Early Thinning Experiments Established by the Fort Valley Experimental Forest

Benjamin P. De Blois, *School of Forestry, Northern Arizona University, Flagstaff, AZ*; **Alex. J. Finkral,** *School of Forestry, Northern Arizona University, Flagstaff, AZ*; **Andrew J. Sánchez Meador,** *USFS, Forest Management Service Center, Fort Collins, CO*; *and* **Margaret M. Moore,** *School of Forestry, Northern Arizona University, Flagstaff, AZ*

Abstract—*Between 1925 and 1936, the Fort Valley Experimental Forest (FVEF) scientists initiated a study to examine a series of forest thinning experiments in second growth ponderosa pine stands in Arizona and New Mexico. These early thinning plots furnished much of the early background for the development of methods used in forest management in the Southwest. The plots ranged from 0.1 ac to 5 ac (0.04 ha to 2.02 ha) in size and many of the thinning plots and control plots were remeasured at 2- to 10-year intervals until the 1940s. The first thinning plots in the Southwest, called the White Spar plots, were established in 1925 on the Prescott National Forest. The residual trees on the thinned White Spar plots maintained higher growth rates than the control until the mid 1970s. The results from these early stand thinning experiments led G. A. Pearson, Director of FVEF, and others to largely abandon uniform thinning treatments and adopt the crop-tree thinning method as an improved method for thinning southwestern ponderosa pine stands.*

Introduction

In 1908, the Fort Valley Experiment Forest (FVEF) was established with a primary purpose of solving forest management problems in the Southwest (Pearson 1942). One issue of particular importance was how to manage densely stocked young stands of ponderosa pine (*Pinus ponderosa* Laws. *var. scopulorum* Engelm.), which were numerous throughout the Southwest by the early 1920s. This prompted G. A. Pearson, Director of the Station, to initiate the first thinning experiments in the Southwest.

Between 1925 and 1936, a series of seven forest thinning sites were established in second growth ponderosa pine stands in Arizona and New Mexico (Gaines and Kotok 1954). The objectives of these original thinning were to: 1) convert an essentially even-aged stand of second-growth ponderosa pine to a more uneven-aged structure through periodic partial cuttings, often referred to as crop tree thinnings (Krauch 1949); 2) shorten the rotation period required to produce crop trees of sawlog size; and 3) determine the volume of wood that could be periodically harvested in both thinned and unthinned stands. The crop tree method involved selecting 60 to 120 trees per acre as crop trees. If a designated crop tree held a dominant position in the canopy, then little to no release was prescribed. If the crop tree did not hold a dominant position in the canopy, then the crown was freed on at least three sides (Gaines and Kotok 1954). In this paper, we list the location, size, and establishment date for all of the original thinning studies established by the FVEF between 1925-1936, and we describe the earliest thinning study site, the White Spar site, in detail.

Study Sites

Stand thinning plots were located in a variety of locations and stand conditions, with the unifying factor being an overstory dominated by naturally regenerated ponderosa pine. Table 1 provides an overview of each study site. The majority of the plots was located in pole-sized stands of ponderosa pine of various ages while the Decker Wash and Corey Pasture plots were established in stands of sapling-sized ponderosa pine (12-20 years old) that established in 1914 (Gaines and Kotok 1954).

The White Spar plots were the earliest plots established, and are the only ones that have been re-measured since the late 1940s. These plots are located on the Prescott National Forest in central Arizona. The plots are located at an elevation

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Table 1. Overview of each series of experimental sites and plots established in the Southwest between 1925-1936 (information from Gaines and Kotok 1954).

Forest	Site Name	Number of Plots	Acreage (ac) (ha)	Establishment Date	Last Historical Re-measurement	Elevation (ft) (m)
Apache Sitgreaves	Decker Wash	5	0.12 to 0.14 (0.12 to 0.05)	1926	1948	7,000 (2,133)
Coconino	Ft. Valley- Ranger	7	0.04 to 0.15 (0.02 to 0.06)	1927	1946	7,600 (2,316)
	Ft. Valley- Sec. 19	8	0.27-0.50 (0.11 to 0.20)	1936	1947	7,600 (2,316)
	Ft. Valley- Corey Pasture	4	0.12 (0.05)	1934	1947	7,350 (2,240)
Gila	Redstone	16	0.1-0.25 (0.04 to 0.10)	1933	1948	7,300 (2,225)
Prescott	Copper Basin	3	0.6 (0.24)	1933	1948	6,400 (1,951)
	White Spar-A	4	0.24-4.2 (0.10 to 1.70)	1925	1946	5,500 (1,676)

of 5,800 ft (1,768 m) and receive approximately 19 inches (50 cm) of precipitation per year (Fogarty and Staudenmaier 2007). The soils are derived from granite and are fairly shallow (Pearson 1936).

Methods

Upon plot establishment, trees were tagged and their height and diameter at breast height were measured and recorded. After each thinning treatment, plots were re-measured at 2 to10-year intervals up until the late 1940s. The White Spar site consisted of two control plots, plots B and D, and one treated plot, plot A.

To remeasure the White Spar plots, we used the same survey and inventory methods that were used at plot establishment in 1925. Measurements were taken in English units and later converted into metric units. The original plot corners were destroyed, so we relocated trees with historical tags and then reestablished a plot perimeter that captured all tagged trees. If the original tree tag still existed, we measured the diameter at the location of the original nail and tag. Otherwise, diameters were measured to the nearest tenth of an inch at breast height (4.5 ft or 1.37 m above ground) using a diameter tape. All living trees, which were left as the result of thinning in 1925, were cored to determine age and decadal growth rates from 1925-2005.

Increment core samples were mounted, sanded, and crossdated with a tree ring chronology from a research site near Granite Mountain on the Prescott National Forest (PIPO-ITRDB AZ036; NOAA 2006). After crossdating many cores, we adapted the Granite Mountain chronology data and created a chronology list for the White Spar plots. After each core was crossdated and inspected, radial decadal growth increments were measured.

To quantify radial growth, we converted the radial growth (from pith to last tree ring) measurements into 10-year basal area increments (BAI). A BAI is a measure of tree growth over a given period of time. This conversion was performed to account for the fact that distance between growth rings may decrease as the tree increases in size, even if actual growth rates remain the same (Thomas and Parresol 1989).

Results

The current status of each original thinning study site is summarized in Table 2. Many sites have yet to be relocated and a portion of those that have been relocated are no longer in a condition that can be remeasured.

The White Spar site was relocated and the plots were remeasured during the summer of 2005 (Figure 1a, b). The thinned plot had a higher BAI until the 1970s. Control plot B never surpassed the growth rates of either the thinned plot or control plot D. Control plot D had the highest BAI from the 1980s until 2005 (Figure 2).

Discussion and Conclusions

These studies were the first to demonstrate the effects of thinning ponderosa pine forests in the Southwest. All seven study sites demonstrated that diameter growth of crop trees was increased when competition was decreased (Gaines and Kotok 1954). Although this does not seem surprising

Table 2. Overview of each series of experimental sites and plots established in the Southwest between 1925-1936 (information from Gaines and Kotok 1954).

Forest	Site Name	Re-located	Condition of Plot
Apache-Sitgreaves	Decker Wash	No	Unknown
Coconino	Ft. Valley- Ranger	No	Unknown
	Ft. Valley- Sec. 19	No	Unknown
	Ft. Valley- Corey Pasture	No	Unknown
Gila	Redstone	8 of 16	Variable, but mostly intact
Prescott	Copper Basin	Yes	Rendered useless by road and insects
	White Spar	Yes	Intact and Re-measured

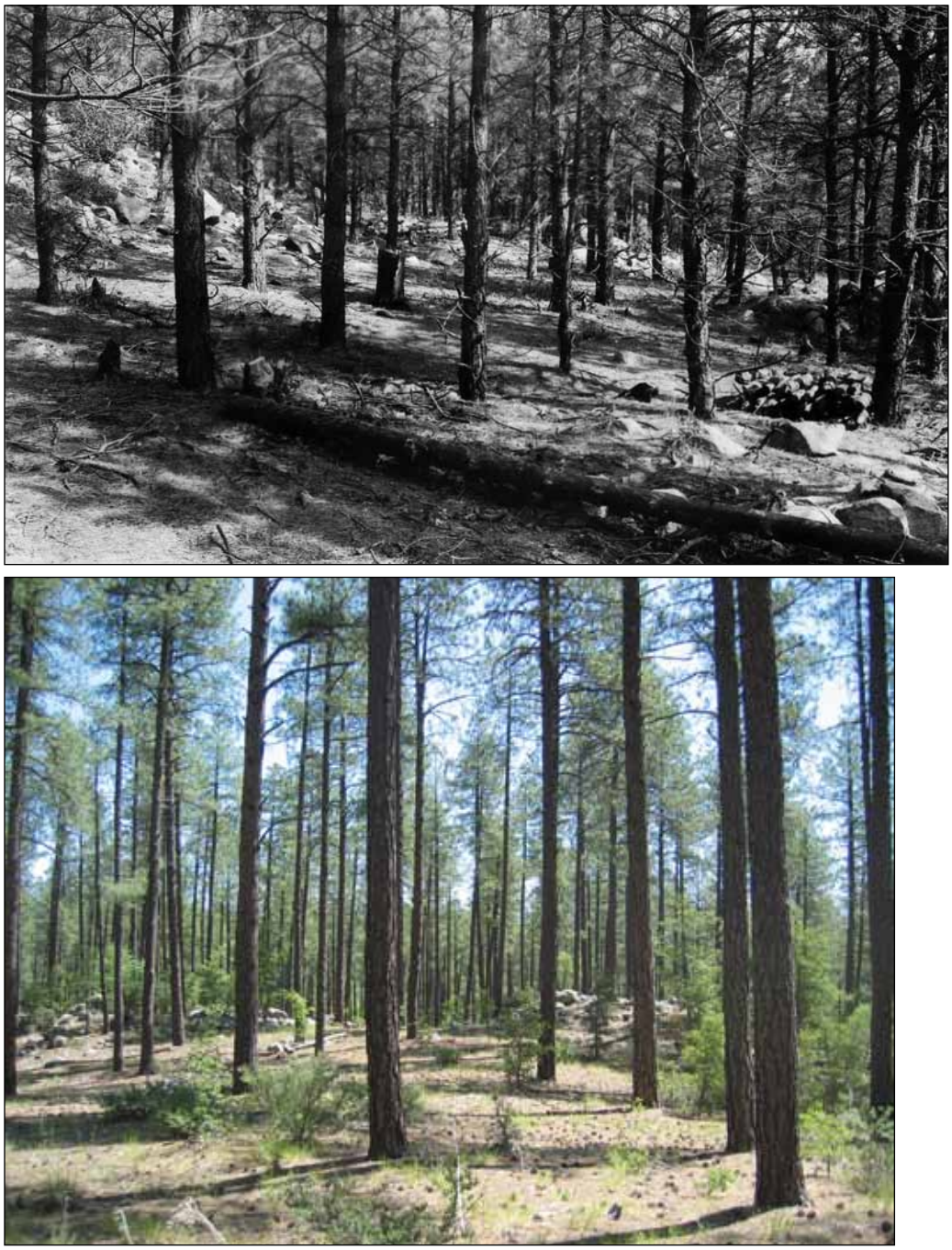

Figure 1a, b. Photographs of White Spar site taken in 1925 (top) as well as a photograph taken in 2005 (bottom). (Source: USFS photo 205392 by Ben De Blois).

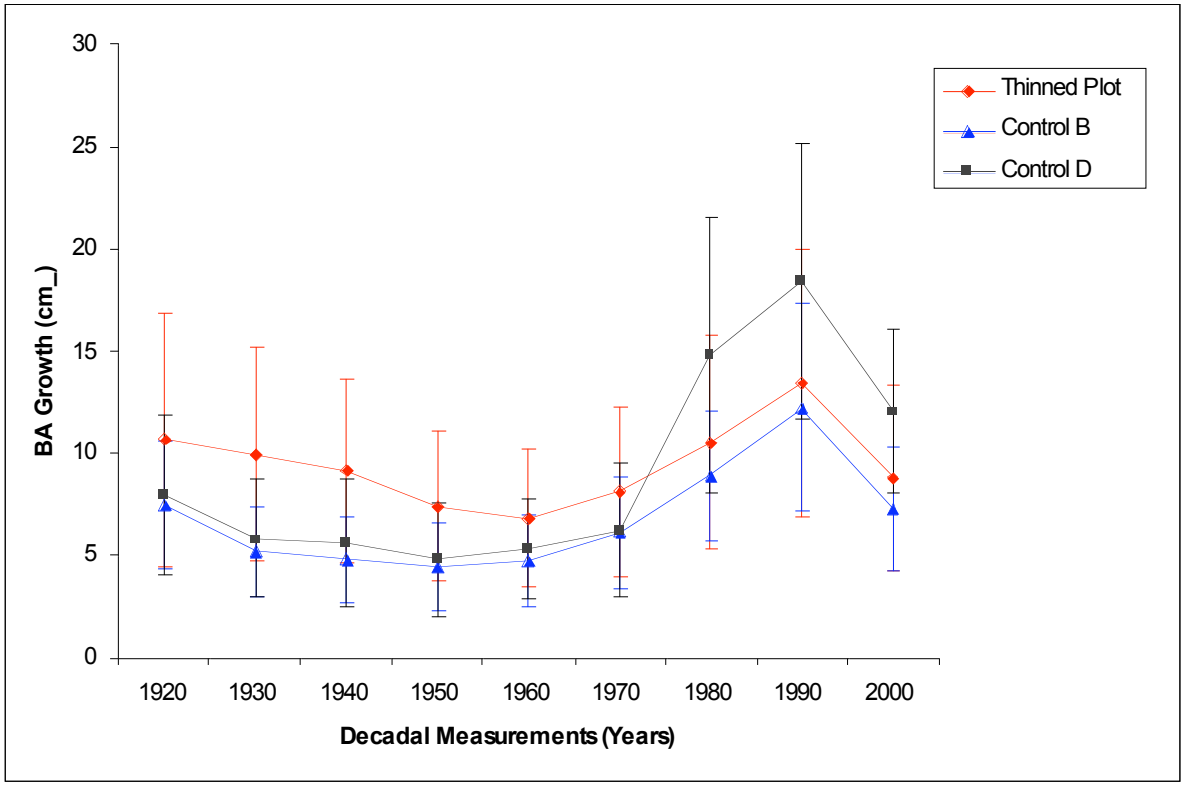

Figure 2. Comparison of the basal area growth increments (BAI), after converting radial growth into basal area growth per tree per year averaged over each ten year period, for the thinned and unthinned White Spar plots.

to foresters today, the spacing guidelines and potential tree growth for ponderosa pine stands were largely unknown when these studies were established.

Ultimately, the results from these early stand thinning experiments led Pearson and others to abandon uniform thinning treatments and adopt the crop-tree method as a more general thinning guide in southwestern ponderosa pine stands (Pearson 1950). The findings of these studies were directly applied to timber stand improvement guidelines throughout the Southwest (Gaines and Kotok 1954, Pearson 1940).

The White Spar plots demonstrate that the crop tree thinning method allowed the residual trees on the thinned plots to maintain higher growth rates for about 50 years. Such findings are consistent with that of earlier studies performed on the White Spar plots (Gaines and Kotok 1954, Krauch 1949, Pearson 1936). Our data also suggest that an additional thinning occurred in the early to mid 1970s, because there is a notable increase in radial growth, especially in control plot D. More details about the pre-treatment stocking levels would be useful and may have shown why the thinned plot had a higher net basal area before the thinning treatment occurred. For example, Krauch (1949) states that many of the pine stands were nearly clear-cut 40 years prior to the establishment of the White Spar study site. Such information on the stand history is critical in determining conditions prior to thinning and suggests other factors that might influence tree growth.

The rigor of experimental design in forestry studies has changed significantly since these early thinning trials in the Southwest. The study sites were not randomly located or thoroughly replicated. Microsite differences may have had a disproportionate affect on the results for the White Spar study site and possibly the other thinning studies. However, these original thinning plots, established by the Fort Valley Experimental Forest in the 1920s and 1930s, furnished much of the early background for the development of methods used in forest management in the Southwest today.

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and ledger data. Finally, we are indebted to G.A. Pearson, who had the foresight to establish these permanent thinning plots in 1925 to advance the knowledge of southwestern ponderosa pine management today.

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