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Seed Fall and Regeneration from a Group Selection Cut . . . *first year results*

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ABSTRACT: To approximate a group selection cut at the Challenge Experimental Forest, 48 small openings of three sizes--30, 60, and 90 feet in diameter--were logged in 1963. One aim was to create conditions of light and soil moisture that would favor establishment and growth of Douglas-fir, sugar pine, and white fir over ponderosa pine. Seed fall and first-year regeneration were comparable within the three openings for the three species.

An increase in natural regeneration is the major aim of a study at the Challenge Experimental Forest, Yuba County, California.[1] Three species--Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), sugar pine (Pinus lambertiana Dougl.) and white fir (Abies concolor (Gord. & Glend.) Lendl.)--have been singled out for several reasons. Current stumpage prices rate young-growth Douglas-fir more valuable than young-growth ponderosa pine (P. ponderosa Laws.); long-range estimates suggest a continuing nationwide demand for structural timbers; and the future for Christmas trees in California appears to be bright.

A group selection cutting method seemed best suited to fulfill the aim of this study. But several questions needed answers: Would sampling by 1-square-foot seed traps give an accurate picture of seed fall? Was the sampling intensity of small (1/4-milacre) regeneration subplots adequate, and what was the quantitative relationship between seed fall and established seedlings? What would be the species composition of the seedlings? Finally, would the group selection method be amenable to the management of Douglas-fir, sugar pine, and white fir?

After one growing season, regeneration results are promising. And several coniferous species are well represented--both in number and in dispersion.

Methods

Individual trees and small groups of trees were logged in a group selection cut to form openings of three approximate diameters: 30, 60, and 90 feet. Each cutting was replicated 16 times and all were located in six compartments totaling 50 acres. Each opening was located near at least one Douglas-fir, sugar pine, or white fir "seed tree."

[1] U. S. Forest Service research at the Challenge Experimental Forest is conducted in cooperation with the Soper-Wheeler Company, Strawberry Valley, Calif.

The area is reasonably homogeneous as to soil (deep, well drained), topography (gently sloping), and residual merchantable volume (26 to 34 M bd. ft. per acre). The timber is even-aged and about 90 years old. The merchantable stand is mainly ponderosa pine with admixtures of Douglas-fir, sugar pine, white fir, and incense-cedar (Libocedrus decurrens Torr.). It is classed as the Pacific ponderosa pine--Douglas-fir type (Society of American Foresters 1954).

Sprouts and seedlings of such hardwoods as Pacific madrone (Arbutus menziesii Pursh), tanoak (Lithocarpus densiflorus (Hook. and Arn.) Rehd.), and California black oak (Quercus kelloggii Newb.) are plentiful. With removal of the overstory, they actively compete with the coniferous regeneration.

Logging was completed in the fall of 1963 and the costs evaluated (McDonald 1965). In May 1964 the unmerchantable conifers and hardwoods were removed and the ground scarified by a heavy bulldozer-tractor.

The slash disposal pattern was adapted to the small openings and the dense, surrounding forest. It resembled spokes radiating from a central hub with a small, flat pile of quick decay potential and low fire hazard at the end of each spoke. In only a few openings was the slash heavy enough to require piling in the adjacent skid road for eventual burning. This combined slash removal and scarifying operation on 3.6 acres (the total acreage in all the openings) cost less than $40 per acre.

To sample seed fall, 1-square-foot seed traps (Boe 1955) were randomly located in each opening (fig. 1). Numbers of traps for the 30, 60, and 90-foot openings were 5, 8, and 10, respectively. The sampling intensity was different for each opening size as it was proportional to the area and anticipated variance in each.

The number of seedlings of both coniferous and hardwood species and their stocking percent were surveyed in late spring by randomly located, circular 1/4-milacre subplots. The sampling intensity was keyed to the variation in seedlings per acre that occurred in similarly treated stands, and a sampling error of ± 15 percent at the 90 percent level of probability. Regeneration subplots for each 30, 60, and 90-foot opening numbered 9, 17, and 20, respectively.

Results

Seed fall.--In a given year, the probability of four coniferous species having an abundant cone crop is small, but that happened at the Experimental Forest in 1964. Ponderosa pine, Douglas-fir, sugar pine, and white fir all had cone crops rated as good. However, seed fall was only fair (table 1). Sugar pine seed fall was not evaluated because the traps failed to catch the seed. Apparently the sugar pine seeds are too large and their wings too rigidly attached for them to drop into the traps. Ponderosa pine occupied 72 percent of the stand and contributed 66 percent of the seed fall; Douglas-fir, 24 percent of the stand, and 16 percent of the seed fall. White fir constituted only 2 percent of the stand, but contributed 18 percent of the total seed fall.

Figure 1.--Portion of a typical 90-foot opening in mid-November 1964. Heavy needle fall often accompanies seed fall, increasing the job of emptying the traps.

Table 1.--*Seed fall, by species and opening size, group selection cut, Challenge Experimental Forest, 1964*

Species	Amount of seed fall per acre when diameter (feet) of the opening was-- 30	60	90	Soundness
	Number			*Percent*
Ponderosa pine	38,660	52,406	46,530	42
Douglas-fir	13,068	8,167	11,375	20
White fir	9,801	15,995	12,375	19

A simple "t" test at the 5 percent probability level was used to check the sampling intensity. Ponderosa pine seed fall appears to have been acceptably sampled in all six compartments, Douglas-fir seed fall in four compartments, and white fir in three. Those compartments that were inadequately sampled for Douglas-fir and white fir indicated a seed crop too "light" to be further analyzed. Differences in seed fall among those compartments that proved to be acceptably sampled were then tested by Tukey's Multiple Comparison Test (Hamilton 1965). No differences in seed fall were found between opening sizes within each compartment or among the compartments.

Regeneration. --Values of 50 percent stocking (milacre basis) and 1,375 2-year-old coniferous seedlings per acre were chosen as minimum acceptable standards for future stand manipulation and growth rate control. Stocking and number of seedlings per acre (table 2) are expected to meet these standards at the end of the second (1966) growing season. Seedling mortality is normally low on well scarified sites free of advance reproduction and hardwoods. And the unusually wet summer of 1965 should hold mortality below 10 percent. The number of conifers (Douglas-fir, sugar pine, and white fir) other than ponderosa pine was close to the acceptable standard at the end of the first growing season.

Table 2.--*Average stocking and number of seedlings per acre, group selection cut, Challenge Experimental Forest, 1965*

Species	Milacre stocked by 1-year-old seedlings when opening size (feet) was--			1-year-old seedlings per acre when opening size (feet) was--		
	30	60	90	30	60	90
	Percent			Number		
Ponderosa pine	59.3	59.1	73.4	2,917	3,368	3,125
Sugar pine	22.4	19.2	12.0	416	265	238
White fir	17.7	32.4	27.9	1,000	1,279	800
Douglas-fir	10.0	14.5	19.9	112	162	288
All species	65.1	71.4	77.4	4,445	5,074	4,451
Douglas-fir, sugar pine, white fir	39.7	50.4	41.8	1,528	1,706	1,326

Number of seedlings and stocking data were separately analyzed by analysis of variance. However, the analysis of stocking data requires two prior manipulations: (a) converting the 1/4-milacre values to the milacre standard (Grant 1951), and (b) using an arc sine transformation to produce an approximately homogeneous variance (Dixon and Massey 1957). The transformed values then form the basis for the analysis of variance. No significant differences were found between opening sizes for any species for either number of seedlings or stocking percent.

Hardwood regeneration did occur, but was negligible--indicating the effectiveness of the scarifying treatment.

Discussion and Conclusions

The adequacy of the seed fall sampling intensity is nearly always uncertain because of the ever-changing variance. For as Roy (1959) has stated: "The variance decreases as seed fall increases from light to heavy, and as trap size increases. When seed fall is light, we expect less variation in the seed catch of large traps than of small traps; and for traps of a given size we would expect more variation in the catch during light seed years than in heavy."

Insofar as the data in this study are concerned, these conclusions can be drawn: (a) for other than sugar pine the 1-foot-square seed trap is a practical means of sampling seed fall for the species and conditions stated; (b) the experimental design and sampling intensity appear to be acceptable for a "medium" seed fall; and (c) the satisfactory relationship between proportionate amounts of seed fall and species of trees supplement the statistical evaluation of acceptable sampling.

The number of seeds per seedling was comparatively low. After extensive work on seed crops in California, Fowells and Schubert (1956) stated: "To obtain 500 established (ponderosa pine) seedlings per acre, or 2,000 seedling after germination, would require conservatively, about 60,000 seeds per acre"--on a mineral soil seedbed and if rodents were poisoned. Thus a single seedling could be expected from about 30 seeds.

In the group selection area, about 3,200 ponderosa pine seedlings resulted from 45,000 seeds, or a 1 to 14 ratio. And rodents were not controlled. The reason for this low seed-seedling ratio is a matter of conjecture, but it may be due to the highly productive site and consistently favorable climate.

The favorable species composition evident after one growing season will permit further testing of the group selection method as a means of establishing Douglas-fir and other coniferous species. Ponderosa pine now has the advantage of numerical superiority, but this condition may change. Because it is the least tolerant of the three conifers, this species may decline in numbers--both in the smaller openings and in the shady edges of the large ones. Differences in height growth among the species being tested and in size of opening also are expected as roots from the bordering trees extend into the openings. No significant variation in seedling numbers or dispersion, however, is now evident among the opening sizes. Therefore, any future differences in seedling growth and species composition can be attributed to the effect of the openings themselves.

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