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Damage Appraisal Cruises In Spruce Budworm Defoliated Stands of Douglas-fir in 1977

D.G. Collis and G.A. Van Sickle
Pacific Forest Research Centre

Summary

Details of some critical dissection of felled trees and damage appraisal cruises in 17 budworm-affected Douglas-fir stands are tabulated. Additional results concerning increment loss, loss of height growth, and periods of previous increment reduction have been summarized (Shepherd et al. 1977). In young and semi-mature stands, tree mortality was rare except in a few patches usually associated with bark beetle activity. There was a wide range in the level of defoliation between stands and among trees within stands. On average, about 54% of the trees were less than 50% defoliated, 30% were in a 51-70% class, and 12% were in a 71-90% class. Radial increment was already decreasing, and terminal height growth had been terminated and even reduced in most trees with heavy defoliation of the upper crown levels. Some of these trees will develop a forked or crooked stem, but as several factors affect the recovery of terminal dominance, predicting the effect of the current infestation will be difficult. In stands with a history of previous infestations, bole distortions were evident on an average of 11% of the trees, but there was a wide range among stands.

The status of western spruce budworm on Douglas-fir in British Columbia as of September 1977 has been summarized (Shepherd et al. Pest Report, PFRC), but a detailed report of the stands examined for damage was not included. During 1977, the condition of Douglas-fir trees was assessed by cruising 17 stands affected by spruce budworm and an interim account of our observations is presented in this report. Stand selection was made based on the 1976 infestation maps and aerial photos, and helicopter flights provided by the B.C. Forest Service. Included were 12 areas in the Fraser Canyon, two near Pemberton and one each in the Skagit River, Rhododendron Flats and Fountain Valley. In each area the affected stand was identified on a forest cover map and bearings were selected to best traverse the type. All trees in 4.47 diopter prism plots at 80 m intervals were examined and tallied for dbh, crown class, extent of defoliation subjectively estimated by crown thirds, bare tops, presence of bark beetles, and old-top kills from previous outbreaks.

In addition, 41 trees were felled and critically dissected at Railroad Creek near Pemberton, where detailed records have been maintained since 1970 (Fig. 1). In the East Anderson River area, 15 trees were felled, and 20 severely defoliated trees were climbed and marked to record the annual progression of top die-back and eventual recovery.

Larval populations determined from branch sampling by the assessment crew for the June 27-30 period, at or near many of the cruise lines (Table), equalled or exceeded the average of 1078 larvae per 10 m^2 for all plots sampled in this period. Budworm populations in 1977 were as heavy or heavier in the stands cruised as elsewhere in the infestation, and because of the non-random selection, cruised stands may have sustained feeding for more consecutive years. Egg populations indicate a continuation of present conditions, with the exception of Rhododendron Flats where lighter feeding is predicted in 1978.

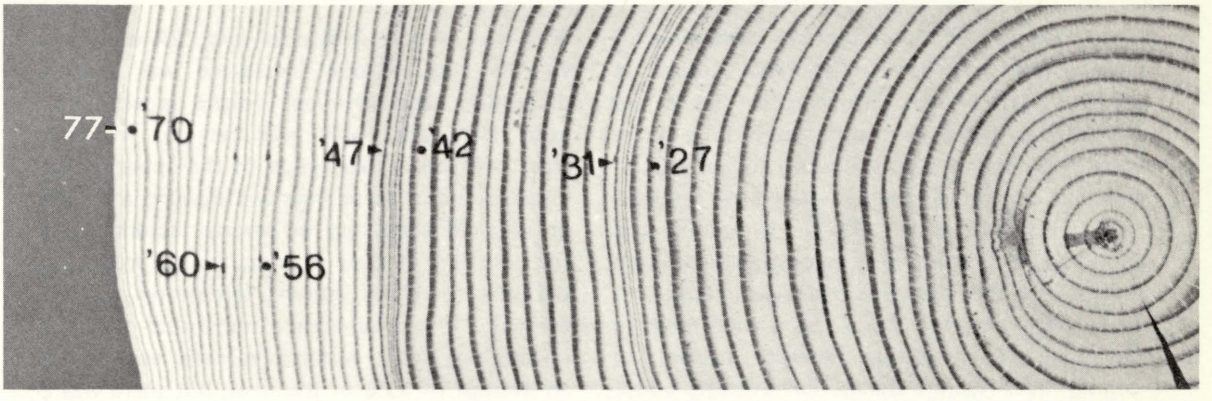

Figure 1. Reduced radial increments from the present and three previous budworm infestations in a Douglas-fir, breast high disk from near Pemberton, B.C.

Tree Mortality and Douglas-fir Bark Beetle Activity

Tree mortality caused by budworm feeding, to date, was rare in the younger stands (Table). In the older stands examined in 1976, mortality averaged less than 1% in 16 of 20 stands (Collis and Van Sickle 1977 Special report. Damage Appraisal Cruises in Spruce Budworm Defoliated Stands). This does not preclude the occasional 40-250 ha patch of higher mortality, always associated with Douglas-fir bark beetle attacks, such as occurred at Siwash, Trafalgar, Rutherford and Tsileuh creeks.

Incidence of beetle attacks declined from 1976. At Rutherford Creek, the number of trees with current attacks dropped from 11 to 2% and these were confined to the root collar. At Siwash Creek east of Yale, and Trafalgar Creek north of Hope, 33 and 50% of the trees, respectively, were dead after defoliation and several years of bark beetle attacks (Table). Current attacks at Trafalgar Creek occurred in 15% of the trees. Similar conditions were observed at Tsileuh Creek west of Hells Gate and, although the area was not cruised, an estimated 80% of the trees over 250 ha were dead and many showed evidence of beetle attack.

At Railroad Creek, north of Pemberton, annual records have been kept on 416 trees. By 1974, the last year of severe feeding in this stand, 43 and 13% of the trees, respectively, were in 71-90 and 91-100% defoliation classes. With the possible exception of a few small areas, we doubt that large stands elsewhere in the current infestation have received, or will soon attain the same high level of feeding (duration and intensity) that has occurred at Railroad Creek. Total mortality from 1970 to 1977 reached 109 trees, of which 27 or 25% had been beetle-attacked before death. Bark beetle attack commenced in 1975 after 5 years of general and severe feeding, but the relationship of bark beetle attack in tree mortality is difficult to ascertain. Of 39 trees beetle-attacked in 1976, only 9 (23%) were dead in 1977 and probably some of these would have died even without beetle attack. In 1977, 23 trees died; 14 from the effects of defoliation alone, and the 9 from defoliation and bark beetle.

Defoliation and Stand Condition

Six of the stands cruised in 1977 were examined, both in the spring before flush and in the fall after feeding. Another five were established in 1976; therefore, 11 of the 17 were examined before and after the current year's feeding. Comparison of the average percentage of trees in higher defoliation categories (Table) shows an increase in defoliation, hence a decline in tree condition from 1976 to 1977. However, within individual stands there is a wide range in the level of defoliation among trees, a situation typical over a large area of budworm feeding.

The greatest increases in defoliation were at Gilt Creek, Branch 300 Anderson River and Nahatlatch Lakes. The greatest tree improvement was at Upper Siwash Creek. In the areas examined, mortality is likely to be low and only in stands with a high proportion of the trees in the 91-100 and perhaps the 71-90% defoliation categories (Table).

At Rutherford Creek, two cruise lines were only a mile apart on the same slope, but the amount of tree mortality varied greatly. In the first, 53% of trees were dead after defoliation and bark beetle attack, but in the second, only 6% of the trees were dead in 1976, with no additional mortality in 1977. The first line was in a rockier, shallow site and defoliation in 1976 averaged 91% compared to 57% on the second strip. No budworm feeding occurred here in 1977, but tree condition declined along the first line and further mortality could be expected. The area is now being salvage-logged.

Top Killing and Bare Tops

In the Railroad Creek stand, the last year of budworm feeding was 1974. In 1977, many tree tops were still bare and presumed dead, but when the trees were felled, only part of the bare

SUMMARY OF TREE CONDITIONS ON CRUISE LINES
IN SPRUCE BUDWORM DEFOLIATED STANDS - 1977

LOCATION	FOREST TYPE	NO. YRS. DEFOLIATION OBSERVED (MODERATE + SEVERE)	NO. OF PRISM POINTS/TREES	AVG. DF DBH (CM)	% OF DOUGLAS-FIR TREES	
					DEAD FROM DEFOLIATION ONLY	DEAD, DEFOLIATION & BARK BEETLE ATTACKS[3]
FRASER CANYON 1 MILE S. 6.5 MILE JUNCTION CATERMOLE RD.	FH 210P	1 + 2 (1+1)[1]	14 / 77	26	0	0
GILT CR. AT POWERLINE N. OF ANDERSON CAMP	F430P	1 + 2 (1+1)	10 / 109	32	0	0
BRANCH 300 E. OF POWERLINE	F540M	2 + 3 (2+2)	9 / 69	40	0	0
UPPER SIWASH CREEK	F430P	2 + 1 (2+0)	11 / 50	35	0	0
GILT CREEK ROAD	F430	1 + 2 (1+1)	8 / 55	34	2	0
EAST ANDERSON RIVER 3RD CROSSING	F330P	2 + 1 (2+0)	13 / 120	18	0	0
BRANCH 300 W. OF POWERLINE	F430P	3 + 2 (3+1)	12 / 94	42	0	0
E. END NAHATLATCH LAKES N. SIDE		2 + 3 (2+2)	10 / 82	62	0	0
1.5 MILES W. CATERMOLE CAMP[2]	FH 220		7 / 41	13	0	0
SIWASH CREEK[2] E. OF YALE	F640	(2+0)	10 / 63	64	0	33
E. OF CHAPMANS[2] W. OF POWERLINE	F220P	(1+1)	11 / 37	19	0	0
TRAFALGAR CREEK[2]	F530P	(2+2)	9 / 72	31	21	50
LILLOOET FOUNTAIN VALLEY ROAD		2 + 1	12 / 88	21	0	0
HOPE SKAGIT RIVER NEAR CENTENNIAL TRAIL	F550M		16 / 105	46	0	0
RHODODENDRON FLATS		2 + 2	12 / 92	27	0	0
PEMBERTON RUTHERFORD CREEK MILE 3.3		3 + 4[4]	14 / 134	39	30	23
RUTHERFORD CREEK MILE 4.4		3 + 4[4]	9 / 75	52	0	0
			187 / 1363			

[1] SPRING VALUES ( ).

[2] CRUISED ONLY IN SPRING.

[3] CURRENT ATTACKS BY BARK BEETLE WERE OBSERVED AT RUTHERFORD CREEK, MILE 3.3 ON 2% OF THE TREES AND AT TRAFALGAR ON 15% OF THE TREES.

[4] NO FEEDING IN 1977.

[5] CRUISED IN FALL 1976.

% OF DOUGLAS-FIR TREES IN DEFOLIATION CLASS:						DOUGLAS-FIR WITH BARE AND/OR DEAD TOPS		% OF DF WITH PREVIOUS KILL EVIDENT AS:			LARVAL COUNTS PER 10 M^2 IN 1977 AND PREDICTED DEFOLIATION IN 1978	
0	1-25	26-50	51-70	71-90	91-100	% OF TREES AFFECTED	AVG. LENGTH AFFECTED (METRES)	CREASE	CROOK	FORK		
5 (1) 1/	11 (8)	25 (38)	46 (47)	13 (6)	0	51 (74)	0.8 (1.6)	0	0	0	1,000	HEAVY
0 (3)	4 (31)	21 (38)	22 (13)	30 (8)	23 (7)	60 (48)	3.9 (2.0)	0	0	1	1,020	HEAVY
0	6 (20)	13 (42)	42 (31)	35 (7)	4	54 (72)	2.5 (2.5)	3	7	15	–	HEAVY
6 (2)	16 (15)	34 (27)	40 (44)	4 (12)	0	24 (58)	2.8 (2.1)	0	0	2	–	HEAVY
0	4 (1)	34 (27)	49 (52)	11 (19)	2 (1)	28 (87)	2.1 (2.3)	0	2	2	1,020	HEAVY
1	17 (6)	60 (42)	20 (48)	2 (2)	0 (2)	40 (89)	1.3 (0.9)	0	0	1	959	HEAVY
0	7 (36) 5/	38 (52)	44 (13)	11	0	52	2.3	1	8	22	–	HEAVY
0	22 (34) 5/	37 (62)	35 (4)	6	0	27	4.4	0	1	0	2,212	HEAVY
0	49	44	7	0	0	44	0.7	0	0	0	–	LIGHT
0	31	26	29	12	2	45	2.7	0	0	24	1,720	LIGHT
3	0	51	32	14	0	86	2.0	0	0	3	–	LIGHT
10	0	5	15	50	25	0	0	0	1	0	–	HEAVY
0	55	31	10	4	0	11	2.8	0	0	0	1,052	HEAVY
12 (23) 5/	80 (77)	7	1	0	0	12	2.3	0	0	0	–	MEDIUM
0	18	70	10	2	0	17	1.5	0	0	0	2,627	LIGHT
0	3	10 (10) 5/	25 (19)	32 (29)	30 (42)	48	3.3	0	0	2	–	LIGHT
2 (24) 5/	7 (14)	50 (38)	34 (19)	7 (6)	0	0	0	0	0	3	–	LIGHT

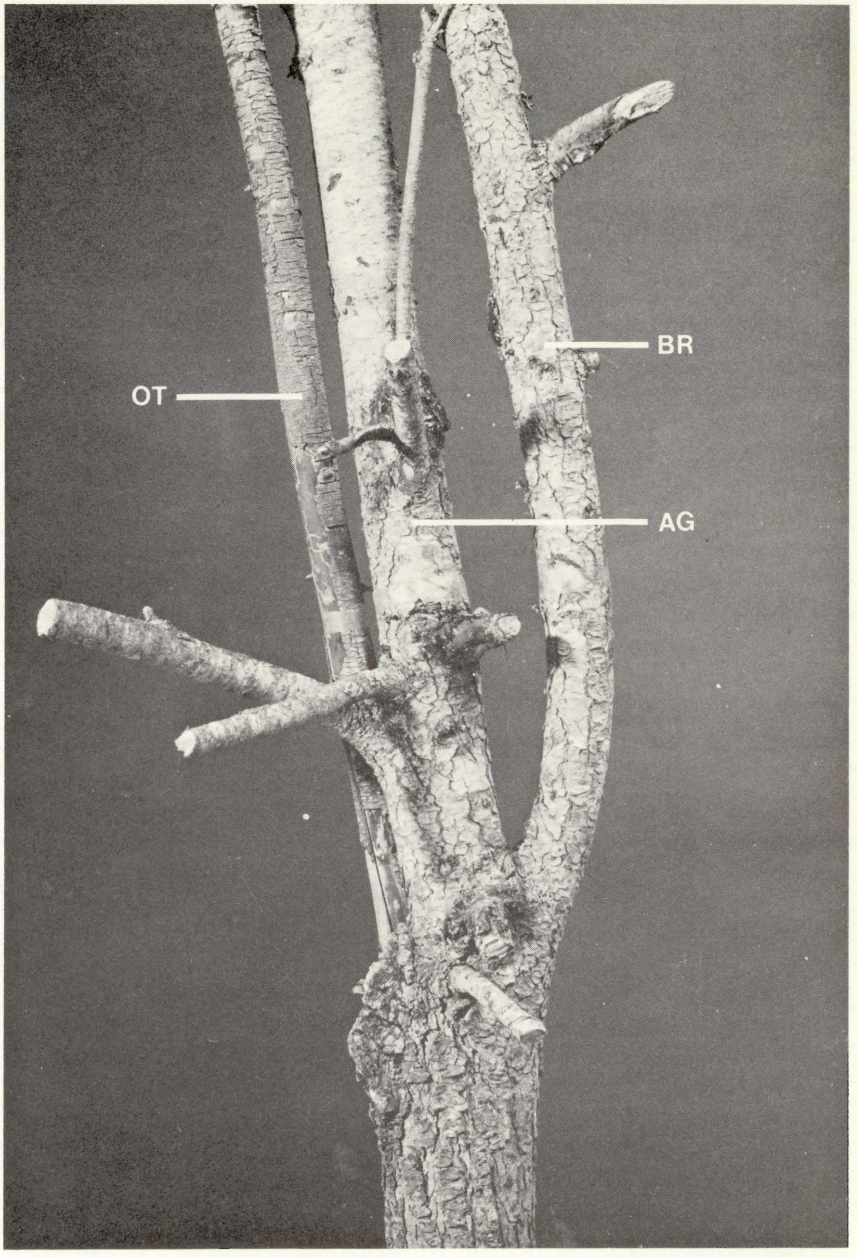

Figure 2. Multiple forking of Douglas-fir from a previous budworm infestation showing the original killed top (OT), an upturned branch (BR), and younger, adventitious growth (AG). Merchantable height growth was curtailed at 3.5 m, 56 years ago.

top was dead. In 20 trees with bare tops averaging 1.4 m in length, seven were still alive for an average length of 0.83 m. Consequently, bare and dead top estimates for the standing trees were combined in the Table.

Most stands have not been defoliated as severely as Railroad Creek and tops should be in better condition. In the Anderson River area, where feeding started about 1975, only four of 10 felled trees had top kills of 0.1 to 0.6 m length, but most had not grown in height for 1 or more years. In 20 severely defoliated trees climbed and marked to monitor top kill and recovery, none had a 1976 or a 1977 terminal internode, 14 lacked or had only a partial 1975 internode and on six trees the 1974 internode had been killed. The estimated defoliation of these trees averaged 91, 70, and 48% for the top, mid, and lower crown level, respectively. Nonetheless, the cambium was moist and active almost to the top whorl, and new buds were present throughout most of the crown.

Figure 3. Slight crook resulting from the 1953-59 infestation which killed the original top back 3 years to a diameter of 2.0 cm.

Top Kills and Recovery

During the cruises, bole distortions, resulting from one to three previous infestations, were evident in some trees as forks (Fig. 2), slight crooks (Fig. 3) or creases (samples of the latter, when split, revealed an overgrown dead top). The frequency of such stem deformities ranged from none in five stands up to 31% in the East Anderson (Table) and a maximum of 70% was observed in a stand at Haylmore Creek in 1976.

Distortion of tree form is not necessarily related to diameter of top kill. A small kill less than 2 cm in diameter may cause the tree to develop a forked top (Fig. 4); if a single top results, the disturbance may soon be callused over. Large diameter kills invariably result in severe tree deformity. Recovery of terminal dominance usually develops from the first living whorl of branches below the dead top, which is often the whorl produced 2 to 5 years before the infestation. These uppermost branches are inevitably severely defoliated and tip killed so new growth usually results from an adventitious shoot. The severity of tree deformity is probably related to the diameter of the branch which successfully gains dominance or to how far out on the branch an adventitious shoot develops.

None of the trees cut with previous or current top kills have contained decay that could be attributed to the dead tops serving as entry courts. Similarly, during felling, breakage at old top kills was not serious. In the 51 trees cut in 1977, there were 18 felling breaks, 10 at old kills and 8 elsewhere in the bole. Eight of the 10 infestation-related breaks were at kills resulting from the 1950s infestation, and occurred near the top of the tree with no loss of merchantable wood.

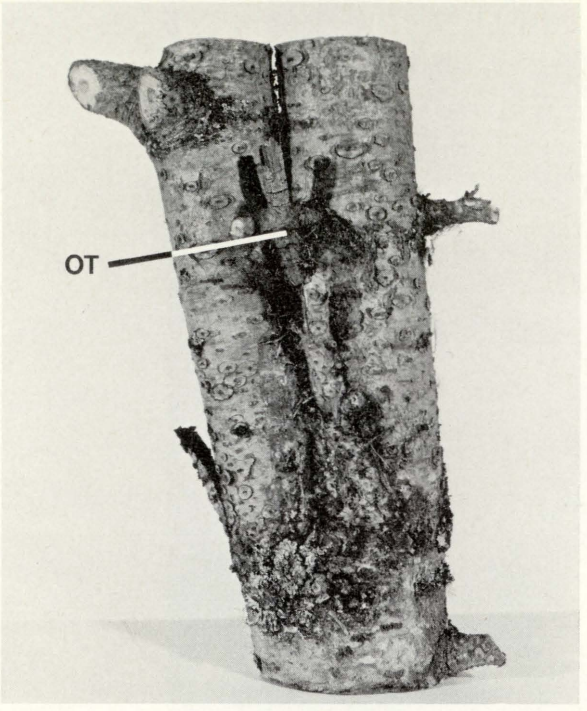

Figure 4. A double-forked top developed adventitiously after the 1953-59 infestation only killed the top (OT) back to a 1.5 cm diameter.

Canadian Forestry Service
Pacific Forest Research Centre
506 West Burnside Road
Victoria, B.C.

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