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Early Red Spruce Restoration Research by the Appalachian Forest Experiment Station, 1922–1954

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This photograph (Fig. 1), taken in June of 1923 by E.S. Ship, depicts a red spruce (*Picea rubens*) stand with advanced reproduction near the summit of Mount Mitchell in the Pisgah National Forest of North Carolina. According to Hopkins (1899), the original extent of red spruce encompassed as much as 1,500,000 ac in the southern Appalachians; by 1895, this had been reduced to 225,000 ac. To help restore this ecosystem, the Appalachian Forest Experiment Station (AFES) was established in 1921. Headquartered in Asheville, North Carolina, the AFES covered an area of 120 million ac in Maryland, Virginia, West Virginia, and North Carolina and parts of Kentucky, Tennessee, Alabama, and Georgia. Earl Frothingham was the first AFES director, and one of his first hires was Clarence Korstian. Red spruce studies brought Korstian to cutover lands owned by the West Virginia Pulp and Paper Company in West Virginia and Champion Paper land in North Carolina (Maunder 1969).

Figure 1. Photograph taken by E.S. Ship, courtesy of the Forest History Society, Durham, NC [image K 1–1,76,506].

Figure 2. Photograph taken by Clarence Korstian, courtesy of the Forest History Society, Durham, NC (image K 1–1,66,331).

By the time (July 1922) Korstian took this photograph (Fig. 2) of a spruce clearcut in the southern Appalachians (in the Pigeon River watershed), the exploitation of red spruce was nearly complete. In the course of his fieldwork on red spruce, Korstian sought answers to four questions: (1) What were the prevailing conditions on lands of varying productivity? (2) What were the reproductive characteristics of red spruce? (3) What were obstacles to successful spruce reproduction? (4) What measures should be taken to restore and perpetuate cutover stands? Korstian (1937, p. 164) reported his findings in a monograph that reiterated what had become a familiar story for eastern forests: "The usefulness of spruce, both for sawtimber and for pulpwood, has resulted in large-scale exploitation, followed by fire and leading to the virtual destruction of the forest."

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Korstian took a remarkable set of photographs during this July 1922 field research, which he later copied onto glass plates, colorized, and used with a projector to cast images onto screens for large audiences (Lehman 2014). Ken Carvell, a student of Korstian in the 1950s, remembers him using these slides in forestry classes at Duke. As this 8-year-old burn on Mount Mitchell, North Carolina shows in this image (Fig. 3), vegetation recovery depended on postharvest disturbance history. A decade earlier, Sterling (1920) had noted the following fire-related responses to cutover spruce in West Virginia: on unburned areas the original stand invariably determined the type of young growth after cutting. Wherever severe fires occurred, hardwood reproduction predominated, but on areas that burned over lightly—which, unfortunately, were few and limited in extent—many of the spruce seedlings survived, producing a mixed hardwood–softwood stand.

Figure 3. Photograph taken by Clarence Korstian, courtesy of the Forest History Society, Durham, NC (image K 1–1,83,000).

After Korstian left the Station in 1930, Leon Minckler, a "junior forester," resumed his work in West Virginia and North Carolina on lands that were now the Monongahela, Cherokee, and Pisgah National Forests. He revisited earlier plantings by Korstian, and he and Ted Coile of Duke surveyed soils in the spruce belt (previously all described as "rough stony land") (Minckler 1939). Minckler's photographs of cutover and burned spruce land, seen above at Black Mountain, West Virginia, in August 1938, illustrated the challenges facing spruce restoration (Figs. 4–7). Logging had removed the spruce seed source, and fire (often more than one) then removed the advance regeneration and the seedbank. In addition, in the spruce belt, soils were typically very shallow and mostly organic material. At higher elevations, practically all of the tree roots were in this A0 horizon. Minckler (1939, p. 6) noted "a typical [spruce] tree is born, lives, and dies in a soil literally created by its ancestors." Wildfire in deep slash eliminated this soil; wind and water erosion did the rest.

Figure 4. Photograph taken by Leon Minckler, archived at the Fernow Experimental Forest, Timber and Watershed Lab, Parsons, WV.

Minckler concluded that the density of competing vegetation, more than species composition, was key to spruce restoration, and he identified three distinct types of planting situations (Minckler 1939, 1945). First were sites with dense herbaceous growth such goldenrod (*Solidago* spp.), hay-scented fern (*Dennstaedtia puntilobula*), or bracken fern (*Pteridium aquilinum*) and low shrubs (blackberry [*Rubus* spp.]), and blueberry (*Vaccinium* spp.) up to 5 ft tall and with a density of 80% or more. This photo (Fig. 5), taken at Black Mountain, West Virginia, is representative of this site type. In this site type, 60 experimental plots and 15,000 tree seedlings, half red spruce and half red pine (*Pinus resinosa*), were planted on the Monongahela and Pisgah National Forests. Ten treatments were tested, ranging from planting superstock to burning to application of fertilizer and root hormones. Red spruce seedlings that had been released during the first full growing season outperformed all other treatments in both survival and growth.

Figure 5. Photograph taken by Leon Minckler, archived at the Fernow Experimental Forest, Timber and Watershed Lab, Parsons, WV.

This 1938 photo by Leon Minckler of Mount Mitchell on the Pisgah National Forest shows the second site type (Fig. 6). These were young stands dominated by brushy hardwoods such as fire cherry (*Prunus pensylvanica*), rhododendron (*Rhododendron* spp.), red maple (*Acer rubrum*), and yellow birch (*Betula alleghaniensis*) that were 15–30 ft tall with a density of 70% or more. Here, 12 experimental blocks of 20 four-seedling groups underwent a total of seven treatments involving different sized release cuttings occurring at different times. In most cases, red spruce required a 10- to 12-ft opening in at least the first and third or fifth growing seasons, and then as many as two subsequent releases, depending on the density and height of the competition.

Figure 6. Photograph taken by Leon Minckler, archived at the Fernow Experimental Forest, Timber and Watershed Lab, Parsons, WV.

The third site type were areas that were severely burned sites with rocky, thin soil and sparse vegetation, illustrated by Minckler's 1938 photo of the Unaka Mountain burn on the Cherokee National Forest (Fig. 7). Here, the problem was less the effect of competing vegetation as whether direct seeding in small soil pockets could be successful. Seeding was done on intensively prepared and fertilized 3-ft plots with mulch and protective screens. However, mortality, due to frost-heaving and an unusually dry and hot spring, was greater than 80%. In West Virginia, better success was realized by planting 2,400 red spruce and balsam fir (*Abies balsamea*) seedlings. After 3 years, survival was 82% and 64% for spruce and fir seedlings, respectively. No advantage was gained by use of superstock, fertilizer, or chemical root stimulation. Here, the objective was the establishment of seed-producing trees, not reforestation. Results did little to encourage Minckler. He predicted that "unaided by man, nature probably will require 500 to 1,000 years or more to restore these lands to timber" (Minckler 1945, p. 349).

Figure 7. Photograph taken by Leon Minckler, archived at the Fernow Experimental Forest, Timber and Watershed Lab, Parsons, WV.

Figure 8. Photograph taken by J.S. Rentch.

In the 1950s, William G. Wahlenberg (1951) and Thomas G. Clark (1954), of the now Southern and Northeastern Forest Experiment Stations, respectively, conducted 10-year reviews of Minckler's work in North Carolina and West Virginia. They concluded that Minckler was correct in targeting vegetative density rather than species composition as the main hindrance to reforestation and that early and repeated release were essential. However, growth was still modest. Ten-year average height growth in site types 1 and 2 were only 3.4 and 1.7 ft, respectively. Clark (1954, p. 430) described conditions on Black Mountain, West Virginia, where wildfires had raged: "Today—30 years after logging and fire—the area is practically denuded. Some blackberry and other shrubs have managed to subsist in scattered soil pockets; and there are occasional small wind-whipped hardwood trees and a few native spruce that have seeded in from surrounding areas." Current spruce restoration efforts are concentrated in site type 2, although competing "brushy hardwoods" have now grown in 80- to 100-year old overstories of red maple and yellow birch atop scattered red spruce saplings (Rentch et al. 2016), as shown in Fig. 8.

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