RELEASE OF WHITE SPRUCE FROM ASPEN FOLLOWING AERIAL APPLICATION OF 2,4-D HERBICIDE

N. M. Cataldo

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Forestry Canada
Manitoba District Office
104-180 Main Street
Winnipeg, Manitoba
R3C 1A6

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Release of White Spruce From Aspen Following Aerial Application of 2,4-D Herbicide

A 113 ha stand consisting of mature white spruce, overmature trembling aspen, and scattered white birch and balsam poplar, in the former Riding Mountain Forest Experimental Area was aerially sprayed on August 12, 1964 with 2,4-D prior to blade scarification for natural regeneration. Because heavy annual leaf fall which tended to smother white spruce germinants was considered a major cause of seedling mortality on scarified mixedwood areas, the control of dense hazel brush and other shrubs in much of the research area was identified as one of the requirements for successful establishment and survival of white spruce (Pratt 1965). The purposes for spraying therefore were to kill the competing hardwood overstorey and shrub understorey to favour seedling growth and minimize smothering losses; and to release the young and older growth white spruce from overhead competition. When fully stocked to white spruce regeneration the treated area was to be logged for white spruce but this was never completed due to the closure, in 1970, of the Manitoba - Saskatchewan District Laboratory in Winnipeg.

Herbicide was applied using a 150 horsepower Super Piper Cub aircraft with a 364 L carrying capacity (Pratt 1965). The application was a mixture of 1.4 L of acid equivalent 2,4-D to 22.7 L of water applied at a rate of 56 L/ha. During treatment

the sky was overcast most of the day, the wind was light, and the air temperatures ranged from 4.5 - 12.8°C. Early the following morning light frost was noticed over the research area. Total cost of the treatment was $1 741.60, or $15.37 per hectare.

A casual inspection of this area in early September 1964 revealed that alders, hazel, and other small shrubs were almost 100% top killed (Pratt 1965). White birch, tamarack, balsam poplar and some of the trembling aspen also showed effects of the treatment. The herbicide did not affect current white spruce terminal growth.

In August 1965 the sprayed area was re-examined to fully assess the effectiveness of the treatment. Table 1 shows that the 2,4-D application effectively reduced the hardwood overstorey and some of the understorey shrub species (Pratt 1966). On overstorey trees severe top kill (61 - 100% reduction of living crown) occurred on 72% of all trees. The herbicide had the greatest effect on trembling aspen (88% with severe top kill) followed by white birch (50%) and balsam poplar (8%). Of the shrub species, all aspen suckers and hazel were killed (6 523 and 56 338 stems/ha respectively), but other understorey shrubs (balsam poplar suckers, currant spp., raspberry, and rose) were little affected. The herbicide application did not affect any white spruce.

Table 1. Effect of 2,4-D aerial spray on hardwoods and shrubs 1965

Hardwoods

Injury class (% reduction of living crown)	% of trees examined tA*	bPo*	wB*	All
0 - 20	3	44	15	11
21 - 40	5	26	20	9
41 - 60	4	22	15	8
61 - 80	15	8	25	14
81 - 100	73	0	25	58
No. trees examined	246	54	20	320

Shrubs

Species	Average no. of stems/ha Killed by spray	Living
Hazel	56 338	0
tA suckers	6 523	0
bPo suckers	99	1 236
Current spp.	99	1 977
Raspberry	0	11 021
Rose	346	10 156

* tA - trembling aspen
bPo - balsam poplar
wB - white birch

Pratt (1966)

The sprayed area was re-examined in August 1969 to assess the condition of the remaining hardwoods (Pratt 1970). Table 2 shows the crown condition and mortality to the hardwoods 1 and 5

years after treatment. In terms of percent reduction of living crown (injury class), in 1965 19% of all the hardwoods were in the 61 - 80% class and 50% in the 81 - 100% class. No mortality occurred one year after spraying. In comparison, in 1969 4% were in the 61 - 80% injury class, 18% in the 81 - 100% class, and 34% were dead.

Table 2. Effect of 2,4-D aerial spray on the crowns of hardwoods 1965 and 1969

Injury class (% reduction of living crown)	Trembling aspen		Balsam poplar		White birch		All	
	65	69	65	69	65	69	65	69
	Number of trees examined							
0 - 20	7	17	6	18	3	6	16	41
21 - 40	12	19	7	3	1	3	20	25
41 - 60	8	11	8	2	3	0	19	13
61 - 80	24	5	4	0	6	1	34	6
81 - 100	79	29	0	0	9	2	88	31
Dead	0	48	0	5	0	6	0	59
	130	129	25	28	22	18	177	175

Pratt (1970)

The response of white spruce growth to the treatment was examined in April and June 1987. A total of 44 increment cores were sampled from white spruce trees at breast height (1.3 m) at about 40 m intervals along a survey line 2 052 m in length. Diameters at breast height (dbh) and species of all live and dead trees within a 5 m radius of sample trees were recorded. Trees with different dbh were chosen to include a range of formerly suppressed advance growth, codominant, and dominant white spruce. The diameters and ages at breast height of sample trees ranged from 19 - 47 cm and 33 - 110 years.

The annual ring growth of each tree was measured using a linear digitizer. Core samples were separated into light and heavy release by the number of dead aspen within the 5 m radius of the sample trees. Light release indicated 1 - 3 dead aspen and heavy release indicated 4 - 10 dead aspen. All trees, live or dead, within the radius were tallied. A total of 32 samples were in the light release and 12 in the heavy release categories. The cores were also separated into 20 - 50, 51 - 75, and over - 75 year age classes to compare response by age. Using 15 years to dbh (Johnson 1986) in determining total age, each class in 1964 contained 23, 12, and 9 trees respectively.

Within the 5 m radius of all the sample trees in 1987, 23 years after spraying, 87% of all hardwoods (18 - 51 cm dbh) were dead (Table 3). This compares to 0% one year after spraying and

34% five years after spraying. Of the total number of dead trees 3% were white spruce (24 - 50 cm dbh). Since the area was never logged mortality was probably due to overmaturity. The extent of herbicide induced hardwood mortality is unknown. The stand density within the sampled plots is 257 t/ha of which 78% is white spruce (8 - 47 cm dbh), 20% trembling aspen (12 - 46 cm dbh) and 2% balsam poplar (23 - 31 cm dbh).

Table 3. Effect of 2,4-D aerial spray on hardwoods 1965, 1969, and 1987

Class	Trembling aspen			Balsam poplar			White birch			All		
	65	69	87	65	69	87	65	69	87	65	69	87
	Number of trees examined											
Live	130	81	18	25	23	2	22	12	0	177	116	20
Dead	0	48	134	0	5	0	0	6	2	0	59	136
	130	129	152	25	28	2	22	18	2	177	175	156

1965 and 1969 data taken from Pratt (1970)

The mean annual radial increments before and after spraying are illustrated in Figure 1 by release intensity and Figure 2 by

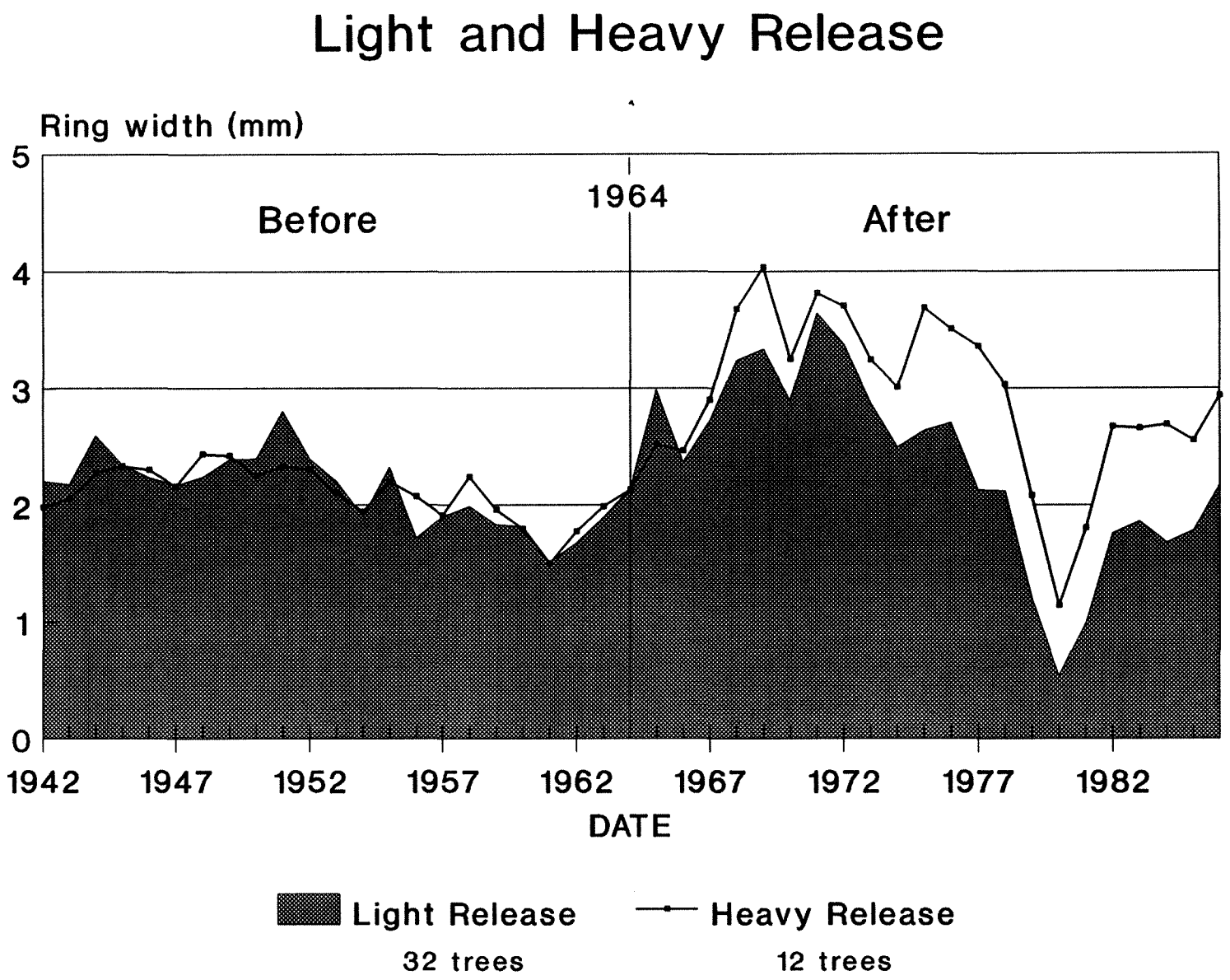

Figure 1. Mean annual radial increment before and after spraying for light and heavy release categories.

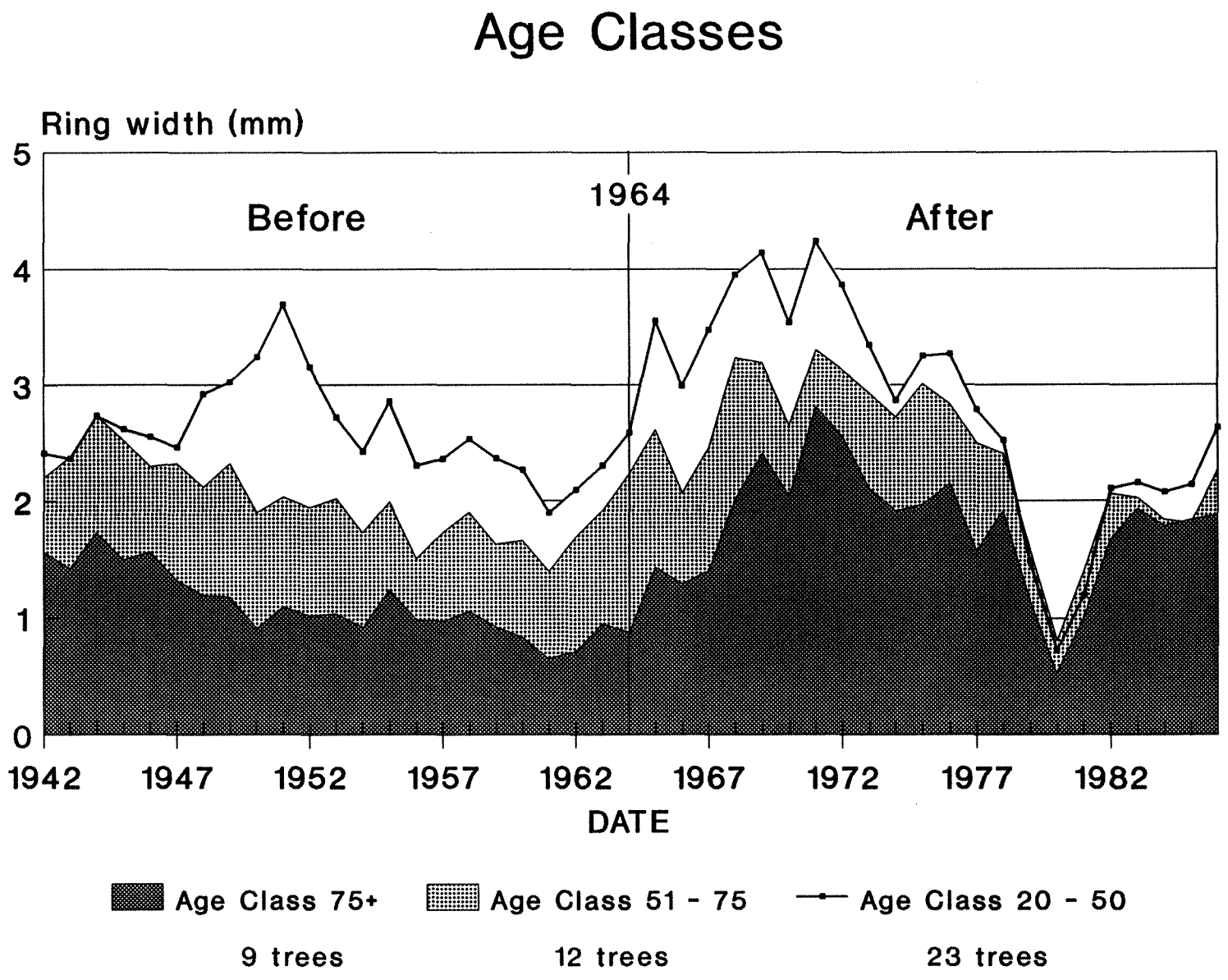

Figure 2. Mean annual radial increment before and after spraying for three age class categories.

age class. There was a significant reduction in ring growth from 1979 - 81 in comparison to the other years after spraying probably due to periodic low precipitation. In 1979 the mean total precipitation was 54% below normal from June to August and in 1980 it was 70% below normal from February to May. The normal was taken for a 25 - 29 year period between 1941 and 1970 at Dauphin (Atmospheric Environment Service). The below normal precipitation is also reflected by the occurrence in 1980 of a major forest fire in Riding Mountain National Park that burned 20 400 ha between May 20 and July 17 (Board of Review Report 1981).

A comparison of equivalent periods before and after spraying all show an increase in diameter increment after spraying (Table 4). In the light release the 5 year period after spraying had a 68% greater diameter increment than before spraying. The heavy release had a 73% diameter increment increase for the same period. After 22 years light and heavy release had 8% and 39% greater diameter increment, respectively, as a result of spraying.

All age classes also showed an increased response after spraying when compared to equivalent periods before spraying. In the 5 year period after spraying the over - 75 year class shows the highest response with a 111% diameter increment increase. This compares to 65% and 64% for the 20 - 50 and 51 - 75 year age classes respectively. A comparison of 22 years shows a 54, 16,

and 8% diameter increment increase after spraying in the over - 75, 51 - 75, and 20 - 50 year age classes respectively. When comparing diameter increments between age classes however, the 20 - 50 year class has the greatest rate of increase after spraying. In the 22 year period after release this class has a 55% greater diameter increment than the over - 75 year class and an 18% greater increment than the 51 - 75 year class.

Table 4. Diameter increment growth rate following treatment

Period following treatment (yrs)	Diameter increment increase (%)				
	Release		Age class (yrs)		
	Light	Heavy	20-50	51-75	75+
5	68	73	65	64	111
10	61	68	53	65	117
15	32	57	26	49	99
20	12	40	10	24	64
22	8	39	8	16	54

Examples of increment cores from heavily, lightly released and unsprayed control areas are shown in Figure 3. The control was taken from a tree located outside the sprayed area having 5 live aspen, 1 live spruce, and 4 dead aspen within the 5 m radius. It is unknown when mortality of the aspen occurred.

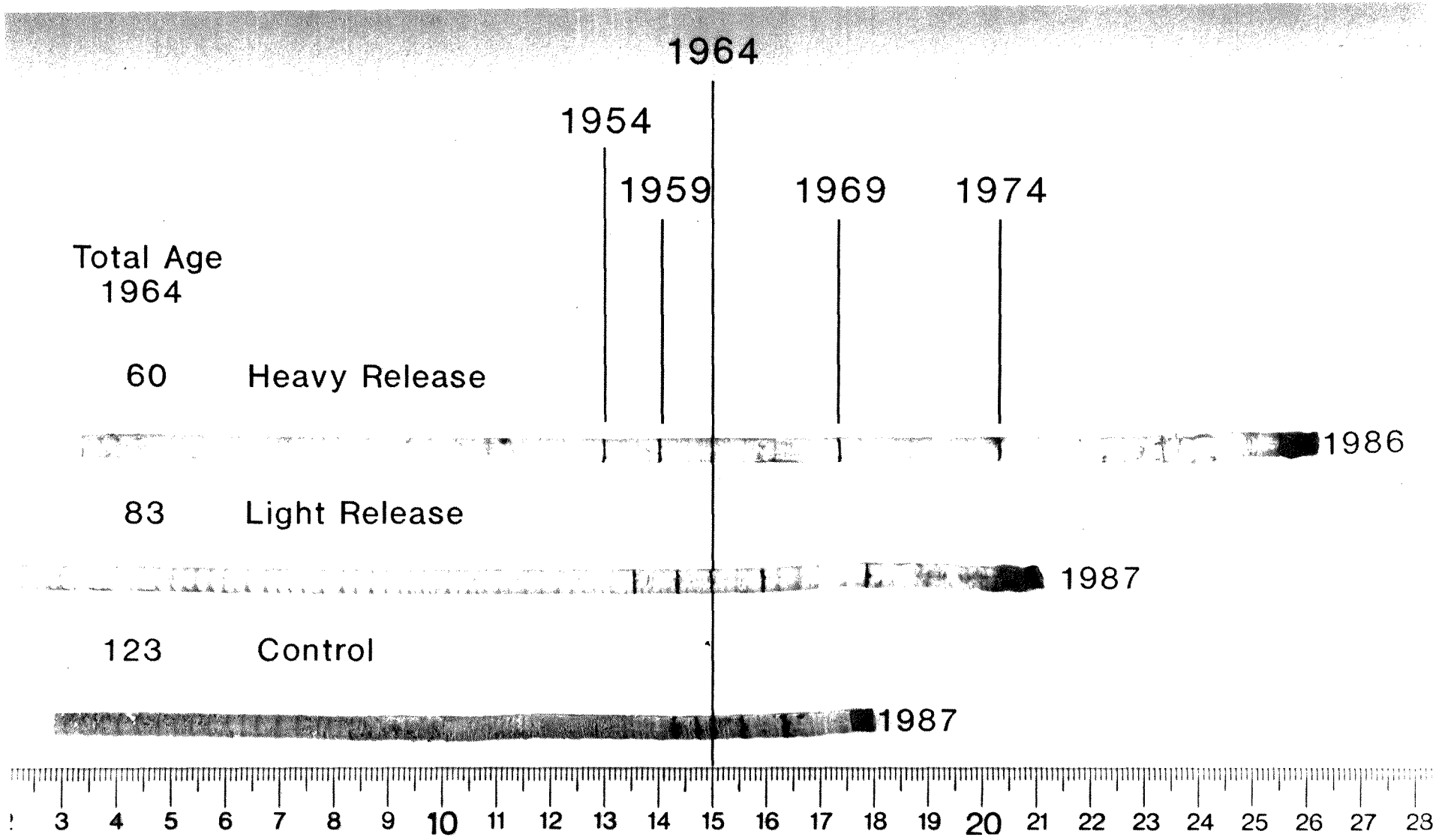

Figure 3. Examples of heavy release, light release and control cores.

Total ages of these trees in 1964 were 60, 83, and 123 years for the heavy, light, and control samples respectively. Although the older light-release tree was affected by only 3 aspen its post-1964 growth rate is about half that of the younger tree under heavy release and affected by 10 aspen.

Results from studies in the prairie provinces show conclusively that all ages of spruce respond to release treatments to approximately age 75, with 30 - 40 year old trees showing the greatest response (Johnson 1986). Yang (1989) found the best response was in trees 15 - 40 years of age. This study, when comparing responses between age classes, has shown similar results with the 20 - 50 year old trees having the greatest rate of increase in diameter increment. The study shows that an aerial application of 2,4-D herbicide is an effective way of releasing white spruce from aspen.

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