THE DEMANDS WE PLACE ON STREET TREES: A CASE STUDY OF *EUCALYPTUS LEUCOXYLON* F. MUELL.

G. M. Moore and A. Chandler
School of Agriculture, Food and Ecosystem Sciences, University of Melbourne
Burnley Campus, 500 Yarra Boulevard, Richmond 3121

Abstract

Given that there has been relatively little research into Australian species for use as street trees compared to major exotic genera, yellow gum, *Eucalyptus leucoxylon* F. Muell. is one of a few eucalypts occurring in south-eastern Australia with bright coloured flowers that is highly regarded for urban use. However, are there species characteristics and performance traits that underpin this high regard? For the most part the arboriculture of yellow gum is unknown and undocumented. This brief paper explores some of the criteria that could be considered valuable for a tree growing in Australian streets. The performance of 300 *E. leucoxylon* street trees growing across the city of greater Melbourne were assessed against these arboricultural criteria that related to canopy structure and density, straightness of the trunk, health (assessed on canopy, trunk and branch condition, production of exudates and presence of fungal fruiting bodies), flower colour and root systems. The results showed that *E. leucoxylon* was a suitable street tree species with most specimens showing good habit, vigour and health. The trees' live crown ratio, height, flower colour and capacity to cope with pruning were considered appropriate for a well performing street tree. Their dense canopies and high live crown ratios provide shade that can reduce the urban heat island (UHI) effect. Yellow gum has the potential to be a successful street tree well beyond it natural range, and not only in Australia but in other parts of the world where it has been successful.

Introduction

We demand a great deal of our street trees. We want them to grow fast but not too fast, establish quickly, have a single stem and a full, dense and spreading canopy. We want them to be attractive in foliage and flower, but would prefer that they don't shed leaves, flowers and fruits. We want them to live a very long time but require no maintenance and we don't want them to cause damage to infrastructure or during storms. There are many more attributes that we want, but you get the point. We want all of this and want it from Australian native species that have never been selected or bred for urban use or had their performance as urban street trees assessed

Elite specimens of *Ulmus, Quercus, Platanus* and *Fagus* have been developed over centuries for urban use, but there has been little research into the selection, breeding and performance assessment of Australian street tree species. For many Australian trees the only data available pertains to high value forestry species, few of which are widely used as street trees. There has been work on different provenances of spotted gum (*Corymbia maculata*) for urban use (Bone 2001) and Williams (1995) tested provenances of brush box (*Lophostemon confertus)* for growth rate and waterlogging tolerance. Both studies noted high intraspecific variation that could be used for selection of elite individuals.

The hundreds of eucalypt species are important components of the Australian landscape and with an inherent tolerance to environmental stresses and local soils many are regarded as potentially suitable for amenity use in a range of sites (Nicolle, 2002). The high level of variability within eucalypts for characteristics such as habit, size and shape of leaves, flowers and fruits and bark colour making selection for urban use worthwhile. Yellow gum, *Eucalyptus leucoxylon* F.Muell. is one of a few eucalypts occurring in south-eastern Australia with naturally bright coloured flowers and it is highly regarded as an important urban tree. Yellow gum is readily propagated from seed but the progeny show the variability and diversity typical of seedlings.

Typically a medium to small woodland tree of 13-16 m height (Boland and Brooker, 1975; Boland et al, 1992), *E. leucoxylon* ssp. *leucoxylon* and spp. *pruinosa* in forest form can reach 30 m (Boomsma, 1981; Nicolle, 2006). It has a smooth trunk with yellow, blue-grey or cream patches, and rough fibrous bark retained for 1-2 metres at the base (Slee et al, 2006; Nicolle 2006). Flower colour ranges from white to red, but there are yellow and apricot variants (Boland, 1978; Slee et al, 2006). Red flowering individuals occur in all subspecies except *E*. *leucoxylon* spp. *pruinosa*, which is predominantly white (Slee et al, 2006).

Pryor and Johnson (1971) recommended four subspecies: var. *leucoxylon* (including var*. erythrostema* and var*. angulata)*, var. *macrocarpa*, var. *pauperita* and var. *pruinosa,* based on fruit size, ribbing and glaucousness, but Boland (1978) recommended four subspecies representative of four geographic distributions: the Eyre Peninsula (ssp. *petiolaris*), coastal (ssp. *megalocarpa*), sub-coastal (ssp. *leucoxylon*) and inland (ssp. *pruinosa*). Two additional subspecies, ssp. *stephaniae* and ssp. *connata*, were described by Rule (1990), who elevated subspecies *petiolaris* to species level, and described subspecies *bellarinensis* (Rule, 1992; 1998). Natural populations of subspecies *bellarinensis* are subjected to cool, salt laden coastal winds, and sites that are water logged in winter (Rule, 1998), suggesting suitability for urban use. Subspecies *megalocarpa* is the most highly horticulturally exploited subspecies while subspecies *stephaniae* has semi-weeping foliage and may be more drought tolerant than other subspecies (Rule, 1991; Nicolle, 1997; 2006). Subspecies *petiolaris* (*E*. *petiolaris*) is regarded by Nicolle (2002) as one of the better subspecies of *E*. *leucoxylon* for street tree use as it has a graceful crown, more flower colours, is tolerant of saline soils, has a good growth rate and is a medium sized tree with large pendulous buds, flowers and fruit (Boland, 1977*b;* Nicolle, 1997; Bennell et al, 2008).

Interrogating the tree inventory data of the 31 municipal councils making up the city of greater Melbourne, identified nearly a million trees from 1127 different taxa with the proportion of Australian species being 60%, and 70% of the most frequently planted species were native (Frank et al. 2006). The most popular native species were from *Acacia*, *Callistemon*, *Eucalyptus*, *Melaleuca* and *Lophostemon* genera which comprised 43% of all trees (Frank et al. 2006), but the genus with the highest number of taxa and number of individuals was *Eucalyptus* and the most common species was yellow gum, *Eucalyptus leucoxylon* with over 20,000 individuals (Frank et al. 2006). Despite its common occurrence, the performance of *E. leucoxylon* in streets can be quite variable (Beardsell et al. 1993).

The aim of this research was to develop a set of tabulated criteria against which the performance of yellow gum as a street tree could be assessed. It was hoped that these criteria might then be utilised more widely to assess Australian native trees for use in streets and the urban forest more generally. The criteria could also be used to identify superior specimens for future propagation and planting. Once the criteria had been developed, they were used to assess *E. leucoxylon* growing across greater Melbourne, providing an interesting and relevant test case.

Method

With an aim of assessing approximately 300 trees across greater Melbourne, it was recognised that sampling single trees in different streets involved too much travel time to be practical. So sampling was based on choosing streets at random where 3-5 *E*. *leucoxylon* trees could be assessed on a single visit. Suburbs were visited and locations where there were sufficient trees were identified so that trees could then be selected randomly for assessment. Trees were sampled randomly from a wide range of suburbs and situations across the city. Assessments were undertaken between the months of April and October. A more complete explanation of methods used and tables developed can be found in Moore and Chandler (2023). This paper presents some but not all of the Tables developed and some have been abridged and/or combined for the purposes of this presentation and for a more practical application of the criteria for use by arborists working in urban forests.

In selecting trees for assessment, the following criteria were applied:

1) Trees had a diameter at breast height (DBH at 1.3 m) of at least 10 cm,
2) There was clear access to the base of the trunk
3) Access was available to measure canopy spread in a north-south and east-west direction.
4) There was safe site access from vehicular traffic

DBH was used as the basis for selecting trees for assessment and while precise data on tree age was not available. All trees assessed were considered to be older than 10 years. Sufficient trees were identified to allow

300 specimens growing across the city to be assessed with the information and data gathered to be used to inform the criteria developed.

Location, site and soil

Tree position and a detailed description of the tree's location on the street were recorded. Site soil surface and paving and any root damage to landscape infrastructure were also noted. Soil compaction was measured by pushing a 10 mm diameter, 1 m long steel spike into the ground within 1 m of the base of the tree trunk. Pressure was stopped when resistance was met. This was repeated three times, to ensure there was no obstruction to penetration and until there were three consistent measurements. The resistance to insertion was recorded on a five-point descriptive scale: **Very soft, Soft, Medium, Firm** and **Impenetrable.**

Growth habit and phenotype

Data were collected to provide a phenotypic description of *E.leucoxylon* trees growing across Melbourne (Table 1).

Height measured from soil surface to the highest living canopy point using a heightmeter.

DBH at 1.3m was recorded.

Canopy spread measured across the drip line along north-south and east west axes and the mean of the two values was used as the measure of canopy spread.

Canopy density estimated using a 5 point scale **<20%, 21-40%, 41-60%, 61-80% and >81%** (Table 1).

General canopy habit described using small images to ensure consistency and 5 descriptors**: rounded, broadly round, oval, pyramidal or vase shaped** (Table 1). Whether the tree had a single dominant leader, and the number of lower order major lateral branches forming the crown were recorded. The height to the first branch from the ground was measured.

Flower colour was described using known flower colours; **red, dark pink, light pink, orange, white** and **bi-colour** was an added category to accommodate a specimen discovered during assessment.

Trunk taper was determined by comparing the difference between the DBH and the stem diameter at ground level as a ratio (**DBH/trunk diameter at ground level**). Trunks were assessed for straightness and lean. Lean was the deviation of the trunk from the vertical and trunk straightness was described by whether there were bends or twists from ground level to the major lower order branch scaffolds.

Live crown was measured as a proportion of the height of the tree measured to the highest living point in the canopy. The resulting ratio indicated how much of the tree's height was occupied by its canopy. The higher ratio, the more impressive is the canopy in relation to a tree's height and the more likely the tree is to provide shade and other benefits in a warming climate.

Tree health and condition

Trees were surveyed for health and the existence of any physical problems (Table 2). The presence of decay and/or fungal fruiting bodies was noted to determine whether *E. leucoxylon* was susceptible to attack by decay causing organisms. Insect damage was also assessed. Trunks and lower branches were assessed for the occurrence of resins and other exudates, the presence of which may indicate the presence of disease or decay in a tree was also noted.

Evidence of vandalism, poor pruning, damage from line trimmers, vehicle damage or wounds from ropes and cables was recorded. The loss of a leader or major lower order branches was assessed and the possible causes of the loss were recorded (Table 2). Given that most trees had a clear trunk which was designated as the primary structure (order1), other branches were ordered (order 2, order 3....) from the trunk to the extremities of the canopy. As a stress, damage or wounding response, most eucalypts produce epicormic shoots and so the occurrence of epicormic shoots was recorded.

Table 1. Phenotypic characteristics relating to tree size, canopy, trunk, branching and flower colour, their description, and the category or unit of measurement recorded.

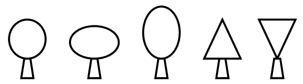
Characteristic	Description	Categories / units
Tree height	Using a Silva® clinometer, the top of the tree was sighted from a predetermined distance (usually 20m), and the correlating angle recorded.	(m)
Diameter at breast height	Measured at 1.3m	(mm)
Canopy spread	Average of canopy spread in a north-south and east-west direction	(m)
Canopy density	Estimated by below looking upwards through the canopy	1. <20%
		2. 21-40%
		3. 41-60%
		4. 61-80%
		5. >81%
Canopy shape	Canopy shape 	1. Rounded
		2. Broadly round
		3. Oval
		4. Pyramidal
		5. Vase
Number of main branches	Number of branches holding the majority of the canopy	1. One branch (single stem)
		2. Two branches
		3. Three branches
		4. Four branches
		5. Five + branches
Dominant leader	Does the tree have a dominant leader	Yes/no
Main branch position	The height to the first main (lower order) branch – including missing branches.	(m)
Flower colour	Flower colour was described using the known flower colours for *E. leucoxylon*	1. Red
		2. Dark pink
		3. Light pink
		4. Orange
		5. Yellow
		6. White
		7. Bi-colour
Trunk taper	The taper between DBH at 1.3m and at the base of the trunk	Ratio: DBH / Diameter at base
Trunk straightness	The amount of twisting and kinks present in the main trunk	1. Very straight
		2. Reasonably straight
		3. Bark twisted, moderately straight
		4. Trunk moderately kinked/twisted
		5. Trunk severely kinked/twisted
Trunk lean	Categories are independent of trunk straightness	1. No lean
		2. Minor lean
		3. Major lean
		4. Extreme lean
Live crown ratio	When observing the full tree profile, the proportion of height which has live crown, is deemed the live crown ratio	1. < 20%
		2. 21-40%
		3. 41-60%
		4. 61-80%
		5. > 81%

Table 2. Trunk and branching scaffold characteristics such as growth, decay, presence of exudates, fungal activity and vandalism, their description, and the category or unit of measurement recorded.

Characteristic	Description	Categories / units
Decay	Any area of the trunk that appeared to be decayed	1. No decay detected
		2. Minor areas of decay
		3. Significant areas of decay
Exudates	Exudates or resin present	Yes/no
Fungal bodies/ cavities	Present or absent	Yes/no
Vandalism	Damage caused by human interference	1. No damage detected
		2. Suspected damage from mower 3. Damage from support structure
		4. Suspected vehicle damage
		5. Graffiti
		6. Other human interaction
Loss of co-dominant leader	Was there a co-dominant leader that is missing	1. No.
		2. Yes.
	Possible reason for missing co-dominant leader	1. Co-dominant leader is dead
		2. Co-dominant leader is missing (pruned)
Epicormic shoots	Presence of lignotuberous or epicormic shoots on the lower or base of the trunk	Yes/no
Branch loss	The number of missing branches within three diameter classes, (greater than 20cm, 10-20cm, and less than 10cm) were counted	1. No branches removed
		2. One to five branches
		3. Six to ten branches
		4. Greater than ten branches
Pruning	Apparent pruning noted	1. No pruning apparent
		2. Minor pruning (foliage/small branches)
		3. Heavy pruning (large portion of canopy)
Wound repair	Damage to the tree suspected to have occurred in response to pruning	1. Not Applicable – no pruning evident
		2. Excellent – no problems detected
		3. Good – some problems, may be due to pruning
		4. Poor – exudates are present and the timber appears to be decaying
Dead or dying branches or twigs	Proportion of the branches and twigs within the canopy that is dead or dying	1. No death evident.
		2. < 20%
		3. 21-40%
		4. 41-60%
		5. 61-80%
		6. > 81%
Abnormal foliage	Percentage of foliage that does not appear normal, including abnormal colour or form	1. Foliage appears normal.
		2. < 20%
		3. 21-40%
		4. 41-60%
		5. 61-80%
		6. > 81%
New growth	Visual assessment of the amount of new growth	1. Significant amounts of new growth
		2. Some new growth evident
		3. No new growth apparent
	Distribution in canopy	1. New growth evenly distributed.
		2. New growth mostly evenly distributed
		3. New growth unevenly distributed
		4. New growth very uneven and localised

To assess the condition of the main lower order branching scaffold, the number of missing branches and the presence of decay as a response to branch loss or pruning were recorded (Table 2). The numbers of missing branches within three diameter classes **(< 10cm, 10-20cm, and > 20cm**) were counted. Any damage to or pruning of the trees was noted, as was the proportion of smaller branches and twigs within the canopy that was dead or dying and the percentage of foliage that was either dead or unhealthy (Table 2). The proportion of new growth (a new flush of growth with juvenile foliage and rapid shoot tip extension) was estimated.

A limited assessment of root systems was undertaken, but was confined to those roots that could be seen above-ground within the drip line (Table 3). The number and diameter of exposed roots were recorded. Damage caused by root systems to infrastructure, such as cracking or lifting of footpath paving and roadside curbing was recorded. The raising or lifting of the soil surface around the trunk was noted as it may contribute to infrastructure damage, to maintenance issues such as pedestrian tripping hazards or to difficulties in trimming of turf or undergrowth below the tree. Interactions of tree roots with infrastructure can prove costly in the management of urban street trees.

Table 3. Exposed roots, their description, and the category or unit of measurement recorded for each Eucalyptus leucoxylon tree assessed.

Characteristic	Description	Categories / units
Root exposure	The base of the tree and surrounding soil were observed for exposed roots	1. Roots exposed and girdling
		2. Major roots (>10cm) exposed
		3. Minor roots (<10cm) exposed
		4. It is suspected that the ground surface had been raised due to the roots

Results

When yellow gums, *E leucoxylon*, growing as street trees were assessed against the criteria described above, some of the results were as expected. For example, most trees were either red or pink flowered with white flowers as the next most common. Flowering can occur in any month of the year, but in this study there was greatest flowering from August to October. Winter flowering trees can be an important food source for native bird species, such as parrots and for native insects.

The characteristics of trunk and canopy often not only define the value of street trees, but also their success. Single, straight trunks and a rounded spreading and dense canopy are frequently desired in successful street trees. While trees ranged in height from 4.3 m to 26.5 m, nearly 70% of trees were between 5.5 m and 10.9 m, with only 12 trees being less than 5.5 m tall and only four trees being in excess of 18 m in height. About 75% of the trees had the broadly round canopy shape preferred in a street tree and nearly 60% of trees had a canopy density rating of above 60% (Figure 1).

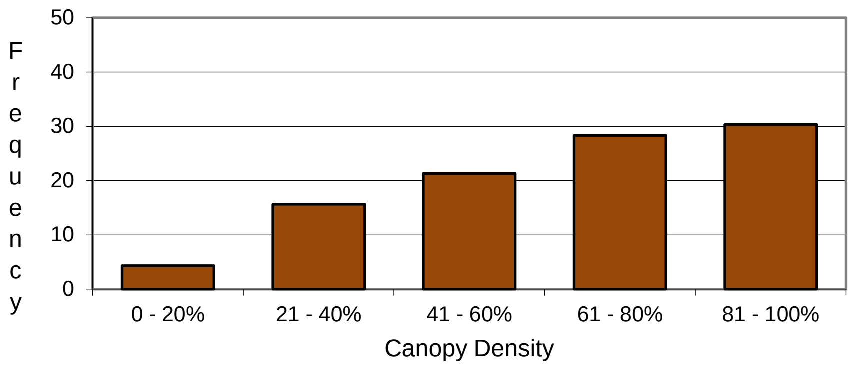


Figure 1. Frequency (%) of canopy density of 300 yellow gum, Eucalyptus leucoxylon street trees.

It will not surprise that most trees were growing in soils that were moderately to highly compacted (Table 4). Soils occurring along major roads and suburban streets are usually, if not always modified, disturbed or turned over. The most common consequence of these construction activities is compacted soil. While a simple field technique was used for determining soil compaction levels, it none-the-less gives an indication of the situations within which yellow gum is growing in urban streets.

Table 4. Occurrence of different levels of compacted soil surrounding 300 yellow gum, Eucalyptus leucoxylon, street trees.

Soil compaction	Number of trees	Frequency (%)
Impenetrable	5	1.7
Firm	123	41.0
Medium	98	32.7
Soft	40	13.3
Very Soft	34	11.3

Canopy spread varied from as low as 4 m up to 21 m, but most trees were in the range of 6-11 m in spread (Figure 2). This is a suitable range for urban street trees, where a low traffic suburban street is often about 7m across while busier and major roads can be considerably wider.

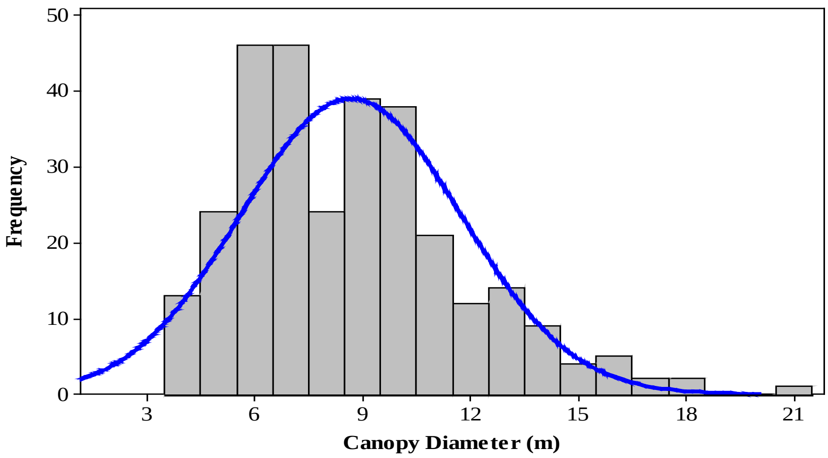


Figure 2. Frequency distribution of canopy diameter (m) of 300 yellow gum, Eucalyptus leucoxylon, street trees.

Of the trees surveyed, only 22.6% of trees had a dominant stem with the remaining 77.4% had a canopy habit where growth was shared between several large lower order branches. The height above-ground to the first branch ranged from 0 to 5.4 m including pruned trees (Figure 3). Branching occurred at the base of the tree (within 1 m of surface level) in only 3.7% (11) of trees while 80.0% of trees branched between 1 m and 3m. This reflects to some degree, yellow gum's reputation as a multi-trunked or -stemmed tree.

It is interesting to see that yellow gums planted on streets measured up against many of the criteria established for this research well (Table 5). Nearly 80% of trees had minor or no trunk lean and 83% of the yellow gums had straight trunks, both characteristics that are highly desirable in an urban street tree. The data for live crown ratio showed that over 92% of trees had a ratio in excess of 41%.

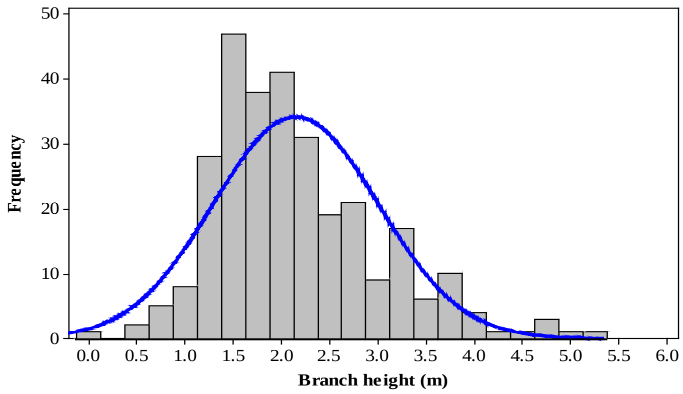


Figure 3. Frequency of the distribution of height (m) to first branch of 300 yellow gum, Eucalyptus leucoxylon, street trees.

Table 5. Trunk and canopy characteristics of 300 yellow gum, Eucalyptus leucoxylon, street trees.

Trunk form category	Number of trees	Frequency (%)
Trunk lean		
No lean	97	32.3
Minor lean	142	47.3
Major lean	56	18.7
Extreme lean	5	1.7
Trunk straightness		
Very straight	105	35.0
Reasonably straight	143	47.7
Bark twisted, moderately straight	33	11.0
Trunk moderately kinked and twisted	14	4.7
Trunk severely kinked and twisted	5	1.7
Canopy		
Evenness category		
Even	144	48.0
Minor unevenness	89	29.7
Severely uneven	67	22.3
Branches		
Even	111	37.0
Minor unevenness	133	44.3
Severely uneven	56	18.7
Live crown ratio		
<20%	0	0
21-40%	22	7.4
41-60%	183	61.2
61-80%	55	18.4
> 81%	39	13.0

Street trees must be tolerant of regular, if not frequent, pruning. Of the 300 trees surveyed only 25 showed no evidence of pruning, meaning that 275 (91.7%) had been pruned (Table 6). In general the rating of their response to pruning was from good to excellent.

Table 6. The response to pruning of 300 yellow gum, Eucalyptus leucoxylon, street trees.

Response to pruning	Number of trees	Frequency (%)
No pruning evident	25	8.3
Excellent	129	43.0
Good	99	33.0
Poor	47	15.7

Discussion

The criteria presented here and the lists and tables provided in (Moore and Chandler 2023) could be applied to street trees generally or modified by local government and other urban forest management agencies not only to characterise suitable species for street tree use but also to assess local street tree performance. They could be of value in assessing candidate species for future street tree planting under changed climate conditions. Rather than using anecdotal assessments of street tree performance, criteria are established and trees are then assessed against these criteria in a measureable and repeatable way.

Selecting high quality planting stock is an essential pre-requisite for the successful establishment, growth and efficient maintenance of street trees. Yellow gum, *E. leucoxylon*, clearly has the potential to be a significant and more widely planted street tree, not just in Australia, but elsewhere where it has been grown successfully or where future climatic conditions would be conducive to its growth. Specimens have canopy and trunk characteristics such as straight trunks and rounded spreading and dense canopies. Most specimens are of suitable height for urban use, but care must be taken to propagate and grow trees with the desired characteristics as poor quality seed sources could undermine the value of planting.

Over 75% of trees assessed showed a good or excellent response to pruning. Given the large sample size, this is a good indication that yellow gum copes well with regular pruning, as indicated by its capacity to seal off, produce woundwood and grow over pruning cuts. Many of the yellow gum specimens were growing under or near powerlines and their ability to cope with poor powerline pruning could have a profound effect on their longevity and in any thorough cost:benefit analysis on their value in comparison to other street tree species. Typical of most eucalypts, *E*. *leucoxylon* trees showed strong epicormic shoot response to pruning and branch loss with 83% of pruned trees initiating epicormic growth (Moore 2021). The species can also rapidly regenerate from lignotuberous shoots after major trunk damage (Moore 2015), allowing a rapid renewal of the canopy and restoration of foliage density, demonstrating an ongoing capacity for carbon sequestration. Generally high crown ratios with 92% of trees with a ratio above 41%, indicate that *E*. *leucoxylon* trees provide valuable shade in a compact canopy. This growth habit and the shade provided can reduce the UHI effect and enhance the species' role in the city's capacity to respond to a warming climate.

It will not surprise any regular attendees of TREENET conferences that most of the trees assessed were growing in moderately to highly compacted soils. Urban soils, especially those along roads sides are often compacted during construction but despite these growing conditions, many yellow gums established and continued to grow well. They are hardy trees capable of withstanding the stresses of urban environments. The successful growth of urban trees with good canopy spread and density will be crucial to establishing adequate urban canopy cover that may assist in mitigating urban heat island effects as climates warm.

The most commonly planted subspecies of yellow gum is *E. leucoxylon* ssp *megalocarpa* and this was evident in this study as almost all of the trees assessed were likely to be ssp *megalocarpa*. Nicolle (2002) suggested that *E. leucoxylon* ssp *petiolaris* was well suited to street tree planting due to its size, growth rate and tolerance of saline soils among other preferred street tree characteristics. Similar research to that reported here but on *E. leucoxylon* ssp *petiolaris* would seem worthwhile, but it is not easily distinguished from other subspecies when mature.

While there are considerable data in this study of yellow gum, *E. leucoxylon*, there is still much that remains unknown. There are little, if any, data on the age classes of yellow gums planted as street trees or on their likely useful life expectancy. It would be useful to know both in determining the real value of yellow box as street trees in the long term. Given the preference for street trees to have single trunks and remain branch free to a height that suits pedestrian traffic and sight lines for vehicles, it would be worthwhile knowing the propensity for multiple stems and low branching in yellow gum. This study provides some relevant data on both aspects, but for a population of trees that has been closely managed and regularly pruned.

Conclusion

Yellow gum, *Eucalyptus leucoxylon*, is a widely planted street tree species across Melbourne, but also more broadly in parts of south-eastern Australia and extending into Queensland and parts of Western Australia. This study shows it to be a successful and valuable street tree that exhibits many of the attributes demanded of an urban street tree. There is considerable variability shown within its phenotype, but careful selection and propagation from superior specimens could improve its performance as a street tree against the criteria suggested. These criteria could also be applied to other eucalypt and related species in a way that could guide the selection of species appropriate for urban street tree use and to assess the success and performance of trees once planted. Yellow gum provides many of the environmental services both demanded and expected of street trees as climate changes. It has been planted well beyond its natural range and performed well, suggesting that it may be considered a climate change ready species. It is also possible that *Eucalyptus leucoxylon* may be a suitable urban street tree in other parts of the world as climates change and new planting options are considered.

Acknowledgements

A. Chandler (Marwick) received an Australian Research Council linkage grant sponsored by Fleming’s Nurseries and Horticulture Australia. Dr David Beardsell is thanked for contributions to the research and in the locations of trees. Statistical advice was provided by Graham Hepworth and Sandy Clarke, Statistical Consultancy Centre, University of Melbourne. Dr Peter May and Dr Rod Jones (Dept of Primary Industries, Victoria) are thanked for contributions to the research.

References

Beardsell, D.V., O'Brien, S.P., Williams, E.G., Knox, R.B. and Calder, D.M. 1993. Reproductive biology of Australian Myrtaceae. Australian Journal of Botany, 41, 511-526.

Bennell, M., Hobbs, T.J. and Ellis, M. 2008. Evaluating agroforestry species and industries for lower rainfall regions of south-eastern Australia: FloraSearch 1a. Report to the Joint Venture (JVAP) and Future Farm industries CRC. RIRDC Publication No. 07/079. Rural Industry RIRDC, Canberra.

Brooker, M.I.H. and Kleinig, D.A. 1983. Field guide to eucalypts. Volume 1. South-eastern Australia. Inkata Press, Melbourne. pp 288.

Boland, D. and Brooker, I. 1975, Yellow gum: Eucalyptus leucoxylon F. Muell.' In Forest tree series; no. 187. Australian Government Publishing Service, Canberra.

Boland, D.J. 1978. Geographic variation in Eucalyptus leucoxylon. Australian Forest Research, 8 (1) 25-46

Boland, D.J.; Brooker, M.I.H,; Chippendale, G.M.; Hall, N, Hyland, B.P.M.; Johnston, R.D.; Kleinig, D.A.; McDonald, M.W.; and Turner, J.D. 1992.Forest Trees of Australia, 2nd Ed. CSIRO, Melbourne:), 687 pp.

Boomsma, 1981 Native trees of South Australia. Woods and Forests Department, South Australia, Adelaide.

Bone, S.L. 2001. The Urban Horticulture of Corymbia maculata. Master of AppliedScience (Horticulture) Thesis, Burnley College, University of Melbourne.

Frank, S., Waters, G., Beer, R. and May, P.B. 2006. An analysis of the street tree population of greater Melbourne at the beginning of the 21st century. Arboriculture and Urban Forestry, 32: 155-163.

Moore, G.M. 2015. The role of Lignotubers (Basal Burls) in the stress recovery of messmate stringybark, Eucalyptus obliqua L’Herit. seedlings and its arboricultural implications. Arboricultural Journal **37:** 113-125.

Moore, G.M. 2021. Root tip growth and presence of leaves affect epicormic and lignbotuberous shoot development and survival of stressed Eucalyptus obliqua seedlings. Arbor and Urban Forestry, 47: 133-149.

Moore, G.M. and Chandler, A. 2023. The potential of yellow gum, Eucalyptus leucoxylon F.Muell. as an urban street tree: an assessment of species performance in the city of greater Melbourne, Australia. Arboriculture and Urban Forestry. 49, 16-37.

Nicolle, D. 2002. Eucalypts with potential for streets. Proceedings of the Third National Street Tree Symposium, 52-55. University of Adelaide/Waite Arboretum, Adelaide.

Nicolle D. 1997. Eucalypts of South Australia. D Nicolle, Adelaide.

Nicolle, D. 2006. Eucalypts of Victorian and Tasmania. Blooming Books, Melbourne, Australia.

Rule, K 1990, Two new subspecies within Eucalyptus leucoxylon F. Muell. and notes on that species, Muelleria, vol.7, pp.389-403.

Rule, K 1998, A new, rare Victorian subspecies of Eucalyptus leucoxylon F. Muell., Muelleria, 11: 133-136.

Slee, A.V., Brooker, M.I.H., Duffy, S.M. and West, J.G. 2006 .Euclid: eucalypts of Australia, 3rd ed. CSIRO. Canberra.

Williams, G.S. 1995. Selection of Australian Rainforest Tree Species and Provenances with Superior Tolerance of Urban Conditions. Master of Applied Science (Horticulture) Thesis, University of Melbourne, Burnley, Melbourne.