under some form of agricultural use. It is noteworthy that at present, some one hundred years later, the percentages of cleared and forested areas are reversed.

From the close network of stone walls and the innumerable piles of stones thrown together within the clearings themselves, one may gain some knowledge of the tremendous amount of labor expended in an effort to bring into good bearing condition land which according to present standards is much better adapted to growing trees than hay and grain.

Because of the great home need for wood for all forms of building construction, fuel, house furnishings, and farm implements, not to mention its growing use in industry, we may be sure that the comparatively small remaining areas of woodland were subjected to frequent cullings to make use of all the most desirable trees. Indeed it may well be that the growing scarcity of good timber in a period when wood was a vital economic necessity was an inducement, among many others, to migrate to less intensively developed regions to the west, and a special incentive to enterprising lumbermen to move their mills to New York, Pennsylvania, or the Lake states, which shortly were to become lumber exporting regions.



No. 4. HISTORICAL SERIES

## F A R M   A B A N D O N M E N T

1850

**BEGINNING** shortly after 1830 and continuing for nearly half a century, the central New England region witnessed an era of farm abandonment on a large scale. The opening of the rich farm lands of the West, the building of the railroads, the growth of industrial centers, the discovery of gold in California, and the Civil War all contributed to the exodus of the New England farmer from the rocky hill lands which he and his ancestors had labored so hard to bring into profitable production.

The process of reclamation of the idle fields and pastures by forest started almost immediately upon abandonment. They were quickly seeded to white pine, with hardwoods such as red maple, white ash, red oak, chestnut, gray and paper birch forming a minor element. Usually there were enough old pine seed trees in the pastures or in nearby woodlands to produce an abundance of seed; and, since sod and grassland furnished an especially favorable seed bed for pine, each successive seed year marked the beginning of scores of new stands, as well as adding to the stocking of those started in the previous seed year. Since two seed years ordinarily were sufficient to give full stocking to those clearings in close proximity to seed sources, the "old field" pine stands were nearly always even-aged. Little did the former owners suspect that within a decade or two after abandonment their idle fields would be covered with a thrifty young forest.

The young pine stands soon became exceedingly thick, and little or no undergrowth could become established during the first thirty to forty years. Then, as the canopy rose, providing increased room and light beneath and making conditions more favorable for animal life, certain shade-tolerant hardwoods began to make their appearance, finally forming a dense thicket. Chief among the valuable hardwoods which thus established themselves were red oak, white ash, chestnut, black cherry, and hard maple. Frequent reference will be made to this hardwood understory in later models.



No. 5. HISTORICAL SERIES

THE ABANDONED FARM PRODUCES A  
CROP OF WHITE PINE

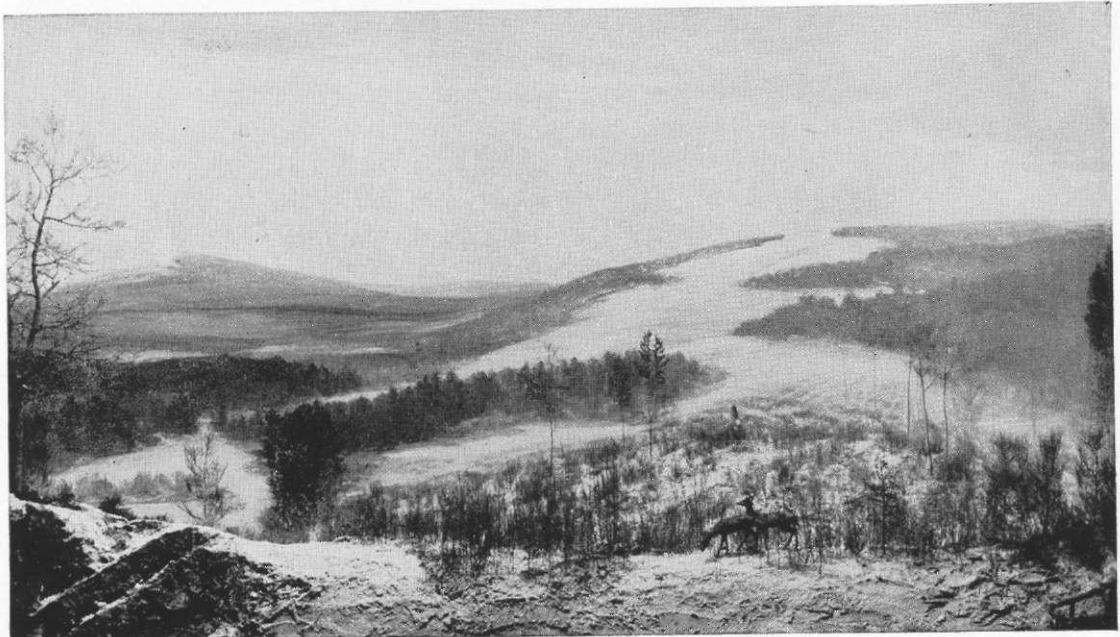
1910

As **THE** "old field" pine stands reached middle age, it became evident to some of the more enterprising persons who were seeking profits in timber speculation that here was a rapidly developing crop of second growth timber which shortly would be worth a great deal of money. Although the trees were very knotty and vastly inferior to the old growth in both quality and size, yet the wood could be used satisfactorily for many products including boxes, pails, match sticks, and woodenware of many sorts. And some of it would be good enough for lumber and finish.

So great was the volume of "old field" pine which became merchantable during the period from 1890 to 1920 that many new wood-using plants were established, and portable sawmills appeared everywhere. With yields of 25 to 50 thousand board feet per acre and stumpage values not far from \$10 per thousand, one might well envy a farmer who owned a 100-acre woodlot worth perhaps \$30,000—a wholly volunteer crop on which only taxes had been expended. It has been estimated that between the years 1895 and 1925 fifteen billion board feet of second growth pine were cut in central New England, with a manufactured value of over \$400,000,000.

As shown in the model, the stands were clear cut, except for scattered trees, chiefly hardwoods of no value at the time. Clear cutting and the use of horses led to a method of felling the trees in strips, windrowing, a practice which greatly facilitated hauling. The logs were carried on wooden sleds, called scoots, to a portable steam sawmill and there sawed into boards and planks in accordance with the demands of the market.

Since no regard was had for future timber crops, the slash and any other material of no value were allowed to remain on the ground. However, despite such carelessness, another stand did ensue, and the secret of its origin lies in the undergrowth of hardwoods mentioned under the previous model.



No. 6. HISTORICAL SERIES

THE "OLD FIELD" WHITE PINE IS  
FOLLOWED BY HARDWOOD

1915

IMMEDIATELY following logging, an "old field" pine cutting presents a picture of nearly complete forest devastation, with ribs of heavy slash occupying a third of the ground, scraggly hardwoods and dead pine poles left standing here and there over the area, one or more piles of sawdust, and odds and ends of worn out camp and logging equipment littering the mill site. But a few years later the scene is greatly changed.

It will be seen in the model that, at five years after logging, hardwoods are growing in the open lanes between the windrows of slash. These trees originated from the very small stumps of the hardwood undergrowth which started in the shade of the pine and which was cut out of the way by the choppers and teamsters when the pine was logged. Fortunately, sprouts of such origin, if of desirable species, will make straight, sound trees suitable for sawtimber. The leading species occurring as sprouts are red maple, red and white oak, white ash, hard maple, chestnut, black cherry, and black birch. Scattered throughout the area are also sprout clumps from the stumps of larger hardwoods which grew with the pine. These are worthless for a sawtimber crop.

During the first year or two after logging, another element takes its place in the new stand, namely, seedlings of such light-demanding species as gray and paper birch, pin cherry, and poplar—species which were unable to grow underneath the previous stand but which come in abundantly under conditions of full exposure to sunlight. The widespread practice of clear cutting has enormously increased the proportion of weed species in our present forests, especially of gray birch and poplar.

When a pine woodlot is cut in a seed year, the hardwoods are supplemented by white pine seedlings, making still another element in the mixture. The model, however, illustrates a case where the previous stand was cut in an off year for pine seed, and therefore the new stand is composed almost wholly of hardwoods.



No. 7. HISTORICAL SERIES

THE HARDWOOD STAND HAS REACHED  
CORDWOOD SIZE

1930

**THE** volunteer mixed hardwood stand which followed the clearcutting of the "old field" pine has now taken definite form, and it is possible not only to identify the various elements as dealt with in silviculture, such as future crop trees, weed trees, etc., but to predict the outcome of the stand in terms of a mature crop. Of outstanding importance is the fact that, with few exceptions, the leading trees are the rank-growing sprout clumps from large stumps, especially red maple, and representatives of the fast-growing weed species, like gray birch, pin cherry, and poplar. For the most part, the only dominant trees among those of desirable species and form are red oaks. Red oak is the most aggressive of the better hardwood species in the present hardwood stands, and this is particularly so since the loss of chestnut from the blight.

Thus, 20 years after logging, many of the most desirable trees for forming a future sawtimber crop are overtopped by inferior trees—stump sprouts, fast-growing weeds, and vigorous, large-crowned red oaks; and, if nature is allowed to take her course, the final crop will consist largely of cordwood and low grade, knotty lumber. Herein lies a need for silvicultural treatment to control the weeds and save the crop trees. Studies made by the Harvard Forest have shown that on the better grades of soil these young hardwood stands on cutover pine land do possess the requisites for high quality sawtimber crop production. Twenty years after the pine logging, when the stand has attained small cordwood size, the average number of suitable crop trees per acre is nearly 300—many more than enough to make a fully stocked final crop at 60 to 70 years of age, provided the weed trees are promptly removed.

Unfortunately, a great many promising young hardwood stands already have been cut clear for cordwood, with the result that the land thereafter is taken over by a stump sprout generation of marked inferiority to the previous stand.



EARLY TREATMENT OF A VOLUNTEER  
HARDWOOD STAND

**IN THE** background at the left is the margin of a 60-year-old white pine stand about to be clear cut for lumber. Just prior to logging, the hardwood undergrowth is mowed off close to the ground with a brush scythe. Seedlings and small saplings of many species are present, among them red maple, red and white oak, white ash, black cherry, hard maple, black and yellow birch, and basswood. Cutting actually saves these young trees for use as part of the next crop. Such undergrowth left uncut is bent or broken by falling trees; and, even if it were possible to save it from damage, it would not develop into straight, thrifty trees. Under the method illustrated, the small stumps less than two inches in diameter send up well-formed sprouts which are fully acceptable as prospective sawtimber.

In the center foreground appears a portion of a pine cutting area six years after logging and at the time of the first weeding. Sprouts from the stumps of the hardwood undergrowth have been supplemented by seedlings of such light-demanding species as paper and gray birch, poplar, and pin cherry. The workmen are cutting trees of inferior species, multiple-stemmed sprouts from the stumps of occasional large hardwoods in the previous stand, and other undesirable individuals, if in a position of dominance, to favor and free the most promising stems. One must be able to identify and choose between the many different species present and the various types of origin—trees direct from seed, single- and multiple-stemmed sprouts, and root suckers; in short, by cutting here and leaving there he must so regulate the vertical and horizontal distribution of stems as to lay the foundation for the best possible final crop.

At the right a similar stand has reached ten years of age and is being weeded a second time. One particular point of this weeding is to reduce to a single stem such sprout clumps as can furnish a desirable crop tree.



No. 2. SILVICULTURE SERIES

### THREE WAYS OF INTRODUCING GROUPS OF WHITE PINE INTO VOLUNTEER HARDWOOD STANDS

*ON CUTTING* areas which contain patches of soil too poor for the better hardwood species, it is often advantageous to supplement the volunteer hardwood stocking with groups of conifers. Suitable groups of hardwoods occur in the low, moist places, but the knolls are more favorable for pine.

At the left-hand side of the model a white pine group is being planted on a knoll where a windrow of slash was burned at the time of logging, two years before. A delay of two years in planting is made necessary by a destructive snout beetle, the pales weevil, which is attracted to fresh pine cuttings and feeds on any small seedlings which may be present.

In the center is a similar groupwise stand of white pine and hardwoods; but in this case the pine owes its origin to the Shelterwood System of reproduction. By this method pine seedlings become established under the shelter of the previous stand, as a result of a series of partial cuttings which improve the seed bed, stimulate seed production, and admit the needed light to the under story. The time is four years after the final removal cutting; and the first weeding is now in progress. Machetes are used to cut fast-growing trees of inferior species, and even faster growing large stump sprouts, to free the best future crop trees, both pine and hardwoods. In the hardwood group areas, the spots where slash was burned support a dense growth of light-seeded "burn" species, such as poplar, paper and gray birch, willow and sumac.

At the right is an area of "wild" forest which happened to be cut over in a pine seed year, seven years previously. Worthless hardwoods left behind by the lumbermen are being girdled and groups of pine and hardwood freed from overtopping weeds.

In all three cases a groupwise distribution of the two elements—white pine and hardwoods—is favored, largely because of their widely different rates of height growth during early life.



No. 3. SILVICULTURE SERIES

## IMPROVEMENT CUTTING IN A VOLUNTEER HARDWOOD STAND

**THIS** shows the treatment of the common present day condition illustrated in the last model of the Historical Series—a 20-year hardwood stand growing on cutover "old field" pine land. Such stands, instead of being clear cut for fuelwood, may profitably be developed into high grade sawtimber through silvicultural treatment. They contain trees of many kinds, shapes and sizes—some of them straight, sound and of valuable species; others forked or crooked, of stump sprout origin, or of inferior species. Improvement cutting aims to favor and free the best future crop trees by cutting overtopping inferior trees.

### *Left*

Portion of the stand not yet treated. A forester is marking those trees which are to be removed.

### *Center*

Improvement cutting in progress. Gray birch, poplar and rank-growing stump sprouts are being cut in favor of well-formed red oak, paper birch, white ash and other selected future timber trees. A large "wolf" tree is being girdled.

### *Right*

A hardwood swale. Straight, single-stemmed white ash and yellow birch are being freed by cutting red maple stump sprouts.



1. MISCELLANEOUS SERIES

### OLD GROWTH FOREST ON THE SHORE OF HARVARD POND

**THIS** remnant of old growth forest survived all the rigors of the local climate until the destructive hurricane of September 21, 1938. In the size and variety of trees and other vegetation, and in the unmistakable signs of antiquity, it contrasts strikingly with the young even-aged forests now so common on abandoned farms and cutover lands in the region. Harvard Pond, in the background, abounds in animal life of innumerable kinds, the whole scene suggesting an ideal retreat for one who would enjoy the beauty and wonder of undisturbed nature and seek refreshment of mind and body. Such a place it was to the late Professor Fisher, first director of the Harvard Forest, who appears in the model in company with the late Professor Nathaniel Sbalter, to whose memory Shaler Hall is dedicated.

Among the characteristic elements of such a forest are



large, prostrate trees, blown down by heavy gales and now in various stages of decay. On the right-hand side of the model may be seen a row of hemlocks growing upon the rotted trunk of such a tree, which fell at least a hundred years ago. Ancient windfalls are further marked by pits, caused by the tearing out of roots no longer able to give anchorage to the towering trunks. Old stubs of trees are records of those whose roots held but whose trunks were weakened through decay. Gaunt poles are all that remain of veteran pines killed by lightning. The whole forest floor is roughened by the moldering remains of forest debris, and is spongy under foot.

To the forester these remnants of original forest serve as invaluable guides to the development of present day forests, for it is becoming increasingly certain that only by closely following nature's methods can we build up healthy and vigorous stands of trees, easily and cheaply established, maintained, and regenerated.



No. 4. SILVICULTURE SERIES

## FIRST THINNING IN MIXED WHITE PINE AND HARDWOODS

**THE** most needed silvicultural treatment after the weeding period is thinning, the purpose of which is to increase the growth rate of selected remaining trees by a reduction in the total number of trees on a given area. In the absence of thinning, excessive competition between roots for soil moisture and nutrients, and between crowns for sunlight and growing space, causes the trees to become tall and spindling, with the result that the mature crop is made up of small logs of little value.

In well-stocked, even-aged stands on heavy soil the first thinning ordinarily is needed at about 25 years of age. The method of thinning being applied to the mixed hardwoods on the right-hand side of the woods road is known as "Crown Thinning," or "Thinning from Above." Well-formed crop trees in such numbers as to give a spacing between boles of approximately 10 feet are given additional crown space by cutting neighboring trees whose crowns are in a competitive position. Insofar as possible, the trees removed will be those which have some noticeable imperfection of bole or crown, together with all long, slim individuals, known as "whips," which cause damage to the crop trees through abrasion. Great care is taken to save the overtopped trees, called "trainers," since they assist in pruning the selected crop trees of lower dead branches, and protect the soil from exposure to increased light.

At the left center of the model thinning has been completed; at the center it is in progress; and at the right a forester is marking the trees to be removed. That portion where thinning has been completed contains but two stand elements—crop trees and trainers. Prominent among the former are paper birch, white ash, red oak, and basswood.

The white pine group on the left-hand side of the road has been thinned "from below," a method in which the trees removed are chiefly from the overtopped classes". In pine the overtopped trees do not act as trainers, and natural pruning is practically non-existent.

THE STATE OF TEXAS  
DEPARTMENT OF AGRICULTURE



No. 5. SILVICULTURE SERIES

### THIRD THINNING IN MIXED WHITE PINE AND HARDWOODS

**THIS** is the same stand as shown in the previous model. It is now 25 years older than at the time of the first thinning, and many of the crop trees are from 12 to 15 inches in diameter and of fine quality. This excellence in growth and form as contrasted with untreated stands is due to the series of weedings and thinnings applied periodically since the stand was six years old. The butt logs from the trees removed in the thinning are suitable for sawing into lumber, while the upper portions of the bole and the limbwood are useful as fuel. As in all previous treatments, the aim is the constant betterment of the stand by removing the poorer elements at such times and in such amounts as will provide the remaining favored trees with optimum conditions for development as high quality sawtimber.

In this third thinning, the number of crop trees in the hardwood portion of the stand is reduced to about 125 per acre, or to a spacing of around 18 feet. Only the choicest individuals of the most desirable species, such as red oak, white ash, paper birch, and basswood, are left to form the final crop. At the extreme right, where the thinning is yet to be completed, blazes on the trees indicate those which are to be cut. These are relatively poor trees which are crowding the selected crop trees. Their removal will leave sufficient room between the crowns of the crop trees to permit continued vigorous growth of both crown and bole for at least ten years.

Through the action of the overtopped trees (the trainers) the boles of the crop trees were cleared of dead branches up to about two full log lengths by the time the stand was 30 years old. During the remainder of their lives they will produce clear, straight-grained wood capable of meeting the most exacting requirements of the market. When grown on a rotation of approximately 70 years, such mixed stands may be expected to yield at least 20 thousand board feet of sawtimber per acre exclusive of the material removed in thinnings.



No. 6. SILVICULTURE SERIES

## CONVERSION OF CORDWOOD TO FUTURE SAWTIMBER

**HAKDWOOD** stands composed almost wholly of trees of inferior species, such as gray birch, pin cherry, and poplar, or of rank-growing stump sprouts, are clearcut for cordwood, and the cutting area planted to conifers or hardwoods, or mixtures of the two, depending upon the quality of the soil and the kind of sawtimber crop desired.

A section of uncut cordwood appears on the right-hand side of the model. In the center a cordwood crop has been cut, the slash burned, and now two crews are at work planting conifers. Four-year transplants are used because of the severe competition with sprouts from the hardwood stumps during the first few years after planting. The planting tool and planting basket are the kind used at the Harvard Forest. Spacing between the plants is wide, 6 to 7 feet, since the necessary high density of stocking is amply provided for by intervening hardwood sprouts and seedlings. Such hardwood material temporarily used to crowd the planted conifers on the sides of their crowns is known as "filler." A variety of species is available for mixed planting. The particular ones chosen depend upon adaptability to a given site, susceptibility to insect or fungus attack, and the influence of one species upon another when in intimate association. Coniferous species planted on the Harvard Forest include white and red pine, white and Norway spruce, European and Japanese larch.

At the left-hand side of the model, an earlier plantation, of white pine and European larch, is being weeded. The purpose of weeding is to regulate the relation of the hardwood sprouts to the conifers. Chiefly it is a matter of cutting those stems which are overtopping the planted trees, but leaving as filler all of those which, by virtue of their position and height, are helpful in restricting the growth of side branches on the conifers. The hardwood filler also protects the soil and furnishes partial shade for certain crop species requiring it in early life.



NO. 7. SILVICULTURE SERIES

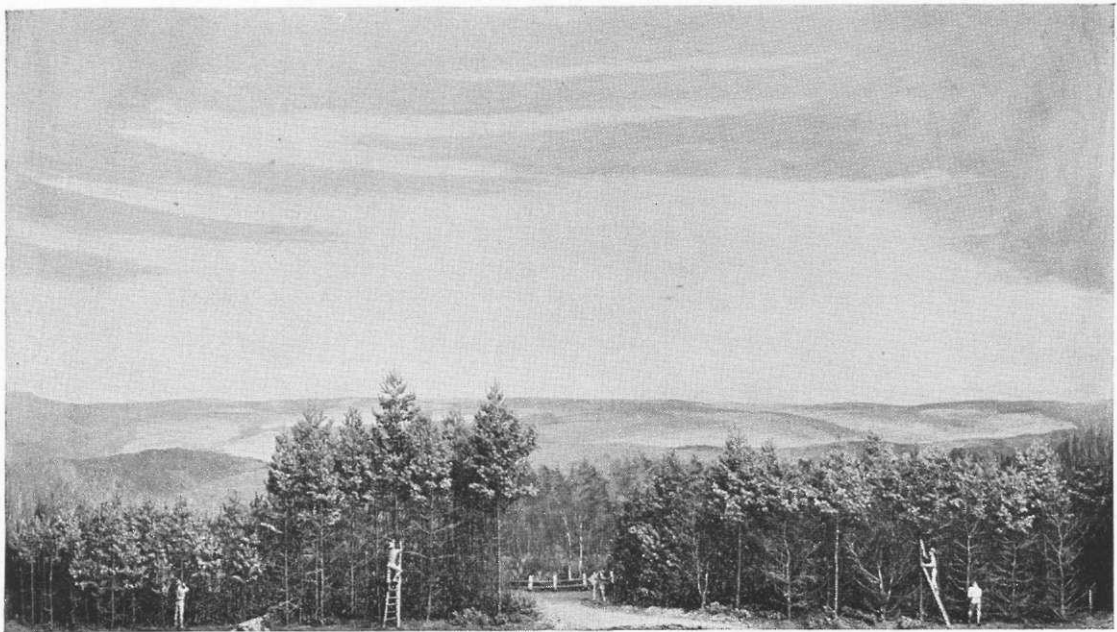
RELEASE OF WHITE PINE FROM  
SUPPRESSION BY GRAY BIRCH

IN THE early years of farm abandonment an abundance of old white pine seed trees in the pastures and adjoining woodlands resulted in the establishment of "old field" pine stands which were essentially "pure." In recent years, however, a diminished supply of pine seed and an increased supply of weed hardwood seed have favored a much larger proportion of hardwoods, particularly gray birch.

Generally the pine and birch seed in simultaneously, forming an even-aged mixture. But, although shorter lived than the pine, the birch grows much more rapidly at the start and soon completely overtops its associate. The injury inflicted on the pine by the birch is largely one of arrested growth due to a whipping off of the buds, thus checking the development of new foliage, rather than to suppression by a reduction in available light. The greatest injury occurs in the winter when the birches are bent over by snow or ice, in which position any swaying movement with the wind is disastrous to the pines underneath.

Mortality varies to a great extent with the fertility of the soil. On rich soils the pine is eliminated almost completely when from 20 to 30 years of age. On light, sandy soils, which are much more favorable for conifers than for hardwoods, the pine may persist until the gray birch reaches maturity. Thereafter it is able to come through and form a pure stand.

Studies by the Harvard Forest have shown that there is a practical height for the white pine at which, if the gray birch is removed, the released pine will not again be overtopped—by the sprouts from the birch stumps. For the better soils this is when the pine is 15 feet high. However, at this time the birch may not have attained a good size for cordwood. All factors considered, release cutting should be made at the earliest age at which the birch is merchantable, ordinarily between 18 and 25 years of age.



No. 8. SILVICULTURE SERIES

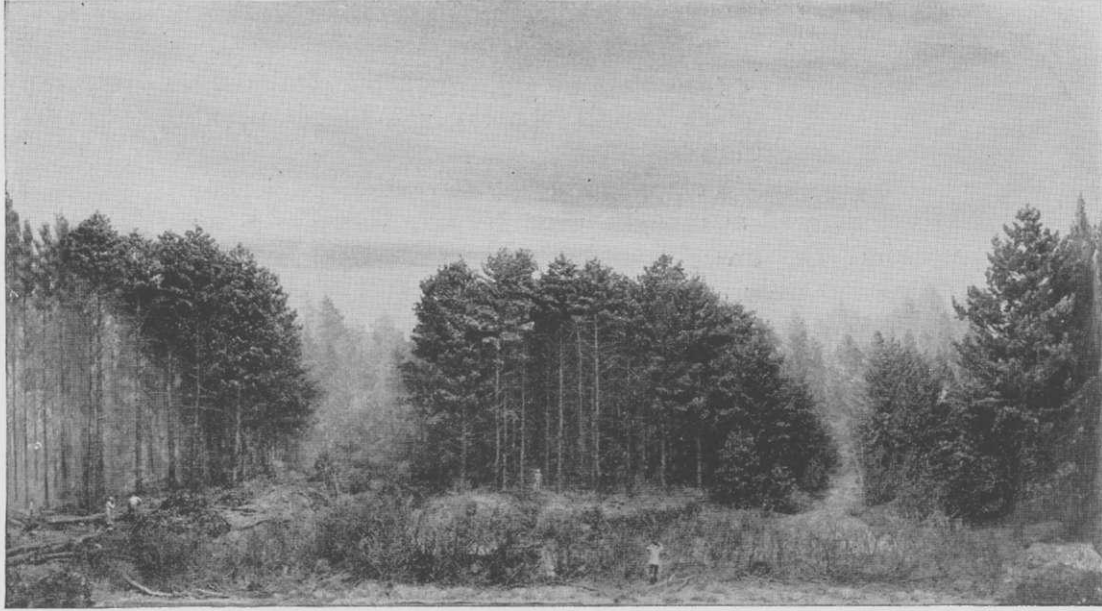
PRUNING WHITE PINE TO PRODUCE  
CLEAR WOOD IN THE BUTT LOG

ONE characteristic of white pine in pure stands is the persistence of the dead branches. In fact, the only practicable method of getting rid of knots and producing clear lumber within a reasonable length of time is artificial pruning when the stand is young.

Densely stocked stands naturally seeded on old fields are especially well adapted to pruning, because close spacing prevents the lower branches from becoming large and forces the trees to grow straight. At the left side of the model is a young stand of such origin, which is now receiving the first pruning treatment. The leading (dominant) trees are about 17 feet high and not over 4 inches in diameter. A sufficient number of the best-formed "dominants" are selected and pruned to form a final crop—about 200 trees per acre. The pruning is carried as high as the workman can reach from the ground with a hand saw.

At the center a similar stand has reached the point when the third, or final, pruning is in order. A full 16-foot log length is cleared, except where a crook in the bole may occur at a slightly lower point. Certain neighboring trees which interfere with the growth of the pruned crop trees may now be cut or girdled to provide more room for crown expansion.

At the right appears a widely spaced plantation where the dominant trees have become forked and crooked through white pine weevil attacks. Here suitable trees for pruning are found chiefly among those which are partially overtopped, and therefore less subject to attack, and less able to become bushy if attacked. To free such trees, it is necessary to girdle many neighboring, severely weeviled "dominants," starting at the time of the first pruning treatment. Most of the trees girdled at the start are now dead, and a workman is girdling others which threaten to suppress the pruned trees. Girdling is preferable to cutting because trees left standing, even though dead, afford greater security to neighboring pruned crop trees against sun scald and snow breakage.



No. 9. SILVICULTURE SERIES

GROUP SELECTION METHOD OF NATURAL  
REPRODUCTION IN WHITE PINE

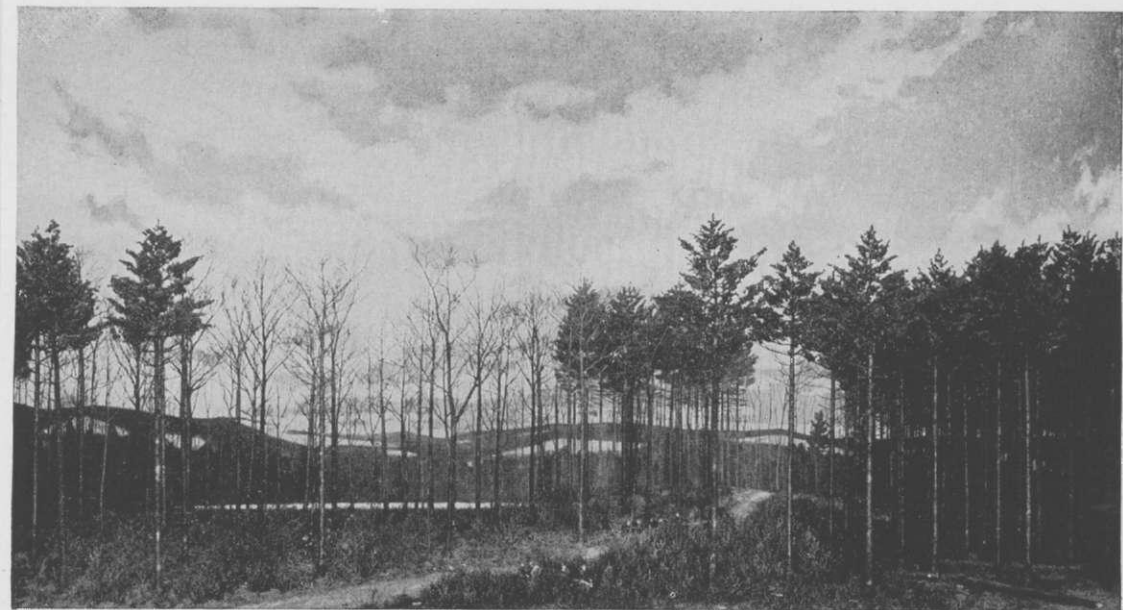
ALONG the valley bottoms where the receding glaciers left deposits of sand and gravel, white pine frequently forms nearly pure stands. Absence of competition with hardwoods, which require better grades of soil for vigorous growth, permits the pine to maintain itself indefinitely as a "permanent" forest type. Generally, such stands are uneven-aged, and composed of groups, together with some scattered individuals, of many different ages and sizes.

Heavy cutting of white pine growing under such conditions is not only wasteful of the smaller trees but undesirable from the standpoint of the next crop. Full exposure of the soil brings in dense mats of blueberry, wintergreen, and other ground plants which seriously hinder reproduction by seed; and restocking by means of planting is almost equally unsatisfactory. A partial cutting system is desirable.

The system illustrated in the model is known as Group Selection. At the left a mature group, 60 years old, is being clear cut. The area so cleared will be seeded by the oldest neighboring immature groups, such as the one shown in the center background, 50 years of age. At the right appears the margin of a still younger group, which will not be ready to cut for two or three decades. In the center foreground is the very youngest age class—seedling reproduction which originated from a group cutting ten years previously. Pine seedlings are most abundant on the two moss beds, one of polytrichum moss near the innermost figure and one of hypnum moss, growing on rotten slash, directly in front of the figure in the foreground. Elsewhere, on less favorable seed beds, pine seedlings occur scatteringly.

At the right center is a bed of reindeer lichen in a natural opening. Very little pine has been able to establish itself, except under the protection of a clump of gray birch "nurse" trees.

In the background at the left center appears a clump of spruces and tamaracks growing in a small bog hole, characteristic of morainal deposits.



No. 10. SILVICULTURE SERIES

SHELTERWOOD METHOD OF OBTAINING  
NATURAL REPRODUCTION IN WHITE  
PINE AND HARDWOODS

IN THE shelterwood methods the new generation of trees is established, under the shelter of the old, by a series of partial cuttings for the purpose of stimulating seed production, creating favorable seed bed conditions on the forest floor, and supplying the young seedlings with sufficient room and light for healthy growth. After the young stand is safely rooted, the old stand is completely removed.

*Left*

Uniform shelterwood method applied to a mixed stand of white pine, oak and hickory on light soil. Two partial cuttings have opened the crown canopy of the parent stand uniformly, in contrast to groups or strips, and seedling reproduction has been established uniformly beneath. The final removal cutting of the old stand will be made a few years hence and the ground turned over to the new stand.

*Right*

Strip shelterwood method in white pine. From the oldest strip of pine reproduction, along the road, all of the parent trees have just been removed. On the adjoining strips partial cuttings are being made to increase the growth of the small seedlings already present and to encourage the establishment of more. Removal of the parent stand will progress by strips from left to right through cuttings spaced several years apart.

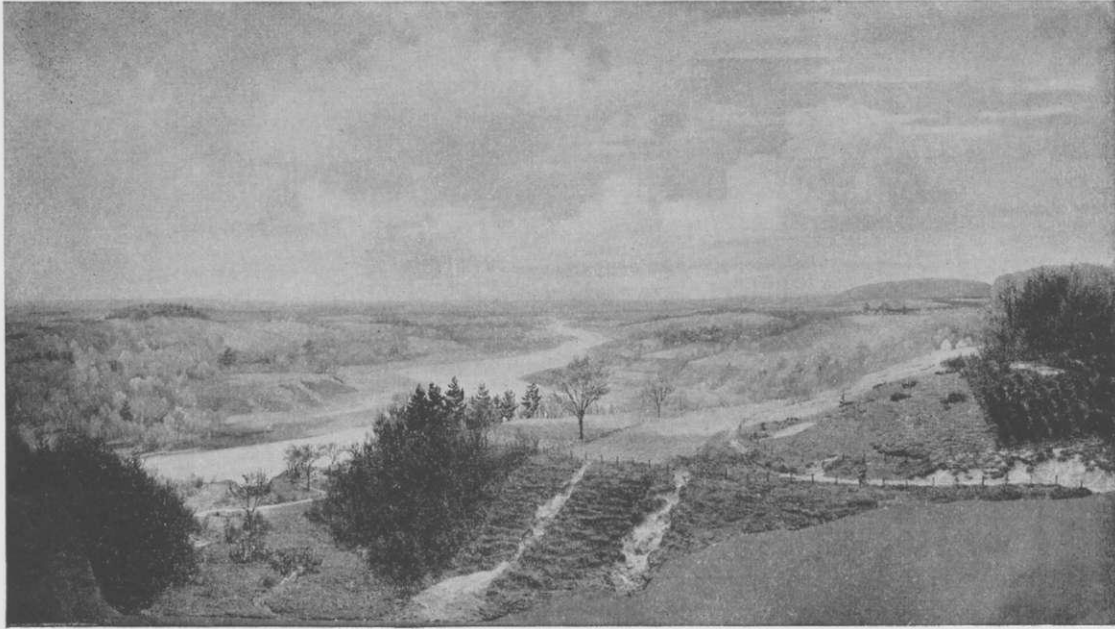


No. 2. MISCELLANEOUS SERIES

## FOOD AND COVER FOR WILDLIFE

LOW-GROWING game foods and cover are much more plentiful and more varied, both in species and in distribution, in abandoned farm areas than they were in the virgin forest. Old fields with groups of shrubs and apple trees furnish fruit and browse, and contain many valuable herbaceous species and a wealth of insects within reach of young birds. Old-field pine stands furnish good cover and, as they approach maturity, plenty of food from woody undergrowth and herbs. Young hardwood sprouts following cuttings are ideal as food for browsing game such as deer and rabbits. Some game species, such as the cottontail rabbit and woodcock, which were absent or scarce in the dense old-growth forests, have come in as a result of the clearing and abandonment of farm land. Many small artificial ponds, usable by aquatic birds and mammals, were created to furnish power. The old stone walls with their vines and shrubs furnish places of escape and large quantities of food for many animals.

Farm abandonment accidentally provided these favorable conditions. Forest management, by giving special consideration to wildlife, can also provide them. The small, continuous silvicultural operations in a forest under sustained yield can be made so as to give the needed variety of food, cover, nesting and rearing sites, etc., within the radius of daily movement of the animals.



No. 3. MISCELLANEOUS SERIES

ACCELERATED EROSION IN  
NEW ENGLAND

ACCELERATED and destructive erosion in New England is ordinarily prevented by the permeability of the soil, by the numerous boulders in the glacial drift which quickly pave the bottom of any gully that may form, and by the rapid growth of brush and trees on abandoned plough land.

The model shows accelerated and destructive erosion in a New England Intervale where terraces of silt and fine sand are unusually susceptible to this process. The following specific processes are illustrated:

Flood erosion—the sand spread on the meadows along the banks of rivers is caused by heavy rains and is independent of human activity.

Gullying on steep terrace front when cleared and pastured. No erosion when these slopes are protected by trees.

Gullying where run-off from ditch is concentrated as in foreground.

Landsliding where steep front of silt terrace is undercut by stream as on left of model. Sheet erosion and gullying by reason of careless husbandry.

Upper part of bill on right shows old ploughing up and down slope. Field now abandoned and being replaced by woods.

Lower hill slope on right ploughed parallel to contour except in nearer portion where some erosion has occurred. Such fields should be in pasture a large part of the time and only the flatter land should be cultivated.



No. 4. MISCELLANEOUS SERIES

## FOREST FIRES IN NEW ENGLAND

THE great majority of forest fires in New England are caused by human carelessness in some form or another. Careless disposal of smoking materials, irresponsible burning of brush and debris, and uncared for camp fires produce most of the fires. Railroads cause some, but the proportion resulting from this source is much smaller than in years gone by. Fires, the result of lightning, so common in the far west, are of infrequent occurrence in New England. The dense population in central and southern New England which is in close proximity to large areas of forest land produces a great fire hazard. It is not strange, therefore, that these regions have a good many fires, but rather remarkable that there are not more.

Fires are one of the principal causes of much of the poor type of forest land found in central and southern New England. The larger merchantable trees are scarred and injured so that the grade of timber which they produce is reduced in quality, while younger trees and advance reproduction are killed entirely. Land burned over does not reproduce to valuable species, but comes up to so-called weed species, gray birch, popple, pin cherry and scrub oak. Not only are these species nearly valueless in themselves, but this brushy type of growth is more inflammable than a normal forest, hence one fire prepares the ground for another.

Keep these facts in mind when you have occasion to be in or near forest land.



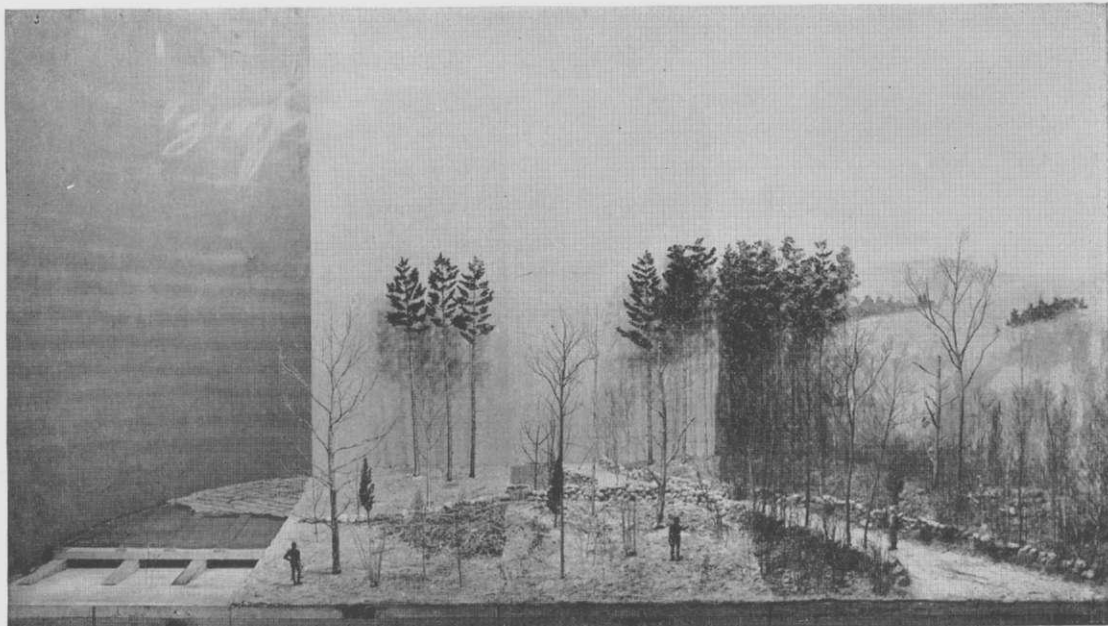
No. 5. MISCELLANEOUS SERIES

## FOREST FIRE CONTROL IN NEW ENGLAND

ALTHOUGH there is some variation in the system of handling forest fires in the various New England states, in general it is much the same. The essential program is one of co-operation between the state and the local community. Each township has a local forest warden who with his men and equipment is the first line of defence. The second line of defence is provided by a number of state district fire wardens, each of whom has one or more fire trucks and crews to go to the aid of the local wardens, and since the advent of the CCC camps, third line of defence is provided by the well trained boys from these camps with the equipment which the Federal government has provided.

In the last ten years much advancement has been made in the mechanical means of handling fires. State district fire wardens are provided with fire trucks carrying one or more power pumps and several thousand feet of small hose and tanks holding several hundred gallons of water. Not only are state wardens so equipped, but many towns have provided similar equipment for their local wardens. In the state forests water holes have been built to provide a convenient source of water for pumping equipment, and towns have made similar provisions through CCC and WPA projects.

For the quick detection of fires, each state maintains a system of forest fire observation towers which are connected by telephone to the nearest exchange and in which an observer is maintained usually from April to October. In Massachusetts many of these towers are being equipped with a two-way radio system, so that the observers may be in constant touch with the state wardens whose cars are similarly equipped. As a result of the improved system of handling fires, the majority are extinguished before they reach large size, and the number that burn more than ten acres is becoming smaller.



No. 6. MISCELLANEOUS SERIES

## DEMONSTRATION MODEL

As THE spectator is usually interested in how these models are constructed, it was decided to make this one showing the various stages.

Starting from the left, we will designate the sections A, B, C and D.

A. This shows the base built of a frame work of battons with copper screening stretched across them. The first coat of surfacing material, gesso, is spread. The background is the bare metal that has been thoroughly cleaned.

The figure is merely a strong wire armature.

B. Here the undulations of the terrain are built up of excelsior dipped in the gesso, and the second coat of gesso is applied. A stone wall of the same material has been started. The background has its first undercoat of paint.

The figure has been bent into the pose desired, and has been built up in wax to the right proportions in the nude.

Here the trees are first shown—completely built but in the copper stage. They are made of copper wires twisted together to form the branches and then the long ends are bound together by wrapping wire about them to form the smooth trunk.

The leaves and needles are of sheet copper, soldered on to wires which, in turn, are twisted into branches.

C. The base has had its second coat and some larger stones and sticks have been put in it to give roughness. The stone wall is complete and the figure is modeled and ready for painting. The background has its second ground coat and the picture has been sketched on.

The trees have been soldered to stiffen them and some are shown with their coat of surfacing paint.

D. The model is here completed. Little sticks and stones have been added, grass has been put in and ground moss used freely to take away any hard look, and then the base has been painted. The figure is painted and finished.

The trees have been sprayed with surfacing paint and then with oil color. They are then painted by hand to give them the variations of the species. The foliage is sprayed with paint, then the branches are trucked up and color variations in the foliage are done by hand.

The background is painted with particular attention to the joining with the foreground.