ALASKA OREGON WASHINGTON
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

USDA FOREST SERVICE RESEARCH NOTE

PNW-177 June 1972

PAPER BIRCH SEED PRODUCTION IN THE TANANA VALLEY, ALASKA

by

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ABSTRACT

A study of seedfall was conducted from 1958 to 1963 in four *Betula papyrifera* stands near Fairbanks, Alaska. Total seed crops varied between 542 and 72,805 seeds per square meter; viable seed per square meter varied between 42 and 27,520. Seed crops adequate for natural regeneration of 100-foot-wide clearcuts occur in at least 1 out of 4 years in this portion of the taiga.

Keywords: Forest seed production, paper birch, *Betula papyrifera*.

The paper birch (*Betula papyrifera* Marsh.) forest type covers over 5 million acres of Alaska (Hutchison 1967). Many of these stands originated from seed following destruction of the previous stands by fire (Lutz 1956, Gregory and Haack 1965). Obviously, information on seed production characteristics of this species will enhance our knowledge of its natural regeneration. We report, here, the results of a study of the quantity and quality of paper birch seed crops.

MATERIALS AND METHODS

The study was conducted in four pure, even-aged paper birch stands (table 1). All were located on upland sites within 80 miles of Fairbanks (64°51' N., 147°44' W.) Ten seed traps each were systematically placed in stand 3 in 1958, stands 1 and 4 in 1959, and stand 2 in 1960. The study was concluded in May 1963.

During 2 of the 5 seed years studied (1958-59 and 1959-60), traps made from galvanized flue thimbles were used (fig. 1A). These were not entirely satisfactory because fallen leaves could temporarily cover the hardware cloth openings on the trap surface. These leaves could then be blown away taking with them any seed which may have fallen on their surface. In this way small quantities of seed may have been lost from the traps, although they were cleaned frequently during the periods of leaf fall. We eliminated this problem by replacing the flue thimbles with a new type trap constructed from tractor funnels (fig. 1B). The hardware cloth surface of the tractor funnel traps was recessed

Table 1.--*Description of study areas*

Stand variable	Stand 1	Stand 2	Stand 3	Stand 4
1959 stand age . . . . (years)	47	68	81	99
Height of average dominant and codominant . . . . . (feet)	50	58	60	69
. . . . (meters)	15.2	17.7	18.3	21.0
Site index 1/	57	51	49	52
Number of trees per acre	1,215	931	645	292
Number of trees per hectare	3,002	2,300	1,594	722
Basal area . . . . (square feet per acre)	94	108	102	90
. . . . (square meters per hectare)	22	25	23	21
Average diameter at breast height . . . . (inches)	3.8	4.6	5.4	7.5
. . . . . (centimeters)	9.6	11.7	13.7	19.0
Percent of normal basal area 2/	94	106	100	85

1/ Based on height of average dominant and codominant trees at breast height, age 50 years (Gregory and Haack 1965).

2/ When dominant and codominant tree crowns occupy most of the available growing space.

A B

Figure 1.--Seed traps: *A*, Thimble trap in place (surface area, 0.041 square meter); *B*, funnel trap in place (surface area, 0.050 square meter).

so that leaves accumulating on the recessed surface were not blown away.

The seed traps were in place by early July of each year. They were emptied as soon as the ground surface was almost free of snow, usually early May of the following year. No attempt was made to determine when seed fell.

Germination tests were made immediately after the seed was removed from the traps. A sample of 1,000 seeds (ten 100-seed replications) from each stand, consisting of an equal number of seed from each trap, was germinated on water-soaked cellulose pads in petri dishes and placed in a germinator with alternating 12-hour periods at 68° and 86° F. The seeds were exposed to weak light. Germinants were counted and removed at 2-day intervals. The tests were terminated when no germination was observed over a 5-day period. A seed was considered to have germinated if an epicotyl or radicle was observed emerging from the seedcoat.

Remaining seed from the emptied traps was air-dried at room temperature and stored at 35° to 40° F. Seeds from six randomly selected traps in each stand were counted. If the mean number of seeds per trap for the six traps had a sampling error over 10 percent at $p = 0.05$, then either seeds from additional traps were counted until a sampling error of 10 percent or less was attained or seeds from all traps were counted.

RESULTS AND DISCUSSION

The total number of seeds produced, viability, and sampling errors for the four stands are presented in table 2. The average annual seed production was 23,303 seeds per square meter; the lowest estimate was 542 and the largest, 72,805. Sampling error ($p = 0.05$) for total seed production averaged 14 percent, ranging between 4 and 32 percent. Sampling error was considerably higher for viability than for production, averaging 36 percent and varying between 10 and 68 percent.

The most significant variable for natural regeneration potential of a seed crop is the number of viable seeds potentially available to produce seedlings. We should emphasize that our estimates approximate the viability of seed overwintered under natural conditions. Although this means of determining viability is realistic, it may have underestimated the seed crop quality for birch as determined by others (Sarvas 1952, Bjorkbom et al. 1965, Horsley and Abbott 1970, Bjorkbom 1971).

Marquis (1969) has suggested classes[1] for rating viable seed crops of paper birch in New England. Although his classes are arbitrary and may not apply as well to Alaskan conditions, they provide a means of rating seed crops. On this basis, three crops (stand 3, 1958; stands 1 and 2, 1960) were much larger than the bumper crop threshold value; three somewhat below the bumper range but far above average (stand 3, 1959 and 1960; stand 4, 1962); seven average to above average crops; one poor (stand 1, 1962); two very poor (stands 1 and 2, 1961). On this basis, Alaskan seed crops appear to be somewhat above average New England standards.

Estimates of the number of viable seeds required to adequately regenerate a cutover vary. Horsley and Abbott (1970) recommended a rate of 500,000 viable seeds per acre (121 per square meter) on partially shaded, narrow (50 feet wide), scarified clearcut strips and 1,000,000 viable seeds per acre (242 per square meter) on more exposed sites (e.g., wider clearcuts). Bjorkbom (1971) recommended a rate of between 630,000 and 800,000 viable seeds per acre on untreated seedbeds. Using the more conservative of these estimates and the estimate that birch seedfall at 100 feet from the seed source will be 20 percent of that in the stand (Bjorkbom 1971), we can predict that the ability of these Alaskan stands to regenerate a 100-foot-wide clearcut was: stand 1, 1 in 4 years; stand 2, 1 in 3 years; stand 3, 3 of 5 years; and stand 4, 1 of 4 years. Although these estimates are probably conservative, they do point out that large quantities of seed are required for adequate

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1/ Bumper crop: 15,000,000 seeds per acre (3,626 per square meter). Average crop: 1,000,000 seeds per acre (242 per square meter). Poor crop: 500,000 seeds per acre (121 per square meter). Very poor crop: 250,000 seeds per acre (61 per square meter).

Table 2.--*Estimates of total and viable seed production and sampling errors for Alaskan paper birch stands, 1958-63*

Seed year and stand number	Estimated total number of seeds per square meter	Sampling error (percent)	Viability (percent)	Estimated viable seed per square meter	Sampling error (percent)
1958-59:[1/]					
1	--	--	--	--	--
2	--	--	--	--	--
3	72,805	4.0	37.8	27,520	9.5
4	--	--	--	--	--
1959-60:[1/]					
1	3,681	11.0	11.4	420	32.8
2	--	--	--	--	--
3	23,831	10.0	10.6	2,526	25.0
4	19,839	10.7	1.7	337	61.7
1960-61:[1/]					
1	40,396	10.4	32.4	13,088	21.3
2	55,526	9.8	41.6	23,099	30.3
3	21,536	8.9	12.8	2,757	32.9
4	42,547	7.5	1.1	468	68.4
1961-62:					
1	542	14.2	16.0	87	(2/)
2	1,045	22.2	4.0	42	(2/)
3	1,878	25.7	27.2	511	(2/)
4	4,182	31.9	12.7	531	(2/)
1962-63:					
1	16,282	16.6	.8	130	63.2
2	22,033	14.7	3.7	815	58.4
3	9,700	21.4	7.9	766	14.2
4	21,026	11.3	9.7	2,036	17.4

1/ 10 seed traps each were systematically placed in stand 3 in 1958, stands 1 and 4 in 1959, and stand 2 in 1960.

2/ Not determined because of small quantity of seed.

regeneration of this species. Bjorkbom (1971) presents a more detailed discussion of the relationship between seed crops, seed dispersal, and width of cutting.

The stands used for this study represented a range of age (47, 68, 81, and 99 years) and density (3,002; 2,300; 1,594; and 722 trees per hectare. However, site index (57, 51, 49, and 52) and basal area (22, 25, 23, and 21 square meters per hectare) were similar for all four stands (table 1). Analysis of variance of data for 1960-63 seed years revealed no significant difference ($p = 0.05$) between these stands in either the total number of seeds produced or their viability. Longer term records may be required to reveal significant differences in seed production between different age and density stands. In addition the overwintering of the seed may have reduced variability in seed crop quality.

Although informative, comparison of seed crops between regions for the same or similar species is difficult because of different methods. However, similar data are available for the same or similar species in other areas. New England seed crops (average 2,715 seeds per square meter; largest 6,303 seeds per square meter) for the period 1958-60 were lower than Alaskan crops (Bjorkbom et al. 1965). Greater seed production in these Alaskan stands does not conform to the more common observation of decreasing seed production with increasing latitude for other species (e.g., Sarvas 1957, Andersson 1965). At similar latitudes (60° N.) in Finland, *B. verrucosa* averaged 34,271 seeds per square meter, with a maximum annual production of 72,426 seeds per square meter. *B. pubescens* averaged 30,731 seeds per square meter, with a maximum of 60,010 seeds per square meter (Sarvas 1952). Although somewhat larger than Alaskan crops, the Finnish seed crops are of the same order of magnitude and much larger than New England seed crops.

It is even more difficult to compare seed crop quality for these three regions because of the great difference in methods used. For example, Sarvas (1952) based his viability estimate on microscopic examination of the seed and used no germination test. Bjorkbom et al. (1965) based their viable seed percentage on germination of seed collected from seed traps monthly from August to November and in the spring. New England seed viability ranged between 13 and 77 percent with an average of 37 percent. Seed crop quality for both Finnish species was about 45 percent. Variation for *B. verrucosa* was from 6 to 64 percent; for *B. pubescens*, the range was from 18 to 55 percent (Sarvas 1965). Germination values from New England and Finland seem to be generally higher than those observed for Alaska. However, germination tests of seed collected from Alaskan birch trees in 1969 and 1970 and stored at 34° to 40° F. yielded percentages of 50 and 70 percent,[2/] respectively. These tests suggest that Alaskan seed viability may be much closer to New England and Finnish values than the values observed in this study.

CONCLUSION

This study quantifies the observation that paper birch stands produce large quantities of seed almost every year. Based on our seed viability data and information from elsewhere, we suggest that seed crops adequate for natural regeneration of 100-foot-wide clearcuts occur in at least 1 out of every 4 years in this portion of the taiga.

2/ *Unpublished data on file at Institute of Northern Forestry, Fairbanks, Alaska.*

LITERATURE CITED

Andersson, E.
1965. Cone and seed studies in Norway spruce (*Picea abies* (L.) Karst). Stud. For. Sueica 23, 214 p.

Bjorkbom, John C.
1971. Production and germination of paper birch seed and its dispersal into a forest opening. USDA Forest Serv. Res. Pap. NE-209, 14 p. Northeast. Forest Exp. Stn., Upper Darby, Pa.

__________, David A. Marquis, and Frank E. Cunningham
1965. The variability of paper birch seed production, dispersal and germination. USDA Forest Serv. Res. Pap. NE-41, 8 p., illus. Northeast. Forest Exp. Stn., Upper Darby, Pa.

Gregory, Robert A., and Paul M. Haack
1965. Growth and yield of well-stocked aspen and birch stands in Alaska. USDA Forest Serv. Res. Pap. NOR-2, 28 p., illus. Inst. N. For. Juneau, Alaska.

Horsley, Stephen B., and Herschel G. Abbott
1970. Direct seeding of paper birch in strip clearcutting. J. For. 68: 635-638.

Hutchison, O. Keith
1967. Alaska's forest resource. USDA Forest Serv. Resour. Bull. PNW-19, 74 p., illus. Pac. Northwest Forest & Range Exp. Stn., Portland, Oreg.

Lutz, H. J.
1956. Ecological effects of forest fires in the interior of Alaska. U.S. Dep. Agric. Tech. Bull. 1133, 121 p., illus.

Marquis, David A.
1969. Silvicultural requirements for natural birch regeneration. *In* Birch Symposium Proceedings, p. 40-54. USDA Forest Serv. Northeast. Forest Exp. Stn., Upper Darby, Pa.

Sarvas, Risto
1952. On the flowering of birch and the quality of seed crop. Commun. Inst. For. Fenn. 40.7, 38 p., illus.

GPO 985-997

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