FOREST GROWERS RESEARCH CONFERENCE FIELD DAY NOTES

THURSDAY 13TH OCTOBER 2016

NZDFI NEW ZEALAND DRYLAND FORESTS INITIATIVE
breeding tomorrow's trees today

Notes for visit to NZDFI trial at Rick Alexander's property,

458 Omapere Road, RD 9 Hastings.

Introduction

In July 2008, the New Zealand Dryland Forests Initiative (NZDFI) was established by founding partners; the Marlborough Research Centre Trust (MRCT), Proseed NZ Ltd, Vineyard Timbers Ltd and the University of Canterbury.

NZDFI is a collaborative tree breeding and forestry research project to improve drought tolerant eucalypts that produce high quality naturally ground-durable hardwood required for New Zealand's agricultural, transport and energy sectors as well as specialty wood products for export to international markets.

NZ's east coast faces increasing drought and high intensity storms due to climate change. These regions need new land use options that can diversify regional economic development.

Our vision is for New Zealand to be a world-leader in breeding ground-durable eucalypts, and to be home to a valuable sustainable hardwood industry based on 100,000 hectares of eucalypt forests, by 2050.

NZDFI's unique research focus and strategic vision will benefit future generations of New Zealanders by delivering to NZ forest growers the plants and knowledge to select and grow the species best suited to their site and to learn how to economically produce a high quality durable wood product that meets the requirements of domestic and international markets.

Growing durable eucalypts will diversify future income and enhance environmental sustainability by combating soil erosion due to eucalypts extensive root systems that coppice (re sprout) following felling. Eucalypts can rapidly sequester carbon while supplying bees and native fauna with nectar/pollen and have low wilding risk.

The delivery of NZDFI's vision lies in encouraging both excellence and innovation in education as knowledge is the key to NZ's success in the global economy. Therefore, central to our strategy is developing a world leading team of new researchers based at the NZ School of Forestry, University of Canterbury (see Appendix below) that are able to ensure elite germplasm and best practice management systems are developed for durable eucalypt forestry in NZ drylands.

The Speciality Wood Products (SWP) partnership commenced from 1st July 2015. This partnership between Ministry of Building Innovation and Employment and Future Forests Research (FFR) now funds both the University of Canterbury and the Marlborough Research Centre Trust to continue NZDFI's durable eucalypt tree improvement programme until 30th June 2022.

Field Day visit to NZDFI species demonstration trial at Rick Alexander's property

The field day visit is to a NZDFI durable eucalypt species trial planted in 2011 by Rick Alexander at his central Hawkes Bay property (see attached location map). His site is one of twenty five trial sites established by NZDFI from 2010-2014 as a series of species demonstration trials to evaluate the potential adaptability, productivity and management of durable eucalypts. The establishment of these trials was supported by the Ministry of Primary Industries Sustainable Farming Fund.

The trials are located in Marlborough, Nelson and North Canterbury regions as well as in Central North Island, Gisborne, Hawkes Bay, Horizons and Wairarapa regions. There are five NZDFI trial locations within the Hawkes Bay region that have all shown average to high growth rates for most of the species being tested when compared to species performance in trials in other regions.

Species represented at the site

A total of 39 trial blocks were planted with 49 trees per block in a square spacing of 2.8 m between trees and between rows. There were 11 eucalypt species and radiate pine included. All were replicated in two, three or four trial blocks across the site.

All eucalypt species included in the trials produce naturally durable timber and were also selected for their proven frost and drought tolerance as demonstrated through NZ farm forester observations or records and/or from observations and records of their occurrence in Australia. Table One below presents the botanical name, common name and durability classifications (ref: Australian Standard AS 5604) for all species planted.

For most eucalypt species, broad-based unimproved seed lots were imported from Australia and root trainer seedlings were propagated for planting into trials. The exception is the *E. cladocalyx* seedlings were produced from 1st generation seed orchard seed sourced from CSIRO. The pine seedlings were produced from GF 19 seed.

Table One: Natural durability classification of species included in NZDFI trials planted 2010-2014

Botanical name	Common name	AS 5604 In ground durability	AS 5604 Above ground
E. argophloia *	Qld western white gum	1	1
E. bosistoana	Coastal grey box	1	1
E. camaldulensis	Red river gum	2	1
E. cladocalyx	Sugar gum	1	1
E. eugenoides	Thinned leaved stringy bark	3	2
E. globoidea	White stringy bark	2	-
E. longifolia	Woollybutt	1	1
E. macrorhyncha	Red stringy bark	3	1
E. notabilis	Blue mountains mahogany	-	-
E.quadrangulata	White topped box	2	2
E. tricarpa	Red ironbark	1	1

Note * durability classification reported in State of Queensland, Department of Agriculture, Fisheries and Forestry, *E. argophloia* fact sheet 2013.

Species performance at the site

The survival and growth rates demonstrated by all species represented at this site has been surprisingly good given that it's a north facing slope with a NIWA estimate for average rainfall of 800 mm. Being located at an elevation of 120 m and about 26 kms inland, it gets a reasonable number of frosts but is warm and dry in summer. The site is well drained with soil being a limestone derived sandy loam.

An assessment of survival and height of all live trees within the trial has been completed on a number of occasions and most trial blocks are now being measured as Permanent Sample Plots. Measurements were last completed in January 2016 (tree age 4.4 years) and a basic analysis of this recent data set for survival and height growth has been made with similar data recorded in April 2014 (tree age 1.6 years).

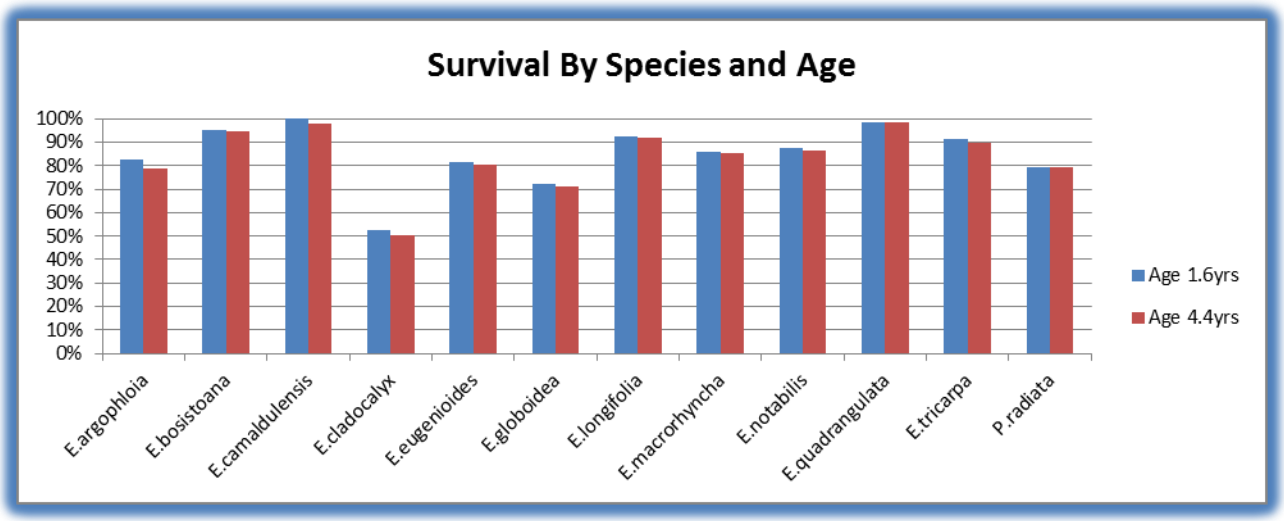
This analysis is presented in Table Two and Graphs One, Two and Three below.

Table Two: Survival and height growth within Alexander's species demonstration trial planted in 2011

	No. Hgt Trees		Min Hgt (m)		Avg Hgt (m)		Max Hgt (m)		% Survival	
	Age		Age		Age		Age		Age	
Species	1.6	4.4	1.6	4.4	1.6	4.4	1.6	4.4	1.6	4.4
E.argophloia	78	77	0.2	1.0	1.3	3.8	2.0	5.7	83%	79%
E.bosistoana	173	183	1.0	1.8	1.9	5.4	2.9	7.6	95%	95%
E.camaldulensis	192	188	1.2	1.5	2.3	5.4	4.5	10.3	100%	98%
E.cladocalyx	75	74	1.0	3.8	2.1	6.1	2.8	8.7	52%	50%
E.eugenioides	153	157	0.4	1.8	1.6	4.6	2.8	7.2	82%	81%
E.globoidea	129	139	1.0	1.7	1.9	6.0	2.9	8.6	72%	71%
E.longifolia	125	132	1.0	1.7	2.1	4.9	3.1	7.2	93%	92%
E.macrorhyncha	165	162	0.7	1.6	1.4	5.1	2.4	7.9	86%	85%
E.notabilis	82	85	1.0	1.5	1.8	4.0	2.8	5.5	88%	87%
E.quadrangulata	145	144	1.1	3.9	2.3	7.0	4.6	9.9	99%	99%
E.tricarpa	177	175	0.7	1.8	1.6	4.8	2.7	6.9	91%	90%
P.radiata	39	38	0.8	3.1	1.6	5.6	2.4	8.0	80%	80%

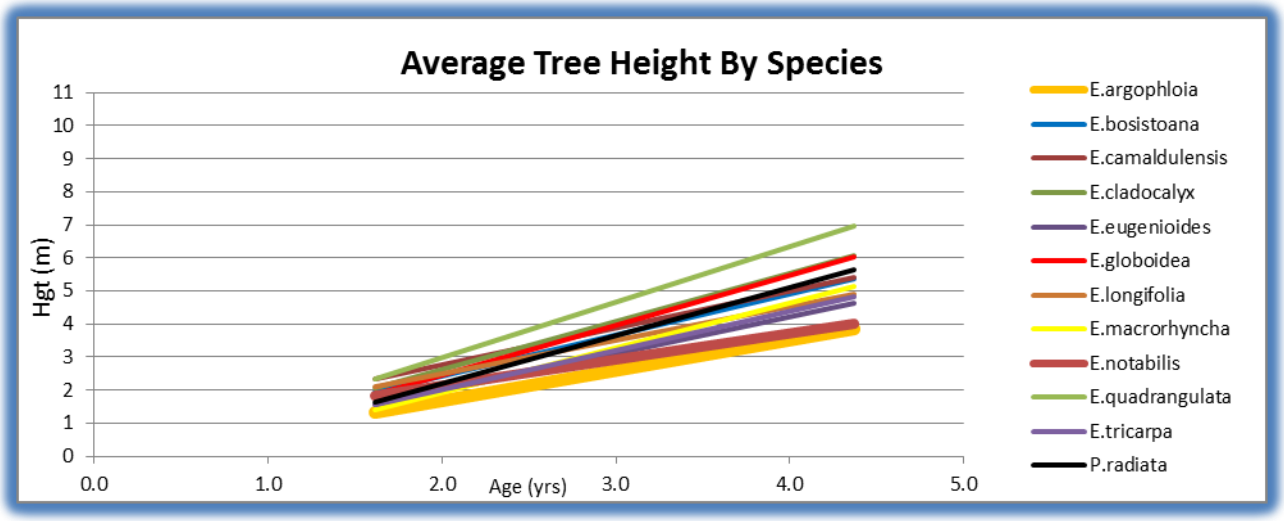
Across the site there has been high survival for most species (80% or more) except E. globoidea (72%) and *E. cladocalyx* (50%). However, for both of these species there were losses due to frost damage in the winter following planting, particularly in one area of the trial, where frost was severe.

Graph One: Survival within Alexander's species demonstration trial planted in 2011



The height analysis shows that the fastest growing three species on the site as *E. quadrangulata* (average height 7m)*, E. cladocalyx* (average height 6.1m) and *E. globoidea* (average height 6m) with the average height of all other species being between 3.8m and 5.5 m.

Graph Two: Average height growth of individual species within Alexander's species demonstration trial.



Graph Three: Maximum height growth of individual species within Alexander's species demonstration trial.

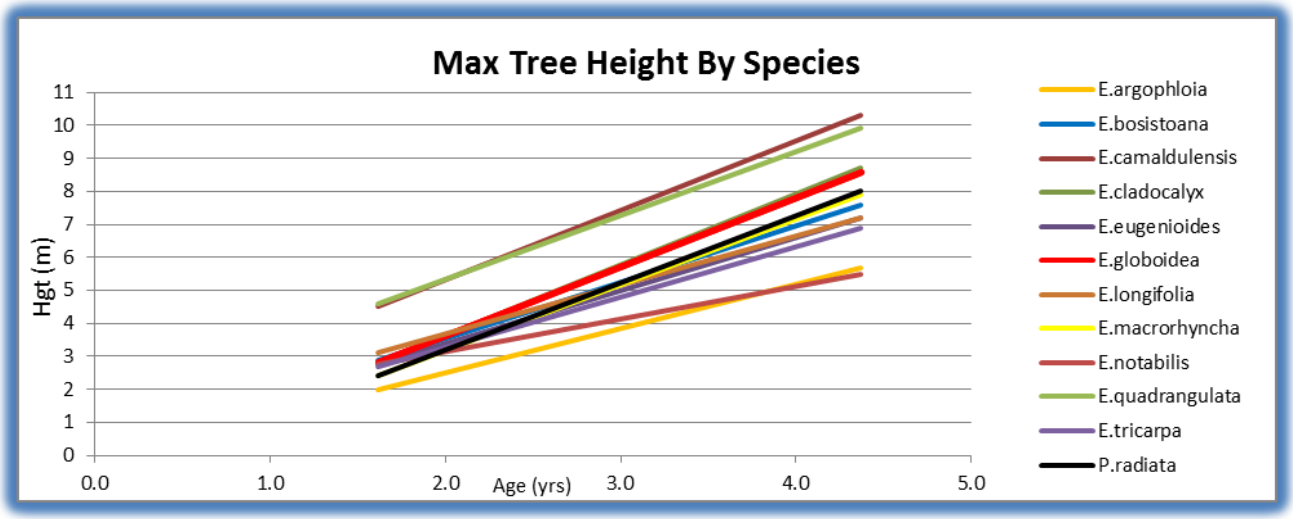
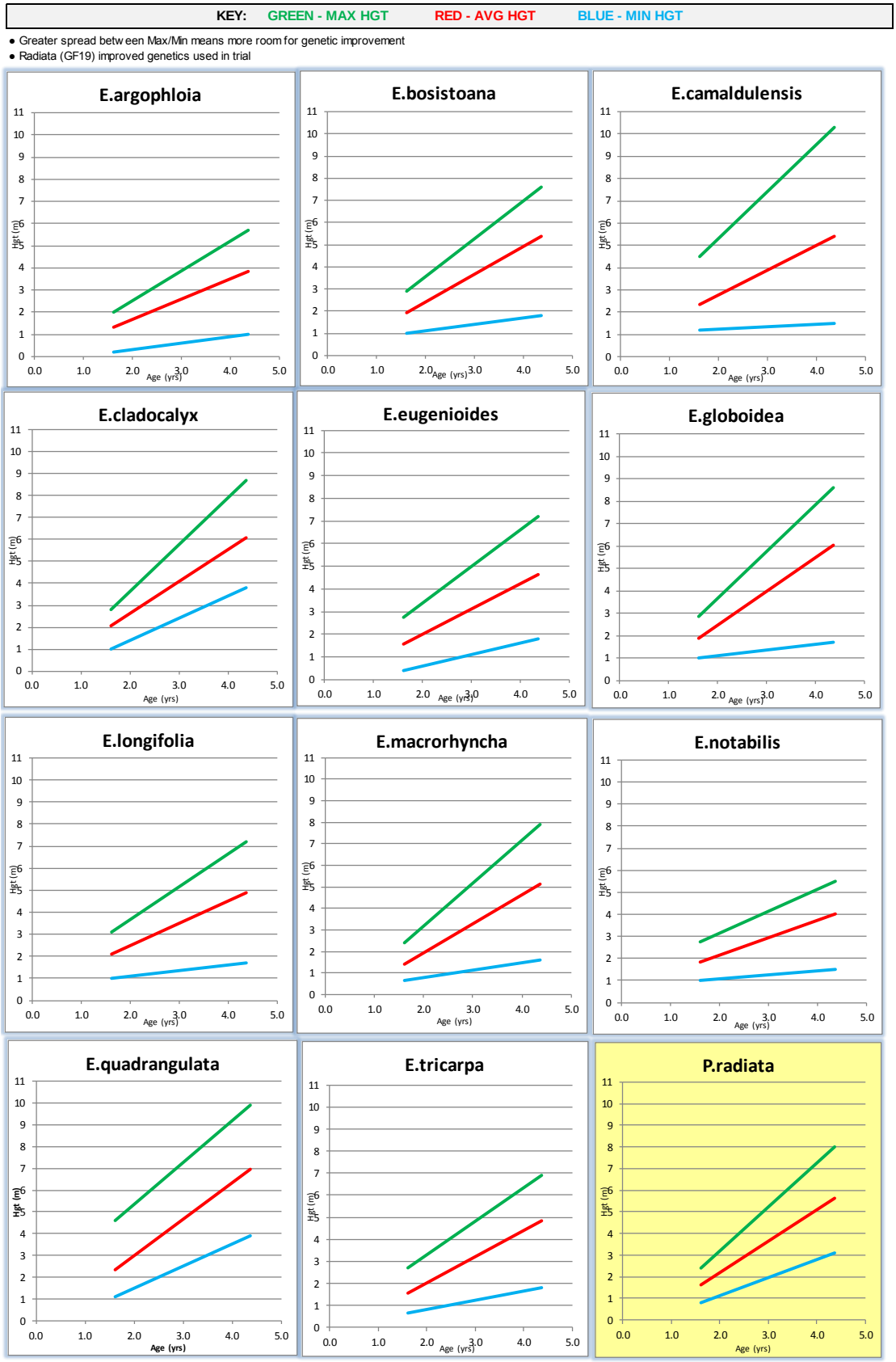


Table Three below is a set of graphs for each individual species that present the average height as well as the height of the fastest and slowest growing trees that were measured. These graphs show there is wide variation between the fastest and slowest growing individuals for most of these species. This variation in growth is typical of plantations of eucalypts being grown from unimproved eucalypts.

Table Three: Individual species graphs of average height growth and the fastest and slowest growing trees.



Trial silviculture

All trees within the trial were form pruned in April 2014 followed by some faster growing species being low pruned in 2015. In July this year, the best trees for all species were selected by Rick and given a variable pruning lift. At this stage only the unpruned trees have actually been thinned from the fastest growing block of *E. quadrangulata* as a possible assessment of the trees to be thinned from the other blocks is under consideration.

Table Four: Trees selected for pruning within Alexander's species demonstration trial planted in 2011

Landowner:	Alexander	**Assess Date:**	13-Jan-16	
Trial Type:	Demo	**Prune Date:**	6-Jul-16	
Plant Date:	Sep-11	**Assess Age:**	4.4	yrs
		Prune Age:	4.8	yrs

Spp	No. Blocks	No. Planted Trees	No. Live Trees	No. Pruned Trees	Survival	% Live Pruned
E.argophloia	2	98	77	29	79%	38%
E.bosistoana	3	147	143	53	97%	37%
E.camaldulensis	4	196	192	77	98%	40%
E.cladocalyx	3	147	74	42	50%	57%
E.eugenioides	3	147	126	45	86%	36%
E.globoidea	3	147	112	57	76%	51%
E.longifolia	3	147	135	63	92%	47%
E.macrorhyncha	3	147	133	55	90%	41%
E.notabilis	2	98	85	35	87%	41%
E.quadrangulata	3	128	126	86	98%	68%
E.tricarpa	4	196	176	65	90%	37%
Total	**33**	**1598**	**1379**	**607**	**86%**	**44%**

Species flowering observations at the site

Flowering observations have been recorded to capture what has been seen during successive PSP measurement visits. This includes recording which trees for each species are showing one or more of the following; flower bud development, inflorescence present, seed capsule development and mature seed present.

The first species that had an individual tree or more start flowering at age 3 was *E. cladoclayx.* During an assessment in January this year 77 % of all surviving *E. cladoclayx* trees were developing buds that would have flowered in February and March and will now be carrying seed capsules. Other specie recorded also developing flowering buds this January included *E. bosistoana* (0.5%), *E. eugenoides* (43%), *E. globoidea* (20%) and *E. macrorhyncha* (23%).

APPENDIX ONE - UC's School of Forestry Science Team that undertake NZDFI's research programme.

Core research is supported by the MBIE and industry funded Speciality Wood Products Research Partnership as well as NZDFI partners and the School of Forestry. Growth strain research is funded by the MPI and industry through the Sustainable Farming Fund. Site-species matching research is supported by an Agmardt Agribusiness Innovation Grant.

The research programme includes:

- **Wood quality (Dr Clemens Altaner)**

  Wood varies in its properties. However, only heartwood which is rich in extractives and easy to process is of value. Good quality will be ensured through a breeding programme, where trees are selected at young age for heartwood quality and quantity as well as low growth-strain. Research is underway by four PhD students:

  Nick Davies (PhD candidate) is currently screening the entire breeding population of two durable eucalypts for low growth-strain. This is only possible after the development of a novel and fast growth-strain assessment applicable to young (age 1-2) trees. By next year improved germplasm will have been propagated.

Fei Guo (PhD candidate) is developing a non-destructive and quick analytical technique to assess strain in solid wood. Current procedures to measure growth-strain are destructive and laborious. His work could make it possible to segregate logs which are suitable for solid wood processing from existing pulp wood plantations.

Yanjie Li (PhD candidate) is screening the durable eucalypts for heartwood. Sampling trials is only manageable thanks to the development of a novel hand-held, battery-powered coring system. The cores are analysed for heartwood quantity and quality. Heartwood quality is only measurable (on the required number of samples) after developing a fast spectroscopic technique to predict extractive content. Extractives are the main factor giving heartwood colour and durability.

Gayatri Mishra (**PhD candidate**) is investigating the process of heartwood formation in young trees. Heartwood formation in young trees has not been studied before. However, heartwood formed by young trees differs from that of old trees as does corewood from outerwood. Exploring the feasibility of early screening (age 1-2) for heartwood, i.e. before heartwood is formed in trees, is also part of her work.

- **Site-species matching (Dr Justin Morgenroth & Professor Euan Mason)**
  Different species of eucalyptus have widely varying responses to environmental stresses like freezing air temperature or low soil moisture content. By modelling the growth of eucalyptus as a function of topographic, edaphic, and climatic site characteristics, we stand to improve our ability to select the most appropriate species for any given planting site. We aim to produce suitability maps for dryland eucalyptus species based on micro-site environmental monitoring.

  Serajis Salekin (PhD candidate) is modelling growth and yield of *Eucalyptus bosistoana* and *E. globoidea* based on topographic, climatic, and edaphic variables. He has measured over 20,000 trees at sites in Marlborough and the Hawkes Bay and has begun analysis to see whether the species are sensitive to within-site differences in elevation, aspect, radiation, temperature, and soil moisture, amongst other factors.

- **Forest Health (Dr Tara Murray**)

  Around 30 insect species specialise on *Eucalyptus* in New Zealand, including several that can cause significant damage. However, susceptibility to insect attack is highly variable. By identifying the most insect tolerant and resistant trees able to withstand and recover from herbivory we aim to future-proof the NZDFI resource against pest damage. Mapping pest biology and phenology will further aid in the prediction and sustainable management of pest outbreaks.

  Huimin Lin (PhD candidate) is conducting defoliation experiments to assess the growth impact of severe and moderate herbivory when inflicted on 5-6 year old E. bosistoana in either the early or late part of the growing season. She is also assessing the degree of insect attack on different genetic families and mapping the phenology of key insect pests in the Marlborough region. Her work on defoliation impacts and local insect lifecycles will help us select more tolerant breeds and inform pest management practices.

- **Genetics and Tree Breeding (Associate Professor Luis Apiolaza)**
  Breeding exploits the genetic variability of our species to select, mate and deploy trees with superior growth, wood durability and low growth-strain. Breeding trials also provide the scaffolding that connects the different research topics in NZDFI. We collaborate with researchers in wood quality, growth modelling and forest health to account for the family structure (and its interaction with the environment) when explaining the varying performance of the NZDFI species.

For more information about NZDFI check out their website: www.nzdfi.org.nz