



Theme Leader: Patrick Milne



# DIVERSIFIED SPECIES THEME UPDATE

Number: 02

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## Meeting held in Napier, 27<sup>th</sup> August 2009

### SUMMARY

There's a buzz of excitement over "alternative" species, the like of which has not been experienced for many years. Enthusiasts from different areas of the species spectrum have successfully merged into a unified and purposeful Diversified Species Theme, and August's Napier meeting well illustrated this.

If New Zealand's forest estate is going to expand significantly, for example for carbon sequestration (as advocated by both government and opposition parties), then it is unlikely to consist of "more of the same". Alternative species are the key. Fortunately, in the Diversified Species Theme, there is a solid core of serious research laying the groundwork for just such an expansion.

This article was written by:

Piers Maclaren, Piers Maclaren & Associates Ltd for FFR Diverse Species Theme Members

### Introduction

Patrick Milne and Heidi Dungey gave strong introductions. For example, did you know that last year's budget for the Diversified Theme was a whopping \$1.35 m? This is a vast increase over the few hundred of thousands available to the old Coops. Research is tightly partitioned by species, but all work must keep at the forefront three main objectives: the chain that stretches from seed to market; high value products and new values; and the models and systems to optimise our actions.



Heidi – enthusiastic as usual

For Douglas-fir, Heidi identified the early successes to be completed this year, as the publication of the Douglas-fir Manual, a peeling study for LVL including the use of production thinnings, and a major analysis of how different genotypes react with different environments.

For cypresses, the highlights include the release of new clones, a cypress calculator, and a report on variations in durability. With redwoods, there was a re-analysis of the Mangatu sawing study, and trials to compare performance of the range of clones that are being currently used. For eucalypts, work continued on

genetic development and models for *E. fastigata*, and the writing of a development plan for one of *E. regnans*, *muelleriana* and *pilularis*. Indigenous forestry also featured, with David Bergin, the author of the totara growth model and the new Bulletin on beech, receiving the prestigious NZIF "Forester of the Year" award. This year also sees the development of the first kauri growth model. And the list does not end there: other species, including *Abies* and Mexican pines, are being examined at a less intensive level.

### Douglas-fir

At 6% of New Zealand's planted area, Douglas-fir is second only to radiata pine and therefore attracts the most interest of the "alternative" species. Cathy Hargreaves' results are of international significance, and we are lucky to have this self-described "lab rat" in our midst. Her work is about turning a single cell into a plantable tree. Although this is old hat with many other species, it is new to those who deal with Douglas-fir in New Zealand.

The situation with Douglas-fir is that seed-fall is irregular and there is plagiotropism (where cuttings from branches continue to grow like branches). It would be useful to multiply up highly desirable and scarce seed, or even – whisper this carefully – genetically engineer such features as insect resistance or turn off reproduction to alleviate the issue of wildings.



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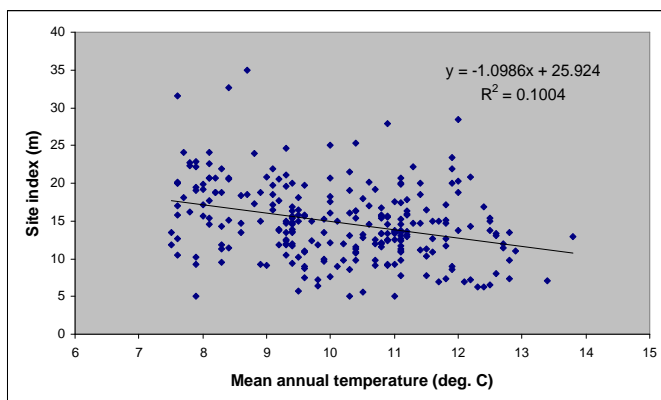
The only limit is one's imagination. But first we must perfect the technique; success has been achieved – and patented – with radiata pine, and needs to be repeated with Douglas-fir. Cathy has produced only two plants so far (she has named these Sam and Sue) but is in hot pursuit of the remaining problems, and looks forward to producing a thousand plantlets for field evaluation.



*Sam & Sue*

In the longer term, we could have 50-70 clones tested over a wide range of sites, and – given that these would be cryopreserved – return to the stronger performers. There could be an automated system for encapsulating “seed”, so the technique might become affordable – if not for routine planting, at least for seed orchards.

A potentially exciting study was revealed by David Palmer. As with other species (radiata pine and *C. lusitanica*), his team attempted to predict the growth of Douglas-fir using environmental variables such as terrain and climate attributes, soil-water balance, wind speed, nutrient availability, and so on. The model explained only 15% of the variation, so what is going on?



*A poor relationship between site index & temperature*

It may be that Swiss Needlecast Disease or new genetics have muddled the relationships. Interestingly, there seems to have been a trend towards increasing growth (both height and total volume) since 1955. Could this be the effect of “carbon fertilisation” from mankind’s increasing use of fossil fuels? Who knows, but certainly the same phenomenon has been observed in other species. The GxE study that Heidi alluded to in her introduction may highlight, or exclude, the effect of genetics in the overall picture.



*Douglas-fir – continuing genetic improvement*

Charlie Low then discussed the breeding plan for Douglas-fir. The overall goal is to increase timber stiffness without compromising diameter growth, and to continue to breed for volume – which should also have the effect of increasing resistance to Swiss Needlecast Disease. An earlier strategy employed three “superlines” for Douglas-fir, which needed to be kept

separate to avoid in-breeding. Superline B comprised the US Coastal fogbelt populations, and this is now unavailable to breeders (as it was a potential vector for pine pitch canker). The advent of genetic fingerprinting can now overcome the threat of in-breeding, so there is no longer any need for Superlines. It was refreshing to see this normally complex and technical subject described in an intelligible way.

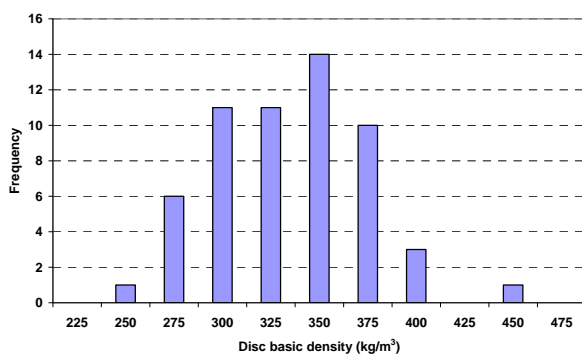
Where to next for this species? There needs to be more work on harvesting, particularly if production thinnings can be shown to be profitable. Douglas-fir needs to be more thoroughly investigated for bioenergy, carbon sequestration and wilding spread. A better thinning model needs to be devised. And scientific links must be maintained with the Douglas-fir association and with the wider international community involved with this most popular softwood.



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## Redwoods

Dave Cown discussed the strategy for improving wood quality. This varies greatly between sites and among trees, so there is plenty of opportunity for improvement. It would be particularly useful to discover the causes of the observed variation. The attributes of greatest interest are density, heartwood, stability and durability.



Density distribution – 22yr-old trees

Some NZ redwood is super-low in density, but there is a considerable range. The most likely explanation is genetics – age is not necessarily very important. The first step is a systematic survey of NZ material, taken from trees 10 years or older. Later steps include an assessment of the 1981 Rotoehu Provenance Trial and the Kuser trials. In contrast to density, there is not a major issue with stability – although we must ensure that future clones are not compromised in this regard.

One way to analyse both stability and durability without destroying the tree is to use Near Infrared techniques on core samples. Previous “graveyard” tests showed NZ redwood to be of low durability, but these studies did not distinguish between inner and outer heartwood. Although outer heartwood is the more durable, the former is more useful for screening of future clones and provenances.

Dave summarised redwoods by saying that the species has some good points – notably its uniformity and the high level of valuable heartwood – but there is a need to cull out material where it fails in key properties. Wade Cornell commented that the current price of redwood is not very high (presumably because of the slump in the US housing market) but Western Red Cedar is doing well. That, however, is another story.

## Cypresses

*Lusitanica* ‘plus tree’



A lot of work has been going on with the genetic improvement of *Cupressus lusitanica* – a much superior performer to *C. macrocarpa* on warmer sites. The ten top clones of the best 15 families were selected from superior families planted by John Miller in 1984. These were tested on three fertile farm sites – two in the Bay of Plenty and one in Northland – and assessed at age 6. After some mathematical juggling to account for microsite variations, the best clones could be identified: they had attained 18 cm dbh compared to the “controls” – which were by no means inferior themselves.

Interestingly, clones did not seem to vary in their resistance to canker. The trees with sparser branches had poorer performance, which is a pity given that cypresses can be very arduous to prune. And lastly, aging in some of the cypress clones does not seem to be a major problem. This means that, once the best clones have been identified, we might be able to return to those clones without the need for expensive and difficult cryopreservation.

Heidi then outlined the cypress development plan. This is very exciting, because it could foreshadow cypress becoming a major new softwood to supplement our highly restricted diets of radiata pine and Douglas-fir. The problem, of course, has been canker, but Leylands are naturally semi-resistant (particularly *Ovensii*). Now that we can create our own hybrids – rather than relying on chance crosses on English country estates – there is enormous potential. The colour, durability and ease-of-use of all the cypresses is well known and well accepted by the market. A systematic development strategy using our core pure species (*C. lusitanica* and *C. macrocarpa*) and improved pollen of *Chamaecyparis nootkatensis* from British Columbia should produce huge dividends.

The detail of the implementation of this strategy is fairly complicated, but the Theme is indeed fortunate to have national and international experts on the task – Patrick Milne, Charlie Low and Heidi Dungey, among others.





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## Eucalypts

Genetic algorithms were the subject of Oliver Chikumbo's talk. This technique is a proven way of finding solutions to highly complex problems – look at any evolutionary adaptation in nature – but only time will tell if it is a practical method for NZ forestry rather than merely an academic exercise. Oliver used the example of a thinning model for *E. fastigata*.

Dean Meason continued with this exploration of new modelling systems by re-examining process-based modelling and, in particular, the 3-PG approach. It soon became obvious that he was totally conversant with the literature, and the strengths and weaknesses of this model. The Australians developed the 3-PG system, are its strongest advocates, and have the greatest knowledge of eucalypts (and land in *E. fastigata*), but there is still room for doubt as to whether the tried-and-true empirical models as traditionally used throughout New Zealand can easily be superseded. One test would be to see if 3-PG can explain the poor predictions of Dave Palmer's model with Douglas-fir (see earlier).

Also speaking on *E. fastigata*, Charlie Low proposed a breeding plan. This was a good example of the "cross-fertilisation" that can occur between research areas: the experience Charlie has gained in a lifetime's work with other species can readily be applied to the new focus. He pointed out that, if we want hardwoods as opposed to softwoods, *E. fastigata* is probably the most reliable producer of large volumes, even though its early growth is not as spectacular as, say, *E. regnans*. Its overall health, wood density and self-pruning ability are favourable attributes but its worst feature is its tendency to fork. "Carbon forestry" has awakened interest in this species.

Early lessons from *E. fastigata* breeding trials indicate a good heritability for both diameter growth and form, with stable rankings across sites, making it important to choose the right provenances. One frustration is the poor supply of seed.

Toby Stovold discussed another popular eucalypt: *E. nitens*. This has spectacular early growth, good form and is cold hardy. Breeding trials have existed since 1978, using 80 seedlots. From these trials, the best 30 selections (particularly those from Central Victoria) were used for a seed orchard. The species lost appeal when it was devastated by the *Paropsis charybdis* beetle, but interest revived in the 1990s when a biological control agent was introduced (*Enoggera nassau*). Substantial more seed was introduced,

including from New South Wales (better for areas blessed with summer rainfall), and new genetics gains trials established. The biological control agent *Enoggera* was in turn overcome by a hyperparasitoid, making *Paropsis* once again a problem, but a new Integrated Pest Control strategy has been formulated



*Paropsis beetle*

to attempt to mitigate this threat. In the meantime, the breeding programme focuses on diameter, wood density and, interestingly, cellulose content. The latter is because the foreseeable use of *E. nitens* is for chemical pulping, where cellulose content is vital.

## Combined Field Trip

Diverse species joined with the Radiata Theme for a combined field trip between the two Napier meetings. The day started with a visit to the long running Pakuratahi land use study where the environmental impacts of both farming and forestry have been compared. The very impressive study results can be found at [www.hbrc.govt.nz/WhatWeDo/Land/PakuratahiLandUseStudy](http://www.hbrc.govt.nz/WhatWeDo/Land/PakuratahiLandUseStudy). Land use and redwood silviculture were the next topics of discussion – firstly on a recently purchased HBRC property and then at the Tutira redwood trial. At the latter, the impact of pruning and thinning on height, diameter and epicormic shoots is being followed. Lunch was at the Holt Forest – an arboretum established in 1933 containing both exotic & native species. This has to be one of the most spectacular plantings in the country and should be on everyone list of things to do when visiting Napier. The day finished with a visit to the Pan Pac Mill – a state of the art mill which has recently added xray scanning to improve productivity. The combined theme meetings and field trip was a new initiative – I think one that proved to be worthwhile.



Lunch at Holt Forest