DECAY OF SPRUCE IN THE MARITIME PROVINCES ¹

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ABSTRACT

Information on decay in 409 white, 653 red, and 51 black spruce was obtained at locations in the Maritime Provinces. Since the number of black spruce examined was small, this paper deals mainly with decay in white and red spruce. Gross and net volume tables are presented for white and red spruce in cubic feet and in board feet by age and diameter. The volume of decay in red spruce was less than in white spruce but, in both species, it was apparently not great enough to influence the selection of rotation ages based on the growth increments of individual trees. Butt decays were found to be more important than trunk decays in causing losses in both white and red spruce. The fungi producing white rots were the most important causes of both types of decay. Butt-decay fungi entered the trees mainly through the roots. Branch stubs were the most important infection courts for trunk-decaying fungi in white spruce, while in red spruce, wounds were as important as branch stubs. A list of the fungi associated with decays in spruce is presented.

INTRODUCTION

During the period 1949 to 1951, living trees of white, *Picea glauca* (Moench) Voss, red, *Picea rubens* Sarg., and black, *Picea mariana* (Mill.) B.S.P., spruce were examined in the Maritime Provinces to obtain information on the causes and amount of decay. The number of black spruce examined, however, was small and this paper deals mainly with decay in white and red spruce.

LOCATION OF STUDY AREAS

The studies of decay in white and black spruce were carried out at several localities in northern New Brunswick concurrently with a study of decay in balsam fir, while a separate study of decay in red spruce was conducted in the St. Margaret's Bay area of southern Nova Scotia. The locations of these study areas are shown in Fig. 1. The numbers of trees of each species examined in these areas are given in Table I.

TABLE I
THE NUMBER OF SPRUCE BY SPECIES EXAMINED IN THE STUDY AREAS

Area	wS	rS	bS
Green River, N.B.	250	—	15
Popple Depot, N.B.	106	—	21
Jacquet River, N.B.	17	—	15
Budworm City, N.B.	36	—	—
St. Margaret's Bay, N.S.	—	653	—
Total	409	653	51

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CAPTION

FIGURE 1. Map of the Maritime Provinces showing the location of the study areas for decay in spruce.

- 1—Green River, N.B.
- 2—Popple Depot, N.B.
- 3—Jacquet River, N.B.
- 4—Budworm City, N.B.
- 5—St. Margaret's Bay, N.S.

METHODS

All spruce over 3 inches D.B.H. located in plots, that varied from 0.10 to 0.25 acre in area, were felled at a 1-foot stump and cut into 4-foot bolts to a 3-inch top. The diameter of the tree and of the decay were recorded at each cut. Bolts were sectioned further to determine the extent of disappearing decays.

A total age was estimated for each tree by adding to the stump age the average number of years required by seedlings in the area to reach the height of one foot. When the age at the stump could not be obtained because of decay, the stump age was estimated by adding to the age at the height, where obtained, the average number of years required by other trees on the plot to grow from stump height to that height.

No culling method was adopted for decay deductions in cubic feet, the decay losses presented being the actual volume of decayed wood. These volumes, together with the gross volumes, were determined by Smalian's

TABLE II
THE RELATIONSHIPS BETWEEN AGE, GROSS MERCHANTABLE VOLUME,
AND DECAY VOLUME IN WHITE AND RED SPRUCE.
BASIS 407 AND 653 TREES RESPECTIVELY
(Curved Values)

Age	Average Gross Merchantable Volume (Cu. ft.)		Average Decay Volume (Cu. ft.)		Average Percentage of Decay		Average Net Merchantable Vol. (Cu. ft.)	
	wS	rS	wS	rS	wS	rS	wS	rS
40	1.7	—	0.0	—	0.0	—	1.7	—
50	2.3	—	0.0	—	0.0	—	2.3	—
60	2.9	—	0.0	—	0.0	—	2.9	—
70	3.5	1.0	0.0	0.0	0.0	0.0	3.5	1.0
80	4.4	2.1	0.0	0.0	0.0	0.0	4.4	2.1
90	5.6	3.4	0.0	0.0	0.0	0.0	5.6	3.4
100	7.4	5.0	0.2	0.0	2.7	0.0	7.2	5.0
110	10.0	6.8	0.5	0.1	5.0	1.5	9.5	6.7
120	14.5	9.0	0.9	0.1	6.2	1.1	13.6	8.9
130	21.9	11.5	1.4	0.1	6.4	1.0	20.5	11.4
140	29.9	14.3	1.9	0.2	6.4	1.4	28.0	14.1
150	36.3	17.2	2.4	0.2	6.6	1.2	33.9	17.0
160	40.7	20.5	3.0	0.2	7.4	1.0	37.7	20.3
170	43.7	23.8	3.5	0.2	8.0	0.8	40.2	23.6
180	45.9	27.1	3.9	0.3	8.5	1.1	42.0	26.8
190	47.1	30.1	4.2	0.3	8.9	1.0	42.9	29.8
200	47.7	32.6	4.5	0.3	9.4	0.9	43.2	32.3
210	—	34.4	—	0.3	—	0.9	—	34.1
220	—	35.4	—	0.4	—	1.1	—	35.0
230	—	35.6	—	0.4	—	1.1	—	35.2

formula. Decay deductions in board feet, however, are expressed as cull. The trees were divided into 8-foot logs with the top log longer where necessary to bring the top diameter as near to 6 inches as possible. Only trees that contained at least one 8-foot log with a top diameter of 6 inches were considered merchantable. Gross board-foot volumes were determined from the New Brunswick Log Scale and cull volumes were calculated from the formula $D^3 \times L$.³ Any log having a cull volume equal to 50 per cent or more of the

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gross volume was considered as a total cull log. In the sections dealing with quantitative measurements of decay losses, the terms "decay" and "cull" are used to designate the cubic-foot volume occupied by decay and the amount of cull in board feet, respectively.

DECAY IN RELATION TO AGE

The relationships between age and decay volume and between age and cull volume are presented in Tables II and III respectively. The average

TABLE III
THE RELATIONSHIPS BETWEEN AGE, GROSS MERCHANTABLE VOLUME,
AND CULL VOLUME IN WHITE AND RED SPRUCE.
BASIS 147 AND 424 TREES RESPECTIVELY
(Curved Values)

Age	Average Gross Merchantable Volume (bd. ft.)		Average Cull Volume (bd. ft.)		Average Percentage of Cull		Average Net Merchantable Vol. (bd. ft.)	
	wS	rS	wS	rS	wS	rS	wS	rS
40	21	—	0	—	0	—	21	—
50	23	—	0	—	0	—	23	—
60	25	—	0	—	0	—	25	—
70	28	—	1	—	4	—	27	—
80	32	42	2	0	6	0	30	42
90	38	44	3	0	8	0	35	44
100	49	46	5	0	10	0	44	46
110	70	48	9	1	13	2	61	47
120	102	55	16	1	16	2	86	54
130	152	65	25	2	16	3	127	63
140	187	81	36	2	19	2	151	79
150	209	103	46	3	22	3	163	100
160	222	128	50	6	22	5	172	122
170	229	149	51	8	22	5	178	141
180	235	162	50	8	21	5	185	154
190	241	170	46	6	19	4	195	164
200	246	175	40	5	16	3	206	170
210	—	178	—	3	—	2	—	175
220	—	180	—	2	—	1	—	178

³ Where D = the largest decay diameter in inches.
and L = the extent of decay in feet.

percentage of decay in white spruce increased from 2.7 per cent at 100 years to 9.4 per cent at 200 years. In red spruce, the amount of decay was considerably smaller and, although variable, never amounted to more than 1.5 per cent of the gross merchantable volume. The average age of the black spruce trees examined was 83 years and the average percentage of decay amounted to 2 per cent.

In white spruce, the percentage of cull in trees of merchantable size increased from 4 per cent at 70 years to 22 per cent at 150 to 170 years and decreased to 16 per cent at 200 years. Cull was again less in red spruce and never amounted to more than 5 per cent of the gross merchantable volume.

When the gross and net mean annual increments were determined, it was found that the maximum net mean annual increments of both species occurred at the same ages as the corresponding maximum gross mean annual increments. It would appear, therefore, that the volume of decay, as measured in this study, in living white and red spruce is not great enough in the areas sampled to be considered an important factor in the determination of rotation ages based on the growth increment of individual trees. The maximum gross mean annual increments in white spruce were obtained at 170 years (cubic-foot

TABLE IV
THE RELATIONSHIPS BETWEEN DIAMETER, GROSS MERCHANTABLE VOLUME,
AND DECAY VOLUME IN WHITE AND RED SPRUCE.
BASIS 409 AND 651 TREES RESPECTIVELY
(Curved Values)

D.B.H. o.b.	Average Gross Merchantable Volume (cu. ft.)		Average Decay Volume (cu. ft.)		Percentage of Decay		Average Net Merchantable Vol. (Cu. ft.)	
	wS	rS	wS	rS	wS	rS	wS	rS
4	0.9	0.7	0.0	0.0	0.0	0.0	0.9	0.7
5	1.8	2.0	0.0	0.0	0.0	0.0	1.8	2.0
6	3.1	3.7	0.0	0.0	0.0	0.0	3.1	3.7
7	4.8	5.7	0.1	0.0	2.1	0.0	4.7	5.7
8	6.9	8.0	0.2	0.1	2.9	1.3	6.7	7.9
9	9.3	10.8	0.3	0.1	3.2	0.9	9.0	10.7
10	12.2	14.1	0.5	0.2	4.1	1.4	11.7	13.9
11	16.0	17.6	0.7	0.2	4.4	1.1	15.3	17.4
12	20.7	21.3	0.9	0.2	4.3	0.9	19.8	21.1
13	26.1	25.4	1.3	0.3	5.0	1.2	24.8	25.1
14	32.1	29.8	1.7	0.3	5.3	1.0	30.4	29.5
15	38.3	34.7	2.0	0.3	5.2	0.9	36.3	34.4
16	43.6	40.2	2.4	0.4	5.5	1.0	41.2	39.8
17	48.5	45.9	3.2	0.4	6.6	0.9	45.3	45.5
18	53.1	52.0	4.2	0.4	7.9	0.8	48.9	51.6
19	57.6	58.4	5.3	0.5	9.2	0.9	52.3	57.9
20	62.1	65.0	6.8	0.5	10.9	0.8	55.3	64.5
21	—	72.7	—	3.5	—	4.8	—	68.2

basis) and 160 years (board-foot basis). In red spruce, the corresponding gross increments were obtained at 210 and 200 years, respectively.

DECAY IN RELATION TO DIAMETER

The relationships between diameter and decay volume and between diameter and cull volume are shown in Tables IV and V, respectively. The percentage of decay in white spruce increased from 2.1 per cent in 7-inch trees to 10.9 per cent in 20-inch trees. In red spruce, the percentage of decay never amounted to more than 1.4 per cent of the gross merchantable volume of trees 20 inches in diameter or smaller but increased to 4.8 per cent in 21-inch trees.

The percentage of cull in white spruce increased from 9 per cent in 8-inch trees to 28 per cent in 20-inch trees while, in red spruce, it never amounted to more than 4 per cent of the gross merchantable volume in any one diameter class.

TABLE V
THE RELATIONSHIPS BETWEEN DIAMETER, GROSS MERCHANTABLE VOLUMES,
AND CULL VOLUME IN WHITE AND RED SPRUCE.
BASIS 171 AND 423 TREES RESPECTIVELY
(Curved Values)

D.B.H.o.b.	Average Gross Merchantable Volume (bd. ft.)		Average Cull Volume (bd. ft.)		Percentage of Cull		Average Net Merchantable Vol. (bd. ft.)	
	wS	rS	wS	rS	wS	rS	wS	rS
7	6	10	0	0	0	0	6	10
8	22	26	2	1	9	4	20	25
9	42	44	6	1	14	2	36	43
10	63	64	9	2	14	3	54	62
11	84	87	14	2	17	2	70	85
12	114	111	20	2	18	2	94	109
13	143	138	29	3	20	2	114	135
14	175	167	39	3	22	2	137	164
15	210	197	48	4	23	2	162	193
16	239	231	58	5	24	2	181	226
17	270	265	68	6	25	2	202	259
18	300	302	78	8	26	3	222	294
19	327	339	88	10	27	3	239	329
20	353	381	98	12	28	3	255	369
21	—	425	—	14	—	3	—	411

RELATIVE IMPORTANCE OF THE TYPES OF DECAY

Butt decays⁴ were found to be more important than trunk decays in causing losses in both white and red spruce. Eighty, or 20 per cent, of the white spruce trees examined possessed decay deductions.⁵ Of these, 91 per

⁴Decays with the largest decay diameter occurring at stump height.

⁵Decay deductions were made if the decay volume exceeded 0.05 cubic feet.

cent possessed deductions for butt decay while 34 per cent possessed deductions for trunk decay. In red spruce, the corresponding percentages of the 117 (18 per cent of the number examined) trees with decay deductions were 55 per cent and 46 per cent respectively. In both species, butt decays were responsible for 72 per cent of the decay volume. Butt decays accounted for 95 per cent of the decay volume encountered in the black spruce trees examined.

TABLE VI

FREQUENCY OF OCCURRENCE OF FUNGI ISOLATED FROM DECAYS IN SPRUCE

Butt Decays			
White Rots	wS	rS	bS ^a
<i>Armillaria mellea</i> (Vahl ex Fries) Quel.	1	1	—
<i>Corticium galactinum</i> (Fries) Burt	10	—	3
<i>Fomes pini</i> (Thore) Lloyd	3	2	—
<i>Omphalia campanella</i> Fries	1	4	—
<i>Peniophora gigantea</i> (Fries) Massee	1	—	—
<i>Polyporus borealis</i> Fries	1	2	—
<i>Polyporus tomentosus</i> Fries	7	5	5
<i>Poria subacida</i> (Peck) Sacc.	1	10	—
<i>Stereum sanguinolentum</i> Alb. & Schw. ex Fries	1	—	—
<i>Stereum chaillatii</i> Pers.	—	1	—
	26	25	8
Brown Rots			
<i>Coniophora puteana</i> (Schum. ex. Fries) Karst.	6	—	1
<i>Merulius himantoides</i> Fries	1	—	—
<i>Polyporus balsameus</i> Peck	3	—	—
<i>Polyporus schweinitzii</i> Fries	2	—	—
	12	0	1
Trunk Decays			
White Rots	wS	rS	bS
<i>Fomes pini</i> (Thore) Lloyd	8	9	—
<i>Omphalia campanella</i> Fries	1	—	—
<i>Peniophora septentrionalis</i> Laurila	—	1	—
<i>Polyporus abietinus</i> Dicks. ex Fries	—	1	—
<i>Stereum sanguinolentum</i> Alb. & Schw. ex Fries	7	3	1
	16	14	1
Brown Rots			
<i>Fomes roseus</i> (Alb. & Schw. ex Fries) Cooke	—	1	—
<i>Lenzites saepiarum</i> Wulf. ex Fries	—	1	—
	0	2	0

^a *Odontia bicolor* (Alb. & Schw. ex Fries) Bres. was isolated from a white butt rot in Newfoundland.

White rots were more important than brown rots in causing decay losses in both white and red spruce. Approximately 80 per cent of the butt decay infections in white spruce and over 90 per cent of these infections in red spruce were caused by fungi producing white rots. Practically all the trunk decay in both species was caused by these fungi.

INFECTION COURTS OF THE FUNGI CAUSING DECAY

Butt-decaying fungi entered both white and red spruce mainly through the roots. Branch stubs were the most important infection courts for trunk-decaying fungi in white spruce while, in red spruce, wounds and branch stubs were of about equal importance.

FUNGI ISOLATED FROM DECAYS

Table VI gives the frequency with which fungi were isolated from decays in spruce. *Corticium galactinum* (Fries) Burt and *Polyporus tomentosus* Fries were the fungi most frequently isolated from white butt rots in white spruce while *Poria subacida* (Peck) Sacc. and *Polyporus tomentosus* were isolated most frequently from white butt rots in red spruce. *Coniophora puteana* (Schum. ex Fries) Karst. was the fungus obtained most frequently from brown butt rots in white spruce. No successful isolations were made from the brown rots occurring in the butts of red spruce.

In a study of decay in subalpine spruce,⁷ *Flammula conissans* Fries was the second most frequently isolated fungus from white butt rots. Although this fungus has been isolated from yellow birch in the Maritime Provinces⁸, it was not obtained during the present study. Conversely, *Corticium galactinum* and *Poria subacida* were not encountered in the subalpine spruce study.

Fomes pini (Thore) Lloyd and *Stereum sanguinolentum* Alb. & Schw. ex Fries appeared to be the most common causes of trunk decay in both species of spruce.

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⁷ Etheridge, D. E. Decay in Subalpine Spruce on the Rocky Mountain Forest Reserve in Alberta. Can. Jour. Bot. 34: 805-816. 1956.

⁸ Annual Report, Forest Insect and Disease Survey, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada. 1952.