

# MANAGEMENT OF WEST COAST BEECH FORESTS

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## SYNOPSIS

The northern west coast of the South Island of New Zealand — between the Taramakau and Mokihinui Rivers — has approximately 242,820 ha of merchantable indigenous State forest, which can be grouped broadly into three major categories — podocarp-beech, beech, and podocarp-hardwood forests. The beech (*Nothofagus* spp.) content of these has been underutilized mainly because of extensive hidden decay and difficulties in sawing, seasoning, and treating. This situation may alter now that the use of beech for pulping is technically feasible. A recent survey of State forest land indicates a beech wood resource of over 28 million m<sup>3</sup>. The pure beech forests offer the best opportunity for practising beech management employing a clearfelling system combined with ground scarification and retention of seed trees, and followed by early thinning of thickets of regeneration.

## INTRODUCTION

On the west coast of the South Island of New Zealand, approximately 242,820 ha of merchantable indigenous State forest occupy low altitude hill country and glacial outwash terraces between the Taramakau (latitude 42° 30') and Mokihinui Rivers (latitude 41° 30'). Within this extensive forest area three broad species categories are recognizable — podocarp-beech forests, beech forests, and podocarp-hardwood forests.

### *Podocarp-Beech Forests*

On the free-draining hill country in Charleston Forest south of Westport and throughout the northern Buller area and the Inangahua and Grey Valleys are mixed softwood-hardwood forests comprising medium-volume stands of rimu (*Dacrydium cupressinum*) with red beech (*Nothofagus fusca*) and hard beech (*Nothofagus truncata*), either singly or in mixture, and silver beech (*Nothofagus menziesii*) generally subdominant. Alluvial and recent glacial terraces support a high forest of rimu, kahikatea (*Podocarpus dacrydioides*), miro (*Podocarpus ferrugineus*), and red beech with silver beech subdominant, while the forest on the older high terraces, which have impeded drainage, varies from good rimu stands with stunted silver, mountain (*Nothofagus solandri* var. *cliffortioides*), and

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hard beech on the better sites to scrubby stands of mixed podocarps with silver and mountain beech on the poorer sites.

### *Beech Forests*

High-volume almost pure beech forests of red (dominant) and silver beech form the region's inland forests occupying the valley bottoms and easier slopes of the Maruia, Matakītaki and upper Grey valleys. More limited in extent on hill country in the Inangahua and Grey valleys are pure beech forests of red, silver and hard beech, the last occupying the drier ridges.

### *Podocarp-Hardwood Forests*

These forests consist mainly of rimu, kamahi (*Weinmannia racemosa*), quintinia (*Quintinia acutifolia*), and rata (*Metrosideros* spp.) and are restricted to the southern portion of the region near the Taramakau River.

## HISTORICAL

Much of the podocarp-hardwood terrace forests and some of the podocarp-beech hill forests have been cut over, primarily for podocarp saw logs and only incidentally for beech.

Cutting first started on the alluvial flood plains and recent low terraces after the decline of goldmining around the turn of the century, with most of the cut-over being cleared for farming after utilization of the merchantable podocarps. Cutting on the low terraces in State forest began around the 1920s and 1930s, first for kahikatea then for rimu, and finally haphazardly for red and silver beech. The partial logging of beech has left patchy stands of beech trees intermingled with areas of beech regeneration.

From these areas cutting moved to the higher infertile terraces where the rimu was extracted, leaving a broken canopy of hard and mountain beech. Windthrow opened much of this canopy and released the crop beneath, resulting in stands which vary from even-aged hard beech to thickets of pure kamahi and quintinia. Only small areas of the virgin forest type remain.

In recent years hill country areas of podocarp-beech and podocarp-hardwood forest have been cut where the podocarp volumes were sufficient for payable logging. In the former type most of the beech canopy has remained intact because of the scattered nature of the rimu; much of the latter type has been converted to exotic forest. The hill country stands (primarily podocarp-beech) constitute the greater part of the remaining virgin forest.

Very little logging has occurred in the pure beech forests, which remain intact, except on some river flats and hill country cleared for farming.

## FOREST CHARACTERISTICS OF BEECH

*Red Beech*

A dominant species, being a strong light demander. It regenerates under its own canopy but seedlings develop only where there is overhead light and little competition from other species. It prefers permanently moist soils, tolerating wet conditions, short of waterlogging. It is sensitive to exposure.

*Hard Beech*

Also a dominant species, but considered more shade-tolerant than red beech, with seedlings capable of developing under a light canopy. It generally thrives under a lower rainfall than does silver or red beech and is not as sensitive to exposure as the latter. Occurs commonly on infertile skeletal soils such as dry steep ridge crests and spurs, and occasionally on wet infertile terraces.

*Silver Beech*

Probably the most shade-tolerant of the beeches, being unable to compete with red and hard on warm sites and therefore generally constituting the understorey when associated with these. It requires a moist soil, tolerating waterlogged conditions if the water is not stagnant. In this region it is dominant on cold, wet aspects and on the wetter low terraces.

*Mountain Beech*

A hardy species capable of tolerating exposure and competing best in very dry or wet conditions. Not as shade-tolerant as silver beech, but in open conditions will outgrow it.

## MANAGEMENT POTENTIAL

Holloway (1965) considers the beech forests of the region to be "in the optimum area of the beech range"; in discussing the term optimum range he says: "... for each species of beech there is an optimum range for rate of growth, a separate range within which the species produces timber of the best and most desirable quality, a separate range within which the species will regenerate naturally in the most satisfactory manner and, linked with this, a range within which it survives best in competition with other timber or scrub species. For successful permanent yield management we require an optimum combination of all these desirable characteristics".

Of the various beech forest types already discussed, the extensive red-silver beech forests of the Maruia, upper Grey and associated valleys afford the best opportunity for practising beech management. Red beech is considered easier to regenerate than hard beech and these forests, situated on relatively easy, well-drained soils and producing timber with mild

properties, offer the best prospects for producing a merchantable crop within 80 to 120 years.

It has generally been accepted that, owing mainly to logging economics, the choice of a silvicultural system for managing beech forests is confined to one based on the removal of all or most of the merchantable crop, such as strip-felling or clearfelling, and allowing seed trees to remain. To date such systems have not been practicable because of the selective nature of saw log utilization, owing to the high incidence of internal decay which renders the majority of beech trees unsuitable for producing saw log material alone. Also associated with this are sawing, seasoning, and treating (heartwood) difficulties, which are common to all species but the first particularly to hard beech. These are the main reasons why extensive beech management based on a clearfelling system has not been possible to date.

The possibility of extensive beech management under such a system is less speculative now than ever before because of recent interest in these forests as a source of raw material for manufacturing pulp or paper.

Research into the numerous facets of beech management has been carried out for many years by Nelson and Westland Conservancy personnel of the Forest Service (at Reefton and Ahaura, respectively) and, in more recent times, by Forest Research Institute staff (mainly Rangiora-based). Because of the nature of past logging, most work has been in the form of small trials, initially restricted to cut-over lowland red beech forest in the Inangahua and Grey valleys but recently extending to the hill country forest containing hard beech.

Over the last few years, prospects of large-scale beech utilization to supply an integrated wood processing industry have rejuvenated research into the management of these forests following logging.

## BEECH SILVICULTURE

The starting point for any silvicultural system aimed at perpetuating the existing forest type is the replacement of this forest, either naturally or artificially, after its removal. Raising of beech seedlings artificially is likely to be relatively costly and natural regeneration is considered the best and most economical method of replacing the existing forest.

The recruitment of satisfactory regeneration depends on providing a suitable seedbed and an adequate seed source. Since Kirkland's (1961) finding that even-aged pole stands have developed mainly from advance growth present at the time of logging, regeneration trials have aimed at recruiting regeneration before logging, when the source of seed supply is greatest.

Since 1965, beech flowering (October-November) has been prolific on four occasions, each following hot, dry summers. Abundant collections of red and silver beech seed falls were recorded in each year except 1970, when inclement weather following flowering prevented seed set. Hard beech was not collected until 1971 when good falls of viable seed were re-

corded. These results confirm the existing theory that beech mast years are related to hot, dry summers and favourable weather following flowering. The history of beech seeding trials in the region indicates mast years occur every 2 to 5 years.

A number of prelogging scarification trials aimed at creating satisfactory soil conditions by disturbing the topsoil and removing ground vegetation have been carried out. These have included both manual and mechanical techniques, but costs permit only the latter, although more restricted by terrain, to be considered now.

In 1961 an area of red and hard beech forest in Granville Forest was scarified using a tractor blade but it generally failed because all the humus layer was removed, leaving a puggy A1 horizon exposed. In 1968 an attempt to scarify an area in Hochstetter Forest by use of crawler tractor tracks only proved disappointing because of near perfect traction and inability to manoeuvre the tractor sharply owing to worn track gear. In the same year more successful trials were established on well-drained soils in the Maruia Valley using a small crawler tractor fitted with a blade. Good results were obtained where the tractor was continually manoeuvred sharply with one locked track, moving fallen logs and pushing over the shrub tier. Patchy scarification resulted when the tractor avoided crushing groups of beech saplings and poles; this was rectified when only large groups were left uncrushed. Prelogging scarification more than doubled the area of disturbed ground present after logging for sawlogs, but where sawlogs and chipwood were removed there was little difference between scarified and unscarified blocks, although the latter had significantly more "lightly disturbed" ground and less "disturbed humus and mineral soil".

To regenerate areas of advance growth destroyed in logging, seed trees will be retained, their numbers being kept to a minimum because both root competition and shading inhibit the development of regeneration. In Southland where twelve medium-size trees were retained per hectare half as much sound seed fell in the centre of gaps as directly beneath the trees (Franklin, 1971). This is probably sufficient in mast years. The most desirable seed trees are canopy dominants with large, healthy crowns. Regardless of the clearfelling system used, unmerchantable pockets, riparian strips, and, to a lesser extent, reserves all constitute additional seed sources in regeneration areas.

Although abundant viable seed falls in mast years, only a small number appear to germinate, especially where the forest floor is not scarified. Early work in the Grey valley revealed that the number of newly germinated seedlings per hundred seeds falling was 2.8 for red beech and 1.7 for hard beech, but subsequent mortality in the following summer was 80% or more under natural conditions. Seedling survival was considerably higher where the forest floor had been scarified. In the more recent pre-logging scarification trials in the Maruia valley, an assessment 1 year after sawlog extraction showed scarified blocks contained approximately twice as

many seedlings as unscarified blocks. Seedling mortality in the following year was 17% for scarified blocks and 2% for non-scarified blocks. Three years after sawlog extraction both scarified and unscarified blocks in which the overwood had been removed the previous year showed an increase in stocking while a reduction occurred in blocks where the overwood remained.

In the early 1960s the modified Malayan line-sampling method and Kirkland's intercept methods were used by the Reefton Ranger School to assess the stocking of regeneration in cut-over beech forest in order to determine its adequacy for subsequent management but the results proved difficult to interpret because of a lack of stocking standards (Beveridge, 1965). No further investigations have been made.

With the likelihood of many of the previously "selectively" logged beech areas being relogged for chipwood, followed in some instances by conversion to exotic species, there is a need to delineate cut-overs not suitable for such treatment; here the best must be made of the existing second crop. Where this crop has developed unevenly because of the presence of an overwood, releasing by stem girdling may be necessary to obtain a uniform crop. At Larrys Creek in Inangahua East Forest, seedlings released by such a girdling grew three to four times the height of non-released ones, and released saplings made three to four times the diameter growth of those not released.

Once a successfully regenerated stand reaches the thicket stage, thinning is desirable in order to concentrate growth on a limited number of the better crop trees. The timing and intensity of thinnings are important, as tight stands produce well-formed trees with clear boles but small crowns and lacking stability to wind, whereas open grown stands produce vigorous, large-crowned, more wind-firm trees of poorer form. The main questions arising from this that current research is attempting to answer concern the effects of thinning at various ages and intensities on growth rates of individual trees, production per hectare, final crop tree form, wind stability and susceptibility to insect damage.

In 1965 a thinning trial was established in red beech thicket near Staircase Creek (Hukawai Forest). The area was logged

TABLE 1: EFFECTS OF VARIOUS THINNING INTENSITIES ON DIAMETER AND HEIGHT INCREMENT OF RED BEECH REGENERATION

<i>Thinning Intensity (stems per ha)</i>	<i>Av. dbh 1965 (cm)</i>	<i>Av. 5-yr dia. Increment</i>		<i>Av. 5-yr Height Increment</i>	
		<i>1970 (cm)</i>	<i>Av. Height 1965 (m)</i>	<i>1970 (m)</i>	
Control	5.3	3.5	6.5	2.9	
To 7,000/ha	5.5	5.1	7.4	3.5	
To 1,700/ha	5.4	5.1	7.0	3.2	
To 750/ha	5.1	5.4	7.0	2.9	

in 1952, regenerated between 1952-55, and thinned in 1965. Table 1 is a summary of the results from 1965 to 1970.

In the 750 stems per hectare treatment, considerable regeneration has occurred since 1965 and its removal may be necessary to avoid root competition.

A number of thinning studies have been carried out in older red beech pole stands but most have suffered volume losses from either windthrow or fungal attack introduced by *Platypus* pinhole borers, the effect generally being more serious the older the stand. The absence of both these in the thicket stands at Staircase Creek and the satisfactory growth rates recorded indicate that early thinning is necessary for developing vigorous wind-firm stands. Coarse branching may be a problem arising from thinning and attempts to remedy this by pruning have recently been implemented.

Prior to 1965 the beech buprestid *Nascioides enysi* was regarded as the most damaging insect in South Island beech forests. It was thought that *Nascioides* killed trees weakened by other causes, especially root damage. In 1965 the suggestion was put forward that *Platypus* pinhole borers might transmit a pathogenic fungus when they attack living trees, and that beech deaths previously attributed to *Nascioides* could in fact be caused by such a fungus. This view tends to be confirmed by current investigations on the mechanisms of beech deaths, though the presumed pathogen has not yet been identified nor its pathogenicity unequivocally demonstrated. Such damage in virgin forest adjacent to logged areas appears most likely to be minimal where a clearfelling system with thorough utilization is followed; in regenerated stands, early (thicket stage) thinning is recommended.

The effect of internal defect on beech utilization has already been mentioned. Numerous rots have been identified, but it is not known yet why they occur. Studies in Westland showed that about one in nine dead branch stubs led to heart rot and it was thought that such rots result from damaged branches. Pruning trials have been established as a result of these findings. It has recently been suggested that the wood invaded by rot fungi may be false heartwood ("affected wood" of Hillis, 1968) produced in response to earlier *Platypus* attack.

While further research is necessary into many aspects of beech management, especially those relating to hard beech, present knowledge of logging economics, silvicultural constraints, and sound forest hygiene indicate that future large-scale beech management will be based on a clearfelling system, will rely on seed trees for regeneration after logging, and will involve thinning of regeneration at the thicket stage.

### UTILIZATION PROPOSALS

A large beech resource in the northern part of the west coast has been known to exist since the completion of the national forest survey (Masters *et al.*, 1957) in the early 1950s. This survey delineated numerous forest types, classifying them as non-merchantable or merchantable. Volume assessment was limited to the sawlog content of the latter and this

excluded much of the beech resource because a high incidence of defect made it unsuitable for sawlogs.

Because of the possibility of utilizing beech for the manufacture of pulp or paper as well as for sawlogs, a reassessment of the region's merchantable forests began in 1969 to determine the total wood resource. The results of this indicate a resource in excess of 28 million m<sup>3</sup>, sufficient for supplying a large integrated wood-processing industry for approximately 30 years. Production beyond this period will necessitate conversion of some 2,024 ha annually to fast-growing exotic species from the commencement of utilization. This will be restricted mainly to the podocarp-beech and podocarp-hardwood forests occupying the free-draining, dissected hill country in the Inangahua and lower Grey valleys. Most remaining areas of beech-podocarp forest will be regenerated in beech, with eucalypt enrichment where necessary. Pure beech forest will be perpetuated as such. A broad breakdown of the proposed management following utilization is given in Table 2.

TABLE 2: PROPOSED MANAGEMENT FOR NORTHERN WEST COAST BEECH UTILIZATION AREAS ('000 ha)

<i>Sub-region</i>	<i>Exotic Conversion</i>	<i>Beech Management with Supplementary Species</i>		<i>Podocarp Management</i>	<i>Beech Management</i>
Charleston	6	10	2	—	—
North Buller	3	14	—	—	—
Inangahua-Grey valleys	68	47	6	12	—
Maruia-Matakitaki and upper Grey valleys	—	—	—	—	27
Total	77	71	8	39	—

Beech management is proposed for practically all the pure beech forest areas available for utilization — *i.e.*, the Maruia, Matakitaki, and upper Grey valleys and small areas in the Inangahua and lower Grey catchments. Beech management in the former group of forests is desirable not only silviculturally but also aesthetically, as in many instances they provide the scenic backdrop to some of the region's major tourist routes.

Whether beech management in these forests requires economic justification alone is questionable. Many would maintain that, if utilization is necessary, then retention as indigenous forests is sufficient justification for such management. However, there is little doubt that economic justification would be enhanced if such management aims at producing timber suitable for special purposes where the value of the products is more likely to justify the costs incurred by this management.



## ACKNOWLEDGEMENTS

The writer wishes to thank P. W. Maplesden, D. A. Franklin, R. H. Milligan, R. E. J. Wylie, and E. E. Ensor of the N.Z. Forest Service for their constructive comments.

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