DECAY ASSOCIATED WITH LOGGING SCARS ON IMMATURE WESTERN HEMLOCK IN COASTAL BRITISH COLUMBIA

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G. W. Wallis, G. Reynolds and H. M. Craig

FOREST RESEARCH LABORATORY
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Intermediate cutting is considered necessary to obtain maximum yield from many immature stands of coastal western hemlock (Tsuga heterophylla (Rafn.) Sarg.) in British Columbia. The thin bark of this species makes it particularly susceptible to logging injury and, consequently, considerable apprehension has been expressed regarding potential cull losses, the wood being rated as highly susceptible to infection and breakdown by wood-decaying fungi.

Buckland, et al. (1949) and Foster and Foster (1951) indicated scars to be major entrance points for decay fungi in mature western hemlock in coastal British Columbia. Shea (1960, 1961) dissected injuries on coastal immature western hemlock 10 and 17 years after logging and found over 90% had associated decay; the wood volume lost to rot, however, was only moderate to small. Hunt and Krueger (1962) examined scars on immature western hemlock in western Washington 6 years following injury; 61% were infected and decay accounted for 3.4% of the gross tree volume. Wright and Isaac (1956) undertook an extensive analysis of logging injuries on 30- to 300-year-old western hemlock in Washington and Oregon. They found decay associated with 51% of the injuries examined in coast forests, and presented curves for assigning specific decay volumes to scars of known age and size.

The following study was undertaken to assess the decay volume associated with logging injuries on western hemlock in coastal British Columbia forests. The usefulness of Wright and Isaac's curves for this region was examined.

METHODS

Three study areas on the coast, East Thurlow Island, Cowichan Lake and Port Renfrew, were selected in 40- to 100-year-old western hemlock stands. Trees with logging injuries were felled and bucked into 16-foot logs. Total tree height, height to a 4-inch top and d.i.b. at each cut was recorded; volumes were computed by using Smalian's formula.

Scars in the 5-, 10- and 15-year age classes were recorded as to length, width, distance from the ground and depth of damage (superficial; i.e., only bark removed, or deep; i.e., wood tissues gouged). Scar ages were established by ascertaining the year of logging or by a count of the annual rings in the callus surrounding the scar face. Stems were further dissected through the middle and ends of all scars and at sufficient points above and below the scars to expose the total extent of associated decay. The lengths and cross-sectional areas of all decay columns were recorded and converted to cu ft volumes. Isolates were taken from decay columns for cultural identification of the causal fungus.

RESULTS

One hundred and fifty-four trees provided 204 scars for analysis. Scars in the 10- and 15-year age classes were present on all three study areas; the 5-year age class was found only at Port Renfrew and Cowichan Lake.

Only 20% of the scars were classed as upper bole and 10% as deep; consequently, it was not possible to quantify them into the various classes utilized in the study. It should be noted, however, that 80% of the upper bole scars were infected and the average volume of associated decay was very similar to that recorded for basal scars. Decay was extensive in all trees with deep scars.

Of the 154 trees sampled 72% were infected by decay-producing fungi. Only 42% of small scars less than 1 sq ft in area became infected, compared to 80% of large scars greater than 1 sq ft (Table 1).

Table 1. Percentage of scars in various size classes having associated wood decay.

Scar size (sq ft)	No. of scars	% infected
< 1	101	42
1-2	32	84
2-3	23	87
3-4	9	89
> 4	39	97

The average volume of decay associated with scars less than 1 sq ft in area was consistently small, even in the 15-year age class (Table 3), and no appreciable percentage loss in total tree volume or volume of the first 16-foot log was indicated (Table 2). Decay did, however, become significant in scars with an area greater than 1 sq ft; a maximum loss of 10% of the total tree volume to a 4-inch top and 19% of the volume of the first 16-foot log was recorded 10 years after injury. Large scars as young as 5 years may have appreciable volumes of associated decay when infected by a fungus which causes rapid decay; for example, Fomes annosus.

Table 2. Percentage of the average tree volume to a 4-inch top and volume of the first 16-foot log decayed in western hemlock having scars of various sizes and ages.

Scar age class (yrs)		Scar size (sq ft)				
		< 1	1-2	2-3	3-4	> 4[1]
		% decay				
5	tree	0.2	2.1	3.9	-	5.0
	log	1.0	4.8	8.2	-	8.8
10	tree	0.4	2.0	2.2	4.6	9.6
	log	1.2	5.4	5.3	13.9	18.8
15	tree	0.9	5.4	6.4	4.7	9.5
	log	1.6	10.3	14.5	12.9	18.3

[1] Includes scars 5 to 8 sq ft in area.

Table 3. Average volume of decay associated with scars of various sizes and ages on western hemlock.

Scar age class (yrs)	Scar size (sq ft)				
	< 1	1-2	2-3	3-4	> 4[1]
	average volume of decay (cu ft)				
5	0.2 (1.0)[2]	0.6 (1.5)	1.0 (2.0)	-	2.5
10	0.2 (1.3)	1.1 (1.8)	1.0 (2.3)	1.9 (2.8)	4.2
15	0.3 (1.8)	2.1 (2.3)	2.5 (2.8)	2.3 (3.3)	5.6

[1] Includes scars 5 to 8 sq ft in area.

[2] Figures in brackets from Wright and Isaac (1956).

Decay, even after 15 years, was confined to the wood laid down prior to the time of scarring.

Some inconsistency is evident when comparing average volumes of decay associated with large scars in the 10- and 15-year age classes, and further sampling should be undertaken to increase the number of scars in this area when material becomes available. Generally, however, the average volume increases with increasing size and age of scars (Table 3).

The average volume of decay ascribed to scars in the 5-, 10- and 15-year age classes by Wright and Isaac (1956) was generally higher than that recorded in this study (Table 3). The most significant difference occurred in scars less than 1 sq ft in area; the decay volume suggested by Wright and Isaac was 5 to 6 times greater than that found in the present study.

Fomes annosus was the most damaging wood-rotting fungus isolated; it was responsible for 45% of the total number of infections and caused 60% of the total volume of decay (Table 4). Some regional variation was evident among the fungi responsible for the major portion of the decay; at Cowichan Lake, *F. annosus* was responsible for only 27% of the decay volume while at Port Renfrew and East Thurlow Island it accounted for 76% and 91%, respectively.

Table 4. Percentage of the total infections and the total volume of decay attributable to various fungi associated with scars of western hemlock.

Fungus	% of total infections	% of total decay volume
Fomes annosus	45	60.0
Haematostereum sanguinolentum	15	5.6
Amylostereum chailletii	3	2.8
Others and unknown	37	31.6

At Cowichan Lake, a number of trees on the margin of the stand had suffered from sunscalding. Dissection of a sample of these indicated that where large scar faces had occurred decay was extensive.

CONCLUSIONS AND SUMMARY

The study has confirmed earlier findings in showing that large scars on western hemlock can lead to significant decay losses. Scars larger than 1 sq ft in area have a greater than 80% probability of becoming infected by wood-rotting fungi and subsequent losses from decay can be quite significant. Scars less than 1 sq ft in area, however, may present less of a problem than indicated earlier; fewer than half may become infected and the subsequent decay volume will usually be small enough to be of little consequence, even after 15 years.

As noted by Craig (1970) for Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco), decay associated with scars on western hemlock was confined to the wood laid down prior to the time of injury. Thinning at the youngest age practical will therefore have the twofold advantage of lessening the likelihood of frequent large scars and minimizing the stem diameter; i.e., wood volume, susceptible to loss through decay.

Fomes annosus was by far the most important fungus isolated in the study, being responsible for 45% of the total number of infections and 60% of the total decay volume. Wright and Isaac (1956) and Hunt and Krueger (1962) also attached considerable importance to this fungus; the former authors found it to be responsible for 63% of the infection in coast forests while the latter attribute to it 30% of the total infections and 80% of the total decay volume.

The curves presented by Wright and Isaac (1956) are reproduced in Figure 1 and it is recommended that they form the basis for assessing losses associated with older scars greater than 1 sq ft in area. However, decay losses determined in this study for scars smaller than 1 sq ft appear more applicable for conditions prevailing in coastal British Columbia.

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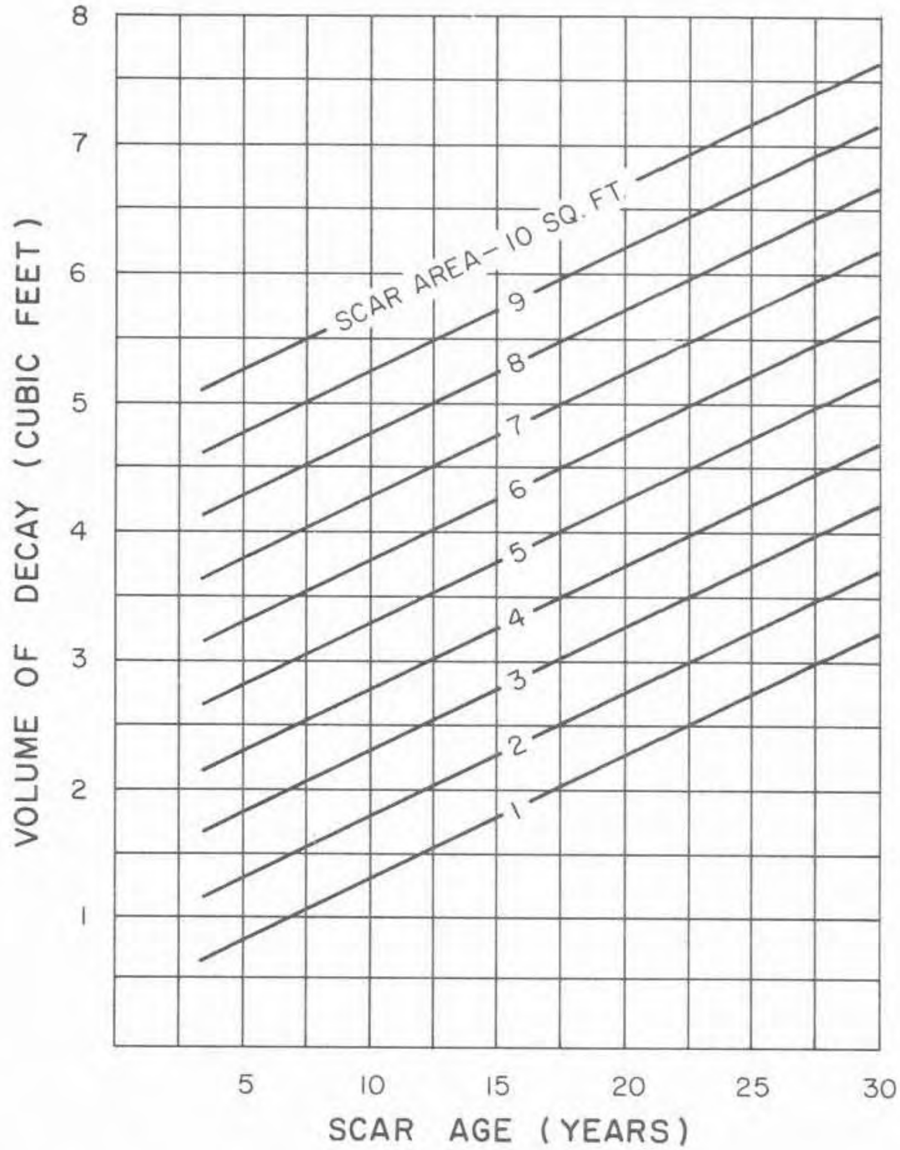

Figure 1. Cubic volume of decay in western hemlock in relation to age and area of scar. Relationship based on 596 scars. Reproduction of Figure 17, Wright and Isaac (1956).