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Seed Fall of Three Conifers In West-Central Oregon

BY
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Abstract. Seed fall of Douglas-fir, western hemlock, and western redcedar was measured with seed traps on clearcut areas in western Oregon from 1954 to 1965. During the 12 years, crops of filled seed per acre showed the following ranges: Douglas-fir 300 to 168,800, hemlock 1,000 to 178,900, and redcedar 0 to 367,400. The percentage of seed that was filled showed a direct relation to size of the annual crop for Douglas-fir and redcedar, but not for hemlock. Percentage of seed that was filled averaged 15 for Douglas-fir compared with 21 for hemlock, and 27 for redcedar. Seed fall began in late August or early September; by December, it reached 70 percent for Douglas-fir and 60 percent for hemlock and redcedar, and was virtually complete for all three species by April. Percentage of the species composition in the adjacent forest and of the total seed fall was: Douglas-fir 80 and 26, hemlock 10 and 40, and redcedar 10 and 34. Distribution of seed of the three species showed similar gradients into the clearcuts. Seed fall declined roughly in the ratio of 7 to 2 to 1 at 75, 225, and 375 feet from the timber edge.

Additional key words. *Pseudotsuga menziesii, Tsuga heterophylla, Thuja plicata*, seed distribution.

EARLY, economical reforestation of logged or burned habitat continues to be an important problem of land managers west of the Cascades in the Pacific Northwest. Considerable reliance is currently placed on artificial regeneration of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) by direct seeding and by planting nursery stock; however, natural regeneration still accounts for restocking large areas and is heavily relied on for western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and western redcedar (*Thuja plicata* Donn). Consequently, the seed supply of these conifers is a subject of much importance and interest. This paper is based on detailed seed fall data accumulated during 12 years in conjunction with forest-wildlife studies (Gashwiler 1967).

Seed traps operated during the seed years 1954 through 1965 provided the data from the 3B, 3G, and 9A clearcuts of the H. J. Andrews Experimental Forest, a part of the Willamette National Forest, in Linn and Lane Counties, Oregon. The clearcuts, all with a southerly exposure, ranged in size from 21 to 41 acres and in elevation from 1,800 to 2,750 feet. The old-growth stands average about 400 years old. The composition of the stands on the study areas averaged 80 percent Douglas-fir, 10 percent hemlock, and 10 percent redcedar. Other species in the stand were relatively unimportant.

Methods

The seed traps used in this study were made of 2- by 3-foot wooden frames floored with painted 14 by 18-mesh

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screen to retain small hemlock seed, and topped with 3/8-inch mesh hardware cloth to exclude small mammals and birds. Annual seed fall was sampled by traps on three clearcuts. In 1954, on the 3B clearcut, two transects were quartered and each of the eight resulting segments was sampled by a randomly located seed trap. In 1955, seed traps were moved to strips paralleling the timber edge on the 3G clearcut. The 50- to 100-foot strip was sampled by five randomly located pairs of seed traps, and the 200- to 250-foot strip by three pairs to make a total of 16 traps. From 1956 to 1959 the pattern of sampling was extended to 12 traps in the 50- to 100-foot strip, 8 in the 200- to 250-foot strip, and 4 in the 350- to 400-foot strip. From 1960 through 1966 the 24 seed traps were relocated on clearcut 9A in a similar pattern except they were individually randomized in the three strips.

From fall of 1956 until the fall of 1960, the seed traps were tended monthly at irregular times except when snow or some other factor interfered. During the following years the traps were tended near the start of germination, generally in early April, and again the latter part of August just before the start of the new seed fall. The samples of seeds were cut open to determine the percentage filled and probably viable (U. S. Forest Service 1948).

Annual Seed Fall

The annual Douglas-fir seed fall on the clearcuts ranged from 300 to 168,800 filled seed per acre (Table 1). In 4 of the 12 years the filled seed totaled 30,000 or more per acre. These heavier crops occurred every 3 years to be followed by a year of negligible seed fall. The duration of records, however, does not appear sufficient for predicting the "up and down" pattern that is generally recognized in Douglas-fir seed crops. For this 12-year period the seed crop records roughly conform with those for western Washington by Reukema (1961) and with the cone crop (not necessarily equivalent to filled seeds) reports by Washington Natural Resources Department (1967).

TABLE 1. Percent of seeds that were filled, and number of filled seed per acre falling on clearcut areas from seed crops of Douglas-fir, western hemlock, and western redcedar 1954–65.[1]

		Douglas-fir		Hemlock		Redcedar		
Clearcut	Seed year	Percent	No. per acre	Percent	No. per acre	Percent	No. per acre	Total per acre
3B	1954	17	18,200	56	94,600	61	91,700	204,500
3G	1955	7	1,400	3	1,000	0	0	2,400
3G	1956	25	85,300	35	73,200	67	367,400	525,900
3G	1957	1	300	4	3,200	8	5,100	8,600
3G	1958	8	2,200	8	12,400	8	300	14,900
3G	1959	37	168,800	41	178,900	51	75,800	423,500
9A	1960	2	300	7	7,300	17	1,000	8,600
9A	1961	15	7,600	11	64,300	25	6,400	78,300
9A	1962	23	30,900	21	47,100	0	0	78,000
9A	1963	4	600	8	10,500	13	300	11,400
9A	1964	13	7,300	21	30,200	48	11,600	49,100
9A	1965	25	71,600	38	138,800	26	14,600	225,000
Average		15	32,900	21	55,100	27	47,900	135,900
9A-T[2]	1965	15	156,700	50	888,300	28	185,300	1,230,300

[1] Based on sampling with 24 seed traps per clearcut except 8 on 3B; 16 on 3G, 1955; 23 on 9A, 1964; and 12 on 9A-T. Number of seeds rounded to nearest 100.

[2] Traps 50 feet within timber edge.

Isaac (1943) reported that higher seed [illegible] based on 10 years records of seed fall on clearcut areas in the Wind River Experimental Forest, Washington. Douglas-fir produced only 26 percent of the filled seed disseminated on the clearcuts during the study although it made up 80 percent of the old-growth stand. However, this is to be expected of Douglas-fir when associated with such heavy seed producers as western hemlock and western redcedar.

Hemlock seed crops ranged from 1,000 to 178,900, falling below 3,000 filled seeds per acre only once during the 12 years and exceeding 30,000 per acre in 7 of the years. Hemlock proved a more regular seed producer than Douglas-fir, with [illegible] tendency for a light year to follow a heavy one. Hemlock trees made up about 10 percent of the old-growth stand but contributed 40 percent of the total number of filled seeds trapped. Thus hemlock, though not abundant, was an important source of seed for regeneration purposes. Similar findings have been reported from Vancouver Island, British Columbia, by Garman (1951).

Redcedar was the most variable of the three species, with seed production ranging from none for 2 of the years to a high of 367,400 per acre. In only 3 of the 12 years did redcedar produce more than 30,000 seeds per acre. Although redcedar made up only about 10 percent of the old-growth stand providing the seed source, it produced 34 percent of the filled seeds falling on the clearcuts during the 12-year period.

Total annual seed crops of the three species combined ranged from 2,400 to 525,900 filled seeds per acre. In 7 of the 12 years of observation, over 49,000 seeds per acre of all three species were captured, or more than one seed per square foot. In 4 of the 12 years, over 200,000 seeds fell per acre, or more than five seeds per square foot.

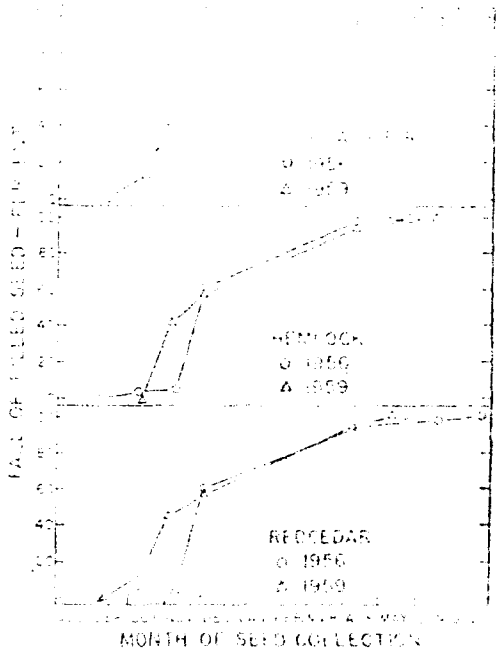

FIGURE 1. *Cumulative monthly percentage of total filled seed of three species falling on clearcut area 36 during the good crop years of 1956 and 1959.*

Time of Seed Fall

The periods of seed fall are given for the three species in Figure 1. These cover 1956 and 1959 seed years and include two good crops.

No Douglas-fir seeds were trapped the first part of September for the 2 years. However, 13 and 26 percent were captured by the first of October. The 1956 seed fall was very light (2 percent) from the first third of October until the first third of November. In contrast, the 1959 seed fall for roughly the same period was 29 percent. The seed fall was relatively heavy from the first of November to the first of December for both years. By that date, nearly 70 percent of the total crop had fallen. This is about one month later than Isaac (1943) found for Douglas-fir at Wind River, Washington. The Andrews traps were not tended again until the first third of April by

then over 95 percent of the total seeds trapped had been recovered. It is of interest that a filled Douglas-fir seed was trapped between the middle of June and late July in 1957.

Hemlock also had good crops during the 2 years. The seed fall in 1956 started between the first of September and first of October, but very few seeds fell until the November-December period. The hemlock seed fall appears to start early but at a low rate and then to increase rapidly. By the first half of December during the 2 seed years the trees had shed about 60 percent of their crop, and most of the remaining seed was dropped by the first half of April. Ruth and Berntsen's (1955) seed-fall curve for Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and western hemlock in coastal Oregon is roughly similar to that of this study. Winter is an important period of hemlock seed fall; often freshly fallen hemlock seeds can be observed on the snow. The latest filled hemlock seed was captured between the first of May and the middle of June.

For the 2 years the patterns of redcedar and hemlock seed fall were roughly similar. The September-October start of the 1956 seed fall, with a delay and then a surge the last two-thirds of November and early December, were almost identical. About 60 percent of the redcedar seed had fallen by the first of December, and 94 percent had fallen by the first of April when the traps were again examined. The relatively heavy seed fall (about 40 percent) for both hemlock and redcedar after the first part of December for all years is noteworthy. Some filled redcedar seeds were found during the June-July period in 1957. Pickford's (1929) clearcut data for redcedar in southern Vancouver Island, British Columbia, and adjacent mainland areas, are similar to those of this study.

During October-November 1956, rainfall was high, and seed fall was very low for hemlock and redcedar and retarded for Douglas-fir. The wet period probably caused the cones to remain closed and thus temporarily halted seed fall, a finding also reported by Isaac (1943). When drier conditions prevailed in November, the seed fall increased to a marked degree.

Filled Seed

The yearly percentage of filled seeds on the clearcuts varied greatly during the 12-year period (Table 1). Douglas-fir seeds ranged from 1 to 37 percent filled and averaged 15 percent. Garman (1951) reported that on Vancouver Island, 66 to 330 feet into clearcuts, Douglas-fir seeds averaged 10 percent filled over a 3-year period. In the present studies, the highest percentages of filled Douglas-fir seeds occurred during years with the heaviest seed fall; the correlation was high ($r = 0.92$). This trend has been noted in several publications including the U. S. Forest Service (1948).

Hemlock seeds ranged from 3 to 56 percent filled and averaged 21 percent. Ruth and Berntsen (1955) gave 4-year data that averaged 47 percent for hemlock on clearcuts in the Cascade Head Experimental Forest, Oregon. Unlike Douglas-fir, hemlock did not show a clear increase in the percentage of filled seed with larger seed crops. Although 10 of the 12 seed years showed good linear grouping on a scatter diagram, the other two were erratic, and the overall correlation coefficient (0.32) was low.

Redcedar with its erratic seed production had annual crops of filled seeds ranging from 0 to 67 percent and averaging 27. Garman (1951) reported an average of 17 percent of the redcedar seed filled in clearcuts on Vancouver Island. As with Douglas-fir, there was a good correlation ($r = 0.85$) between the size of the seed crop and the percentage of filled seeds.

The percentage of filled seeds varied not only annually, but within season. Similar variations have been noted by Ruth and Berntsen (1955) for spruce and hemlock. In the two seed years,

1956 and 1959, the highest percentage of filled Douglas-fir seeds occurred after the start of dissemination during the last two-thirds of September and the first third of October; relatively high percentages held until the first of December followed by a sharp drop until April and then a gradual decline. In general, the percentage of filled Douglas-fir seeds closely followed the seed fall abundance, with a low percentage at the start and end of seed fall, and a marked increase during the period of heavy seed fall.

The percentage of filled hemlock seeds within season also appeared to follow its seed fall abundance. The season differed from that of Douglas-fir in starting a little later in the fall and extending into the following April-May period. Greater numbers of spring hemlock seeds were filled, even when there was a light seed fall, than corresponding numbers of Douglas-fir.

Percentages of filled redcedar seed also tended to follow seed fall abundance, but not nearly so closely as those of Douglas-fir and hemlock. Relatively high percentages of filled seed occurred through the year; however, the two heaviest seed years were not consistent. In 1956, the percentage of filled seeds was high from September until the following August; in 1959, it was high from October until the first part of May.

Seed Distribution

The average percentage of filled Douglas-fir seed collected in the clearcuts at various distances from the timbered edge was: 61 percent at 50 to 100 feet, 26 percent at 200 to 250 feet, and 13 percent at 350 to 400 feet. The rapid decline in abundance away from the uncut edge is an important consideration when establishing clearcut logging patterns where natural regeneration is intended. This decline has been noted by Isaac (1930), Dick (1955), and others. In 1965 the estimated Douglas-fir seed fall 50 feet within the forest edge was [illegible] times greater than that 363 feet out. Garman (1951) showed that about seven times as much seed was captured at the timber edge as out to the 363-foot mark in clearcuts in coastal British Columbia. Isaac (1943) found 1.5 times as much Douglas-fir seed under virgin forest in Washington as he found 200 to 1,000 feet from the edge of clearcuts.

The average percentages of filled hemlock seeds captured at various distances from the forest edge were similar to those of Douglas-fir (67 percent at 50 to 100 feet, 22 percent at 200 to 250 feet, and 11 percent at 350 to 400 feet). It is of interest that Siggins (1933) found hemlock seed to have the lowest speed of fall of the three species investigated here. The 1965 hemlock seed fall 50 feet within the forest was over six times that estimated for the adjacent clearcut; this was smaller than was reported by Garman (1951) and Ruth and Berntsen (1955).

An average of 79 percent of the filled redcedar seeds in the clearcut occurred in the 50- to 100-foot belt; this was the most for any of the three species. Dense stands of redcedar seedlings often found within the clearcut edge support this finding. Redcedar seed found at 200 to 250 feet amounted to 17 percent, and only 4 percent at 350 to 400 feet. In 1965 the redcedar seed fall 50 feet within the timber was over 12 times that found in the clearcut. Redcedar seed fall within the timber has been reported by Garman (1951) as 17 times greater than that out to 363 feet in the clearcut, and by Pickford (1929) as 54 times as much as was caught at 350 feet within a clearcut. This concentration of seed fall is consistent with the finding by Siggins (1933) that redcedar had the highest speed of fall of the three conifers studied.

In 1965, total seed fall of all three conifers at 50 feet within the forest edge was 5½ times greater than for the clearcut. Percentage distributions of total seed fall on belts at successive distances

into the clearcut were as follows: 60 at 50 to 100 feet, 22 at 200 to 250 feet, and 9 at 350 to 400 feet from the timber edge.

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