Seedfall From Young-Growth Ponderosa Pine

Fig. 1. All seed trees were selected for good form, even spacing, and evidence of cones beneath the tree. In this cutting on the Challenge Experimental Forest, California, nine trees to the acre remain.

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ABSTRACT—Young-growth ponderosa pine seed trees were evaluated in terms of seed production. Seed trees ranging from 3 to 9 per acre produced 5,000 to 35,000 seeds per acre in years of moderate and heavy cone crops. Seed-tree selection before harvesting by the seed-tree method of cutting must be keyed to evidence of past cone production to assure best seed production in the future.

The seed-tree cutting method leaves selected trees to regenerate the timber stand for the next crop. This method is tailored for the forest land owner who wants to harvest timber and regenerate similar desirable stands of ponderosa pine (*Pinus ponderosa* Laws). It reduces anxieties about additional capital outlays for seeding, planting, or other cultural work necessary after some other types of cutting. But how many seed trees should he leave? How much seed will young-growth trees produce from a cone crop, and how often will there be a good cone crop? These are some of the questions being asked by owners, managers, and others interested in ponderosa pine stands in north-central California.

Finding the answers is one major aim of trials underway on the Challenge Experimental Forest.[1] Here the fortunate combination of deep soil, moderate climate, and 67 inches of annual precipitation make this a high site, where trees grow more than 140 feet tall in 100 years (*1*). It is typical of over 1½ million acres occupying a long continuous belt running northwesterly along the westside Sierra Nevada near the 2,600 foot elevation.

The timber stand studied was a 90-year-old, even-aged stand of Pacific ponderosa pine type (*4*). Other conifer species found were Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco], sugar pine (*Pinus lambertianna* Dougl.), white fir [*Abies concolor* (Gord & Glend.) Lindl.], and incense-cedar (*Libocedrus decurrens* Torr).

Seed-tree cuttings were completed in 1959, 1960, and 1962. The area cut in a given year is designated as

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

a unit, and the units in turn are divided into irregular compartments ranging from 10 to 35 acres. Units of this study aggregated about 130 acres from which we removed about 18 to 33 M bd. ft. per acre, or 50 to 80 percent of the total merchantable volume measured to a 12-inch diameter limit. The remaining volume was essentially in seed trees numbering from three to nine per acre.

Seed trees were selected by these criteria in order of descending priority:

1. Good form, dominant height, a full crown, good vigor, and 20 inches in diameter or larger (*Fig. 1*).
2. Evenly spaced throughout the unit.
3. Evidence of cones, both new and old, at the base of the trees.

Cone Production

Cones were counted on all seed trees in the late summer of 1960, 1961, and 1962. They were counted either by tallying cones on six ½-acre plots in each compartment or by tallying all cones in the compartment. Cones on a tree were counted from one position about 100 feet away from the stem. New cone axis discarded on the ground by squirrels were counted and added to the adjusted cone count to determine total cone production for the year. Total number of seeds produced was estimated by multiplying the number of cones by 71 (*2*), an average for samples in cones from old-growth trees.

The cone crops of 1961 and 1962 were "very light" (defined as a few cones on less than one-fourth of the trees in the undisturbed forest). In these years the average number of cones per tree was estimated, by diameter classes, for trees bearing cones (*Fig. 2*).

Seedfall

Seedfall was sampled for eight years (1959-1966) by using 1-foot square seed traps (*3*). Seeds began falling as early as late August. The traps were emptied each November. Initially they were also emptied in February and June, but little sound seed fell after November, so the later seed collections were stopped.

Two methods were used to sample seedfall: (1) In some compartments, 18 seed traps were paired and placed at three selected points on each of three randomly placed transects. (2) In others, six traps were placed in each of six circular ½-acre plots per compartment.

Seeds collected from traps were cut to determine soundness. A seed with a developed outer coat, endosperm, and embryo qualified as sound. The percent of sound seed was estimated each year from the seeds caught in traps. Sound seed percentages by compartments ranged lower in years of light cone crops (13 to 41 percent) than in years of heavy cone crops (1960 and 1964) when ranges were 24-41 and 31-57 percent, respectively.

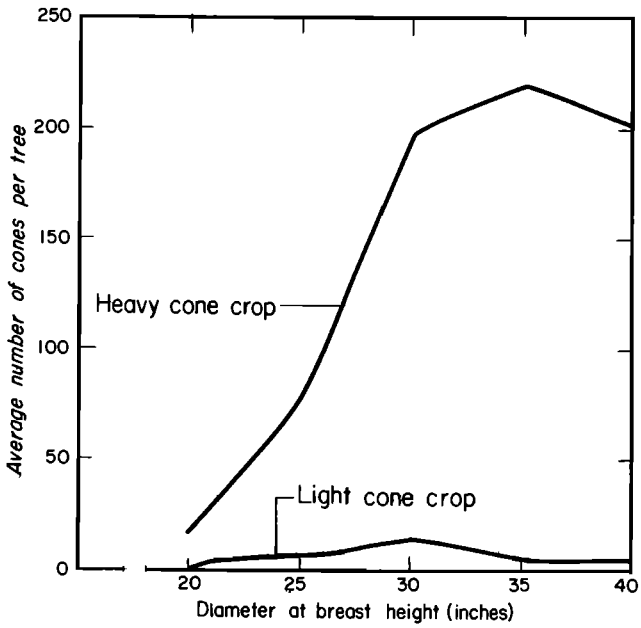

Fig. 2. Average number of cones per tree by diameter classes in young-growth ponderosa pines at the Challenge Experimental Forest.

Seed-Tree Performance

In the 90-year-old, even-aged stands, trees 30 inches or larger in diameter numbered 10 to the acre, and trees 20 to 29 inches in diameter averaged 16.6 per acre.

Thirty-four percent of the seed trees selected bore cones in 1960. Seed production by the larger trees was markedly better than by the smaller trees (*Table 1*), and more cones were produced on trees 30 inches in diameter in light seed crops (*Fig. 2*). Consequently, the larger trees were determined to be most desirable as seed trees.

Although the seed trees selected represented the best available—selected partly on evidence of past cone production—the number of productive seed trees per acre was less than planned. For example, 66 percent of the trees were productive where three seed trees were left per acre, and 28 to 53 percent of the trees were productive on areas where six seed trees were left.

Seed fall estimated from seed caught in traps did not always agree with seed production estimated from cone counts, as in compartment 5 (1960), and in compart-

Table 1. Seed Trees Bearing Cones, By Diameter Classes and Cone Crops, Challenge Experimental Forest, California, 1960-1962.

Diameter class (inches)	Amount of trees bearing cones when the cone crop was:					
	Heavy (1960)		Light (1961)		Light (1962)	
	percent	*number of trees*	*percent*	*number of trees*	*percent*	*number of trees*
20	0	1	0	1	0	25
25	33	15	7	15	10	40
30	28	25	4	25	51	39
35	40	15	13	15	35	20
40	38	8	13	8	30	13
45	0	1	0	1	0	1

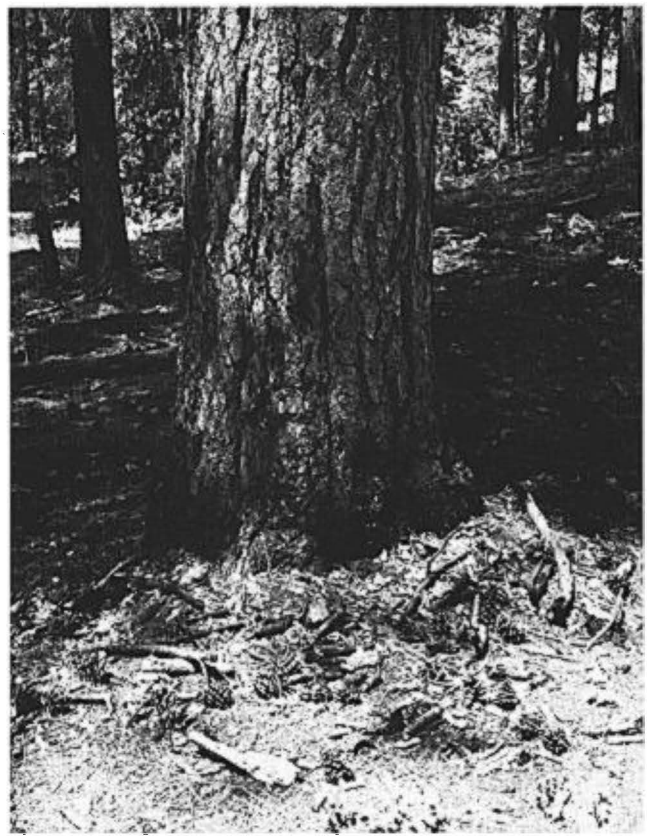

Fig. 3. Evidence of past cone production is the most characteristic means of selecting prolific seed trees. Trees about 30 inches in diameter, as in the foreground above, are desirable because in years of light cone crops they produce more cones than trees of other diameters.

ment 9 (1964) (*Table 2*). In these compartments abundant seedfall was produced by a few highly productive seed trees bordering the sample plots.

After cutting, the remaining seed trees produced more cones than before cutting. In 1960, the cones from flowers initiated before cutting produced less seed than the controls (*Table 2*). Flowers initiated after cutting produced numbers of seed either equal to or in excess of seed produced in the control area, showing an increase in cone production by the selected seed trees.

Conclusions

During the eight years of observation, two heavy seed crops occurred, in 1960 and 1964 (*Table 2*). Crops were light in two consecutive years, 1961 and 1962. A moderate crop in 1963 was followed by a heavy crop in 1964. Great variation in seed crop frequencies can be expected from factors other than a tree's natural variation in ability to produce cones. The flowers and conelets are affected by climate, insect depredations, and other factors. Experience indicates that at least moderate cone crops can be expected at intervals of one to three years (*Table 2*).

Cone crop frequencies in the three cutting units, located ¼ to to 1-¼ miles apart, were quite consistent (*Table 2*). Cone production on the three units was comparable, whether light or moderate.

The performance of individual trees was consistent in cone production. This also has been noted in old-growth ponderosa pine (*2*). In the years when light cone crops were recorded, only one seed tree produced more than half the number of cones produced by a similar-sized tree during a heavy cone crop. This condition indicates the trees are somewhat synchronized in their cone production.

In general, no differences in seed fall occurred where three to nine seed trees per acre remained. This consistency indicates two important points: (1) not just any tree with good form and well shaped crown has potential as a good seed tree; and (2) as more seed trees are retained, the more often we are forced to depart from selection criteria and compromise by using whatever is available.

The basic criterion for selecting seed trees must be good form. But among trees of acceptable form, primary emphasis in seed-tree selection should be placed on evidence of past cone production as evidenced by cones near the base of each tree (*Fig. 3*). Consideration of spacing should follow. In even-aged stands, the larger trees tend to be the cream of the crop and, therefore, are phenotypically best to regenerate progeny for the next generation.

Literature Cited

1. Arvanitis, L. G., J. Linquist, and M. Palley. 1964. Site index curves for even-aged young growth ponderosa pine of the west-side Sierra Nevada. Calif. Forest & Forest Prod. Calif. For. Prod. Lab. No. 35, 7 p.
2. Fowells, H. A., and G. H. Schubert. 1956. Seed crops of forest trees in the pine region of California. USDA Tech. Bull. No. 1150, 48 p.
3. Roy, Douglass F, 1959. Small seed traps perform well in the Douglas-fir type of California. U.S. Forest Serv. Pacific SW. Forest & Range Exp. Sta. Res. Note 150, 7 p.
4. Society of American Foresters. 1954. Forest cover types of North America. Wash., D.C. 67 p.

Table 2. Seed Production Estimated From Seeds in Traps and From Cone Counts, As Related to Number of Seed Trees, Challenge Experimental Forest, California, 1959-1966.

	Sound seeds when number of seed trees per acre was:												
	3. (10–1960[1])		4.3 (5–1959)		6. (9–1960)		6. (3–1959)		8. (16–1962)		8.6 (15–1962)		23.1 Control
Year	traps	cones	traps	cones	traps	cones	traps	cones	traps	cones	traps	cones	traps
	thousands of sound seed per acre												
1959	—	—	0	0	—	—	0	0	—	—	—	—	—
1960	26.1	33.6	30.2	2.7	35.9	47.5	15.4	16.2	—	—	—	—	81.6
1961	0	0	0	0	0	0	0	1.2	—	—	—	—	0
1962	0	0.7	0	1.3	1.2	0.6	3.6	2.8	0	0.9	0	0.3	0
1963	13.7	—	23.6	—	7.7	—	17.4	—	4.8	—	0	—	3.4
1964	18.2	—	21.8	—	83.5	—	20.0	—	27.0	—	28.6	—	19.7
1965	0	—	0	—	0	—	0	—	0	—	0	—	0.6
1966	29.0	—	0	—	3.6	—	16.3	—	4.9	—	1.2	—	2.5

[1] Compartment and year in which the stand was cut.