Redwood in New Zealand

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Abstract

Redwood is probably the third most important solid wood crop in New Zealand behind radiata pine and Douglas-fir. A small, but regular, area of redwood forest has been planted since 2002. Establishment techniques and silviculture regimes have been developed for New Zealand conditions and improved clonal varieties are available to growers. Well-sited redwood is very productive and as a stable, durable and attractive wood is potentially valuable. New Zealand-grown redwood has similar qualities to young-growth Californian redwood and should be in demand in the only significant market for redwood. Redwood also has qualities that make it a candidate crop for erosion-prone and remote sites where slope stabilisation and high water quality are important. Because it is long lived and has a low risk of windthrow and loss through fire, redwood can be a high-yielding and low-risk carbon crop.

Introduction

The New Zealand forest industry is very important to the economy and its significance is almost certain to increase due to rising demand for land-based natural resources and a growing appreciation of the 'other' services our forests provide, such as clean water and removal of atmospheric carbon. Our industry lacks species diversity, but so far this does not appear to be causing any significant loss of value or impediment to the future viability of the industry.

We take a low-risk, low-reward approach to forestry where high volumes of a low-value commodity are profitable while demand is strong. Radiata pine will grow just about anywhere in New Zealand and the wood can be used for a wide range of purposes. A visit to a hardware store or building supplies merchant will demonstrate the utility of our radiata with two options on offer – treated pine or untreated pine.

Our industry has other options. There are high-value tree crops that will grow well in New Zealand if well sited, and that have existing markets and can provide non-timber benefits as well as (or better than) our beloved radiata pine.

A survey of forestry nurseries carried out in 2018 shows enough redwood trees sold since 2000 to plant over 8,000 ha. Most of the planting is in the North Island but low-lying sheltered sites in the Northern South Island are productive.

The National Exotic Forest Description (NEFD) shows the national exotic forest estate to be as follows (see Table 1).

Table 1: NEFD net stocked area in ha – New Zealand 2018

Crop	Net stocked area in ha
Radiata pine	1,532,734
Douglas-fir	104,173
Eucalypt Spp	23,182
Cypress Spp	10,140

Redwood is included in the NEFD category of Other Softwoods so we cannot make a direct comparison, but we can use the results of the 2018 nursery survey estimate of 8,000 ha.

Radiata pine is the most widely-planted crop followed in the distance by Douglas-fir. Only a small proportion of the 23,182 ha of eucalypt plantation is established for solid wood production, with most of the volume destined for chip log production. Of the 10,140 ha planted in cypress, 4,709 ha of this is in South Westland, much of it on marginal land. Well-sited North Island cypress stands are certainly more productive, but good quality information is not readily available.

Using this information, redwood is the third most important solid wood crop in New Zealand. Further, most of the young resource is clustered in two operational centres. The greatest concentration of redwood plantations is in the King Country where several forest owners have planted more than 150 p.a. (an average of 170 ha p.a. has been planted) since 2002 and where expected yield at age 35 is 1,000 to 1,500 m^3/ha. One grower who is committed to planting 100 ha/year until 2028 has the resource to produce 100,000 to 150,000 m^3/p.a., with wood from other growers in the King Country working circle bringing the volume to over 200,000 m^3/p.a. of logs.

A second smaller area of redwood forest is the upper South Island. Enough redwood has been established in North Canterbury, the Tasman District and Marlborough to supply a steady volume of wood to a mill possibly near Kaikoura.

Redwood markets

The only existing market for redwood is in California where the import of redwood logs is prohibited. The start of the harvest from the young New Zealand redwood is 20 years away, and while it may be possible to have the rules changed (as the radiata pine log exporters did) there are obvious benefits to New Zealand in processing the logs here. We do not know what the cost of shipping logs will be in 20 years, except that it will be higher than for shipping sawn, dried and profiled wood.

Redwood is valued for appearance (red-brown heartwood and pale sapwood), dimensional stability, durability and its ability to hold nails, screws, paint and stain. Approximately two-thirds of young-growth Californian redwood and New Zealand-grown redwood contains non-durable sapwood (known as commons). The durable heartwood is the most sought after and valuable, with grades of commons selling for 60–70% of equivalent heartwood grades.

Almost all of the uses to which redwood is put in the long-established markets of California are those where the wood is visible. The most common use is for decking followed by residential fencing, siding (weatherboards) and interior panelling. These are similar uses to which western red cedar is put. In the Californian market, young-growth redwood is a more desirable and more expensive product than old-growth western red cedar.

A redwood marketing report by Kent and Williams (2011), California-based consultants and registered professional foresters, prepared for a group of New Zealand redwood growers gave them the following insights into the market:

- The market for specialty products from the architectural grades (or uppers) which have clear lumber or few tight knots is small due to limited supply, but indications are that this market can expand if more supply is generated
- The supply of the upper grades is not expected to increase from Californian forests as landowners do not prune to create clears
- New Zealand redwood products from plantations could be sold into the Californian market if they are acceptable to consumers and are of similar or superior quality to Californian-grown redwood. Factors such as ring width, colour, density and tightness of knots affects the actual and perceived quality of the lumber. Efforts to select genetically superior clones and use cultural practices to produce similar or superior quality redwood are thought to be necessary to penetrate the current California market.

A study by Meason et al. (2017) found New Zealand-grown redwood to be equal in durability to Californian young-growth redwood. McKinley and Cown (2008) collated studies on New Zealand redwood and determined that basic density is about 330 kg/m^3. Young-growth Californian redwood has a basic density of 350 kg/m^3 according to Cown (2008). These measures indicate New Zealand-grown redwood has a basic density of about 94% of Californian redwood.

It is worth noting that basic density gives a comparison of New Zealand and Californian redwood, but is not a variable of interest to redwood growers or the market. One of the reasons for this is that redwood is a very dimensionally stable wood because of its low basic density. Walker (2009) explains that high-density woods have proportionally more cell wall and less lumen (the space inside the cell) and so shrink and swell more. Neither growers nor processors actually want to produce dense redwood but are attempting to produce wood of consistent properties.

New Zealand-grown redwood dimensional stability is described in Table 2.

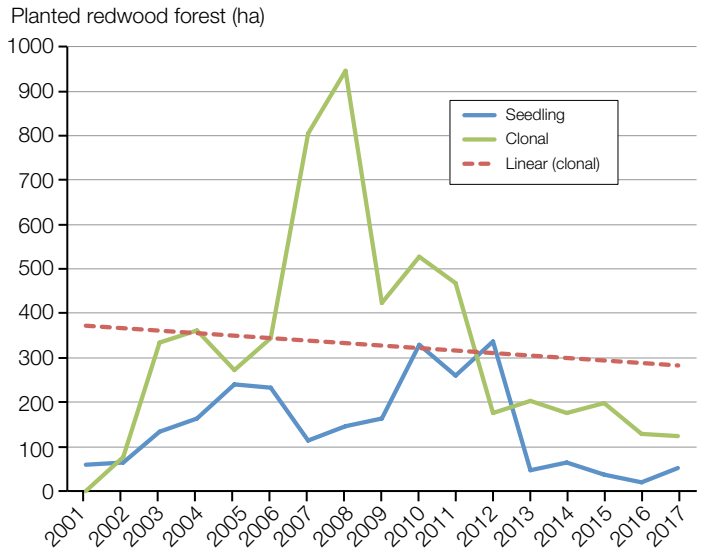

Figure 1: Area of planted redwood forest in New Zealand – estimated using redwood nursery sales

Table 2: Dimensional stability of Californian and New Zealand-grown redwood

Rates of shrinkage	Tangential	Radial
Californian young-growth	4.9%	2.2%
New Zealand grown[2]	2.5%	1.4%

While the density of New Zealand redwood is a little lower, the dimensional stability is better (Walker's reasoning holds true), and the evidence shows this country's redwood is a very similar product to Californian young-growth redwood.

Construction using New Zealand redwood

Redwood silviculture

Most of the New Zealand redwood growers are pruning their trees and this is providing important summer work for a number of silviculture contractors. Pruned logs are worth more in most tree crops, and as redwood is almost exclusively used for 'appearance' purposes, wood with bark-encased (black) knots is hard to sell.

The New Zealand redwood growers also prune to mitigate problems with boring insects and stem rot. Branches that die on the lower part of the stem due to shading begin to decay and provide an entry point for boring insects. The heartwood of redwood is resistant to decay and insect attack, but the sapwood is not. The sapwood provides entry into the stem where the insects can bore up and down through the sapwood.

The insect galleries allow the entry of pathogens which can cause secondary rot. As the trees grow, the sapwood ceases its vascular function and becomes heartwood and the part of the stem that should be the most valuable is compromised by insect galleries and sometimes rot.

The culture of redwood

Establishing a new forestry crop is a large and complicated job. To be successful, a forester must understand site selection, establishment practice, nursery production, genetics and silviculture. Much of the information needed to successfully establish redwood forests in New Zealand has been found in the trial plantings of the NZ Forest Service at a time when foresters were trying to find exotic crops that could help this country meet our needs for wood.

Another rich resource is of course the membership of the NZ Farm Forestry Association (NZFFA) who seem inclined to experiment with a wide range of species. There are also redwood enthusiasts in the NZ Forest Research Institute (NZFRI) who have worked hard to find funds for redwood research and to establish and measure permanent sample plots as budgets allow. The redwood growers of the 21st century owe a lot to those who were prepared to take risks and to try something new.

Site selection

Redwoods are very 'site-specific', which means they are very particular about where they want to grow. Redwoods are very productive on warm fertile sites with good summer rainfall, although the natural range of redwood is almost desert in places. Redwood also does not like the cool, dry sites that we know are suitable for the other Californian conifers, radiata pine and Douglas-fir. Redwoods can withstand hard frosts, snow and very dry summers, but will not thrive in places where these are common. New Zealand redwood growers have a clear preference for North Island sites up to 500 m elevation.

Establishment practice

Redwoods do not like weed competition when they are young, especially from grasses that can take virtually all of the moisture and nutrients from soil with their thick fibrous root systems. This is especially so in dry summer conditions. Redwoods are also very shade tolerant and can make their way through tall weed cover, including desiccated mānuka, which is often associated with New Zealand hill country.

The redwood foresters of California do not rely on seedling production for a number of reasons. Redwoods produce small numbers of small (20–25 mm long) cones in the occasional year. They flower in the middle of the cold and wet California winters and a typical rate of seed viability is 3–4%. Redwood seed does not store very well, not necessarily even from one seed year to the next.

Redwoods are unusual as a conifer in that mature trees can be cloned. There is the opportunity to identify trees in a forest that have desirable traits and, in a relatively short time, deploy clones of those trees

Left: Redwood coppice following harvest; Right: Mature polycormons

into forests. Through tissue culture it is possible to produce large numbers of plants and avoid the supply constraints caused by seedling production systems. Clonal varieties are selected for growth, form, ease of propagation, health and wood properties.

Redwood silviculture

Initial stockings in New Zealand are typically 500–700 SPH of clonal stock. Redwoods are naturally fine-branched trees and clonal stock has usually been selected for fine-branching. While it may not be necessary to have higher stockings to achieve branch size control, it is becoming apparent that higher stockings are important in keeping the cost of pruning to acceptable levels.

Most New Zealand redwood growers prune their trees to 6.5 m and are finding that the cost of removing epicormic shoots can be very high. Epicormic shoot growth is driven by light, removal of foliage and genetics. Light levels can be controlled by higher stocking but higher stockings and consequent thinning adds cost. Epicormic shoot growth is being selected against in tree improvement programmes.

Establishing redwood stands in a mixture of high-quality clonal material and lower-cost seedlings of *alnus* or *sequoia* has been proven to be an effective strategy in achieving rapid site occupancy and reducing tending costs/epicormic development.

Silviculture of redwood coppice is not well understood. We know that up to 100 sprouts can grow from on and around a stump following harvest. The intense competition between polycormons (sprouts) will cause fine-branching and stems with little taper, allowing pruning in one or two lifts. The polycormons are self-thinning to a degree, but a thinning treatment of unpruned stems will be necessary.

It would be hard to name a weed that could compete with redwood coppice that is driven by the root system of the mature tree. Site preparation, planting and weed control will simply not be necessary following harvest, except perhaps in extraordinary circumstances.

What next for redwood in New Zealand?

Redwood research is being done by individual redwood growers and foresters and through co-operatives. Redwood was part of the Diverse Species programme of Future Forests Research (FFR), but is no longer in what is now the Forest Growers Research programme within the NZ Forest Owners Association (NZFOA) and funded by the Forest Growers Levy Trust. Recent projects have been planned and managed by representatives of the redwood growers, NZFFA redwood enthusiasts and scientists from the NZFRI who have an interest in redwood. Two important studies have been completed post-FFR as referred to above and more are planned.

Redwood is a good carbon crop due to good growth rates on suitable sites and an ability to maintain high stockings of live trees. A 90-year-old King Country stand has been measured by the NZFRI and is estimated to have 3,500 m^3 of live volume in 460 stems/ha. The standing volume has been static since age 60 according to simulations using the New Zealand redwood growth model. The mean top height is 67.1 m and the basal area is 235 m^2. It is on steep land and lies into the prevailing wind.

The New Zealand redwood growth model does not estimate carbon stocks for such an old stand, but shows 2,500 tonnes/ha at age 50. Redwood is known to live to over 2,000 years in California. Windthrow is rare in redwood stands, and even if a fire were to burn through a stand, it is unlikely to kill the trees which sprout up the full length of the stem following a hot fire. This means an event leading to the 'loss' of the carbon and a

Left: Redwood recovery following fire, Mendocino County, California; Right: Post-fire redwood

grower having to repay claimed NZUs is less likely with redwood than other crops.

Phillips and Marden (2013) measured tree height, root spread diameter, maximum root depth, root length and root biomass in a study of below ground performance of nine species of trees. While some of the hardwoods in the study performed significantly better than redwood and radiata pine, redwood as a commercial timber crop performed well and would likely have shown better results with better quality planting stock and weed control. Redwoods root graft, and when cut down the stumps and roots stay alive while they coppice and produce another timber crop.

The window of vulnerability that occurs following the harvest of other timber crops (as roots and stumps rot and lose their strength before the replanted trees are old enough to hold the soil) does not occur. This makes redwood a strong candidate for wood production and carbon sequestration in erosion-prone areas such as the East Coast and Whanganui River catchment. Further, the higher value of the logs allows transport of greater distances, making isolated plantations more likely to be profitable.

Conclusion

Much of the hard work has been done to establish redwood as a viable crop for the New Zealand forest industry. Good genetics are available and New Zealand-specific silviculture regimes have been developed. There are existing markets for decorative, stable and durable softwoods and the prices are better than for industrial softwoods. The traits of wind-firmness, resistance to fire, root grafting and coppicing mean redwood can provide a range of benefits other than economic and on sites that other tree crops would not be viable on.

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