



TREE STOCK STANDARD PROJECT: A BETTER WAY TO ASSESS THE QUALITY OF AUSTRALIAN TREES

Outreach tour 2018

Testing the Australian Standard AS 2303:2015

A background image showing a tree with vibrant red flowers and green leaves. A path or walkway is visible in the lower part of the image, leading through a garden or park area. The image is slightly faded to allow text to be read over it.

Project team

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The relevance of trees in urban landscapes

Healthy trees are integral to sustainable urban landscapes now and in the future. Never before have trees received the current level of attention as key component of sustainable urban design, delivering substantial benefits to ever growing cities. These services include cooling, stormwater mitigation, carbon sequestration, improving air quality, biodiversity and property value, as well as making our cities more liveable and sustainable.

Major national initiatives such as the 2020Vision are on their way to increase urban green cover by 20% by the year 2020. Also, Western Sydney University, in collaboration with Hort Innovation and its “Hort Frontiers Green Cities Fund”, have embarked upon a 5-year plan to develop planning tools, engaging the public and stakeholders in a new conversation about urban greening and the role that trees play in urban ecosystems.



**GREEN CITIES
FUND**

Container-grown trees are the building blocks of greener and more sustainable city landscapes

Nurseries and consumers play a crucial role in the development and success of such initiatives. Industries and markets involved in urban greening depend on high quality tree stock. High quality container-grown trees increase planting success with enhanced rates of survival and growth in the urban landscape.



Nationally-recognised Standards help in assessing the quality of container-grown trees. Improved tree stock quality generates profits for growers and raises confidence in consumers. Following the guidelines for qualitative and quantitative metrics specified in such Standards to assess tree stock, helps ensure the successful establishment of container-grown trees in landscape plantings.

Tree Stock Standard Project: from the Australian Standard 2303:2015 to the revised AS 2303:2018, Tree Stock For Landscape Use

Adopted in April 2015, the AS 2303:2015 Standard is currently used to assess the quality of trees within three main categories: aboveground, belowground and the root to shoot balance. The industry called for **new research to validate the Standard**, particularly the root to shoot balance metrics, through field surveys of trees produced in nurseries throughout Australia.

Specifying root to shoot balance criteria in Standards has been problematic owing to a lack of information on potential influences of biological variation among species, nursery production practices and the role of climatic influences on root to shoot balance.



The importance of root shoot ratios and the balance concept

Functional and structural plant traits are important in ensuring a healthy tree. These functional traits are reflected in structural balance between root and shoot in container-grown trees. Thus, how a tree is grown and whether the root ball is of sufficient structural integrity to support a self-standing shoot is key to enhancing positive legacy effects of container-grown trees following dispatch and planting.

The **Tree Stock Standard Project** was initiated to better understand how the shoot to root balance varies with species and climatic regions. This information was later used to support the development of the new **AS 2303:2018, Tree Stock Standard for Landscape Use**.



A nation-wide field survey of 14,000 trees in production nurseries assessed tree stock characteristics. Researchers visited 23 wholesale nurseries where they assessed 650 production batches that ranged in container size from 18L to 3000L. Only stock deemed ready for sale and that had passed the above-ground and below-ground quality criteria set out by AS 2303:2015 were measured.

Research Methodology

- 1 Identify batches of trees ready for sale by consultation with nursery.
- 2 Complete visual assessments of above and below-ground morphological quality.
- 3 Measure the tree's height and calliper on a large selection of trees that have passed step 2.
- 4 Measure additional factors such as canopy width and leaf sizes.
- 5 Collect climate, production information from each nursery.

Why?

This methodology ensures that the trees being measured possess the quality morphological attributes required at dispatch. From this database we can assess variation in above-ground tree size in relation to container size, species, climate and nursery.

Introducing the new AS 2303:2018, Tree Stock for Landscape Use

The research output from the Tree Stock Standard Project was used to modify and develop new criteria to assess the root to shoot balance in tree stocks. These new criteria better reflect the variability of the Australian tree stock and the climate regions and species available in nurseries.

With the research completed, a wider range of preferred sizes (size index values) for a given container volume is now included in this Standard.



TESTING PROCESS FOR THE AS 2303:2018 STANDARD

Before starting

- Place tree stock on a firm surface
- Do not remove the container
- Remove any stakes or support system if present

**Containerized
and ex-ground
tree stock?**

1

Above ground testing

- Is tree stock labelled correctly? (True to type).
- Have you measured and recorded height and calliper?
- Does tree stock exhibit good health? Check crown density, cover and form. Leaf colour and size. Absence of epicormic shoots and dieback.
- Is the crown symmetric?
- Is the stock free of significant injury? (no wounds, bleeding areas, cracks, fungal bodies).
- Does the stem taper? Calliper at any point on the stem should be less than calliper at any lower point on the stem.
- Is the tree self-supporting? Does it exhibit a good stem and branch structure?
- Does the formative pruning follow AS 4373?
- Are branch and stem unions free of inwardly turned concave bark?
- Is the trunk position within 10% of the centre of the rootball diameter?
- If grafted tree stock, is the graft union sound and compatible?
- Is the tree stock free of active pests and diseases?

This information has been extracted from AS 2303:2018 Tree Stock for Landscape Use as a broad guide. Refer to the original text of the Standard for a more detailed explanation of the measurements necessary to assess your tree stock.



2

Balance and rootball assessment

- Have you calculated the size index? Size index is the product of the stem height from the root crown to the top of the trunk (m) multiplied by the calliper (mm).
- Does the size index fall within the 25th to 75th percentile for a given container size? (Appendix D)
- Have you assessed the rootball diameter, depth, height of root crown?
- Is your tree stock free of suckering rootstock and active pests or diseases?

3

Below-ground testing

- Is the rootball fully occupied? (at least 90% of the growing media remains intact upon removal of container)
- Are the roots growing in an outwards (radial) or downwards direction?
- Is the rootball free of j-roots, girdled, kinked and circling roots?

4

Bare-rooted tree stock testing

- Is rootball diameter $\geq 10 \times$ the calliper?
- Are the roots growing in an outwards (radial) or downwards direction?
- Is the rootball free of j-roots, woody circling roots, kinked roots or girdled roots?

Bare-rooted
tree stock?

Key Findings from the Tree Stock Project

A large proportion of otherwise conforming trees ready for sale do not fall within the size index range set by AS 2303:2015

- Size index at a given container volume exhibits large natural variation among trees surveyed across Australia
- Only 32% of measured trees fell within the specified range across all container sizes (18 to 3000L)
- 23% of measured trees exceeded maximum limits
- 45% of measured trees fell below minimum limits

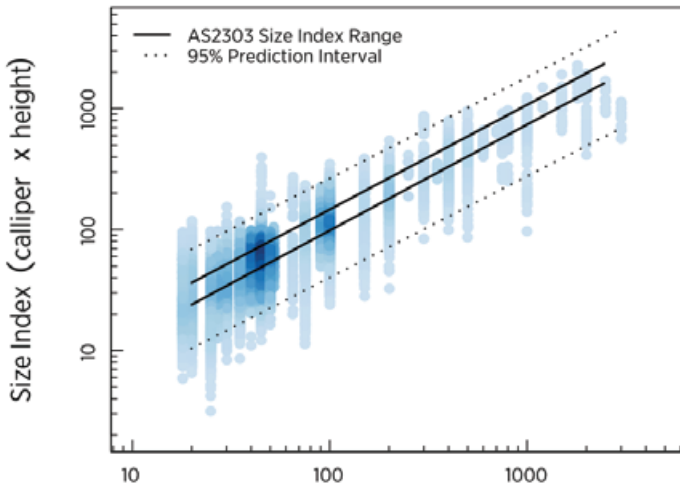


Figure 1. Above-ground size index across a range of container sizes for trees measured across 23 production nurseries in Australia. The specified size index range in the AS 2303:2015 Standard is shown with solid lines. The 95% prediction interval shown with dotted lines was obtained from the Tree Stock Research Project. A large proportion of the measured trees, ready for sale, do not fall within the set range by this Standard.

Table 1. Top 10 genera by numbers of species surveyed

Genus	Species
<i>Eucalyptus</i>	18
<i>Ficus</i>	6
<i>Acer</i>	5
<i>Corymbia</i>	5
<i>Syzygium</i>	4
<i>Callistemon</i>	3
<i>Fraxinus</i>	3
<i>Melaleuca</i>	3
<i>Quercus</i>	3
<i>Araucaria</i>	2

The variation against the AS 2303:2015 Standard differed with container size

Trees in smaller container sizes tended to be larger than specified by the Standard, compared to trees in larger container sizes which tended to be smaller than specified by the Standard.

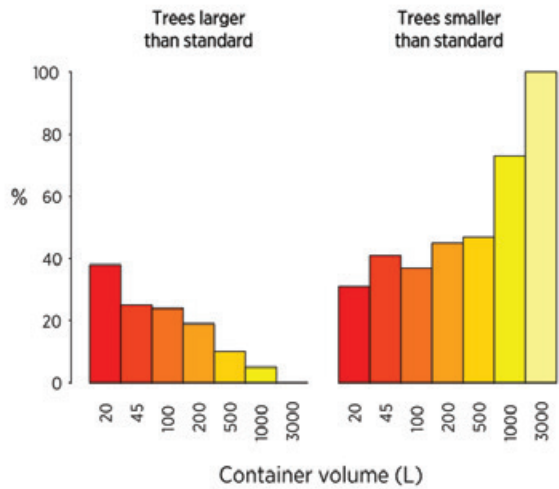


Figure 2. Percentage of trees by container volume that deviated from AS 2303:2015. More plants in small containers (20-100L) were larger than specified by the Standard. Tree stock in large containers (500-3000L) were smaller than specified in the Standard.

Size index variation is influenced by broad species differences

Non-native deciduous trees tended to have greater size index values than native evergreens in smaller (<50 L) container sizes, contributing to the observed natural variation among tree stock.

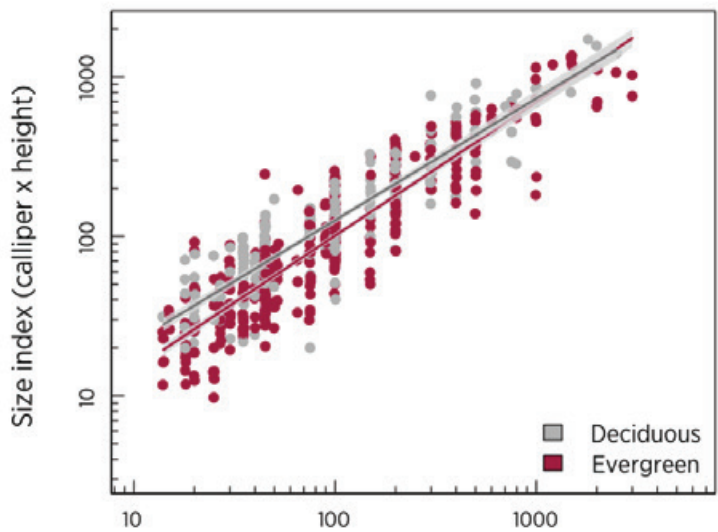


Figure 3. Size index variation of deciduous and evergreen trees. Deciduous trees in containers with a volume less than 50 L, on average, tended to have higher size index values than evergreen trees.

Origin	Leaf habit	Species (varieties)
Native	Deciduous	10
Native	Evergreen	75
Non-native	Deciduous	58
Non-native	Evergreen	16

Table 2.
Native and non-native trees.

Ranking	Species (variety)	Sites	Regions
1	Corymbia maculata	10	NSW, SA, VIC, WA
2	Angophora costata	12	NSW, QLD, SA, VIC, WA
3	Magnolia grandiflora Little Gem	10	NSW, QLD, SA, VIC, WA
4	Callistemon viminalis Kings Park Special	7	NSW, SA, VIC, WA
5	Jacaranda mimosifolia	12	NSW, NT, QLD, VIC, WA
6	Lagerstroemia indica Natchez	9	NSW, QLD, SA, VIC, WA
7	Lophostemon confertus	9	NSW, QLD, VIC
8	Araucaria heterophylla	12	NSW, NT, QLD, SA, VIC, WA
9	Waterhousea floribunda	9	NSW, QLD, VIC, WA
10	Ficus microcarpa Hilli Flash	7	NSW, QLD, VIC, WA

Table 3. Top 10 species by numbers of trees surveyed

To sum up

- The specified range of size index in AS 2303:2015 captures only about one third of otherwise conforming trees ready for dispatch at Australian nurseries nation wide.
- Trees in smaller containers tended to exceed the upper limits of size index more so than trees in larger containers.
- Landscape tree stock have a much greater natural variation in size index than the AS2303:2015 Standard specifies. This could mean that buyers are rejecting trees based on a Standard that is **OVER-LIMITING** compared to real-world tree production.
- A modified generalised specification of root to shoot balance with revised upper and lower limits is now included in the Standard. These new criteria were adopted to better reflect the variability of Australian tree stock across climate regions and the species available in nurseries (Table 4).

Table 4. New and wider range of preferred sizes (size index values) for a given container volume included in the revised AS 2303:2018.

Nominal container volume (L)	5th percentile	Preferred range			95th percentile
		25th percentile	50th percentile	75th percentile	
18	10	17	25	36	57
20	11	19	27	39	62
25	14	23	33	47	73
27	15	25	35	50	77
30	16	27	38	54	84
35	18	31	44	61	94
40	20	35	49	68	104
45	23	38	54	75	114
50	25	42	59	82	124
52	26	44	61	84	127
65	31	53	74	100	151
75	35	60	84	113	168
90	42	71	98	130	193
100	46	77	107	142	209
150	65	111	151	196	284
200	84	142	193	247	354
250	102	173	233	295	419
300	119	203	272	341	481
350	136	233	310	385	541
400	153	262	347	429	598
500	186	318	420	512	709
600	218	373	490	593	814
700	250	428	559	670	915
750	265	454	592	708	964
800	281	481	626	746	1012
1000	341	585	756	891	1199
1200	400	686	883	1031	1377
1500	487	835	1067	1232	1631
1800	571	980	1246	1425	1872
2000	626	1075	1363	1550	2028
2500	761	1308	1647	1852	2402
3000	892	1535	1923	2142	2758

Advisory board members

Dr Anthony Kachenko	<i>Hort Innovation</i>
Mr Ken Bevan	<i>Alpine Nurseries</i>
Mr Tim Carroll	<i>Andreasens Green</i>
Ms Carole Fudge	<i>Benara Nurseries</i>
Ms Leanne Gillies	<i>Fleming's Nurseries</i>
Mr Hamish Mitchell	<i>Specialty trees</i>
Mr Chris O'Connor	<i>Nursery and Garden Industry Australia</i>

Nursery and staff

Adelaide Advanced Trees	Freshford Nurseries
Adelaide Tree Farm	Greenstock Nurseries
Alpine Nurseries	Heynes's Nursery
Andreasens Green-Kemps Creek	Ibrox Park Nursery
Andreasens Green-Mangrove Mountain	Logans Nursery
Arborwest Tree Farm	Manor Nurseries
Benara Nurseries	Mt William Advanced Tree Nursery
Cleveland Nursery	Pallara Trees
Darwin Plant Wholesalers	Plants Direct
Ellenby Tree Farm	Speciality Trees
Established Tree Transplanters	Trees Impact
Fleming's Nurseries	

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TREE STOCK STANDARD OUTREACH

**A better way to assess the quality
of Australian trees**



**Nursery & Garden Industry
Australia**

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Innovation**

**WESTERN SYDNEY
UNIVERSITY**



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