

PROSPECTS FOR INTENSIVE MANAGEMENT OF WEST COAST BEECH FOREST

C. D. GLEASON*

ABSTRACT

Some 140 000 ha of production beech forest occurs in State forest of the northern West Coast but its productive potential is severely limited by the absence of an outlet for low quality industrial wood. Intensive management of beech forest, best applied to areas dominated by red and silver beech, the present commercial sawlog species, has not been practised to any significant extent. By introducing heavy thinning at an early age sawlog rotations of 60 to 80 years and recoverable sawlog volumes of 200 to 300 m³/ha should be achieved. Beech management presents an opportunity for sustained yield of a versatile good quality hardwood timber and/or raw wood material.

INTRODUCTION — THE RESOURCE

Pure beech forests or mixed forests of beech and podocarp species, principally rimu, are extensive in New Zealand, especially in the South Island where they constitute some 80% of the indigenous forest area (Thomson *et al.*, 1972). Only a portion of this gross area is suitable for wood production, the bulk of the forests being set aside for protective management for soil and water conservation, or as ecological reserves. Nevertheless, a considerable area of beech forest suitable for production remains, particularly in the northern West Coast of the South Island, where there is estimated to be a resource area of at least 140 000 ha. This potential beech resource is much reduced from that on which earlier beech utilisation proposals were based (N.Z. Forest Service, 1971), owing to subsequent reservation of ecological areas and withdrawals of forest from production zoning for reasons of amenity, recreation, and marginal accessibility.

PAST MANAGEMENT

Historically most beech forests have been logged for their podocarp content, with sporadic removal of beech sawlogs, principally red and silver beech, but occasionally hard beech. The situation has only recently improved from that described

*N.Z. Forest Service, Reefton, Westland.

nearly thirty years ago: "In many of the forests, rimu is still the draw-card, and the milling of beech but incidental" (Conway, 1952). Beech regrowth stands develop readily after such logging but they are fragmented, densities are usually very high and the residual overwood of poor quality trees damages regeneration as it dies or is windblown. Pinhole borers maintain their populations in such uneven-aged cutover forest and eventually establish themselves in the regrowth stand where they contribute to timber degrade. Although natural competition thins out regrowth dramatically in the first 20 to 40 years, dense pole stands normally develop which often ultimately deteriorate by catastrophic mortality and windthrow. Stand growth after such logging is good amongst the regenerated component but gross stand increment is reduced by the attrition of veteran trees and self-thinning mortality. Sawlog quality stems are slow to develop and there is no real improvement in quantity or quality of sawlogs compared with the original forest.

Although a market for industrial quality beech or other wood is not present locally, intensive management of some West Coast beech forests is possible, and has been implemented in recently cutover stands worked for their podocarp and beech sawlog component. These cutover forests can be readily moulded into relatively even-aged stands comparable to plantations by applying simple tending practices.

Failure to systematically utilise red and silver beech for sawn timber stems not from the poor wood properties of the species but from the traditional structure of the sawmilling industry and the high incidence of defect in mature trees within virgin forest. With no positive programme to promote the utilisation and marketing of the beeches, particularly from green sawn timber to end-users, and to overcome minor technical problems, it was natural that sawmilling should concentrate on "easier" softwoods such as rimu and radiata pine. Beeches are special-purpose quality hardwoods with excellent "factory" properties but they are not general-purpose building timbers. With sporadic exceptions, principally in Southland, the New Zealand timber industry has been largely unsuccessful in appropriately processing or marketing beech timber. This in turn has discouraged any sustained efforts in beech silviculture and management.

By the end of the 1960s a range of options were open for management of the West Coast beech forests then considered to be available for production, following extraction of the podocarp sawlog content. These were:

- (1) Create uniform stands of beech by deliberate regeneration systems and subsequently apply intensive silviculture to produce quality sawlogs.
- (2) As above, but confine intensive silviculture to red and silver beech stands, leaving hard and mountain beech to be managed as uniform stands for predominantly industrial use or left unused.
- (3) Manage all species as uniform stands for predominantly industrial use.
- (4) Leave cutover areas to their own devices.
- (5) Convert the forests to farmland and exotic plantations.

Despite efforts at various times in localised areas the last two options have generally prevailed. The consequences of option (4) are described above; the effects of (5) are obvious.

Concern at the lack of positive management and the magnitude of wood waste incurred by this traditional exploitation of beech forests stimulated the 1971 Forest Service utilisation proposals (N.Z. Forest Service, 1971). These proposals were not successful in attracting a major industrial wood plant compatible with the available resource and able to operate profitably without significant and unacceptable environmental change.

While the conflicting claims, wild speculation, and emotional pleas which characterised the debate on the 1971 "beech scheme" proposals were unfortunate enough in themselves, they have obscured the basic rationale for the proposals. The components of this rationale remain unchallenged. They are:

- (1) The productive utilisation of massive wood waste in forest being logged for sawlogs only, and that associated with establishment of plantations of exotics, and land clearing generally.
- (2) The improved opportunity for beech sawmilling as an industry, provided by sustained supply and full log recovery.
- (3) The introduction of positive, continuous management to all areas of production beech forest in place of an essentially exploitive style of management.

SILVICULTURE AND UTILISATION

The management potential for wood production of New Zealand beech (*Nothofagus* spp.) has been recognised from an early period (Cockayne, 1926, 1928).

Aggressive regeneration and vigorous growth of the beech species are the basis for the longstanding interest in production beech forestry. The propensity of all the beech species to internal rots and pinhole damage has confounded many of the earlier attempts to manage beech. For this reason good examples of successful beech silviculture are confined principally to recent times when the significance of these factors has been recognised and appropriate counter-measures adopted.

Recent comprehensive research has examined silvicultural systems, artificial re-establishment, pathology, thinning and pruning, and development of regrowth stands. In western Southland, where silver beech forests have been managed since 1950, considerable knowledge has accumulated. On the West Coast the better understood beech forests are those of the Buller, Inangahua and Grey Valley regions where man's disturbance stretches back over a century. In broad terms the most pertinent silvicultural characteristics of the beeches in the northern West Coast forests are:

- (1) They normally seed at fairly regular intervals and at an early age. Fluctuating levels of seedling/sapling advance growth occur beneath most stands. Regeneration of forests can be achieved under a wide range of natural regeneration systems from both advance growth survival and post-logging seedling recruitment.
- (2) In virgin forest tree increments are small and subcanopy trees are heavily suppressed. Fast growth of younger trees is achieved only in full sunlight; for red and silver beech annual height growth of 0.5 to 0.7 m is normal. In regenerated stands high densities restrict diameter growth in individual trees (2 to 6 mm/yr) but do result in small knotty cores. At wide spacings large spreading crowns develop; under such "free-growing" conditions sustained diameter growth of red and silver beech has been measured at more than 15 mm/yr.
- (3) A comprehensive survey in the early 1970s showed that virgin forest contains merchantable volumes which commonly range from 330 to 800 m³/ha, depending on site quality and stocking. In all types of forest beech sawlog volumes are generally a small proportion of total volumes (10-30%) because of unsatisfactory form and the very high incidence of internal decay.
- (4) The variety of internal rots to which beech species are susceptible severely reduces the merchantability of trees and

the utility of beech wood, and their extent is difficult to predict or assess in the standing tree. Physical wounding leads to fungal infection, though stem rots require considerable time to develop and are rarely extensive in trees less than 80 to 90 years old. Pinhole borers (*Platypus* spp.) will attack and degrade trees at pole size and larger, and their attack is associated with the formation of easily-decayed pathological wood. Natural mortality or man-made harvesting and thinning slash may stimulate attack on adjacent living trees and such host material permits pinhole to become established within the stand (Milligan, 1972, 1974, 1979; Litchwark, 1978).

- (5) Trees whose boles are weakened by rot and trees having high height/diameter ratios are very susceptible to windthrow. Beech is characteristically shallow-rooted and serious windthrow may accompany thinning when tree heights exceed 20 m.

Volume growth in untended and tended stands of red/silver beech forest has been examined over a number of sites (Franklin, 1965; Evans and Jackson, 1972; unpublished data of the writer's). Site quality varies considerably within red/silver beech types but salient features pertinent to prescribed intensive management of these two species are:

- (a) Basal growth is very rapid in even-aged stands, reaching 40 to 50 m²/ha by age 50-60 and occasionally exceeding 55 m²/ha.
- (b) Thinning to final crop spacings of 150 to 300 stems/ha reduces basal area to 2.0 to 4.0 m²/ha. Subsequent increment is affected by site quality (0.6 to 1.2 m²/ha/yr) but response to thinning is rapid and within 40 to 60 years near static basal area levels should be reached. Sustained diameter increments of 0.8 to 1.2 cm/yr have been achieved after heavy thinning. With rotations of 60 to 80 years and wide spacing regimes, tree sizes at harvest are likely to range between 45 and 75 cm d.b.h.
- (c) Total stem volume increases substantially after basal area stabilises; a MAI of 8 to 9 m³/ha can be expected on most sites for rotations up to 80 to 90 years yielding merchantable volumes of 500 to 700 m³/ha.

Utilisation properties of the beech species are diverse but they share special-purpose qualities in fine, even texture and good strength, turning, bending, finishing and machining properties.

As outlined previously, from the traditional sawmilling point of view beeches are the poor relation of podocarps though their utilisation has been researched and the utility of the beech timbers has been recognised and documented (Reid, 1953; Hinds and Reid, 1957; Foley, 1975; N.Z. Forest Service, 1974, 1977; Purey-Cust, 1979), and confirmed by past and present end-users.

Judging by basic wood properties and practical sawmilling/seasoning constraints, red and silver beech are undoubtedly good quality hardwood species; hard beech is marginally suitable for sawn timber and is principally of industrial quality, while mountain beech is best regarded as industrial wood. All the beeches have been utilised for pulpwood via short-term export chip sales from Nelson. They have the potential to be made into kraft pulps of good quality and in reasonable yield (Uprichard, 1976) as well as alternative pulps and/or hydrolysis products (N.Z. Forest Service, 1977).

Specific research projects in beech silviculture and management trials have concentrated on red and silver beech. Intensive management of these two species seeks to integrate their silvicultural and utilisation properties. Intensive management for maximum quality sawlog production is best achieved in a regime that:

- (1) Minimises the production of building grade timber by focusing growth on a large butt log with a small defect core.
- (2) Avoids early development of dense regeneration during the re-establishment phase.
- (3) Minimises variation of tree age and size within the stand and excludes out-of-phase veterans.
- (4) Completes tending before trees are susceptible to pinhole attack or confines attack to the low quality knotty core.
- (5) Identifies final crop stems as early as practicable and gives them virtually free-growing conditions.

Translating these features into prescriptions for red and silver beech forest in Buller, Maruia, Inangahua and Grey Valley forests gives:

Year 0: Extract with minimum disturbance the maximum amount of beech sawlogs and, if markets permit, associated chipwood material, retaining a light-medium "shelterwood" (20-30% of the basal area of the stand) comprising primarily low quality material and unmerchantable advance growth.

Year 1-5: Regeneration period to secure recruitment of areas disturbed by logging. Once satisfactory stocking is achieved, release young seedlings and saplings from overwood by girdling and occasional felling to promote a uniform stand. Relogging for incidental sawlogs and residual industrial wood is desirable where logging constraints permit. Supplementary planting with beech stock may be carried out where significant stocking gaps occur.

Year 10-13: Thin to waste thicket regeneration to 1000 to 1500 stems/ha at 4 to 6 m crop height (optional).

Year 20-30: Thin to waste to final crop stocking of 150 to 300 stems/ha, at crop height 12 to 18 m. Pruning to a height of 5 or 6 m a year or two prior to thinning is necessary if clean butt logs are to be produced.

Year 60+: Crop harvest.

Early thinning of thickets is not essential but greatly stimulates diameter growth and the formation of a uniform stable stand that is readily treated later. Where regeneration densities are low (below 7500 stems/ha) good results can be achieved with a single thinning to final crop spacing. A similar approach is applicable to hard and mountain beech types and forest of variable composition containing podocarps and combinations of all four species. Any thinning, preferably to final crop densities no greater than 600 stems/ha, minimises natural mortality and by increasing average tree size promotes eventual volume recovery. However, intensive management with multiple thinning or pruning is only recommended in forest where red and silver beech are dominant.

All beech types, excepting those on infertile poorly drained soils, can have low numbers of compatible exotics, notably *Eucalyptus* species, planted into the stands after conventional sawlog extraction (Franklin, 1972). Residual overwood inhibits growth of the planted seedlings and the high pinhole populations in such untended cutover degrade the timber quality of the trees that develop. The concept of low-cost "enrichment" has not been as successful as originally hoped; however, given full forest utilisation, it would have great potential with low grade material being harvested and future tending implemented.

Wood production from tended stands of well-spaced trees can be divided into relatively defect-free butt logs and toplogs containing many large branches. Assuming that no sawlog market exists for this latter material (logs of essentially industrial quality),

yield from butt logs only is estimated to be 200 to 300 m³/ha in a rotation of 60 to 80 years with 100 to 200 m³/ha of low grade top log material. Good pruning practice could increase sawlog yield if butt log lengths were raised beyond 5 to 6 m. In either case sawlog yield is substantially greater than that for natural old-growth stands.

Volume production from stands containing several beech species is comparable to that of red/silver beech forest for some sites. For the most part, however, mixed beech types, especially hard/mountain beech stands, occupy inherently less productive sites and lower volume increments are encountered. With rudimentary tending merchantable volumes of 300 to 400 m³/ha can be reached on rotations of 50 to 60 years for mixed types excluding mountain beech-dominant stands. Greater volumes up to 600 m³/ha are possible with longer rotations. The impact of exotic species, particularly supplementary planting of eucalypts, is difficult to predict accurately. The light crowns of the species employed do not suppress regeneration and growth of adjacent beech, and improved volume production can be expected in at least the short term from the fast-growing eucalypts.

Regrowth red beech aged 40 to 85 years that simulate crop trees from tended stands have been examined in recent sawing trials. As in earlier trials (D. A. Franklin, pers. comm.) sawing itself was accomplished easily. Many trees had experienced pinhole attack and contained some degree of internal decay arising from the death of large branches and poor occlusion. However, being largely confined to the central defect core, these factors did not preclude good grade out-turn. Overall recovery of 70-85% factory and dressing grades (Standards Association of N.Z., N.Z. Standard 3631) was achieved from butt logs. It should be noted that in the beeches (and podocarps) dressing grade approaches a clear grade; green knots are not permitted to any extent.

Regrowth red beech boards were dried in two stages to a low moisture content suitable for quality end-use (12-15%). The younger age of the heartwood appeared to permit more rapid drying than in old-growth material. Air drying to 30% m.c. took 12 weeks during spring, and forced air drying to 30% m.c. took five weeks; final kiln drying was accomplished successfully with and without reconditioning. Fast-grown red beech timber, both sapwood and heartwood, displays a much more featured grain than slow-grown old-growth material. The wood reveals more of an ash figure and could be used to visual advantage in

timber-veneer products. Small diameter regrowth silver beech pose no problems to conventional sawn timber utilisation. Such material is already harvested and sawn in the course of current operations and is undifferentiated from old-growth timber. In terms of stand merchantable volume, timber recovery and seasoning, tended sawlogs are expected to be an improvement over sawlogs from virgin old-growth forests.

THE FUTURE

The options for production beech forest management have not altered greatly from the five listed earlier. The silvicultural constraints and tending strategies for those options are better understood now, and the spirit or intention of Forest Service management is clear in the Draft North Westland Regional Management Plan (N.Z. Forest Service, 1980). The Management Plan gives effect to the stated intention to manage beech forests positively (West Coast Forest Policy, N.Z. Forest Service, 1978). With no certain outlet for low-grade industrial wood, proposed beech management will concentrate on red and silver beech forest for production of quality sawlogs. Unfortunately this does nothing towards utilising the massive amounts of waste from current operations (*ca.* 100 000 m³ usable wood per annum), improving the viability of beech sawmilling, or placing the production beech forests on a sound sustained yield foundation. Failure to fully utilise beech forests when they are logged undervalues the forests in the eyes of many and strong pressure will continue to be exerted for their conversion to either exotic plantation or farmland. Farm development is steadily reducing the extent of the most valuable and productive red/silver beech types on Crown Land tenures.

Acquiring an outlet for low quality material would completely alter the potential for beech forest management. It would also generate sufficient additional podocarp sawlogs (by making available logs from beech podocarp forests whose podocarp volumes are too low to permit logging for that component alone), to ease the tight resource allocation to the existing sawmilling industry. Because the pattern of zoning, including reservation, has been determined by the North Westland Management Plan, the extent of production forest would remain the same. However, fuller utilisation facilities would permit the development of a significant industry based on a sustained yield of beech. Broadly, two major working circles are possible:

- (1) A quality sawlog working circle based on intensive management of red/silver beech forest in the Grey-Inangahua-Buller-Marua regions, an area of approximately 30 000 ha.
- (2) A general beech working circle based on mixed beech species with minor yield of podocarps on a periodic basis, an area of approximately 110 000 ha.

Using conservative increment and recovery figures for quality sawlog regimes and regimes aimed at industrial wood production, the maximum sustainable yield for both working circles is estimated to be 100 000 m³ per annum of red and silver beech sawlogs, 100 000 m³ per annum of associated low grade material, and 700 000 m³ per annum of industrial wood. This potential sustained yield cannot be harvested at once because only a small area of regenerated forest has received appropriate tending and much of the beech resource area carries an existing poor quality over-mature growing stock. However, industries using low-grade material could be sustained in the short term and medium term up to 400 000 m³ per annum by drawing from the total production area.

Yield from the beech working circles could be supplemented by low-grade arisings from plantations of radiata pine that reach maturity in significant quantity from 1990. Planting of compatible hardwoods, particularly eucalypts, could augment the gross beech yield from supplementary planting and plantation sources. Although New Zealand experience indicates high quality timber of the ash-group eucalypts can be produced, utilisation is most likely where a market exists for low-grade material. Utilisation properties link the beech species and eucalypts; both require careful sawing and seasoning and selective marketing of the higher grade out-turn for special-purpose end-use.

Cost-benefit analyses and the economics of beech management are difficult to assess with no significant background of operational costs. Labour inputs in man-hours per hectare for the direct silvicultural operations prescribed are estimated to be: releasing regeneration 3-7, supplementary planting 4-7, sapling and one-hit thinning 35-100, small pole thinning 20-40, pruning 10-25. Thinning represents the first substantial investment in the regrowth stand and it bears interest for some 30 to 50 years. As an investment of labour and resources, beech silviculture compares favourably with requirements for establishing and tending alternative special-purpose hardwood species such as *Eucalyptus saligna*, *E. regnans*, *E. obliqua*, and Tasmanian blackwood. Just

as importantly, beech management is a productive land use maintaining indigenous forest over land already held as State forest.

CONCLUSION

Northern West Coast beech forests have the potential to generate a substantial sustained yield of wood material. The forests can be managed on a cutting cycle as short as 60 to 80 years and still produce high quality timber naturally suited to special-purpose end-uses. Lower grade wood could be drawn from the forests if an outlet existed for such material. Such an industry could be sustained at an increasing level of supply. In the short term this would permit great improvements to regional forest management through utilisation of the massive waste in current logging/land clearing operations, greater saw-milling efficiency, improved sawlog supply, positive programmes of post-logging silviculture, and generally increased industry activity. In the longer term, users of low-grade material could harvest a sustained yield of hardwood material large enough to assume national significance.

REFERENCES

- Cockayne, L., 1926. *Monograph on the New Zealand Beech Forests. Part I.* Government Printer, Wellington.
- 1928. *Monograph on the New Zealand Beech Forests. Part II.* Government Printer, Wellington.
- Conway, M. J., 1952. The silviculture of red beech in Nelson and Westland. *N.Z. Jl For.*, 6(4).
- Evans, D. J.; Jackson, R. J., 1972. Red beech management: Implications from early growth plots. *N.Z. Jl For.*, 17(2).
- Foley, T. A., 1975. Utility of indigenous wood. *N.Z. Jl For.*, 20(1).
- Franklin, D. A., 1965. Growth rates of even-aged beech stands. *FRI Symposium No. 4, Beech Forestry.*
- 1972. Enrichment of logged West Coast beech forests with eucalypts. *N.Z. Jl For.*, 17(2).
- Franklin, D. A.; Beveridge, A. E., 1975. Forest management and research in indigenous production forests. *N.Z. Jl For.*, 20(1).
- Hinds, H. V.; Reid, J. S., 1957. *Forest Trees and Timber of New Zealand.* Government Printer, Wellington.
- Kirkland, A., 1975. Management, classification and zoning of New Zealand indigenous forests. *N.Z. Jl For.*, 20(1).
- Litchwark, H. S., 1978. Insect and fungal defects in red and silver beech. *N.Z. Jl For.*, 8(2).
- Milligan, R. H., 1972. A review of beech forest pathology.
- 1974. Insects damaging beech (*Nothofagus*) forests. *Proc. N.Z. Ecol. Soc.*, 21.

- 1979. The native pinhole borers. *Forest and Timber Insects of N.Z. No. 37*. Government Printer, Wellington.
- N.Z. Forest Service, 1971. *Utilisation of South Island Beech Forests*. Parliamentary Paper C4.
- 1974. *Timber Properties and Uses of the New Zealand Beeches*.
- 1977. Seminar held at Hokitika on future of West Coast forests and forest industries.
- 1978. *West Coast Forest Policy 1978*.
- 1980. *Draft North Westland Regional Management Plan*.
- Purey-Cust, J. R., 1979. Workshop on special purpose species. *N.Z. Jl For.*, 24(2).
- Reid, J. S., 1953. Beech Timbers. *N.Z. For. Serv. Inf. Ser. No. 17*.
- Thomson, A. P.; Kirkland, A.; Miers, K. H., 1972. Planning for multi-use management of New Zealand's beech (*Nothofagus* spp.) forests. *N.Z. Jl For.*, 17(2).
- Uprichard, J. M., 1976. Pulping of New Zealand beeches (*Nothofagus* spp.) and associated forest species. *N.Z. Jl For.*, 21(1).