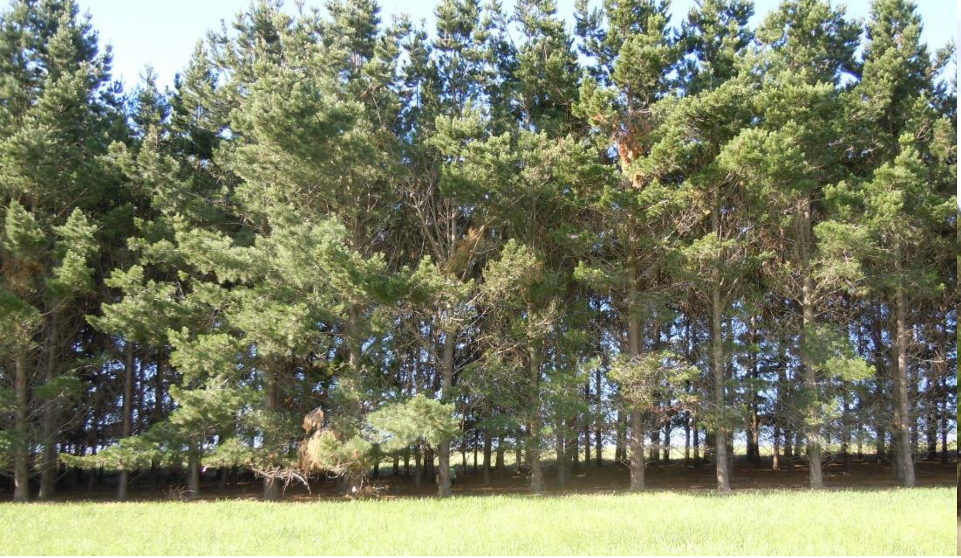
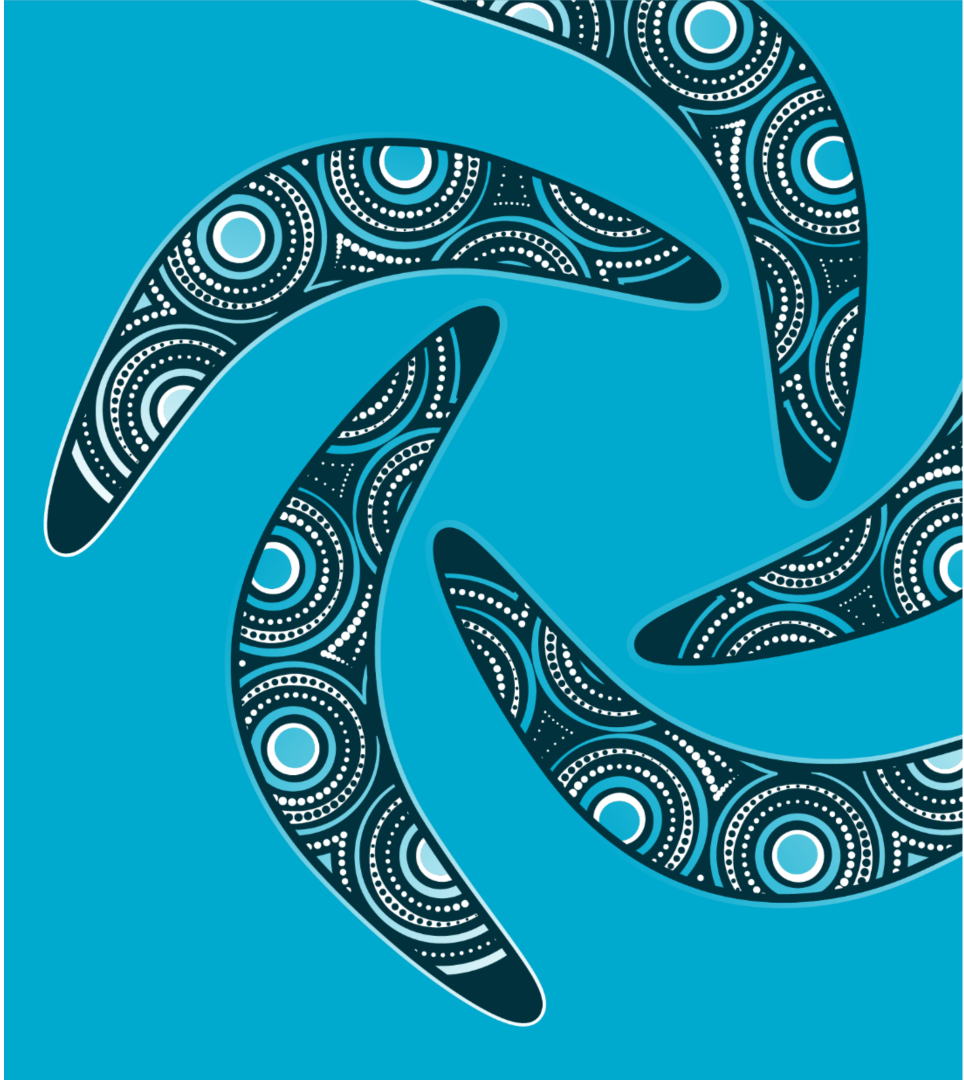


Quantifying the carbon and wood production benefits from commercial shelterbelt plantings

ANZIF Conference, October 2023

Jacqui England, Keryn Paul, Shaun Brooks, Melissa Piper, Gordon McLachlan, Daniel Mendham

I would like to begin by acknowledging the Traditional Owners of the land that we're meeting on today, and pay my respect to their Elders past and present.



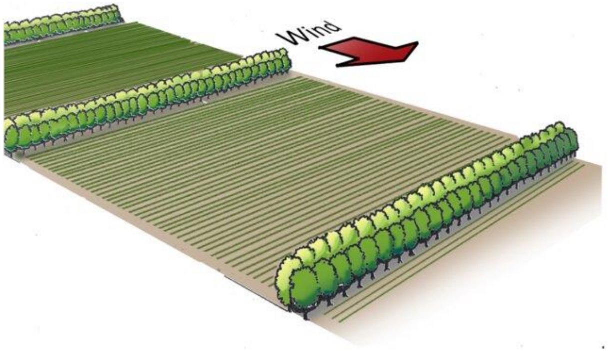
Trees on farms and natural capital accounting

- Woody plantings on farms common activity in agricultural landscapes for multiple purposes
- Range of planting compositions and configurations
- Improved models needed to quantify services to inform natural capital accounts




Shelterbelts on farms

- Linear planting configuration
- Typically oriented perpendicular to the prevailing wind direction
- ‘Edge’ trees represent a relatively large proportion of planting




Carbon & wood production services

- Relatively large existing dataset and model calibrations for predicting:
  - C sequestration in restoration plantings and commercial block plantings
  - Wood volumes in commercial block plantings
- More limited knowledge base for commercial shelterbelts

Forest Ecology and Management 460 (2020) 117838
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Predicting carbon sequestration of woody biomass following land restoration

Keryn I. Paul[*], Stephen H. Roxburgh

Trees, Forests and People 9 (2022) 100284
Contents lists available at ScienceDirect
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Sequestration of carbon in commercial plantations and farm forestry

Keryn I. Paul[a,*], Stephen H. Roxburgh[a], Jacqueline R. England[b]

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Available online at www.sciencedirect.com
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Forest Ecology and Management 193 (2004) 251–282
Forest Ecology and Management
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CABALA: a linked carbon, water and nitrogen model of forest growth for silvicultural decision support

Michael Battaglia[a,b,*], Peter Sands[a,b], Don White[c], Daryl Mummery[a,b]

Aim & research questions

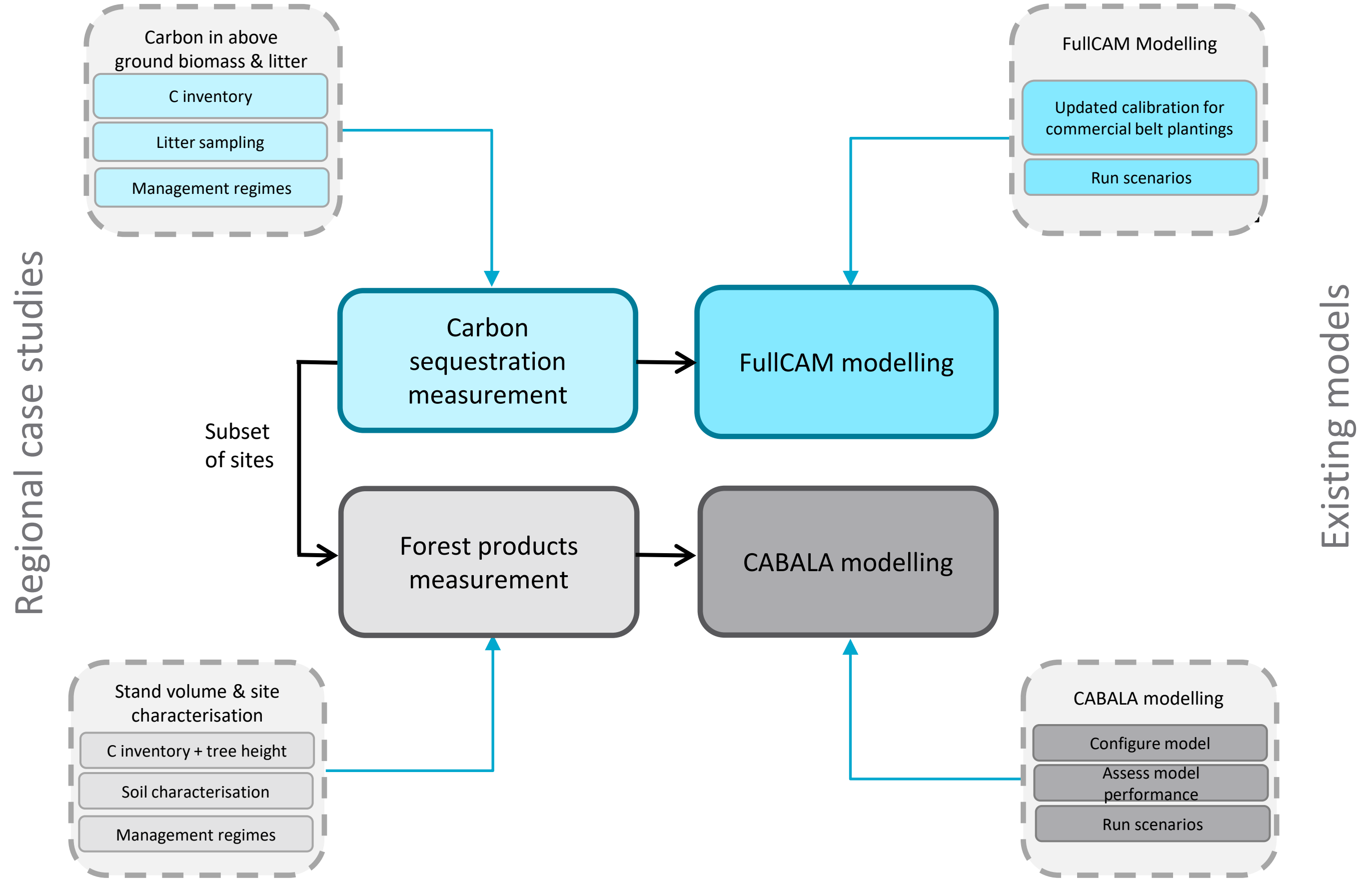
Aim

- Improve quantification of carbon and wood production benefits from shelterbelts of commercial species to inform development of farm-scale natural capital accounts

Questions

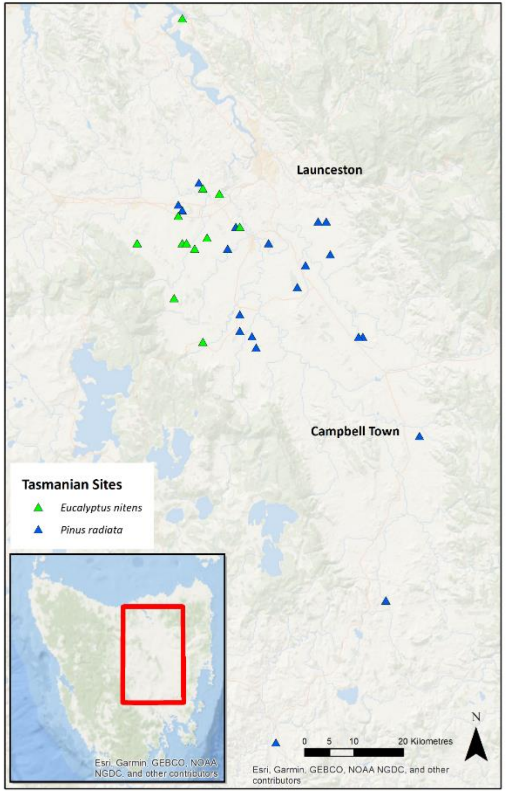
- How do rates of carbon sequestration and wood production in shelterbelts differ with planting characteristics (e.g., age, species composition, belt width, stand density)
- How do rates of growth differ between edge versus inner rows in shelterbelts of differing planting characteristics?

Measurement and modelling approach



Tasmanian Midlands case study

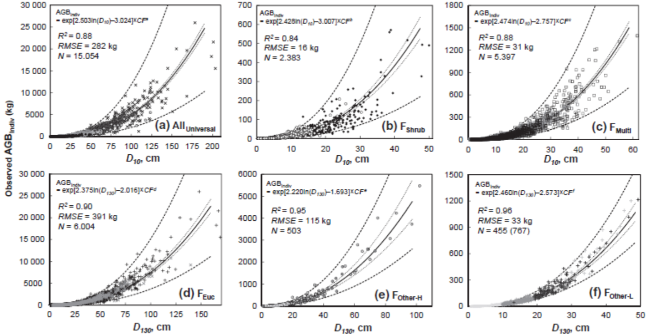
- Composition: *Pinus radiata, Eucalyptus nitens*
- Age: 3-33 years
- Belt width: 3-9 rows, 8-35 m
- Stand density: 383-1788 trees ha^{-1}

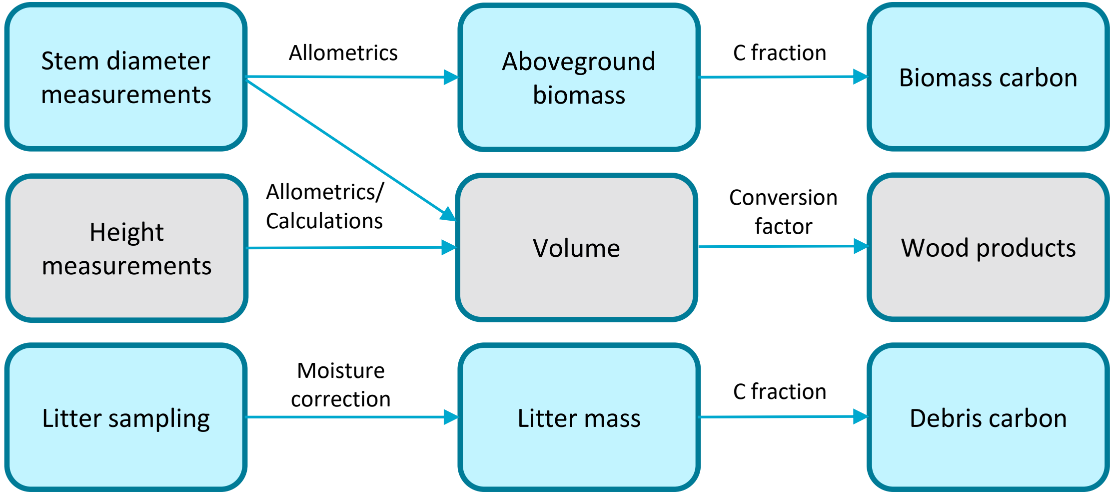


Victorian Corangamite case study

- Composition: *E. cladocalyx* (sugar gum), sugar gum + mixed species
- Age: 6-28 years
- Belt widths: 3-15 rows, ~10-60 m
- Stand density: 592-1466 trees ha^{-1}

Measurements





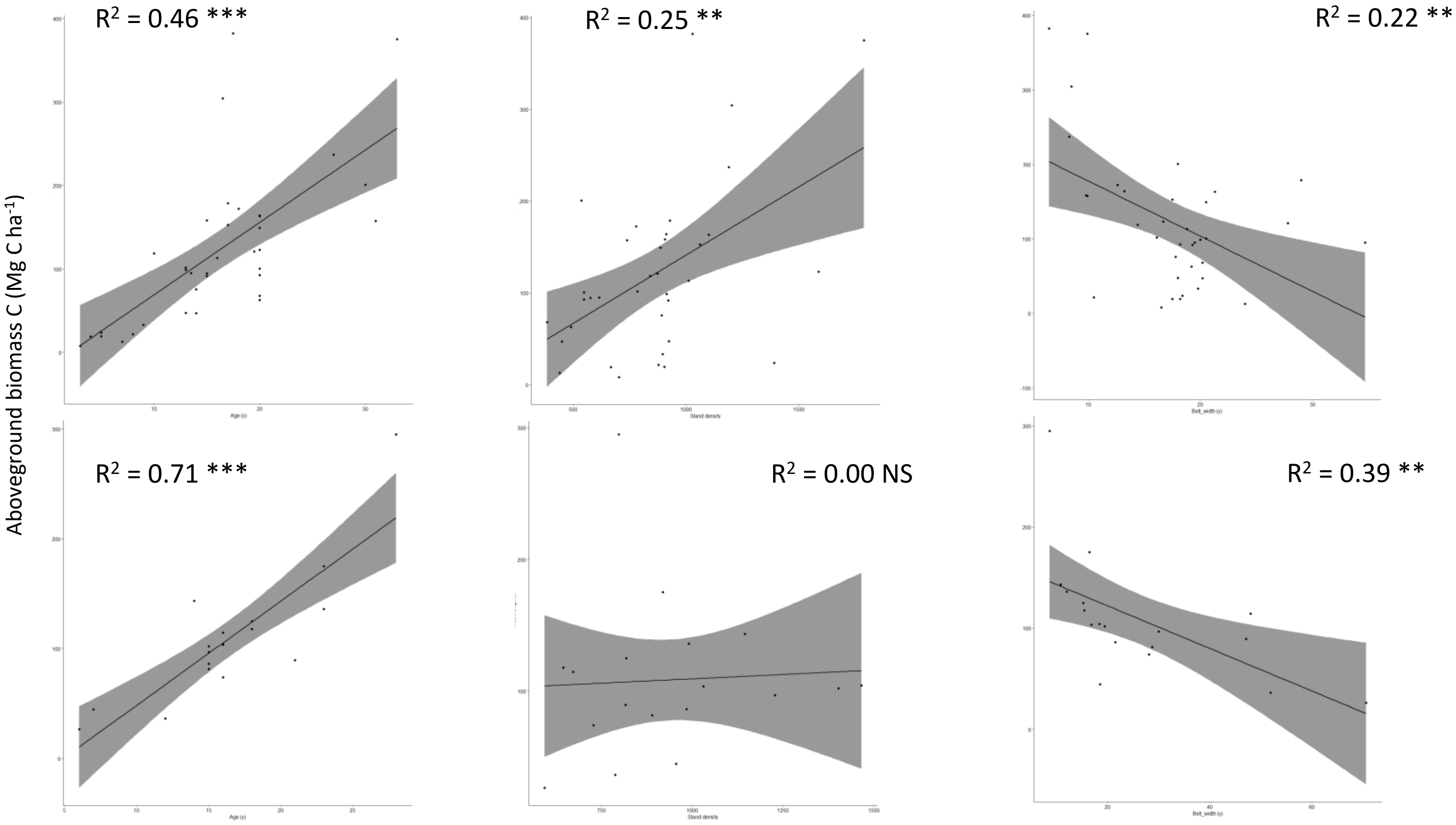
Aboveground biomass carbon

Stand age and configuration

Age | Stand density | Belt width

Tasmania

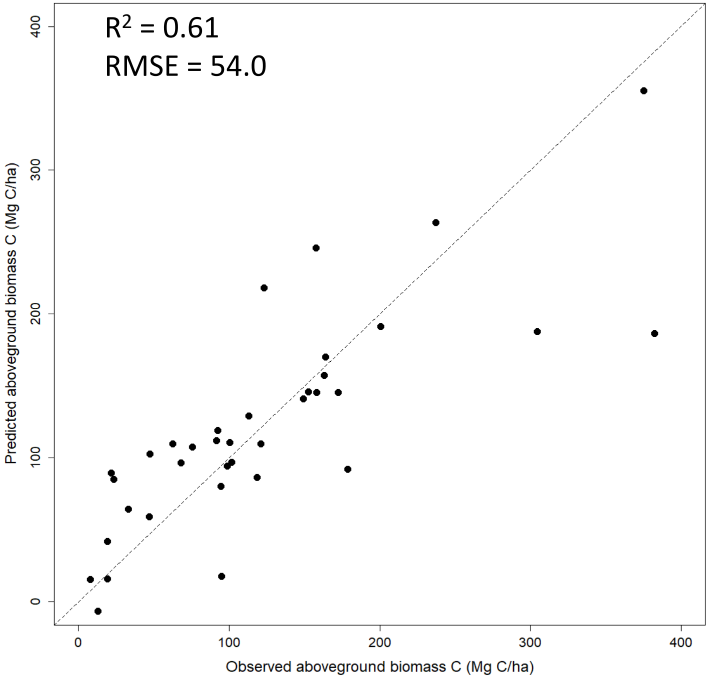
Victoria



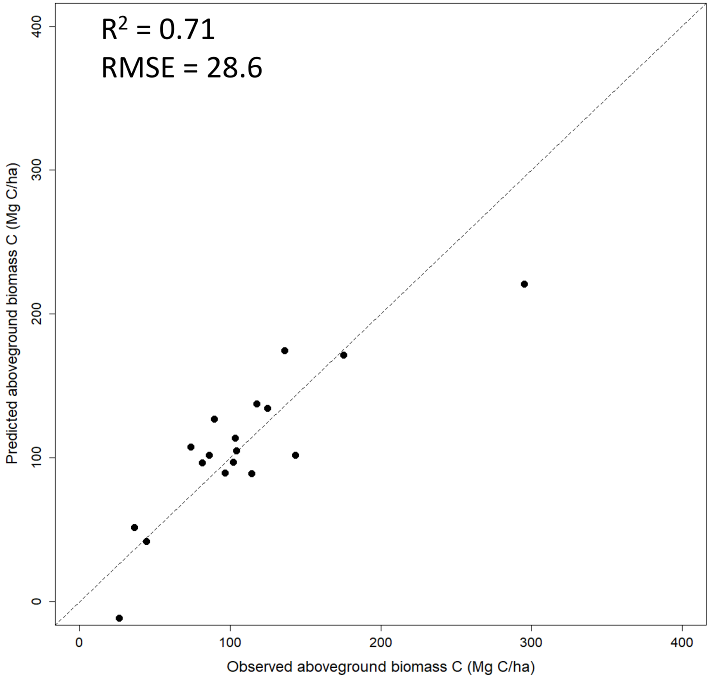
Empirical models – stand structure

- Multiple linear regression: age, belt width, stand density

Tasmanian Midlands



Victorian Corangamite

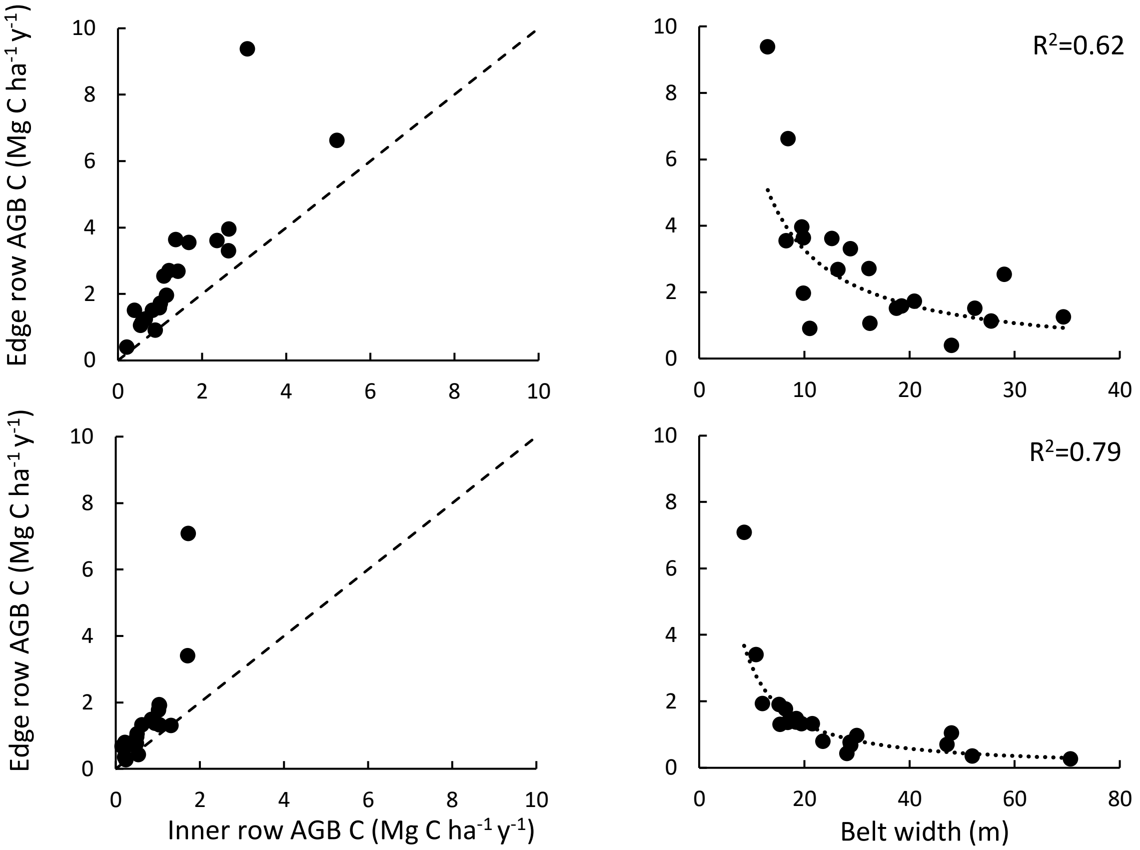


Edge effects on C accumulation rates

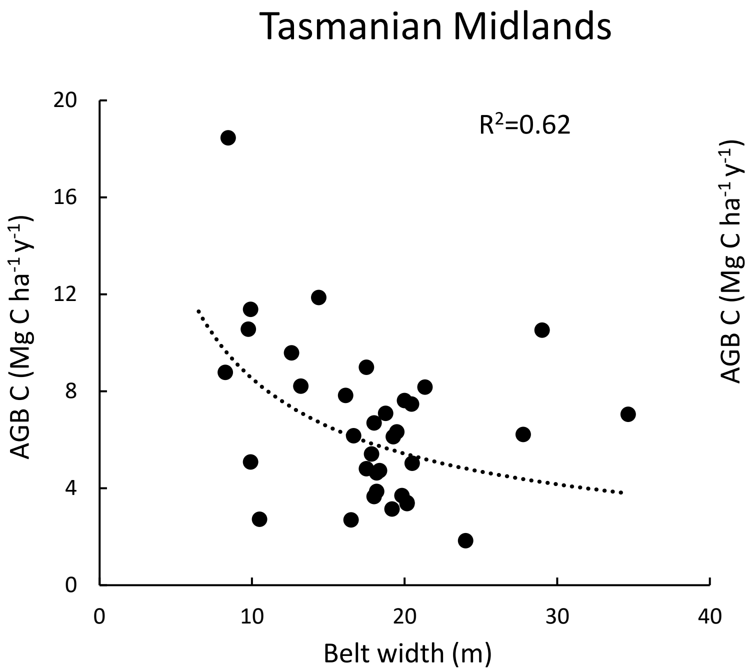
Preliminary analysis

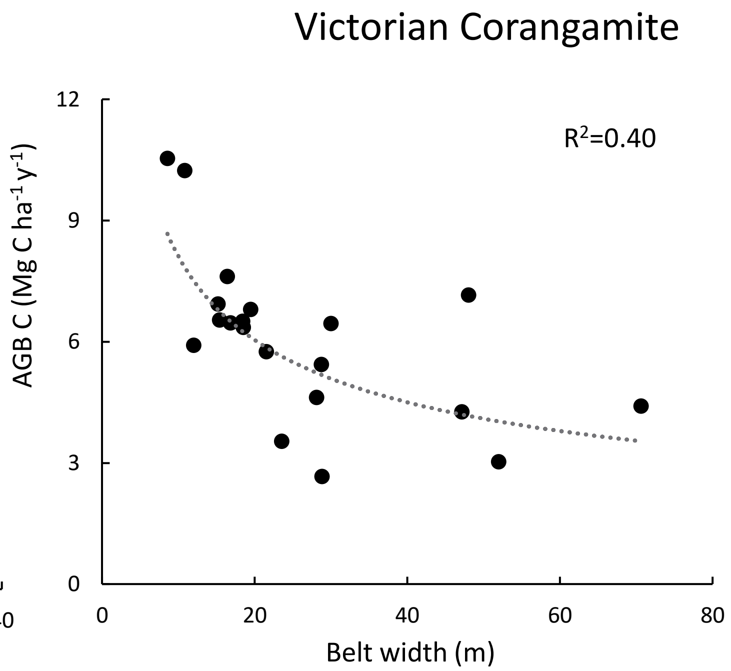
Tasmanian Midlands

Victorian Corangamite



Belt width and whole shelterbelt





National carbon accounting tool, FullCAM

How FullCAM estimates aboveground biomass (AGB):

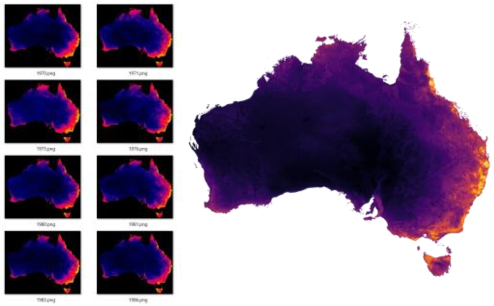
1. Site potential → 2. Climate → 3. Yields

1. Site potential

M input layer of max. stand above-ground biomass

Empirical ‘site productivity potential’ based on undisturbed remnant native vegetation

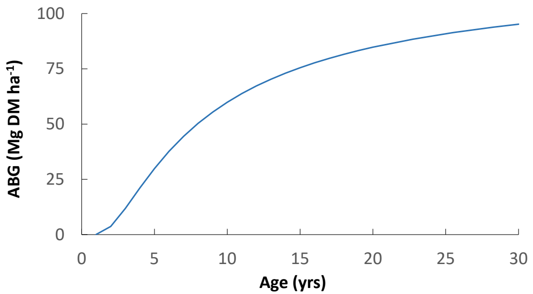
2. Climate



Annual increments adjusted based on the ratio of index for that year compared to long-term average index

3. Yields

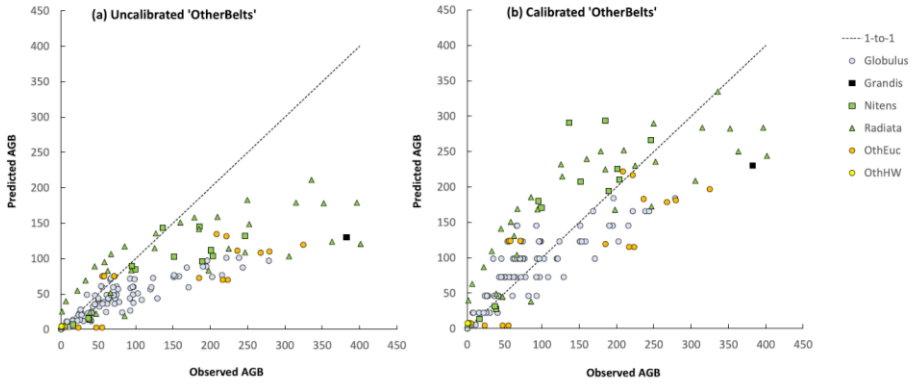
Tree Yield Formula



Empirical yield curve calibrated to different stand types

FullCAM parameters

'Block' parameters applied | 'Belt' calibration



- 'OtherBelt' calibration with limited empirical data
- Multiplier required to adequately capture aboveground biomass
- Insufficient data to further categorise

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Table 4

New recommended default TYF parameters (*G* and *ar*, *br*) for various categories of plantings, including the $\mathrm{Min}_{r\times M}$ and $\mathrm{Max}_{r\times M}$ values of application, and the six fit statistics obtained against the corresponding calibration datasets given in Table 1. Fit statistics include Bias (Mg DM ha^{-1}), mean absolute error (*MAE*, Mg DM ha^{-1}), Mean Absolute Percentage Error (*MAPE*, %), Root Mean Squared Error (*RMSE*), Model Efficiency (*EF*) and Lin's concordance correlation coefficient (*LCC*). Only the *MAPE* was applied to the transformed scale, with all other fit statistics applied to un-transformed data.

Type	*G*	*ar*	*br*	*Bias*	*MAE*	*MAPE*	*RMSE*	*EF*	*LCC*
Globulus	5.554	4.358	-0.767	0.000	21.8	8.1	30.1	0.347	0.736
Nitens	6.913	3.317	-0.576	0.000	23.7	9.7	31.6	0.408	0.709
Grandis	4.229	2.695	-0.514	0.000	26.9	15.7	35.6	0.665	0.837
PellitaHyb	4.051	2.861	-0.446	0.510	19.4	6.9	26.7	0.607	0.732
Radiata	6.311	3.828	-0.617	0.000	36.4	7.2	49.4	0.553	0.739
Pinaster	11.318	2.769	-0.386	0.000	24.2	13.4	35.0	0.621	0.799
SouthernPine	6.505	3.204	-0.447	3.600	47.7	9.4	59.4	0.202	0.666
Mangium	3.936	3.630	-0.681	0.000	19.4	5.7	24.1	-0.004	0.131
OtherEuc	8.002	2.355	-0.368	-0.010	28.5	21.2	46.0	0.611	0.778
OtherHW	6.745	3.230	-0.584	0.100	22.9	21.4	32.0	0.694	0.831
OtherSW	10.917	3.204	-0.447	0.000	9.7	18.8	16.5	0.803	0.890
OtherAcacia	6.547	2.251	-0.384	0.000	14.0	18.5	27.0	0.438	0.543
MalleeBlock	6.317[1]	0.000[1]	0.000[1]	1.108	14.3	17.7	19.4	0.173	0.534
MalleeBeltL	4.533[1]	0.182[1]	0.000[1]	5.500	15.1	15.8	19.4	0.001	0.358
MalleeBeltHW	3.492[1]	0.182[1]	0.000[1]	5.816	15.5	15.5	25.2	0.333	0.569
MalleeBeltHN	2.288	0.475	0.000[1]	7.884	22.0	18.4	32.0	0.555	0.739
OtherBelt	*NA*	*1.212[2] (1.120)[3]*	*NA*	-7.813	40.7	15.2	57.5	0.699	0.814

[1] TYF parameters were calibrated previously by Paul and Roxburgh (2020) and verified here. Note, given *br* was zero, the value of *r* reported in Table 4 of Paul and Roxburgh (2020) is calculated as Exp(*ar*).

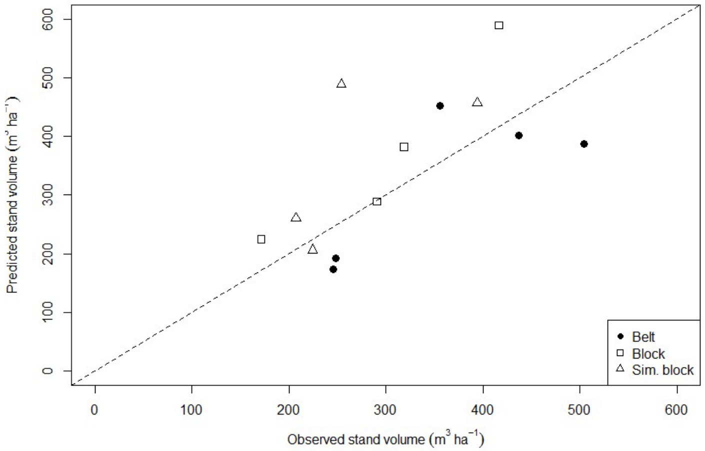
[2,3] Multipliers of the TYF parameters for the belt species. Only the *ar* parameter required adjusting for belt plantings, and was 1.212 for most species, except for Radiata, which was 1.120. For example, if the belt was Globulus, the value of *ar* to be applied would be 1.212×4.358. If the belt was Radiata, the value of *ar* to be applied would be 1.120×3.828.

Wood production

Wood products services

- Age significantly influenced standing volume but influences of belt width and stand density variable between case study regions.
- Previous work assessed the capacity of the forest growth model, CABALA, to predict production potential of shelterbelts
  - Compared pine belts & pine blocks in Tasmania
  - Reasonable but model tended to underpredict productivity of belts
- Currently updating modelling based on new field data

Preliminary analysis



Source: England et al. (2018)

Conclusions & next steps

- Age and planting configuration are key factors in determining carbon sequestration services provided by shelterbelts of commercial species

- Next steps are to use these new data to inform refined FullCAM calibrations and case study natural capital accounts.

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- Hamish McDonald

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- Andrew Lang
- Gary Featherston
- Landholders

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