DIVERSIFIED SPECIES THEME UPDATE

Number: 06

Theme Leader: Patrick Milne

Date: September 2011

Meeting held in Wellington, 16th August 2011

SUMMARY

At this meeting, Heidi summarised the achievements of the Diversified Forests Theme, over its short existence. There have been an amazing number of successes particularly given that effort is spread over a number of species: Douglas-fir, eucalypts, cypresses, redwoods, and "indigenous" (mainly kauri and totara). Each of these needs to be researched – ideally as intensively as for radiata pine – from seed to product. That is a tall order, and one which demands a narrow species focus; too many species and nothing worthwhile would be achieved.

Because of the weather, only 17 people arrived at the meeting (out of 33 registered). Members of Diversified Forests represent a small brave band facing a Herculean task. But it is an important one. Species other than pine need to be actively researched if for no other reason than to give New Zealand plantation forestry a "licence to operate" and to expand plantings onto a million hectares of erosion-prone hill country. As Patrick Milne said, we need to move away from the "one size fits all" approach, and to produce a wider range of forest products. In view of possible biological threats to radiata pine, there is also a need to reduce dependence on a single species. We need to provide evidence that the risks of alternative species can be managed, and that the expected returns can equal or exceed that of radiata pine. The forestry sector is now New Zealand's third largest export earner. The goal is to piggyback on the lessons we have learned from that remarkable tree and add value to alternatives for the sake of both the forest industry and our whole nation.

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Douglas-fir

Heidi Dungey's summary showed us that for Douglas-fir – by far the largest of the sub-themes within Diversified Forests – there have been some impressive achievements. There is now a breeding plan, with second generation progeny trials. These promise to give us a staggering 20-50% improvement in growth and form. There are also huge opportunities to enhance wood quality for structural wood, given that the heritability for stiffness is a massive 50%. The Theme has discovered that the stringent building codes developed for radiata pine do not necessarily apply to Douglas-fir, with its substantially lower ability to uptake moisture and therefore decay. We know a lot about how to grow this species, and this knowledge has been installed in two main delivery systems: the Calculator and Forecaster. The problematic Swiss Needle Cast (SNC) disease (which has the capability to halve growth rates) is affected by warmer temperatures, including possible global warming. SNC-resistance has a heritability of 0.37 so there is hope in the breeding programme. For vegetative propagation of superior individuals, Cathy Hargreaves has developed techniques of international interest but there are still problems that need to be overcome before clonal Douglas-fir becomes a reality.

Should Douglas-fir be restricted to higher altitudes and to more marginal sites, merely because it can tolerate those sites? At the Wellington meeting, Stuart Kennedy discussed both height and wood properties. With a convincing presentation, Stuart analysed survey plots and thinning trials to prove conclusively that there were substantial downsides with altitude. There was a progressive height loss (about 6.2 m in terms of site index) from 800m to 1080masl. Also, wood density and stiffness (as indicated by acoustic velocity) both suffered major declines across this range; outerwood density declined by some 53 kg/m3 and acoustic velocity was down by about one third.

So why does altitude have this effect? It may not be anything to do with soils (the C/N ratio had little effect, and the DBH was similar across all altitudes) but 'mean annual temperature' was shown to be important

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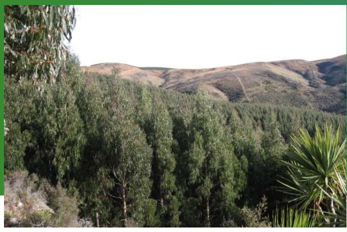


particularly for density, and rainfall was important especially for velocity.

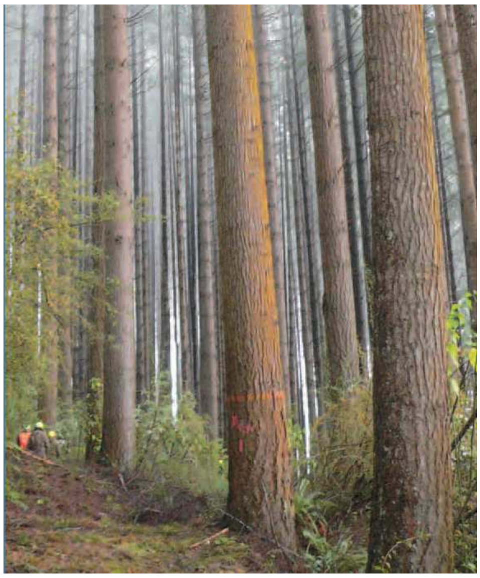
It is possible that there is a tendency for higher rainfall at higher altitudes which may mask some of the negative effects of lower temperature. “Slenderness” was also correlated with both properties: the more slender the tree, the stronger and stiffer it is likely to be. Both stocking and site index influence slenderness. In other words, if your trees are not sufficiently slender, you can switch your planting to lower altitude (and therefore better height growth) sites or you can maintain a higher stocking (and therefore smaller diameter trees).

High altitude sites are described in terms of “exposure” but this concept has as much to do with wind as with temperature. The obvious deficiency in Stuart’s work is that there is no good dataset – or even accepted method – for measuring wind exposure. TOPEX can be derived from terrain maps but this is a crude measure at best. Despite this reservation, Stuart has done highly commendable work and his findings may deter decision-makers from assuming that the cheaper, higher altitude sites are necessarily the best investments for Douglas-fir.

Heidi then spoke about the delivery mechanisms for management of Douglas-fir. Knowledge about this species can be accessed by either the Calculator or Forecaster. Use of these tools enables growers to calculate the productivity of their sites and discover how to manage initial stocking, timing and intensity of thinning, and rotation age. They can therefore optimise growth and quality and – obviously – profit. It is important to use the right seed, available either from Proseed or Ernslaw One orchards, which are selected for improved growth as well as stiffness. There is as yet no definitive way to quantify the value of these new selections, but (as already mentioned) we should expect volume gains of 20-50% and for stiffness 2-10%. That is a huge gain and needs to be emphasised. Having said this, there is clearly a GXE interaction: the most vigorous seedlots will suffer the most damage on exposed sites. There is a need for caution. Similarly, with SNC: there is provenance variation in resistance to this disease, so if the site is too warm and humid it may be necessary to sacrifice some volume growth and choose seed from resistant, albeit less productive, families.

Lastly, we may need to revisit the idea of using thinnings to produce veneer for LVL. Although it may be true that trees at age 20 have too small a diameter to produce a panel with one veneer bolt, why can’t more than one tree be used per panel? The current situation is that most Douglas-fir thinnings are going to waste on our hillsides, the species would improve the quality of LVL, and Christchurch is desperately in need of a huge quantity of new resources to rebuild the city.

To finish, FFR have scheduled a 2-day Douglas-fir Southland based workshop and field trip for the 23rd & 24th November. The workshop will focus on the current state of knowledge in growing and managing Douglas-fir - topics covered will include genetics, silviculture, processing, an update on regulatory issues and future research needs. This promises to be a very interesting 2 days, so if you are a Douglas-fir grower, please put these dates in your diary and plan to attend.

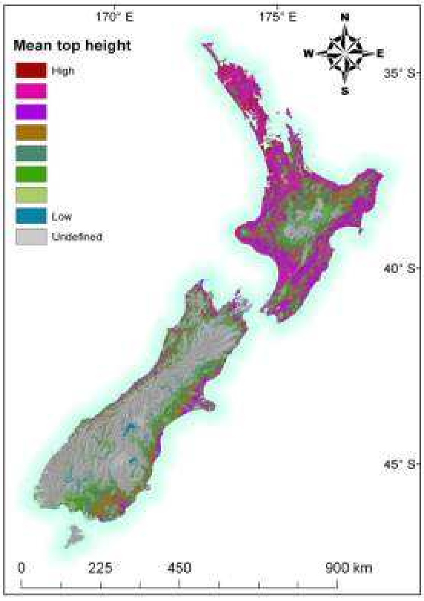


Douglas-fir

Cypresses

The cypress section was a summary and an integration of all the work that has been done on this genus. To attract investors into this species, the following questions need to be addressed: is there an existing market for logs and timber? Can natural durability be enhanced? What particular combination of species and hybrids is most suitable for a given site or for the likely market? What genetics are superior for the purpose? What is the best way to manage the genus to optimise growth, quality and profitability?

There was a short discussion on each of these topics. Yes, there is an existing market for cypress wood and very good returns have been recorded. Natural durability is an important market feature and all species/clones tested have high durability, but outliers exist that are not so durable. Generally speaking, the Leylands have less variability than the pure species and are therefore more reliable, but in all cases there is an opportunity using NIR testing to screen out the poor performers. Site suitability can be evaluated using (for example) the lusitanica “productivity surface” that Dave Palmer has constructed.



C. lusitanica productivity map

Regarding the choice of genetics, as Isaac Newton said, if he had seen far it was because he stood on the shoulders of giants. The current achievements in cypresses are based on years of hard, unspectacular work by previous scientists. One such person was John Miller who, in the early 1980s, established progeny trials of *C. macrocarpa* and *lusitanica*. This underpins a complex breeding plan (available on the website) which also involves *Ch. nootkatensis* and *C.guadalupensis*. A vital part of the plan is to overcome the effect of cypress canker, which is the only obstacle to a wonderful future for cypresses.

The best way to manage the genus? Every person has a different set of circumstances, including site and discount rate, so there is no single answer. But a Cypress Calculator (available on the website) has been constructed so that users can easily discover their own solutions. Such tools are also very useful for understanding the complex interactions that occur with silvicultural regimes. Patrick Milne gave one example of its application: using realistic costs and prices for a farm site in southern Hawkes Bay, he demonstrated that a real return of more than 6% could be generated and that production thinning could be profitable. With income from carbon, the profitability would be substantially higher. The model’s total prediction of yields is realistic, and is relatively simple to generate believable costs and prices, but there is still scope to improve the way that volumes are divided into log grades.

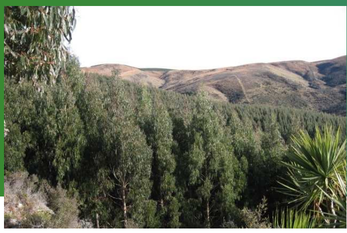
Although the future of cypresses looks bright, we must be patient. It will take some years before the new hybrids are tested and we can confidently recommend them to growers. In the meantime, we can perform useful research in studies of sawing, seasoning and durability.

Eucalypts

Kevin Molony gave a strategic overview of the genus. He showed that over half of the global resource was produced by just three countries: India, Brazil and China. Australasia – the home of Eucalypts – accounted for less than 5%. New Zealand has just 24,249 ha in total, of which more than half is grown in the South Island. The long-term trend is for a decreasing area, although carbon incentives may alter this. Eucalypts can provide the best carbon return because of their early fast growth combined with their higher density wood.

The main use of eucs is for short-fibre pulp, which provides superior returns for high-quality printing and writing paper. The solid timber also has great potential because of its excellent strength, durability and appearance. Rather than waiting until the trees are very old and large (as was once the prevailing wisdom), younger trees can now be sawn using “simultaneous tension release” – described by Dean Satchell in previous FFR reports. Eucalypts could also be incorporated in LVL, or grown for a multiplicity of other uses including biofuel, oils, or honey.

Of the 30 species grown worldwide for industrial use, only about 10 are suitable for New Zealand. The forest-dwelling Monocalyptus show better growth than the open-grown Symphyomyrtus. For pulpwood and sawntimber, the best bets seem to be *E.regnans*, *fastigata, nitens* and possibly *obliqua* and *fraxinoides.* For durable wood, the preference is *E. pilularis* or bosistoana. Two species that show promising potential are *E.globulus* subsp. *maidenii*, and *E. benthamii*.



Kevin showed some yield curves of *E. regnans* with an astonishing MAI of 47.7 m3/ha/yr, but there is considerable variability depending on site. E. fastigata can also occasionally be even more productive. So why is there such a small resource compared to pine? Answer: because low-priced pulpwood has been the only major market, and because there was never a sufficiently large or continuous resource to justify developments in processing and marketing. And, lastly, because you can't abuse the genus in the same way that you can with pine: eucs are more sensitive to nursery and establishment practices; they are more sensitive to herbicides; they are more palatable to browsing animals; and they are sensitive to frosts when recently established.

Substantial interest is being generated in the carbon potential of eucalypts, but most investors are waiting to see if the present carbon price persists. Domestic pulpwood markets are limited by the demand from existing mills, and – as mentioned – sawmills need an assurance of continuing and substantial supply. The export market for raw logs looks promising; with India and China accepting logs down to 16cm sed. Export chips are at a disadvantage because of the transport distance involved. There may also be other opportunities in pellets, ethanol production, or durable poles.

30yr-old E. regnans – East Coast

One of the problems with eucalypts is that they are very sensitive to microsite. Whereas radiata pine models are based on 20,000 plots, and models can be built from the empirical information alone, the national fastigata dataset is inadequate for a similar approach. To make a 'productivity surface' similar to Dave Palmer's national radiata pine maps of 300 Index and site index, an alternative approach must be used. Dean Meason outlined such a system in his presentation of the Hybrid Model 3-PG *for E. fastigata*. This is a stand-level model that determines the amount of photosynthate made by light falling on a certain leaf area, and then allocates it among the various components of biomass (roots, foliage, stem, etc). Using national maps of sunlight, rainfall and soil Dean was able to construct a *fastigata* productivity surface for the whole country. He calibrated this model against actual measurements and, finally, tested the improved model against a validation dataset. The model fitted reasonably well, and can capture the response of fastigata to thinning and for a range of management scenarios. It is weak, however, at lower stockings (<1000 sph). Soil data that the model requires are also inadequate. Nevertheless, it is a good start and Dean is to be congratulated.

Models are useless without the means to deliver the equations to practitioners. Following on from the successful radiata pine, Douglas-fir and cypress calculators, Heidi gave an overview of the *fastigata* Calculator which employs a similar format to the others, but does not yet include Dean's 3-PG model. The Calculator can be accessed from the website. Like the others, it seeks to predict growth, yield and financial outcomes from growing *fastigata* It can report on the DBH, stocking, BA, MTH and volume for any age, and the volume removed with thinning. A carbon column is to be added, and growth trajectories will be made to pass through inventory measurements. NPV and IRR are determined for a given regime. There is a need to improve the mortality functions and possibly to make the model more sensitive to regional variation.

In question time, a query was made about the sometimes atrocious form of the species. The reply was that it was totally unimproved and we could expect to improve form greatly by breeding.

Redwoods

One of redwood's major assets is that it is naturally durable, but this property varies greatly. Traditional methods of testing durability are very slow and require many samples, so there is a need for methods to rapidly screen standing trees and to grade boards. The objective of this project was to evaluate variation from a wide range of coastal redwood sites and tree ages,

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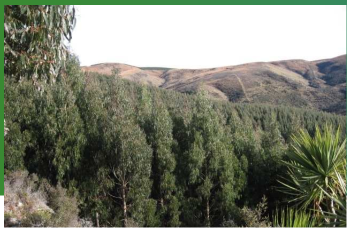

and to see how the near-infrared (NIR) spectroscopy method compares against decay testing in fungal cultures.

Two species of brown-rot fungus were used, and one species of white-rot. The former is the main cause of decay in softwoods like redwood, whereas the latter is particularly active on hardwoods. One of the brown-rots caused most of the decay, but the damage was (unsurprisingly) least in the 70-year old Kinleith trees, and worst in the 22-year old Rotoehu trees. Although only heartwood was tested, the wood nearest to the pith suffered worst. This could be because fewer extractives are produced by younger trees, and in addition the older material (ie the inner heartwood) might have suffered some leaching loss. The CSIRO Bruker NIR tool seemed to give predictions of weight loss compared to the NIR Line Camera, but either would be effective for screening out the non-durable outliers. They could also be effective for segregating clones if there was adequate replication.

Follow-up work could involve a NIR board-screening tool for use in sawmills, testing durability in the Kuser clonal trials, and identifying the nature and extent of heartwood compounds by chemical analysis of extractives. It is surprising that we still don't know which chemical – or combination of chemicals – is responsible for durability.

Simon Rapley (from the NZ Redwood Company) gave an overview of redwoods, starting with the history in New Zealand It was interesting that 6,300 ha have been established since 2000. It is not known exactly why plantings in the 1920s and early 1930s failed, but we now know the importance of siting and weed control – and we have a range of chemicals for that purpose. Quality treestocks are also available, without inbreeding depression. There is now a redwood growth model (including carbon) that was donated to industry by NZ Forestry Ltd and NZ Redwood Company and improved by Scion. There is a productivity map useful for the regions of Auckland, Northland, the BOP and small areas elsewhere.

By virtue of its dimensional stability, appearance, heartwood durability and retention of finishes, redwood commands a market similar to Western Red Cedar, and is used for decking, fencing, interior panelling, cladding and outdoor furniture. It is priced slightly higher than old-growth WRC and slightly below either the tropical wood Ipe or composite decking. The only established markets are in the western states of the USA, but there used to be markets elsewhere when the supply was greater.

Coast Redwood

NZ redwood seems to sell readily at a stumpage price consistently higher than Douglas-fir. The only negative feedback is for wood with "black knot" – but this problem can be removed by pruning. New Zealand seems to have a competitive advantage given our summer rainfall and fertile soils and relatively cheap, Kyoto-compliant land. We have silvicultural expertise and co-ordinated, government subsidised research. One surprising advantage is the absence of black bears! (You can't prune in the USA because black bears damage the bark of pruned trees).

Other Presentations

Non-Scion members gave four presentations altogether. In addition to Simon Rapley's talk on redwoods, Mark Dean from Ernslaw One gave a strategic overview of Douglas-fir; Shaf van Ballekom from Proseed discussed trends in seed demand and New Zealand's seed production capability in the short term; and (award-winning) Dave Lowry from Hancock Forest Management summarised the place of alternative species in general in the NZ Forest Sector. All these people have a staggering wealth of knowledge and experience, and the insights they bring to the table are most worthwhile.

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