FORESTRY RESEARCH:
Fernow Experimental Forest

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Northeastern Forest Experiment Station

Fernow Experimental Forest
Parsons, West Virginia

The central Appalachian mountains were almost completely forested when the first settlers arrived from Europe. Gradually at first, then at a greatly accelerated pace after the Civil War, the magnificent virgin forest was cleared. The most fertile land was put into agriculture, but areas not suitable for farming were allowed to revert to forest. Wildfires were common, as heavy concentrations of logging slash were ignited by sparks from logging equipment. Some areas were burned several times until most of the humus was consumed. This was deforestation on a regional scale, often followed by accelerated soil erosion, stream sedimentation, and flooding.

To protect the headwaters of navigable streams from further abuse, the U.S. Congress in 1911 passed the Weeks Law, which allowed the government to purchase land in the Eastern United States to establish National Forests.

In 1915, the Forest Service purchased a 7,136-acre (2887 ha) tract called the Arnold Tract for $5.50 per acre ($13.59/ha), the first unit purchased for the Monongahela National Forest. The Forest Service recognized the need for research to establish scientifically sound guidelines for managing public land, and on May 28, 1934, the Fernow Experimental Forest was established on a major portion of the former Arnold Tract. Named in honor of Bernard E. Fernow, a well-known German-born forester who had pioneered scientific forestry in the United States, it initially comprised 3,640 acres (1473 ha) and expanded to about 4,700 acres (1902 ha) in 1974.

In 1945, administration of this outdoor laboratory was transferred from the Appalachian Forest Experiment Station, in Asheville, North Carolina, to the Northeastern Forest Experiment Station, now headquartered in Broomall, Pennsylvania. The Fernow Experimental Forest is a field laboratory for two research projects, one on the growth and culture of central Appalachian hardwoods, the other on protection of water resources in central Appalachian forests. Offices for both projects are at the Northeastern Forest Experiment Station's Timber and Watershed Laboratory in Parsons, West Virginia.

Characteristics of the Fernow Experimental Forest

Approximately 75 percent of the land area in the central Appalachians is forested, and 90 percent of the forest is in private ownership. Wood products are of major importance to the local economy. Information from research on the Fernow Experimental Forest is used to improve the management of central Appalachian hardwood stands and water resources.

Topography.

The experimental forest is in the Allegheny Mountain section of the unglaciated Allegheny Plateau. Its elevation ranges from 1,750 to 3,650 feet (533 to 1112 m), with slopes from 10 to 60 percent. Slopes of 20 to 30 percent are common.

Drainage.

The original Fernow Experimental Forest encompassed practically the entire Elk Lick Run drainage—about 3.8 miles long and 2.3 miles across at the widest point (6.2 X 3.7 km). Elk Lick Run has seven major tributaries, including Big Spring Run, which drains a headwater limestone formation. Periodically, research areas have been set aside adjacent to the original experimental forest and in 1974, through a cooperative agreement with the Monongahela National Forest, an additional 1,400 acres (567 ha) were designated as part of the Fernow. This additional area includes the Stonelick drainage and a portion of the Canoe Run watershed.

Geology and soils.

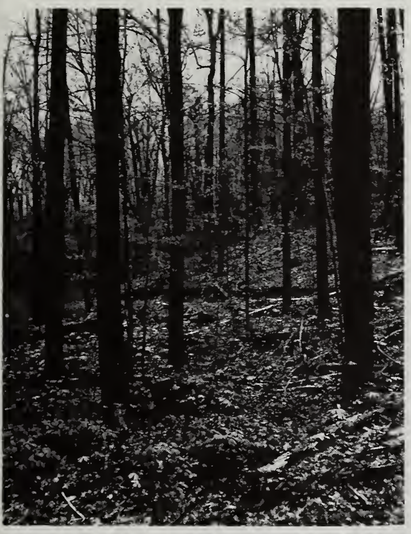
Soils on most of the forest are derived from acid shale and sandstone of the Hampshire series. The most common soil types are Calvin and DeKalb. At one point, beyond Big Springs Gap, Greenbrier limestone outcrops in places to produce a midslope zone of limestone soil of the Belmont series. Almost all soil types are well-drained, medium-textured loams and silt loams. The average soil depth is about 3 feet (1 m).

Climate.

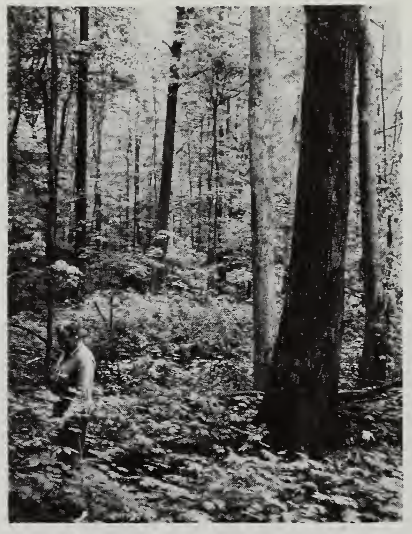
A rainy, cool climate is typical for the experimental forest. Prevailing winds are from the west to southwest. Mean annual precipitation is about 58 inches (147 cm), evenly distributed throughout the year. Snow is common between December and March, but alternating warm and cold fronts usually prevent a snowpack from lasting more than a few weeks. Mean annual temperature is about 48° F (9 C), and the frost-free season averages about 145 days. Temperatures fall to between -10 and -20° F (-23 and -29 C) periodically during most winters.

Sites.

Tree growth, like the growth of field crops, reflects the influence of such factors as soil, topography, and climate. Their combined influence determines site productivity. The timber yield per acre of a forest site is predicted by its site index (the height of dominant trees of a particular species growing on that site at age 50). Site index is also measured by topographic and soil characteristics, as has been done throughout the experimental forest. Almost all areas on the Fernow rate excellent, good, or fair—designations that correspond to oak site indexes of 80, 70, and 60 feet, (24, 21, and 18 m) respectively.



High site — trees have the potential to grow fast and produce high quality forest products. Area typically moist — cove hardwood stands.



Second growth oak stand on a good hardwood site.

The effects of different site qualities are important in the overall research program. The forest is well stocked with mixed hardwood tree species, but species composition and growth rates are influenced by site index.

Oaks are the most common species and are found on all sites along with beech and sweet birch. Excellent sites in coves and on north slopes support primarily northern red oak, sugar maple, yellow-poplar, black cherry, white ash, basswood, cucumbertree, and beech. Fair sites on south and east slopes usually support oak stands composed of red, white, chestnut, and some scarlet oak. Other fair-site species include red maple, sweet birch, beech, blackgum, sassafras, and sourwood along with some species found on good sites. Good sites commonly grow a mixture of excellent- and fair-site species. Black locust, sweet birch, and Fraser magnolia are a consistent but generally minor component of the forest on all sites.

Noncommercial tree species include flowering dogwood, pin cherry, striped maple, and downy serviceberry. The forest floor on good sites is carpeted during the growing season with stinging nettles which grow to a height of about 3 feet (1 m). Ginseng, which grows in isolated locations, is eagerly hunted during late summer. Its dried roots sell for more than $100 per pound ($220/kg). Ramps, wild leek-like plants that grow on good sites, are gathered in the spring for food. Rhododendron, which grows on acidic soils, is also found on the experimental forest and normally flowers during July.

Fauna.

The experimental forest supports an abundant population of white-tailed deer, black bear, ruffed grouse, turkey, and squirrels. The main stream, Elk Lick Run, has a few trout. Hunting, fishing, and trapping are allowed on the experimental forest, subject to State game laws.

Fishing—Elk Lick.

Recreation and Other Uses.

The main road system, which is open year-round to the public, gets heavy use. The 20,000-acre (8,094-ha) Otter Creek Wilderness Area is accessed at Big Springs Gap via the Elk Lick Road. Others use the road for hunting or for recreational driving. The Elk Lick drainage also provides a major source of water for people living in the Parsons area. A 2.7-acre (1 ha) reservoir was built by the Civilian Conservation Corps in 1934 at a cost of $69,000. The crew hand-dug a ditch for 3.5 miles (5.6 km) and laid an 8-inch water line to a gravity-fed storage tank on a hill near Parsons.

Elk Lick Reservoir built in 1934 to provide water for Parsons.

Hiking trails and skidroads throughout the Fernow Experimental Forest are available for public use and enjoyment. During the fall and winter months, these trails are often used for hunting, cross-country skiing, and snowmobiling. There are also some limestone caverns on the Fernow and the Blowing Cave near Big Springs Gap is often explored by spelunkers. The cave also provides a hibernation site for the Indiana bat. No overnight camping or campfires are permitted on the experimental forest.

Roads.

Most roads on the Fernow Experimental Forest are part of the Monongahela National Forest road system and maintained by the National Forest. The network of haul roads on the Fernow totals 33 miles (53 km), or about 1 mile of road per 150 acres (1 km/38 ha). Though most of the roads are open to the public, some are closed during logging because of the risk of vandalism of equipment or property.

Logging History.

During early logging operations, in 1905 to 1910, the stands on the Fernow Experimental Forest were heavily cut near the railroads. Sugar maple, beech, and hickory were not considered merchantable species during the early logging. Horses and occasionally log slides were used to skid logs to the railroad grades. In a salvage operation during World War II, loggers cut American chestnut trees killed by the chestnut blight. Since the start of the research program in 1948, tree harvesting has been confined to designated areas for research purposes.

The Fernow's three-man logging crew of Forest Service employees is primarily responsible for removing timber for research purposes. About 750,000 board feet (2600 m^3) of sawlogs are sold each year.

The Fernow logging crew uses mainly a crawler tractor with a rubber-tired arch, a rubber-tired skidder and occasionally a truck crane. The logging crew has tried experimental logging equipment in cooperation with the Forest Service engineering unit at Morgantown, West Virginia, including early testing of rubber-tired skidders, a small skyline cable logging system developed in Austria, and a modified knuckle-boom loader mounted on a crawler tractor.

The Research Program

Timber Management.

Timber management research on the Fernow began in 1948. An early objective was to develop ways of controlling erosion during logging. The Fernow logging crew was first in the Appalachians to use tree-length skidding in combination with carefully designed skidroads. It was also among the first to use gasoline-powered chain saws, around 1950. Research was conducted on stand management and on ways to reduce damage to trees left standing after logging.

Initially, harvest cutting practices were demonstrated on the experimental forest. Now these areas are among the oldest periodically treated stands in the eastern United States. During the 1950's and early 1960's, researchers developed ways to estimate the productivity of forest sites in West Virginia from their soil and topographic characteristics. This research provided the basis for much of the information on site indexes in the Appalachians. In the mid- and late 1960's, research was directed toward establishing regeneration after harvest. Information was published on the silvicultural effects and management of clearcutting, compared to selection or partial cutting. Considerable research was done on timber stand improvement (TSI) and on mechanical and chemical techniques to kill cull trees and other unwanted vegetation.

Regeneration of white pine was a major part of the research program during the 1960's. Poor-quality hardwood sites were partially converted to pine by hand-planting seed or seedlings in an effort to produce wood products of higher value.

Another research program studied how to establish red oak by planting, because young planted oak stems often grow so slowly that they cannot compete with the faster growing trees. Several techniques were used to stimulate their height growth—fertilizing, mulching, stem pruning, different planting techniques, and selecting nursery stock of different sizes and ages. None of these could be recommended, however, because untreated seedlings grew just as tall as the treated ones.

During the early 1970's, fertilizers were used to stimulate tree growth in natural forest stands and in plantations. Fertilizers did increase tree growth, but the gains were not enough to justify the cost of fertilizer plus its application. Therefore, fertilizers are not used in the management of hardwoods except in special cases.

Several species were studied to determine how their value increases as the trees grow. This eventually led to a system for harvesting trees at financial maturity, which is currently being applied to several stands on the Fernow.

From 1976 to 1978, a small Austrian skyline cable logging system was tested on the Fernow in cooperation with the Forest Service engineering research project in Morgantown, West Virginia. Although this skyline yarder is costly to purchase and operate, it caused less site disturbance than conventional ground skidding— an advantage on the steep slopes of the Appalachians. Cable logging requires better but fewer roads, leading to savings in the future when the same area is logged again, and it is acceptable to landowners concerned about the environment.

Urus skyline

Research in silvicultural practices to improve young hardwood stands has been a significant part of the Fernow program in recent years. Preliminary guidelines for selecting and releasing crop trees from less desirable trees and vines reflect both biological and economic considerations. In general, the release methods developed have not been too successful in stands less than 25 feet (7.6 m) tall. In taller stands, diameter growth has been increased by cutting trees that have branches above or below the crowns of crop trees or touch them. Guidelines for controlling wild grapevines in hardwood stands have also been developed to suit several landowner objectives and stand situations.

Cable logging

Studies of the growth of individual trees have been used to determine the rates of diameter growth of important species and relate them to site quality, stand density, and position of the crown. Permanent study plots have been established in areas harvested by different methods, thinned even-aged stands, and uncut stands. These plots provide information needed to relate individual tree and stand responses to silvicultural practices. Studies of stand yield in both volume and value are continuing in stands managed under even-age and uneven-age systems.

As a result of past logging and other land uses, large areas of the central Appalachians are too densely stocked to achieve optimal productivity. Such silvicultural practices as crop tree release, thinning, removal of cull trees, control of grapevines, removal of competing vegetation with herbicides, and fertilization in special cases can alter species composition, increase the stand's growth in volume, improve tree quality, and enable fewer but larger trees to reach maturity earlier. Economic analyses are being done to determine what level of tree-quality response is required to make such measures cost-effective.

Research continues to develop growth, yield, and economic information on harvest methods to encourage regeneration of hardwood stands. Different techniques—clearcuts of different shapes and sizes, shelterwood cuts, and partial cuts of various kinds—all are needed for different stand and site conditions and landowner objectives.

Watershed Management

Although water is generally abundant in the central Appalachians, it can be scarce during the late summer and it is often polluted by sediment during and shortly after surface disturbances. Scientists are developing improved watershed management practices to reduce pollution and make more rainfall available for human use.

Forest hydrology research began on the Fernow in 1951 when five watersheds ranging from 38 to 96 acres (15 to 39 ha) were instrumented to measure precipitation and streamflow. The first 5 years were spent calibrating the watersheds so that effects of timber cutting on total streamflow could be determined. Then a different level of timber harvesting, from commercial clearcutting to a light selection cut, was imposed on each of four watersheds in 1957-58. The rate of return to pretreatment hydrologic conditions varied with the severity of treatment, but less than a year was needed after light cutting with careful road management.

Later research showed that water yield could be increased by timber harvest and that the magnitude of the increase was roughly proportional to the amount of timber harvested. But forest revegetation is so rapid and vigorous in the central Appalachians that little more than 5 years was needed for hydrologic recovery on even the most heavily cut watershed.

Weir installation to monitor water quality.

In the late 1960's, just as the controversy over clearcutting erupted in West Virginia, a watershed on the Fernow that had been managed under a partial cutting practice and monitored for almost 20 years was clearcut using the best forest management practices of that time. As expected, water yields increased substantially during the first year after logging, but changes in chemical and physical water quality were minimal.

Pretreatment data were collected on other watersheds from 1956 to 1963, before these watersheds received the most destructive treatment of any on the Fernow. The saleable trees were harvested in 1963 and all regrowth was sprayed with herbicides annually until 1969. Water yields were about 10 inches (25 cm) higher than pretreatment flows, soil erosion was minor, and chemical water quality was not greatly impaired. Natural revegetation began immediately after herbiciding stopped. In 1973, one watershed was planted with Norway spruce and competing vegetation was controlled during succeeding years to allow the spruce to grow. Changes in streamflow and chemical properties of the water are being monitored as the spruce begins to develop in the stand.

Forest hydrology research at Parsons has not been limited to watershed treatments. Basic studies of rainfall interception, solar radiation, soil moisture dynamics, stormflow analysis, and streamflow modeling have been completed. These studies provided a better understanding of changes in water quantity and quality caused by forest management practices.

In the 1970's, research continued to concentrate on physical water quality changes resulting from logging road construction; chemical water quality changes resulting from fertilization, herbicide application, and harvesting; and basic hydrologic processes on watersheds.

Field Weather station.

Current Research Program.

Currently, two problems are identified for high priority research: the impacts of forest management on water resources, and acid precipitation. Since logging roads and surface disturbance during logging are the main causes of stream siltation, one research objective is to develop standards for logging road construction. A minimum standard road, by definition, minimizes construction costs, provides for the removal of forest products, and protects the water resource from unacceptable turbidity levels. Several minimum standard roads have been built and evaluated during the past 5 years. They have broad-based dips about every 150 feet (45 m) and culvert-ditches on streams or active seeps to minimize water movement on the road surface.

The watershed project is part of the monitoring network of about 150 stations established throughout the United States by the National Atmospheric Deposition Program. Monitoring sites have been established throughout the Fernow Experimental Forest and Monongahela National Forest and at the Laboratory. About 2000 precipitation and stream samples are collected each year and analyzed at the Timber and Watershed Laboratory.

The second research problem is atmospheric deposition (acid rain) and its effect on the soil and water resources of the central Appalachian forests. This research seeks information on such topics as the chemical characteristics of precipitation; how precipitation is altered as it passes through the forest canopy, soil, and bedrock; changes in streamflow chemistry during the past 20 years; combined effects of acid rain and forest management practices on streamflow chemistry; and the influence of land-use history and possible changes in stream chemistry on aquatic organisms. Future studies will test the idea that acid deposition affects the growth rate of certain tree species.

Cooperative Research

Scientists from universities, industries, State organizations, and other agencies within the Forest Service conduct research on the Fernow in cooperation with the Station. The results are disseminated through scientific and professional journals and symposia to public and private foresters, landowners, timber operators, students, and the general public. Trips and tours of the experimental forest are arranged on request for a wide variety of interest groups.