



Theme Leader: Patrick Milne



DIVERSIFIED SPECIES THEME UPDATE

Number: 03

Date: May 2010

Meetings held in Rotorua & Dunedin, March 2010

SUMMARY

Heidi Dungey, Patrick Milne and Russell Dale set the scene – always useful, because there are always newcomers and even we old timers need constant reminding as to what has been achieved and what is intended for the future. Russell pointed out that, in the 1980s, New Zealand had a world-class reputation in forest-growing research. We seem to have lost that edge, and our strategy is to recover it. This will involve a subtle combination of funding success, good communication of research results, and integration of research – despite the silos that force us into the four “themes”. Every theme should be driven by the criteria of productivity, quality and sustainability and should produce excellent science combined with a wide kitbag of communication techniques, so that the full value of the research is achieved.

This article was written by:

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

Douglas-fir

Although Douglas-fir is the most widely planted, and the best funded, of the alternative species, it is more suitable for South Island conditions. It was therefore sensible to hold the Douglas-fir meeting in Dunedin (with other species in Rotorua the previous week). But despite the specialist focus, some 21 people turned out in Dunedin for the morning's presentations.

Genotype x environment trials

What clones grow best under each type of environment? Do some clones do well everywhere, or are there “horses for courses”? This is of course a key question for our breeding programme and for our nurserymen. Not that we are deploying clones in operational practice, but nonetheless we still need to know how genotype interacts with the environment. Trials have been established from Gowan Hills to Kaingaroa to determine the behaviour of 224 families from the coastal fog-belt of California and Oregon and at last there are some results.

Nature, as usual, is cussedly complicated. The answer is that, yes, some provenances and families do indeed show distinct superiority in selected environments – but most do not! For the bulk of families, the winners in Gowan Hills are the same as those in Golden Downs and even in Kaingaroa. This awkward conclusion even applies to the top four provenances – three show consistent behaviour but one does not. And when we analyse exactly which properties are involved, the complexity gets worse. Straightness appears to have a

very good correlation - the straightest families are always the straightest everywhere – but stiffness (as measured by sonic velocity) is far weaker. And, the provenance is a more consistent (except for DBH) than the family, which makes sense as provenances represent a wider range of genetic material. The important point is that selection for straight trees will be consistent – so go for the best families. If you want the fattest tree, things are not as predictable, because of the lower heritability for this trait, but the story is consistent - go for the best families regardless of where those originated. This story still has to be interpreted for the Douglas-fir grower – what seed to plant where.

So where do we go from here? We need an authoritative report, we need to test the effect of genotype on Swiss Needle Cast, add extra sites (including low elevation and tougher locations) and write it up in a popular journal.

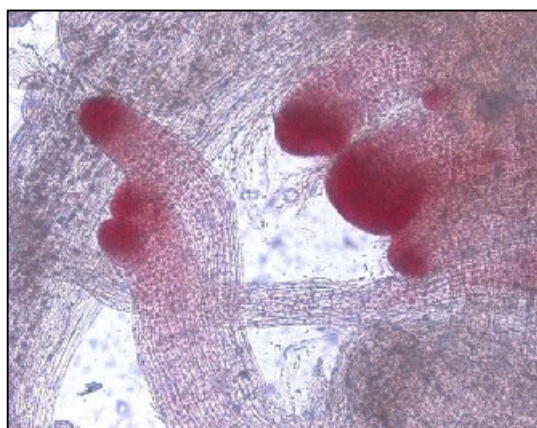
Nobel Prize winner?

The next item is science worthy of a Nobel Prize (written only partly with tongue-in-cheek), and the Diversified Theme is very lucky to have Cathy Hargreaves. She may have uncovered the principle behind rejuvenation – the elixir of life itself! She has been working with embryogenesis to make new seedlings. This is all very ho-hum for some species, but is leading-edge research for Douglas-fir. To recap, there is an irregular Douglas-fir seed crop in New Zealand and cuttings have their problems (plagiotropism – the tendency of branch material to grow horizontally – and dormancy in propagules).



DIVERSIFIED SPECIES THEME UPDATE

Given this background, options for clonal forestry are very limited. But embryogenesis has the potential to multiply up seed, with the clonal material stored in its juvenile state while field testing takes place. Clones are also useful for stool-beds in nurseries or for container-grown stock. Looking to the future, clones herald an age where good breeds are selected by reading genetic markers on their chromosomes rather than by field testing alone. Genetic engineering (say that quietly) also becomes a possibility. One outcome of GE could be sterile seedlings. Imagine that! Huge increase in growth plus the impossibility of wilding spread!



***Embryogenic tissue on D-fir
maturation media***

The year 2010 has been a great step forward for Cathy's research. Despite not being able to collect cones at the optimum time, Cathy was able to grow cell-lines from 49% of her cones. Even the worst-performing tree/cone achieved 5% success. It had taken twenty years to achieve the same impressive results with radiata pine. Her recipe for initiation is now a sure winner, and an international first (it really is),.

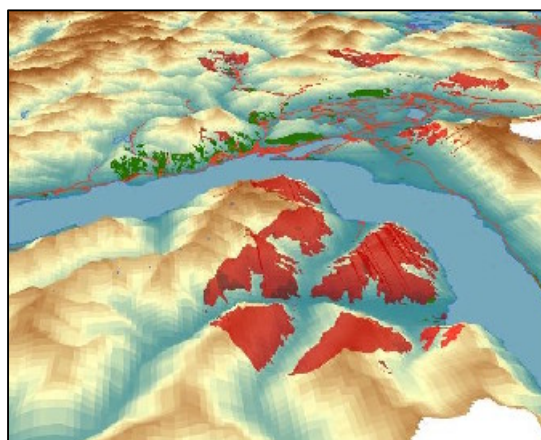
Wildings

One cannot write about wildings without mentioning that the Chief Wilding himself, Nick Ledgard, was recently awarded the Queens Service Order for his work. Nick, as most will remember, was secretary of the Douglas-fir Research Coop until it morphed into the Diversified Theme. Congratulations, Nick, and fully deserved!

Nick and Thomas Paul updated the meeting on the Sustainable Farming Wilding Project, which has now completed its 3-year programme. The idea was to increase awareness of the problem, improve and

promote control options, and determine vegetation successions that result from wilding control.

Thomas showed maps and the following digital terrain model of Lake Wakatipu-Queenstown illustrating the modelled threat of wilding spread.



High risk low risk



This would be very useful in any new planting programme, if only for counteracting objectors and satisfying regional councils. The published wilding manual gives comprehensive guidance on tools and methods to control wildings, and the situations that best suit each option. The wilding website was – regrettably – hacked, but the silver lining is a new design. This is the doorway in which one would locate reports, papers and tools.

The research on vegetation succession has produced some impressive results. In one study a patch of mature Corsican wildings was burnt and then oversown with a grass-legume mix. Eighteen months later, only two conifer seedlings were found and even then only where there had been no oversowing or browsing. The point to note is that conifer seeds are not like gorse – they will not last for 100 years in the ground waiting for suitable conditions to germinate: if you have achieved initial success then it is more than likely this will continue.

In the case of Douglas-fir invading native forests, height growth is directly related to the amount of sunlight penetrating the canopy, except for a few troublesome exceptional individuals. Interesting comparisons were made with similar situations with beech and D-fir in South America. It seems that some seedlings can survive and grow well in beech gaps.



DIVERSIFIED SPECIES THEME UPDATE

Having said this, it is possible that an exceptional droughty summer could kill off these invaders, the older newcomers having deeper roots and more efficient canopies. Time will tell.

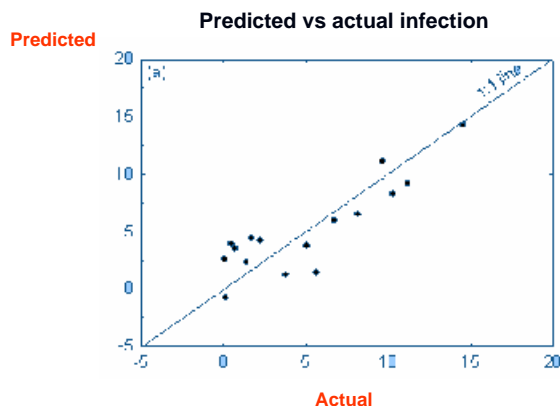
One piece of research showed good mortality of D-fir wildings using a mixture of Roundup and Escort, but the collateral damage to native species needs to be evaluated and other chemical brews tested. Another trial showed the effect of felling contorta wildings in a unique monoaolichen ecosystem. Regrettably, the flush of nutrients allowed grass to totally dominate. A third, in contrast, showed strong native emergence under contorta slash in a different type of ecosystem. So obviously, there is no obvious "one size fits all" prescription.

Swiss Needle Cast

Mike Watt gave a brief overview into this disease, which since its discovery in 1959 has spread southwards causing an average national volume growth decline of about 20%. But in some places there is low infection and acceptable growth. So what climate factors affect disease and growth?

The disease is not serious in native Douglas-fir, but when it appeared in Oregon plantations, volume reductions were at least as great as in New Zealand. The Oregon researchers found that the fungal fruiting bodies block stomata and reduce gas exchange, causing the needle eventually to be shed. The best predictors of disease, they discovered, were mean daily winter temperature and spring leaf wetness. Does this apply in New Zealand?

In a collaborative project between New Zealand and Oregon, the researchers found – in a very thorough study – that the Oregon model does indeed fit this country very well as shown in the following graph.



To make this convincing conclusion, some 5-10 trees were sampled among 3 seedlots in sixteen different sites and over two seasons. Needle retention was directly related to the level of infection, and infection severity was directly related to average June temperature. Future work will try to refine the model so that we can better predict growth by site and region. There are also question marks about what global warming will do to Douglas-fir, given that a typical rotation is 45-60 years.

Douglas-fir LVL?

In many steeper areas, it is prohibitive expensive (\$800/ha) to thin Douglas-fir to waste using men on the ground and chainsaws. (The mass of branches encourages trees to hang up). On such country, it is often possible to production-thin with tracked machinery and felling heads, but to be profitable this requires some market for the thinnings. Douglas-fir is not used for pulp in New Zealand. Small sawlogs can yield timber of quite acceptable quality although the lengths from production thinnings are too short for normal sawmills and markets – there needs to be a market for material that is only 2.4 m long.

Mark Dean, from Ernslaw One, reported on a study to assess the possibility of using production thinnings for making veneer for the manufacture of LVL. Ideally it would have been best to test 15-year old thinnings, 25-year old thinnings, and top logs from clearfellings, because this would cover the range that is available. In the event, he had to make do with 75 logs from 23-year old trees, which Mark debarked, submerged and peeled. We await the results with great interest.

New Douglas-fir Calculator

Mike Watt announced that a new version of the Douglas-fir Calculator was now ready and would be posted to members soon. The upgrade includes a way of inputting plot data to calculate the indices for each plot.

Redwoods

We have a good idea of the sort of volume that can be expected from redwoods, but how does that translate into recoverable volume by log grade and therefore profitability? This question is vital if the fledgling industry is going to grow.

To help answer this, Paul Silcock from NZ Forestry Ltd described the Mangatu sawing study, which was funded by FIDA and researched by FFR, Interpine and Scion. The original idea was to examine the



DIVERSIFIED SPECIES THEME UPDATE

conversion percentage of sawn wood and its timber grade, and to analyse the wood properties. But initial findings were that the potential was not fully achieved, and that recovery could have been improved with better silviculture and log grading.

Log size, heartwood content and branch status were the most important components of log value, but it proved difficult to establish a good relationship between log-level measurements and the outturn of heartwood lumber. The PLI (pruned log index) gave a good relationship with clear lumber and log value, although the actual PLI values were lower than expected. This was because of epicormic shoots and a high incidence of dead/rotten knots. Not to worry, modern silvicultural techniques would probably avoid these problems.



The new study by NZ Forestry intended to find a way to improve pruning in the Mangatu stand, to re-grade timber affected by the new pruning operations, and to predict average grade recovery for a 38-year well-managed redwood stand at 400 s/ha. The re-grading was undertaken according to three new scenarios: re-grading to account only for defects outside the 300 mm defect core (ie ignoring the effect of epicormic shoots, which should not be present in good silviculture); the same with a 185 mm defect core (ie assuming an optimal pruning regime); re-grade the second log ignoring dead/rotten knots (ie assuming the lower crown is managed by "brashing").

The result was that 210 of 771 boards (27%) were re-graded with a major gain in grade recovery. From 993 m³/ha total standing volume, there was a total recoverable volume of 625 m³/ha. It was clearly beneficial to reduce the size of the defect core and there were also distinct advantages in managing branches in the second log. The real payoff of this research, however, will come when accountants and investors need to calculate the profitability of growing redwoods as an alternative to radiata pine: they will have realistic recoverable volumes to use rather than

numbers based on flawed silvicultural regimes. This was a useful study.

The second presentation was on a "redwood benchmarking trial". Toby Stovold described how good redwood material had been assembled from overseas imports and from many independent selections from throughout New Zealand, but these had never been tested at the same time and place. Then there are the well-known Kuser trials, already established (2003-2006). So the project combines "linkers" – or clones from those trials that are also present in the study. The end result will be a much clearer idea of which material to use in different sites around New Zealand.

Cypresses

For a while, cypresses have been teetering on the edge of becoming New Zealand's third major species, but they have been held back by the poor choice of genotype – in particular with regard to canker resistance. Now we have learned to make a vast range of clones and hybrids – some of them intergeneric as well as interspecific. Some of these clones/hybrids promise a new dawn for cypresses.



New hybrid seedlings

These are exciting times. We know that the 'ovensii' Leyland clone is almost totally canker resistant, so how about making some new clones, this time by careful choice of "parents" rather than by lucky chance? We have now succeeded in doing this, although the seed from the progeny has very poor



DIVERSIFIED SPECIES THEME UPDATE

viability. This means the hybrid would always need to be propagated vegetatively, which limits both the genetic variability in a future resource and potential breeding options. Instead, we could use a hybrid between the well-known *C. lusitanica* and the canker-resistant *C. guadalupensis* – the seed of this hybrid is just as viable as from pure *lusitanica*, and a hundred times more viable than from *ovensii* clones.

Although cypresses have been propagated vegetatively for centuries, large-scale clonal trials started only in 2001 and good comparisons are only now being made. There is a set of trials of 150 pure *C. lusitanica* clones, on three fertile farm sites. But how do they perform as a stand of equals rather than as an individual surrounded by inferior trees? To test this, 100-tree blocks of each clone of the best clones of *C. lusitanica* and *C. macrocarpa* have been established. A third series uses the excellent work of John Russell and Kathy Horgan, who in 2005 together jump-started the problematic creation of intergeneric hybrids. There are 106 hybrids being tested (46 *C. lusitanica* x *C. guadalupensis*, 33 *C. lusitanica* x *Ch. nootkatensis*, and 27 *C. macrocarpa* x *Ch. nootkatensis*).

So what next? The programme will continue to make more hybrid crosses, including *C. macrocarpa* x *C. guadalupensis* (this combination is absent in the above hybrids). Some canker-resistant *C. macrocarpa* has also been identified in the 1984 Gwavas trial and this will be used for making hybrids. Another clonal trial is planned for 2011.

There is one further development with cypresses. A new cypress calculator has just been released and will be delivered to members via www.ffr.co.nz - it is based on the work by Pascal Berrill and others and put together as a web-based calculator by Lars Hansen. It will give predictions of stocking, height, basal area and total standing volume. The calculator is set up so that the user defines the site index or the starting conditions of a stand, thinning regimes, stand information (e.g. area, altitude), discount rate, land values and overheads; the calculator then provides estimates of the mean top height, stems per ha, basal area and standing volume. The calculator will also provide volume harvested, gross value of the stand, as well as NPV (for a specified discount rate) and the internal rate of return (IRR). This is a very promising start for cypresses.

Eucalypts

Toby Stovold described a third generation trial for selecting the best individuals and families of

Eucalyptus regnans, and proposals for rolling-front trials to establish a breeding population for *E. fastigata*. Dean Meason talked about a web tool for approximate estimates of carbon sequestration for *fastigata* – a very brave task given the paucity of data, complexity of the model and the potential importance of the results. One discovery was that temperature was the most important determinant of growth, and another was that although wood core density increased with age, it was not affected by region or growth rate.

Cathy Hargreaves reported on an interesting project to facilitate tissue culture with *E. bosistoana*. This species has been identified as having potential for vineyard posts, because CCA-treated pine is unpopular ("contains chemicals" and breaks too easily). Trees are being selected for site tolerance, growth, form, timber strength and durability so tissue culture would be useful for stool-beds or for general production. One problem is the need to develop a sterilisation technique which will not actually kill the plant. The most promising brew seems to be a mixture of ethanol and mercuric chloride, but this is still not perfect – killing 16% of trees.

Indigenous species

Dave Bergin and Greg Steward continue their lonely research into native species for timber production. A totara provenance trial is now 21 years old and seed has been collected from the best individuals. A beech bulletin, supported by Tanes Tree Trust – is the sixth in the series on indigenous species – has just been written as a first draft and will be available in mid-2011. If it's like all the others, it should be good value and we look forward to it. A study into nursery-raised seedlings, in conjunction with Tanes Tree Trust and Lake Taupo Protection Trust has been started with the objective of reducing costs. It is widely known that native seedlings can be very expensive compared to common plantation species, so perhaps a bare-rooted option may be cheaper? A paper has been written on the productive potential of 13 indigenous species.



Open ground production of native seedlings



DIVERSIFIED SPECIES THEME UPDATE

As far as kauri is concerned, there is now a growth model based on 30 PSPs from 16 sites – including 6 from outside the natural range of the species. There are robust regressions for both height and diameter. Unsurprisingly, there is a strong relationship between the height of a tree and its diameter. There is also a good relationship between stocking and diameter, confirming that the well-known “3/2 self-thinning” rule also applies to kauri. There is evidence of a positive response to silviculture and superior genetics.



Kauri responds well to silviculture

Other species

Charlie Low is a fan of the *Abies* genus (ie true firs). It is a well-known timber tree in the Northern Hemisphere and usually occurs in a mixture with other species like Douglas-fir, but unlike the latter it does not develop Swiss Needlecast Disease. So could it be suitable for some sites in New Zealand where SNC prohibits the use of Douglas-fir? There are many species of *Abies* and different ones prefer different ecological niches.

There were several introductions of material with trials going back as far as 1959, but most of these failed to get through the establishment phase. As with the earlier plantings of Douglas-fir, could this be due to inadequate inoculation by mycorrhiza? In which case, growth rates may now be acceptable, given that only a few well-distributed stands can eventually provide sufficient spores, believe it or not, to infect the whole country. Be that as it may, it is a good time to compare the performance of nine *Abies* species and provenances within those species, against that of Douglas-fir.

The results are as follows: the most vigorous species are *A. grandis* (USA and Europe) and *A. religiosa* (Mexico) with *A. concolor* maintaining high stockings and being nearly as good. One Hanmer trial which applied forest duff from beneath *Abies* generated a good response as did the use of fertiliser. *A. procera* and *A. magnifica* ran into mid-rotation problems, which might have been due to rootrot fungi. A general result is that volume production can be very high – higher than Douglas-fir – a finding that should create a lot of interest among pioneering foresters.

Insect pests of alternative tree species

For enthusiastic entomologists, like Toni Withers and Lisa Berndt, the following tree species are extremely boring: redwoods, Douglas-fir, cypresses, and possibly *Acacia*. All known insect pests are of very minor consequence. Now, when we come to eucalypts, that's a totally different story! A fascinating genus, with a myriad of problematic pests.

The best known eucalypt pest is of course Paropsis, or tortoise beetle. At worst, it totally defoliates the important timber species *Eucalyptus nitens*. Only the inherent vigour of the tree will get it through the attacks. Paropsis is also a major problem with *E. globulus*, but doesn't seem to be such an issue with monocalypts (stringybarks, peppermints and ashes).



The biocontrol agent *Enoggera nassau* was released and provided successful control for a while until a hyperparasitoid (*Baeoanusi albifunicle*) found its way across the Tasman. Now that *Enoggera* doesn't work very well, the search is on for an alternative. One proposal is *Cleobora mellyi* ladybird. Let's hope that one works, or we'll have to try Plan B: keeping damage below economic injury level with integrated pest management and acceptable sprays.

The damage has to be quantified, and biocontrol needs to be assessed for some other problematic pests. Blackbutt leafminer is a concern for growers of stringybarks in Northland. Leaf roller is most abundant on *Eucalyptus microcorys*, *E. nitens*, *E. fastigata*, and *E. saligna* but less susceptible species include *E. cladocalyx*, *E. baxteri*, *E. muelleriana*, *E. obliqua*, *E. globosidea*, and *E. regnans*. Shoot psyllids damage



DIVERSIFIED SPECIES THEME UPDATE

new growth of the *Symphyomyrtus* subgenus (includes red mahogany, boxes, gums, and tallow wood). Brown lacy lerp has caused a lot of damage to *E. botryoides* and *E. saligna* in the past, but this is now under biocontrol – although our *Paropsis* experience tells that this needs to be continually monitored. The gum leaf skeletoniser affects all commercial eucalypts, but particularly in Auckland, Waikato, Coromandel and the BOP. There has been no significant damage as yet, but there is the possibility of a “disease outbreak” so precautionary measures should be taken.

Visit to The Long Mile

Charlie Low & Heidi guided a small group of members through The Long Mile plantings – this was like stepping back in time. Not only are their numerous *radiata* archives, there is a myriad of other species plantings dating back 50 years or more. Many of these were planted by past forestry stalwarts such as Ib Thulin, and John Miller. There are definitely too many to mention here, but three of the older plantings stood out. The first, a 1961 *Abies* planting had many magnificent trees in it - it supported Charlie's *Abies* presentation of the day before very well. The second was a 1964 planting of *Pinus ayacahuite* – a Mexican white pine. The growth looked very impressive and this combined with reportedly very good wood properties suggests the species warrants further investigation. The third of these older plantings were 45 year-old *Eucalyptus regnans* planted by Mike Wilcox.



Very impressive regnans

These have to be some of the most impressive trees in The Long Mile with diameters approaching 1.5m and heights upwards of 70m.

In addition to these older plantings, there were many younger plantings of cypresses, redwoods and eucalypts – all of these provide very good support to the research programme.

Combined Dunedin field trip

It must be difficult to organise a field trip involving all four Themes, but this seems to have been achieved at the Dunedin meeting. Even if a topic does not fall within the immediate interest of an FFR member, it is nevertheless useful to be aware of developments in other areas and to meet the key personnel from other Themes.

The first stop was at a Douglas-fir thinning trial in Wenita's Berwick Forest. The trial runs along the top of a ridge at 530 m a.s.l., and had been established at 1940 stems/ha. The trial is a “response surface” – designed to yield the maximum information for the minimum number of plots – so it is not ideally suited for demonstration purposes, although it is vital for building models. Treatments were thinned to various stockings at various heights and the differences are clearly visible. There was some interesting discussion from the assembled experts about the cost and difficulty of thinning Douglas-fir to waste, particularly on steeper slopes. It is obviously important to investigate regimes that allow the possibility of profitable production thinning.

The next stop demonstrated modern harvesting techniques, and these were quite an eye-opener to those FFR members in unrelated areas. Unfortunately, a heavy shower precluded much discussion – but this may have been unnecessary: the operation spoke for itself. Trees were of very poor form (being on a ridge 650 m a.s.l. at Waipori) but the ability of the Cat 330 DFM felling machine, the Satco felling head, the Tigercat skidder, and the Cat 324 DL loader were clearly apparent. A feller-delimber-buncher is certainly impressive to watch and although it performs best in good stands, the demonstration showed it could also handle severely wind-damaged and malformed trees.

Further on was a trial of interest to several Themes. It was one of the 14 nationwide Long Term Site Productivity trials. It investigated the interaction of genotype and environment from the perspective of both growth and wood quality. Do some clones (ie genotypes) perform better in certain environments, or are the winners the best choices everywhere? The study examines three species as well as the effects on nutrient/water efficiency, and the disease resistance of different sites and genotypes. There is almost no



DIVERSIFIED SPECIES THEME UPDATE

overlap in growth performance, with radiata pine exceeding the growth of Douglas-fir which in turn exceeds the cypresses – but these are early days yet, some species being sprinters and others marathon runners. The best clones of a given species? It may not matter, because it is unlikely they could be widely deployed, but the scientific understanding they provide may be invaluable; for example, if clones with certain genes always do well under certain conditions, we would search for those genes in our breeding population.

After lunch, the group visited Millburn Timber Processing Site. To reduce transport costs, City Forests favoured local processing of their pruned resource. When converted to dried rough-sawn lumber, Machined Clear and Dressing Grade boards and Machined Mouldings (door jambs, picture frames and decking), much of the wood is exported to the USA, Australia, Spain and Asia. The site, in the welcoming Clutha District, was chosen after a failure to secure a consent for the original preference – on the Taieri Plains. A sawmill is eventually planned, but in the meantime a local sawmiller (Gorton Timber) is contracted and the Processing Site is limited to a drying operation with three large kilns, a sorting line, moulder and trim saw. The plant now produces 20,000 m³ of timber, some 98% of which is kiln dried.



For those who had not seen good cypress plantations, the macrocarpa thinning trial at McLaren's Road was an interesting experience. Under evaluation were three stockings (400, 800 and 1600 stems/ha) and four pruning intensities. In former times, foresters were keen to see the "results" of such trials, but the current approach is to use the data to create and calibrate computer models, so that the optimum physical and financial results can be evaluated on the screen. The small piece sizes and slow growth rates may be

disappointing to those more familiar with pine or eucalypt, but the cypresses produce very valuable timber, with no core-wood and minimal downgrade for green knots (thus enabling small logs to be sawn). Not surprisingly, the lowest stockings had the lowest total volume (200-250 m³ at age 22) but also the fattest stems (up to 43 cm MTD). The big contrast to radiata pine is that the lowest stockings were among the tallest of the treatments, although this may be an anomaly.

The last stop visited Wenita Forests Super Skid. Super skids have existed in New Zealand elsewhere for decades, but on far larger scale. The theory is that so much potential profit is lost by an inefficient operator on a normal skid site that it pays to transport the whole stem of the tree to a central point, where scanning technology combined with specialist expertise can optimise the bucking pattern. In this instance, we were lucky enough to see a large number of fire-damaged logs being processed. The wood sells at a \$5/m³ discount – a small reduction, but the charring damage seemed to be fairly trivial. The outer bark was blackened, but this is removed in processing albeit leaving some minor charcoal contamination on the sawlogs.