Radiata pine

The future wood

How foresters can manage radiata pine to produce wood for high-value end uses

In past annual reports we have explained the role of plantation-grown radiata pine (also known as Pinus radiata or Monterey pine) in the world's markets for industrial lumber. We have pointed out that:

- New Zealand is a world leader in commercial plantation forestry research and technology;
- There is a looming gap between the demand and supply of industrial lumber worldwide; and
- New Zealand's intensively-managed radiata plantations are highly productive and can be very profitable long-term.

This year we look at the potential for radiata in high-value end uses; and how New Zealand foresters manage their plantations for optimum wood quality and profitability.

Forecast world timber supply

Industrial roundwood by region – in millions of cubic metres

Region	1996	2010	2020
Oceania (NZ, Australia)	41.5	57.5	74.0
South America	129.5	158.0	190.0
North and central America	600.1	502.7	539.1
Europe and Baltics	281.9	330.1	354.9
Asia	252.0	217.0	228.0
Africa	67.1	66.0	70.0
Russia	67.0	130.0	160.0
Total supply	1,439.1	1,461.3	1,616.0
Forecast demand		**1,801.0**	**2,100.0**
Forecast shortfall		**339.7**	**484.0**

Source: Apsey and Reed, Canada, 1998.

Terminology. The term "clearwood" is used often in these pages. It is a term commonly used in the forest industry worldwide. It means wood that is free of defects such as knots, holes or other blemishes. Forest sites are managed under a "clearwood" or pruning regime to yield knot-free lumber from the first log.

A market niche for **appearance**

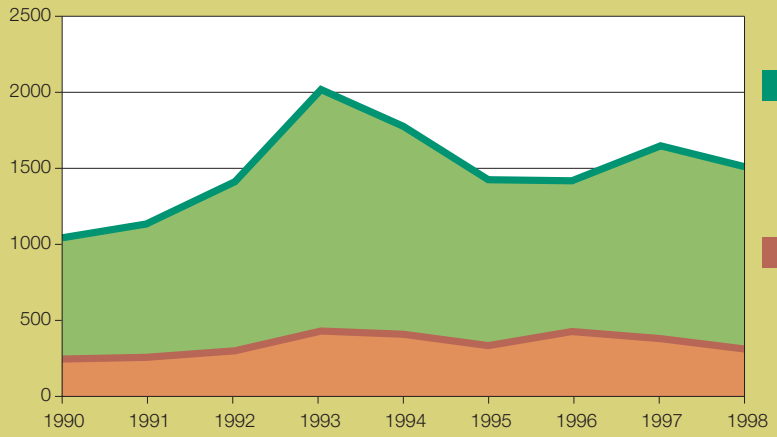
As worldwide efforts intensify to reduce or halt unsustainable logging in the old-growth forests of Eastern Europe, tropical Asia, North America, Africa and the Amazon Basin the supply of large, high quality logs will decline. Community demands in the 1990s for larger areas of forests to be reserved have seen the allowable harvest decline markedly in parts of the United States and Canada. More recently India and China have restricted the harvest of their natural forests as a result of concerns about the environmental consequences of forest depletion.

As a result of these declining traditional resources, an international market for radiata pine is emerging with customers who demand the "look and feel" of real wood. They want wood that is defect-free for end uses in which appearance and superior finishing qualities are coveted. Radiata is ideal for this significant high value market. A number of New Zealand companies are already selling lumber to manufacturers of solid wood doors and windows in the United States. Others are selling finished products, such as solid mouldings. Clear lumber and edge glued panels are also sold to Australian and Asian furniture markets.

PINEWOOD PICTURES

The price differential between appearance grade and structural grade timber

In $US per thousand board foot by calendar year



***Appearance grade** is based on Ponderosa pine 5/4 random width, appearance grade moulding and better.*

***Structural grade** is based on Douglas fir – 2x4, green, random length structural grade.*

Source: DANA Research.

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high value grade wood

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The versatility of Radiata pine

Radiata pine has all the quality attributes needed to penetrate the high value appearance grade market (see over page) but it also has the versatility for a large number of structural and functional end uses, including:

- **Structural lumber – studs, joists, trusses;**
- **Engineered lumber – laminated beams and laminated veneer lumber;**
- **Poles, piles and fence posts;**
- **Railroad ties;**
- **Landscaping products – retaining walls, edgings, garden structures; and**
- **Structural plywoods.**

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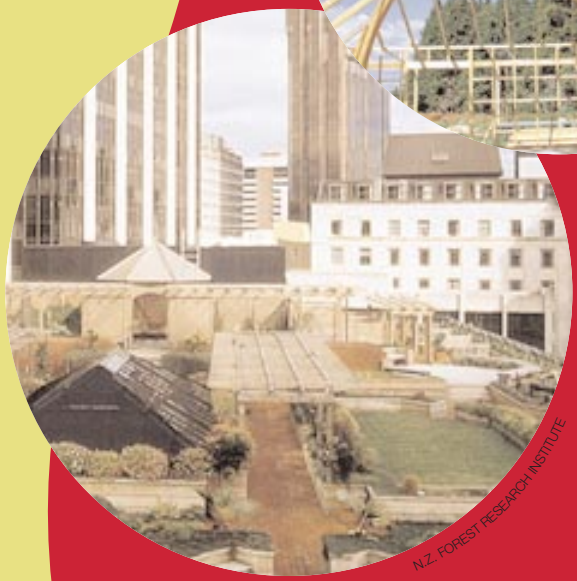

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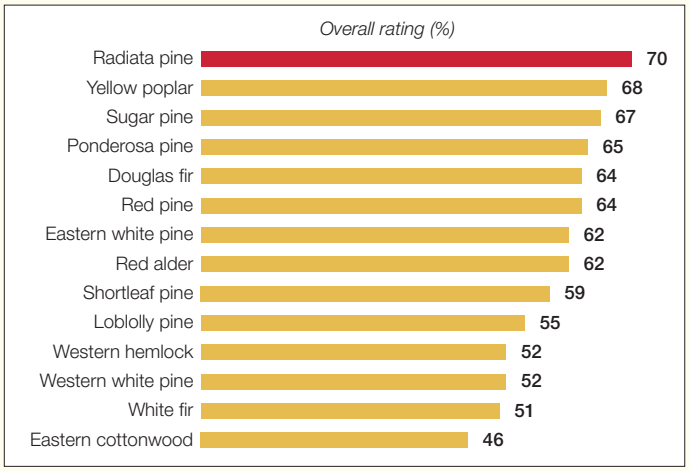
A valuable secondary income source

Residues of wood chips, shavings and sawdust from the production of solidwood products provide a high quality feedstock for pulp and paper and a variety of products such as medium density fibre board and fibre cement products.

Radiata pine compares
major international

In a major study at the University of California, Berkeley, in 1995, radiata was compared with Douglas fir and other major North American timber species *(see summary below)*. The study compared the suitability of each timber for planing, shaping, turning, cutting, boring, and sanding; and for qualities such as finger-jointing, glueing, hardness, nail withdrawal, nail splitting, screw splitting and stability. The radiata used in the study was 33 years old with multiple thinning to maintain growth and was pruned to allow the formation of clearwood. The typical age of harvest for radiata in New Zealand is 27 to 28 years. However, this lower age is not considered to have a significant impact on the machining and finishing properties assessed in this study.

Comparison of machining and related mechanical properties



Source: New Zealand Forest Research Institute.

The overall rating percentage is a combination of Grade and a Weighting. Grade is based on the percentage of acceptable samples. Weighting is the perceived importance of each characteristic tested.

. . . and against Asian species

In a similar study in 1998 by New Zealand's Forest Research Institute, radiata scored well against six Asian timber species, which included five hardwoods. The study concluded that the differences between species were so small that radiata could be considered a replacement for them all.

Radiata pine has strengths as a structural timber

There is a common misconception that fast-growing radiata is soft and lacks strength. The reality is quite different. Radiata has the density and strength to meet the building design specifications of Australia and New Zealand and over the last 30 years it has all but totally replaced timber from local indigenous forests for structural purposes. New Zealand marketing initiatives have led to radiata being used in traditional Japanese houses, which use three times as much lumber as the average New Zealand house. Similar initiatives are likely to lead to the inclusion of radiata in the building design specifications of other Asian countries. In the table *(right)*, radiata's strength properties are compared with four internationally-used structural lumber species.

Radiata, especially from medium and high density plantations, compares well.

Fibre density testing.

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favourably with timber species

Radiata has very good ultimate strength.

Radiata is comparable with the other species.

Comparison of strength properties

	Basic density (kg/m^3)	Modulus: Rupture (kg/cm^2)	Compression strength (kg/cm^2)	Modulus: Elasticity (kg/cm^2)
Radiata *(low density sites)*	0.430	870	380	101,000
Radiata *(medium density sites)*	0.460	930	400	108,000
Radiata pine *(high density sites)*	0.500	1000	440	117,000
Englemann spruce	0.350	650	310	91,000
Siberian larch	0.480	950	500	128,000
Douglas fir *(coast)*	0.480	870	520	137,000
Douglas fir *(interior north)*	0.480	920	490	125,000
Douglas fir *(interior south)*	0.460	840	440	105,000
Lauan	–	800	410	114,000

Source: New Zealand Forest Research Institute.

***Basic density** is the ratio of oven-dry weight of wood to the saturated volume in kg/m3. The higher the basic density, the more wood fibre for a given volume. **Modulus: rupture** is a measure of ultimate strength – the amount of pressure that can be applied before the wood ruptures. The higher the pressure, the stronger the wood. **Compression strength** is measured by applying pressure on the ends of the timber parallel to its length. This characteristic is important when timber is used for trusses or structural supports such as posts or studs. **Modulus: elasticity** is a measure of stiffness – the extent to which the wood will bend before breaking.*

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Strength testing.

Radiata has less stiffness and will flex more under a given load. Mechanical grading for stiffness can identify wood that meets individual market specifications. Lower elasticity can be overcome in laminated veneer lumber by selective combination of veneers with different elasticity properties.

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Hardness testing.

The table above also shows the variations in strength that arise from different growing regions for radiata in New Zealand and Douglas fir in North America. Over the page we explain how New Zealand foresters manage radiata plantations to produce wood that meets the needs of specific markets and delivers maximum investment returns.

Managing the tree for **quality and**

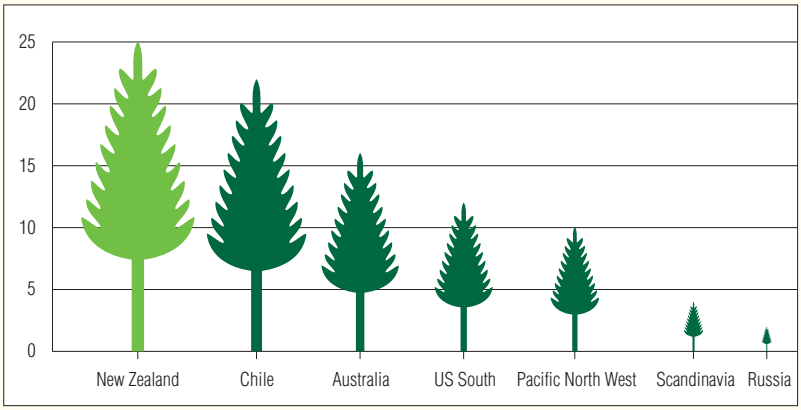
Why radiata pine?

Since being introduced to New Zealand from its native coastal California nearly 140 years ago, radiata has proven economically superior to more than 400 other tree species studied by New Zealand foresters and scientists. The main reasons for this are that radiata plantations in New Zealand:

- Deliver more wood per hectare than other species grown for solid wood end uses elsewhere in the world *(see graph)*;
- Can be managed to produce wood to meet a wide range of market needs and specifications.

Average forest growth rates (solidwood end-use markets)

In cubic metres (m^3) per hectare per year



Source: Dr W. R. J. Sutton and DA Neilson and Associates.

Plantation management for optimum results

With 140 years of experience in plantation forestry, New Zealand foresters and scientists have a solid understanding of the effect that the growing site and alternative plantation management regimes have on the wood's characteristics and its suitability for different end uses.

How wood quality can be influenced

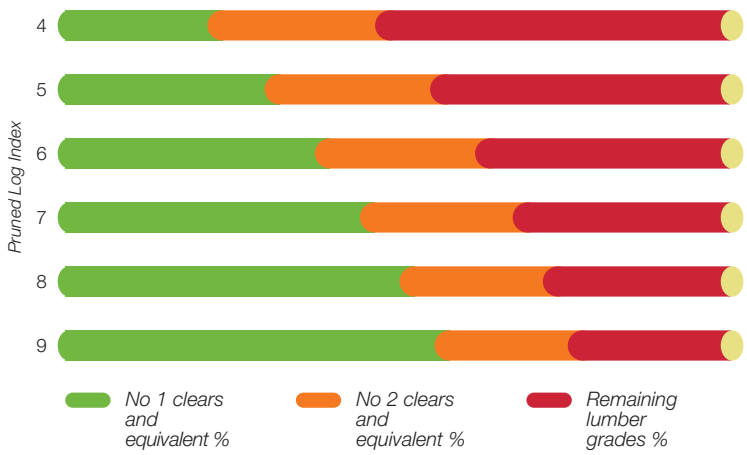
	Through plantation management	*Through the growing site*	
New Zealand's forest industry is a world leader in using state-of-the-art biotechnologies to breed improved strains of radiata.	**Genetic quality**	**Soil fertility**	Inherent deficiencies of micro or macro nutrients can be supplemented to provide optimum growing conditions.
This involves selection of the best trees for a final crop at a rate that delivers the optimum tree size and wood volume per hectare.	**Initial and final tree stocking rate**	**Latitude and mean temperature**	These influence the basic density of the wood, an important strength parameter in structural end uses.
The timing of tree thinnings and the pruning regime each affect, in different ways, the volume of wood produced, the presence and size of knots and the quantity of clearwood.	**Timing of thinning** *(selecting the best trees and reducing the number growing per hectare)*	**Rainfall**	Rainfall must be sufficient to allow optimum growth without prolonged drought stress.
Pruning is a significant cost. Its objective is to produce knot free wood for high value appearance grade products.	**Pruning** *(progressive removal of lower branches – see next page)*	**Altitude and wind exposure**	High altitude and exposure to wind can cause poor growth and wood quality. But higher stocking rates can reduce the impact.
The average harvest age is 26 to 28 years. A later harvest will normally provide a higher proportion of higher quality wood, particularly if the trees have been pruned and thinned. The forest owner's decision on harvest age will usually depend on market prices.	**Harvest age**		

optimum return

Pruning for clear wood

Evergreen manages its plantations for maximum investment return on each growing site. Its primary objective is to produce high value appearance grade wood wherever this delivers the optimum return. This involves a combination of intensive management (pruning and thinning) to produce knot-free clearwood on the bottom log and knotty grades suitable for a variety of structural and functional uses from the rest of the tree. On a few forest sites, where growing conditions do not justify intensive management, the trees are managed to produce wood for structural and functional end uses. The table *(upper right)* shows how the volume of clearwood in an individual log can vary according to the timing of thinning and pruning, the growth potential of the site, and the harvest age. As a result, the "mill gate" value of the timber also varies.

Clearwood recovery

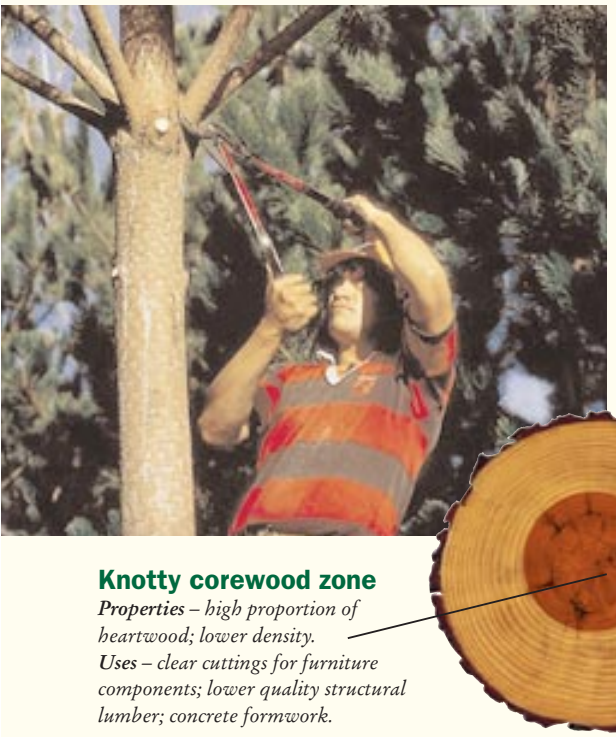


Source: Interface Forest and Mill, unpublished mill studies and sawing simulations – 1993-1996.

Pruned Log Index (PLI) (Park, 1989, 1994) is an absolute measure of basic pruned sawlog quality and clearwood potential. It is derived from measured log variables only and so is independent of differences in sawmill efficiency. However, PLI may be directly related to Clears recoveries from any sawmill. PLI predictions exclude any degrade due to randomly occurring defects such as resin pockets. No 1 Clears or equivalent are defect free. No 2 Clears or equivalent are free of defects on the best face. This table is based on the percentage of sawn volume, at a log conversion rate of 58% from an average sawmill cutting dimensional clear lumber. While the exact percentage of grade out-turn and conversion will vary between sawmills and in relation to sawing patterns, the proportion of clear lumber increases significantly as the Pruned Log Index rises.

What pruning involves

The pruning of radiata pine involves the removal of the lower branches from the tree to produce clearwood on the outer portion of the trunk – also known as a log, or stem. Clearwood is used in defect-free veneer or for high value appearance grade markets. The proportion of clearwood in the stem is dependent on the size of the central knotty core and the diameter of the stem at the time of harvest. This can be influenced by the timing of thinning and pruning and harvest age. The pruning height is varied between four and eight metres according to the intended final market.



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Clear outerwood zone

Properties *– high proportion of sapwood; higher density.*
Uses *– solid wood mouldings; door and window components; furniture; plywood.*

Knotty corewood zone

Properties *– high proportion of heartwood; lower density.*
Uses *– clear cuttings for furniture components; lower quality structural lumber; concrete formwork.*

. . . and substitutes use more energy

Substitutes for radiata pine include aluminium, steel, concrete, plastics, and brick. But all consume much more energy in production than wood. Steel for building studs, for example, consume roughly nine times the energy in production as wood. If the industrial world is serious about the atmospheric release of fossil carbon then wood is a solution. And, besides, forests absorb large quantities of carbon dioxide.