

# Does plant diversity contribute to soil carbon storage?

## Insights from a long-term tree diversity experiment in Western Australia's Wheatbelt

ELINA RITTELMANN-WOODS<sup>1,2</sup>, ALEXANDRE PEDRINHO<sup>1,2</sup>, FELIPE E. ALBORNOZ<sup>1,3</sup>, RAPHAEL A. VISCARRA ROSSEL<sup>2,4</sup>, RACHEL J. STANDISH<sup>1,2</sup>

**Aim:** To test the relationship between woody plant diversity and soil carbon storage and untangle underlying mechanisms in the Mediterranean-type climate of south-western Australia using a tree diversity experiment.

### Why it matters:

▪ **Tree planting projects for carbon storage** often use monocultures of fast-growing, exotic species.

▪ Improving outcomes for biodiversity from carbon projects is crucial for **combating biodiversity loss and mitigating climate change**.

▪ **Soil carbon** is the **largest terrestrial carbon pool** but is often disregarded.

### Experimental Design & Findings

#### Ridgefield Multiple Ecosystem Services Experiment:

- Ca. 23x23m plots with varying levels of woody species and functional richness
- Planted in 2010
- On formerly grazed land
- UWA Farm, Pingelly, WA

#### Measurement of vegetation and soil variables (Fig. 1) 14 years after planting for 30 plots:

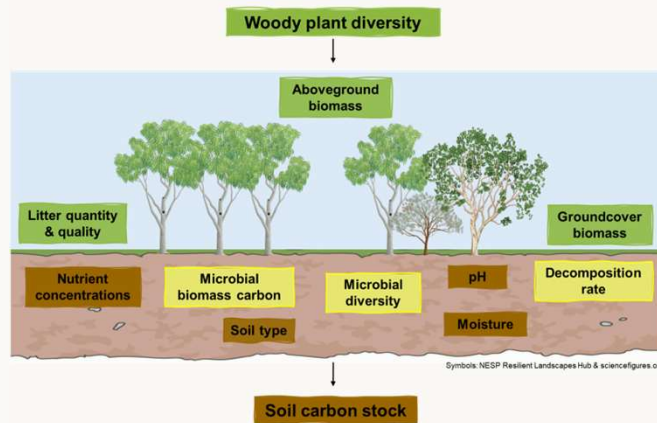
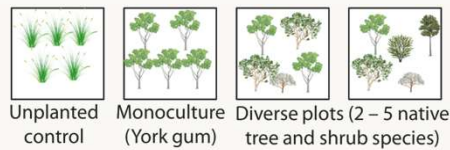


Fig. 1: Schematic figure of measured variables. To test the effects of woody plant diversity on soil carbon storage and potential underlying mechanisms, the depicted carbon inputs, abiotic soil characteristics and soil microbial properties and processes were measured for 30 plots with an observed woody species richness level of 0 to 5 (min. 3 replicates per level). Soil variables were measured for the 0-10cm and 10-30cm soil layers. Sampling took place 14 years after the experiment was established.

#### Species pool:

- *Eucalyptus loxophleba* Benth.
- *Eucalyptus astringens* (Maiden) Maiden
- *Acacia acuminata* Benth.
- *Acacia microbotrya* Benth.
- *Callistemon phoeniceus* Lindl.
- *Calothamnus quadrifidus* R.Br.

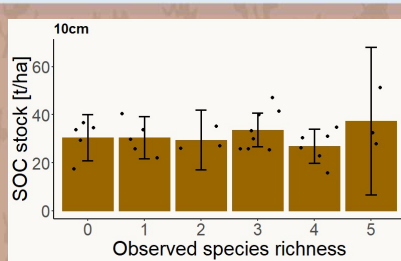
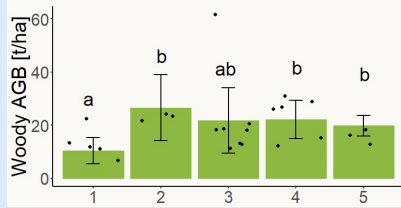


Fig. 2: Modelled means and 95% confidence interval for woody aboveground biomass (AGB) and soil organic carbon (SOC) stock at 0-10cm across observed woody species richness levels. Dots represent observed values. Note that for AGB control plots were not considered. Letters denote significant differences ( $p < 0.05$ ).

→ **Diverse plantings stored more carbon aboveground** than York gum monocultures, but there was no difference in **soil carbon stocks** at 0-10cm (Fig. 2).

**Note:** Results for microbial diversity and biomass carbon are still outstanding.

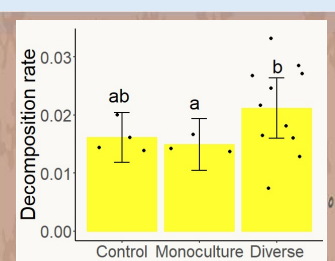
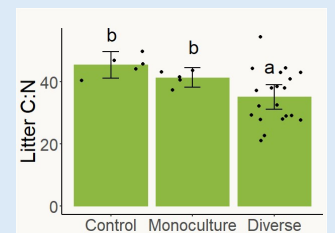


Fig. 4: Modelled means and 95% confidence interval for litter C:N (indicating litter quality) and decomposition rate (measured by tea bag index) for unplanted control plots, monocultures and diverse plots (observed species richness 2 to 5). Dots represent observed values. Letters denote significant differences ( $p < 0.05$ ).

→ **Higher litter quality and decomposition rate** in diverse plots (Fig. 4) indicate the **return of ecosystem functions and differences in carbon dynamics**.

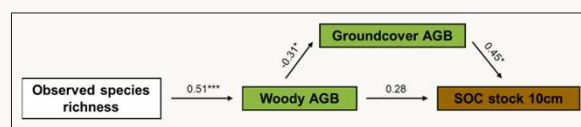


Fig. 3: Structural equation model for the relationship between observed species richness, carbon inputs by woody and groundcover aboveground biomass (AGB), and soil organic carbon (SOC) stock at 0-10cm. Positive coefficients indicate positive effect, whilst negative coefficients indicate negative effect. Asterisks indicate significance (\*\*\*  $p < 0.001$ , \*  $p < 0.05$ ).

→ **Weedy groundcover had greater effect on soil carbon stock** than woody plants (Fig. 3). **Variations in soil carbon stocks** at 10cm can be explained by groundcover biomass (Fig. 3), soil clay content, nitrogen concentration, electric conductivity and moisture.

**Conclusion:** Woody plant diversity contributed to **carbon stored in aboveground biomass**, but **not soil carbon**, 14 years after planting. Findings contribute to the growing evidence of the **benefits of biodiverse plantings for carbon storage and ecological restoration outcomes**.

<sup>1</sup> School of Environmental and Conservation Sciences & Harry Butler Institute, Murdoch University

<sup>2</sup> ARC Training Centre for Healing Country, Curtin University

<sup>3</sup> CSIRO Environment

<sup>4</sup> Molecular & Life Sciences, Curtin University

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PhD candidate  
elina.rittelmann-woods  
@murdoch.edu.au

