

Revisiting Pearson's Climate and Forest Type Studies on the Fort Valley Experimental Forest

Joseph E. Crouse, *Ecological Restoration Institute (ERI), Northern Arizona University, Flagstaff, AZ*; **Margaret M. Moore**, *School of Forestry, Northern Arizona University, Flagstaff, AZ*; and **Peter Z. Fulé**, *ERI and School of Forestry, Northern Arizona University, Flagstaff, AZ*

Abstract—Five weather station sites were established in 1916 by Fort Valley personnel along an elevational gradient from the Experimental Station to near the top of the San Francisco Peaks to investigate the factors that controlled and limited forest types. The stations were located in the ponderosa pine, Douglas-fir, limber pine, Engelmann spruce, and Engelmann spruce/ bristlecone pine (“timberline”) forest types. Climatological and phenological data were collected at one or more of these sites weekly from 1916 through 1920. Soil samples were taken monthly during the growing season at all sites in 1918. Experimental plantings were conducted at some of these sites to determine the ability of species to survive outside their normal growing conditions. Recent field reconnaissance at Campbell's Camp located fence posts and steel corner pipes associated with the seedling experimental area. The historical weather stations and nearby tree plantations were an important contribution to the new science of ecology in the early twentieth century and they may be an important resource for helping scientists understand climate change today.

Introduction

Climate and vegetation studies have been conducted on the San Francisco Peaks of northern Arizona since the late 1880s (Maienschein 1994). C. Hart Merriam developed his pioneering life-zones concept here because of the wide range of climate and vegetation types in close proximity to one another (Merriam 1890). In 1898, Daniel T. MacDougal, a physiological ecologist (most famous for his desert ecology studies at the Desert Laboratory, Carnegie Institution), conducted a lesser known, but important study on the effects of temperature inversions on plant distributions of the San Francisco Peaks and Flagstaff area (MacDougal 1899, 1900). This latter project was sponsored by the USDA to investigate the potential for agriculture in the region. These early climate and vegetation studies prompted the Forest Service to begin an investigation, known as “The Study of Forest Types,” to determine the factors that controlled and limited forest types (Pearson 1920a, Zon 1908). Raphael Zon, U.S. Forest Service Chief of Silvics in 1907 and later Chief of Forest Investigations, noted that climate was not the only factor that determined vegetation type but that soil type, soil moisture and topography played a large role (Zon 1908). He encouraged G.A. (Gus) Pearson to initiate a forest type study at the newly formed Fort Valley Experimental Forest (FVEF).

Fort Valley Studies

Soon after the creation of the FVEF in 1908, Pearson initiated a study to determine the influence of microclimate and forest cover on ponderosa pine regeneration (Pearson 1913). He established six weather stations in the immediate vicinity of the headquarters, along a line from the ponderosa pine forest on the west side of FVEF headquarters buildings, across a large grassland (Fort Valley Park; Figure 1), and into the forest on the east side of the headquarters. From 1909-1912, Pearson took daily readings of temperature, precipitation, humidity, and wind movement at three of the stations (stations 1-3) and only temperature at the other three (stations 4-6), and eventually related these data to pine seedling establishment, survival, and growth (Pearson 1913).

Beginning in 1916, Pearson began a second study to investigate the physical factors that controlled and limited forest types on the San Francisco Peaks and in the Southwest (Pearson 1920a 1920b, 1930, 1931). That year, a series of weather stations were established by FVEF personnel along the southwest shoulder of Agassiz Peak (Figure 2). These five station sites were located within each of the vegetation types found on the Peaks beginning with the ponderosa pine type and moving up in elevation into the Douglas-fir type, the limber pine type, the spruce-fir type and, finally, what Pearson



Figure 1. Weather station in Fort Valley park adjacent to the Experimental Forest headquarters. USFS photo 91883 by Max H. Foerster in 1911.

called the timberline type¹. The ponderosa and Douglas-fir sites each had three individual weather stations and the spruce-fir and timberline sites each had two weather stations. Multiple stations at these sites allowed microsite temperature and precipitation variations to be investigated.

These weather stations on the Peaks were visited weekly or semi-weekly from 1917 through 1920 for the collection of meteorological data (Pearson 1920a, b), an amazing fact considering a climb of over 4,000 feet was required to visit the highest station. Under the best of conditions this would have been a difficult undertaking, but considering this task was accomplished even during the winter months makes it even more impressive (Figures 3 and 4).

In addition to the climatological records, detailed phenological records and seedling experiments were conducted at the weather station sites to determine the survivability of individual tree species outside of their normal growing conditions. These planting experiments were started in 1917 (Pearson 1931) but seedlings were planted at the Douglas-fir site in 1912 and mapped in 1914 (Figure 5) perhaps with the knowledge that the weather stations might be established at a later date. Funding shortages and, later, Forest Service personnel called to duty during World War I, forced Pearson to conduct his research as resources allowed.

¹ In Pearson's "Factors controlling the distribution of forest types" articles (1920a, 1920b), he also describes the climate and soils for the desert-grassland and pinyon-juniper forest types, yet these records were obtained by U.S. Weather Bureau (Kingman, Williams, Flagstaff, and Winslow) or Forest Service (Ash Fork) or Park Service (Walnut Canyon) personnel.

Tree seeds were both collected and germinated at Forest Service nurseries in the Southwest. Then, the seedlings were transplanted to the weather station locations on the Peaks. The Douglas-fir site seedling experiments were carefully mapped and seedling survival was monitored for several years (Figure 5). This map shows Douglas-fir species from three different nurseries and ponderosa pine from five nurseries that were planted. Austrian pine and Norway spruce were also planted. Seedling survival appears to be mixed in an early photograph from the site (Figure 6). According to the photo caption, sheep are to blame for the browsing damage to the seedlings.

Permanent structures were constructed on at least two of the sites: the Douglas-fir and the spruce-fir sites. The Douglas-fir site was known as Campbell's Camp and is shown on an early Forest Service map as being the location of the Frisco Ranger Station (Figure 7). The cabin at Campbell's Camp is shown in Figure 8. The Spruce Cabin, located at the spruce-fir weather site (Figure 9), would have provided a welcome refuge from freezing winter weather even though, at times, it was nearly covered in snow (Figure 10).

A reconnaissance by the authors to the ponderosa pine (near FVEF headquarters) and Douglas-fir (Campbell's Camp) sites was conducted in the fall of 2007. No evidence of the ponderosa pine weather station structures was found. A single Douglas-fir, from the seedling experiment, is still alive. Surprisingly little is left to indicate all the work that was done at the site. There is considerably more evidence at the Douglas-fir site. While neither of the weather stations or even the cabin foundation were found, the seedling experiment area was easily located. The fence posts delineating it are still standing and bits of wire fence line exist (Figure 11). Galvanized pipes, spaced one chain (66 feet) apart, were



Figure 2. The San Francisco Peaks as seen from the southwestern edge of Fort Valley. USFS photo 89770 by G. A. Pearson in 1918.



Figure 3. Timberline on Agassiz Peak, 1918. Snow is 6-8 feet deep. Timberline weather station site is nearby. USFS photo 41427A.

located. It appeared that very few, if any, of the ponderosa pine seedlings survived and, not surprisingly, no Norway spruce or Austrian pine were evident. Survival of the ponderosa pine seedlings was likely limited by the dense aspen overstory (Figure 12). A considerable number of Douglas-fir are located within the seedling experiment. A handful of these were cored and the rings counted on-site. These appeared to be the correct age for trees that were planted by Forest Service personnel in 1912, the time of the establishment of the seedling experiment.

Summary

Data from the San Francisco weather stations established by G. A. Pearson and Fort Valley Experiment Forest personnel gave southwestern foresters a better understanding of growing conditions needed for particular tree species, and factors that limit their distribution. Some of the factors he determined to be of the greatest importance were that the upper elevational limits for vegetation are largely defined by low temperatures and that the lower elevational limits are determined by soil moisture rather than by high temperatures. These original weather station and transplant experiment sites have the potential to continue to be a valuable resource for climate change research in the Southwest.



Figure 4. Forest Assistant Lenthall Wyman traveling to weather station sites, 1917. USFS photo 31951 by G. A. Pearson.

This type of long-term dataset allows researchers to investigate nearly a century of changes. Studies such as the “Woolsey Project” (Moore and others 2004) have used similar datasets, also attributable to Pearson, to analyze changes in ponderosa pine in the Southwest.

Acknowledgments

The authors would like to acknowledge the hard work and dedication of all the past Forest Service personnel that collected and maintained the weather station and seedling experiment data over the years. Thank you to Susan D. Olberding, David Huffman and John Paul Roccaforte for their reviews of an earlier version of this manuscript.

References

- MacDougal, D. T. 1899. Influence of inversions of temperature and vertical air-currents on the distribution of plants. *The American Naturalist*. 33: 211-213.
- MacDougal, D. T. 1900. Influence of inversions of temperature, ascending and descending currents of air, upon [plant] distribution. *Biol. Lectures Wood's Hole*. 1899: 37-47.
- Maienschein, J. 1994. Pattern and process in early studies of Arizona's San Francisco Peaks. *Bioscience*. 44: 479-485.
- Merriam, C. H. 1890. Results of a Biological Survey of the San Francisco Mountain Region and Desert of the Little Colorado, Arizona. Government Printing Office, Washington, DC.
- Moore, M. M.; Huffman, D. W.; Fulé, P. Z.; Covington, W. W.; Crouse, J. E. 2004. Comparison of historical and contemporary forest structure and composition on permanent plots in Southwestern ponderosa pine forests. *Forest Science*. 50(2): 162-176.
- Pearson, G. A. 1913. A meteorological study of parks and timbered areas in the western yellow pine forests of Arizona and New Mexico. *Monthly Weather Review*. 10: 1615-1629.
- Pearson, G. A. 1920(a). Factors controlling the distribution of forest types, Part I. *Ecology*. 1(3): 139-159.
- Pearson, G. A. 1920(b). Factors controlling the distribution of forest types, Part II. *Ecology*. 1(4): 289-308.
- Pearson, G. A. 1930. Studies of climate and soil in relation to forest management in the southwestern United States. *The Journal of Ecology*. 18: 139-144.
- Pearson, G. A. 1931. Forest types in the Southwest as determined by climate and soil. Technical Bulletin 247. USDA Forest Service, Washington, DC. 27 p.
- Zon, R. 1908. Principles involved in determining forest types. *Forest Quarterly*. 6:263-271. [Reprinted from Proceedings of the Society of American Foresters, 1906]

SCA, E
2/3 INCH 1 CH.

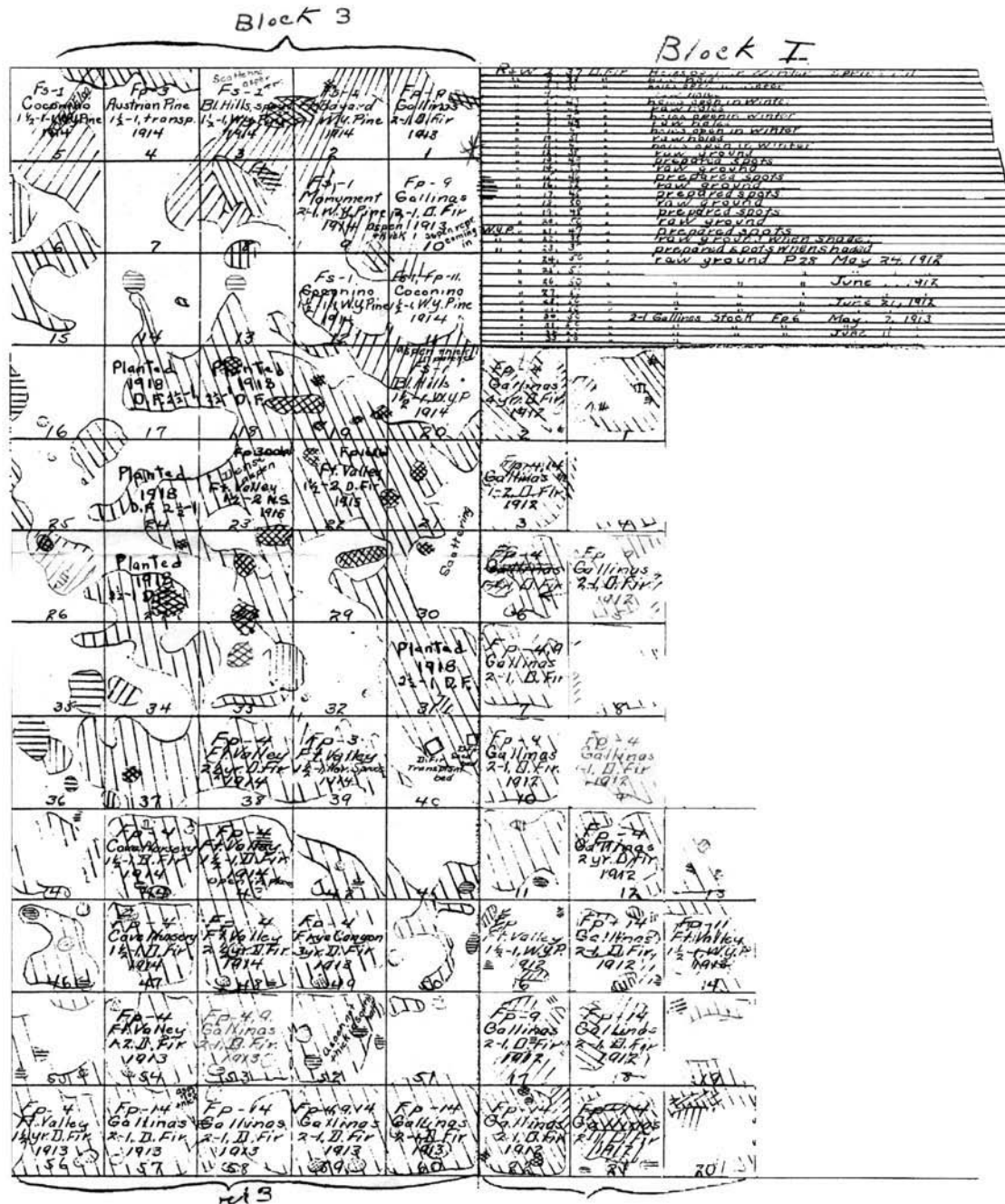


Figure 5. Seedling experiment located near the Douglas-fir weather station site; plantings were in 1912 and map was made in 1914. USFS Fort Valley Experimental Forest archives.



Figure 6. Hermann Krauch at seedling experiment at Campbell's Camp, 1925. USFS photo 205397 by G. A. Pearson.

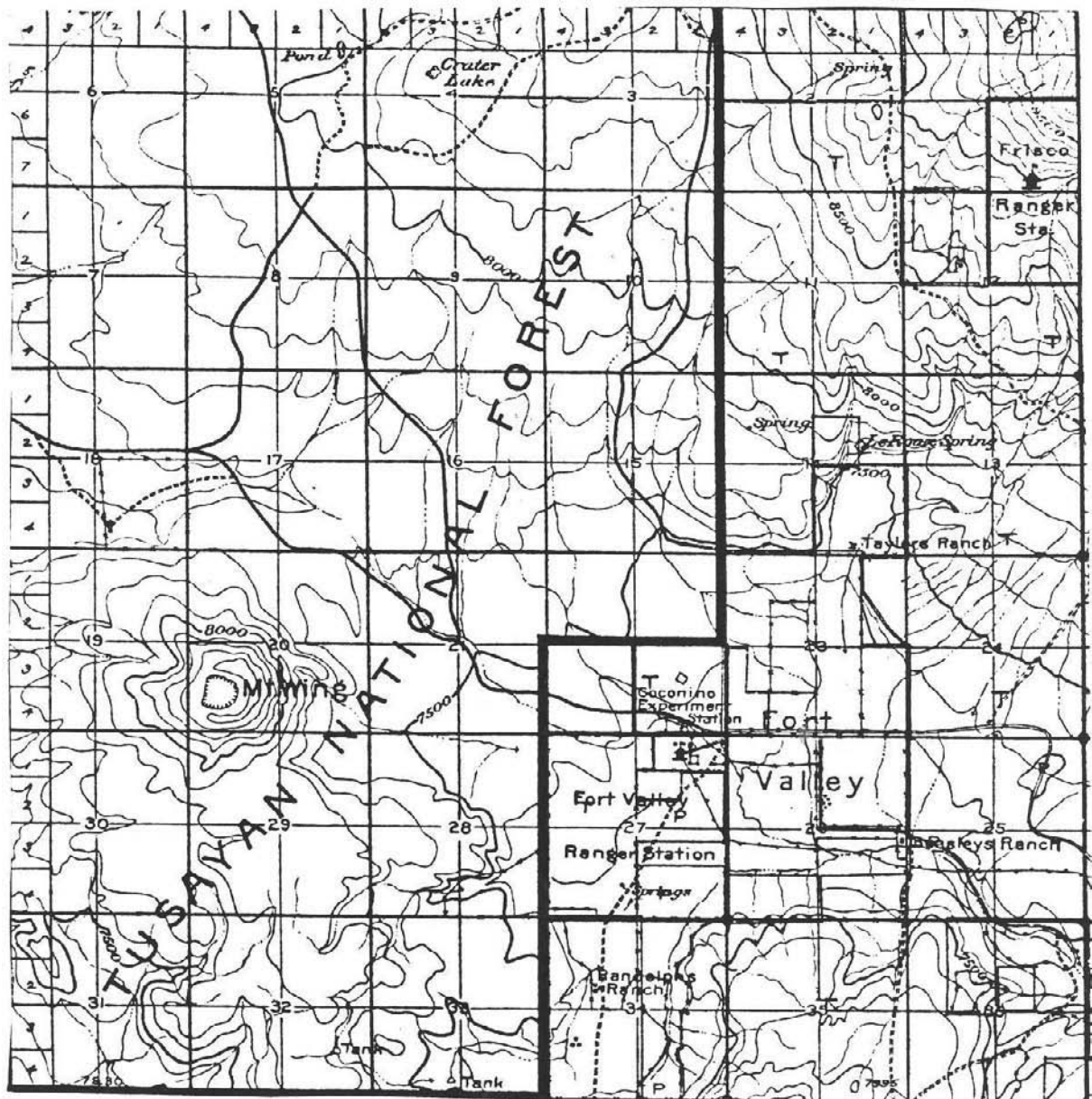


Figure 7. USFS map showing location of Frisco Ranger Station (upper right) (Campbell's Camp) relative to the Fort Valley Experimental Forest.



Figure 8. Cabin at Campbell's Camp, 1911. USFS photo 83932 G. A. Pearson.



Figure 9. Spruce Cabin located at the spruce-fir weather station site, 1917-1919. USFS photo 41429A by G. A. Pearson.



Figure 10. Spruce Cabin, ~1919.
USFS photo 43839A by G. A.
Pearson.



Figure 11. Fence posts at
Campbell's Camp located
during September 2007
reconnaissance. P. Z. Fulé,
photographer.



Figure 12. Ponderosa pine seedling planted underneath canopy of aspen at Campbell's Camp experimental planting site, 1929. USFS photo 239922 by G. A. Pearson.

The content of this paper reflects the views of the author(s), who are responsible for the facts and accuracy of the information presented herein.