Project Update – January to June 2017

RESEARCH HIGHLIGHTS FROM THE PAST FEW MONTHS

- Marlborough Research Centre's Specialty Wood Products (SWP) work programme has included further growth and form assessments of 7 year old *E. bosistoana* and an assessment of early flowering. Also, an assessment has been completed of growth and form of 6 year old *E. globoidea* located in Juken NZ Ltd's Ngaumu forest in Wairarapa.
- Under their SWP work plans, the University of Canterbury (UC) has continued to make good progress with the further collection and analysis of cores from another 39 *E. bosistoana* families located in Marlborough and Canterbury. In addition, under their SFF project they have completed the cutting and assessment of another tranche of 2 year old nursery raised *E. bosistoana* seedlings to assess growth strain.
- Proseed has found significant variation in clonal propagation by coppice between *E. bosistoana* families.
- Myrtle rust has arrived in NZ and we need to wait to see whether it affects NZDFI species and operations.
- UC's entomologists have discovered there is significant variation in the level of insect defoliation between *E. bosistoana* families; also that significant defoliation does not severely reduce productivity.
- An initial assessment of the new eucalypt variegated beetle's species preferences has been made in NZDFI Hawke's Bay trials. .
- UC's research on the soil, topographic, and climatic variables that affect the growth of durable eucalypts has continued including the re-measurement of many PSPs, production of trial site DTMs and site soil sampling.
- On April 19th and 20th, the NZFDI partnered with UC to run a successful two-day workshop: **Ground durable eucalypts: Protecting and Enhancing Value.**

NZDFI's SWP Tree Improvement Programme update

from Paul Millen and Ruth McConnochie

2010 *E. bosistoana* breeding population growth and form assessment

In 2010, 40 families collected from the northern inland and the southern extremes of the natural distribution of *E.bosistoana* were successfully established in single-tree-plot incomplete block trials at three sites, two in Marlborough and one in north Canterbury. These added to the 66 families already planted in NZDFI's breeding populations in 2009.

In summer 2017, the families in the 2010 Breeding Population were measured for DBH and assessed for stem straightness and form at the Cravens Road site in Marlborough and the Martin site in North Canterbury. The trees were 6 years old.

The Cravens Rd site is prone to flooding, but otherwise sheltered with free draining soil being fertile alluvial stony silt. The Martins site is ex-pasture andexposed to the westerly winds with poorly drained heavy loam soils. These site factors are reflected in the growth and form results of each trial shown in Table 1. The growth at Cravens Rd is approximately 30% greater than Martins and stem form is significantly better at Cravens.

The poorer form at Martins is largely attributed to early toppling. There are significant differences in growth across families with a 51 – 54% increase in diameter between the worst and best families. This presents a promising opportunity to make large gains in growth with this species.

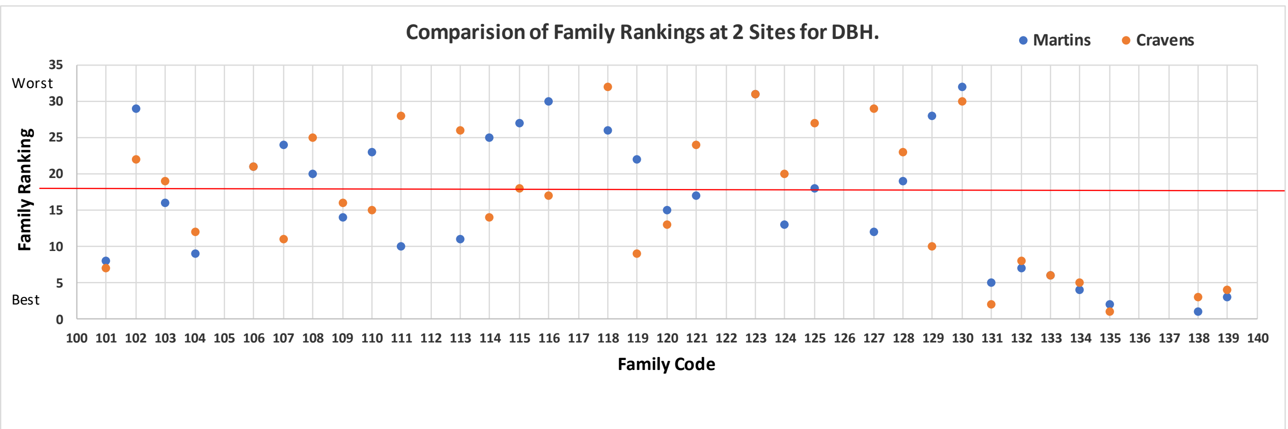
Survival is not reported as the Cravens Rd site has been thinned by 50%.

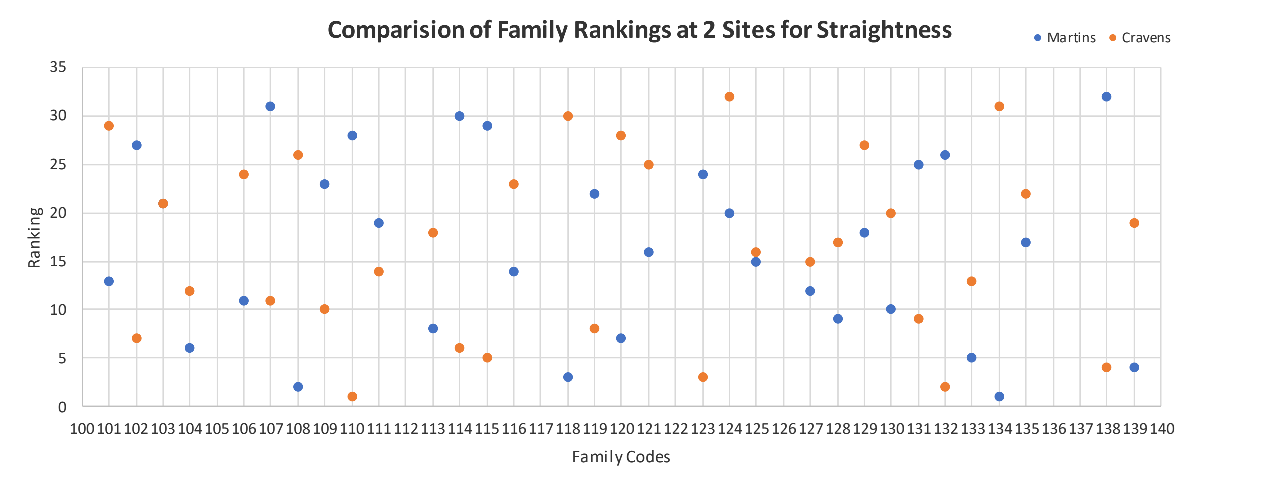
	DBH mm			Mean Straightness	Mean Form
	Min	Max	Mean		
Martins	44.6	94.1	62.8	3.6	3.2
Cravens	63.6	138.7	86.0	4.5	5.4
				1 -6 Scale 1= bad 6 = good	1-7 Scale 1= bad 7 = good

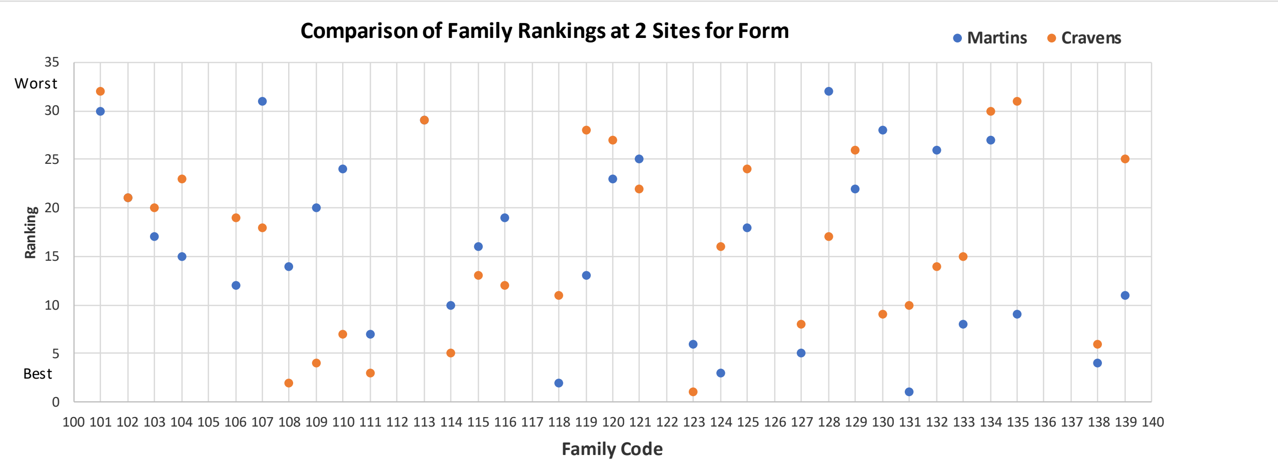
Table 1. Growth and form trait values for age 6 *E. bosistoana*.

It is important to understand the low level of genetic x environmental interaction and how consistently the families are performing between sites. Rankings are highly stable between the Cravens Rd and Martins sites for diameter (0.88) and straightness (0.75). The correlation for form is comparatively low (0.45). This is likely due to the toppling at the Martins site. These high correlations will enable selections for seed orchard establishment to be made this summer from the same best families at both sites.

The following graphs highlight those families that are consistently ranked high for each trait at both sites.







E. bosistoana flowering assessment and analysis

We want outcrossing between trees from different families through abundant flowering and open pollination. This will produce seed for collection from all elite families in NZDFI's *E. bosistoan*a breeding populations and deliver new improved genotypes to advance our breeding programme.

We have commenced monitoring the timing of flower receptivity of *E. bosistoana* to ensure that open pollination between families can occur within our original breeding populations. If concurrent flowering doesn't occur then controlled pollination may be required in a grafted seed orchard to ensure outcrossing.

Very little is known about the genetic and environmental factors influencing flowering of *E. bosistoana*. The Operations Manual of the CSIRO Australian Tree Seed Centre records *E. bosistoana* flowering in January and February. In Jan/Feb 2016, there were observations of a few trees flowering in NZDFI trials.

Flowering assessments were completed in our 2009 (age 8) and 2010 (age 7) breeding population at Cravens Rd and in the 2010 trial at Martins. Results are shown in the table on the next page.

	2009 Cravens	2010 Cravens	2010 Martins
Month of assessment	Feb	Jan	March
No. families in trial	60	33	40
% families flowering	51.6	84.8	50
% trees flowering	13.6	11.6	6.6

Table 2. Flowering of age 6 and age 7 *E. bosistoana* families

Despite the one-year age difference, there are a greater percentage of families with individuals flowering in the 2010 breeding populations than the 2009 breeding population. The northern and inland provenances of *E. bosistoana* may reproduce at a younger age than the southern families.

Many of the 2010 families are flowering at both Cravens and Martins sites suggesting that this trait could be under strong genetic control.

2011 *E. globoidea* breeding population growth and form assessment

NZDFI planted three *E. globoidea* breeding populations in September and October 2011 with 100-160 open pollinated families to select superior genotypes of this species for future deployment. Seed had been collected from across the natural range of the species in Australia and from three NZ plantation sites with a known seedlot. The progeny trials were planted at JNL's Ngaumu forest (Wairarapa); Avery (Marlborough) and Atkinson (Wairarapa).

The trial at Ngaumu was established across a predominately north facing slope within a second rotation cutover pine forest. Three issues affected early survival in parts of the site: (i) severe frost on lower slopes, (ii) mid slope springs resulting in water logged conditions and (iii) soil compaction from previous logging operations.

Height growth of surviving trees for first 2-3 years was slowed by slash and root systems needing to decay before releasing organic matter to the *E. globoidea* planting. For this assessment, diameter (DBH) was measured, with stem straightness and form assessed within blocks with more than 50% survival.

There is significant variability across the site, reflecting a combination of genetic and site influences. The diameter range is 30 – 163mm with an average of 68.1mm (trees less than 30mm DBH were not measured). Optimal growth was noted in the mid and upper slopes where there were some individual trees with diameters exceeding 150mm. Crown health is generally good although minor insect browse is evident on some trees. There was a lot of variability in stem form noted with some excellent form and others less so (See Figs 2, 3).

Although losses have significantly reduced the trees available for selection, enough survive to provide the opportunity for a full analysis and comparison with our 2011 *E. globoidea* breeding population located at Atkinsons in southern Wairarapa. This analysis will identify the best individuals in the top ranked families for propagation as grafts for a clonal seed orchard. The trial trees will be pruned and wilding pines removed by JNL.

Big thanks to Kat Gordon from JNL for assisting with this assessment.

Figure 1: A mid slope view across the 2011 *E. globoidea* breeding population at JNL's Ngaumu forest in Wairarapa.

Figure 2: A well-formed *E. globoidea* tree.

Figure 3:An *E. globoidea* tree showing repetitive forking.

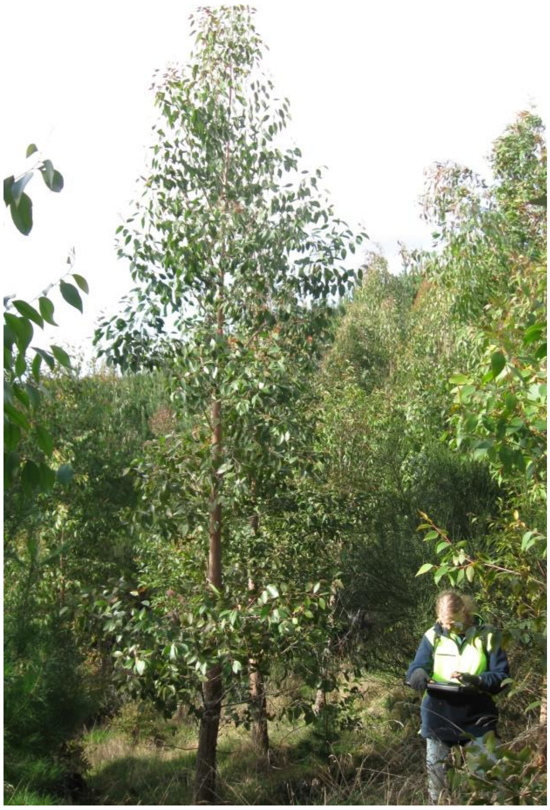


Figure 4: Kat Gordon, JNL's forester recording data in *E. globoidea* breeding population.

Wood quality research update

from Clemens Altaner

UC's SFF 407602 Project: Minimising growth-strain in eucalypts to transform processing

The Wood Quality research team have produced two new reports describing the first harvest and testing of *E. bosistoana* from the large trial planting at Woodville Nursery. The reports are available on the NZDFI web site link http://nzdfi.org.nz/news/woodville-harvest/

The reports cover the analysis of the first 4032 *E. bosistoana* trees from 81 families that were planted in February 2015 and then cut and processed using UC's growth strain splitting test in November 2016. . The top 25% of the trees were selected for clonal propagation and this has been underway with Proseed using coppice growth that grew over the late spring and early summer (See Propagation section p8).

Screening for heartwood in *E. bosistoana*

In the previous Project Update we reported on the analysis of the heartwood in cores collected by our post-graduate student, Yanjie Li, using our new corer, from the 66 families within the 2009 *E. bosistoana* breeding populations in Marlborough. These first results showed genetic influence between families in the production of heartwood by the trees.

Yanjie continued this work in April and May by taking cores to screen the 2010 *E. bosistoana* breeding populations for heartwood quantity (diameter) and quality (extractive content). All surviving trees were cored at two sites, one in Marlborough where 650 trees representing 35 families were cored; the other in Canterbury where 1115 trees were cored representing 40 families. Heartwood was highlighted and then measured by applying a pH indicator (methyl orange) to the core surface. Heartwood changed colour to pink while no colour change occurred when applied to sapwood (Figure 5).

Figure 5: *E. bosistoana* cores stained with methyl orange. Heartwood is highlighted pink.

NIR spectra were collected from the cores using a fibre optics probe and the extractive content was predicted for each spectra using a model we developed from the cores collected last year.

1351 of the 1765 *E. bosistoana* cores (76.54%) contained heartwood at age 7. The data is comparable to that obtained from the 2009 *E. bosistoana* breeding populations with the mean heartwood diameter over both sites being 26.24 mm and average sapwood diameter 63.63mm.

Trees were larger at the Marlborough site than the Canterbury site although the additional volume was largely sapwood with little or no heartwood observed in some trees. However, the larger trees had more heartwood although they do not necessarily produce the highest percentage of heartwood to sapwood. Variation in heartwood diameter was observed between the families (see Figure 6 below). This indicates genetic selection is possible to improve heartwood volume by selection of superior genotypes.

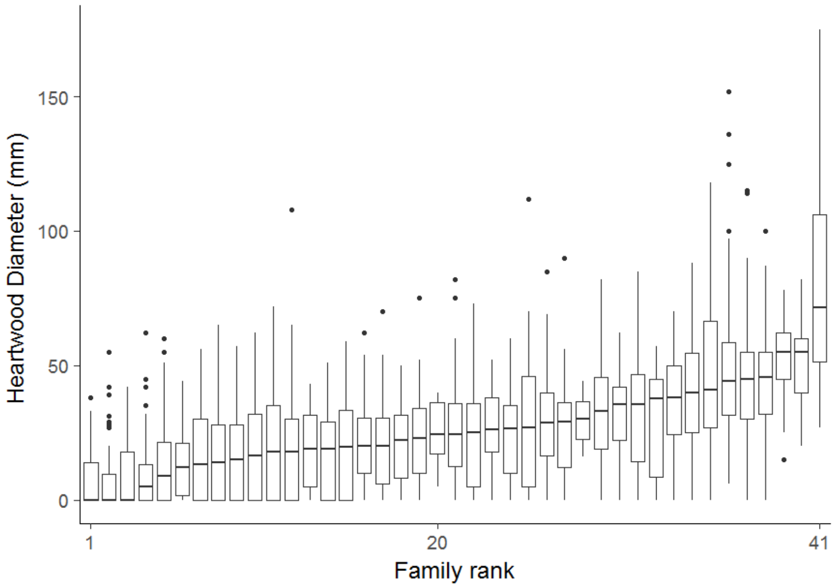


Figure 6: *E. bosistoana* families ranked for heartwood diameter at age 7 on 2 sites.

Similarly the results for extractive content (Figure 7) show a large variability between families (ranging from 0 to ~20%) and that selection of superior genotypes is also possible.

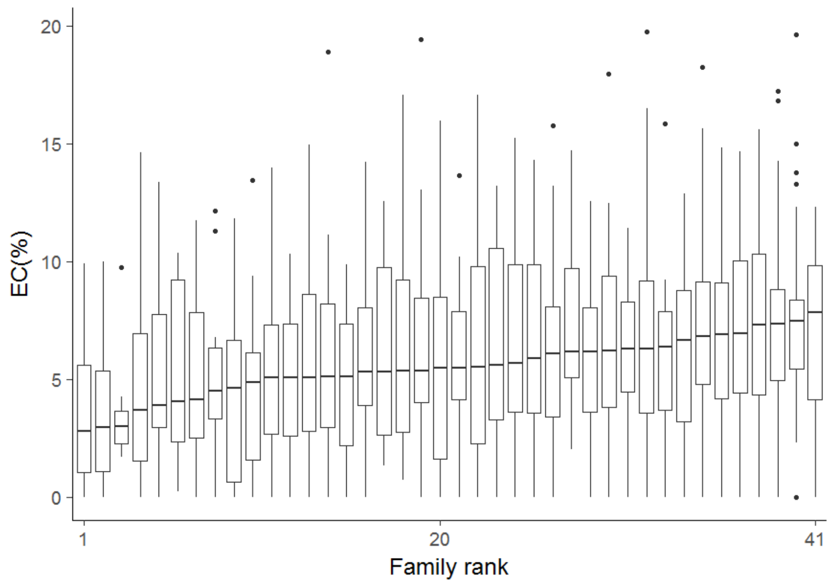


Figure 7: *E. bosistoana* families ranked for extractives content at age 7 on 2 sites.

Propagation research by Proseed
from Paul Schroeder

In November 2016 (as part of the SFF grant 407602), 81 families of *E. bosistoana* and a total of 4032 seedlings were cut and processed at Murrays Nursery, Woodville. The top 1000 trees (low growth-strain and large diameter) were marked for propagation by allowing the stumps to grow coppice shoots that were then harvested for vegetative propagation as cuttings (Figure 8).

Coppice was collected twice, in February and March. On each occasion coppice was cut from those trees which had grown shoots of the required size. Coppice was placed in polystyrene fish crates and transported overnight by refrigerated freight to Proseed's propagation facility at Amberley.

The scions were set within five working days. A total of 11,300 cuttings from 693 selections were processed . Replicates of cuttings were set in two different locations with varying climate control. It was not possible to collect material from all selected trees as not all trees had grown shoots of the necessary size before the end of the propagation season so these will be retained through winter and recut for new coppice in spring.

Successfully rooted plants are potted for growing on (**Error! Reference source not found.**9). Rooting success is under genetic control, with some selections achieving high success rates (70-80%) while others are very difficult to propagate (0%). The cutting-grown plants will be planted new clonal breeding populations in spring 2018.

Figure 8: Well developed *E. bosistoana* coppice growth prior to taking cuttings.

Figure9: Rooted *E. bosistoana* cuttings.

The next phase of propagation work will follow the cutting and coppicing of the second tranche of a further 68 families of *E.bosistoana* and a total of 4,155 seedlings that were planted in November 2015.

Myrtle rust alert

from MPI

Myrtle rust (*Austropuccinia psidii*) is a serious fungal disease that affects plants in the myrtle family. Plants in this family include a nuber of NZ native species including the iconic pōhutukawa and mānuka as well as eucalypts. It has been found in Northland, Waikato, Bay of Plenty and Taranaki. It is also widespread on Raoul Island in the Kermadec group, about 1,100km to the north-east of New Zealand.

Myrtle rust spores are microscopic and can easily spread across large distances by wind, or via insects, birds, people, or machinery. It is thought the fungus arrived in New Zealand carried by strong winds from Australia. There have been a number of significant weather events capable of transporting spores here and the discovery of the disease in large, established trees lends weight to this assumption.

MPI and the Department of Conservation (DOC), with the help of local iwi, the nursery industry and local authorities are running a large operation to determine the scale of the situation and contain and control myrtle rust in the areas it has been found.

For more information go to MPI's web site:

https://www.mpi.govt.nz/protection-and-response/responding/alerts/myrtle-rust/

If you think you've seen any signs of myrtle rust, don't touch it, take a photo and call 0800 80 99 66.

More information from Dr Tara Murray (UC entomologist)

Young soft foliage is particularly susceptible to myrtle rust and known eucalypt hosts grown in New Zealand include *E saligna, E. botryoides, E. pilularis, E. regnans* and *E. nitens* (Colley, 2005).

Australian researchers evaluating the effects of myrtle rust in Tasmania found there is a phylogenetic effect with the *Symphyomyrtus* group having more resistance to myrtle rust than the *Eucalyptus* group. (Potts, B., Sandhu, K., Wardlaw, T., Freeman, J., Li, H., Tilyard, P., Park, R. (2016) Forest Ecology & Management, 368:183-1930)

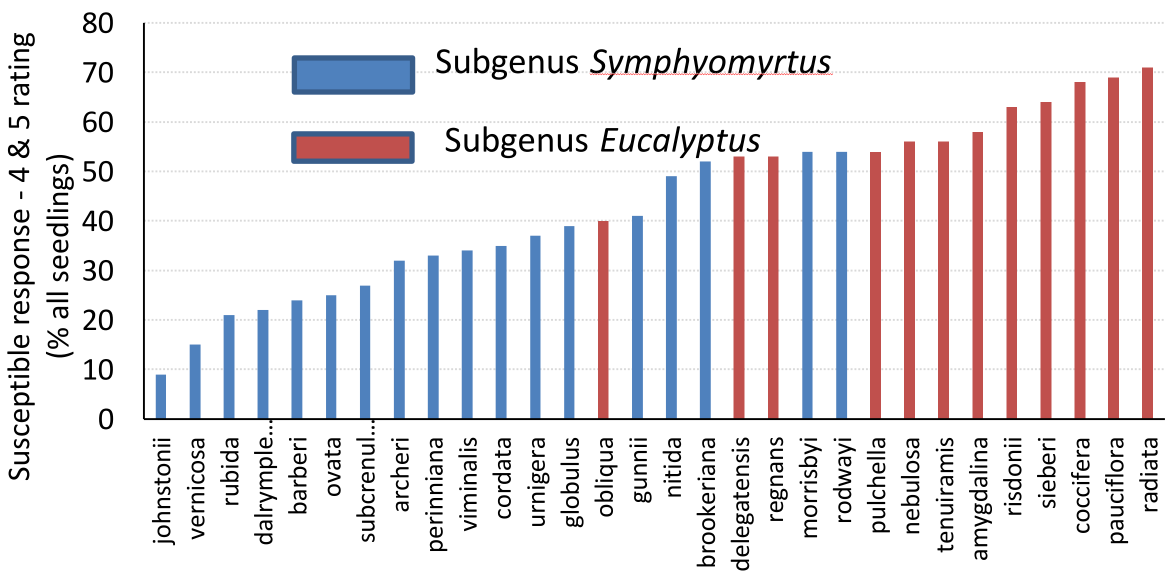


Figure 10: Susceptibility of Tasmanian eucalypt species to Myrtle rust (*Austropuccinia psidii)*

Modelling based on suitable environmental conditions for rust survival indicates much of the North Island (except the central plateau) and parts of Marlborough and North Canterbury can be expected to fall within the future geographical range of myrtle rust (Kriticos and Leriche 2008). This includes areas where durable eucalypts have already been established as part of the NZDFI programme.

It is unlikely myrtle rust can be eradicated so depending on the extent of its impact there could be the obvious need to identify the least susceptible eucalypt genotypes within the current breeding populations.

There are also potential implications for all other aspects of the durable eucalypt research programme which involve the movement of plant material. Therefore protocols are being developed and implemented with regard to the movement of plant material and personnel between field sites and between the field and research institutions to ensure we do not aid the spread of either pest or pathogen. This is planned over the next 6 months.

Initial results of Eucalyptus variegated beetle assessment in NZDFI's Hawkes Bay trials

from Huimin Lin

My research aim was to assess the initial incidence and defoliation caused by the Eucalyptus variegated beetle *(*EVB) *(Paropsisterna variicollis)* within durable eucalypt species trials already established close to the initial detection site in Hawkes Bay. Also to establish if the EVB has any early species preferences. A survey of three NZDFI *Eucalyptus* multi-species demonstration trials in Hawke's Bay was conducted in January 2017. This resulted in assessments of 11 species at one site planted in 2011, 10 species at another site planted 2011, and 8 species at a third site planted in 2014. Each species was assessed for defoliation level and numbers of eggs; larvae and adults were recorded using shoot counting method for the presence of EVB and *P. charybdis*. Tree height was measured for all assessed trees.

Key results:

1. *E. bosistoana, E. quadrangulata* and *E. tricarpa* sustained the greatest defoliation, and *E. macrorhyncha, E. cladocalyx,* and *E. globoidea* had the least.
2. Adult beetles were observed on all 11 species. The greatest abundance of *Pst. variicollis* eggs and larvae were on *E. bosistoana* while *E. macrorhyncha* and *E. globoidea* had the fewest.
3. *Pst. variicollis* was present in larger numbers than another well-established paropsine beetle *Paropsis charybdis* in two of the three sites.
4. These results confirm that *Pst. variicollis* is already widely spread in Hawkes Bay. It caused moderate to significant defoliation on some of NZDFI's durable eucalypt species. Its impact on tree growth in the trials needs further monitoring due to its wide host preference.
5. Parasitism of EVB eggs was observed in two sites but the agent (*Enoggera nassaui*, *Neopolycystus insectifurax* or an unknown species) was not confirmed.

A conference presentation and paper on EVB host preference in the three NZDFI trials in Hawke's Bay has been accepted for the NZPPS August conference proceedings.

Figure 11: EVB larvae in Hawkes Bay trial.

Figure 12: Adult Eucalyptus variegated beetle *(Paropsisterna variicollis).*

Figure 13: EVB larvae and suspected parasitized eggs.

from Ben McNeill, one of NZDFI's landowners with durable eucalypt trials in Hawkes Bay

The EVB got to huge numbers over summer and every new leaf was covered in larvae then suddenly in about March the *Cleobora* population bolted phenomenally.For a while there I was finding more *Cleobora* on the trees than EVB. Note *Cleobora mellyii* is an introduced ladybug for biological control of the Eucalypt tortoise beetle *(Paropsis charybdis)*. Late autumn growth flush was near perfect on the *E. quadrangulata*, but there are still issues on the recovery of *E. bosistoana* . So looks like *Cleobora* likes EVB and Tortoise beetle about the same. Looking through the *E. quadrangulata* coppice it was amazing every now and then (maybe one branch per 50 stools) you'd find a branch that the *Cleobora* had not found, totally covered in EVB larvae and all growing points eaten out. Maybe *Cleobora* have solved the issue.

Insect pest research update

from Huimin Lin

Defoliation trial

This research trial assessed the impact of simulated Eucalypt tortoise beetle (*P. charybdis)* defoliation on the growth of *E. bosistoana* in a plantation on a dryland farm in Marlborough. 142 trees in seven treatments were used to assess growth impact of different severity, frequency and timing of defoliation: control (undefoliated), moderate and severe defoliation in spring, summer and spring plus late summer respectively. Following defoliation in October 2015 (spring) and/or April 2016 (late summer), tree growth was measured over a period of 18 months at one to two month intervals during the growing seasons.

Key results:

1. Impact on stem and tree height growth was similar, but greater on stem growth;
2. Moderate and severe defoliation significantly reduced growth, except spring moderate defoliation. This implies that moderate defoliation in early spring alone may not warrant pest control.
3. Moderate and severe defoliation had a similar impact on tree growth;

4. Increasing frequency had greater impact on moderate than severe defoliated trees.

Family assessment trial

This research trial assessed variation in insect resistance and tolerance within *E. bosistoana* families. 237 trees were assessed representing 14 *E. bosistoana* families and 1 family of *E. globoidea* that was included for comparison (as it is the only monocalypt in the durable eucalypt breeding programme).

Each tree was assessed on four occasions from November 2015 – March 2016 and given four health scores representing natural damage percentage caused by the different guilds of insect herbivores as follows: 1) overall insect damage (all insects), 2) chewing damage (eucalyptus tortoise beetle and gum emperor moth), 3) mining damage (leaf blister sawfly), 4) leaf roll damage (eucalyptus leaf roller).

In the second season methods were refined such that a more rapid assessment could be made. Trees were assessed in January and April 2017 and given a score for each of the damage types 1 – 4 as above. Defoliation was recorded as a) little or no damage, b) light damage, c) moderate damage, d) severe damage. Tree height and DBH were measured in December 2015, February 2016, January and April 2017.

Key results:

1. Chewers inflicted the greatest damage and mining damage was relatively minimal.
2. Some provenances of *E. bosistoana* families sustained less or similar levels of overall and chewing damage compared to the single *E. globoidea* family.
3. There is wide family variation with some families preferred by the chewing insects and other families that are more resistant.
4. Despite being chewed some families managed to sustain moderate growth rates compared to others that were not preferred.

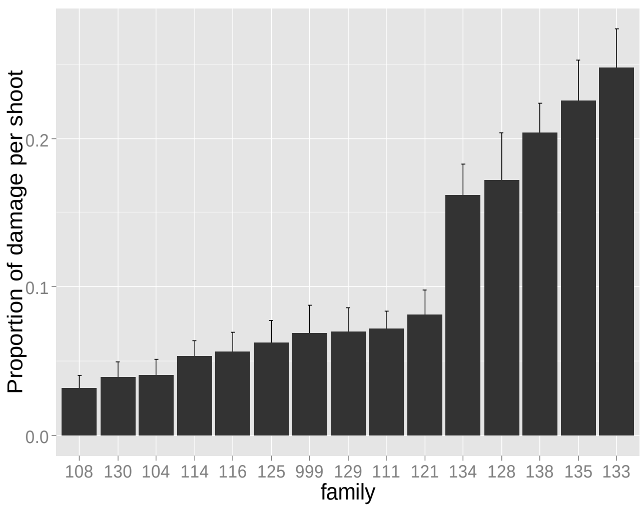


Figure 14: Ranking of E. *bosistoana* families from lowest to highest damage by insects. Note family 999 represents *E. globoidea* as a comparison (monocalypt species).

Site species matching and productivity research

from Jack Burgess

Throughout last summer and autumn, I undertook field work for my Masters project in a large number of the NZDFI trial sites, with the assistance of Satoru Kurabawa (UC Forestry student). We also spent a few weeks assisting Serajis Selakin (PhD student) with his field work.

Our major focus has been measuring thousands of trees in the PSPs spread across NZDFI's trial network from Bay of Plenty to North Canterbury. We also dug many soil samples and walked many kilometres in the trial sites capturing data with a Trimble Geo7x GNSS unit to develop high resolution maps of NZDFI's trial sites.

It was a real bonus we didn't need to use the Trimble unit for the sites in the Wairarapa and at Lake Taupo Forest Trust, as LiDAR tiles are freely available; here we only needed tree measurements and soil samples.

One of the biggest challenges I had was measuring the NZDFI trials in Gisborne. There are two demonstration trial sites, one coastal and the other inland. My first trip in April was washed out thanks to Cyclone Debbie so I made another trip in June. The second trip was much more successful and we got everything needed at both sites.

Figure 15: UC forestry student, Saturo Kurabawa measuring two year old *E. globoidea* in a durable eucalypt demo trial planted in 2014 by Lake Taupo Forest Trust.

More recently Serajis, Satoru and I visited Marlborough once more to set up anemometers (wind speed) at the *E. globoidea* breeding population at Avery's, also re-measure more trials and collect soil samples.

In between trips away to collect data, I have been busy checking data as it includes observations from assessments started in 2012 and as well as the data I have collected for NZDFI every summer since 2014. The total number of observations is now over 80,000.

I have used data from the Trimble Geo7x GNSS unit or local LiDAR to create high quality Digital Elevation Models (DEMs) for each site. Using the DEMs, I am now developing high quality slope maps, aspect maps, curvature maps, wetness index maps, and wind exposure maps for every site. See examples below.

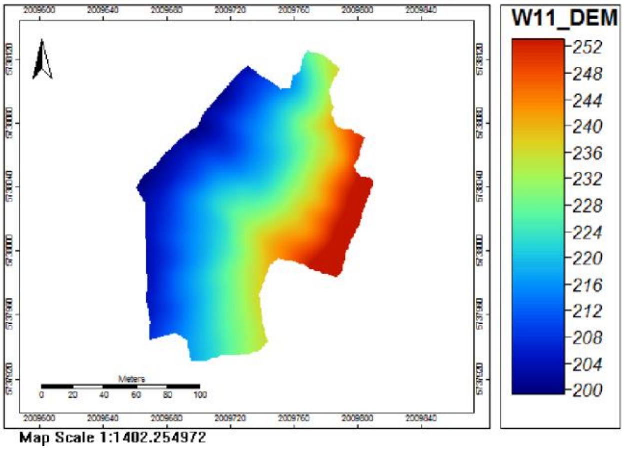


Figure 16: Wishart 2011 Demo Trial DEM – Elevation in legend (m)

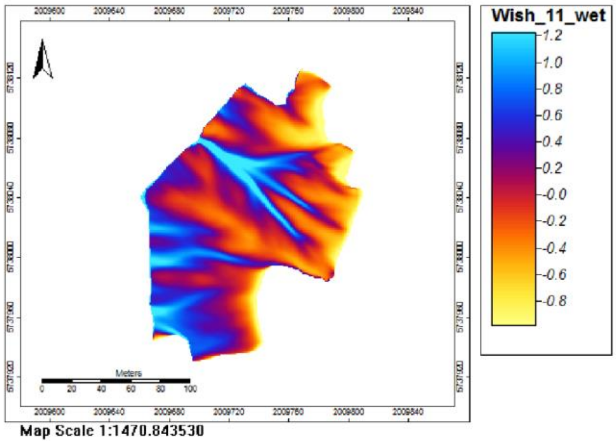


Figure 17: Wishart 2011 Demo Trial Wetness Index

My next step is to analyse the 70-plus soil pits we dug that will help interpret the variation across some sites in potential water holding capacity of the soil.

I will then develop a statistical model to predict tree height at a given age for each species to see which sites predict taller trees, and compare this to the actual site data.

Thanks to all the NZDFI landowners whose properties I have been able to visit. Also thanks to the UC Foundation, Marlborough Research Centre, Neil Barr Farm Forestry Foundation and Forest Growers Levy Trust for funding my research work.

UC's NZDFI research workshop at Marlborough Research Centre

from Clemens Altaner

On April 19th and 20th, the NZFDI partnered the University of Canterbury School of Forestry to run a two-day workshop: **Ground durable eucalypts: Protecting and Enhancing Value.**

Around 55 people attended the workshop. The high-calibre participants included Swedish, Austrian and Chinese scientists and forest industry representatives. International speakers travelled from Australia and Japan, while a USA scientist presented via a Skype link.

The first day comprised a series of presentations at the Marlborough Research Centre's excellent conference facility in Blenheim. On the second day, participants visited a NZDFI trial site on Marlborough District Council land at Craven's Road. Here they saw science being put into practice, as the site is an *E. bosistoana* breeding trial site. University of Canterbury PhD student Yanjie Li also demonstrated the sophisticated coring tool developed to enable cores to be taken from thousands of young trees. The cores are then tested for extractives content, potentially a guide to future durability of the timber.

Participants also visited Nelson Pine Industries laminated veneer lumber (LVL) plant in Richmond, Nelson, where eucalypt veneer has been trialled as a component of LVL.

Videos of all Day 1 presentations, plus pdfs, are available on our web site: http://nzdfi.org.nz/news-and-events/resources/workshop-durable-eucalypts-protecting-and-enhancing-value/

Conference proceedings will also be produced in due course.

The international experts that contributed to this workshop as well as the international team on SWP's External Advisory Panel have critically reviewed NZDFI's SWP research programme. These experts from universities and industry provided positive feedback ranging from tree breeding to matching sites; tree health to wood science; processing and timber engineering. Their valuable input will help to guide our continuing research programme.

Thanks go to our sponsors: MPI, AGMARDT, Neil Barr Farm Forestry Foundation, the Specialty Wood Products Partnership, and the Marlborough Research Centre.

A final word from Paul

This Project Update is much longer than I had planned but the last six months has seen the NZDFI research gain significant momentum. This has only been possible due to the substantial funding that both University of Canterbury and the Marlborough Research Centre are receiving from the MBIE/FGR Specialty Wood Products Programme. There has also been all the work by the UC team on their MPI-funded SFF project focused on reducing growth strain in durable eucalypts.

It is very exciting to see the results that are coming through. At the same time flowering is commencing in our breeding populations and the same can be expected in Proseed's grafted seed orchards in the next year or so. Once we have abundant flowering and subsequent seed production, we can start to make improved material available to the supporters and landowners who have got behind our research programme.

We also received significant recognition by MPI in the recent '1000 SFF projects' celebrations, when NZDFI was chosen as one of 33 projects to best highlight the achievements of the Sustainable Farming Fund. The projects are described in a full-colour booklet produced by MPI's Sustainable Farming Fund team. Read all about us on pages 32-33.

Download a copy of the booklet here: SFF-1000-Project-report-WEB (1)

So thanks to all for their continuing support and hope the rest of winter treats you well!

Paul Millen

Figure 15: Late January – 6 year old *E. bosistoana* flowering and setting seed.