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EXPERIMENTAL CUTTING IN A MIXEDWOOD STAND IN SASKATCHEWAN, 1924

by
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INTRODUCTION

Reconnaissance surveys carried out by Fernow (1916) and by Millar (1921) in undisturbed and cut-over mixedwood (white spruce-aspen) stands in Manitoba indicated that white spruce was not reproducing in sufficient quantities to form future well-stocked stands. As a preliminary step in solving this problem the Forestry Branch began an investigation to study the effects of different methods of cutting on the abundance of white spruce reproduction. In 1924, diameter limit, seed tree and strip cuttings were carried out in a mixedwood stand in eastern Saskatchewan.

DESCRIPTION OF EXPERIMENTAL AREA

The experimental area is located approximately 40 miles southwest of The Pas, Manitoba, on the northeast-facing slope of the Pasquia Hills.

Prior to 1924 no logging had taken place in the vicinity of the experimental area. Charred wood found in the humus layers indicated that fire had played an important role in the origin of all or at least part of the stand.

At the time of treatment the forest cover on the experimental area consisted of a mixture of white spruce (*Picea glauca* (Moench) Voss), balsam fir (*Abies balsamea* (L.) Mill.), white birch (*Betula papyrifera* Marsh.), trembling aspen (*Populus tremuloides* Michx.), and balsam poplar (*Populus balsamifera* L.). Species representation was as follows:

Species	Trees per acre (4″ d.b.h. and up)	Basal area per acre (sq. ft.)
White spruce	107	72
White birch	136	62
Balsam fir	42	9
Trembling aspen and balsam poplar	13	13
Totals	298	156

Figure 1 shows the diameter distribution of each species. The white spruce was approximately 120 to 140 years old, the poplar[2] and birch 80 to 100. The balsam fir was uneven-aged. The area is evidently well adapted for the growth of white spruce, as dominant trees up to 115 feet in height were found.

The topography of the area is gently undulating to rolling. Several deep V-shaped ravines carrying intermittently flowing streams traverse the area.

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[2] In this report the term "poplar" includes both trembling aspen and balsam poplar.

The soils, which overlie shale deposits, have formed from shallow, calcareous, glacial tills. Their textures vary from loam to clay loam with moisture regimes ranging from 4 to 6 according to Hills' (1952) classification.

Prior to cutting, both underbrush and herbaceous vegetation on the area were light to moderately heavy. After cutting the lesser vegetation became dense.

Harrison (1925) estimated that in 1924 approximately five pounds of white spruce seed fell per acre on the experimental area. This extremely heavy seed fall, as discussed later, possibly tended to mask the intended effects of the different treatments on white spruce reproduction.

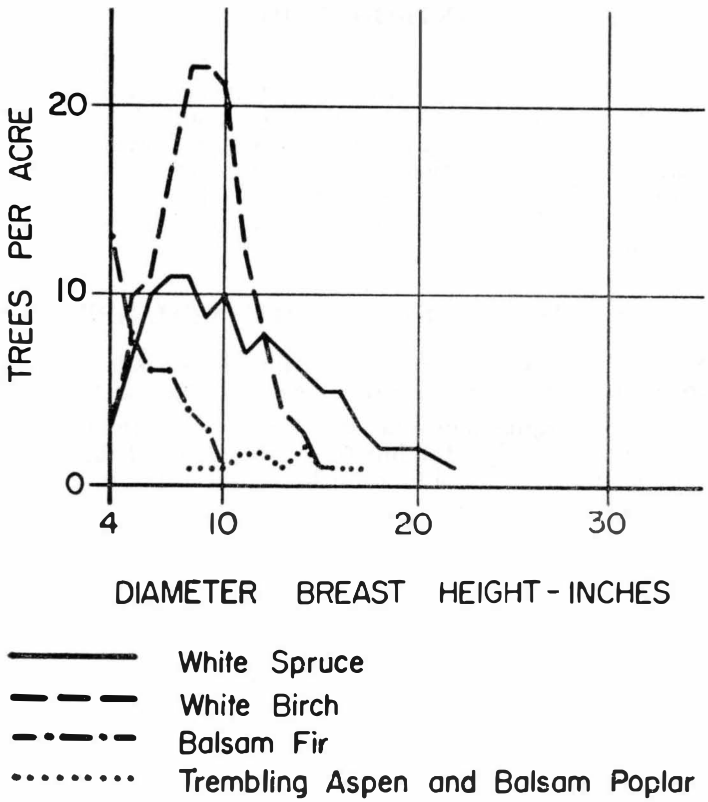

Figure 1. Stand composition, 1924.

METHODS

Establishment of Treatment Areas

During the field season of 1924, nine 10-acre compartments were established on the experimental area. Trees were tallied by species and in one-inch diameter classes on four permanently established strips, $\frac{1}{2} \times 10$ chains, on each compartment.[3] On each strip, two single examination subplots, 1/160 acre in size, and spaced five chains apart, were examined for seedlings and saplings.

[3] Reproduction includes seedlings, sprouts, suckers and saplings up to 3.5" at b.h.; trees are over 3.5" at b.h.

Methods of Cutting

The following cutting methods were carried out by The Pas Lumber Company during the winter of 1924-25.

Compartment 1—All spruce logged to 12-inch diameter limit.
" 2—All spruce logged to 10-inch diameter limit.
" 3—All spruce logged to 7-inch diameter limit.
" 4—Spruce seed trees left at 200-foot intervals and remaining spruce logged to 10-inch diameter limit.
" 5—Spruce seed trees left at 100-foot intervals and remaining spruce logged to 10-inch diameter limit.
" 6—Spruce seed trees left at 200-foot intervals and remaining spruce logged to 10-inch diameter limit; hardwoods girdled.
" 7—Spruce seed trees left at 100-foot intervals and remaining spruce logged to 10-inch diameter limit; hardwoods and balsam fir clear cut and removed.
" 8—Alternate strips 100 feet wide logged for spruce to 10-inch diameter limit.
" 9—Control; no cutting.

All coniferous slash was burned at the time of logging; slash from the hardwoods cut on compartment 7 was scattered.

Field Examinations

In August 1925 five permanent sample plots (1/10-acre) were established on each compartment. All saplings and trees were tallied by species and one-inch diameter classes. In two diagonally opposite corners of each plot a reproduction sub-plot, 1/160 acre in size, was laid out. On these sub-plots reproduction was tallied by species, age and height. All permanent plots, strips, and reproduction sub-plots were remeasured in 1929, 1936 and 1946. In 1956, saplings as well as trees were tallied on the strips. A stocked quadrat tally of reproduction was also made on 80 milacre plots on each compartment; the tallest seedlings, both spruce and balsam fir, up to 0.5 inch at breast height, were recorded by height classes.

RESULTS AND DISCUSSION

Reproduction and Replacement Stock

Replacement stock is defined as stems that entered the one-inch and up diameter classes between the time of treatment and 1956. This portion of the 1956 white spruce stand was used as a criterion for assessing the effectiveness of the various treatments in returning white spruce representation to the cut-over compartments.

White Spruce:—On all compartments, a large number of seedlings became established in 1925, reflecting the excellent seed year of 1924. By 1946 many of the seedlings had developed into saplings and by 1956 some had reached tree size (Table 1).

The heavy crop of white spruce seed in 1924 has masked any effect there may have been between the seeding potential of residual white spruce after logging and reproduction, as no correlation between the two could be shown.

However, a correlation between the residual basal area of all species and white spruce replacement stock does seem to exist, the optimum basal area being approximately 75 square feet (Figure 2).

The most abundant replacement of white spruce occurred on compartment 3 (Figure 2), which had been logged for spruce to a 7-inch diameter limit. None of the remaining compartments were logged more heavily for spruce than to a 10-inch limit, though other species were cut or girdled on compartments 6 and 7. This supports the conclusion that density of the total residual stand was more important in influencing the abundance of white spruce replacement than the availability of seed following logging.

Balsam Fir:—Large numbers of balsam fir seedlings were present each year and in 1956 the stocking was good to excellent on most compartments. The seedlings established in the earlier years had not developed into saplings by 1946 (Table 2). Because of observation in 1956, this is attributed to browsing.

White Birch:—White birch reproduction and replacement stock (Table 3) was greatest on compartments 6 and 7 where the hardwoods were girdled and cut. On these compartments, much of the white birch reproduction appeared to have arisen from seed, whereas on the others it was mostly the result of sprouting from the bases of dead and dying trees. It is supposed that the development of the reproduction on the compartments where birch was cut and girdled resulted from the greater availability of light. On the whole, the quantity of white birch replacement stock seems to have been roughly an inverse function of basal area after treatment.

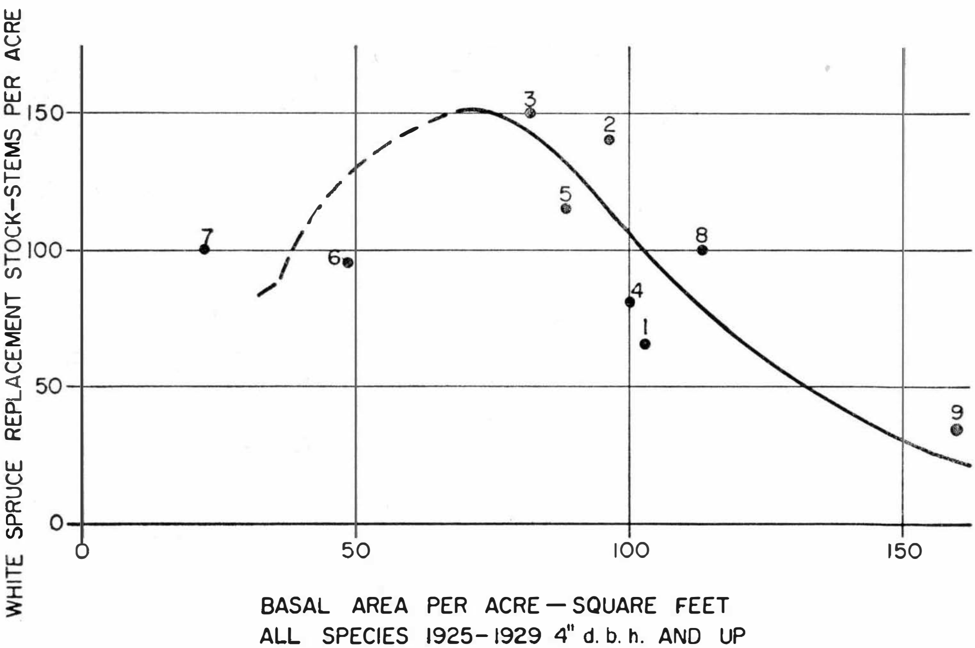

Figure 2. Relationship between white spruce replacement stock and basal area of residual stand, 1925-29, for the nine compartments.

TABLE 1. REPRODUCTION AND REPLACEMENT STOCK PER ACRE, WHITE SPRUCE

Compartment Number	Reproduction													Replacement Stock 1956		
	Seedlings (up to 0.5″ at b.h.)							Saplings (0.5″ to 3.5″ at b.h.)								
	1924	1925	1929	1936	1946	1956	Stocking 1956 (%)	1924	1925	1929	1936	1946	1956	Trees	Saplings	Total
1	50	1,700	700	600	300	100	14	60	—	—	5	85	60	5	60	65
2	50	700	550	350	200	350	27	—	—	—	5	85	130	10	130	140
3	150	900	300	450	350	100	8	—	30	25	40	135	125	25	125	150
4	—	250	450	450	200	150	11	—	25	25	35	60	75	5	75	80
5	—	700	550	450	450	250	24	—	—	—	—	65	105	10	105	115
6	50	650	300	250	200	100	12	—	—	—	30	135	75	20	75	95
7	50	1,050	300	300	50	300	20	—	10	—	45	165	85	15	85	100
8	—	500	600	600	350	300	20	—	—	—	—	40	95	5	95	100
9	100	300	600	400	300	250	15	40	90	105	95	90	25	10	25	35

TABLE 2. REPRODUCTION AND REPLACEMENT STOCK PER ACRE, BALSAM FIR

Compartment Number	Reproduction													Replacement Stock 1956		
	Seedlings (up to 0.5″ at b.h.)							Saplings (0.5″ to 3.5″ at b.h.)								
	1924	1925	1929	1936	1946	1956	Stocking 1956 (%)	1924	1925	1929	1936	1946	1956	Trees	Saplings	Total
1	350	550	550	400	250	2,750	60	—	15	5	—	—	—	—	—	—
2	2,400	1,300	750	1,000	800	3,350	67	—	10	5	5	—	—	—	—	—
3	700	1,150	900	1,050	500	3,500	69	—	10	5	—	5	—	—	—	—
4	800	1,250	1,650	2,850	900	6,950	90	—	10	—	—	—	—	—	—	—
5	550	1,300	1,000	500	550	6,250	88	—	40	25	10	5	—	—	—	—
6	1,200	1,400	850	900	600	2,150	51	—	20	20	—	—	—	—	—	—
7	550	850	650	500	400	800	23	—	—	—	—	—	—	—	—	—
8	900	1,450	1,200	800	550	5,000	81	—	50	35	5	—	5	—	5	5
9	700	450	650	500	500	1,400	37	—	—	—	—	—	—	—	—	—

Trembling Aspen and Balsam Poplar:—Poplar was not replaced on any compartment, although compartment 7, on which poplar was cut, had approximately five saplings per acre in 1956.

TABLE 3. REPRODUCTION AND REPLACEMENT STOCK OF WHITE BIRCH PER ACRE IN 1956*

Compartment Number	Size Classes at Breast Height (inches)				Total Replacement Stock
	0.5 or less		0.6 to 3.5	Greater than 3.5	
	No. of stems	Stocking (%)	No. of stems	No. of stems	No. of stems
1	0	0	30	5	35
2	150	5	90	5	95
3	0	0	100	5	105
4	500	5	130	0	130
5	350	11	130	5	135
6	0	0	535	80	615
7	300	10	645	55	700
8	50	1	60	5	65
9	0	0	20	0	20

* Not recorded during earlier examinations.

Development of Stands to 1956

The development of each compartment between 1925 and 1956 has been similar. White spruce and white birch have come in as replacement stock, balsam fir seedlings were established but did not develop, and poplar was almost completely removed (Table 4).

The abundance of white spruce reproduction in the 1956 stands may have been largely a result of the excellent seed year of 1924. It is probable that if these treatments had been carried out after a poor seed year, the representation of white spruce in the 1956 stands would have been much smaller.

It is apparent that balsam fir (mainly as a result of heavy browsing) and poplar will be poorly represented in the future stands. White spruce and white birch will be well represented and the future stands may, in fact, be as well stocked with these species as were the original stands. It appears that the treated compartments will develop into white spruce-white birch stands with a possible scattering of balsam fir. The untreated compartment will probably tend towards a more open white spruce-white birch stand.

Increment

Table 5 shows the net annual increment in total cubic feet of all trees 4″ d.b.h. and up for each species for the periods 1926-1929, 1930-1936, 1937-1946, and 1926-1946 on each compartment. Negative net increments for white spruce resulted on most of the compartments for the periods 1926-1929 and 1930-1936. In the period 1937-1946 most of the compartments had positive net increments. The untreated compartment had consistently large negative increments. Growth for species other than white spruce was erratic. Consistent negative increments for poplar for all periods showed that this species was rapidly dropping out of the stands.

TABLE 4. STAND COMPOSITION, 1956

(Stems per Acre)

Compartment Number	White Spruce: 1924 Stand (4″ d.b.h. and up)	White Spruce: 1956 Stand: Residuals from 1925 Stand (4″ d.b.h. and up)	White Spruce: 1956 Stand: Replacement Stock	White Spruce: 1956 Stand: Seedlings* (up to 0.5″ b.h.) A	B	C	White Spruce: 1956 Stand: Total Number of Stems	Balsam Fir: 1924 Stand (4″ d.b.h. and up)	Balsam Fir: 1956 Stand: Residuals from 1925 Stand (4″ d.b.h. and up)	Balsam Fir: 1956 Stand: Replacement Stock	Balsam Fir: 1956 Stand: Seedlings (up to 0.5″ b.h.)	Balsam Fir: 1956 Stand: Total Number of Stems
1	90	20	65	—	25	105	215	40	20	—	2,750	2,770
2	120	30	140	80	25	270	545	45	25	—	3,350	3,375
3	90	30	150	30	—	60	270	25	15	—	3,500	3,515
4	110	40	80	—	—	165	285	35	15	—	6,950	6,965
5	90	20	115	125	30	140	430	60	60	—	6,250	6,310
6	120	25	95	30	15	85	250	55	5	—	2,150	2,155
7	110	30	100	80	10	210	430	10	—	—	800	800
8	105	25	100	190	10	105	430	85	65	5	5,000	5,070
9	100	40	35	170	—	85	330	20	15	—	1,400	1,415

Compartment Number	White Birch: 1924 Stand (4″ d.b.h. and up)	White Birch: 1956 Stand: Residuals from 1925 Stand (4″ d.b.h. and up)	White Birch: 1956 Stand: Replacement Stock	White Birch: 1956 Stand: Seedlings and Sprouts (up to 0.5″ b.h.)	White Birch: 1956 Stand: Total Number of Stems	Trembling Aspen and Balsam Poplar: 1924 Stand (4″ d.b.h. and up)	Trembling Aspen and Balsam Poplar: 1956 Stand: Residuals from 1925 Stand (4″ d.b.h. and up)	Trembling Aspen and Balsam Poplar: 1956 Stand: Replacement Stock	Trembling Aspen and Balsam Poplar: 1956 Stand: Suckers (up to 0.5″ b.h.)	Trembling Aspen and Balsam Poplar: 1956 Stand: Total Number of Stems
1	145	50	35	—	85	5	—	—	—	—
2	125	45	95	150	290	30	5	—	—	5
3	130	40	105	—	145	15	—	—	—	—
4	130	45	130	500	675	5	—	—	—	—
5	130	70	135	350	555	10	—	—	—	—
6	145	10	615	—	625	10	—	—	—	—
7	125	—	700	300	1,000	15	—	5	50	55
8	140	65	65	50	180	5	—	—	—	—
9	135	50	20	—	70	20	—	—	—	—

* Seedling sizes: A = up to 0.5 foot. B = 0.5 foot up to 3.0 feet. C = 3.0 feet to 0.5 inch breast height.

TABLE 5. NET ANNUAL INCREMENT, TOTAL CUBIC FEET

(4" d.b.h. and up)

Compartment Number	White Spruce				Balsam Fir			
	1926–1929	1930–1936	1937–1946	1926–1946	1926–1929	1930–1936	1937–1946	1926–1946
1	−5	2	18	8	−2	1	8	4
2	−38	3	6	−3	−6	0	11	4
3	0	4	15	9	−6	0	3	0
4	−7	0	16	6	5	0	−7	−2
5	−5	−6	4	−1	1	1	26	13
6	−15	−30	9	−9		girdled		
7	−75	−30	12	−19		cut		
8	−16	−9	−1	−6	10	15	26	19
9	−24	−71	−48	−51	−1	6	1	3
	White Birch				Trembling Aspen and Balsam Poplar			
1	46	12	22	23	−5	−17	0	−6
2	17	15	2	9	−2	−26	9	−5
3	36	−16	−32	−13	−2	−50	−3	−18
4	30	1	47	28	0	−30	−13	−16
5	7	15	−1	6	0	0	−28	−13
6		girdled				girdled		
7		cut				cut		
8	−13	30	7	11	15	−7	−8	−3
9	−40	−11	−36	−29	−7	−29	−7	−14

SUMMARY

In 1924 the Forestry Branch carried out diameter limit, seed tree and strip cuttings in a mixedwood stand on the Pasquia Hills in Saskatchewan. Periodic examinations of growth and reproduction plots were made between 1925 and 1956.

The most important finding from the study is that the white spruce component of the new stands which were created by the various cutting methods will probably equal or surpass that of the original stands. This apparently was the result of an exceptionally heavy white spruce seed year in 1924 which also tended to mask differences between cutting methods. However, there appeared to be some relationship between the amount of white spruce replaced in the stands by 1956 and the residual basal area of all species. The optimum was approximately 75 square feet per acre.

Balsam fir was abundant in the seedling class but did not develop, apparently because of intensive browsing. The poplars had passed from the stands. White birch was well but variably represented; its level of replacement appears to have been inversely related to basal area of all species after treatment. It seems that most of the new stands on the treated compartments will become as well stocked as the original ones.

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