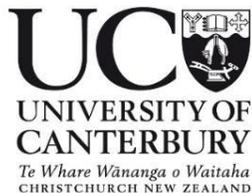# SLMACC PROJECT 406896

MARLBOROUGH REGIONAL DURABLE EUCALYPT FORESTRY AND BIOMASS CASE STUDY

Durable eucalypt forestry for heartwood, biomass and for carbon sequestration
Background science

Friday 16th February 2024

Euan Mason

University of Canterbury — Te Whare Wānanga o Waitaha — Christchurch New Zealand

NZDFI — New Zealand Dryland Forests Innovation — Breeding durable hardwood | Whakatipu taikākā mauroa

XyloGene — Durable Eucalypts by NZDFIP Ltd

NZDFI SLMACC Project 406896 objectives

1.   Develop *E. bosistoana* and *E. globoidea* tree-level models of biomass & carbon storage.

2.   Evaluate use of drone-based LiDAR data for estimating tree size, biomass and carbon storage of *E. bosistoana* and *E. globoidea*.

3.   Complete four Marlborough farm/forestry/vineyard property case studies based on analysis of GHG emissions and carbon sequestration by existing *E. bosistoana* and *E. globoidea* plantations.

4.   Complete a regional case study on how naturally durable hardwood forests could contribute to sustainability and reduce greenhouse gas (GHG) emissions in Marlborough's wine industry through a sustainable supply of:
- naturally durable posts
- sawn timber
- biomass for bioenergy.

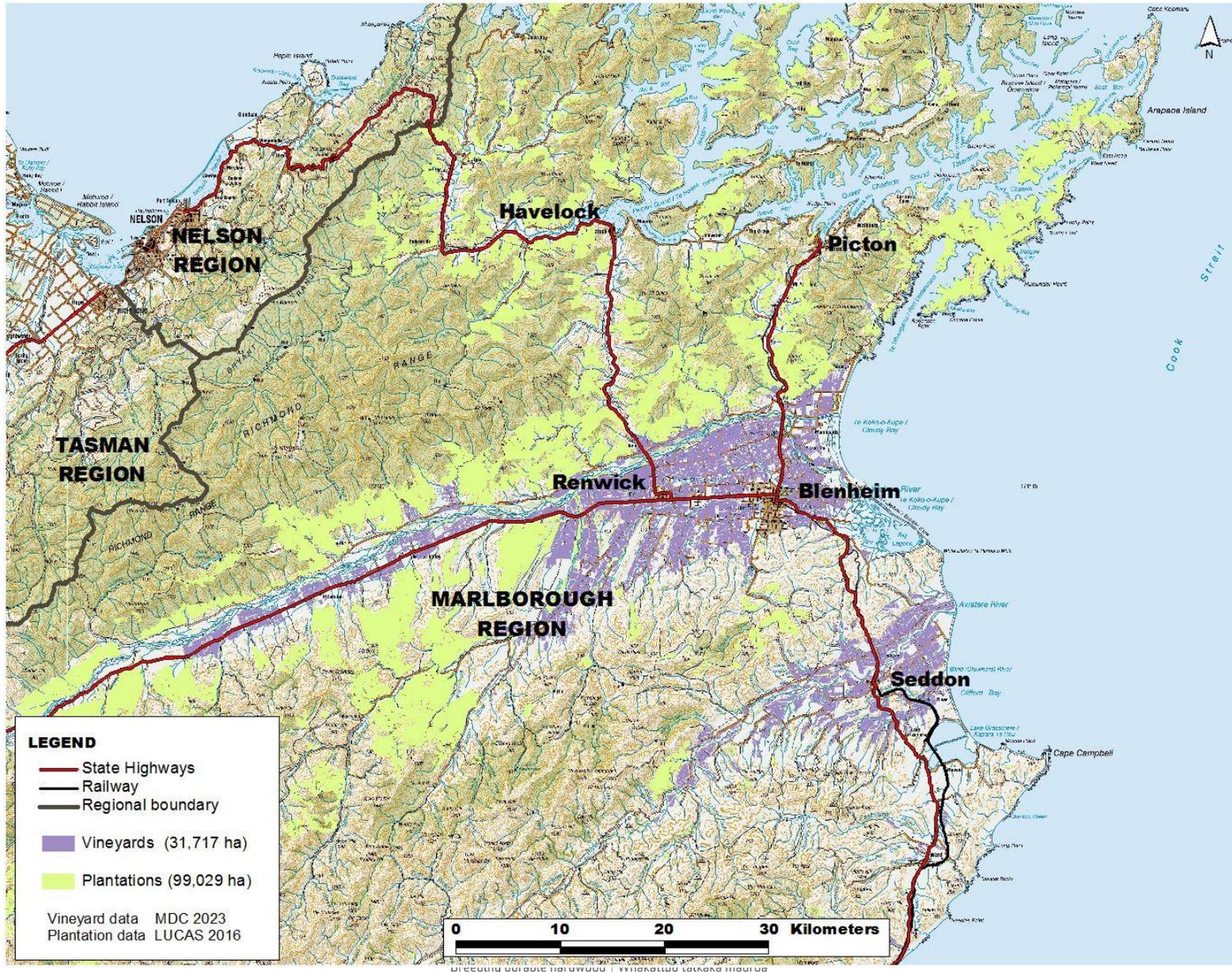5.   Communicate and promote the project outcomes.

Natural forest (including DOC land) and
Land Use Capability class 6 and 7 land
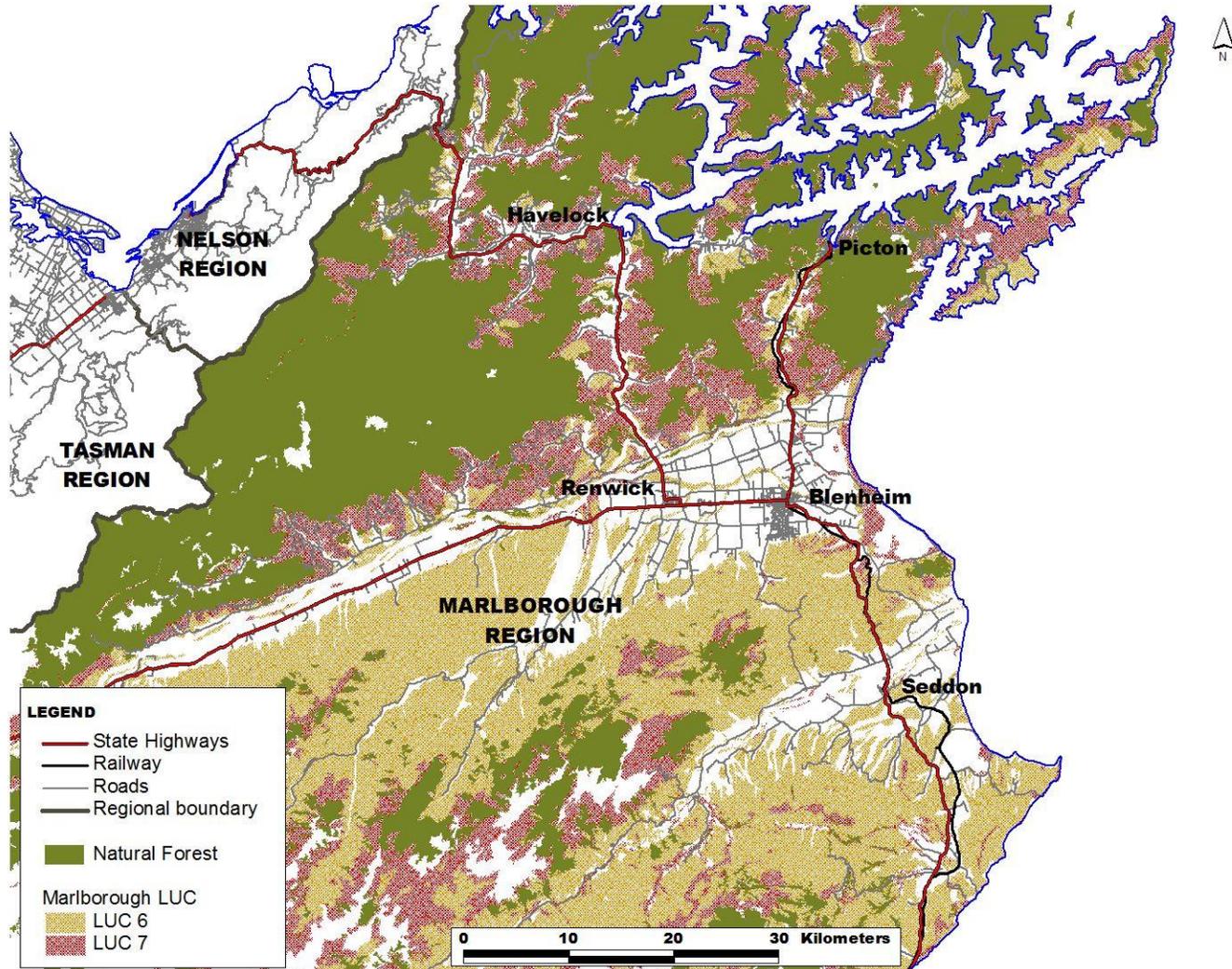
North Marlborough sub region dominated by natural forest and class 7 steeplands (much of this in plantations).

South Marlborough sub region has little natural forest and extensive areas of class 6 hill country (some plantations but much of it dryland farming).

Marlborough's wine and forest industries

LEGEND
State Highways
Railway
Regional boundary
Vineyards (31,717 ha)
Plantations (99,029 ha)

Vineyard data MDC 2023
Plantation data LUCAS 2016

Our durable eucalypts 'coppice' i.e. re-grow from the stump

Coppicing tree species offer several advantages:

- Breeding and propagation.
- Multiple rotations from one planting.
- Popular for short rotations.
- Reduced erosion risk on steep slopes.

Disadvantages:

- May need form pruning
- Replacement of stand needed with improved genetics but this is not so important if good genetics planted in the first place

Funding NZDFI R&D programme

Nine successful work programmes have funded 15 years' of R&D.

- 2008-11   AGMARDT Innovation regional project

- 2010-2019   3x MPI Sustainable Farming Fund projects

- 2015-2023   MBIE/FGR Specialty Wood Products programme

- 2020-2022   TuR One Billion Trees partnership project

- 2023   2x FGR ITP projects

- 2022-2024   current MPI SLMACC project

A list of our failed proposals would fill at least another two slides!
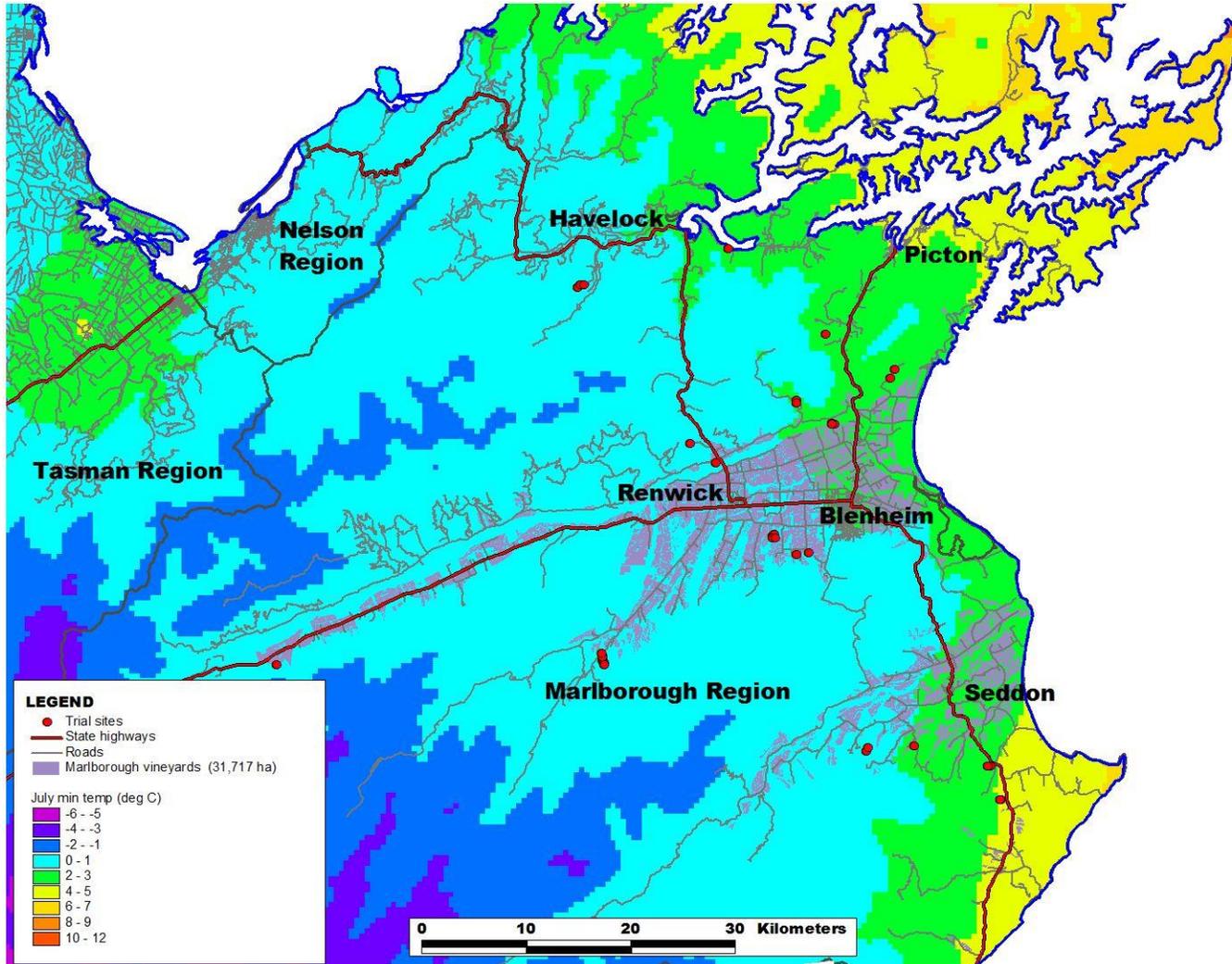
Marlborough Climate influences on landuse
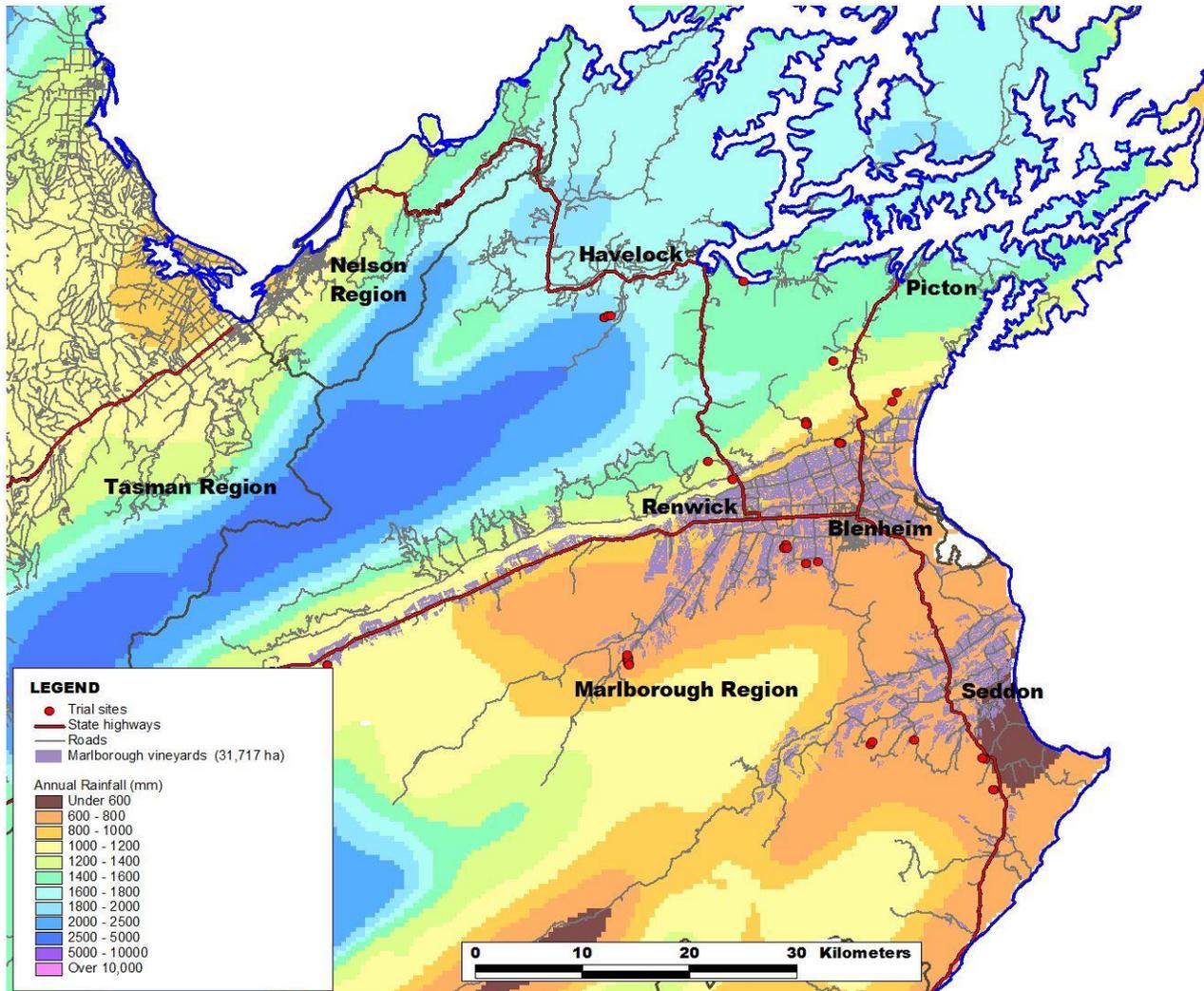
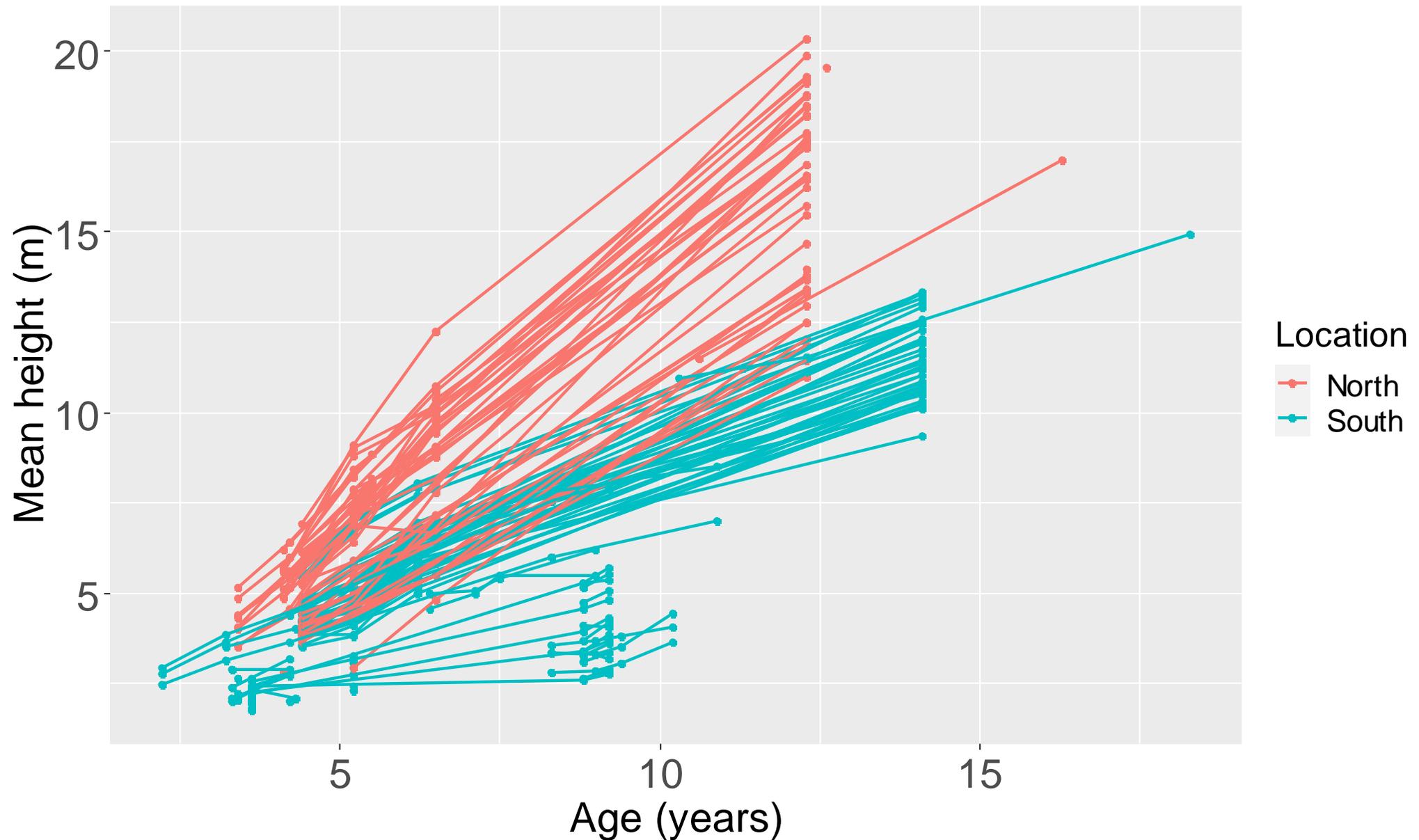Marlborough's climate is strongly influenced by its regional location and geography.

Mountains to the south and west create a rain shadow resulting in one of NZ's driest regions able to produce some of NZ's best wines.
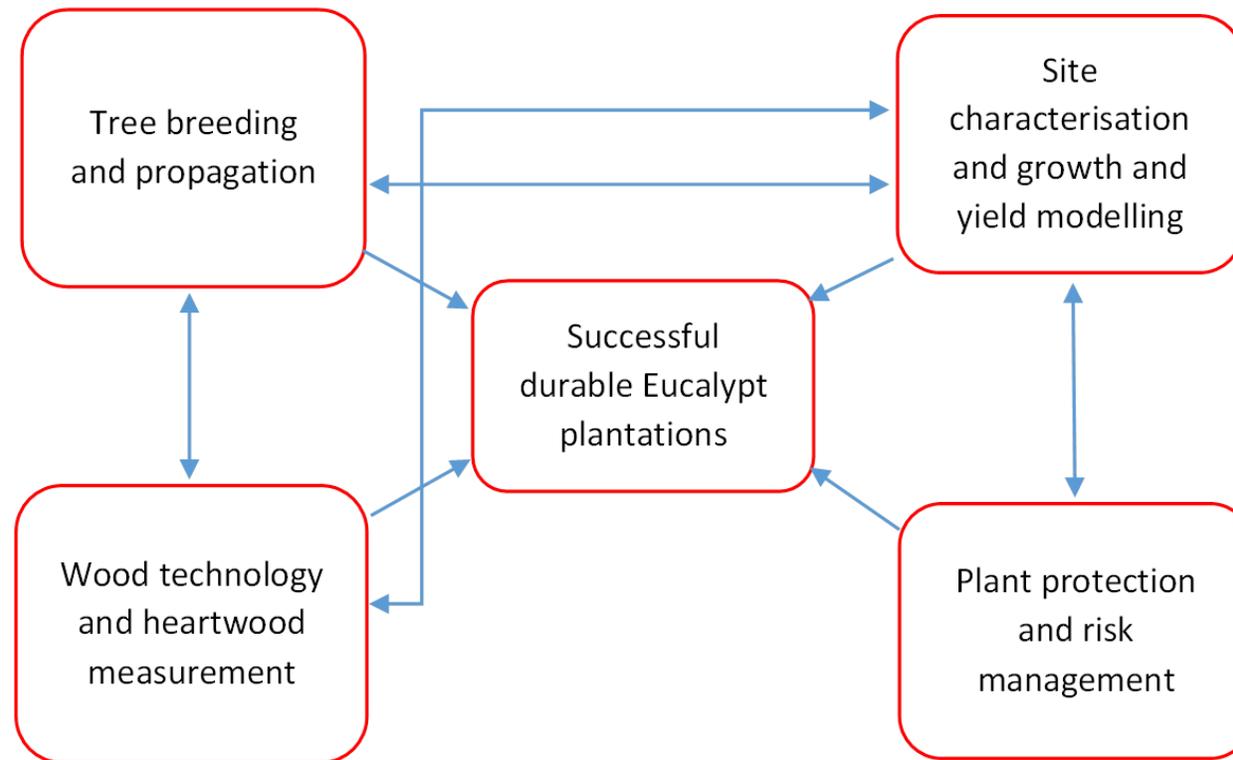
Marlborough Climate influences on landuse

The Marlborough Sounds and south eastern Pacific coastal areas are 2 to 7 degrees warmer than the inland regions of the Pelorus, Wairau and Awatere River catchments.

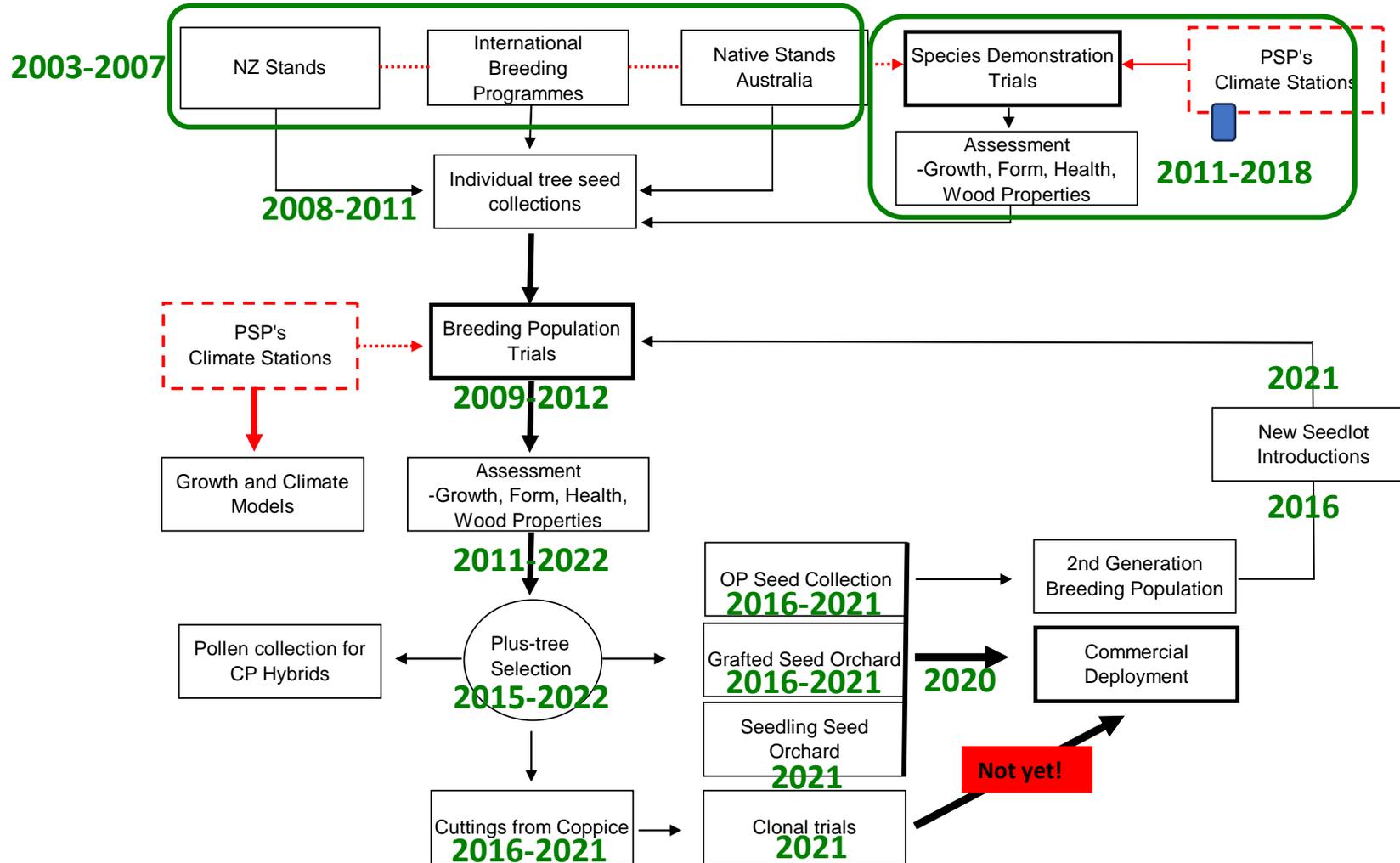*E. Bosistoana* experimental data in Marlborough

NZDFI's forest research programme

NZDFI Tree Improvement Programme
E. bosistoana and *E. globoidea*

The NZDFI breeding and demonstration trial site network

37 landowners host breeding and demonstration trials across over 40 different sites.

The trial network is the foundation of NZDFI's improvement programme with over **500** pedigreed families of five different species.

248 *E. bosistoana* families
162 *E. globoidea* families

These sites and additional demonstration trials contain approx. 700 permanent sample plots (PSPs).

Assessments for Plus tree selection

E. Globoidea progeny trial at Avery property, Grassmere, south Marlborough

Planting in 2011
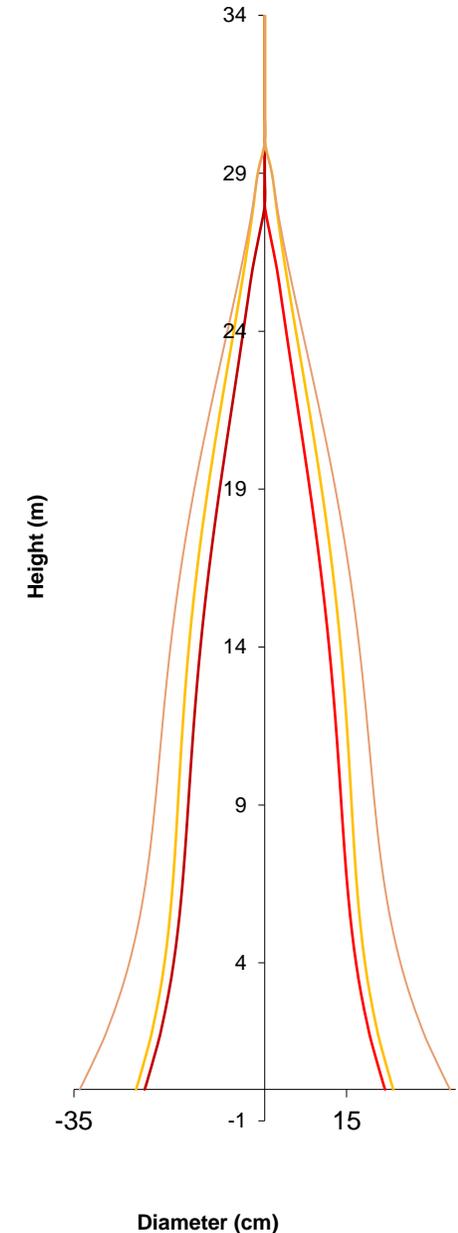
Biomass sampling

- Candidate trees measured
- Trees marked in the field
- Priorities set
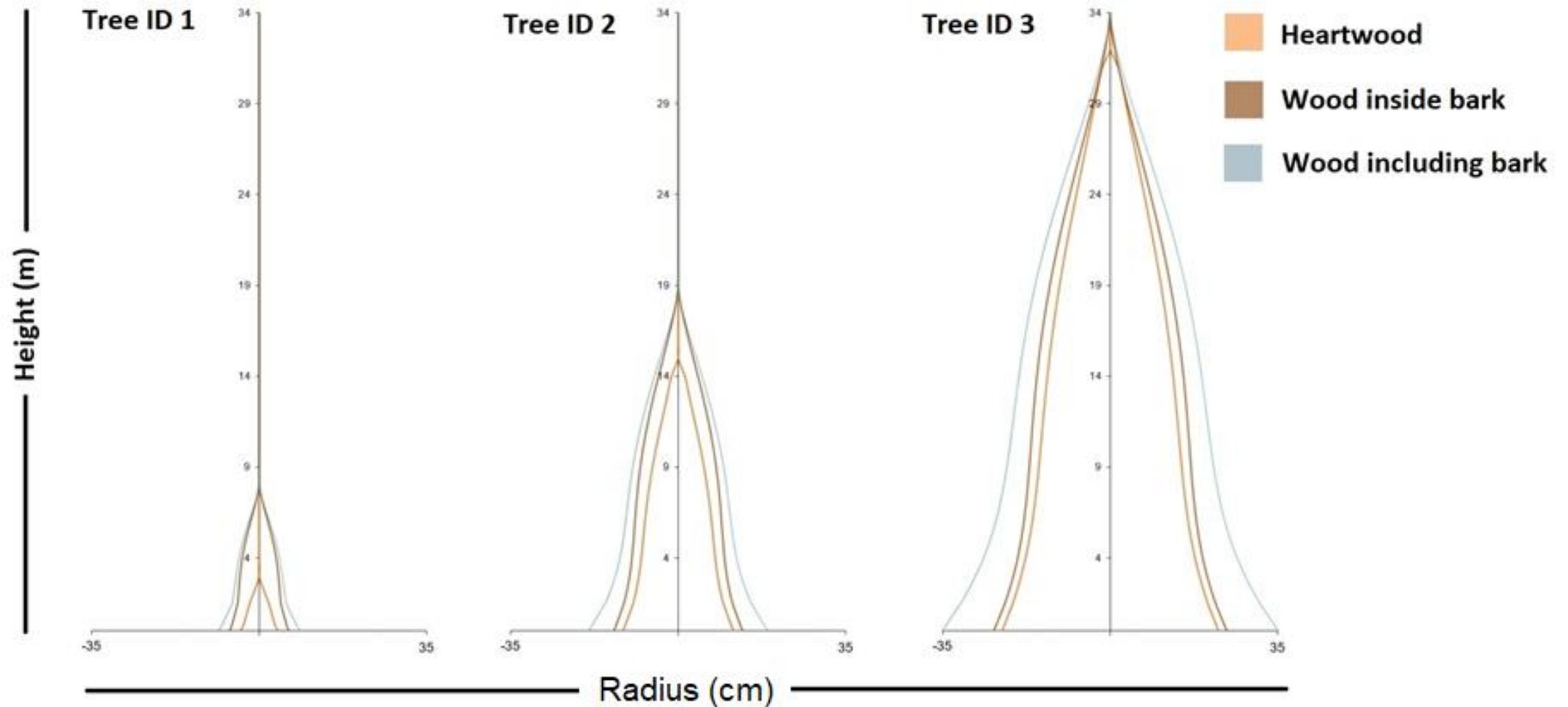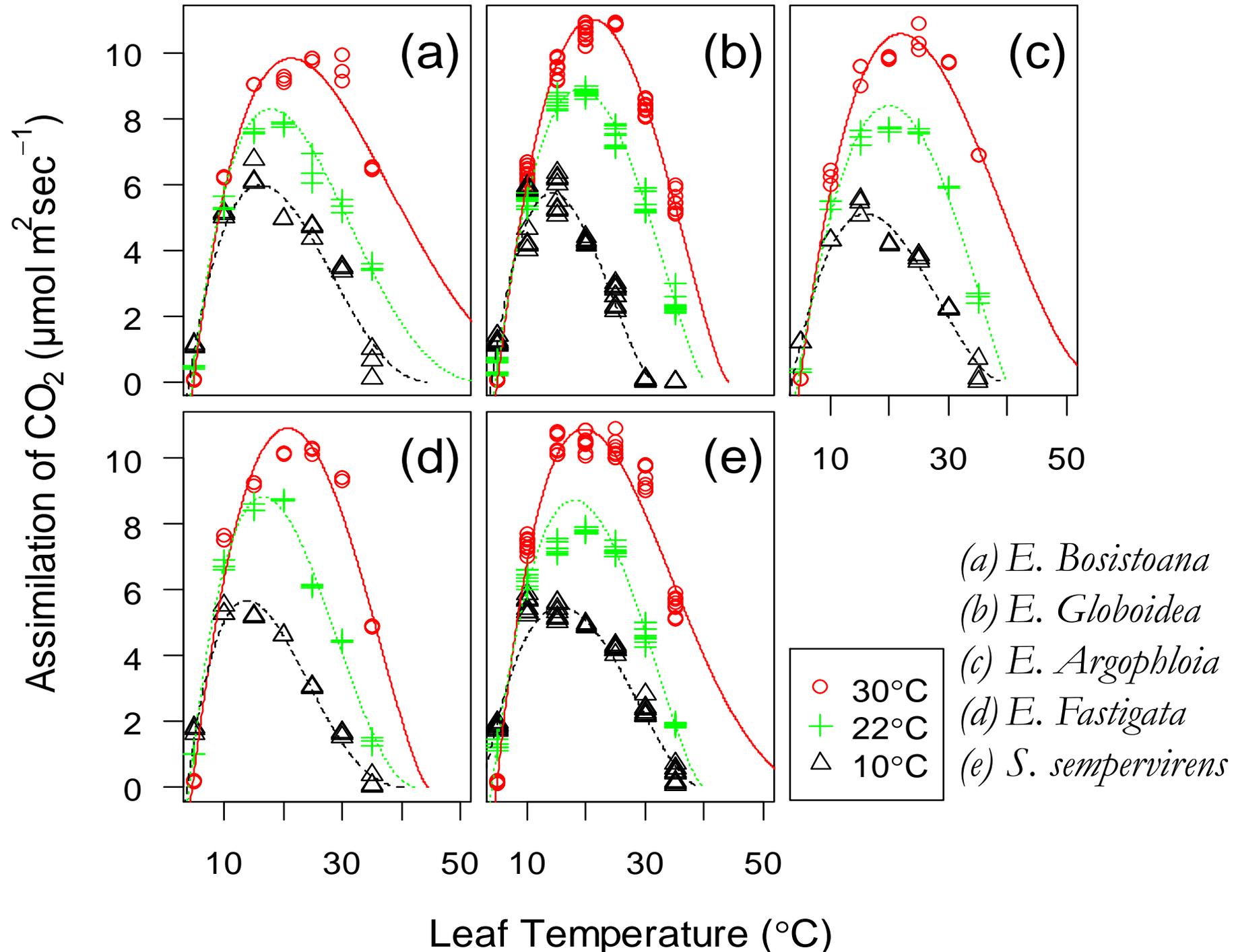 - Wide range of height vs dbh

Contribution to SLMACC project

- 4 case study sites
  - Create local biomass versus stem dimension models
  - Assess biomass and C contents of existing stands
  - Model future biomass and CO_2-e sequestration
  - Calculate area of forest required to become net GHG neutral
- General
  - Taper & volume models
  - Growth and yield models that include CO_2-e sequestration
    - *E. globoidea*
    - *E. bosistoana*
  - Individual tree biomass models
  - LiDAR assessment of biomass and C contents

Daniel Bozcniewicz – PhD study

Assimilation of CO_2 ($\mu mol\ m^2\ sec^{-1}$) vs *Leaf Temperature (°C)*

Legend:
- ○ 30°C
- + 22°C
- △ 10°C

(a) *E. Bosistoana*
(b) *E. Globoidea*
(c) *E. Argophloia*
(d) *E. Fastigata*
(e) *S. sempervirens*

Growth and yield model for *Eucalyptus globoidea* Blakely in New Zealand

Model: Serajis Salekin, Euan Mason, Justin Morgenroth, Dean Meason & Mark Bloomberg
Plot volume functions: Euan Mason, Daniel Boczniewicz & Justin Morgenroth
Carbon function: Euan Mason
Programming: Euan Mason   NB: Simulations with age > 25 or basal area/ha > 80 are extrapolations

Starting values: Age: 6 Mean top ht (m): 12 Basal area/ha: 17 Stems/ha: 1200

Ending age: 25 Calculated site index: 27.925

Go Delimited output: ☐ Thin Info

Age (years)	Mean top height (m)	Basal area/ha (m^2)	Mean dbh (cm)	Stems/ha	Volume/ha (m^3)	Heartwood volume/ha (m^3)	CO$_2$-e (tonnes/ha)
6	12	17	13.4	1200	49	10	139
7	13.9	24.5	16.2	1193	80	23	240
8	15.6	32.3	18.6	1187	116	41	378
8	15.6	17.9	21.3	500	66	27	117
9	17.2	22.1	23.8	497	88	41	151
10	18.7	26.3	26	494	112	57	185
11	20	30.2	28	492	137	75	220
12	21.3	34	29.7	489	162	93	255
13	22.4	37.5	31.3	486	186	112	288
14	23.4	40.8	32.8	483	211	131	321
15	24.4	43.9	34.1	481	234	150	353
16	25.2	46.9	35.3	478	257	169	383
17	26	49.6	36.4	475	279	187	412
18	26.7	52.2	37.5	473	300	205	439
19	27.3	54.6	38.4	470	320	222	465
20	27.9	56.8	39.3	467	340	238	489
21	28.4	58.9	40.2	465	358	254	512
22	28.9	61	41	462	375	269	533
23	29.3	62.8	41.7	460	391	283	554
24	29.7	64.6	42.4	457	407	296	573

Use of LiDAR to estimate stored C

- Current methods (for *all* species)
  - Ground-based measurements of tree height and diameter in plots
    - Prediction of C storage with national models

- Current study using LiDAR funded by MPI – Indirect method
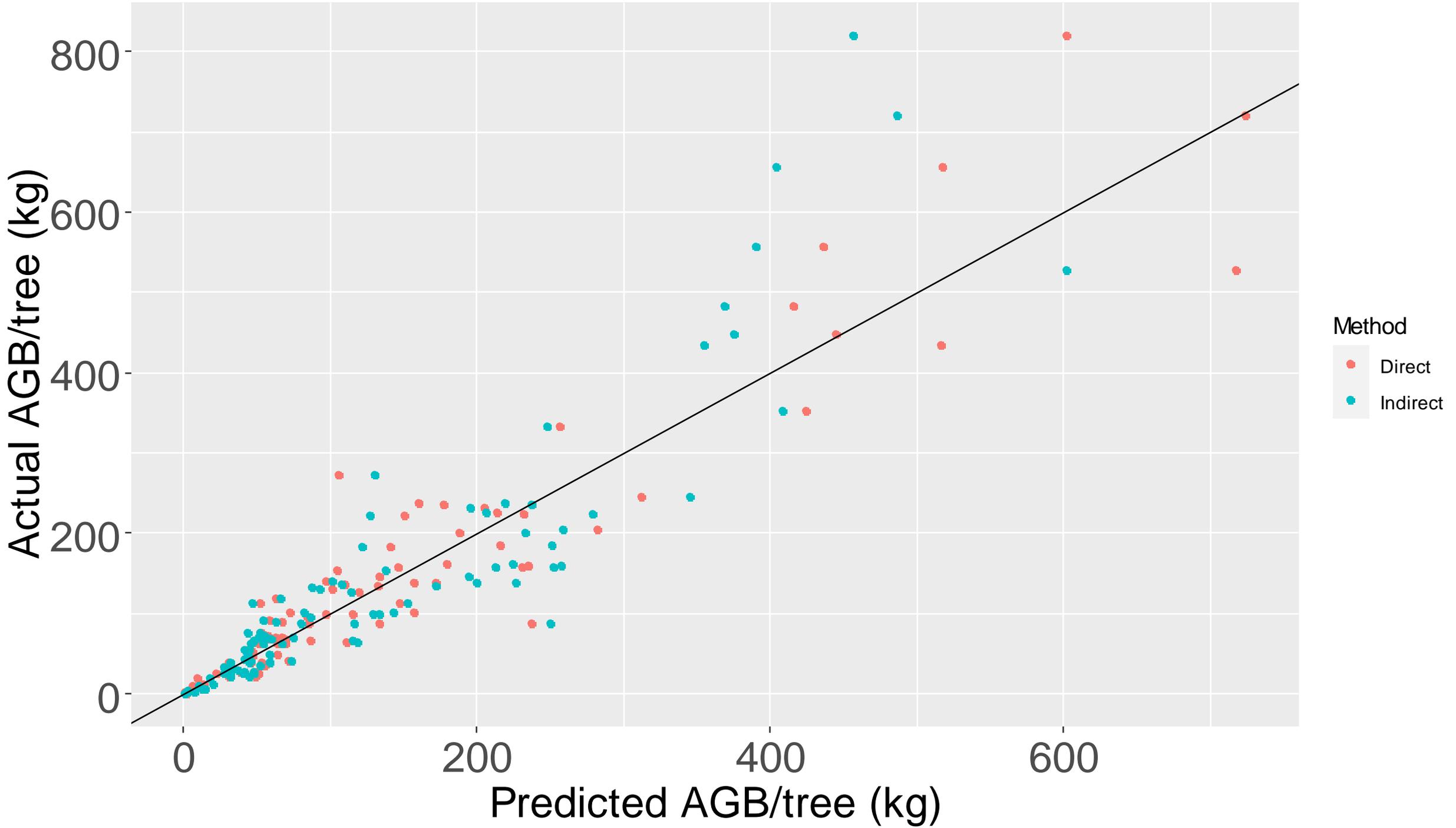 - Use LiDAR to predict tree height and diameter
    - Prediction of C versus DBH and Ht
    - Bias and maybe less precision

$$C = (dbh + \epsilon_{LiDAR}) + (height + \epsilon_{LiDAR}) + \epsilon_{Biomass}$$

- Alternative approach – Direct method
  - Use LiDAR to directly predict C
    - Potentially smaller errors
  - May solve local bias problem
  - NB: Requires local biomass studies to develop the methodology
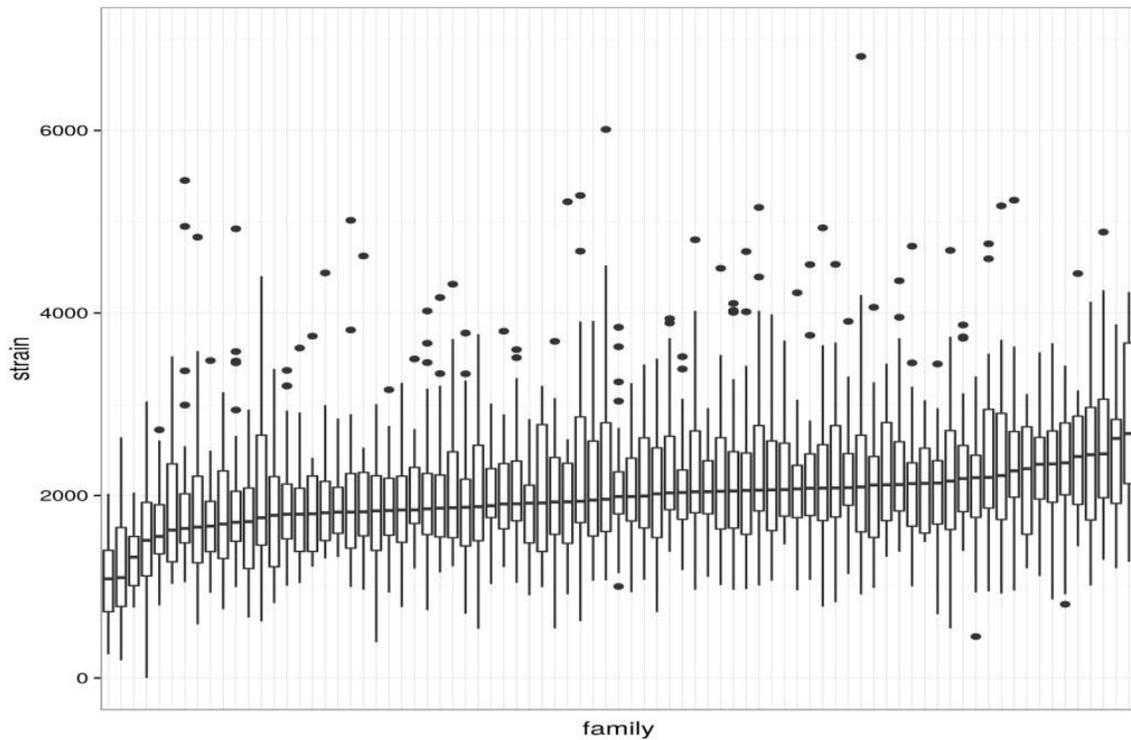
$$C = LiDAR + \epsilon_{Biomass}$$

Heartwood quality

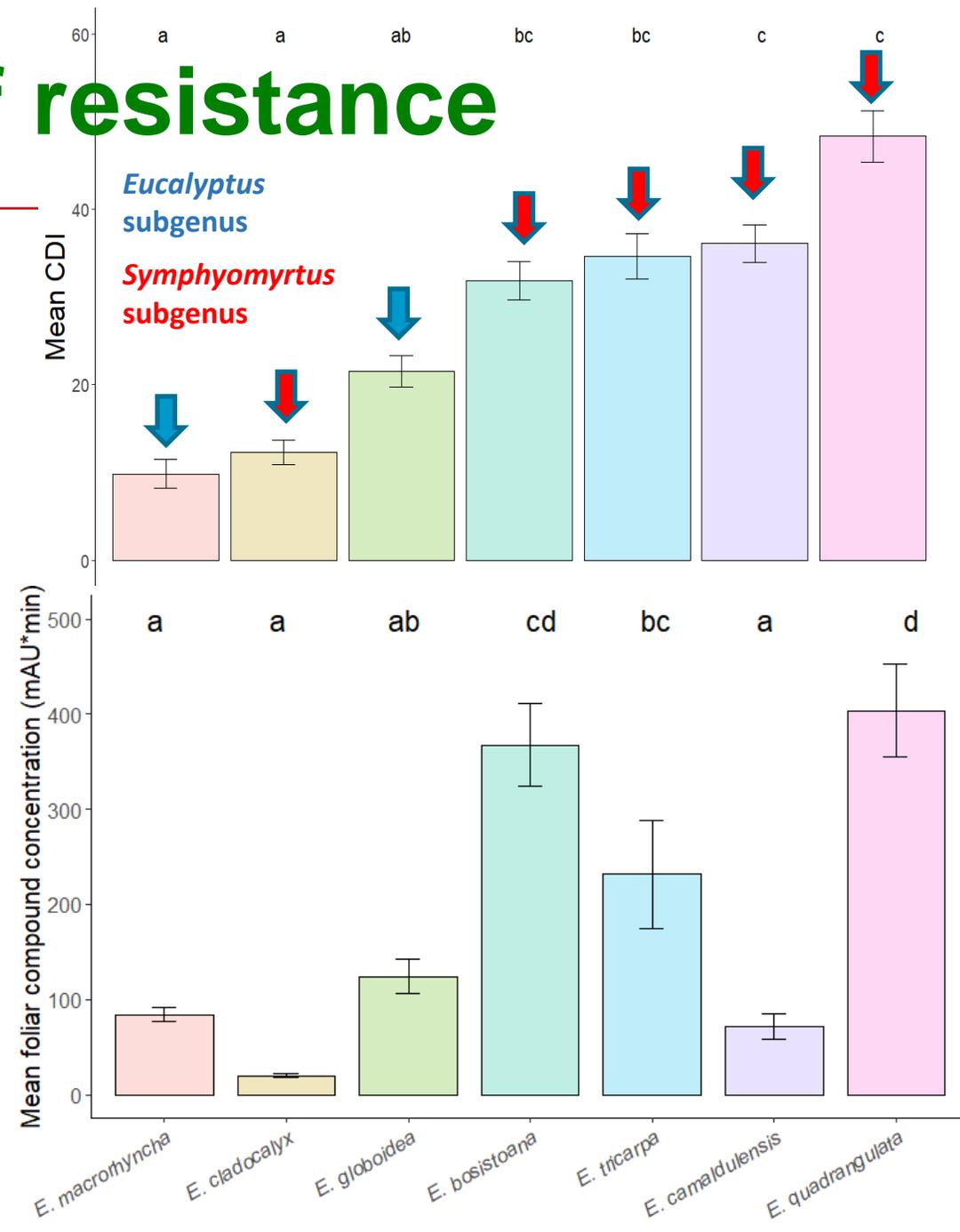Variation in 4-yr *E. bosistoana*:

Growth stress

Understanding drivers of resistance

- Does foliar chemistry act as
  - A repellent?
  - An attractant?

- Are single chemicals important or is it the composition of multiple chemicals.

Classical and Conservation Biocontrol

- Biocontrol: Still a work in progress for *P. charybdis*

- Priority to investigate biocontrol agent(s) for *Pst. cloelia*

- Wide variety of identified predators
  - Unknown how this varies nationally
  - Which environmental conditions improve natural enemy abundance?
    - Alternative prey?
    - Alternative cover/resources, e.g., nectar, overwintering refugia.
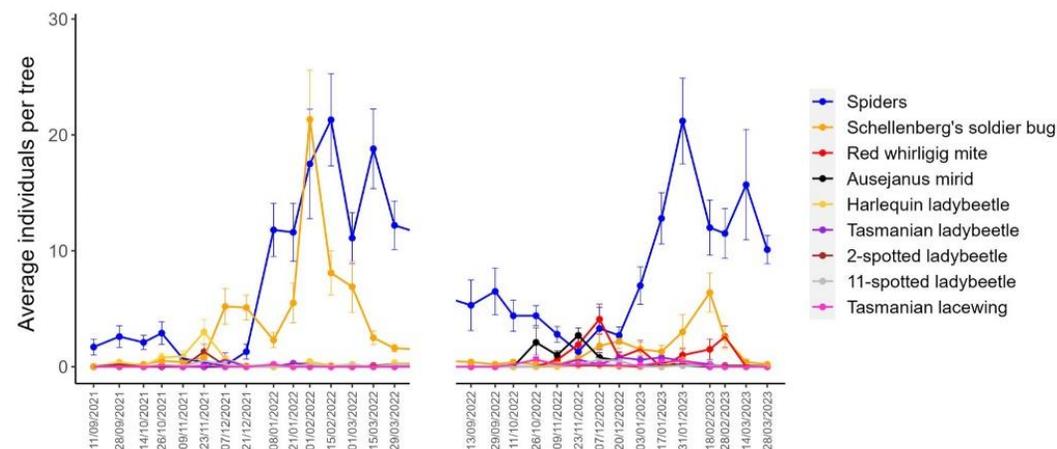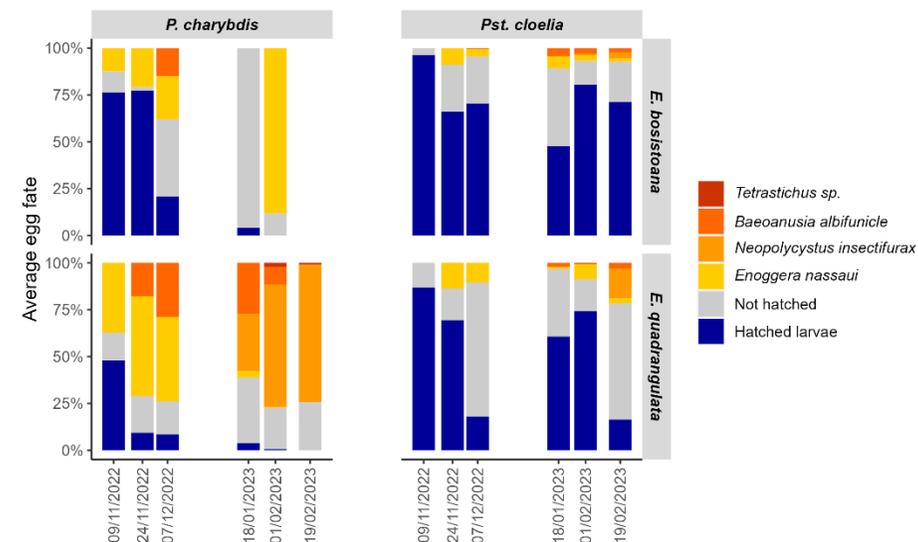
Landowners of case study and biomass sampling sites

Phil Woodward, Marlborough Regional Forests manager, Blenheim – Case study

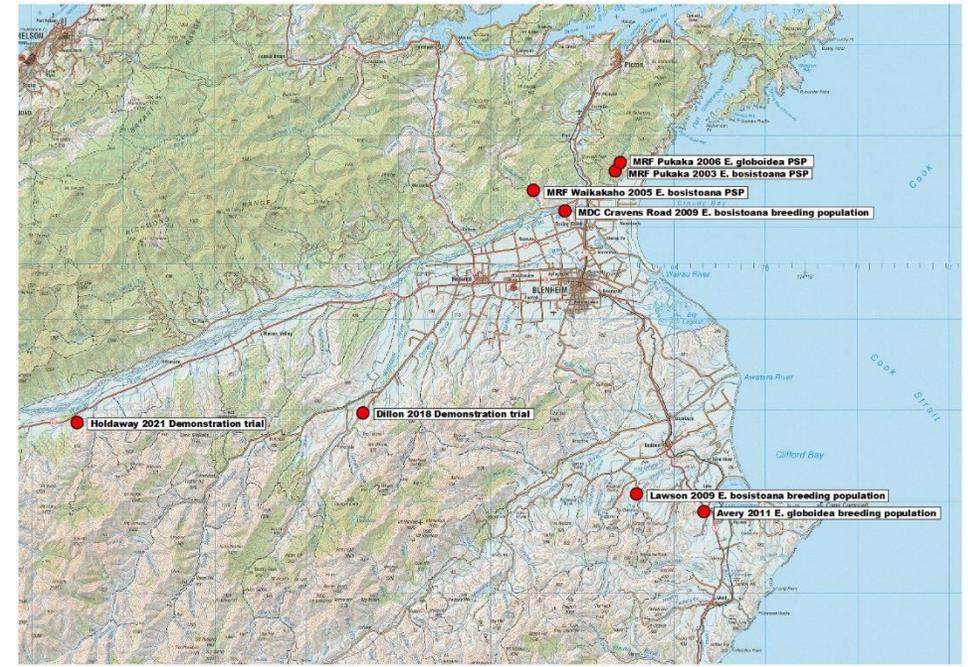Fraser Avery, Seddon, Marlborough – Case study

Andrew Lawson, Seddon, Marlborough – Case study

Robert Holdaway, Wairau Vly, Marlborough – Case study

David Dillon, Waihopai Vly, Marlborough

Gary Fleming, Sefton, North Canterbury

Robb MacBeth, Cheviot, North Canterbury

We plan to continue research and education at the University of Canterbury's NZ School of Forestry

NZDFI's Science Team is led by the NZ School of Forestry, University of Canterbury.

13 PhD research projects along with several Masters projects and numerous undergraduate projects focused on:

- Wood quality, processing, products and markets for durable hardwood.
- Genetics and tree breeding of NZDFI species.
- Site species matching and modelling heartwood production of NZDFI species.
- Eucalypt health and protection.

NZDFI's tree breeding and forest research programme