Five Years of Research on the Fernow Experimental Forest West Virginia

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CONTENTS

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on the

Fernow Experimental Forest

by

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THE FERNOW FOREST

In 1948 the U. S. Forest Service's Northeastern Forest Experiment Station set up a research center in West Virginia to study forestry problems in the Appalachian Mountain region. It was named the Mountain State Research Center.

To carry out these studies, the Fernow Experimental Forest was established, on land set aside by the Monongahela National Forest.

Located near Parsons, W. Va., the Fernow Forest contains 3,640 acres of second-growth Appalachian hardwood stands. In topography, history of cutting and fires, and variety of forest types and conditions, the area is representative of more than 13 million acres of mountainous forest land in West Virginia and adjacent states. It includes the entire watershed of Elk Lick Run.

The Fernow Forest is a field laboratory, devoted to research in growing and harvesting Appalachian hardwoods. The research program here is aimed toward finding practical solutions to problems of managing the timber and water resources of this region.

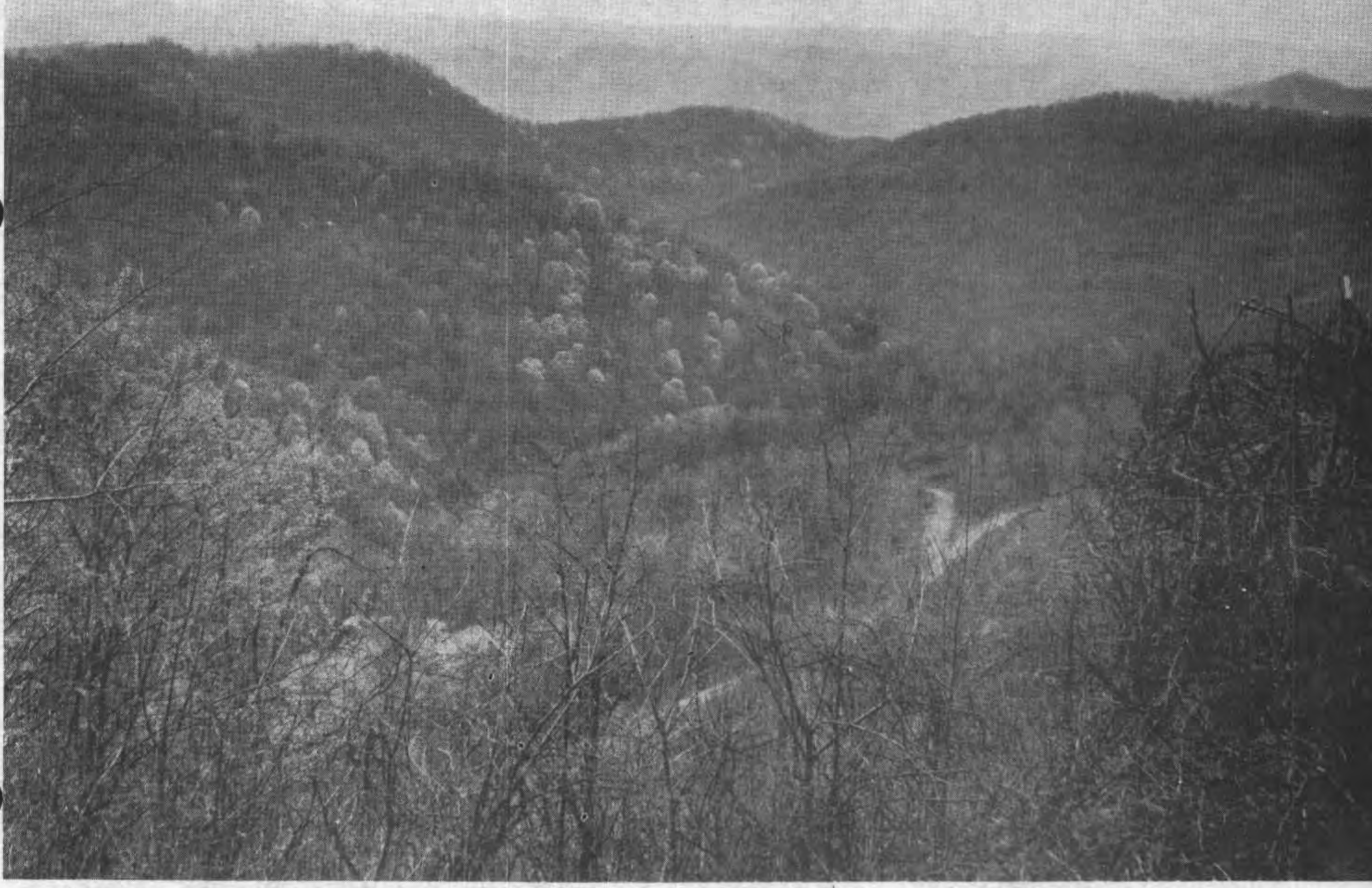
This area originally supported an excellent stand of timber. At the lower elevations the original forest was mainly hardwood, with hemlock along the creek bottoms. The slopes had fine specimens of oak, cherry, poplar, chestnut, maple, birch, and other hardwoods. The higher elevations were covered with an excellent stand of spruce and hardwoods. Small patches of pure spruce occurred on the tops of the mountains. At the time of cutting, the tract is estimated to have averaged 15,000 board feet per acre, with many areas exceeding 30,000 board feet per acre.

The cutting and subsequent history of the experimental forest followed the pattern so common for Appalachian hardwoods. Logging took the best species. Undesirable trees of poor form and unmarketable species were left. Forest fires burned the area repeatedly, and chestnut blight killed the chestnut, one of the best species. The area was logged by railroad, log slides, and horse-skidding. Skid roads used 50 years ago are still in evidence today.

In 1915, the area was acquired by the United States as part of the Monongahela National Forest. Since that time fire and grazing have been excluded. Until the experimental forest was established, no cutting was permitted.

Topography The topography is rugged. The valleys are deep and narrow. The slopes of the watersheds are steep and precipitous. Much of the ridge-top area is flat or gently sloping. Elevations range from 1,750 to 3,554 feet above sea level.

Soils The soils of the area are chiefly loams and silt-loams of the Upshur and DeKalb series. Though these soils occur on slopes too steep for agricultural use, they do grow excellent stands of timber. They originate from shales and sandstones on the western half of the forest and from sandstones, shales, and limestone on the eastern half of the forest. The soil is in no place very deep. Generally it contains a large proportion of shale and stone fragments.



Rugged typography is the dominant characteristic of the Fernow Experimental Forest and the area it serves.

Climate The climate of the area is characterized by sufficient and well-distributed rainfall, moderate temperatures, and a growing season suitable for the growth of hardwoods. The tract lies within the 45- to 55-inch rainfall belt, and precipitation is well distributed throughout the year. Snowfall is moderate, but not reliable enough to influence logging methods. The mean annual temperature is between 45° and 50° F. Extremes of 102° and -28° have been recorded at Parsons. The length of the growing season averages 145 days.

Cover types The forest types and conditions now found on the Fernow Forest reflect the site qualities and past treatment of the area. They fit generally into three types: (1) cove hardwoods in the moist fertile valleys and on lower slopes; (2) northern hardwoods and mixed oaks on the middle and upper slopes; and (3) the ridge types. Twenty commercially valuable species are found here. Hard maple, beech, yellow-poplar, and oaks are most prominent. Hemlock is the only coniferous species left in the stands, but it is of minor importance.

Much of the area is dominated by decadent, overmature remnants of the original stand left by the "high-grading." Of poor form, damaged by fire, and infected with rot, these trees are stifling the younger ones beneath them.

The total volume of timber is more than 21 million board feet--an average of 6,000 board feet per acre. The stands vary from 16,000 board feet and more per acre to as little as 200 cubic feet per acre, with no board-foot volume.

Markets There are local markets for a variety of forest products. Within a radius of 25 miles there are several large mills that provide outlets for veneer bolts and high-grade logs. Several smaller mills utilize the poorer-quality timber for construction and mine timbers. The products of improvement cuttings and thinnings are accepted locally by the mine-timber industry and to a lesser degree by pulpwood markets. There are few, if any, outlets for fuelwood.

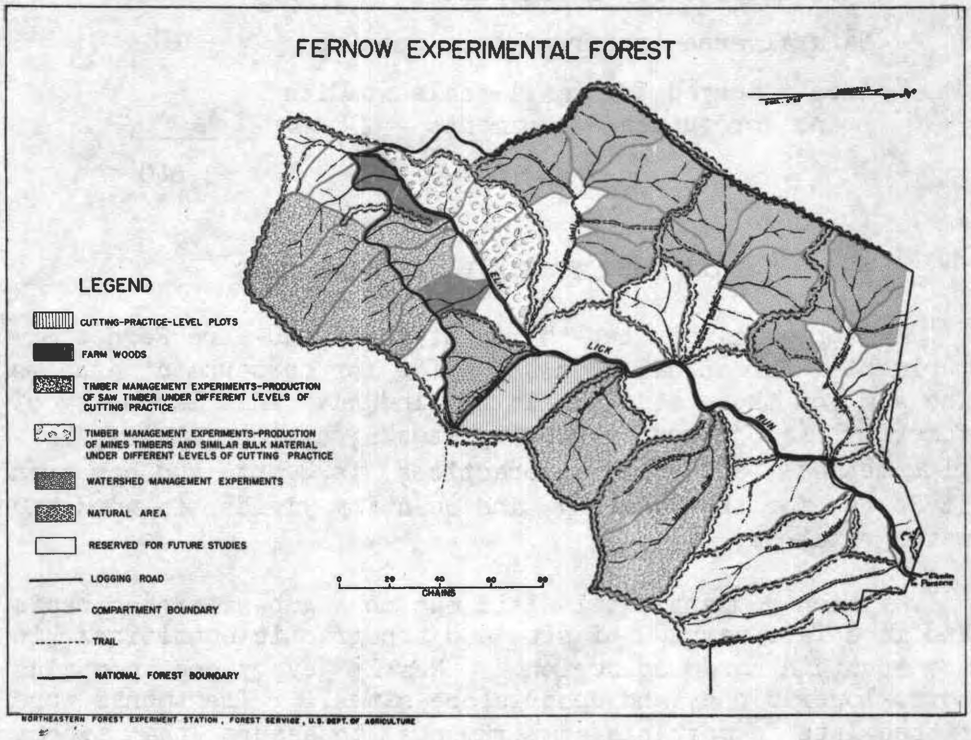
Fire protection The experimental forest is protected against fires by the Monongahela National Forest's fire-protection system. The district ranger at Parsons is in immediate charge of the fire protection. He is assisted by the research staff of the Fernow Forest.

<u>Road system</u> An adequate and well-designed road system is required for the experimental cuttings on the forest. There are approximately 10 miles of all-weather roads on the forest now. Short spurs and logging roads will be constructed as logging operations extend over the forest. Parts of the road system will be experimental; they will be used to study the relationships of such design features as location, grade, and drainage to road erosion and stream sedimentation.

GENERAL PLAN OF RESEARCH

The work of the research program may be broadly divided into two separate types of studies, although all research projects are inter-related for the purpose of growing better forest crops.

One type of study is the compartment management study. Here the workability and the financial feasibility of timber- and watershed-management practices are tested on



Location of the different studies on the Fernow Experimental Forest. Some areas are reserved for future studies.

areas ranging in size up to 150 acres. These areas are natural logging units or sub-watershed compartments.

The second type of study, equally important, is the special study or small-scale study. These studies are designed to answer specific problems of a technical nature. Usually they are conducted on plots or smaller areas. Some portions of the forest are reserved solely for this purpose. Other small-scale experiments may be undertaken on compartments where they will not hinder, but will supplement, the main purpose of the compartment studies.

The tentative assignment of compartments or sub-watershed areas to the various types of study or intensities of cutting practices is as follows:

Research use	Acres
Compartment tests:	
Timber-management practices	1,047
Watershed-management practices	1,209
Farm forestry	62
Cutting-practice-level plots	20
Natural area (reserved from cutting)	102
Area reserved for small-scale studies and for future experiments	1,200
	3,640

COMPARTMENT STUDIES

Approximately two-thirds of the 3,640-acre Fernow Experimental Forest has been set aside for compartment studies. The aim of these studies is to find out what intensity of forestry (as judged by growing stocks, cutting cycles, logging methods, and cultural practices) is best; and how much it costs for the quality and quantity yields of wood and water obtained.

Each compartment is laid out on a sub-watershed basis and is a fair sample of site and topographic conditions in the mountain hardwood region. Nearly every one contains cove, lower slope, and upper slope sites. Treatments were fitted into comparable compartments to assure that types, condition classes, topography, soil, and aspect were equally represented among compartments of each major treatment. So the results of these compartment studies should have wide application.

Records on which analysis can be based are maintained for each compartment. These include periodic inventories of the stands as to volume, quality, and composition, and the progress of reproduction, materials removed in any harvest cut, cultural methods employed, the costs of any and all operations on the compartment (in man- and machine-hours as well as dollars), and income credited to the area. These records will tell the story of success or failure, and they will be available to guide the forest owner and manager toward the successful management of his forest.

The size of the individual compartments is such that the forestry practices and operations will approximate those on extensive holdings. Costs will be reasonably close to those likely to be met on commercial jobs. By keeping records of costs and returns, as well as quality and quantity of timber produced, the economic and silvicultural feasibility of managing and logging mountain hardwoods will be determined.

These integrated compartment studies will determine how to best manage an area where the primary objective is: (1) Integrated timber management, (2) mine-timber management, (3) farm forestry, or (4) watershed management.

In addition, the effect of each cutting-practice level on water quality and quantity will be studied. In that way the composite effect of a level of management will be available for both timber production and water regulation.

Integrated Timber Management

This series of studies is designed from the viewpoint of the owner of an Appalachian hardwood forest who is interested in the management of his property as a going and profitable business.

He would want to know whether forestry pays, and how much; how to diversify his crops by holding some trees longer for more valuable products such as sawlogs and veneer bolts. He would ask how well it pays to "cultivate" his timber crop by release cuttings, weedings, and pre-merchantable thinnings, and when the limits of profitable cultivation have been reached. He would want to know how much and what kind of growing stock or capital he should maintain, and how he could best attain it. And he would want to know the proper length of cutting cycles, or how often he could obtain income by harvesting his crops, and how his property should be organized and developed for harvesting them.

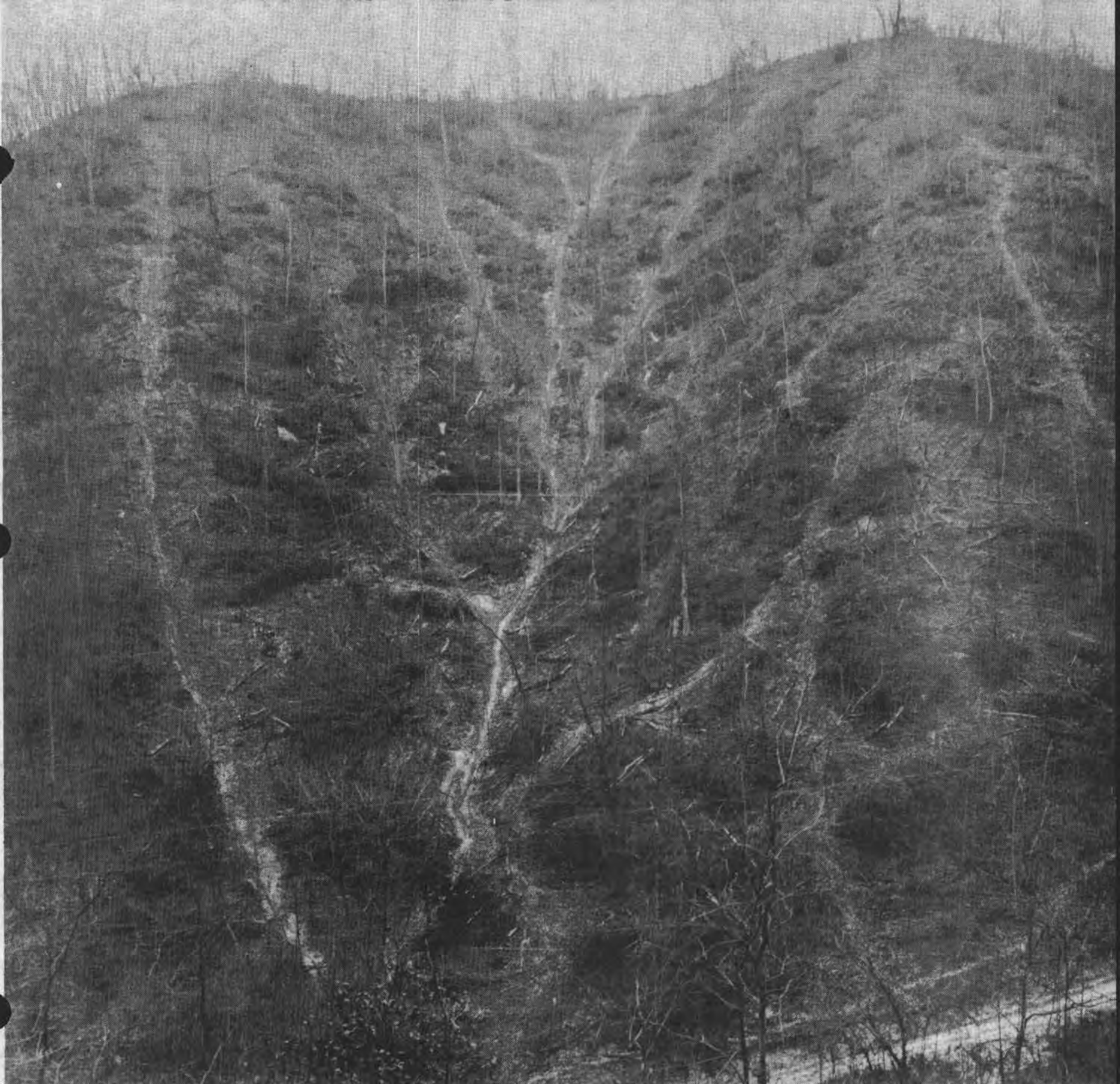
Four intensities of treatment are being tested on a commercial logging basis. Each combines forest-management and watershed-management practices into a "package" treatment. The practices have been selected from among those that a review of the literature and experience indicate are appropriate to the cutting practice assigned. The four treatments are:

Clear cutting — This is the common liquidation method of cutting. All trees that pay their way are cut, down to mine-prop size. Unmerchantable low-quality trees are left. No provisions are made for adequate regeneration or stocking. There are no restrictions on methods of cutting or skidding, and no cultural improvements are made. There is no definite cutting cycle--each future cut will remove all merchantable trees. No provisions are made for watershed protection.

Diameter limit cutting — All trees 16 inches and larger are cut--but no more than 70 percent of the gross volume is removed. A diameter-limit cutting such as this is usually the first step in practicing forestry. Trees are not marked for cutting. There is no control over species composition, spacing, or quality, since the only silvicultural tool is a diameter limit. Enough timber is left so that another cutting can be made in 20 or 30 years. Minimum cultural measures are used. Unmerchantable trees down to the 16-inch diameter limit are cut or girdled. Although there are no restrictions on logging methods, water diversions are established on skid roads at approximately 2-chain intervals.

Extensive management — This intensity of cutting is the beginning of technical forestry. All trees to be cut are marked by a forester. The initial cutting is limited to about 50 percent of the gross volume. Defective trees are cut first. Desirable species are encouraged. Cull trees are girdled. Succeeding cuts will be made at 10- and 20-year intervals. This cutting practice is substantially better than diameter-limit cutting; it includes some cultural measures. Care is taken in felling and skidding to protect standing timber and reproduction. No skidding can be done in stream channels, and skid roads are limited to a 20-percent grade. Necessary water bars are established immediately after logging.

Intensive management — In this cutting practice, the best method of harvest cutting, logging, and silviculture is used. The initial cutting is limited to 40 percent of gross volume. Defective trees are cut first.



An example of the clear-cutting practice. All the salable timber has been cut. Skid roads, run straight up and down hill, create new water channels and open the way for erosion. · It will be a long time before another cutting can be made here.

An example of the diameter-limit cutting practice. Notice the large opening left. The remaining trees are small; many are badly formed. Since only the large trees were cut, the logging costs here were lower than in the clear-cutting.

Extensive-management cutting practice is the beginning of technical forestry. Cull trees like this one are cut first. Part of the profits from the first cutting are invested in stand improvements.

Intensive-management cutting leaves a good distribution of desirable trees. Although returns from the initial cutting were small, the stand has been put into good condition for producing valuable future crops at fairly short intervals.

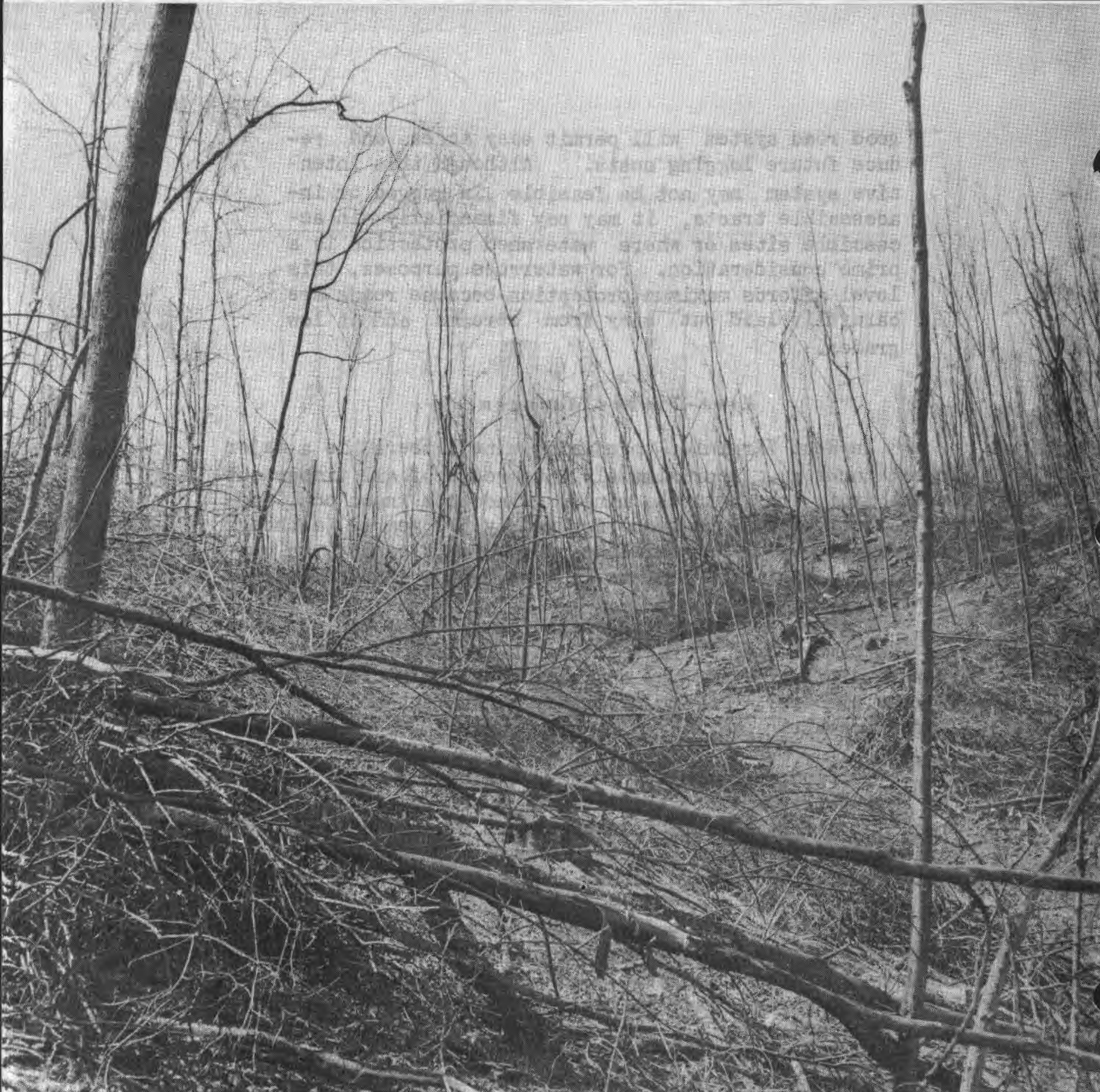
Good growing stock is maintained. Cull trees are removed. Cutting cycles are short, either 5 or 10 years. In addition to the cultural measures practiced under the extensive forestry practice, direct measures to establish reproduction may be taken, if necessary. Weeding and thinning will be done as needed. Skid roads are limited to a 10-percent grade.

Records from the initial cuttings have been collected and analyzed. Although the final merits of each cutting practice will not be established for years--since we are dealing with timber growth--some tentative results are indicated. These will undoubtedly be modified as more information becomes available. Nevertheless, the results will give the practicing forester an idea of what he can expect. In general, results to date indicate:

- The clear-cutting practice will probably not prove economically or silviculturally desirable in the long run. With this kind of cutting one cannot plan on growing high-quality timber. Although the gross return per acre is highest, since this is a liquidation cut, the net return per 1,000 board feet is less than in the next better cut. Cutting smaller trees increased the cost of operation. Since the next operation will be delayed until another crop of trees grows up, the average annual return to the owner will be low. There is no protection of watershed values.

- The diameter-limit cutting practice level is more attractive silviculturally and financially. Economically, this system gives promise of returning several times as much as the clear-cutting over several cuts. Present returns per 1,000 board feet cut are higher than under clear-cutting. Enough growing stock has been left on the ground to permit another cut in 20 or 30 years. However, there is no assurance of improved quality, since the only cultural treatment is the girdling of large unmerchantable trees. For watershed purposes, only a minimum of protection has been obtained.

- The extensive-management cutting, although not returning as much financially in the first conditioning cut as diameter-limit cutting, will probably equal or exceed the returns from the diameter-limit practice over a few cuttings. Part of the profit had gone into cultural work. Since stand



This "mine-prop" cutting was expensive, and did not leave much for future harvests. All trees 8 inches in diameter and larger were cut.

In this "mine-timber" cutting, trees under 16 inches diameter were left for future harvests. In the long run, returns from this lighter cutting will be greater than those from the heavier cuttings.

Mine bar — In the "mine-bar" cutting, all trees down to a 12-inch diameter limit are cut. Trees of this minimum diameter produce several mine bars and several props from each tree removed. Yet this kind of cutting leaves a reasonable growing stock on the ground and another cutting can be made in 10 years. In addition, unmerchantable trees are girdled or poisoned and care is taken in felling and skidding to protect standing timber and reproduction. Skid roads do not exceed a 20-percent grade, and water bars are installed on the skid roads after logging. Thinning is done where necessary.

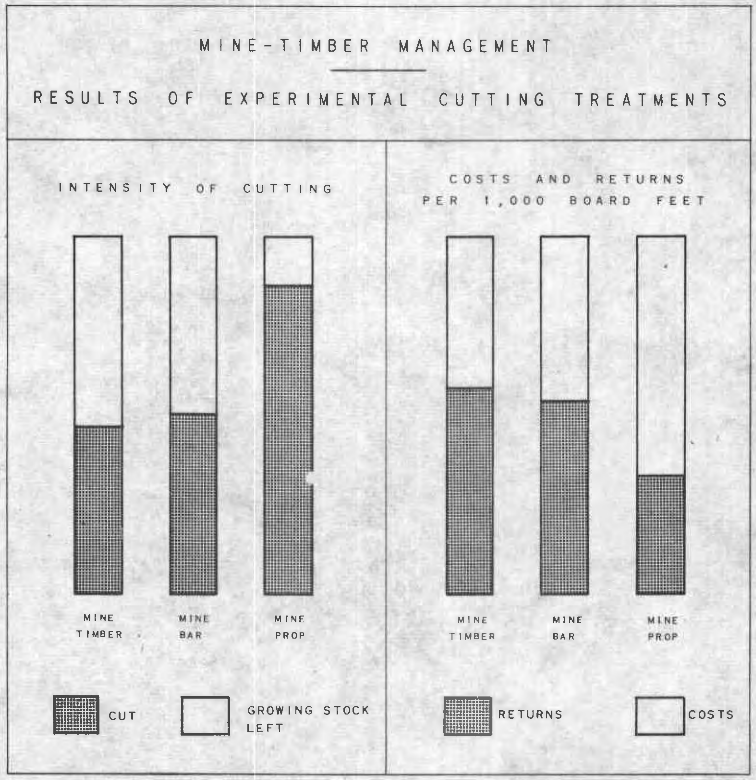
Mine timber — In the "mine-timber" cutting, trees are cut to a 16-inch diameter, which leaves a good growing stock on the land for future growth. A cutting cycle of 5 years will be used. Trees of this size provide rough timber for construction as well as several mine bars and props. In addition to the cultural measures practiced under the "mine-bar" cutting, skid roads are limited to a 10-percent grade and seeding and thinning are done as needed.

The same general trend in costs and returns was found in the mine-timber cutting as was found in integrated management: cutting all the growing stock (8-inch diameter) gave a lower return than the 12-inch and 16-inch diameter cuttings which left something on the ground. The 16-inch diameter cutting showed the greatest return from the initial cut. Results to date indicate:

- The "mine-prop" cutting will probably not prove economically desirable in the long run. Cutting all trees down to an 8-inch diameter leaves the area pretty bare. As in the clear-cutting integrated-management practice, there is no provision for adequate regeneration or stocking. There is no protection of watershed values.

- The "mine-bar" cutting is much more attractive financially. Not only are the immediate returns better than in the "mine-prop" cutting, but this level should net a greater return in the long run. Another cut can be made in 10 years because a reasonable growing stock has been left. Watershed values have been protected and this may be adequate where conditions are not too critical.

- The "mine-timber" cutting will probably exceed both lower levels in economic returns. The short cutting cycle will permit maximum opportunity to harvest trees before they die. Because of good



In studies of management for mine timbers, the lightest cutting showed promise of returning the greatest profit. This cutting practice also affords maximum watershed protection.

stocking, growth should be near a maximum. The permanent road system has been established and paid for. This practice affords maximum watershed protection.

Farm Forests

Farmers own about 33 percent of the forest land in West Virginia. This amounts to more than 3¼ million acres. The average farm forest is about 47 acres, although thousands of farms have several hundred acres in woods. If properly managed, these woodlands could contribute a regular income to the farmer.

On the Fernow Forest, two areas were chosen to be managed as farm forests. The object was to learn what a farmer could do with them. Could he get an annual profit from these woodlands and build up the stand at the same

A carload of pulpwood was cut from the "farm forests". Studies on the Fernow Forest show that a farmer can make money growing timber.

time? These two areas were selected because they represent conditions common in the state.

One farm forest was selected from as poor a piece of timber land as there is on the forest. This woodland was severely burned after logging, and even today it is made up in part of temporary and low-value trees. Many trees are infected with rot and disease. Several areas in this woodland have a low volume.

The second forest has some areas of large over-mature trees. There is very little reproduction under these old holdovers. Many of them are so heavily infected with rot that they are worthless. They had to be girdled and left to die.

The cuttings will be made annually. The plan is to cut no more each year than grew that year. Because of the large amount of cull and defect in the original stand, cutting was a little heavier than growth in first few cuts.

Efforts will be made to log these farm-forest areas with the kind of equipment that is available to a farmer. The first cutting was made with crosscut saw and ax. Skidding was done in one area with horses. In the second and third cuttings, it was impossible to hire a team of woods horses locally. And by that time many of the farmers who work part-time in the woods were using power saws. This trend in logging methods was followed. Tractor and power saws were used in the woods for the second and third cuttings. Tractor skid roads were constructed with the Soil Conservation District tractor.

Results to date indicate that growing timber as a farm crop is good business, especially if the farmer has the time, equipment, and knowledge to do the job himself. The hourly return compares very well with what he could earn in harvesting other farm crops or as wages. Wages earned for labor over a 4-year period in these two farm forests ranged from $0.70 to $1.62 per hour. The average annual net income from these farm forests was $148 per year, or nearly $5 per acre per year.

Watershed Management

One-third of the Fernow Forest has been set aside to find out how good or bad various timber-production and logging practices are for watershed purposes, and to develop plans and guides for good watershed management.

Such studies are especially significant in West Virginia--a state that is aptly called the Mountain State and is frequently referred to as the "mother of rivers." This mountainous province contains large areas of forest land that are vitally important for protecting the headwaters of rivers that carry the commerce, provide water for domestic use, and provide power--and the threat of damaging floods--for millions of citizens. The Monongahela National Forest is such an area; it was acquired under the Weeks Law because of its headwaters' importance.

The manner in which the watersheds on the Fernow Forest can be made to yield timber crops without losing their watershed-protection value, and the extent to which the best practices are applied on a wide front, matters a great deal to many people, in a number of ways. Affected in the mountains as well as in communities far downstream will be the livelihoods of people, their standards of living, their security against floods, and even the existence of some of their industries.

Five sub-watershed areas are now under study. The amount of rainfall on each sub-watershed and the quality and quantity of water that come off each one are carefully recorded under present undisturbed conditions. In that way a relationship between the amount and intensity of rainfall and the volume and value of runoff from each individual drainage will be established. This is called "calibrating".

After they have been calibrated, these watersheds will be cut. Each individual watershed will be cut according to one of the cutting-practice levels previously described in integrated timber management. The change in quality and quantity of water, peak flows, and low flows, will be a measure of the treatments' effects. In that way, the composite effect of each cutting-practice level will be established for timber management, economic returns, and watershed management.

SPECIAL STUDIES

Although the major effort at the Fernow Experimental Forest is committed to compartment studies, some individual studies in both timber and watershed management must be undertaken independently. These special studies are expected to fill gaps in our present knowledge, to aid the compartment studies, or to answer immediate pressing local problems.

Special studies fall into the following classes: Silviculture, logging and economics, sedimentation and erosion, forest influences, and wildlife. Although most of these studies are conducted on the Fernow Forest, some are occasionally made on lands outside the forest. This is sometimes necessary to get conditions that are representative of a particular forest problem.

The following are examples of the kind of special studies that are carried on by the Mountain State Research Center and the Fernow Experimental Forest.

Planting Spruce Land

It is difficult to regenerate areas formerly covered by the spruce type in West Virginia. It is important to learn how to plant these sites because approximately 350,000 of the original 500,000 acres formerly in this valuable forest type are now either barren of woody plants, covered with shrubby vegetation, or dominated by temporary and less-valuable hardwoods.

A study of planting and seeding had already been made on the Monongahela National Forest in 1940. In 1950 the planted and seeded plots were re-examined. This remeasurement, made 10 years after planting, indicated that:

- The character of the competing vegetation has a great effect on plantation survival and growth. Red spruce planted under temporary hardwoods survived better than red pine under similar conditions. Where bracken fern is the dominant cover, there appears to be no real difference in survival between the two species, although red pine made almost double the height growth of spruce.

- Direct seeding of red pine and red spruce seed was a failure under either type of competing vegetation.

- Early release increased survival.

- On severe rocky sites, where competing vegetation is not a factor in survival, red spruce and Southern balsam fir were tested. After 10 years the planted red spruce showed the better survival and Southern balsam fir led in height growth.

Reforesting Strip-Mined Lands

Strip-mining operations create unique problems. They leave the site bare, subject to erosion, and entirely unproductive. In all likelihood, strip-mining is here to stay as long as there are coal deposits that can be reached by surface operations.

Shortly after it was established, the Mountain State Research Center made a study of strip-mined areas. Reforestation appears to be the best treatment for most of the stripped areas.

It was estimated that 95 percent of the stripped land could be reforested. Some highly acid soils seem to prevent any kind of revegetation. But where the soil is not too acid (pH over 4.0), the following tree species were recommended for planting on mine spoils: Red pine, pitch pine, jack pine, and Virginia pine; black locust, yellow-poplar, red maple, and sycamore.

Growth Of Yellow-Poplar

Yellow-poplar stands, because of their favorable locations, fast growth, and desirable species composition, lend themselves well to forest management in West Virginia. To encourage management of such stands, a study was made to find a reliable way of selecting individual trees for partial cuttings.

A simple vigor classification, based primarily on crown size and position, was found to be a reliable guide to growth rate. From this, rates of increase in volume and value were developed, and a practical method of using this information for selecting trees to be cut was developed.

Testing Hybrid Poplars

Tree breeders at the Northeastern Forest Experiment Station have developed several hundred excellent hybrid poplars. The best of these have been selected for clonal propagation on the basis of their growth rate, form, and freedom from disease and insect damage. These clones are being tested at selected localities throughout the Northeast to determine which are the most promising for different localities.

Test plantings of 100 different clones have been made in West Virginia. Annual measurements are being taken on growth and mortality. The first plantings were made in

1951; it will be several years before results can be reported.

Study Of Power Saws

One of the objectives of the research program on the Fernow Forest is to find cheaper and more efficient ways to log mountain hardwoods. Economic logging is a major problem in this difficult logging area. When the Experimental Forest was opened, most operators still used the cross-cut saw and ax to prepare logs for skidding.

Studies elsewhere showed that power saws are generally more efficient for producing hardwood logs than the hand-pulled crosscut saw; so a brief exploratory study was made on the Fernow Forest with the following results.

- A 2-man crew with a power saw was found to be 2.0 times as efficient as a 2-man crew with a crosscut saw.

- One man with a power saw is about 1.7 times as efficient as a 2-man crew with a crosscut saw.

- The productive capacity of either kind of saw is reduced by the time the equipment is idle (time lost in walking from tree to tree, sharpening saw, resting, etc.)

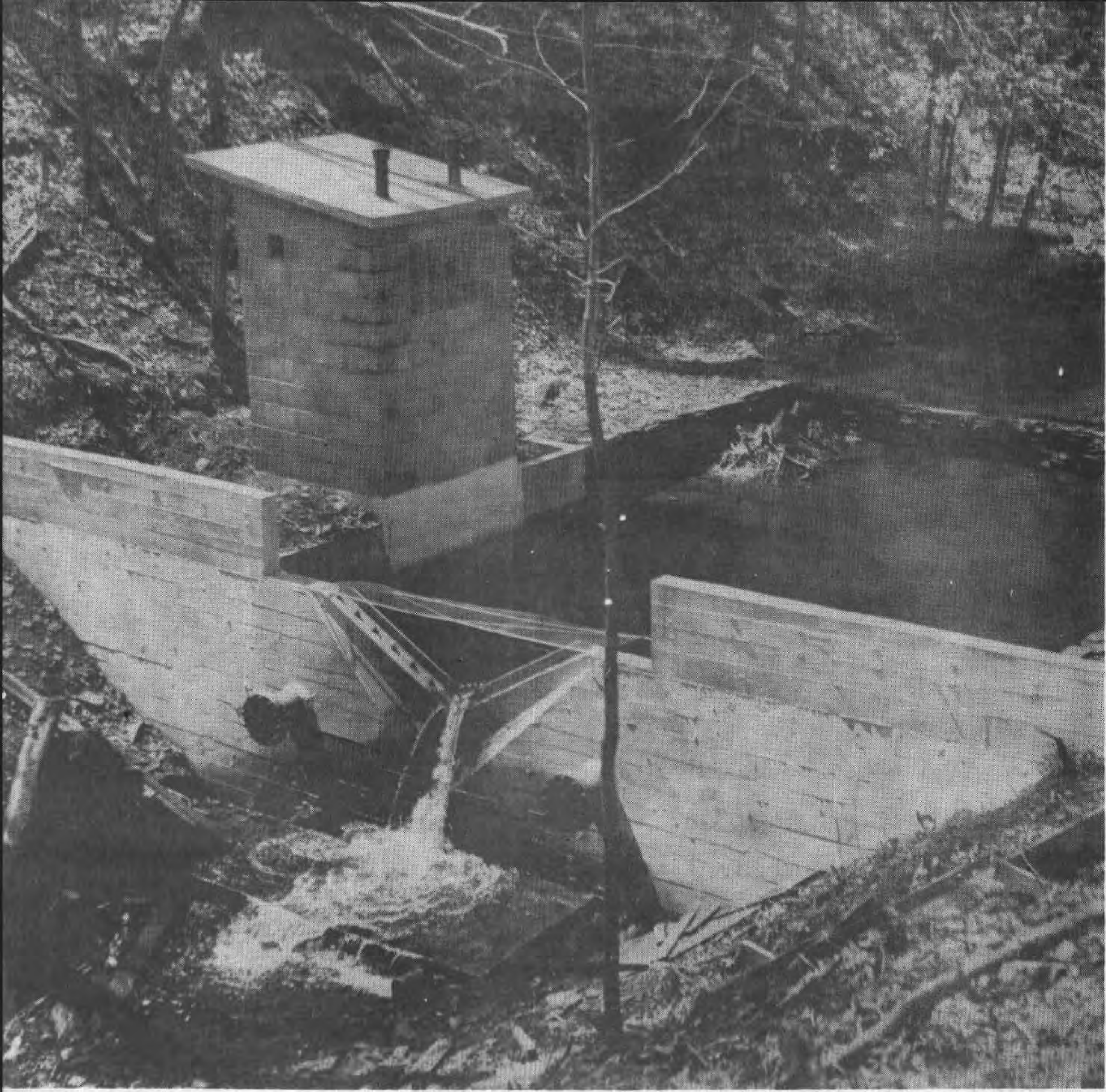
- In an 8-hour day (and allowing for lost time) a 2-man power-saw crew can cut $1\frac{1}{2}$ times as many board feet as a 2-man crosscut-saw crew. And one man working alone with a power saw can cut about $1\frac{1}{4}$ times as much as two men using a crosscut saw.

By converting the time involved into dollars-and-cents cost, these studies show that--

- With a power saw a 2-man crew can produce 1,000 board feet of logs at about 60 percent of the cost it takes to produce the same volume with a 2-man crosscut-saw crew. These costs include depreciation, maintenance, and replacement for the power saw at $0.56 per operating hour.

- With the same saw, one man can produce 1,000 board feet of logs at about 45 percent of the cost for a 2-man crosscut-saw crew.

These data show a considerable saving as a result of using power saws.



A third of the Fernow Forest is used for watershed studies. A continuous record of watershed behavior will show how forestry measures and logging affect the water resource. An automatic recorder in the gage house charts the behavior of this stream.

A successful spruce plantation on a once barren site in West Virginia.

A red pine plantation on a strip-mine spoil bank in Randolph County, West Virginia. Reforestation seems to be the best treatment for most of the stripped areas.

A vigor classification was developed as a guide for selecting yellow-poplar trees to be cut. Three vigor classes, determined from crown size and position, are illustrated here.

Demonstrations on the Fernow Experimental Forest have shown West Virginia loggers that the 1-man chain saw has many advantages over the traditional ax and crosscut saw.

With well-planned skid roads, modern equipment like the tractor-winch-arch combination can be used efficiently for mountain logging.

Several methods of killing cull trees are being studied on the Fernow Forest. Chemical poisoning has proved effective. Ammate is being used on this tree.

Logging Equipment & Methods

Despite a long history of logging experience in this area, logging methods leave much to be desired. They are costly. They are destructive to watershed values. There is little planning in the average logging operation. Road locations and standards are not designed to best meet the needs of the individual logging chance. Logging equipment used is inefficient. Mechanized equipment and modern methods are not common in the area. Before improved forest practices can be adopted, the forest operator needs to know how these mountain forests can be logged economically.

Improved logging methods and equipment were used in experimental logging operations on the Fernow Forest to test their applicability to similar areas. Experience to date indicates that the cost of logging need not remain an obstacle to good forest management even in this difficult logging area. Two changes from present methods are recommended:

- Plan and construct an efficient system of roads in advance of logging.

- Use modern equipment and methods that have been adapted to mountainous terrain.

A practical demonstration of the advantages in reduced costs, fewer miles of skid road, less road erosion, and less maintenance is available on the Fernow Experimental Forest.

Removal Of Cull Trees

How to efficiently remove large cull trees from present stands is a problem that most forest managers face. Many stands in West Virginia are made up of decadent trees that are putting on no net growth and are hindering the regeneration and growth of desirable species.

These cull trees cannot be logged economically, yet they should be removed from the stands. Research elsewhere has indicated that poisoning is one promising solution. Girdling with an ax is one of the methods most frequently used. Power saws have been tried successfully. On the Fernow Forest each of these methods were tested.

Results of the study indicate that poisoning with Ammate (ammonium sulfamate) in recommended doses killed more than 90 percent of all trees within 1 year. Girdling killed less than 20 percent of the trees during the same period.

Observations of kill will be made annually to chart the effectiveness of each method.

Poisoning costs about 1 cent per inch of tree diameter; girdling about $\frac{1}{4}$ cent per inch of tree diameter.

Skid-Road Erosion

In this rugged area, the forests occupy the steepest slopes. Traditional logging practice is to build skid roads straight up and down hill. Some erosion always results. Often it is serious. Some skid roads used 40 or 50 years ago can be identified today by the erosion that followed. Erosion not only increases the cost of logging by making former skid roads unusable; it also damages the watershed values of the region. Siltation pollutes waters downstream. Muddy waters are usually in evidence after a typical logging operation.

Results of studies on the Fernow Forest indicate that erosion on skid roads can be controlled by limiting the gradient and using after-logging maintenance. The mileage of skid roads required can be greatly reduced by careful planning. The less mileage needed, the less the erosion and the less the cost.

Moreover, careful planning of skid roads may pay off as a long-term investment. A skid road properly located and well maintained will not wash out, and can be used for future logging operations. And, as the standards of forest management are improved, a simple skid road that was properly located may later be converted into a high-standard truck road at a considerable saving in cost.

Use Of Soil Conditioner

One of the causes of skid-road erosion after logging is the severe compacting caused by dragging logs over the surface. The bare and compacted skid-road surface has a low infiltration rate. It offers a poor medium for the germination of seeds and the establishment of vegetation.

Can the soil structure be improved to allow better infiltration and provide a more favorable medium for vegetation? If this can be done, then perhaps the rate of erosion on skid roads can be materially reduced.

A study is being made to determine if use of one of the new chemical soil conditioners will reduce post-skidding erosion when applied to the surface of compacted soils. The results of treatment have not yet been determined.

Truck-Road Standards

Standards for logging truck roads have not been established in this Appalachian hardwood region. Private operators build truck roads with excessive grade and with little regard for water values. In many operations streambeds are used as roads. Continual road maintenance because of poor location and drainage adds to the total cost of the roads. Poor roads also increase truck-operating costs. Since these roads usually wash out because no provision is made to protect them, the total investment is lost.

On the Monongahela National Forest, a set of standards for constructing and maintaining logging truck roads has recently been developed. These standards are based on the best information available in respect to width, grade, and maintenance. Experimental logging roads have been constructed and are being studied to determine if these standards for logging truck roads are adequate to meet the needs of the operator and at the same time protect soil and water values.

Skid-Road Revegetation

Vegetation is known to reduce soil erosion. However, bulldozed and other heavily used and compacted skid roads offer poor seedbed conditions. Natural revegetation is often delayed many years. This is especially true when the road has been cut deep into an infertile and acid subsoil.

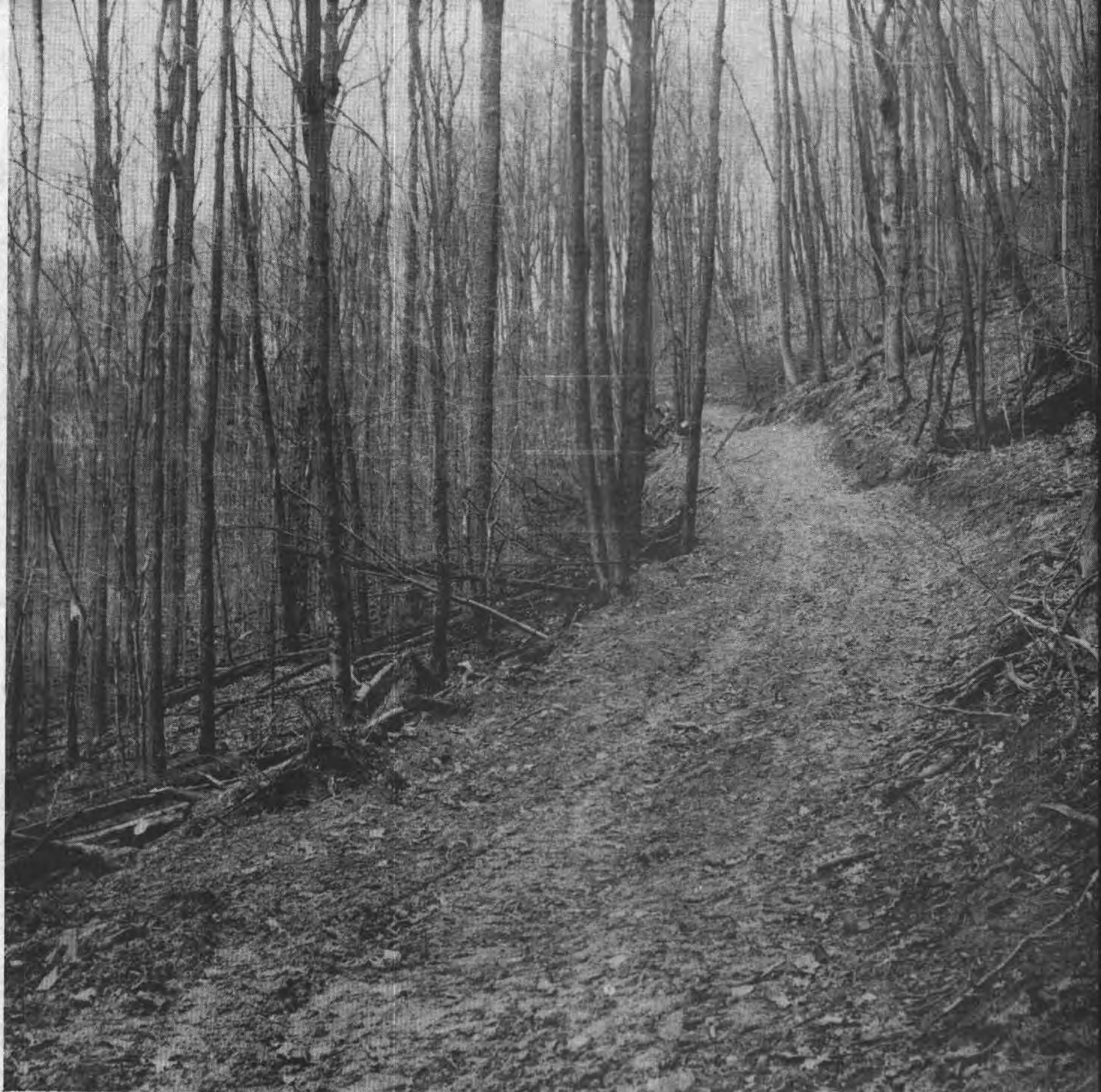
Some means of revegetating these skid roads is desired. Since they are permanently located and will be used for cutting the next crop, there is no desire to reforest them. But is there a cheap and easy way to obtain a cover of annuals and perennials that will prevent erosion?

A study was begun in the spring of 1953 to determine if a vegetative cover can be established on skid roads through use of chaff. The chaff (which contains weed seeds) was spread over skid roads. On some plots the surface was mechanically disturbed. Fertilizer and lime were applied to some plots.

Truck Roads & Water Quality

To get a measure of the effect of constructing truck roads in a mountainous watershed, measurements of water

A poor skid road on a steep slope. Already run-off is tearing the road to pieces and ruining the stream below.



A good skid road like this can be used for future logging jobs. The grade is slight, water is drained off properly, and erosion is kept to a minimum.

Building a logging truck road. Driving the bull-dozer to the top and building the road from the top down is the recommended practice.

How does forest vegetation affect watershed management? In one study, rain gages like this are used to determine how the tree canopy reduces the force of rain striking the forest floor.

Wildlife also has a place in forest management. A study is being made to find out how forestry practices affect the food supply for deer.

quality were taken prior to road construction and timber removal. These measurements will be compared with comparable measurements taken during road construction and logging. The change in water quality will then indicate the effect of conventional road location and logging methods on the quality of water.

This study was begun in the summer of 1952. Results indicate a marked depreciation in water quality after road construction. Measurements will be continued to determine the additional effect of logging.

Hardwood Forest Canopy & Rainfall Intensity

A study was made to determine the effect that a full hardwood forest canopy has in changing rainfall intensities as rain passes through it. This information is needed to fill a gap in our knowledge of the role of forest vegetation in watershed management.

Ground rainfall intensities and throughfall were measured under a fully stocked hardwood forest over a period of a year. Maximum 5- and 15-minute intensities were compared to similar measurements made in the open.

The results of this experiment indicate that the forest canopy has little effect in reducing the erosion potential of rainfall on the forest floor. Studies to determine the use of forest cover in preventing erosion should place emphasis on the relationship of the forest to soil factors rather than rainfall characteristics.

Wildlife

The deer population in West Virginia is increasing. Management of the deer population is becoming a necessity. Of course one approach is through control of the annual kill. Another is manipulation of the environment, which, in this instance, is primarily the 10 million acres of West Virginia's forest growth. Timber management of necessity becomes a tool of the wildlife manager; so he must know what effect different methods of timber cutting will have on the deer population. It is at the same time important to learn what effect a deer herd can have on timber stands following each of the various cutting practices.

A cooperative study with the Game Division of the West Virginia Conservation Commission is under way to determine the effect of each cutting practice on the availability of food for deer.

Permanent plots and enclosures have been installed in each cutting-practice-level. Measurements of available browse before and after cutting are being made. These measurements will be continued to determine the change in available browse and the effect of deer browsing on hardwood reproduction after logging.

DEMONSTRATION AREA

The Fernow Forest has as a "show window" a series of small plots that show the effects of the different cutting practices that are being tested elsewhere on the forest with commercial cuttings.

These plots, each 5 acres in size, are conveniently located along a trail. Here, in one spot, the general public and the professional forester can see and compare the effects of different intensities of forest management. The plots are also used to train research foresters.

THE NATURAL AREA

One compartment of 102 acres on the Fernow Forest will be reserved from all cutting, and the stand will be permitted to develop without interference. This compartment will serve for study of the ecological development of the forest. The course of soil and humus development in the undisturbed forest will also be followed, and the area will be available for use by cooperating or visiting botanists and other scientists.

AREA RESERVED FOR FUTURE STUDIES

Nearly a third of the Fernow Forest is available for future assignment to uses and studies not yet selected. They will be concerned with problems disclosed in the pilot-plant compartment studies, or perhaps encountered by practicing foresters. Or, it may be found necessary, for one reason or another, to repeat one of the compartment studies.

In the main, however, the studies will be conducted on small plots and for limited times. They will constitute the "test-tube" trials of new ideas for application on the compartments and for the resolving of minor problems of technique and methodology.

Research is wasted unless the new ideas it develops are put to use. Here a group of foresters see a demonstration of experimental forestry practices on a "show-me" trip.

GETTING RESEARCH RESULTS
INTO PRACTICE

The general over-all objective of the Fernow Experimental Forest is to develop improved timber and watershed practices appropriate for use in the forested watersheds of the problem area, and to point the way toward attaining the highest possible return per acre from the woodland. The results of research and the demonstration of good forest practices should aid practicing foresters, both public and private, as well as timberland owners and operators.

The results of research on the Fernow Forest are published in scientific journals, trade journals, and popular magazines. In addition, newspaper articles, show-me trips, and on-the-ground training sessions are used to inform the public about latest developments.

In getting these research results put into use, the Fernow Forest has the close cooperation of the Monongahela National Forest, other state and Federal agencies, the University of West Virginia, and other private agencies and individuals who are interested in the advancement of forestry practices in the Mountain State area.

Of special value is the Advisory Committee to the Mountain State Research Center. The members of this committee represent state, Federal, and private agencies. They are:

E. D. CURRENCE, chairman; Superintendent, Lumber Department, Elk River Coal and Lumber Co., Swansdale, W. Va.

ARCH BOICE, Landowner, Fairmont, W. Va.

WILLIAM C. CURNUTT, Timber Management Assistant, Monongahela National Forest, Elkins, W. Va.

HAYS E. HELMICK, State Forester, W. Va. Conservation Commission, Charleston, W. Va.

Dr. W. C. PERCIVAL, Head, School of Forestry, West Virginia University, Morgantown, W. Va.

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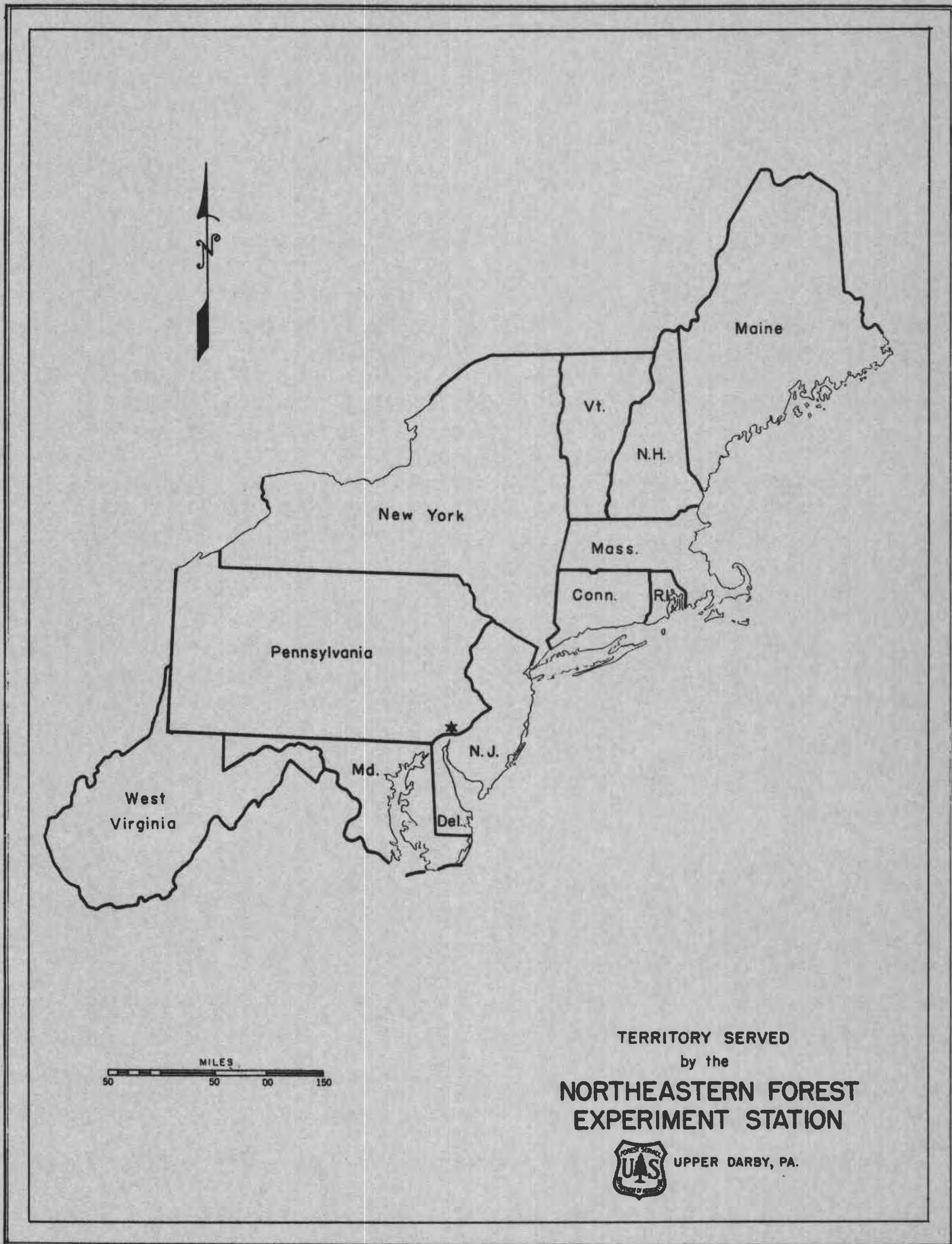
A. S. WILSON, General Manager, Boone County Coal Corp., Sharples, W. Va.

Agriculture - Forest Service - Upper Darby, Pa.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