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An assessment of root to shoot balance in tree stock for landscape planting in Australia

Update on the trials for the tree stock standard

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Photo: M Tjoelker

Trees are integral to sustainable landscapes

The EucFACE experiment is determining the response of Cumberland Plain Woodland to rising atmospheric carbon dioxide concentrations

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Hawkesbury Institute for the Environment

Canberra City Walk

Urban green infrastructure provides social benefits

Increased tree canopy cover mitigates the “urban heat island” effect while enhancing cityscapes (*Vision 202020 project*)

Photo: D Thompson

Containerized trees are high-value products

Landscape markets depend upon quality tree stock

Photo: D Thompson

Trees enhance urban landscapes

Proper root:shoot balance at dispatch is one of several factors that help ensure successful establishment

The importance of root-shoot balance

- **Balancing function** water loss via transpiration area (shoot) and the water absorbing area (root) of a tree
- **Balancing structure** ensures that a properly formed root ball supports a self-standing shoot
- **Managing balance** ensures positive legacy effects following dispatch

Photo: D Thompson

Does tree stock balance matter?

- Root:shoot balance must be **considered in context** of a range other stock quality factors
- Site conditions following dispatch are important

Photo: D Thompson

Australian Standard AS2303:2015
Tree Stock for Landscape Use

Identified outcomes

- Improved tree stock quality
- Recognition for growers of high quality tree stock and a market driver for those growers
- Nationally recognised specifications for growers and consumers of landscape tree stock
- Increased support for green infrastructure investment

The knowledge gap

"The major area of contention during the formation of the standard centred on the tree stock balance concept and its calculation as it applies to varying production regions and across various species." *(O' Conner, Nursery Papers, October 2015 vol. 9)*

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An assessment of root to shoot balance in tree stock for landscape planting in Australia

RESEARCH

Aim 1: acquire information on root to shoot balance of tree planting stock from scientific and trade literature

Aim 2: Quantify root to shoot balance in tree stock for contrasting regions in Australia

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Aim 1: Acquire information on root to shoot balance of tree planting stock from scientific and trade literature

Data mining

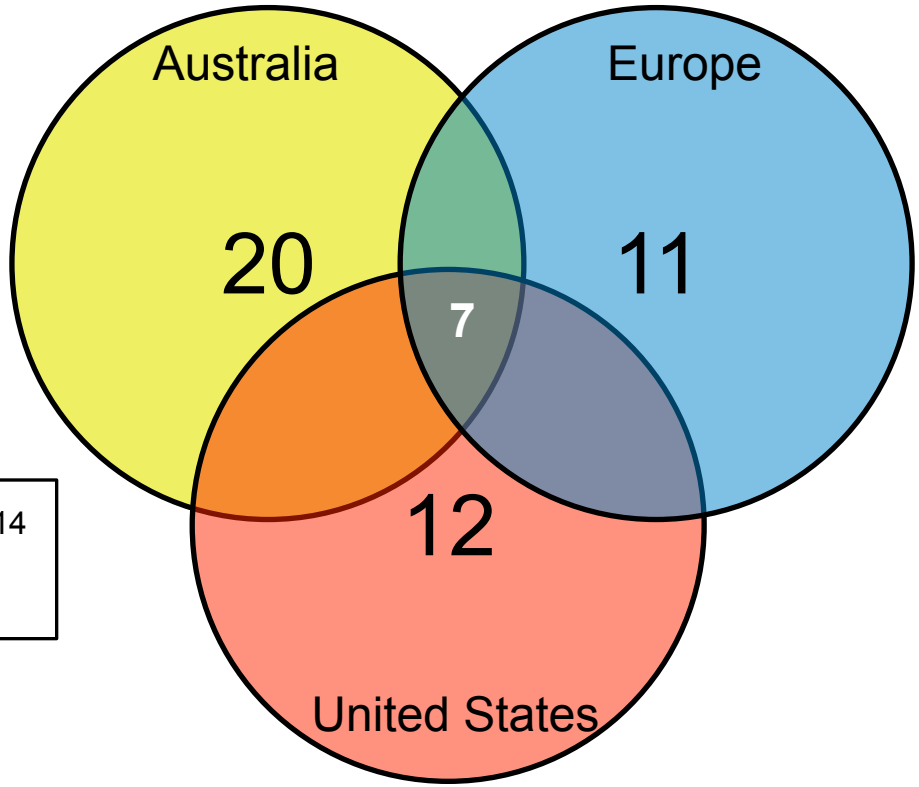
- Extract and analyze literature data to determine root to shoot balance of containerized stock

Expert synthesis

- Review other standards and industry best practices

Photo: D Thompson

Above and belowground quality testing: Comparing global nursery standards



USA: ANSI Z60.1-2014
AUS: AS 2303:2015
EUR: ENA 2010

What's the Same?

Height, calliper, rootball diameter and true to type
Assessments of crown health, pests and disease

Comparing global nursery standards: Differences from AS 2303:2015

USA

- Many aboveground criteria offered as optional buyer specifications
- Less assessment of root morphology

Europe

- Less attention to stem criteria such as taper, stem structure, included bark, etc.
- Root division and rootball depth not evaluated

Tree Stock Balance:
Comparing major global players

Australia

- **Size index per container volume**
- Size Index = Height (m) * Calliper (mm)
- Container testing begins at 20 litres

USA

- **Plant size & rootball diameter per container volume**
- Plant size = height/calliper, height or canopy width depending on tree type

Europe

- **Minimum height per container volume**
- Container sizes are generally small (<10 litres)
- Species specific relationships

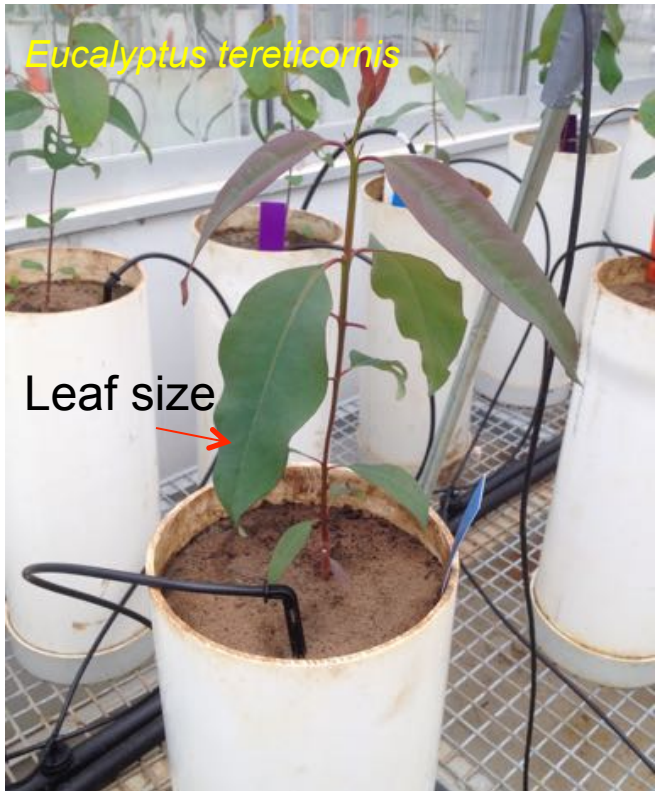
Aim 2: Quantify root to shoot balance in tree stock for contrasting regions in Australia

Photo: D Thompson

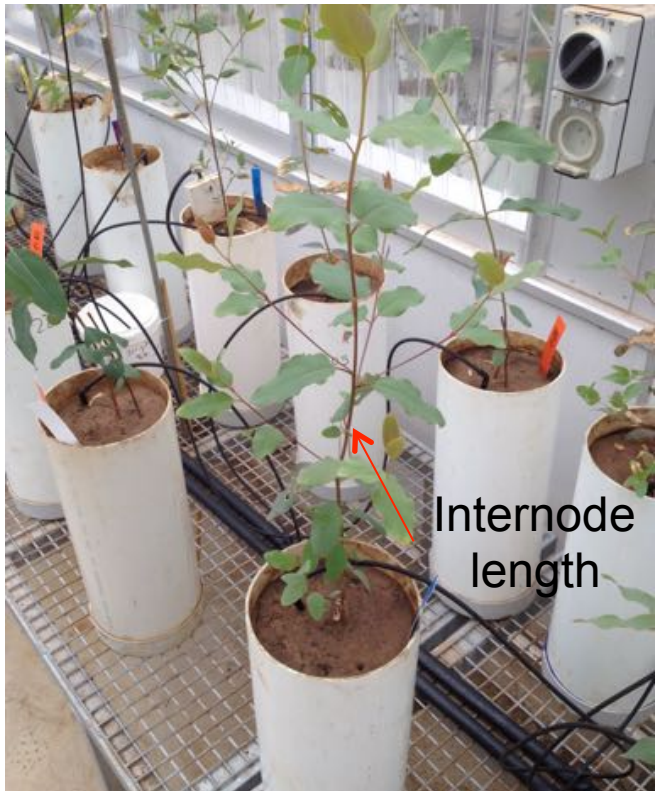
Are there important species and regional differences in tree stock root to shoot balance?

- Do species differ in root to shoot balance?
- Do warmer climates accelerate growth resulting in shifts in optimal root to shoot balance?
- Do species differences in root to shoot balance depend upon region?

Temperature directly alters tree morphology



Cold (15 – 24 °C)

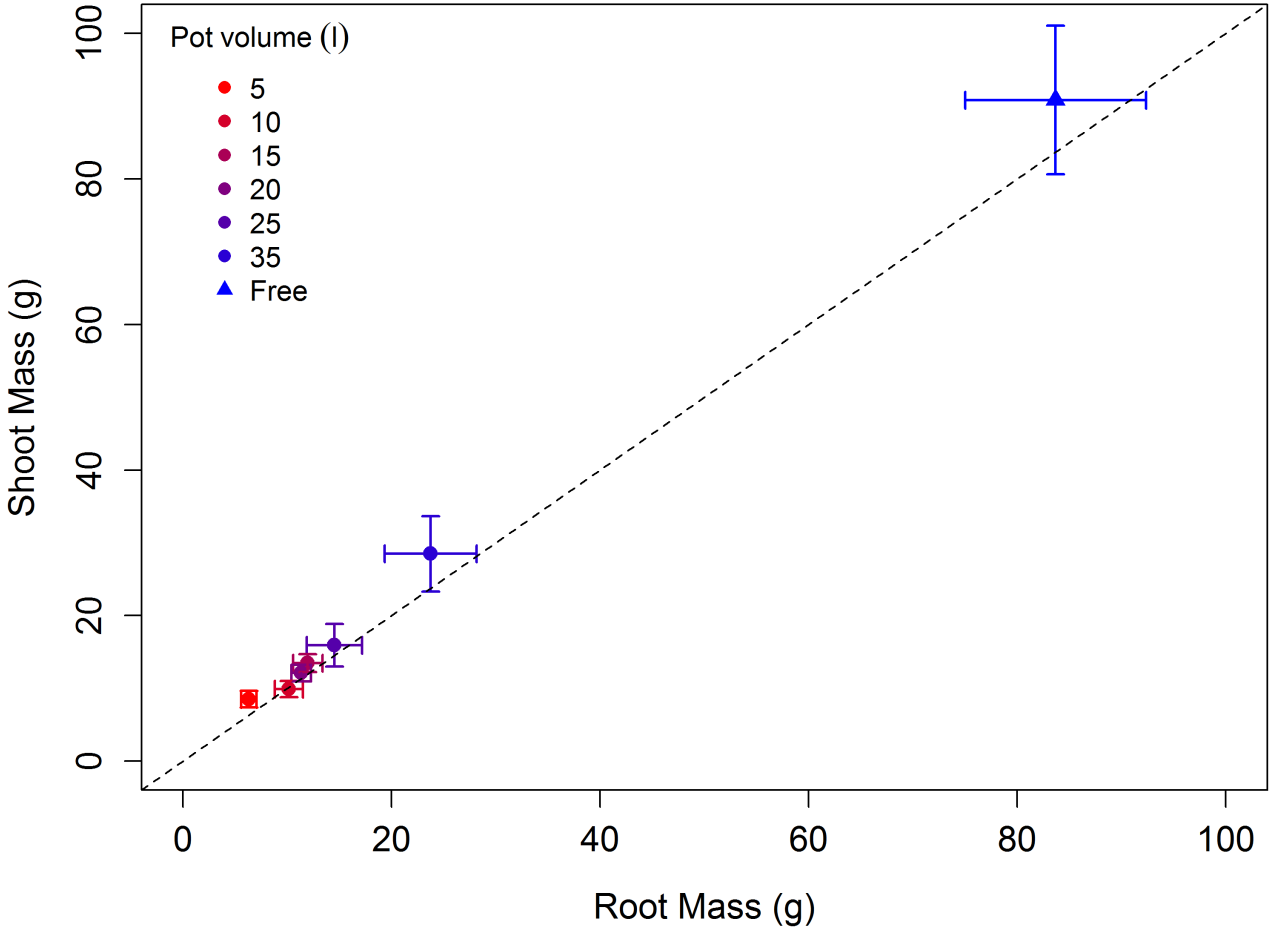


Warm (29 – 38 °C)

Photo: M Tjoelker

Growing environment has the potential to modify root:shoot balance

Tree growth “self balances” and is constrained by container size



Eucalyptus tereticornis (Campany *et al*. unpublished)

Tree stock balance: maximising the potential for transplant success?

- **Oversized shoot** evaporative surface may exceed water uptake capacity
- **Undersized shoot** lack of photosynthetic capacity to produce needed carbohydrates
- Should **balance** be managed alongside possible effects of climate/species differences?

Photo: D Thompson

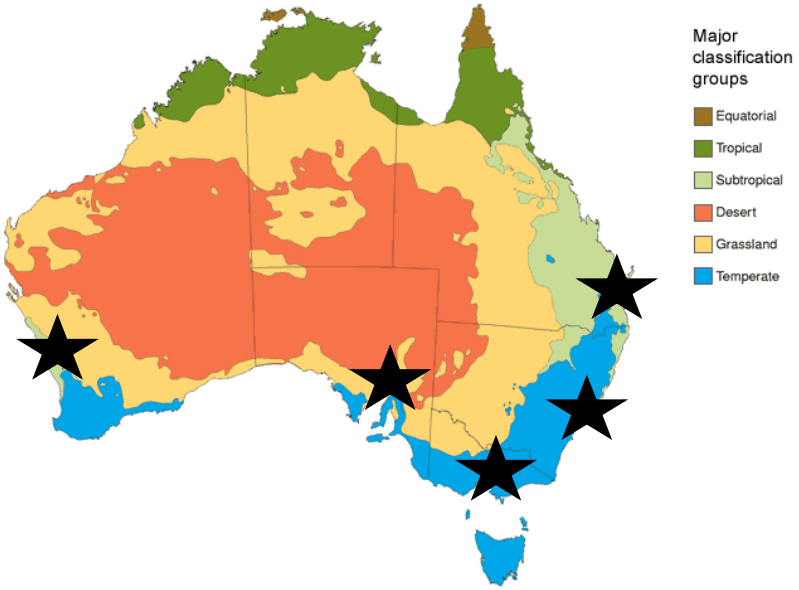
Aim 2: Quantify root to shoot balance in tree stock for contrasting regions in Australia

- Collect quantitative data from production nurseries throughout Australia
- Aggregate species into “stock types”
- Resolve regional/climatic differences
- Produce easy to use tables

Photo: D Thompson

Are there important regional differences in tree stock root to shoot balance?

- Cover major regions and landscape tree markets in five states
- Site visits to be completed in 2016



Working list of 28 tree species/cultivars for assessment

Species	Type	Origin	Growth Rate
Agathis robusta	Evergreen	Native	Fast
Agonis flexuosa	Evergreen	Native	Fast
Angophora costata	Evergreen	Native	Fast
Callistemon ‘Kings Park’	Evergreen	Native	Fast
Corymbia citriodora	Evergreen	Native	Fast
Corymbia ficifolia	Evergreen	Native	Moderate
Corymbia maculata	Evergreen	Native	Fast
Eleaocarpus reticulatus	Evergreen	Native	Fast
Eucalyptus caesia ‘Silver Princess’	Evergreen	Native	Slow
Eucalyptus leucoxylon ‘Rosea’	Evergreen	Native	Fast
Eucalyptus sideroxlyon	Evergreen	Native	Moderate
Eucalyptus torquata	Evergreen	Native	Moderate
Ficus hilii ‘Flash’	Evergreen	Native	Moderate
Lophostemon confertus	Evergreen	Native	Fast
Tristaniopsis ‘Luscious’	Evergreen	Native	Slow
Waterhousia floribunda	Evergreen	Native	Fast
Brachychiton acerifolia	Deciduous	Native	Slow
Melia azedarach	Deciduous	Native	Fast
Magnolia grandiflora ‘Little Gem’	Evergreen	Non Native	Slow
Olea europa	Evergreen	Non Native	Slow
Acer ‘Autumn Blaze’	Deciduous	Non Native	Moderate
Jacaranda mimosifolia	Deciduous	Non Native	Fast
Lagerstroemia ‘Natchez’	Deciduous	Non Native	Fast
Lagerstroemia ‘Sioux’	Deciduous	Non Native	Fast
Pyrus ‘Chanticleer’ or ‘Cleveland Select’	Deciduous	Non Native	Moderate
Auracaria heterophylla	Evergreen	Non-Native	Fast
Platanus x acerifolia	Deciduous	Non-Native	Moderate
Ulmus parvifolia	Deciduous	Non-Native	Fast

Aggregation of species into stock types

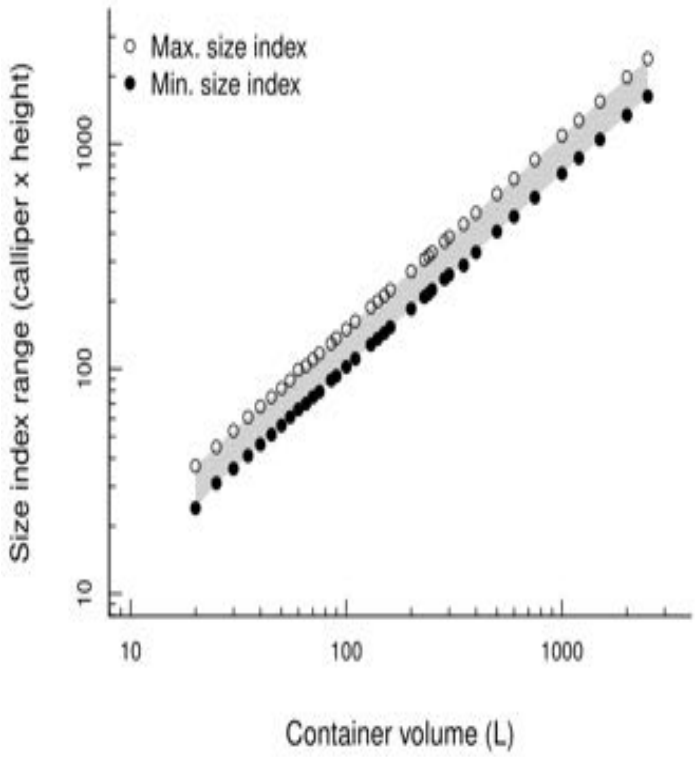
- Stock type A: tall, slender species, typically faster growing

- Stock type B: average form and growth rate

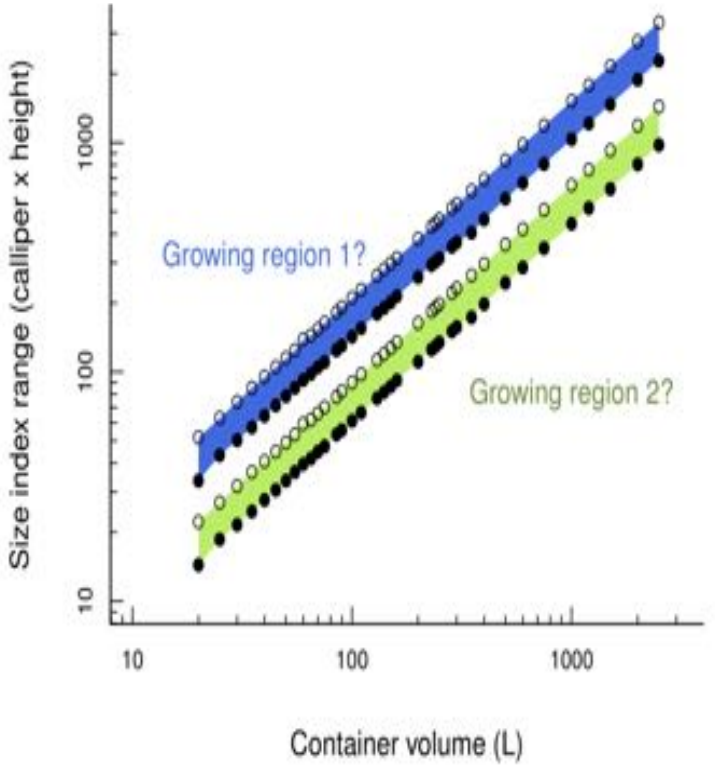
- Stock type C: stockier/ thick stemmed species, typically slower growing

Does root:shoot balance differ among regions and species?

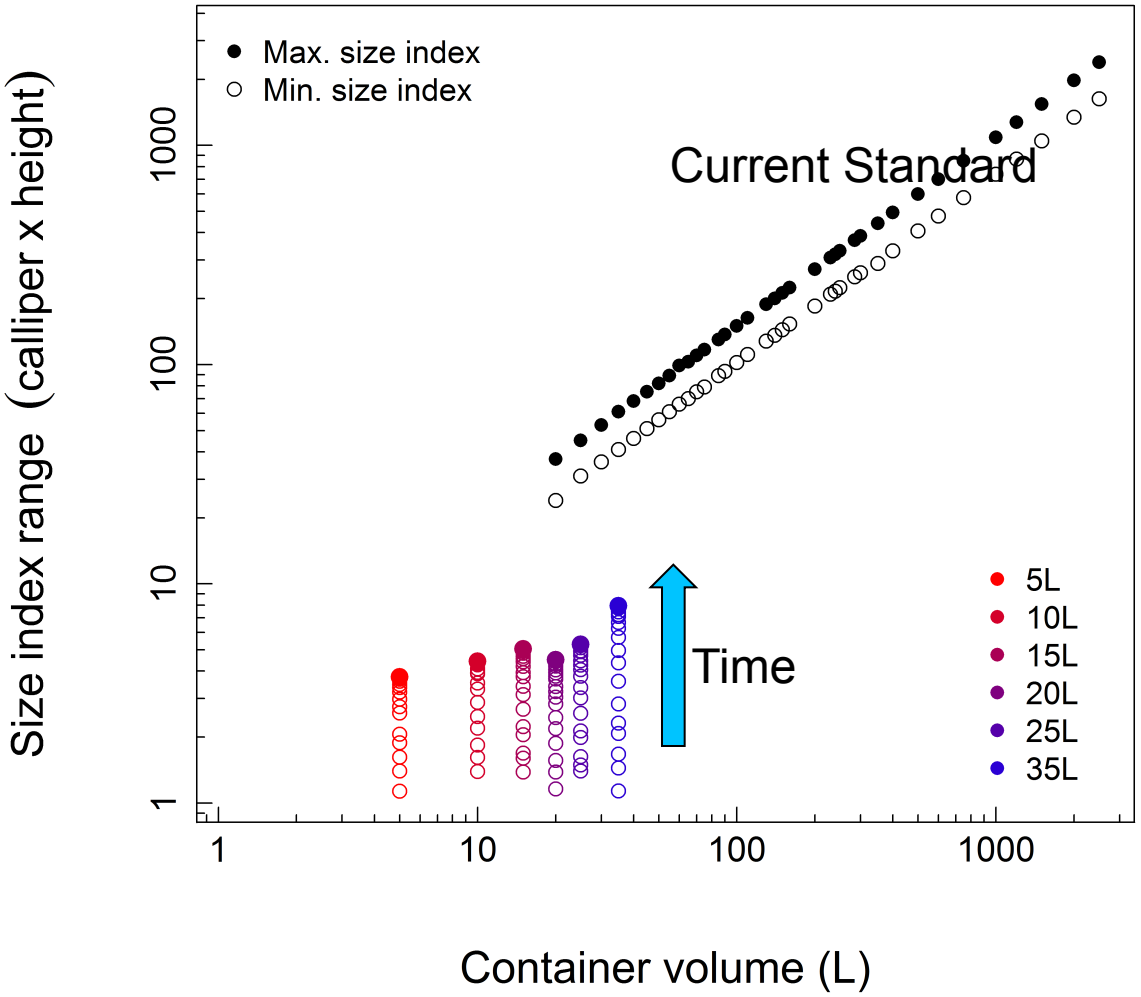
Current standard



Test for regional differences



Root:shoot balance metric is influenced by time since transplanting



Eucalyptus tereticornis (Campany *et al*. unpublished)

Appendix: Field sampling strategy

Stock Type	Product types	Samples	Variables
A, B, C minimum of 5 species per stock type	-Tube/cell stock (< 20 L), bareroot -Container (20 to 2500 L) -Ex-ground stock (ca. 57 to 3075 size index)	- 200 trees per stock type (non-destructive) - 20 trees per stock type (destructive)	**Aboveground** Height Size index = height (m) x caliper (mm) Stem taper Aboveground drymass (*research only*) **Belowground** Rootball diameter Rootball depth, height of root crown Rootball occupancy Root direction Root division Root dry mass (*research only*) **Allometric relationships**[1] Height vs. calliper Size index vs. rootball diameter Rootball diameter vs. container volume Size index vs. container volume

[1]Using log-transformed data to interpolate predictive linear relationships (e.g. log [size index] = a + b log [container volume]). These relationships will be used to create lookup tables for discrete ranges of values.

Tree stock balance: Summary and take-home message

- Root:shoot balance reflects a range of **functional** and **structural** traits important for healthy, successful trees
- Our study aims to determine **whether or not** regional/ species differences are important
- Our findings will inform tree stock balance in "*Australian Standard AS2303:2015 Tree Stock for Landscape Use*"

Photo: D Thompson

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Would like more information?

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