

Welcome to the latest update of the six-year 'Growing Confidence in Forestry's Future' (GCFF) research programme (Oct 2013 - Sep 2019). The programme involves a multi-disciplinary team of scientists at Scion and collaborators from other Crown research institutes and universities. It is jointly funded by the Ministry of Business, Innovation and Employment (MBIE) and the Forest Growers Levy Trust, with the support of the NZ Forest Owners Association (FOA) and the NZ Farm Forestry Association (FFA).

The research aims to raise the profitability of current and future commercial forests in a manner that is environmentally and economically sustainable. Detailed information about the research programme is contained in the research summary document available on the GCFF website (<http://gcff.nz/>) and the FOA website (www.research.nzfoa.org.nz).

Our newsletters provide a quick update of the key research activities and findings of the GCFF research

programme to a wide audience - from research, industry and iwi to policy makers. More detailed information on specific outcomes is provided through regular events (workshops, field days, annual conference, and innovation cluster meetings) and in peer reviewed science publications and technical reports (<http://gcff.nz/publications/>).

First results are now coming in from work that was started when the programme kicked off. Some of these were presented at the recent second annual GCFF programme conference in Christchurch in March. We would like to thank all the participants who attended and contributed to the discussions on the day and the conference field trip. Several members of the project team also gave well received presentations at the April NZ Farm Forestry Association Conference in Whangarei, Northland.

Peter Clinton
(Programme Leader) and the research team

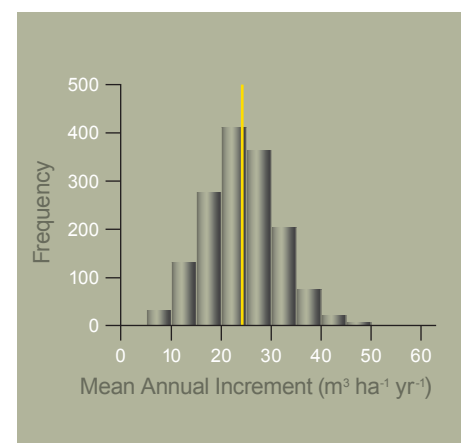
Research update

Is there a productivity gap in radiata pine and how big is it?

by John Moore

Data from the permanent sample plot system have been used to estimate the current level of productivity (in terms of maximum volume mean annual increment) in radiata pine forests and the gap between this and attainable productivity. Attainable productivity is defined as the maximum observed yield for a given combination of soil and climate. Based on data from almost 2500 plots established after 1975, the analysis showed that the current productivity of radiata pine forests is approximately 24 m³ ha⁻¹ yr⁻¹. The most productive plot

in New Zealand had a maximum mean annual increment of 61 m³ ha⁻¹ yr⁻¹ and a periodic annual increment for the past two years of over 100 m³ ha⁻¹ yr⁻¹. The 300 Index and stand density index (a measure of site occupancy) are able to explain over 90% of the variation in productivity and a benchmark level of productivity has been established for a given 300 Index. For a given value of 300 Index, there is a gap of approximately 5-6 m³ ha⁻¹ yr⁻¹ between current and attainable productivity. For a 30 year rotation and using current average log prices, closing this gap would yield another \$13,000 in gross revenue per hectare for forest growers. The productivity benchmarks developed here can be used by forest managers to determine how effectively they are using their sites.



Distribution of maximum MAI values from 2472 radiata pine plots throughout New Zealand that were established after 1975. The yellow line shows the median value of 24.2 m³ ha⁻¹ yr⁻¹.



Wood quality sampling in Atiamuri

by John Moore

A series of trials was established between 1987 and 1991 to examine the effects of seedlot and silvicultural regime, and their interaction, on the growth, yield and wood properties of radiata pine. Most of these trials will be harvested in the next few years, creating the opportunity to examine the effects of these variables at the end of rotation. Trials such as these are extremely rare anywhere in the world.

A silviculture breeds trials at Atiamuri (FR121/2) was recently assessed. Standing tree measurements were made in 2014 and discs were collected from log ends when the trial was felled in early 2015. Data were collected from five seedlots (GF7, GF14, GF16, GF25

and LI25) and six levels of stand density after thinning (100, 200, 300, 400, 600 and 1000 stems/ha). Preliminary analyses of the standing tree results showed that there was a significant positive effect of stand density on estimated wood stiffness (i.e. acoustic velocity), but the effect on wood density was less clear-cut. From a volume and value perspective, the highest gross revenue were obtained for the plots that had been thinned to a residual density of 400 stems/ha. Discs collected from the trial will be scanned using the new disc scanning facility being built by Scion. The results of which will enable the effects of seedlot and silviculture on end product quality to be predicted.

Woodhill long-term site productivity trial - an early look at what has happened to the soil resources

by Loretta Garrett



The Woodhill long-term site productivity trial (AK1029) and treatments applied at the beginning of the second rotation.

The Woodhill Long-term Site Productivity Trial offers a unique opportunity to assess soil changes over two planted forest rotations. Early results that help in addressing a knowledge gap - what is happening to our soil resource over multiple rotations? - are now available.

The Woodhill trial was started in 1986 to test the impacts of harvest removals and fertilisation on site productivity. The site has Typic Sandy Recent Soil low in carbon and nitrogen. Nutrient pools,

including soil, were assessed before the harvest of the first rotation in 1985 and again at the end of the second rotation in 2014. Some early results comparing 1985 soil data with 2014 soil data for the 0-10 cm soil depth showed no change in soil bulk density, total carbon and nitrogen, an increase in total phosphorous and a decrease in available phosphorous.

The treatments applied at the beginning of the second rotation showed that, with

severe organic matter removal (FF treatment) on these sandy soils, total carbon and nitrogen levels decreased in the upper soil only. With fertiliser application, total carbon and nitrogen increased to depth, but decreased available phosphorus, and total phosphorus in the top 10 cm of soil only. The application of fertiliser to the forest floor removal treatment was unable to restore soil total carbon and nitrogen to the initial values. The results show that, on a sandy soil like Woodhill, forest floor and harvest residue retention benefit soil carbon and nitrogen. The site is nitrogen deficient even with fertiliser application, indicating another over-riding limitation to the site. There is benefit in nitrogen fertiliser application, but there is a need to consider impacts on other nutrients such as a further decrease in available phosphorus.

This work provides a crucial insight into future productive potential of our planted forest. More than 50% of NZ's planted forest estate will soon be in its 3rd or 4th rotation. Next up is more comprehensive data analysis of Woodhill that will include the forest floor and the recently collected Tarawera long-term site productivity trial data. The findings of this work will feed into a site specific **Nutrient Balance Model (NuBaIM)** for improved nutrient management precision.

Boost to planted forest water quality research

by Loretta Garrett

Water quality research in New Zealand's planted forests has received a significant boost with the work of Dr Dan Neary from the USDA Forest Service. Dan has been working with Scion and Dr Brenda Baillie to pull together existing knowledge of water quality conditions under existing forest management and projections of possible future intensification management scenarios on water quality. Dan's time at Scion has come about through receiving a five month OECD Fellowship.

Key to the work is an assessment of the cumulative effects of the aerial

application of chemicals to water quality in planted forests. Among this assessment is consideration of the number of applications within a rotation; the time between treatments; the amount of area treated within a larger catchment; the fragmentation of the area treated; and thresholds of safe water quality - all of which have different consequences on the resulting water quality. The outcome of the work will be a cumulative effects framework that will have the ability to evaluate the environmental impacts of intensified regimes on water quality.

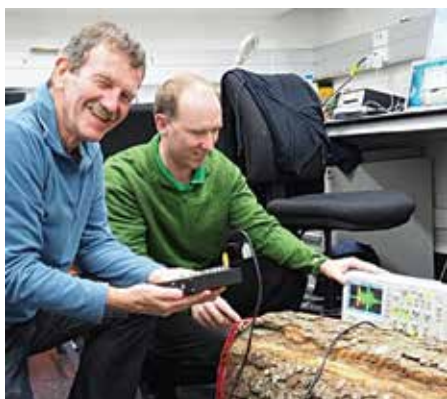


Dr Dan Neary

Developing capabilities

Students and a post-doc contribute to the GCFF programme

The GCFF research programme currently includes three PhD students and a post-doc. Two students were also employed over the 2014-15 summer. The work of some of the students is profiled below.



Stuart Bradley (left) and Mathew Legg (right).

Mathew Legg, post-doc, Physics Department, University of Auckland.

Project: GCFF RA1.1. Segregation of the current resource - acoustic methods to assess wood properties.

There can be significant variation in the properties of wood, even within trees in the same stand. If these properties can be measured, segregation can be performed so that individual tree stems are processed in a way that maximises profit. Acoustic methods are among the

most commonly used Non-Destructive Testing (NDT) techniques for measuring properties, such as stiffness, of tree stems for the wood industry. This project is investigating methods of improving acoustic techniques for measuring wood properties. A main focus is looking at ways of improving the accuracy of stiffness measurements on standing trees. The research explores new acoustic multi-path, multi-sensor, and imaging techniques that allow a better picture of tree structure. It is hoped that stiffness measurements that are more representative of the average stiffness of these standing stems than is currently achieved with existing acoustic NDT techniques will be obtained.



Grant Pearce

Grant Pearce, PhD candidate, New Zealand School of Forestry, University of Canterbury.

Thesis title: Leaf Area Index and Large Scale Fertility Assessment in Plantation Forestry

My research aims to develop methods for assessing Leaf Area Index (LAI) using LiDAR and satellite imagery in New Zealand's plantation forests. The ultimate goal is to establish whether LAI can be used as a proxy for assessing site quality over large areas. This would open the way for targeted mid-rotation interventions to boost productivity of the current crop. Fortuitously, my research coincided with the release of a new generation of instruments for measuring LAI and, with support from Scion and the GCFF programme, we were able to obtain these instruments. Early results are quite promising, and have demonstrated that the latest instruments make measurement of LAI far more accurate and easier to obtain.

A key benefit of integrating my research into the GCFF project has been the ability to partner with industry members who have contributed unique datasets to the project. This has given me an opportunity to develop a niche set of skills handling LiDAR data and the latest RS technologies. While my research still has some way to go, participating in the GCFF project has offered me a unique opportunity to develop capabilities with a suite of technologies which have promising applications in forestry.

Marta Gallart, PhD candidate, School of Biological Sciences, University of Canterbury.

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Marta Gallart

Thesis title: Developmental Plasticity and Resource Use Efficiency in *Pinus radiata*.

My research is focused on identifying the underlying factors and mechanisms driving phenotypic plasticity across multiple clonal *Pinus radiata* genotypes under different nitrogen (N) environments, organic N and/or inorganic N. Differential developmental tree responses are being used to elucidate the genotype by N

environment (G x E) interaction in a potted greenhouse experiment mirrored by a field trial. We hypothesise the genotype-dependant responses to organic and inorganic N are more or less sensitive to the carbon (C): N soil environment due to resource allocation in ectomycorrhizal fungal. As a means of explaining phenotypic plasticity, we aim to define the costs and benefits of this relationship by understanding the composition and structure of fungal/bacterial community.

I am contributing to the GCOFF research programme by expanding the mechanistic understanding of the complex nature of plant-soil relationships in order to minimise the environmental impact of forestry practices and efficiently use the limited resources. Moreover, my research project will help to improve the restoration and conservation efforts through increasing knowledge on how plant and soil communities impact on ecosystem functioning in response to disturbances and environmental changes.

Summer student

David Anderson (University of Waikato) worked with Sarah Addison and Simeon

Small on a project that examined a soil stimulant with the potential to enhance the rate at which soil organic matter is decomposed by soil organisms, making nutrients more available to plants. However, use of the stimulant comes with a risk – it is toxic to some plant life. Consequently, the project involved both a survival test, using a range of concentrations of the stimulant to test for negative effects, and a plant growth test, where the application of the stimulant was compared to control soils where nothing additional was added and fertiliser treated soils.

Radiata pine and maritime pine were used in the trials. Both showed no significant ill effects from exposure to the treatments, even at the highest concentrations. Not a single plant death occurred, even after the highest dosage rate was applied three times over six weeks. The growth of both species was enhanced by the presence of the stimulant, at a rate comparable to fertiliser addition, indicating that this treatment has real potential as a growth promoting option. This will be further explored in a longer term trial that will be established shortly.

Engagement

Update on the GCOFF innovation clusters

The GCOFF programme runs four specialty innovation clusters that aim to foster communication among the different stakeholders and engage in research developments and uptake and are open to all. Below is a short summary of recent activities and planning:

The Productivity Enhancement Innovation Cluster, jointly led by Peter Beets and Andrew Karalus, had its inaugural meeting on 5th Nov 2014 in Rotorua. Eighteen people took part, including forest growers, nursery managers, fertilizer specialist, researchers and others. Presentations were given a number of topics and discussions were held on which areas and activities to follow up on in the next couple of years. Among others, it is likely that a field day at Puruki, a soil sampling workshop and discussions on GxE trial thinning procedures will be pursued.

The first face-to-face meeting of the **Product Quality Innovation Cluster**, jointly led by John Moore and Graeme

Young, was held on 26th November 2014 in Rotorua. Among the 17 participants were researchers, tree breeders, wood processors, forest growers, log sellers and members from Solid Wood Innovation, and the Wood Processors and Manufacturers Association. The discussion focused on the three research priority areas: (1) wood quality of the current resource; (2) wood quality of the future resource; and (3) segregation and characterisation of the current resource. A follow-up event focused on segregation is planned for mid-year.

The **Phenotyping Innovation Cluster**, jointly led by Mike Watt and Aaron Gunn, held a video conference meeting in Christchurch/Rotorua on 23 March 2015 which was attended by 24 people.

Presentations were given on several topics including the use of terrestrial laser scanners for inventory, the use of remotely sensed data to predict productivity indices, current research around advanced methods to assist small to medium sized growers utilise LiDAR data, an update on LiDAR providers, technologies and projects, and an outline of the of Matakana Island LiDAR case study. The meeting went very well and there was animated discussion around a number of topics.

The **Sustainability Innovation cluster**, jointly led by Tim Payn and Brett Gilmore, is planning a number of field visits and topic specific workshops. Details on these activities will be available on the GCOFF website soon.

The FOA Forest Growing Research Conference

The FOA Forest Growing Research Conference was held from 29-31 October 2014 in Rotorua. The GCOFF research team presented highlights of the GCOFF programme. The conference field trip was organised with strong support from the team by identifying areas and topics to be visited and highlighted, organising the presentation of a UAV by the Aeronavics team, and supplying material for the field trip guide. A field trip presentation on the latest growth data from FR9 provided a real example of the gap between actual productivity and attainable productivity at a site.



The second annual conference of the GCFF research programme - "First glimpse at results"

The second annual conference of the GCFF research programme - "First glimpse at results" was held from 24-25 March 2015 in Christchurch. The conference included presentations on programme results as well as national and international keynote presentations on advances in productivity research in the Pacific North-west, international trends in water and forest research, and forestry and catchment management into the future. The second day was spent visiting a seed orchard and two Canterbury forests (Balmoral and Ashley) where genetic x environment issues, boron rate trials, radiata pine genetic gain trials, and some Douglas-fir related topics (Swiss needle cast) were discussed. All presentations are now available on the GCFF website <http://gcff.nz/news-and-events/gcff-2015-conference-presentations/>

They include:

1. Welcome and introduction (Peter Clinton, Scion)
2. What's in it for someone paying the Forest Grower's levy? (Russell Dale, FOA)
3. Advances in productivity research in the Pacific North-west (Doug Maguire, Oregon State University)
4. Is there a productivity gap and how big is it for New Zealand planted forests? (John Moore, Scion)
5. Prediction of site index and 300 index (a large scale case study) (Mike Watt, Scion)
6. Can we remotely sense phenotypic information from genetics trials? (Dave Pont, Scion)
7. Promoting growth: from glasshouse to the nursery and out into the forest (Simeon Smaill, Scion)
8. Quantifying wood property variation in radiata pine and the implications for segregation (John Moore, Scion)
9. International trends in water and forest research (Dan Neary, USDA Forest Service)
10. Nutrient management: How is the GCFF programme contributing to forestry's case for sustainable nutrient use in NZ forestry? (Tim Payn, Scion)
11. Long term site productivity trials - What happened to the soil resources? (Loretta Garrett, Scion)
12. Revealing the long-term impacts on soil microbial communities (Simeon Smaill, Scion)
13. Perceptions of erosion (Duncan Harrison, Scion)
14. Forestry and catchment management into the future (Simon Stokes, Bay of Plenty Regional Council)
15. Validation of a spatial economic model for planted forests (Richard Yao, Scion)
16. What is the full value of planted forests in New Zealand? The case of Ohiwa catchment (Sandra Velarde, Scion)
17. Forestry and dairy in the central North Island (Juan Monge, Scion)



"First glimpse at results" field trip.

International links

ForestSAT 2014. Scion's Mike Watt and Jonathan Dash attended the ForestSAT conference in Northern Italy in November 2014 and presented three papers. ForestSAT is the world's premier conference covering the use of geo-spatial and remote sensing technologies for forest assessment and forest management. Conference presentations were wide-ranging with topics including remote sensing of canopy chemistry, the role of remote sensing in monitoring carbon cycling, and forest inventory research. The conference was attended by 370 delegates, from 42 countries, and provided a great opportunity for learning, exposure to new ideas and networking.

To capitalise on new connections made at ForestSAT, and to further develop international linkages, Jonathan visited several leading European forest remote sensing research groups after the conference. Jonathan presented an overview of Scion's remote sensing research and discussed Scion's research direction. This prompted much discussion, sharing of ideas, and plans for future collaborations. Overall this was a highly successful trip and even the biting cold of the Scandinavian winter couldn't diminish Jonathan's enthusiasm for remote sensing research.

Looking ahead

Innovation cluster meetings.

Productivity Enhancement Cluster - **Soil sampling workshop**, 10.30 am - 6 pm, 14 May 2015, Christchurch - If you are interested in this workshop contact Graham Coker at graham.coker@scionresearch.com phone 03 364 2987 ext 7740 and view <http://gcff.nz/news-and-events/> A similar North Island workshop is also planned. Details TBC.

Forest Ecosystem Services (FES).

National Forum 'Integrating forestry in the landscape with other primary sectors', 19 May 2015, Te Papa, Wellington. Information and registration links at <http://gcff.nz/news-and-events/>.

FOA Annual Forest Growers Research Conference 2015. Nelson, 14-15 October 2015. (<http://research.nzfoa.org.nz>)

Selected recent publications related to the GCFF programme

Bayne K W. (2015). Wood quality considerations for radiata pine in international markets. *New Zealand Journal of Forestry*, **59** (4), 23-31.

Cown D, Dowling L. (2015). Juvenile wood and its implications. *New Zealand Journal of Forestry*, **59** (4), 10-17.

Marden, M, Basher, L, Phillips, C, Black, R. (2015) Should detailed terrain stability or erosion susceptibility mapping be mandatory in erodible steep lands? *New Zealand Journal of Forestry*, **59** (4), 32-42.

Moore J R, Cown D J. (2015). Wood quality variability - what is it, what are the consequences and what we can do about it? *New Zealand Journal of Forestry*, **59** (4), 3-9.

Wan X, Huang Z, He Z, Yu Z, Wang M, Davis M R, Yang Y. (2014). Soil C:N ratio is the major determinant of soil microbial community composition in subtropical coniferous and broadleaf forest plantations. *Plant Soil*. DOI 10.1007/s11104-014-2277-4.

Watt M S, Trincado G. (2014) Modelling between tree and longitudinal variation in green density within *Pinus radiata*: implications for estimation of MOE by acoustic methods. *New Zealand Journal of Forestry Science*, **44**:16.

Note: Results of this programme and related work are often published in the *New Zealand Journal of Forestry Science*. Access is open and publications are easily accessible through their website (<http://www.nzjforestryscience.com/>). Summary abstracts of other subscription only journal publications are typically available online through the individual journal's websites and full information can be obtained directly from the authors. The GCFF website <https://scionforestry-future.wordpress.com/publications/> provides the appropriate links to access the published information.

To learn more about the research projects in the programme:

Contact

Dr Peter Clinton at peter.clinton@scionresearch.com

Visit

the programme website at <http://gcff.nz/>

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