

Some Effects of Freeze Injury on Development of Douglas-Fir

DONALD L. REUKEMA

*Pacific Northwest Forest and Range Experiment Station,
Forest Service, U.S. Department of Agriculture,
Portland, Oregon*

THE COLD wave that swept through the Pacific Northwest in November 1955 killed large numbers of native forest trees. Countless others were damaged but survived (Duffield 1956). Records from trees in 50-year-old, site III stands of Douglas-fir (*Pseudotsuga menziesii*) on the Voight Creek Experimental Forest¹ in western Washington now shed light on further consequences of the freeze injury.

Data were taken from 32 felled and dissected trees that appeared to be only moderately damaged. In 1950, five years before the freeze, all had been classed as codominant and had at least three major competitors.² At that time, 29 were partially freed by the cutting of at least one competitor, and 3 remained undisturbed in an adjacent unthinned stand (Reukema 1962). Subject trees averaged 12.4 inches in d.b.h. and 100 feet in height. Annual increments in stem radial growth were measured at various heights on 11 of the released trees and the 3 unreleased trees. Annual height growth and branch elongation were measured on all 32 trees.

Observations

During the observed period, 1948-1959, fluctuations in amounts of annual stem radial growth, height growth, and branch elongation were common—apparently related to precipitation and temperature variations. However, in no other year were growth reductions as great as in 1956 (Figure 1). Defoliation, bud injury, and cambial injury, as consequences of the freeze, were undoubtedly the primary causes, although growth may have been further depressed by the relatively dry 1956 growing season, as noted by Griffith (1960) in British Columbia. Growth responses in subsequent years were undoubtedly affected by recovery from freeze damage, superimposed upon climatic fluctuations.

¹ Maintained by the Pacific Northwest Forest and Range Experiment Station in cooperation with the St. Regis Paper Co.

² A major competitor was considered to be any tree exceeding D-2 inches and growing within 1.5D feet, where: D=d.b.h. of the subject tree in inches.

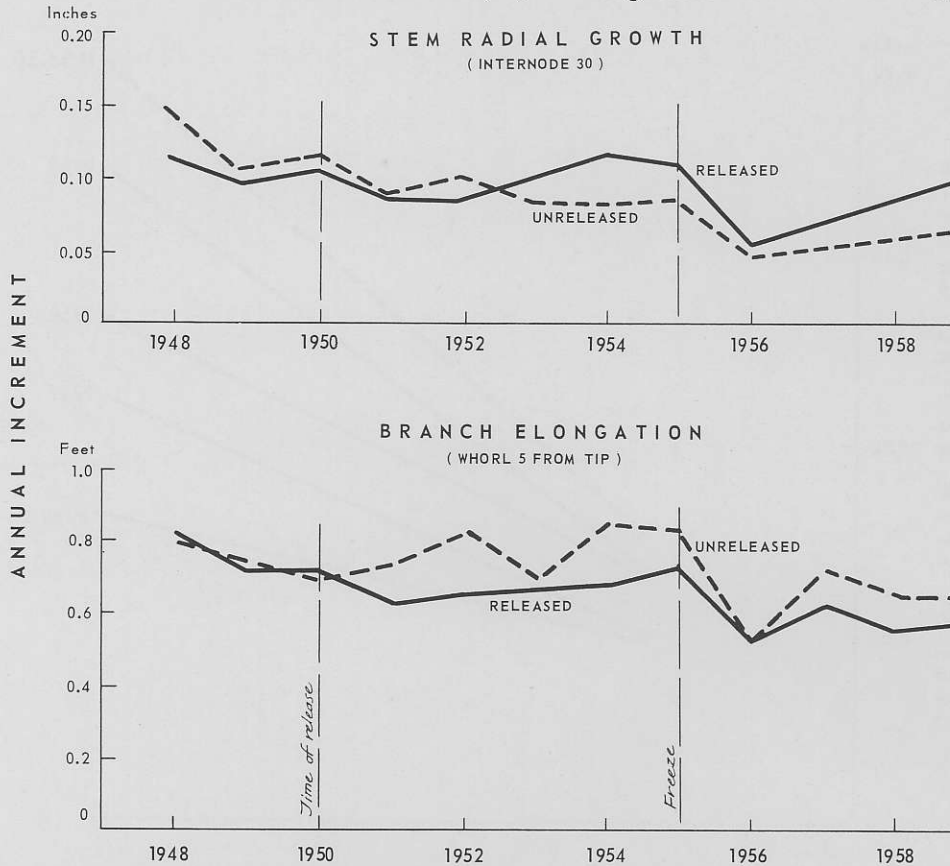


Figure 1. Patterns of annual stem radial growth and branch elongation on released and unreleased Douglas-fir trees illustrating the sharp reductions in 1956 and recovery in subsequent years.

Stem Radial Growth

Reduction of radial growth in 1956 occurred on all 14 trees measured. Ratios of 1956 growth to 1954-1955 average growth within internodes 20 to 40—roughly base of live crown to breast height³—ranged from 10 to 71 per cent, and averaged 51 per cent. Trees that had been growing most rapidly prior to the freeze tended to suffer the greatest reductions (Figure 2). Growth generally was more curtailed lower on the stem than near the base of the crown; but even within the crown, stem growth was reduced substantially.

Radial growth increased quite consistently during the following three growing seasons, 1957-1959, although magnitude of recovery varied considerably. The trees with greatest initial growth reduction tended to make the best recovery (Figure 2).

³ Internodes counted from the tip of the tree as of 1958.

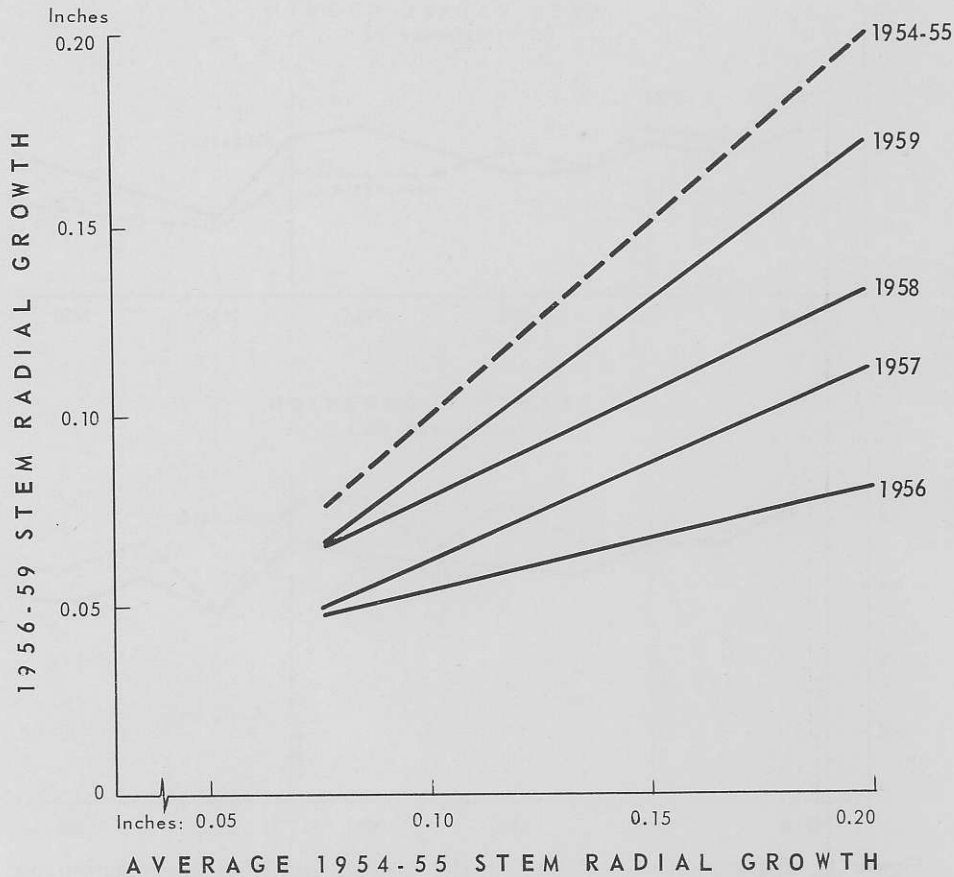


Figure 2. Reduction in stem radial growth of codominant Douglas-fir trees due to the November 1955 freeze.

Crown Expansion and Its Relation to Stem Radial Growth

On 28 trees, height growth in 1956 ranged from 14 to 114 per cent of the 1954-1955 rate, averaging 70 per cent; branch elongation at whorl 5 in 1956 ranged from 42 to 95 per cent of the 1954-1955 rate, averaging 76 per cent. Both height growth and branch elongation generally improved in 1957, then tended to decrease somewhat in 1958. In 1959, branch elongation rates tended to increase again, whereas height growth was very erratic.

Terminal leaders of the other four trees studied were killed by the freeze, and on three of these most branch leaders were also killed. Three of the four trees formed new terminal leaders in 1957 through the turning up of upper branches; the fourth did not recover until 1959, when numerous sprouts developed. Of the three trees on which branch leaders were killed, one produced new branch leaders through sprouting in 1956, and elongations

in 1957 generally exceeded the 1954-1955 rate. On the other two similarly damaged trees, branches produced many lateral sprouts, but new leaders generally had not yet formed by 1959.

As one might expect, the trees suffering greatest reductions in stem radial growth in 1956 were those on which terminal and branch leaders were killed, and the tree suffering the least stem-growth reduction was among those also showing the least reduction in height growth and branch elongation. On the other trees, however, similar relationships between radial growth and elongation were not evident. Likewise, subsequent to 1956, radial growth did not appear to be closely related to stem and branch elongation. On some trees, elongation recovered better; on others, radial growth.

Severity of the initial reduction in growth did not appear to be related to exposure or earlier treatment. After 1956, stem radial growth improved more on released trees and elongation improved more on unreleased trees, following the trends exhibited prior to the freeze.

Literature Cited

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