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SHORT COMMUNICATION

A STUDY OF A *LIBOCEDRUS BIDWILLII* POPULATION AT PEGLEG FLAT, ARTHUR'S PASS, NEW ZEALAND

Summary: A timberline stand of *Libocedrus bidwillii* subalpine low forest at Pegleg Flat, Arthur's Pass, was partly destroyed by fire in the late 19th century. Patches of surviving low forest contain very few *Libocedrus* seedlings and lack young trees of 5-15 cm d.b.h. Only 14 large seedlings and saplings were located in the post-fire sere in the formerly burnt areas. The small numbers of seedlings on both undisturbed and disturbed sites have not replaced the trees which were burnt or died of natural causes and *Libocedrus* is now absent from certain, climatically unfavourable locations.

Keywords: *Libocedrus bidwillii*, timberline stands, size-class distribution, forest regeneration, post-fire succession.

Introduction

The montane to subalpine tree *Libocedrus bidwillii* Hook.F **(Cupressaceae) has been the subject of a number of studies concerned with problems of forest regeneration in New Zealand. Many mature *Libocedrus bidwillii* stands contain only small numbers of young trees, a fact also observed for other New Zealand gymnosperms, e.g. *Dacrydium cupressinum, Podocarpus hallii, Prumnopitys taxi/olia*. Holloway (1954) and Wardle (l963a, 1978) suggested a 'regeneration gap' for New Zealand gymnosperms, i.e., a period of lacking or insufficient regeneration caused by a climatic deterioration with a shift to cooler and drier climates. Systematic population studies of *Libocedrus bidwillii,* however, indicated that the species often regenerates in dense even-aged stands following massive disturbance and that seedlings are unable to mature under a closed canopy (Clayton-Greene, 1977; Veblen & Stewart, 1982; Norton, 1983).

This study investigates an isolated high altitude stand (830 m a.s.l.) of *Libocedrus bidwillii* at Pegleg Flat, Arthur's Pass (Fig. 1), comparing regeneration in undisturbed sites and those burnt in 1878 and 1890 (Cockayne, 1899; Calder & Wardle, 1969). AIl living *Libocedrus bidwillii* in the study area were examined. Growth habit, vigour, and microsite of the trees were noted and diameters at ground level (d.g.l.) and breast height (d.b.h.) were measured. Most dead trees were also included in the study. Little coring was done because heart rot renders accurate age estimates for older trees impossible (LaMarche *et al*., 1979). Details of the local flora, soils, and climate are given in Haase (1985, 1986).

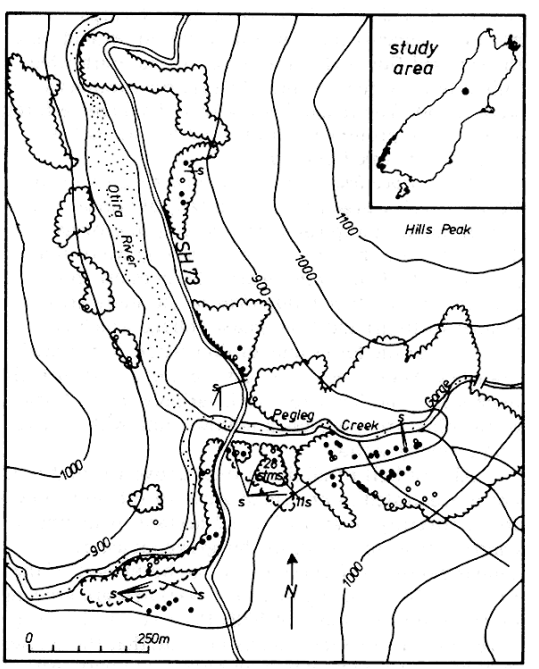

Figure 1: *Map of the study area at Pegleg Flat, Arthur's Pass. The present extent of subalpine low forest is outlined; areas of burnt forest with* Libocedrus *remains are indicated by broken lines. All* Libocedrus *trees are marked (solid circles for live trees, hollow circles for dead trees, s = seedlings and saplings).*

Local Distribution of Libocedrus bidwillii

The study area covers only the upper altitudinal range

**Nomenclature follows Allan (1961) and Philipson (1965, Araliaceae).

of *Libocedrus bidwillii*. Most living trees are located between 850-900 m; only a few dead trees were found at about 950 m altitude. About 90% of the population has a restricted distribution on the N-NW facing slopes south of Pegleg Creek and the Otira River, which support the floristically most diverse stands of subalpine low forest in the study area. These stands with *Libocedrus bidwillii* are comparable to the tall climax *Dracophyllum-Olearia* subalpine scrub (class E4a) of Wardle's classification for Westland National Park (Wardle, 1977). The small clumps of forest south of Pegleg Creek survived the late 19th century fires (Cockayne, 1899) and probably formed a continuous strip of forest along the lower parts of the N-facing slopes prior to the fires. The distribution of charred stems, believed to be *Libocedrus* or podocarps, however, suggests that this forest did not extend onto the exposed fluvio-glacial terraces to the south where only a few severely crippled *Libocedrus* specimens were found. The remaining pockets of subalpine forest south of the prominent Otira Moraine and east of Lake Misery lack *Libocedrus*.

The *Libocedrus* trees on the lower slopes of the Pegleg Creek Gorge are 12-15 m tall, of typical growth habit, and possess weIl developed crowns. These sites are sheltered from the strong winds that prevail at the Flat proper where the trees are more exposed. Most other *Libocedrus* in the study area are smaller (6-10 m) and bear sparse foliage which is restricted to the lower and/or down-slope orientated branches. Many trees have lost the upper part of their main stems and heart rot has invariably set in. Some of the older trees possess a hoIlow trunk with a mere ring of living wood.

Almost half of all living trees above 10 cm d.b.h. are concentrated in one small grove of subalpine low forest covering an area of c. 0.2 hectare. A number of charred stems to the SE of this grove indicates a similar density of *Libocedrus* in the burnt part of the forest. Only five living mature *Libocedrus* are growing on the W-facing slopes of Hills Peak north of Pegleg Creek but large rotten stumps indicate that the species may have been more common here in the past. All five trees west of the Otira River have died some time ago and the dead stems now retain only the larger branches.

Libocedrus trees killed by the late 19th century fires are today only represented by decaying stems up to 3 m tall. The dead trees which were included in the study, however, still possess a complete trunk with major branches; many still retain most small branchlets, suggesting that they died considerably later, probably not more than 50 years ago. Most of the dead trees occur together in smaIl groups in certain locations; nine were noted close to the local timberline between 900-950 m on the N-facing slope of the Pegleg Creek Gorge where no living *Libocedrus* now remain. Two dead trees further west occupy a similar position at the timberline which is here locally depressed on a ridge crest. All trees west of the Otira River are dead as weIl. Dead trees span all diameter-classes (Fig. 2), suggesting a dieback unrelated to age, most do not appear to have been senescent at the time of death. Cores taken from two dead individuals at timberline do not reveal a decline in ring width of the outer growth rings which also suggests that the trees may have died during a single season.

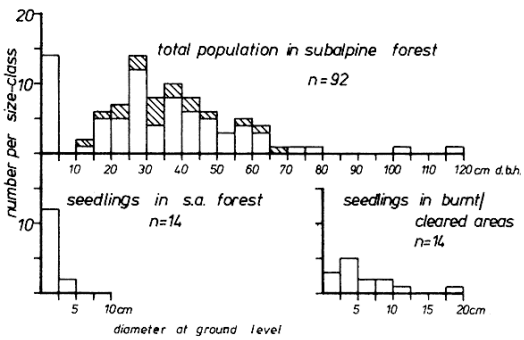

Figure 2: *Size-class distribution of* Liboccdrus *in undisturbed subalpine low forest and seedling histograms for undisturbed and disturbed sites. Dead trees are indicated by hatching.*

Growth rates and size-class distribution

Five cores taken at Pegleg Flat during the present study show a sudden decline in radial increment from previously 0.62± 0.22 mm to a mean ring width of 0.29± 0.14 mm during the last 40-45 years. A comparable mean ring width of 0.64 mm was determined by Norton (1983) in subalpine *Libocedrus* stands in the Cropp River Valley, Westland, and Wardle (1963b) gave a range from 0.25-0.71 mm for subalpine *Libocedrus* in the Toaroha Basin, Westland.

Libocedrus bidwillii is usually an exposed emergent in the subalpine low forest at Pegleg Flat and therefore particularly prone to the effects of wind. Many surviving trees in exposed positions have severely damaged crowns which may account for the decline in wood increment starting some 40 years ago.

Figure 2 gives the size-class distribution of *Libocedrus* on undisturbed and burnt sites. Although seedlings constitute the most numerous single class,

trees in the size-classes 5-25 cm, and 5-15 cm in particular, are less represented than the larger diameter classes. This size-class distribution is typical for many *Libocedrus* stands (e.g. Veblen & Stewart, 1982; Norton, 1983).

Regeneration

Eleven of the 14 seedlings found in undisturbed subalpine low forest were located in the dense *Libocedrus* stand. Seven small seedlings, estimated to be 5-8 years old, probably originate from the same seed year. Most occupy typical seedling habitats, i.e., moss patches on fallen logs and boulders. Four larger seedlings have made only poor progress, they have developed procumbent stems, or grow in deep shade, and are unlikely to persist and reach maturity. Only two large seedlings were located in the more extensive forest in the Pegleg Creek Gorge; they became established in a canopy gap after a tree-fall.

Probably the oldest *Libocedrus* in the burnt or cleared areas is a pole-sized tree (19.7 cm d.g.1.) growing in scrub south of the Pegleg Creek Bridge. It is assumed that this scrub is regrowth after forest clearance for the dray road built soon after the discovery of Arthur's Pass in 1864.

Another 13 saplings and large seedlings were located in the burnt areas. Five saplings of 7-10.5 cm d.g.!. appear to have established soon after the fires and may originate from the same seed year. Five large seedlings (2.9-4.6 cm d.g.1.) and three stunted smaller seedlings are considerably younger. As far as could be ascertained, all seedlings and saplings appear to have become established on mineral soil or litter on the soil surface.

Compared with the present extent of undisturbed *Libocedrus bidwillii* subalpine low forest, the regenerating burnt sites cover only small areas at some distance from potential seed trees. Nevertheless, the disturbed sites contain the same number of juvenile *Libocedrus* as the considerably larger area of undisturbed forest, or twice this number if the seven recent seedlings in the dense *Libocedrus* stand are not considered. This implies that establishment of *Libocedrus* seedlings is particularly favoured in open vegetation after large scale disturbance as has been suggested by Veblen & Stewart (1982).

Even in the burnt areas regeneration appears relatively poor and the apparent former density of *Libocedrus* on these sites is not yet matched by a comparable seedling density. The subalpine low forest stands at Pegleg Flat constitute marginal habitats for *Libocedrus* and it is assumed that seed years only occur infrequently and produce poor seed crops. No flowering was observed from 1981/82 to 1984/85 except for one crippled individual north of the Otira Moraine.

If stem diameter of juveniles is used as an indicator of age, most saplings and large seedlings appear to have originated from two periods of regeneration, one following soon after the 1890 fire, the second probably before the decline of the population some 40 years ago. A recent seed year some time in the 1970's is only reflected by a few surviving seedlings in the dense grove of forest containing 20-25 potential seed trees.

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