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THE EFFECT OF ADVANCE GROWTH ON PONDEROSA PINE SEEDLING MORTALITY AT CHALLENGE EXPERIMENTAL FOREST

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ABSTRACT: In seed-tree cuttings at Challenge Experimental Forest, preliminary data show that as advance-growth stocking (20 inches in d.b.h. or less) increased from 11 to 49 square feet, seedling mortality increased from 4 to 32 percent (based on stocked mil-acre plots). A comparable increase in the stocking of seed trees over 20 inches in d.b.h. did not increase mortality.

In 1958, a series of silvicultural cutting experiments was started at Challenge Experimental Forest in Yuba County, California, in cooperation with the Soper-Wheeler Co., Strawberry Valley, California. The major objective was to determine the most efficient and economical methods of harvesting and regenerating young-growth mixed-conifer forests approximately 90 years of age.[1] Slash disposal and its site preparation aspects are a part of the study.

The stands were established about 1875 and, before logging, averaged 50,000 board feet per acre, Scribner rule. Ponderosa pine predominated with small admixtures of Douglas-fir, white fir, sugar pine, and incense-cedar.

1/ Jackson, Willard L. Working Plan, 1959, Supplement No. 4 to Cooperative Agreement for Forest Research on the Challenge Experimental Forest. 1959. (Unpublished report on file at Pacific SW. Forest & Range Expt. Sta., U.S. Forest Serv., Berkeley, Calif.)

Methods

Seed-tree harvest cuts, at three different levels of intensity, were made in 1959, 1960, and 1962. Compartments, averaging 16 acres in size, were the treatment units. Seed trees were retained to provide an estimated seed potential for each compartment of 25,000 (low), 50,000 (medium), or 100,000 (high) seeds per acre in a good seed year. Seed trees were 20 inches or more in diameter at breast height (d.b.h.). They were selected on the basis of the theoretical average seed production potential of dominant trees, according to d.b.h., as derived from Fowells and Schubert (1956). Ponderosa pine was the preferred species. Twelve-inch and 20-inch diameter-limit cutting levels were superimposed on the seed-tree standards to test the influences of advance growth. Advance growth included all trees less than 20 inches d.b.h.

Each compartment contained three different slash disposal treatments. The lopping of tops was the only treatment on one sub-compartment. On the other two, site preparation consisted of piling the slash, brush, and small hardwoods for burning: on one, slash was piled immediately after logging; on the other, piling was deferred until just before seed fall in the year of a good seed crop. Slash on deferred sub-compartments was piled in August 1960. Slash piles were burned when fire danger was low. The reduction in seedling and sapling stocking due to slash piling will be described in a later Research Note.

Hardwoods larger than 12 inches d.b.h. were poisoned before harvesting. Most of the smaller hardwoods were destroyed in slash disposal.

This preliminary report uses the combined data from the 1959 and 1960 cuttings and considers only the sub-compartments where slash was piled. The two series of cuttings made in 1962 have yet to experience a good seed crop. Growth of the residual stands will be discussed in a future paper.

Sawtimber stocking data were obtained from two half-acre plots in each sub-compartment. Trees from 3.5 inches to 11.5 inches d.b.h. were tallied on quarter-acre plots, concentric with the half-acre plots. Residual stocking data were obtained upon completion of slash disposal in 1959 and 1960.

Seedlings were tallied on 216 circular mil-acre plots symmetrically located along the radii of the half-acre plots. Tallies were made in July 1961 and May 1962. Seedling numbers and the numbers of stocked plots were derived from these counts.

Results

The harvest cuttings removed from 75 to 90 percent of the board foot volume. The species composition of the remaining seed trees was: ponderosa pine, 81 percent; Douglas-fir, 12 percent; sugar pine, 6 percent; and white fir, 1 percent.

The residual basal-area stocking, 3.5 inches d.b.h. and up, in the low and high seed potential compartments was 59 and 56 square feet, respectively (table 1). In the medium seed potential compartments, residual basal area was appreciably less (35 square feet). Seed-tree stocking, at 9, 26, and 45 square feet, was approximately proportional to seed-production potential. In contrast, the low seed potential compartments had about four times as much advance growth in residual basal-area stocking as the other two.

Table 1.--Conifer stocking after seed-tree harvest cuts[1]

Size class (inches)	Stocking where seed potential (seeds per acre) was--					
	25,000[2]		50,000[3]		100,000[4]	
	PP	All conifers[5]	PP	All conifers[5]	PP	All conifers[5]
	TREES PER ACRE					
3.5 - 11.5	5.0	49.0	1.8	24.0	3.4	23.1
11.6 - 19.9	8.9	25.6	0.4	2.7	0.6	1.8
20 or more	1.9	2.1	4.0	4.5	7.0	8.6
Total	15.8	76.7	6.2	31.2	11.0	33.5
	SQUARE FEET OF BASAL AREA PER ACRE					
3.5 - 11.5	1.26	13.19	0.72	7.47	1.98	9.17
11.6 - 19.9	13.62	36.02	0.36	2.30	0.45	1.46
Subtotal (adv. growth)	14.88	49.21	1.08	9.77	2.43	10.63
20 or more	8.10	9.37	23.20	25.55	36.79	45.30
Total	22.98	58.58	24.28	35.32	39.22	55.93

[1] The few small hardwoods remaining after slash disposal were considered insignificant.

[2] Cutting limit 20 inches d.b.h.; 2.1 seed trees per acre; simulated minimum standard under the California Forest Practice Rules with the addition of the prescribed seed-production level.

[3] Cutting limit 12 inches d.b.h.; 4.5 seed trees per acre.

[4] Cutting limit 12 inches d.b.h.; 8.6 seed trees per acre.

[5] Ponderosa pine, sugar pine, Douglas-fir, white fir, and incense-cedar.

The first good seed crop occurred in 1960. Seed trap counts showed the following ponderosa pine seed fall:

Seed production potential (seeds per acre)	Seed fall-1960 (seeds per acre)
25,000	19,000
50,000	28,000
100,000	25,000

Corbett (1962) described the coniferous seedling stocking as of July 1961. Seedling stocking was recorded again in May 1962, about a year after establishment, and mortality estimates derived (table 2).

A comparative summary of residual stocking and seedling stocking reductions indicated the influence of advance growth on mortality (fig. 1). Seedling losses increased with increased basal-area stocking of advance growth, but decreased with increased stocking of seed trees, suggesting that, for equivalent basal area, the relative influence of a number of small stems is greater than that of a few large stems.

Discussion

Soil moisture has been cited frequently as the critical factor in ponderosa pine seedling survival (Curtis and Lynch 1957; Fowells and Schubert 1951; Pearson 1950). Plant competition, exerting an influence on soil moisture, is credited with having a decisive influence on mortality of pine seedlings (Curtis and Lynch 1957; Tackle and Roy 1953).

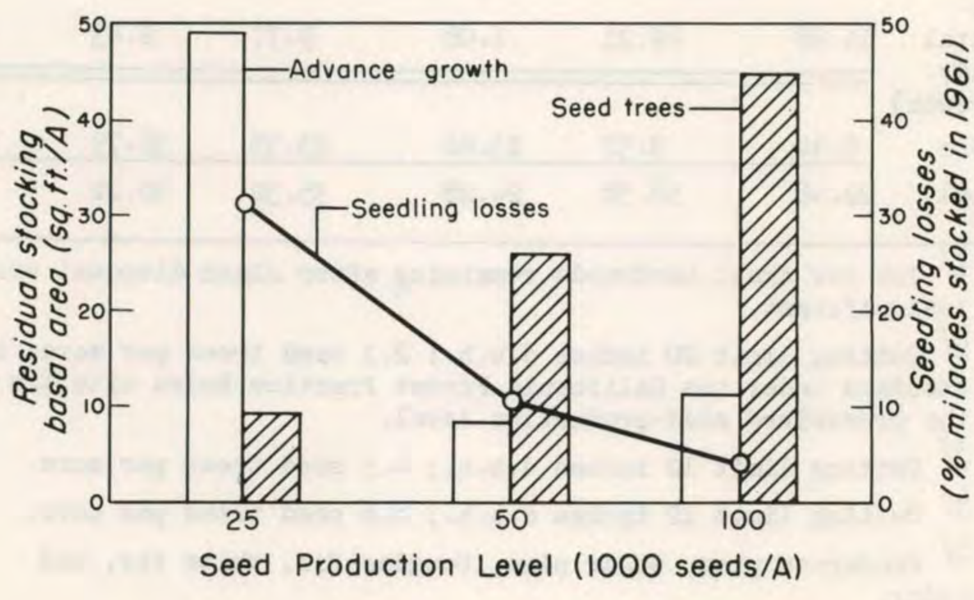

Figure 1.--Residual stocking and seedling losses.

Table 2.--Estimated seedling mortality one year after establishment[1]

Seed production potential (seeds per acre)	Ponderosa pine only: Milacres stocked	Ponderosa pine only: Seedlings per acre	All coniferous species[2]: Milacres stocked	All coniferous species[2]: Seedlings per acre
	- - - - - - - - -	- - Percent - -	- - - - - - - - -	
25,000	36	48	32	49
50,000	13	39	13	40
100,000	4	29	4	34

1/ Based on stocking in July 1961, and May 1962.

2/ Ponderosa pine, sugar pine, Douglas-fir, white fir, incense-cedar.

Presumably, the harvesting of stands should increase the amount of water available for remaining plants. Removal of additional vegetation in slash disposal treatments should further reduce the drain on water supplies and increase soil moisture. These treatments would tend to increase soil moisture evaporation, "but the evaporation losses from any soil are extremely slow after the surface 8 inches becomes dry" (Kittredge 1948, p. 156).

Many factors influence seedling survival. Our results tend to substantiate the importance of plant competition on seedling mortality. It seems likely that an extensive network of roots (for example, under a relatively undisturbed stand of advance growth) uses more soil moisture than the limited root network of a few well-spaced seed trees having a comparable basal area. Relative seedling losses during the critical first-year establishment period support this hypothesis. The residual seed trees will probably exert a greater influence on future seedling growth for, as Pearson (1950, p. 26) observes, "Ponderosa pine exhibits a remarkable capacity for appropriating soil areas which have been vacated by felled trees."

Other factors are undoubtedly interacting in these stands, because, as seed-tree stocking increased, mortality appeared to decrease. An intensive environmental study would be required to quantify and relate these other factors and establish the limits for the relationship.

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