Decay in Advanced Alpine Fir Regeneration in the Kamloops District of British Columbia

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"Because these fungi cause most of the decay, preventing injury is essential to the good management of alpine fir."

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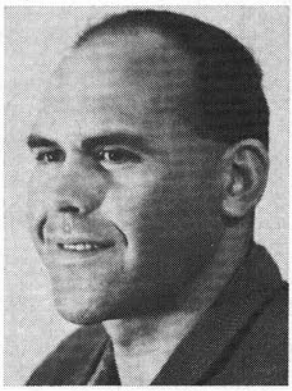

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Abstract

The extent of decay in alpine fir (Abies lasiocarpa) *advanced regeneration in the Kamloops District varied greatly among individual trees, but there was an overall increase in the volume and incidence of decay with increasing diameter and age, even within the same diameter class. Decay was most serious in trees with suspect indicators, of which the most reliable were conks, scars, broken tops and large or numerous branch stubs. The most important decay-causing fungi were* Echinodontium tinctorium *and* Stereum sanguinolentum.

Advanced regeneration in clear-cut areas was essentially decay free. This was attributed to the small size and young age of the understory at the time of release, and to the absence of injury from windfalls after logging. Where spruce (Picea engelmannii) *— alpine fir stands are not cleanly logged, decay in residual alpine fir may be considerable. To reduce future decay losses, all residual trees over 6 inches dbh, and all smaller alpine fir with conks, broken tops, scars and large or numerous branch stubs should be felled after logging.*

Etude des caries dans les jeunes peuplements de sapin subalpin (Abies lasiocarpa **(Hook) Nutt.) de la région de Kamloops, Colombie Britannique**

Résumé

*L'importance du volume de caries chez les jeunes peuplements de sapin subalpin (*Abies lasiocarpa *(Hook) Nutt.) de la région de Kamloops varie considérablement d'un individu à l'autre. Il se produit également une augmentation dans le volume et la présence de bois pourri ou affecté, parallèlement à l'accroissement du diamètre et de l'âge des tiges, et ce, même à l'intérieur d'une classe identique de diamètre.*

Les caries les plus dommageables se rencontrent chez les arbres qui affichent certains signes externes dont les plus importants proviennent de la présence de carpophores, de blessures, de cîmes cassées, de grosses branches mortes et de nombreux chicots de branches.

*Les champignons associés aux pertes les plus importantes sont l'*Echinodontium tinctorium *et le* Stereum sanguinolentum.

Les jeunes peuplements régénérés dans les superficies formées par la coupe à blanc sont pratiquement exempts de carie; ce phénomène est attribué d'une part au jeune âge et aux faibles dimensions des individus constituant le sous-étage au moment du dégagement, et d'autre part à l'absence de blessures dues aux chablis qui se produisent à la suite de l'exploitation.

*Lorsque les peuplements mixtes d'épinette d'Engelmann (*Picea Engelmanii *Parry) et de sapin subalpin ne sont pas convenablement exploités, le volume de carie peut être très élevé chez cette dernière espèce.*

L'A. recommande la coupe, après exploitation, de tous les individus résiduaires d'un diamètre (d.h.p.) supérieur à 6 pouces (15 cm), de même que l'élimination des jeunes tiges de sapin subalpin qui portent des carpophores, des cîmes brisées, des blessures, des branches mortes et de nombreux chicots de branches de variables grosseurs. Ainsi pourra-t-on réduire les pertes occasionnées par de telles infections.

Alpine fir **(Abies lasiocarpa** Hook. Nutt.) occurs commonly with white spruce **(Picea glauca** (Moench) Voss) and Engelmann spruce **(P. engelmannii** Parry) in interior British Columbia. The understory of these stands is predominantly alpine fir, much of which remains after logging. Residual alpine fir stems vary greatly in quality, as indicated by external appearance, and in density. With the knowledge that large, old alpine fir is seriously decayed (Bier, Salisbury and Waldie, 1949; Browne, 1952), forest managers are understandably concerned about the role of alpine fir in future crops. For this reason, the Federal Government, acting on a request by the British Columbia Forest Service, initiated a decay study in small alpine fir. The objectives were to determine the amounts and kinds of decay, relate these to readily observed or measured features of the trees, and on this basis suggest measures to improve residual stands intended to form all or some part of the future crop. Studies completed in the Sub-boreal spruce zone in the Prince George District (Smith and Craig, 1968) indicated that decay occurred commonly in small alpine fir, but that treatment of residual stands could reduce the present incidence of decay and thereby lessen future losses. To determine if amounts or types of decay were different in other areas, studies were extended to the ecologically distinct Engelmann spruce — Subalpine fir zone (Krajina, 1965) in the Kamloops District of southern British Columbia.

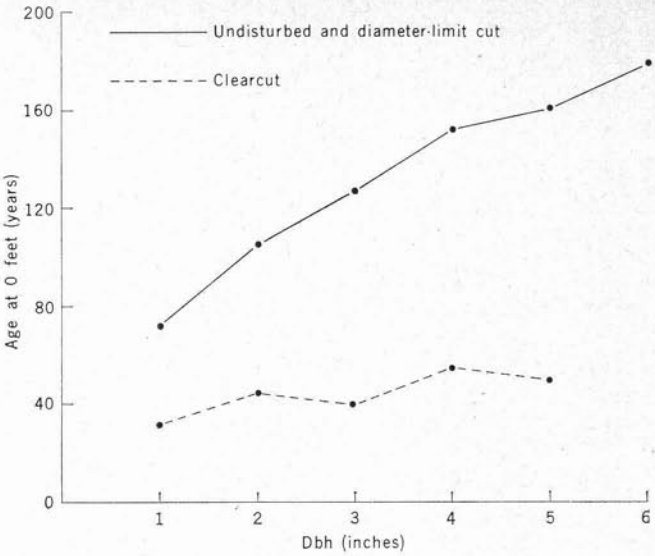

Fig. 2. Average age of alpine fir trees 1-6 inches dbh in undisturbed and diameter-limit logged stands, and in clear-cut stands.

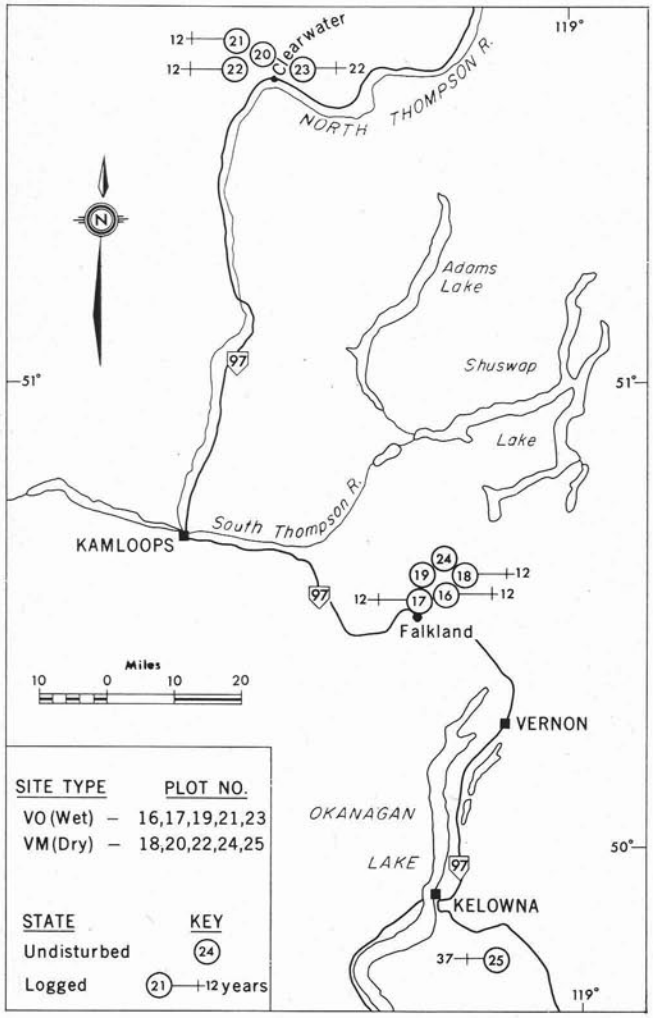

Fig. 1. Location, site and stand history of plots.

Materials and Methods

Decay analysis was undertaken in ten ⅕-acre plots established in logged and undisturbed stands near Clearwater, Falkland (Bolean Lake) and Kelowna (Little White Mountain), all over 4,000 a.s.l. (Fig. 1). Three stands (19, 20 and 24) were undisturbed, and four (16, 18, 21 and 22) were logged to a diameter limit of about 11 inches dbh. One stand (25) near Kelowna was logged to a 12-inch diameter limit in 1928 (Stettler, 1958). Two stands were clearcut, one (17) experimentally at Bolean Lake in 1952 (Clark, 1963) and one (23) with high-lead equipment near Clearwater in 1943. Stem analyses of trees on the two clear-cut areas indicated that much of the regeneration present at the time of sampling existed in trees less than 1 inch dbh before harvesting.

Alpine fir was predominant in all stands and little difference in the proportion of tree species occurred between understory in undisturbed stands and residual stands left after logging. Based on the sample plots, which were placed in relatively dense clumps of advanced regeneration, there were, on the average, 904 alpine fir and 96 Engelmann spruce 0-6 inches dbh, and 1,080 alpine fir and 387 Engelmann spruce less than 4.5 feet in height per acre.

Suppression was severe except in the clear-cut stands (Fig. 2). Sample tree ages varied from 10 to 285 years, most of the youngest trees coming from clear-cut stands. The average sample tree took 37 years to grow to 2 feet in height, and 58 years to grow to 4 feet.

Five stands were classified as wet (oakfern **(Gymnocarpium dryopteris** (L.) Newm.) abundant), and five as dry (blue huckleberry **(Vaccinium mem-**

branaceum Doug. ex Hook.) and white rhododendron (**Rhododendron albiflorum** Hook.) dominant) (Sprout, Lacate and Arlidge, 1964) (Fig. 1).

In each plot, 10 alpine fir were selected from trees less than 4.5 feet in height, and 10 from each 1-inch diameter class up to 6 inches dbh. In four plots, because of a scarcity of trees, a smaller number were sampled in the higher diameter classes. In all, 230 trees less than 1 inch dbh, and 509 trees 1-6 inches dbh were sampled. Before felling, sample trees were assigned to one of two decadence classes: Class I — trees with no suspect indicators; Class II — trees with at least one indicator that suggested the tree contained decay. The position of indicators was recorded and stem dissections made at these points and at 4-foot intervals along the bole. Cultures were taken from samples where decay was suspected.

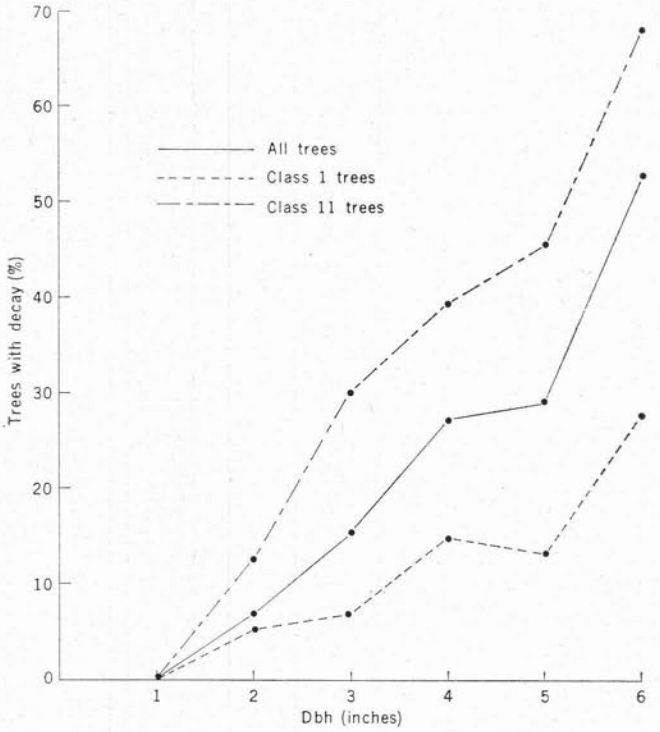

Fig. 3. Percentage of trees with decay for Class I, Class II and for all alpine fir.

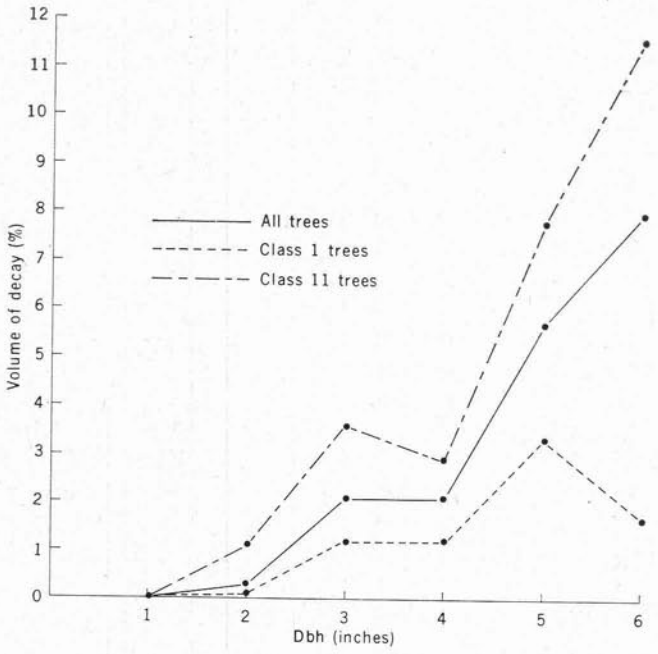

Fig. 4. Percentage of decay based on total tree volume for Class I, Class II and for all alpine fir.

Results

Extent of Decay

Decay was absent from trees in the 1-inch diameter class and less, and was present in only a small percentage of trees 2 inches dbh, but increased to 53% of the stems infected (8% of total volume decayed) for trees 6 inches dbh (Figs. 3 and 4). Except for the two clear-cut stands in which only a trace occurred, there was no appreciable difference in the amount of decay between logged and undisturbed stands. Generally, decay was more extensive in older trees than younger ones of the same diameter class. Percentages of decay volumes in trees of the top three dbh classes in two age groups were as follows:

	4″	5″	6″
under 140 years old	0.6	1.7	3.1
over 140 years old	3.1	6.7	9.0

Differences in the extent of decay between wet and dry sites were not evident.

Suspect Indicators and the Decadence Classification

Of all trees 3-6 inches dbh, 48% had at least one suspect indicator and were included in the Class II group. The most common suspect indicators were scars, crooks with or without dead or green leaders, forks, large or numerous branch stubs, broken tops, massed branches, corky bark and severe butt sweep. Of these, scars, broken tops and large or numerous branch stubs were the only reasonably reliable indicators. Conks of the Indian paint fungus (**Echinodontium tinctorium** Ell. & Ev.), the only wood-destroying fungus fruiting on live alpine fir, were positive indicators of decay but rarely occurred. Crooks with dead secondary leaders, a useful indicator in the Prince George District were common but were seldom associated with decay in this study.

Results from the tree decadance classification indicate that this system, originally designed for merchantable size classes (Foster, Thomas and Browne, 1953), could be applied successfully to small alpine fir in the field; Class I contained more trees without decay, and a lower average volume of decay per tree than Class II (Figs. 3 and 4). This good correlation probably existed because Class II trees generally had more than one suspect indicator, and thus more than one chance for decay to become established. The importance of multiple scars was recognized by Parker and Johnson (1960).

Fungi Causing Decay

Browne (1952) listed **Echinodontium tinctorium** as the most important wood-rotting fungus in live merchantable alpine fir in the Bolean Lake area. Our data show that it was also responsible for the major decay losses in small alpine fir. It was isolated from

35% of the decay samples, and was designated the causal agent of decay in an additional 8% after visual identification of decay from which cultures were unsuccessful. It was associated with 64% of the total volume of decay. In most cases, branch stubs were the indicated entrance point for the fungus.

The bleeding conk fungus **(Stereum sanguinolentum** (Alb. & Schw. ex Fr.) Fr.) was isolated from 19% of the infections sampled, and was associated with an additional 18% after visual examination. Twenty-seven per cent of the total decay volume was ascribed to this fungus. Entrance courts for **S. sanguinolentum** appeared to be mainly scars and broken tops.

Butt rots were not common in any of the plots in this study. **Odontia bicolor** (Alb. & Schw. ex Fr.) Bres., an important butt rot in the Prince George District, was rarely found.

Fungi associated with minor amounts of decay were **Amylostereum** (formerly **Stereum) chailletii** (Fr.) Boid., **Coniophora puteana** (Schum. ex Fr.) Karst., **Armillaria mellea** (Fr.) Kumm., **Peniophora gigantea** (Fr.) Mass., **P. septentrionalis** Laur., **Stereum sulcatum** Burt and **Naematoloma** sp. The latter four were not recorded in the Prince George stands.

Height Growth after Logging

Height-growth response to logging was good in all diameter classes, but best in trees about 4 inches dbh at the time of logging. Average annual height growth of trees 1-6 inches dbh 12 years after logging was 12 inches, an increase of 9 inches over pre-logging growth. Height growth in undisturbed stands during the same 12-year period increased from 3 to 7 inches per year, signifying a natural increase in height growth as individual trees improved their crown position and overstory trees died. Height growth in the two clear-cut stands was slightly less for the first 12 years after logging than in stands logged to a diameter limit, probably because of the small size of residual trees. In one clear-cut stand (23) there was an opportunity to gather data for a longer period after logging. Here, height growth increased steadily to 16 inches per year 22 years after logging.

Discussion and Conclusions

Stereum sanguinolentum is a wound pathogen which infects only recently injured trees (Davidson and Etheridge, 1963), and infection by **Echinodontium tinctorium** has traditionally been associated with branch stubs and scars (Maloy, 1967). Because these fungi cause most of the decay, preventing injury is essential to good management of alpine fir. Normally, alpine fir understory in the Kamloops District is seriously suppressed and subject to long periods when injury may occur. After harvesting, the understory remaining as advanced regeneration undergoes further damage from windfalls. From a decay standpoint, Engelmann spruce-alpine fir stands should therefore be harvested to as low a diameter limit as feasible. The two clear-cut stands, in which only a trace of decay occurred in residual alpine fir up to 5 inches dbh, are excellent examples. Where stands are not as cleanly logged, post-logging treatment should include the removal of all residual trees over 6 inches dbh and all smaller alpine fir, especially those of 3-6 inches dbh, with conks, broken tops, scars and large or numerous branch stubs. Secondary leaders, crooks, forks, swellings, corky bark, multiple leaders and sweep are not reliable indicators of decay, but in severe cases trees with these defects might also be removed. Benefits accruing from such treatment should include not only a reduction of future decay losses but an improvement in the growth of remaining trees, and an increase in the proportion of the currently more valuable Engelmann spruce.

Acknowledgments

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