

A black and white photograph of a dense forest. The trees are tall and thin, with bare branches. The ground is covered in snow or a light-colored layer of vegetation. A person is standing in the distance on the left side of the image. The title "THE HARVARD FOREST MODELS" is centered in the upper half of the image.

THE
HARVARD FOREST
MODELS

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To
Richard Thornton Fisher

INTRODUCTION

THE HARVARD FOREST models were designed to portray the history of the central New England forests, beginning with the first European settlement in Petersham. Furthermore, they show the silvicultural practices developed for local forest conditions during the first thirty years of research at the Harvard Forest. With appropriate changes for new techniques and equipment these practices are still valid. Finally, certain allied functions of modern forestry are illustrated. There is a model of wildlife management, one on the control of soil erosion, and two on forest fires. The last three 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.

Today, people realize more than ever that forests are not merely producers of timber and other products. They have a favorable effect on microclimates, they absorb noise and glare, promote stable soil and watershed conditions, harbor a wide variety of wild creatures, and are pleasant places to live in and enjoy recreation. Developing these and other values for our changing society calls for continued research in the developing field of forestry.

The models in the Historical Series and the Silvicultural 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, who became the third 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.

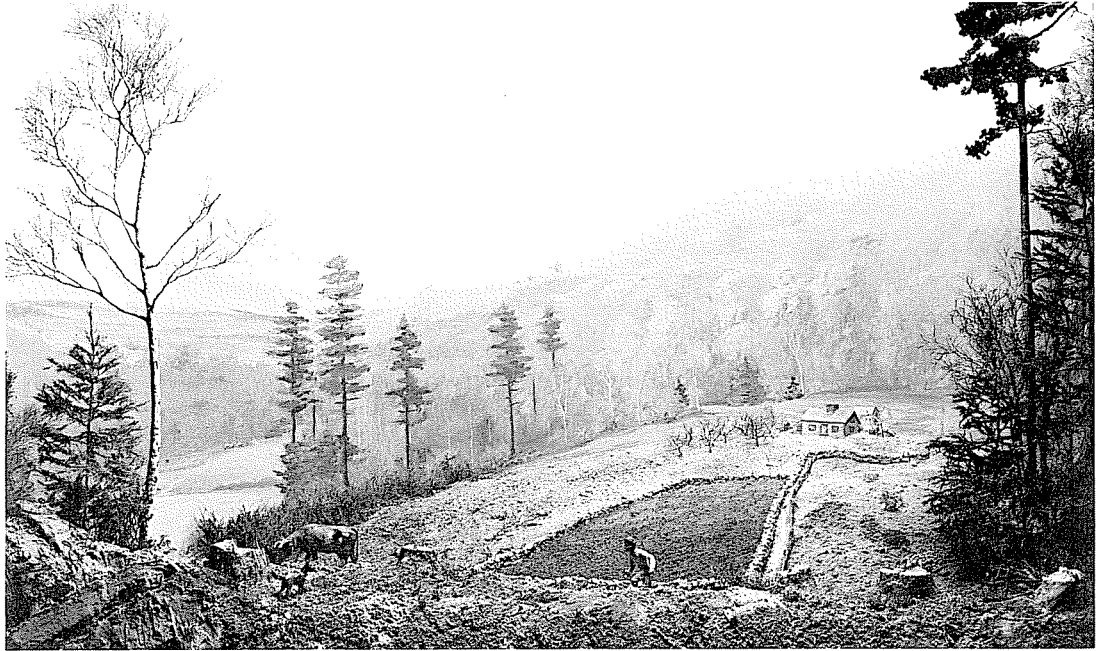


**PRIMEVAL FOREST OF CENTRAL
NEW ENGLAND
1700 A.D.**

THE PRIMEVAL forest of the Central New England region consisted of mixtures of coniferous and broad-leaved trees. Geographically speaking, this is in the Transition 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, red 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 neither "northern" nor "central", among them white pine, hemlock, white ash, black cherry, and red maple.

Pure white pine formed a permanent type only on dry, sandy soils, and a transient type 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. Detailed analysis of old growth in a tract near Mt. Pisgah, New Hampshire showed that fires, wind storms and hurricanes had destroyed the forest periodically since 1650. Such catastrophes created the patch work of even-aged pine and of pine-hemlock-hardwood forests found on the area when the settlers came. Each stand started after some natural disturbance.

Thus, the primeval forest was not a stable community, unchanging in the representation of the various species; but, rather, one subject periodically to drastic alteration in composition and form and in its natural trend of development.



**AN EARLY SETTLER CLEARS
A HOMESTEAD
1740**

THE TOWN of Petersham, in which most of the Harvard Forest is situated, was granted to 71 proprietors in 1733 as compensation for 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. 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. Dugouts and rough lean-tos were often used for immediate shelter, 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 — a board foot being a volume of lumber one foot square and one inch thick. Log cabins were first used in Maryland by immigrants from Sweden.

In clearing the land, the choicest timber trees were cut into logs for sawing into boards and planks, or else hewn into timbers for frame construction. Some of the other 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, thus releasing valuable nutrients from the trees and forest floor litter to fertilize the farm crops. There could have been little thought of conserving wood — a resource which appeared to be inexhaustible.



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 1,775, the highest number in the town's history. 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 70 percent of the land area was under some form of agricultural use. It is noteworthy that 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 stone 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 farming condition land which, under present conditions, is better adapted to growing trees than hay and grain.

Because of the great home need for wood in 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 cuttings which took out the most desirable trees for lumber and the least desirable ones for fuel. Indeed, with so little woodland left, a growing scarcity was likely when wood was such a vital economic necessity. However, the introduction of coal into cities for heat relieved some pressure on local forests and lumber was imported from Maine by sea and later by railroad from New York, Pennsylvania, or the Lake States.



FARM ABANDONMENT 1850

BEGINNING shortly after 1830 and continuing for nearly half a century, the central New England region entered an era when farming was given up on a large scale. The opening of the rich farm lands of the West by the building of the Erie Canal and the railroads, the growth of industrial centers, the discovery of gold in California, and the Civil War, all helped draw the New England farmer away from these rocky hill lands that could no longer be farmed profitably in competition with the west.

Almost immediately upon abandonment the forest started to reclaim the idle fields and pastures. 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. 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 year. Since two pine seed years ordinarily were sufficient to give full stocking to those clearings in close proximity to seed source, the "old field" pine stands were nearly always even-aged.

The young pine stands soon became exceedingly thick, and little or no undergrowth could become established during the next thirty to forty years. Then, as the canopy rose, providing increased room and light beneath and making conditions more favorable for animal life, certain hardwoods began to make their appearance, finally forming a dense thicket. Chief among the hardwoods which thus established themselves were red oak, white ash, black cherry, red and hard maple and formerly chestnut. In the discussion of other models frequent reference will be made to the hardwood understory present at the time of logging as "advanced growth".



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 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, the wood could be used satisfactorily for many products including boxes, pails, match sticks, heels, toys, and woodenware of many sorts. And some of it would be good enough for finish lumber.

So great was the volume of "old field" pine which became merchantable during the period from 1890 to 1920 that portable sawmills appeared everywhere and many new wood-using factories were established. 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. Between the years 1895 and 1925, an estimated fifteen billion board feet of second growth pine was cut in central New England, with a manufactured value of over \$400,000,000.

As shown in the model, the stands were clearcut, except for scattered hardwoods of no value at the time. Clearcutting and hauling with horses was facilitated by felling the trees in strips and windrowing the slash. The logs were carried on wooden sleds, called scoots, to a portable steam sawmill and there sawed into boards and planks.

No special steps were taken to insure a future timber crop; slash and other material of no value was left to rot. However, despite such carelessness, another stand did ensue. The secret of its origin lies in the advanced growth of hardwoods which started under the pine. Clearcutting the white pine removed the overstory trees, much as a natural disturbance would, so that a new, even-aged stand could start from "advanced growth" sprouts and from new seedlings.



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, 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.

The model shows that five years after logging, hardwoods are growing primarily in the open lanes between the wind-rows of slash. These trees originated from the very small stumps of the hardwood advanced growth 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. 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. Sprouts from large stumps are less desirable because they develop stump rot and poor form.

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 unable to grow underneath the previous stand, but which come in abundantly once the site is in full sunlight. New seedlings can invade the stand until the tree crowns close to completely shade the ground. Widespread clearcutting may have increased the proportion of short-lived pioneer species in our landscape.

When a pine woodlot is cut in a good seed year, the hardwoods are supplemented by white pine seedlings, and a few may succeed 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 volunteer stand is composed almost wholly of hardwoods.



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 dealt with in silviculture, such as future crop trees, weed trees, whips and trainers, 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. Red oaks make up a high proportion of those long-lived trees that eventually become dominant and also have good form. This is particularly so since the loss of chestnut from the blight.

Thus, 20 years after logging on this moderately moist soil, the red maple, gray birch, black birch, and most other species begin to slow down in height growth, but the red oaks maintain a steady height- and diameter-growth rate so that by 60 years they will have emerged to form an overstory above the other trees.

The oaks in this diorama are just beginning to take over, and they will eventually suppress and almost stop the growth of their companion trees. The dominants in a stand have room to grow rapidly, while the others with less space grow more slowly. This continues until differential growth produces a stand of trees with many sizes in it. However, the stand is still even-aged and the small trees one often sees growing under large ones seldom represent a new "advanced growth" invading to take over when something destroys the main canopy trees.



EARLY TREATMENT OF A VOLUNTEER HARDWOOD STAND

IN THE background on the left is the margin of a 60-year-old white pine stand about to be clearcut for lumber. Just prior to logging, the hardwood advanced growth is mowed off close to the ground. Seedlings and small saplings of many long-lived hardwood species are present and cutting will actually save these young trees for the next crop. Such undergrowth, if 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. After mowing, however, the small stumps less than two inches in diameter send up well-formed sprouts which are fully acceptable as prospective crop-trees. These sprouts may grow as much as six feet per year, if they are not browsed back by deer.

In the center foreground appears a portion of a pine cutting area six years after logging. Sprouts from the stumps of the hardwood undergrowth have been supplemented by seedlings, many of which are light-seeded pioneer species. Workmen are cutting back the multiple-stemmed sprouts from the stumps of occasional large hardwoods and short-lived trees whenever they dominate over more desirable trees. This will allow the healthiest trees with the best chance of a long life to take over the stand at an early stage.

A second weeding at age 15 may further speed development of a healthy stand of vigorous trees. However, all extra stems are not cut because those that fall behind now will serve a useful purpose later by shading off the lower branches of the dominant crop trees to help them form straight clear boles.

Nowadays weeding can be accomplished by careful use of selective herbicides more effectively than by cutting. For aesthetic reasons, it may be more desirable to cut the stems first and then prevent new stump sprouts by applying a safe herbicide.



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

ON CUTTING areas which contain patches of dry, poor soil it is often advantageous to supplement the volunteer hardwood stocking with groups of conifers. It takes less effort to keep the hardwoods under control on such sites because here, in contrast to moist sites, hardwoods do not grow as well as pines.

On 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 necessary because a destructive snout beetle, the pales weevil, is attracted to fresh pine cuttings and feeds on any small seedlings which may be present. The hot fires in the windrows destroyed much of the hardwood advanced growth. Advantage is being taken of this reduced hardwood competition by planting the white pine there.

In the center is a similar groupwise stand of white pine and hardwoods, but in this case the pine owed its origin to the Shelterwood System of reproduction. By this method pine seedlings become established under the shelter of the previous pine stand, as the result of a series of partial cuttings which improve the seed bed, stimulate seed production, and admit the needed light to the understory. Four years after harvest, 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 a pine forest once stood before it was cut 7 years ago in a good seed year. Some pine groups were established along with the hardwoods and the best pine and hardwood is now being freed from overtopping weed trees.

In all three cases a groupwise distribution of the two elements — white pine and hardwoods — is favored, largely because the pine is so often killed by the hardwoods that in early life grow more rapidly in height.



IMPROVEMENT CUTTING IN A VOLUNTEER HARDWOOD STAND

HARDWOOD stands which had not been weeded in early life commonly look like this about 25 years after the clearcutting of the “old field” pine. They contain trees of many kinds, shapes and sizes — some straight, sound and of valuable species; others forked or crooked, sprouts from large stumps or short-lived species. Improvement cutting, like weeding, aims to favor the best-formed and healthiest trees for the future crop by cutting inferior stems which overtop or unduly crowd the selected crop trees. At this stage, however, most of the trees are big enough to be used for fuel wood or pulp.

Left

Portion of the stand not yet treated. A forester is marking those trees which are to be removed. He has just marked a vigorous, overstory aspen because it is short-lived and will soon die and be wasted unless it is used now.

Center

Improvement cutting in progress. Gray birch, poplar and poorly-formed multiple stemmed stump sprouts are being cut to favor well-formed red oak, paper birch, and white ash. At this age many of the red oaks are forging ahead of the other species which are being left as “trainers” to shade and kill off branches and thus help prune the trunk of the crop trees.

Right

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



FIRST THINNING IN MIXED WHITE PINE AND HARDWOODS

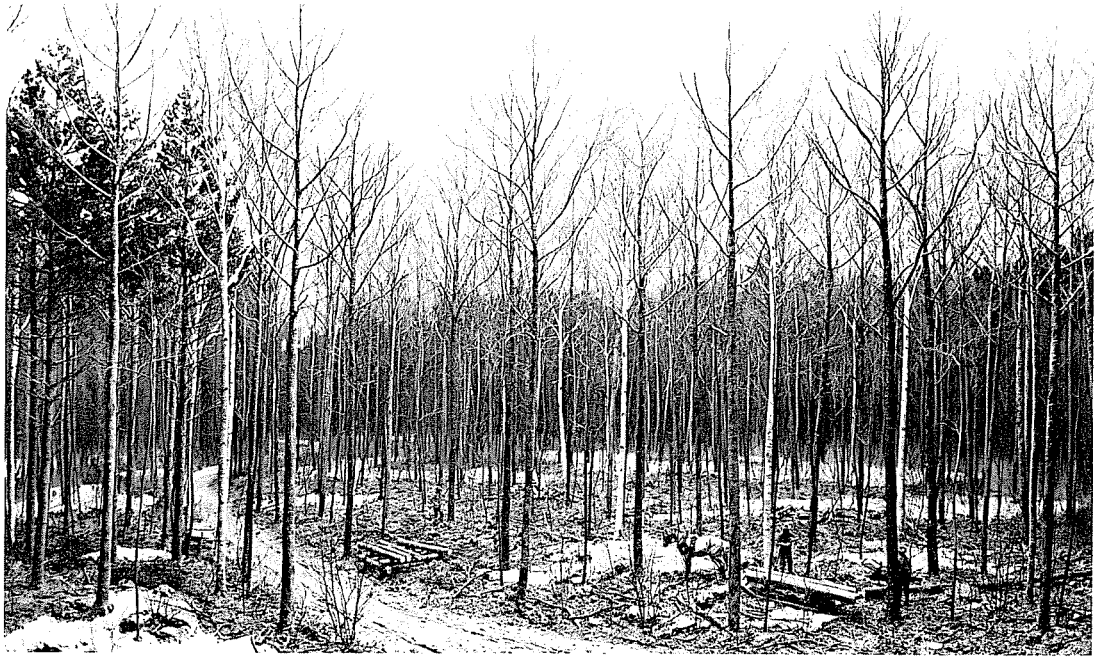
THE IMPROVEMENT stage is followed by thinning, a treatment designed to speed up the growth of selected crop trees by giving their crowns room to expand. Large crowns with plenty of foliage exposed to the sun are needed to produce enough food to thicken the main stem quickly. The overcrowded stand is likely to be full of tall spindly stems, unless neighboring trees that compete for water and nutrients in the soil and for crown space overhead are cut.

Even without help, and despite overcrowding some individual trees will eventually surpass the others in height and start to suppress their neighbors and dominate the stand. Thinning speeds up this natural process and also insures that the healthiest and most desirable trees take over. In this region red oak generally starts to outgrow other species after two or three decades but paper birch can keep up with the oak for 60 years or more.

The thinning in the hardwood stand to the right of the road is a "crown thinning" or "thinning from above" designed to give the best oak, birch and white ash plenty of crown space by cutting the poorest of the competing trees. Wherever possible the cut trees have some noticeable imperfection of bole or crown, or are long slim "whips" which abrade against the crop tree crowns. Great care is taken to save the other overtopped trees as "trainers" to shade the crop tree stems and help prune off dead limbs.

At the left center of the model, thinning has been completed; in the center it is in progress; and on 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.

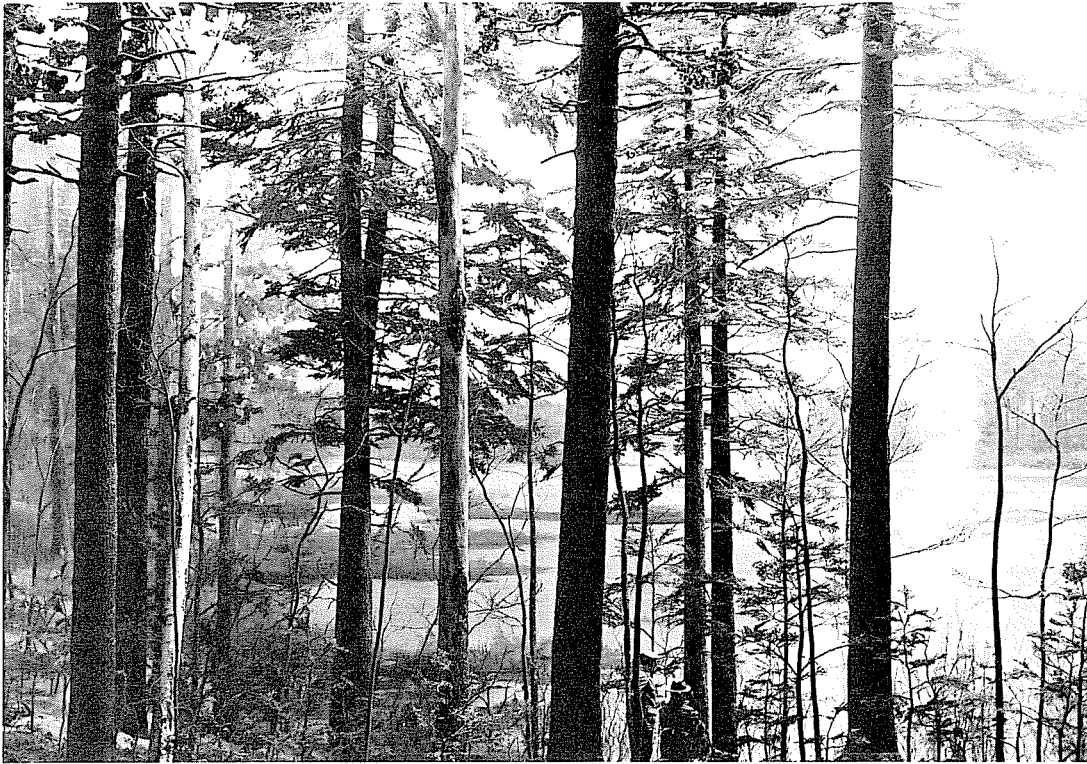


THIRD THINNING IN MIXED WHITE PINE AND HARDWOODS

THIS is the same stand as shown in the previous model. It is now 25 years older and many of the crop trees are from 12 to 16 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 this thinning are suitable for sawing into lumber, while the upper portions of the bole and the limbwood are useful as fuel or pulp. 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.

In this third thinning, the number of crop trees in the hardwood portion of the stand is reduced to about 100 per acre, or to a spacing of around 20 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 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 another ten or fifteen 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.



OLD GROWTH FOREST ON THE SHORE OF HARVARD POND

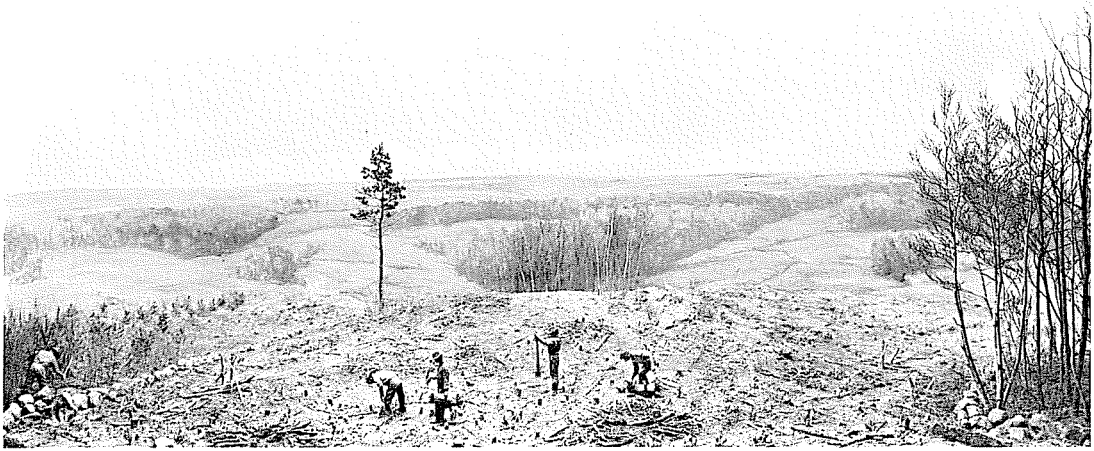
THIS REMNANT of old growth forest survived all the rigors of the local climate until the destructive hurricane of September 21, 1938. The overstory trees are all about the same age but in their size and variety and in the unmistakable signs of antiquity they contrast strikingly with the young even-aged 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 place for one who would enjoy the beauty, wonder and quiet of 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 Shaler, to whose memory Shaler Hall is dedicated.

Among the characteristic elements of such a forest which



show the dynamics of disturbance, 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 shallow pits in the soil, caused by the tearing out of roots no longer able to give anchorage to the towering trunks. Old stumps 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 natural development. These lessons can be applied to present day forests so we can build up healthy and vigorous stands of trees, easily and cheaply established, maintained, and regenerated.



CONVERSION OF CORDWOOD TO FUTURE SAWTIMBER

ON DRY upland sites such as this, hardwoods do not grow vigorously and are likely to develop crooked stems like those in the stand on the right. Pines, on the other hand, can do quite well on such sites provided they are not overtopped by the hardwoods.

With relatively little effort, the hardwood stand at the right can be converted to conifers. In the center, the hardwood forest has been cut for cordwood, the slash burned, and now two crews are at work planting conifers. Transplants first grown in a nursery are used. The sprouting hardwood may temporarily crowd the sides of the planted conifers, thus helping to prune off lower branches. However, the sprouts must be removed, before they overtop the pine.

A variety of species is available for 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 if they are to be grown together. Coniferous species planted on the Harvard Forest include white and red pine, white and Norway spruce, European and Japanese larch.

On the left side of the model an earlier plantation of white pine and European larch is being weeded to keep the hardwood sprouts from suppressing the conifers. On dry sites, hardwoods do not resprout very vigorously so few such weedings are necessary to keep the conifers from being shaded out. On moist sites, the increased vigor of hardwoods may call for frequent weeding unless modern herbicides are used in a basal spray to prevent resprouting. Even on a dry site herbicides may greatly reduce the cost of hardwood control, provided they are used properly.



RELEASE OF WHITE PINE FROM SUPPRESSION BY GRAY BIRCH

IT SOMETIMES happens that abandoned fields seed in with gray birch and white pine, most often on dry sites with an abundant supply of birch seed trees and not many white pine. Although shorter-lived than the pine, the birch grows much more rapidly at the beginning and soon completely overtops the pine. The light shade provided by the birch slows the growth of the pine. Shaded white-pine leaders are less attractive to white-pine weevils, so damage from this insect is reduced. Eventually, however, the pines are tall enough to be severely whipped and damaged by the birch, which should then be cut.

White pine mortality under the birch varies to a great extent with the fertility of the soil. On moist soils, the pine is eliminated almost completely by the time it is 20 to 30 years of age. On dry, sandy soils which conifers can tolerate better than hardwoods, the pine may persist until the gray birch reaches maturity and dies. 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.



PRUNING WHITE PINE TO PRODUCE CLEAR WOOD IN THE BUTT LOG

ONE CHARACTERISTIC of white pine in pure stands is the persistence of dead branches that cause loose knots in lumber. If knot-free lumber is desired, the branches must be pruned by sawing them off close to the live stem.

Densely stocked, naturally seeded stands on old fields are especially well adapted to pruning, because close spacing shades off the lower branches while they are small and forces the trees to grow straight. On the left side of the model is a young stand of such origin, which is now receiving its first pruning. The dominant trees are about 17 feet high and are pruned up as high as a man can reach; about 6 or 8 feet. A sufficient number of the best-formed "dominants" are selected and pruned to form a final crop of 100 to 150 trees per acre.

In 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 with the help of a pole saw or ladder, except where a crook in the bole may occur at a slightly lower point. Neighboring trees which interfere with the growth of the pruned crop trees should now be cut or girdled to provide more room for crown expansion.

On the right is a widely spaced plantation where the dominant trees have become forked and crooked after white pine weevil attacks. Here trees suitable for pruning are found chiefly among those which are partially over-topped 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. Most of the trees girdled earlier at the start of pruning are now dead, and a workman is girdling others which threaten to suppress the pruned trees. Girdling is preferable to cutting because dead trees left standing protect neighboring pruned crop trees against sun scald and snow breakage. Also, the dead stems eventually rot and do less damage to the surrounding trees when they fall.



GROUP SELECTION METHOD OF NATURAL REPRODUCTION IN WHITE PINE

IN THE broad valleys the receding glaciers left deposits of sand and gravel; and on such dry sites 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 areas contain a mosaic made up of small even-aged patches or groups, each of which started after some fire, wind storm, or cutting.

Clearcutting large areas 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. On the left a mature group, 60 years old, is being clearcut. The small 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. On 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 earlier. 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, scattered pine seedlings occur.

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 boggy "pot hole" characteristic of morainal deposits.



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.

Reproducing white pine by shelterwood regeneration can help avoid damage from the white pine weevil which kills the well-lighted, open-grown leading shoots of this species. One method of avoiding this damage is to grow the young white pine in the partial shade of the shelterwood where the shaded terminal shoots of the pine are less often attacked by the weevil.

Left

Uniform shelterwood method applied to a mixed stand of white pine, oak and hickory on dry 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

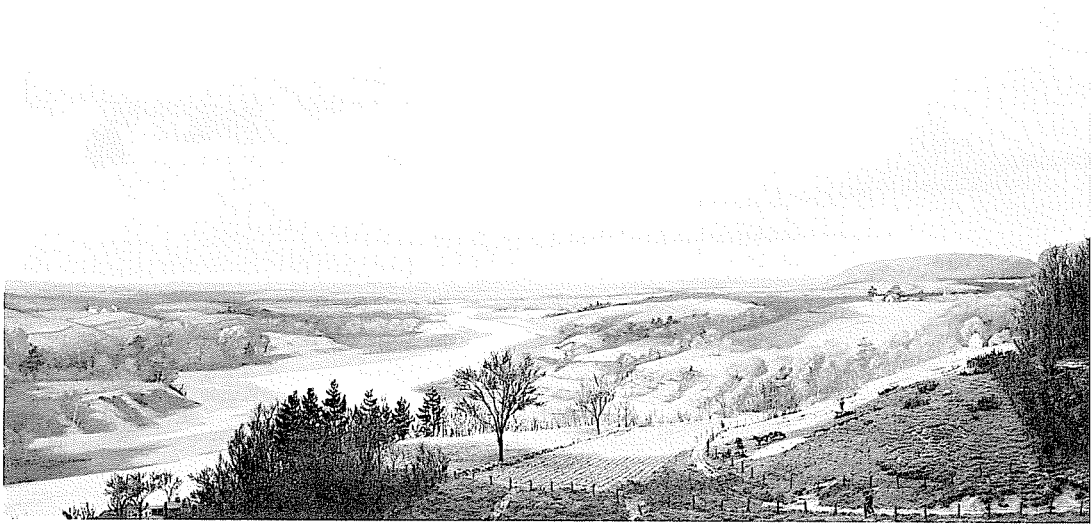
Strip shelterwood method in white pine. From the oldest strip of pine reproduction along the road, all of the parent trees have just been removed. On the adjoining strips, partial cuttings are being made to increase the growth of the small seedlings already present and to encourage the establishment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



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, created by the settlers to furnish power, are used by aquatic birds and mammals. 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. Forestry, by giving special consideration to wildlife, can also provide for them. The small, continuous silvicultural operations in a forest under sustained management 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. However, as timber management becomes more intensive, conflicts can arise. Deer can browse down the young trees needed to make a new stand. Or the large openings made necessary by more efficient harvesting equipment may reduce the edges between small stands that are so necessary for wild animals. It is generally impossible to get the highest yield of everything from a forest area — timber, wildlife, water, recreation, amenity, grazing and the like. Normally a choice must be made to trade off one thing for another as forest management proceeds.



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, stones and pebbles 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 fields and cut-over land.

The model shows accelerated and destructive erosion in a New England intervalle 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 a steep terrace front when cleared and pastured. Erosion can be prevented if these slopes are protected by trees.

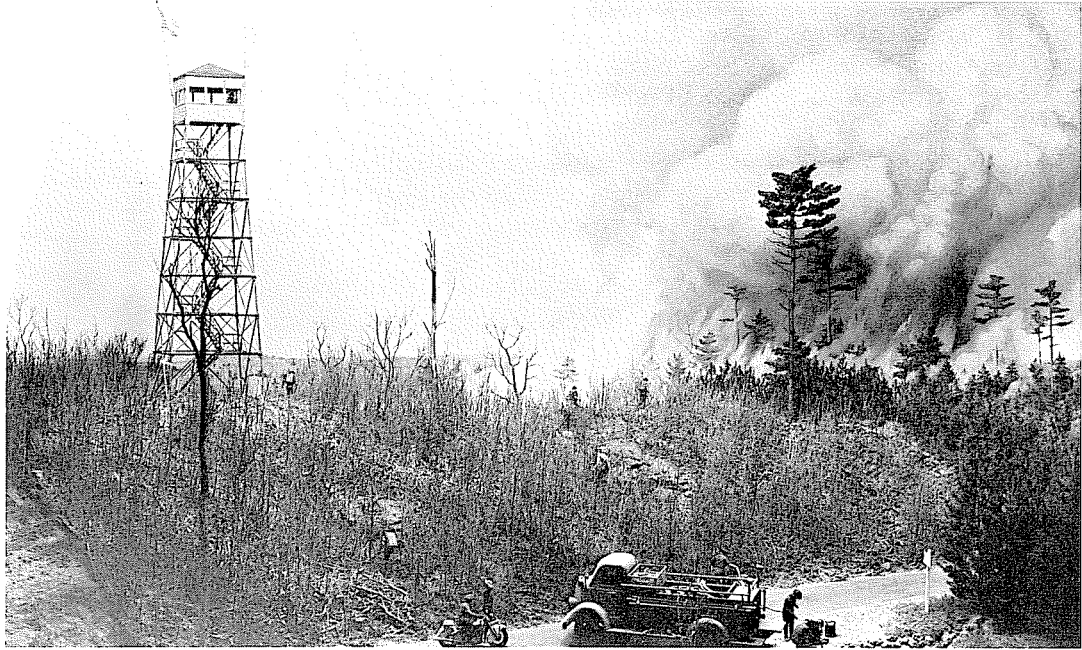
Gullying can result where run-off from a ditch is concentrated, as in foreground.

Landslides may occur where the steep front of a silt terrace is undercut by stream as on left of the model. Sheet erosion and gullying can be caused by careless husbandry.

The upper part of the hill on the right shows old ploughing up and down slope. The field now abandoned is being replaced by woods.

The lower hill slope on the right was ploughed parallel to the contours except in the nearer portion where some erosion resulted. Such fields should be in pasture a large part of the time, and only the flatter land should be cultivated.

Carelessly built farm and wood roads probably cause more erosion on forest land than any other human activity. When left in place, litter on the forest floor keeps the soil so sponge-like that water sinks in and flows through the soil rather than over the surface. Eventually this “underflow” comes to the surface again to form a spring or stream.



FOREST FIRES IN NEW ENGLAND

THE GREAT majority of forest fires in New England are caused by human carelessness, by disposal of smoking materials, irresponsible burning of brush and debris, uncared-for camp fires, etc. Railroads cause some, but the proportion resulting from this source is much smaller than in years gone by. The fires that so commonly result from lightning 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. The same density of population, however, leads to early detection so fires are generally found and extinguished while they are still small.

Some of the poorest forest stands in the region are the result of fires. 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 advanced reproduction are killed. Land burned over does not often 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.



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 cooperation between the state and the local community. Each township has a local fire chief or forest warden who, with his men and equipment, is the first line of defense. The second line of defense 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 fire departments. In addition, the states stand ready under a special compact to send aid to each other if the need arises.

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 fire departments. 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.

For the quick detection of fires, each state used to maintain a system of forest fire observation towers which were connected by telephone to the nearest exchange and in which an observer was maintained usually from April to October. In Massachusetts these towers were also equipped with two-way radios, so that the observers were in constant touch with the state wardens whose cars are similarly equipped. Many towers have been given up, however, because air patrols are often cheaper and more effective. As a result of general improvements in the 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.



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 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 touched up and color variations in the foliage are done by hand. The background is painted with particular attention to the joining with the foreground.

