PATHOLOGICAL DETERIORATION IN WIND-THROWN BALSAM FIR IN NEWFOUNDLAND¹

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ABSTRACT

Fifty wind-thrown balsam fir were examined in Newfoundland for pathological deterioration 3 to 4 years following death. Ninety-eight per cent of the trees examined possessed incipient deterioration in the form of a reddish-brown, or occasionally, a yellowish discoloration. The average depth of radial penetration of incipient deterioration was 0.5 inches. Twenty-two per cent of the trees possessed advanced deterioration, mostly a brown cubical sap rot. The incipient deterioration, caused predominantly by STEREOUM CHAILLETH Pers., occupied approximately 33 per cent of the total merchantable volume. The advanced deterioration was caused chiefly by LENZITES SAEPIARIA Wulf. ex Fr. and occupied less than 1 per cent of the total merchantable volume. Based on present practices in Newfoundland, the loss from deterioration in these windthrown trees once the wood has reached the mill amounts to the volume occupied by advanced deterioration, less than 1 per cent. There are, however, several types of losses which may be incurred before the raw material has reached the mill.

INTRODUCTION

Under normal conditions, loss from wind-throw in undisturbed stands at any one time is confined to individual trees, or at most to restricted groups of trees. However, winds occasionally do cause the partial or complete blow-down of stands over rather extensive areas (Fig. 1). Such was the case in

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western Newfoundland in September, 1948, and as a result large quantities of dead wind-thrown balsam fir (*Abies balsamea* (L.) Mill.) are present in the Deer Lake-Humber District.

Balsam fir, both living and dead, is attacked by decay-producing organisms. Living trees are attacked by heart-rotting fungi, but following death the trees are subject to attack by additional fungi through the outer sapwood. In June, 1952, a study was initiated on the Lomond Road, approximately 15 miles northeast of Deer Lake to determine the rate and nature of deterioration from these sap-rotting fungi in the wind-thrown balsam fir. This paper is based on the first annual examination of 50 trees in 1952, 3 to 4 years following the storm. All of the trees examined had been uprooted with the exception of one which had been broken off above ground-level.

METHODS OF STUDY AND COMPILATION OF DATA

Each of the trees examined was cut into 4-foot bolts, and measurements of tree diameter inside bark, diameter of heart rot, and depth of deterioration were made at each cut where necessary. The bolts were sectioned further to determine the extent of disappearing decays. Using these measurements, each tree, along with deterioration and heart rot, was plotted graphically on a logarithmic tree measurement form. Additional information such as age, diameter at breast height outside bark, and the presence of fruiting bodies of wood-destroying fungi was obtained for each tree. Sample of deteriorated wood were collected for culturing of the causal organisms.

For purposes of compilation, the total merchantable volume (portion between a 1-foot stump and a 3-inch top diameter) was divided into five components (where present) namely: (1) sound; portion showing no heart-wood decay or deterioration, (2) incipient deterioration; portion showing deterioration in the form of a discoloration but which retained its firmness, (3) advanced deterioration; portion showing deterioration which had lost its firmness, (4) incipient heart rot; portion showing heart rot in the form of a discoloration but which retained its firmness, and (5) advanced heart rot; portion showing heart rot which had lost its firmness. The volume of each component was obtained from the graph by the use of a planimeter, which measured the area occupied by each on the tree measurement form. This area multiplied by a known conversion factor gives the volume in cubic feet. Computations were carried to two decimal places and the resulting values were taken to the nearest tenth of a cubic foot. Volumes less than 0.05 cubic feet were considered as negligible. The total merchantable volume was obtained by the addition of its components. As a check, the total merchantable volume of each tree was determined by Smalian's formula⁴. In all cases, the two volumes were found to agree to within 1%.

⁴ $\frac{B + b}{2} \times L$ where B is basal area of large end of bolt in square feet
b is basal area of small end of bolt in square feet
L is length of bolt in feet

Since heart rot occurs in living trees and since the prime purpose of this investigation was to determine what happens to the trees following death, limited attention only is given to the heart rots in the following discussion.

RESULT

Condition of the Wind-thrown Trees

Table I contains a summary of the number of trees with deterioration and the average depth of radial penetration of incipient deterioration by diameter classes. Forty-nine, or 98% of the trees examined, possessed incipient deterioration, and 11, or 22%, advanced deterioration. The average depth of radial penetration in all the trees examined was 0.5 inches. The depth of penetration increased from 0.1 inches in the 4-inch trees to 0.7 inches in the 8-inch trees. This suggests that there may be a relationship between the depth of penetration of incipient deterioration and the size of the tree. The analysis of a greater number of trees is necessary, however, before any definite conclusion can be reached.

The volumes of wood occupied by the two types of deterioration are presented in Table II. Incipient deterioration was present in 32.7% of the total merchantable volume. Although 11 of the trees examined contained advanced deterioration, only 0.1% of the total merchantable volume is attributed to this type of deterioration. The reason for this is that only 2 of the 11 trees contained a volume of advanced deterioration greater than 0.05 cu. ft.

TABLE I

NUMBER OF TREES WITH DETERIORATION AND THE AVERAGE DEPTH OF RADIAL PENETRATION OF INCIPIENT DETERIORATION BY DIAMETER CLASSES

Diameter class	Average diameter	Number of trees	No. of trees with incipient deterioration	No. of trees with advanced deterioration	Average depth of radial penetration of incipient deterioration in inches
3	3.5	1	1	—	0.1
4	4.4	4	4	—	0.1
5	5.1	9	8	1	0.3
6	6.2	6	6	2	0.5
7	7.0	12	12	3	0.6
8	8.0	9	9	3	0.7
9	9.4	3	3	—	0.5
10	10.0	3	3	1	0.8
11	11.1	2	2	1	0.6
12	—	—	—	—	—
13	13.4	1	1	—	0.6
Total or average	7.1	50	49	11	0.5
Percentage of total	—	100	98	22	—

TABLE II
CUBIC VOLUME OCCUPIED BY TYPES OF DETERIORATION
BY DIAMETER CLASSES

Diameter class	Total merchantable volume	Volume & percentage of total merchantable volume occupied by incipient deterioration		Volume & percentage of total merchantable volume occupied by advanced deterioration	
3	0.5	0.1	20.0	—	—
4	5.8	0.8	13.8	—	—
5	19.2	4.7	24.5	—	—
6	22.9	7.9	34.5	0.1	0.3
7	59.6	24.1	40.4	—	—
8	57.5	20.5	35.6	—	—
9	25.7	7.5	29.2	—	—
10	26.3	9.8	37.3	0.2	0.8
11	31.5	7.6	24.1	—	—
12	—	—	—	—	—
13	22.5	5.9	26.2	—	—
Total	271.5	88.9	—	0.3	—
Average	—	—	32.7	—	0.1

Fungi Causing Deterioration

Incipient deterioration was in the form of a reddish brown, or occasionally, a yellowish discoloration (Fig. 2). Cultures of the fungi associated with these types of discoloration were predominantly *Stereum chailletii* Pers. References to this fungus in forest pathological literature dealing with deterioration have been few. Buchanan (3) observed fruiting bodies on one wind-thrown silver fir tree. In a study of deterioration of spruce budworm-killed balsam fir, Basham (1) found that a yellowish discoloration was present in practically all of the trees examined that had been dead for less than one year. Cultures of the causal organism of this discoloration were identified without exception as *Stereum chailletii*.

Several isolations made from incipient deterioration yielded *Stereum sanguinolentum* Alb. & Schw. ex Fr. This fungus is responsible for the major loss from decay in living balsam fir. According to Boyce (2), *Stereum sanguinolentum* is widespread on balsam fir slash and occasionally decays dead sapwood on living trees. Engelhardt (4) reported that the fungus is of importance in causing deterioration of white spruce and alpine fir in British Columbia.

Fruiting bodies of *Stereum chailletii* occurred less frequently on the wind-thrown trees than did fruiting bodies of *Stereum sanguinolentum*. Those of *Stereum chailletii* were present on 7 while those of *Stereum sanguinolentum* occurred on 15 (Figs. 3 and 4). As indicated by cultural results, the occur-

rence of the fruiting bodies of these fungi is, therefore, not a reliable indicator of their relative importance in causing deterioration.

Advanced deterioration was of the brown cubical type of sap rot (Fig. 5) with the exception of one infection recorded as a white pitted sap rot, which affected a negligible volume. Wood in the advanced stage of brown cubical decay is brittle and breaks into irregular cubical blocks. Cultures of the fungus associated with brown cubical sap rot were without exception *Lenzites saepiaria* Wulf. ex Fr. This fungus is one of the most common destroyers of coniferous slash and also causes decay of timber in use (2). Fruiting bodies of *Lenzites saepiaria* (Fig. 6) were produced readily and were associated with the brown cubical sap rot in 9 out of 11 trees containing that type of rot.

DISCUSSION

It is extremely difficult to determine exactly the amount of salvable material in deteriorating trees as much depends, among other things, on the methods used by the companies in the transportation of raw material and in the manufacture of pulp. The following discussion deals with a number of factors which must be considered before the loss in deteriorating trees can be determined.

The volume of wood occupied by heart rot amounted to 1.8% of the total merchantable volume of the trees examined, 1.2% being in the incipient stage and 0.6% in the advanced stage. This, when added to the results presented previously, means that 33.9% of the total merchantable volume is occupied by incipient decay and 0.7% is occupied by advanced decay. The advanced decay may be considered as loss because most of the soft sap rot will be removed in the barking process and further losses from the soft heart rot will occur in the chipping and screening processes.

From the information available (1) it is apparent that the wood in the incipient stages of decay, found associated with the wind-thrown trees examined, can be used satisfactorily in the manufacture of pulp by the sulphite process. There are limitations to the amount of such material that can be used in other processes, and in the groundwood process, where color and cleanliness are of prime importance, none can be used. In cases where a small portion of discolored wood can be utilized, this wood from

CAPTIONS

- Fig. 1. Wind-thrown balsam fir in the Deer Lake-Humber District of Newfoundland.
- Fig. 2. Cross section of wind-thrown balsam fir showing incipient deterioration in the form of a firm, brownish discoloration.
- Fig. 3. Fruiting bodies of *Stereum chailletii* Pers. on bark of wind-thrown balsam fir.
- Fig. 4. Fruiting bodies of *Stereum sanguinolentum* Alb. & Schw. ex Fr. on bark of a dead balsam fir.
- Fig. 5. Cross section of wind-thrown balsam fir showing advanced brown cubical sap rot caused by *Lenzites saepiaria* Wulf. ex Fr. on the upper side.
- Fig. 6. Fruiting body of *Lenzites saepiaria* Wulf. ex Fr. on wind-thrown balsam fir.

deteriorating trees could be mixed with wood having little or no discoloration, thus reducing the amount used at any one time. Based on present practices in Newfoundland, where the total quantity of discolored wood represents only a small percentage of the total pulpwood manufactured, the wood containing incipient decay can be satisfactorily used once it has reached the mill. The loss in the wind-thrown trees, 3 to 4 years after the storm, would on this basis be reduced to the amount occupied by advanced decay, or less than 1%.

Several types of losses may be incurred, however before the raw material has reached the mill. These result from breakage, excessively high stumps, and from sinkage during water transport. Losses of these types are difficult to estimate. Those from breakage and high stumps were low in the trees examined, but it must be pointed out that these forms of loss may vary greatly, depending on topographic conditions. Information on the losses incurred during water transport of wood in the incipient stages of decay is lacking, but it has become apparent to those moving such material by water that the smaller bolts sink readily owing to the increased absorption of water by the decayed portion.

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