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Seedfall under Coastal Douglas-fir Shelterwood Stands

Abstract

Natural seedfall under Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) shelterwood stands provides both benefits and costs to the land manager, partly depending on resultant stand density. Under lean seedfall conditions, on the average, natural seedfall has the potential to restock 480 seedlings per acre within 3 years.

Introduction

Natural seedfall under coastal Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) shelterwood stands provides both benefits and costs that should be considered by land managers planning for regeneration and early management of such stands. The major benefit is assurance of at least adequate[1] regeneration when site preparation is adequate (Williamson 1973). Also, natural seedlings should be better adapted than planted seedlings to adverse conditions (e.g., root pathogens and frost) peculiar to the site. Some benefits may be realized through genetic improvement if seed is provided by the most vigorous and dominant trees from the initial stand.

If planting of seedlings after the seed cut in shelterwood operations is planned, then the only direct cost associated with seedfall and resulting natural regeneration would be for precommercial thinning if seedling density is too great. Planting is commonly practiced under shelterwood stands to shorten the regeneration period. If survival of planted trees is good and natural seedlings are abundant, precommercial thinning may be necessary. With natural regeneration, on the other hand, insufficient density may result in a cost for fill-in planting.

Methods

Seedfall was measured under five shelterwood stands and one seed-tree stand, plus uncut stands adjacent to each cut stand (Fig. 1), beginning the first year after the seed cut. Collections started with two shelterwood units (Beeline and Deadhorse 6-2) and one seed-tree unit (Deadhorse 31-3) in southwestern Oregon, on the Tiller Ranger District of the Umpqua National Forest. The seed-tree unit was quite open initially and became more open through extensive windthrows of overstory trees. Measurements on these three areas began with the 1971 seed year. Beeline only included the seed years 1971 and 1972; the other two areas extended through the seed year 1975. A shelterwood study on the H. J. Andrews Experimental Forest (Hi-15), in the mid-Oregon Cascades, began providing data in 1975. An additional area on the Tiller Ranger District (Six

[1]As defined by the *Forest Service Handbook*, 2409.26d, appendix 64, Douglas-fir.

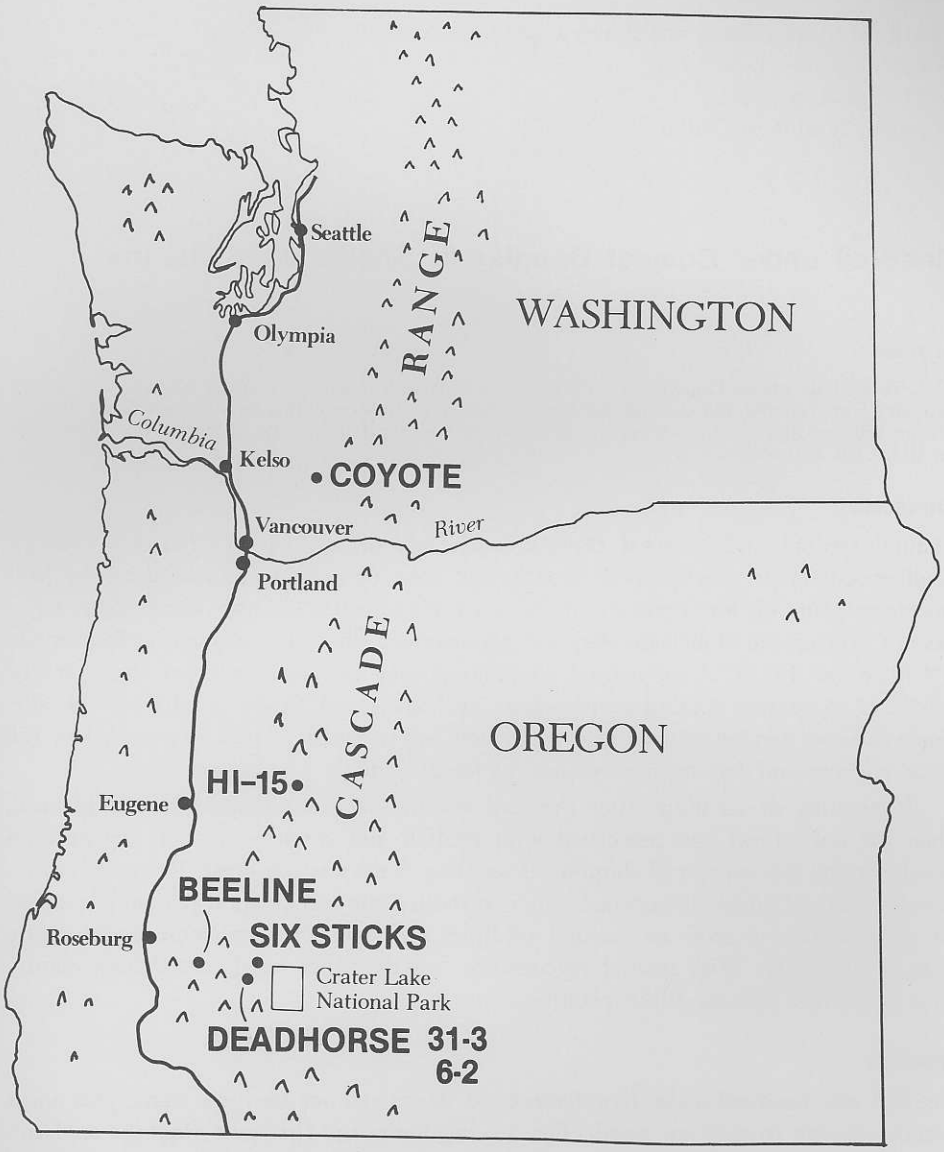

Figure 1. Six areas where shelterwood seedfall was studied.

Sticks) and one on the St. Helens District of the Gifford Pinchot National Forest (Coyote) provided data starting in 1976. Measurements were continued on these last three areas through seed year 1978. Overstory stand characteristics for each cutting unit were recorded (Table 1). All initial stands were on gentle topography, well stocked, and mature—with Douglas-fir predominant. None were considered overmature.

Seedfall was measured on or near the 15th of December, April, and August of each seed year by placing seed traps in the stands. Seed traps were 1 by 2 feet; no trap

TABLE 1. Characteristics of the shelterwood stands where seed was measured.

Unit	Location	Stand characteristics				Residual stand		
		Approximate age	Size	Traps per shelterwood unit	Year cut	Trees	Avg. diameter	Basal area
		Years	Acres	Number		No./acre	Inches	Feet/2acre
Beeline	T29S,R1W,S9	200	61	22	1969	15	32	85
Deadhorse 6-2	T31S,R2E,S6	200	24	13	1969	15	32	85
Deadhorse 31-3	T30,R2E,S31	300+	50	26	1969	4	41	37
Six Sticks	T29S,R2E,S23	300+	43	20	1976	8	60	157
Hi-15	T15S,R5E,S14	140	38	21	1974	45	24	140
Coyote	T8N,R6E,S36	300+	29	20	1975	18	37	134

[1]All based on Willamette Meridian.

TABLE 4. Total sound seed per acre (thousands) during regeneration period and live seedlings per acre for two shelterwood stands in southwestern Oregon.

Study area	Seed	Seedlings	Ratio
Beeline	216	245	882:1
Six Sticks	642	520	1235:1

was placed closer than 2 chains to a cutting boundary. The trap pattern for all areas was similar to that for the Beeline area.

In the laboratory, seeds were separated by species and counted. Potential viability was estimated in cut seeds; viability was assumed if seed coats were intact and seed interiors were full, firm, and white, with no indications of unfirmness, milkiness, or necrosis. The cutting test may be as good an estimator of viability of this seed as are the more sophisticated laboratory tests (Stein 1967, Bonner 1974).

Natural seedlings were available for the Beeline and Six Sticks areas only, from regeneration surveys by the Tiller Ranger District. These systematic surveys used a 4-milacre quadrat; 1 percent of the area was sampled in February 1980.

The data on Douglas-fir seedfall were analyzed as a paired-plot experiment with 4 degrees of freedom ($p = 0.1$). Deadhorse Unit 31-3 was not included in the analysis because it differed too much from the other units in overstory density. Data for other conifer species were not analyzed.

Results

Douglas-fir

Some seed was provided by both shelterwood and uncut stands almost every year (Table 2). The only year of complete failure was 1972. The difference in total seedfall between shelterwood stands and uncut stands was statistically nonsignificant ($t = 1.46$ with 4 degrees of freedom, $t_{0.1} = 2.132$) for the comparison of total seedfall in shelterwood stands to that in uncut stands.

Considerable variation in quantities of seed existed among different seed traps, areas, and seed years. This variation appears normal and in agreement with previous reports about Douglas-fir seedfall (Isaac 1943, Roy 1960, Reukema 1961). The seedfall in the seed-tree unit (Deadhorse 31-3) was only about half of that in the associated unit 6-2. The very wide spacing of the residual overstory had a major impact on seed production.

TABLE 2. Sound seed per acre (thousands) and sampling errors (p = .10), by study area, seed year, and treatment.

Area and species	1971 Uncut	1971 Shelterwood	1972 Uncut	1972 Shelterwood	1973 Uncut	1973 Shelterwood	1974 Uncut	1974 Shelterwood	1975 Uncut	1975 Shelterwood
Douglas-fir										
Beeline 22	193±75	214±45	0	2[1]						
Deadhorse 31-3 26	244±72	102±37	3[1]	1[1]	84±15	45±15	0[1]	12[1]	118±66	66±20
Deadhorse 6-2 13	304±102	211±88	3[1]	0[1]	96±73	76±25	7[1]	4[1]	68±28	117±37
Other conifers										
Beeline	317±208	35±11	0[1]	0[1]						
Deadhorse 31-3	—	—	0[1]	0[1]	0[1]	2[1]	0[1]	0[1]	72±124	3[1]
Deadhorse 6-2	—	—	0[1]	0[1]	5[1]	2[1]	13±15	8[1]	0[1]	0[1]

Area and species	1975 Uncut	1975 Shelterwood	1976 Uncut	1976 Shelterwood	1977 Uncut	1977 Shelterwood	1978 Uncut	1978 Shelterwood
Douglas-fir								
Six Sticks 20			154±84	113±29	17±12	22±10	388±84	507±87
Hi-15 21	39±12	29±25	5[1]	14[1]	0[1]	6[1]	35±17	124±27
Coyote 20			205±79	207±48	12±9	24±18	166±68	386±82
Other conifers								
Six Sticks			87±101	12±9	19±16	19±11	158±49	44±27
Hi-15	12[1]	3[1]	3[1]	0[1]	5[1]	1[1]	41±25	99±64
Coyote			174±108	9[1]	165±63	597±589	339±80	194±104

[1]Seedfall deemed too low to provide a reliable estimate of sampling error.

Seed production in the Hi-15 area was low relative to other areas, even in the generally better seed year of 1978 (124,000 sound seed per acre). In that year, the Coyote unit provided three times as much seed (386,000), and the Six Sticks unit, four times as much (507,000). All three stands contained vigorous, mature seed trees; no reason for the low seed production at Hi-15 is evident. Low production in three consecutive years at any particular area is probably not uncommon.

In the first year after the seed cuts, all five shelterwood stands produced from two-thirds to as much sound seed as did uncut stands (Table 3), although residual overstories had no more than half the number of dominants as did these uncut stands. By the second year and beyond, shelterwood seedfall generally was near or above that of uncut stands so that the five year totals were similar. These results suggest immediate and greater production of sound seed per tree in shelterwood stands than in uncut stands.

Natural seedling and sound-seed data for the Beeline and Six Sticks areas indicate seedling-to-seed ratios for these two units on gentle topography in the South Umpqua drainage of the Tiller Ranger District of about 1:1000.

Other Conifers

Most of the overstory trees in these shelterwood stands were Douglas-fir. Nevertheless, sound-seed production by other conifers—principally western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and western redcedar (*Thuja plicata* Donn ex D. Don), with minor amounts of true firs (*Abies* spp.) and western white pine (*Pinus monticola* Dougl. ex D. Don)—was appreciable, though usually half or less of that provided by Douglas-fir. Undoubtedly, much seed of other species came from surrounding uncut stands, because these seeds are light and can be disseminated widely by winds.

The Coyote unit had many pole-sized western hemlock and western redcedar trees that evidently were unmerchantable and were not cut. These trees were responsible for this unit's having had more abundant seedfall from these species than the other units.

As with Douglas-fir, seed production by other conifers varied from area to area and year to year. For instance, for the Deadhorse units, even uncut stands had complete failures two years of four, with low seedfall in the other two years. In contrast, the uncut areas in the Six Sticks unit produced abundant seed all three years, and seedfall on the Coyote unit was abundant in two years and moderate in a third.

Discussion

The sampling errors (Table 2) range from about 17 to over 100 percent of the mean for Douglas-fir. Many more traps would have been needed to bring these errors down to, say, 10 percent of the mean. I had planned for a 10 percent sampling error (at least for good seed years), but variation was much greater than expected. Fortunately, the improvement in seed production by trees in shelterwood stands relative to that in uncut stands was consistent between areas and supports the statistical suggestion of no difference between treatments.

The Washington State Department of Natural Resources, the Oregon State Board of Forestry, and the U.S. Forest Service's Pacific Northwest Region cooperate annually in publishing cone-crop reports to provide seed gatherers and nurserymen with estimates of forthcoming seed supplies. No report during the period of this study predicted

TABLE 3. Sound seed per acre (thousands), by study area, seed year, and treatment.

Area and species	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
	Uncut	Shelter-wood	Uncut	Shelter-wood	Uncut	Shelter-wood	Uncut	Shelter-wood	Uncut	Shelter-wood	Uncut	Shelter-wood
Douglas-fir												
Beeline	193	214	0	2							193	126
Deadhorse 31-3	244	102	3	1	84	46	0	12	118	60	(449)[1]	(221)[1]
Deadhorse 6-2	304	211	3	0	96	76	7	4	68	117	478	408
Six Sticks	154	113	17	22	388	507					559	642
Hi-15	39	29	5	14	0	6	35	124			79	173
Coyote	205	207	12	24	166	386					383	617
Other conifers												
Beeline	317	35	0	0								
Deadhorse 31-3	—	—	0	0	0	2	0	0	72	3		
Deadhorse 6-2	—	—	0	0	5	2	13	8	0	0		
Six Sticks	87	12	19	19	158	44						
Hi-15	12	3	3	0	5	1	41	99				
Coyote	174	9	165	597	339	194						

[1]Not included in analysis.

seed abundance above 4.2, on a scale of 1 to 5.[2] Seven years of the eight had predictions of a light crop or poorer. In spite of this dismal forecast, substantial amounts of seed (at least 20,000, or about half a pound per acre) were provided about every other year by these shelterwood stands. The overall average production of sound seed for the Beeline and Six Sticks shelterwood stands was 161,000, or about four pounds of seed, per acre per year. If one assumes a seedling/seed percentage of 0.1 (suggested by the regeneration surveys and seedfall data from these two shelterwood units), then three years' seed production might restock an area to about 480 seedlings per acre on gentle northerly slopes in the vicinity of the South Umpqua drainage under the standard site preparation techniques in use today, and under seed production circumstances that are probably typical.

With medium or heavy seed crops, and good site preparation, seeds can germinate and seedlings survive by the thousands under shelterwood (Williamson 1973). Thus, shelterwood regeneration may lead to overstocking. On the other hand, understocking may result from inadequate site preparation, insufficient control of competing vegetation, and careless logging practices during overstory removal. Research on these practices could lead to minimum costs for establishing regeneration whenever shelterwood harvesting is practiced.

The results presented here agree with previous reports concerning thinning effects on Douglas-fir seedfall (Reukema 1961) and seed production by seed-tree stands (Garman 1955), which indicated not only the variation in seed production between areas and years, but also increased production per tree in partial-cut stands compared to uncut stands, except in years of seed failure.

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[2]The cone-crop scale is: 1—failure, 2—very light, 3—light, 4—medium, and 5—heavy.

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