

The Legacy

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The USDA Forest Service, Northern Research Station and one of its organizational predecessors, the Lake States Forest Experiment Station, has conducted a program of tree genetics research since the 1920s. In the Lake States (Minnesota, Wisconsin, Michigan) alone we have established dozens of field studies including experimental seed source and progeny tests on Agency lands and on the lands of collaborating institutions including the University of Minnesota. After 80 years of conducting this program of scientific research we have come to know much about the genetics of our major tree species. Unfortunately, while much of our knowledge has been published, more remains poorly published or unpublished. The reasons for this are many. Research projects are often closed and retirements occur with little warning leaving no time for a research team to capture what was left unwritten. Also, methods of analysis improve over time, especially those that require powerful computing ability. We find many instances where data analyses done between 1930 and even 1970 would be considered cursory and inadequate by today's standards. Further, research context and justification constantly change. Thus, the measurements we might have taken and the analyses we might have done in 1940 and 1950 to support *tree improvement* work might not be the same methods we would apply today as we attempt to understand the possible implications of global climate change. And people, even in the best of circumstances, rarely have the opportunity to publish personal expert opinion in the scientific literature. Each retiree who walks out the door for the last time carries invaluable yet undocumented knowledge that, absent extraordinary measures, is lost. My goal here is to capture that portion of our corporate knowledge related to forest genetics research conducted in Minnesota, Wisconsin, and Michigan.

One objective of the legacy project is to make existing data and metadata available to the public. The first objective, while necessary, does not take the project far enough because data are devoid of feeling. We should seek to know why the work was undertaken in the first place. What was the state of the landscape and our forestry institutions that justified the start and near 80-year continuance of forest genetics research? I am assembling our old records so that we might understand what people thought and why they did what they did. I have many old photographs that I use to convey a feeling for the condition of the landscape in those days. One of them is included in this paper. I seek to create a *community of interest*, an audience that having seen the images and read the stories will be motivated to take a closer look at the research and perhaps use our data and knowledge as an aid in the pursuit of their own interests. As an example, I present here a brief summary of one of the first forest genetics projects ever undertaken in the Lake States, a red pine seed source test.

Tree planting began in the Lake States much earlier than tree genetics research. From the beginning, red pine (a.k.a. Norway pine) became a preferred species for nursery growers and tree planters and it was assumed that the species would continue to play a large part in reforestation in the northeastern quarter of the US. The great wave of logging had passed through the Lake States, the Peshtigo and Hinkley fires had burned thousands of cutover acres and a strong feeling prevailed that intervention was needed to reforest the land. It was by then known that many,

perhaps most, living species consisted of geographic races that differed in their adaptation to various environments. It was logical that Lake States trees would exhibit such racial variation and that it would be important to match the genetic characteristics of planted trees to the environment in which they were planted. Thus, tree genetics research was initiated at the Lake States Forest Experiment Station. I can only guess at the reasoning that led to the design of the first experiments, of which a red pine seed source test was the earliest. The oldest document I can find that describes the experiment is a *Working Plan for 1931* written by Carlos O. Bates, then Senior Silviculturist for the Lake States Forest Experiment Station. Mr. Bates described the beginnings of the work with some sense of frustration “Following the spring planting operations in the source-of-seed experiments, on the Chippewa and Superior National Forest, and the hasty and inadequate preparations which had to be made for those operations, with insufficient funds, the following plan is laid out for keeping up current observations during 1931, growing new planting stock, and preparing the sites for the next and final field plantings.”

Too little time and too few resources plagued Bates and his colleagues then just as the same issues plague us now. Yet, seed was collected, seedlings were grown, field test sites were prepared and planted, and data were collected, analyzed and reported. Several field test sites were planned for the Superior, Chippewa and Huron National Forests. Of these plantings, all begun in 1931, only the planting on the Superior National Forest grew well enough to be tended over the long haul. The Huron National Forest planting succumbed to drought. The Chippewa National Forest planting succumbed to the misguided efforts of an *errant plowman*. A planting on the Chippewa National Forest was successfully established years later, in 1937, with a smaller set of seed sources than was used earlier. Work on this project began in 1927 with seed collections from individual trees, groups of trees, or stands throughout Minnesota, Wisconsin, and Michigan. Trees were climbed for cone collection or cones were taken from *squirrel caches*.



Figure 1. This photograph was taken during a seed collection expedition in 1930. The site is a roadside parking place in Itasca State Park in northern Minnesota.

Cones were shipped to a headquarters laboratory in St. Paul, MN, for germination and other testing. In total, more than 150 collections were made between 1927 and 1934. Collection records were detailed in those days and often included hand-sketched maps to individual trees and photographs of those trees.

What kind of thinking, what kind of commitment to the future led Bates and others to take the time, and it must have been a great amount of time, to document their work so thoroughly? Whatever their reason or motivation, the record provides opportunities for us today. Of the more than 150 collection locations, many with maps and photos, most can still be found. Thus, it is possible to revisit collection sites, resample populations, and test whether forest management practices have altered population characteristics. It is also possible to compare the landscape of 1928 with the landscape of today, more than 75 years later.

Preparation of a test site on the Superior National Forest began in May, 1931 according to Paul O. Rudolf, a LSFES silviculturist. The plot corners were laid out by transit or compass with distances measured by chain or pacing. Once the plots were located, it was necessary to remove the stumps left over from logging. So, “the stumps were all blown by means of comparatively heavy center shots and, as a general rule, rather large holes were made.” Once blown, “A Fordson tractor, borrowed from the Lake County road crew working on the Ely-Finland road, was used to complete the removal of the stumps.” These means of preparation, having apparently been judged inefficient led to refinement. Thus, “It was attempted to blast the stumps with the smallest charge of dynamite which would loosen them up satisfactorily...Along this same line, instead of placing the entire charge below the center of the stump, two or three smaller charges were placed under the main roots...a 50-shot electric blasting machine, which had been borrowed from the Lake County road crew, was used part of the time.”

The drastic means of site preparation is described here mostly because it is interesting to contemplate the time it would take today to prepare the requisite environmental analyses and then obtain the approval, safety training and certification prior to blowing the first stump. Things were different in the old days. At any rate, we know that the total cost for site preparation, including supervisory labor, was \$1,087.34. Again, we see the attention to detailed record-keeping. Seed obtained from the collection expeditions was grown in the Cass Lake, MN, USDA Forest Service nursery. Collection numbers 10 to 88 were planted at the test site in 1931. Collection numbers up to 262 were planted in the nursery in 1931 and seedlings field planted in 1933. Many problems were encountered and overcome in the ensuing years. In a memo to then Station Director Raphael Zon from a Mr. Eyre on the National Forest we find “An error in the status records of the Superior National Forest which affect us has just come to light. The site upon which the Bates plantation was made this spring ... proves to be private land.” Bates writes some days later that “It is certainly a shock to me to learn that we have been playing around all of this time on private land at Camp 8.... tough luck!!” In due course, however, the land was acquired in return for *adjustment in taxes* which went before the County Commissioners in 1932. Weed control, mostly aspen sprouts, was a continual problem and a local forester “made arrangement with a Mr. Stickney, who lives by Chub Lake, to cut more aspen during January.” A bill from Mr. Stickney in the amount of \$1.50 for “cutting popel” was received and duly paid on January 20, 1933.

Many measurements of this experiment were made over the years including height and diameter of the trees, crown density, stem soundness, damage and its causes, and stem taper. It is tempting to notice the absence of what we might now consider *ecological attributes* of the experiment such as abundance of nontimber plant species, presence of migratory birds, nongame animal species, and infer thereby some error of omission. But, we were not yet attuned to the coming importance of such observations in those years; the work was still driven by the perceived need to reforest the landscape using the most expeditious means. In a memo to Bates, a field forester notes that “Pieces of apple, poisoned with strychnine, were distributed at the woodchuck holes. The woodchucks seem to be scarce and no new damage was noted.” Case closed.

The last damage to the experiment occurred sometime around 1960 due to “a relocation plan for Highway 1 through the Stony River red pine plots.” About 60 trees stood within the new right-of-way and were removed. The last measurement of the experiment was done in 1964 and the plantation has subsequently been managed as a normal part of the forest. Some trees still remain, but plot and seed source identities are lost. Little visual evidence remains to suggest to the casual or even professional visitor that those large, *old-growth* red pine represented the beginnings of forest genetics research in the Lake States

This may rank as one of the greatest ironies in the history of USDA Forest Service genetics research. The species we chose to study first ended up being the species that possessed the least amount of genetic variation in growth rate of any species studied subsequently. When growth data are analyzed it is rare, to this day, to find an experiment where more than about 5 percent of the variation in tree height or diameter is attributable to seed sources or families of trees. Yet, Carlos Bates found seed-source-related variation in cold hardiness. In an experiment conducted under artificial conditions in what later became the University of Minnesota Cold Hardiness Laboratory, Bates found that “northern sources of seedlings survived much better than those from the warmer portions of the range of Norway pine” (link to web document). Even then, it was recognized that seed sources did not always perform according to expectation as “Group 4 shows less hardiness than Group 5, the latter being composed almost entirely of samples taken very close to the southern limit of the Norway pine range in a diagonal line across Wisconsin and Minnesota.” Very high hardiness was characteristic of seed source number 60. “The collection ... from Kilbourne, Wisconsin, which, except for sandstone outcrops occurring along the Wisconsin River, would apparently be outside the natural range of Norway pine.” So, the racial patterns that did exist sometimes were consistent and sometimes were in conflict with expectation.

In 1956, Paul O. Rudolf used measurements of the Superior National Forest experiment to test much the same phenomenon using field data. The research led to one of the first *seed zone* recommendations ever published for the Lake States. The work was reported as significant because “Most forest tree species probably have developed races that differ from one another physiologically rather than morphologically....For this reason it is important to establish homogeneous seed collection zones and to designate as to origin each lot of seed used in reforestation.” What differences in seed source growth existed were related to climatic zones based on summer growing-degree-days and winter minimum temperature. Sufficient differences were found to justify certain boundary recommendations that are still in use (albeit modified)

today. As best I can discern, data from the Chippewa National Forest planting was never used to corroborate any results based on data from the Superior National Forest field test.

Rudolf reported later in 1964 that “When it comes to picking out a pattern there is some difficulty. The best lots were from northeastern Minnesota, northwestern Minnesota, north-central Minnesota, northeastern Wisconsin, and adjacent southern Upper Michigan.” Further, “This general pattern seemed to hold for the various characteristics measured or computed.” Yet, Rudolf maintained support for his 1956 results stating that “Again we have the picture that there is better development of reasonably local sources in considering this one particular planting area...” But he hedges his rhetoric with “... sources from quite a distance away from the planting site still may perform quite well.” At the same meeting where Rudolf presented his results, Hans Nienstaedt, in an analysis of only those collections that came from single trees (called an open-pollinated half-sib family), found that when those sources were grouped according to Rudolf’s zones no differences among zones in tree height or diameter could be declared significant. In recommending a tree improvement protocol for red pine Nienstaedt held that “... measurements must be of sufficient accuracy to permit evaluation of small differences,” a recognition that variance attributable to genetic causes might be small. Nienstaedt concluded in the end that “to write, on the basis of these results, that a red pine breeding program is feasible is perhaps unconvincing. What we need is an analysis of ...costs and...ultimate economic gains.” Nienstaedt’s reasoning was that a little bit of improvement spread over a large acreage of valuable timber might justify the research and development investment.

Results were also produced from the Pennsylvania experiment by A.F. Hough of the Northeastern Forest Experiment Station. Hough justified the work with some passion writing “In the Lake States, in New England, and in the Middle Atlantic States thousands of acres of abandoned farm land and land denuded by ax and fire have been planted with red pine” and “out conditions of planting sites far distant from its seed source?” Quite well apparently because Hough found “grouping of these 50 seed sources into nine geographic-climatic (Rudolf’s zones) regions brings to light highly significant differences as measured by the value of F” and that “Seedlings of many of the Lake States seed sources outstripped those from the best Northeastern sources.” He asked “why did the seed...70 airline miles from the Kane plantation, fail to produce the best height growth of all?” The question was asked and we still do not know the answer.

Overall, the story on red pine racial variation is anything but straightforward; local sources were often outpaced in growth by exotic sources. This is not altogether bad because the first seed sown in the new USDA Forest Service nursery in Rhineland, Wisconsin, in 1932 was not local. More than 400 pounds of white pine and red pine seeds were sown to produce seedlings for planting in Wisconsin.

There are many more stories to write in addition to the red pine seed source test I have described. Similar research has been done with all our major conifer species and some hardwoods by the USDA Forest Service, the University of Minnesota, the University of Wisconsin, and Michigan State University. Yet, some wonder whether such work has a strong future. It is difficult to envision how *tree improvement* can remain a viable activity unless there is an increase in acres devoted to tree plantations. One logically asks whether there is any sense developing a *domesticated* tree crop if the means of deployment is lacking. Tree plantations will probably be

needed, if not for the production of wood for the fiber-using market then for bioenergy feedstock. I agree that under a low-energy-price paradigm our forest inventory data make it difficult to justify plantation R&D in the short term. We do grow more wood than we consume. But, the North Central region will ultimately need to increase the wood supply for many reasons. Our energy demand dwarfs our current biomass production. As energy prices increase all kinds of biomass production systems will become economically viable and ecologically important as they act to shift demand away from the forest. Given such a future, the need to understand our past work and the opportunities it provides seems powerful.