BEECH *(NOTHOFAGUS)* SILVICULTURE IN THE SOUTH ISLAND

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INTRODUCTION

Of the four native species of beech, silver beech *(Nothofagus menziesii)* is important as a commercial timber species in western Southland (and to a lesser extent on the West Coast), red beech *N. fusca* is also milled to some extent on the West Coast, but hard beech *(N. truncata)* and mountain beech *(N. solandri* var. *cliffortioides)* are seldom cut. On the debit side, all these species are difficult to saw and season (silver beech is the least difficult), logs often contain extensive heartrot, and attack by *Platypus* beetles (pinhole) often precludes the use of otherwise clear timber for decorative purposes. In addition, poorer grades of beech timber are difficult to market in competition with exotic softwoods. On the credit side, beech timbers are stronger and more decorative than most of our exotic timbers. There is a market for quality timber for mouldings, turnery items and flooring, and one could possibly be developed for veneers.

If the objects of beech forest management are to produce sawlogs and veneers in competition with other timbers, the aim of silviculture must be to obtain adequate stocking and to produce logs with a maximum amount of clearwood and a minimum amount of heartrot and pinhole attack in the shortest possible time. All beech species make satisfactory kraft pulp, but because pulpwood is a low-value product it is very unlikely that silvicultural treatments other than those required to ensure adequate regeneration could be economically justified if beech were to be grown mainly for pulpwood.

Although small seedlings of all the beech species are reasonably shade-tolerant, saplings and poles are relatively light-demanding (see Wardle 1974, p. 22). The only feasible form of selection management would be group selection using fairly large groups. On the limited evidence available, clearfelling would not be generally successful because newly germinated seedlings are prone to desiccation in summer and to frost-lift in winter. Silver beech may be a possible exception as vigorous regeneration after clearfelling has been observed in a heavy seed year. The most satisfactory form of management, then, is the shelterwood system, where some overwood is retained after logging. This is the system that is currently practised in western Southland and will be practised on the West Coast if the proposed scheme for intensive utilisation of beech forests eventuates.

RECRUITMENT AND DEVELOPMENT OF REGENERATION

The main factors that favour good seedling recruitment are:

1. a reasonably good supply of seed;
2. an absence of dense ground vegetation and accumulations of slash; and,
3. overhead shelter.

In Southland, a reasonably heavy seedfall (1000 or more sound seed per m^2) of silver beech occurs usually every three years, but in the Inangahua Valley there has only been one good seedfall (1971) in nine years (cf. Manson 1974, p. 28). For the other species, heavy seedfall is apparently often correlated with hot dry summers immediately prior to flowering (Poole 1948, Johnston 1972). In the Inangahua Valley there is usually a heavy seedfall of red beech every five to six years, with one fair crop in the intervening years, but it appears that seedfall is a little more regular and a little heavier in the Maruia Valley. Only two good seedfalls (1960 and 1971) have been recorded for hard beech in the last 13 years.

Kirkland (1961) and Franklin (1971 unpubl.) found that, where there is dense ground vegetation, recruitment and survival of seedlings is very much better on disturbed ground than on undisturbed ground. On areas where there is not normally a dense ground vegetation (e.g. in dense pole stands, on some poorly drained areas and in some red beech forests on good quality sites) dense regeneration is normally present for several years after a heavy seedfall. On other sites regeneration is often very scattered.

Studies of red beech forest in natural windthrown areas (Kirkland 1961) and areas clearfelled for mining timber (Inglis 1967) show that, under these conditions, advance growth forms the major proportion of subsequent regeneration. Current management in silver beech forest in Southland aims to promote advance growth by scarifying with a tractor several years before logging to remove dense ground vegetation (mainly *Blechnum discolor*) and disturb the duff (see Manson 1974, p.29). Because logging destroys some of the advance growth, seed trees must be left to regenerate the gaps. In the Maruia red beech forests, five large-crowned seed trees per hectare are sufficient for this purpose, but in western Southland, where the silver beech have smaller crowns, probably 10 to 15 seed trees/ha are required.

Where logging is intensive, as it will be if chipwood is removed, successful regeneration is more dependent upon obtaining recruitment after logging (see Wardle 1974, p.26). In these circumstances some overwood protection against desiccation and frost-lift may be required. From current knowledge, it appears that the seed trees plus smaller trees remaining after chipwood logging would be sufficient to obtain adequate regeneration for beech management.

Once beech seedlings are about 10 cm high, good survival and development is dependent upon freedom from root competition with the overwood and freedom from competition with weed species, particularly waterfern *(Histiopteris incisa)*. Waterfern can become dense within a few years of logging, and its development appears to be favoured by the presence of a light overwood. Removal of the overwood within two or three years of logging allows beech seedlings to grow faster and suppresses the height growth of waterfern. Retention of seed trees beyond about five years after logging results not in any increase in stocked area, but in severe depression of height growth of seedlings in the immediate vicinity of the trees (see Wardle 1974, p.22). In western Southland, where beech has been extensively regenerated after removal of sawlogs, the practice has been to scarify where practicable before logging; to retain between 25 and 40 seed trees/ha; to fell all other overwood (cull trees) immediately after logging; and to ring bark or poison seed trees up to 12 years after logging. The felling of cull trees increases the amount of slash on the ground, inhibiting regeneration. If the trees were killed standing, a greater proportion of the ground would be suitable for the recruitment of regeneration, and the shelter provided by the standing dead trees would allow seed tree numbers to be reduced to 10-15/ha. This of course looks untidy, and is not favoured for this reason.

SUPPLEMENTARY PLANTING

Where there is dense ground vegetation on hill country, and it is not feasible to disturb the ground by tractor, current logging for sawlogs does not prepare sufficient seedbed for adequate regeneration. Logging for both sawlogs and chipwood will undoubtedly disturb more ground, but it is unknown whether even this will be sufficient for adequate regeneration. Hard beech apparently seeds heavily only at infrequent intervals so that adequate regeneration cannot be assured where this species is dominant unless a heavy seedfall occurs within two or three years of logging.

In these circumstances, intensive beech management is probably not feasible and considerable work has been done on supplementary planting using eucalypts (e.g. Franklin 1972). Results indicate that the most promising species are *Eucalyptus delegatensis, E. nitens,* and *E. regnans.* These species have little, if any, adverse effect on the development of any beech regeneration; instead they promote good form if the beech regeneration is sparse and provide ameliorating shelter on frosty sites.

GROWTH RATES AND THINNING

Rotations of 150 to 180 years for red beech and 180 to 200 years for silver beech to produce trees 50 to 60 cm d.b.h. can be expected if regeneration is left unthinned (Conway 1952, Williams and Chavasse 1951, Manson 1974, p.30). Considerable work has been done on the effects of thinning pole stands (where stems are over 10 cm d.b.h.) of silver beech and red beech. Later work on red beech (Evans and Jackson 1971) shows that mean annual increments of 7 to $10m^3$/ha, producing trees of about 50 cm d.b.h. in 100 years, are possible on the best sites provided that thinning is reasonably heavy. However, this practice has often resulted in windthrow and has led to extensive attack of the residual stems by pinhole borers which have reached high population levels in the stumps of the felled stems (Milligan 1972).

Most current work on thinning is aimed at thinning to final crop spacing before the regeneration is subject to windthrow or pinhole attack. For sawlogs this will mean slasher thinning of regeneration and completion of thinning and pruning by the time the trees are 12 to 15 m high and 12 to 15 cm d.b.h. This will produce short (6 m) logs, but on reasonably good sites it will lower the rotation to 60 to 80 years. Because of the expense of slasher thinning thicket beech regeneration ($150 to $200/ha), this can probably be justified only for sawlog regimes (see also Milligan 1974, p.39).

Results indicate that heavy early thinning promotes wind stability and does not greatly affect the form of the lower bole. Pruning of live branches has not led to stem rots because the rapid growth rates result in the wounds healing within a few years, long before heartwood develops. A study of fast-grown red beech and silver beech (70 cm d.b.h. in 70 years) shows that such timber saws and seasons as well, if not better, than slow-grown material. Fast growth does not significantly alter the strength properties and produces a timber which is easier to work.

PATHOLOGY

The pathology of the beech species has recently been summarised by Milligan (1972). The most serious pathogen, particularly in stands scheduled for utilisation, is apparently a fungus associated with pinhole borer (*Platypus* spp). This fungus kills the inner sapwood and, where attack is severe, can lead to mortality. Where trees survive the killed wood is readily attacked by rot fungi, resulting in both stem and butt rots. Attack by pinhole borer is probably indirectly the major cause of the high incidence of stem rots in all beech species. At present the only method of control is to avoid leaving stumps and logs that are suitable breeding material for pinhole borers (see also Milligan 1974 p.39).

SUMMARY OF MANAGEMENT POTENTIAL

Where the ground can be scarified before logging there are no technical difficulties in obtaining adequate silver beech regeneration in western Southland or red beech regeneration in the Westland-Nelson region. Similarly, mountain beech regeneration can probably be obtained with ease in both locations. Where there is dense ground vegetation and pre-logging scarification is not possible, it is doubtful whether even chipwood logging will produce enough disturbed ground to allow adequate regeneration. Some supplementary planting of eucalypts will probably be required, at least until more experience of chipwood logging has been obtained. Adequate regeneration cannot be guaranteed where hard beech is dominant except where a heavy seedfall occurs within two or three years of logging, and extensive supplementary planting or conversion to exotic conifers may be required in some areas (see also Wardle 1974, p. 26).

The only acceptable alternatives for treating regeneration appear to be either to leave it unthinned or to thin it early and heavily before there is any danger of windthrow or insect attack. Unthinned stands will result in long rotations for sawlogs and probably a rather high incidence of stem rots and insect damage, but they may be used for chipwood production if a small average piece size is acceptable. Early thinning is expensive, and for sawlogs will result in short-boled trees, but it should keep the stands healthy and will considerably shorten the rotation.

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