



Improving Biodiversity outcomes for Urban Forest Strategies through incorporating Native Trees Species

Christina O'Donnell and Jane Chambers

with thanks to Jill Holland, Trillion Trees

A NatureLink Perth Intern Project



Executive Summary

Perth is in a global biodiversity hotspot in south-western Western Australia. The city of Perth is one of the most biodiverse areas in the south west, with a high diversity of locally endemic species under threat. The city is facing multiple pressures from population growth, climate change, invasive species, disease and increased nutrients. Urban Forest Strategies (UFS) are one strategy being developed by local governments to address multiple pressures to improve the city's liveability for our present and future population.

The aim of this study is to aid local governments to increase the value of their UFS by incorporating biodiversity outcomes through selection of local native trees species and their associated biodiversity values. A review of the current UFS within Perth was undertaken and found that no UFS had biodiversity as the rationale for choice of tree species planted and while two had goals to increase biodiversity, none contained strategies to assess biodiversity improvements (for example through KPIs (key performance indicators)).

A desk-top study identified appropriate tree species and characteristics that can be used to improve biodiversity outcomes for Perth's UFS. It also identified critical information for use in urban areas such as fire, salinity and drought resistance and separation from buildings and utilities. Native trees were found to have multiple economic, environmental, and social benefits over exotic species. This report provides a framework to incorporate native trees in UFS and monitor improved biodiversity outcomes. This will add value to existing UFS and enable local governments to achieve greater multiple benefits than current UFS allow.



This project was done in collaboration with Trillion Trees and we would particularly like to thank Jill Holland for contributing a significant portion of the information found in the Native tree species and attribute tables.



NatureLink Perth is a community of practice of diverse stakeholders working together to integrate nature into our city, to conserve and enhance our internationally-recognised biodiversity and provide a healthy, liveable city benefiting the economy, the environment and people.



This project was undertaken by Christina O'Donnell (nee Chambers) as an internship in Environmental and Conservation Sciences at Murdoch University through NatureLink Perth and was supervised by Jane Chambers.

This is a live document. We welcome your feedback, comments, additional information and corrections to improve the document for other users. Please contact us at naturelinkperth@murdoch.edu.au

Photo on front cover: Joe Fontaine

Introduction

The city of Perth is in the South West of Western Australia, a globally recognised biodiversity hotspot¹. This international acknowledgment is due to the exceptional number of endemic flora species concentrated within the region, which are under severe threat¹. Perth's native vegetation is highly diverse and unique to the region, adapting specifically to its poor nutrient soils, fire regime and climate. Perth flora has had thousands of years of evolution under harsh conditions, adapting to survive and thrive². As a result, much of the flora is endemic, existing only in this region of the world^{1, 3}.

Many economic and social aspects of Perth's society rely on the native vegetation with flora playing a critical role in cleansing rivers, retaining soils, and conserving functional ecosystems and their processes⁵. Loss of native trees and vegetation has serious consequences, both environmental including loss of biodiversity, species extinction, reduced wetland and bushland ecosystem health, poorer water quality, increased carbon emissions, reduced ecological function and ecosystem services; but also social including loss of character and sense of place, loss of cultural and heritage significant sites and reduced productivity,^{1,4, 5,6}. Biodiversity in Perth continues to decline due to increasing pressures from development, urban expansion, climate change, invasive species, disease, increased nutrients, and public perceptions^{7,8,9,10,11}. The amplification of pressures and new ecological challenges on the exquisite ecosystems of the Swan Coastal Plain and Darling Scarp will diminish the quality of people's livelihood as well as their physical and mental health^{12,13}.

Urban Forest Strategies (UFS) across Perth are being developed by local governments to address threats related to climate change, species extinction, and human health. The strategies aim to increase the tree canopy cover within local areas, which is measured by the coverage provided by the canopy area of the tree, the number of trees, and reduction in tree loss¹³. Enhancing urban forests brings economic, social, and environmental benefits through providing shade and cooling, reducing costs of energy, storing carbon, reducing air pollutants, increasing house prices, improving biodiversity, providing a sense of place, improving mental and physical health, and reduction in storm water run-off^{4,6,14}. In a city suffering massive biodiversity loss, it is vital that the UFS being undertaken by local governments have a strong focus on increasing native tree and plant species diversity, not only to allow Perth to maintain its sense of place and its individual character, but to also sustain healthy ecosystems and people. The aim of this report is to aid local governments in integrating biodiversity outcomes within their UFS through selection of local trees and their biodiversity values they provide.

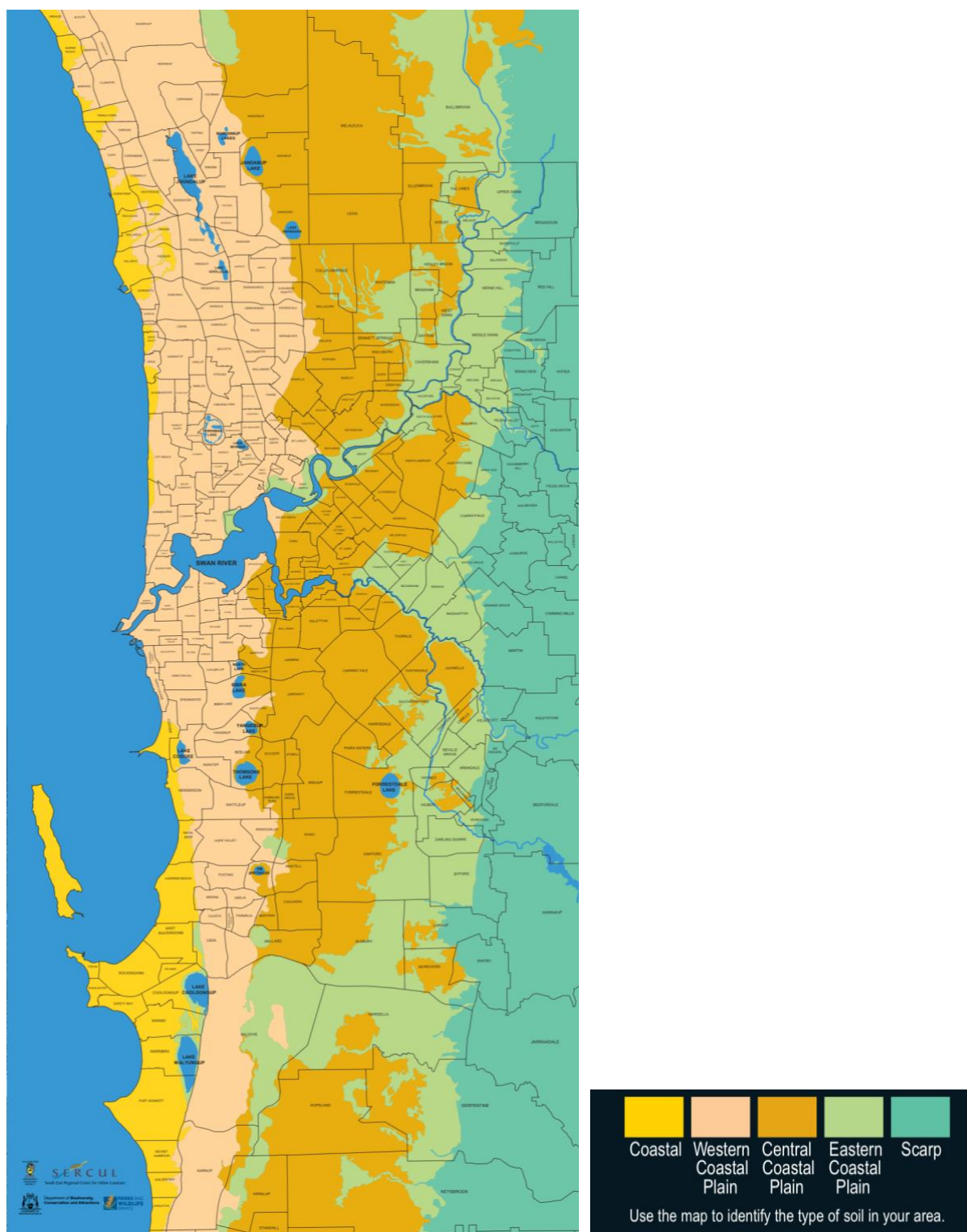


Figure 1: A map of the five main soil types across the Swan Coastal Plain. Source: <https://www.sercul.org.au/our-projects/fertilise-wise/>

Methods

Assessment of Urban Forest Strategies

To assess whether greater biodiversity outcomes were needed in Urban Forest Strategies in the Perth region, a review was undertaken between August-October 2019. UFS included those from the Cities of Armadale, Bassendean, Bayswater, Belmont, Cockburn, Fremantle, Melville, Nedlands, Perth, Serpentine-Jarrahdale, South Perth, Stirling, Subiaco and Victoria Park.

While several councils had biodiversity plans, it is important that biodiversity outcomes are not reliant on a single plan. To be successful, biodiversity outcomes need to be integrated across council operations. Having biodiversity outcomes in UFS that support those in biodiversity plans increases chances of success.

Incorporating Biodiversity Outcomes in Urban Forest Strategies

A desk-top study was undertaken to identify appropriate tree species and characteristics that can be used to improve the biodiversity outcomes within Perth's UFS. Information was collated from a range of sources that have practical experience of Perth flora and soils. The findings were incorporated into tables divided into the five main soil types of the Swan Coastal Plain (Figure 1) so that the user can go directly to the information pertinent to the region applicable to them, saving time and increasing the likelihood of the information being used. Choice of information was determined by its capacity to enable the user to design local, legal, safe, beautiful, resilient habitats, allowing local councils to improve their UFS by selecting trees that improve the city's health and liveability. Information into the tables incorporated a suite of biodiversity outcomes (e.g. insect, animals, bird attracting) aesthetics, (e.g. flower colour and season of flowering) together with identified critical information for use in urban areas such as height, fire, salinity and drought resistance and separation from buildings and utilities.

Results

Assessment of Urban Forest Strategies

Urban forest strategies have become a popular tool for local councils since the influence of the 2020 Vision produced in 2013²⁷ and the formation of the National Urban Forest Alliance (NUFA) Australian Partnership Plan in 2014²⁸. The 2020 Vision is to "create 20% more green space in our urban areas by 2020"²⁷. The NUFAs Australian Partnership Plan is to form collaborations and partnerships to create change in policy, planning, and

implementation used by developers, private stakeholders, and governments to benefit vegetation cover. The driver for the creation of both plans is the enormous benefits green spaces have on health and well-being for the public². According to the NUFA, an urban forest is “all plants on public and private land in and around urban and peri-urban areas”²⁸. Urban forests essentially embrace all vegetation in the parks, bushlands, streets, verges, gardens, rooftops, walls, patios, courtyards, and even inside the buildings of our city.

Perth’s local and state governments had started to engage with both initiatives in 2014 with the Urban Forest of Perth and Peel Statistical Report being published³, along with two local councils producing an UFS^{30,31}. Since 2014 eleven other local councils within the region have followed suit producing their UFS³²⁻⁴², and another is in the midst of doing the same⁴³. It is becoming increasingly evident that incorporation of UFS in the designing and planning of towns and cities is critical, as signs of climate change present risks to the liveability of our cities⁴⁴.

Local governments play a significant role in helping to conserve, protect, and manage the local species that reside within the city’s boundaries. The current UFS recognise the dangers of a treeless city and aim to deliver a healthy liveable city for present and future residents. Recognising the benefits of an urban forest allows the current strategies to improve public awareness and enables the protection and enhancement of local trees.

Of the fourteen UFS assessed all

- illustrated the social, economic and environmental benefits
- recognised the impact of climate change
- strived to protect trees and increase canopy cover
- sought to create a healthier liveable city
- had similar goals – creating a consistent approach across the city

In contrast, just over half the councils in the Perth region did not have an UFS and six councils did not have either a UFS or biodiversity plan. Only two of the UFS specifically had a goal to increase biodiversity (Figure 2) and none had KPIs (key performance indicators) to measure biodiversity outcomes of their UFS. Just over a quarter of local governments recognised the need to improve baseline data, allowing them in the future to produce strong aims and objectives for a healthy urban forest. None of the UFS stated the reasons for planting specific trees for biodiversity and only one stated it would favour native over non-native trees. While the majority of UFS included trees and vegetation in their definition of an urban forest (Figure 3), three of the UFS included only trees (a missed opportunity as forests incorporate understory as well as trees). No UFS had a goal to increase understory vegetation. This suggested there was opportunity to improve biodiversity outcomes of UFS across Perth if resources were made available.

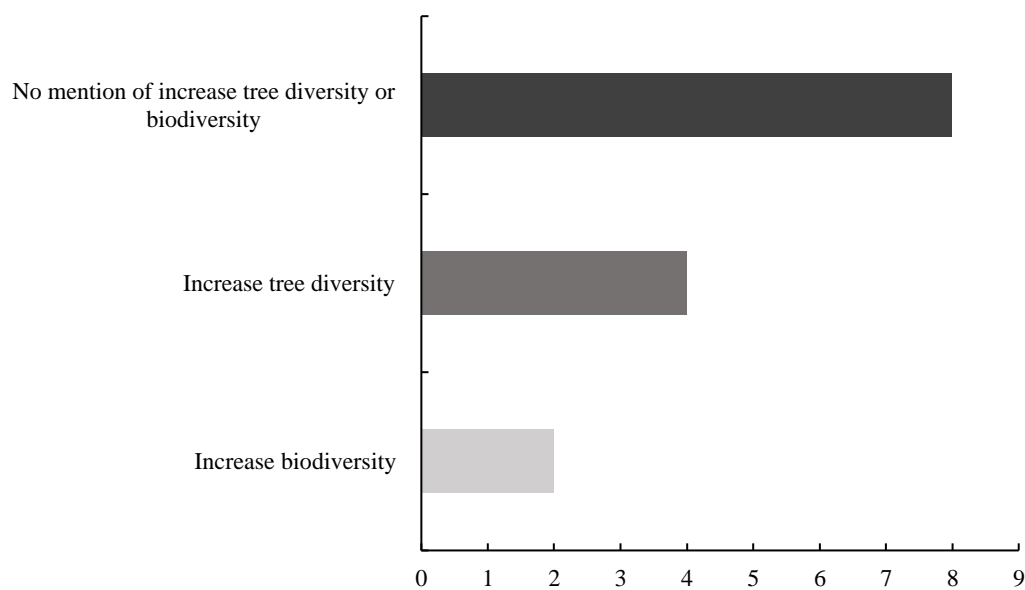


Figure 2: Number of UFS within Perth metropolitan region with goals to increase tree diversity or biodiversity.

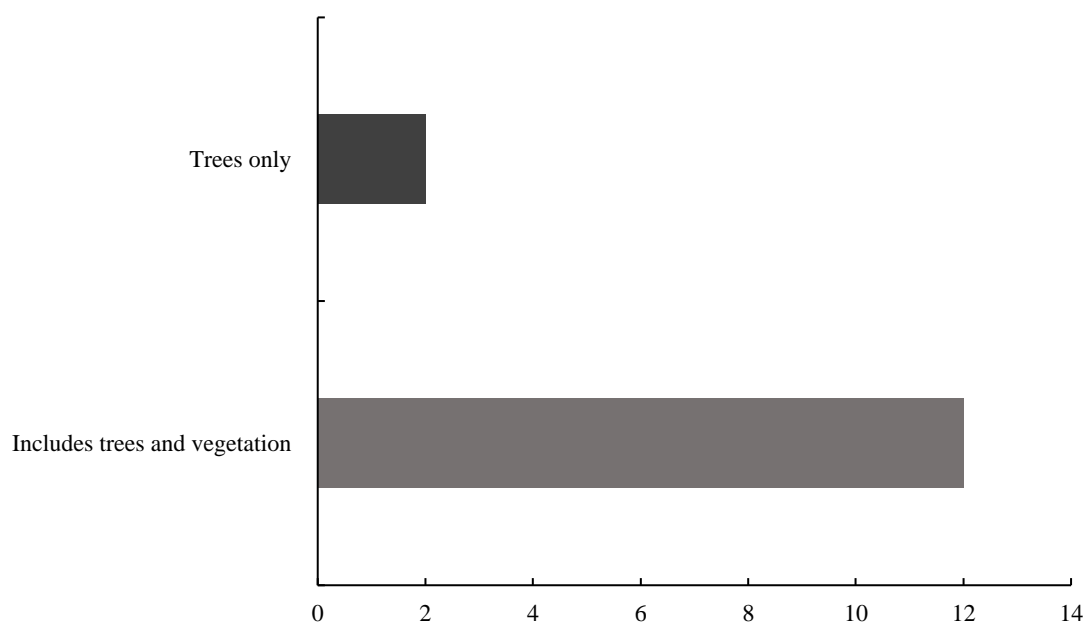


Figure 3: The number of UFS within Perth metropolitan that include trees and vegetation within their definition of an urban forest, compared to those that describe urban forests as only trees.

Key challenges to incorporating native trees and vegetation into UFS include:

- Fire restrictions – Perth’s Mediterranean climate is prone to seasonal bush fires. The state and local governments have policies and restrictions to reduce the risk of bush fires in urban areas, which influence the planning and design of the landscape^{46,47}.

- Policy and planning restrictions are in place to reduce any risk to the public. Local governments can decide on their policy for distances and heights of trees and vegetation, but it must co-exist with the regulations set by state government^{47,48}.
- Community and council engagement – both community and the local councils need to be engaged with the UFS for it to be successful.
- Climate change - Perth's climate is changing; over the last 100 years, Perth has become drier and hotter. Therefore, plants need to be robust and hardy to not only survive, but thrive within the changing climate^{49,50}.
- Disease - Die-back (*Phytophthora cinnamomi*) is a disease that poses a significant threat to flora within the Perth metropolitan. It thrives in hot environments and spreads easily through activities that move soil such as wheels, shoes, and water. Many native plants are vulnerable to *Phytophthora cinnamomi*⁵¹.
- Invasive species - Weeds are a major environmental problem which can change ecosystem composition and structure, replace native species, and change fire frequency⁵².
- Lack of knowledge as to what is the best native plant species to go where, means that there will be a lack of diversity amongst the trees used. Therefore, only a limited number of trees might be used that may not necessarily be best for the surrounding infrastructure or wildlife.

Incorporating Biodiversity Outcomes in Urban Forest Strategies

The goal of this document was to provide a resource outlining the range of tree species that could be included in UFS to improve biodiversity outcomes. The following framework outlines steps to improve the choice of tree species; to increase the choice of locally or WA native tree species or where that was not appropriate choosing exotic species that provided biodiversity services (e.g. food for Carnaby's cockatoos). The first step is to determine the soil type(s) for the area of the UFS (Figure 1). Then, to gain the best biodiversity outcome from your choice of tree, follow five key steps using the charts provided:

1. Make it local – choose a tree species that is naturally found within the area
2. Provide a habitat – what animals are attracted to the tree? Insects, birds, mammals, all three?
3. Make it beautiful- selecting trees that flower in different seasons means the area will always be beautiful
4. Make it legal – Some trees are best grown only in parks or bushland due to their size and flammability. Plant trees within the recommended distances.
5. Help it survive - Trees that are drought tolerant/ salt tolerant/ fire resistant/ frost tolerant will survive better than other trees in harder conditions.

Tables 1-5 of tree species on the following pages have been arranged by origin, and listed in alphabetical order within their recommended soil type (i.e. Coastal (1), Western Coastal Plain (2), Central Coastal Plain (3), Eastern Coastal Plain (4), Scarp (5)) (Figure 1). The types of plants and animals that naturally occur in any part of the Perth and Peel region depend on these soil types, so choosing a tree species that comes from this area is an important first step. Plant and animal communities have evolved within these soil types to create a wonderful array of species – which is what contributes to our high biodiversity. This resource seeks to mimic the natural tree species to provide the best habitat and services for the local species.

In each table scientific name, common name, flower colour, flowering time, origin, the types of fauna they attract, their tolerances (Fire, drought, frost, salt), and their recommended spacing from buildings, sewage pipes, and each other are provided for each tree species. All data available has been included about each tree, however there are information gaps. The information is indicative and tree growth will be affected by changes within soil structure, water availability and fertiliser usage.

Current trees being used by local governments are now classed as an environmental weed within Western Australia and are listed in Table 6, along with alternative tree species that provide a comparable aesthetic¹⁵. It is recommended that local governments using environmental weeds stop immediately and use these alternatives.

Abbreviations used in tables

Drought - Drought tolerant

Frost – Frost tolerant

Aus - Australia

E - Exotic

Building protection zone – an area adjacent to a building¹⁶ (see figure 5)

Hazard separation zone - The area of land between the building protection zone and bush usually up to 100 metres¹⁶. (see figure 5)

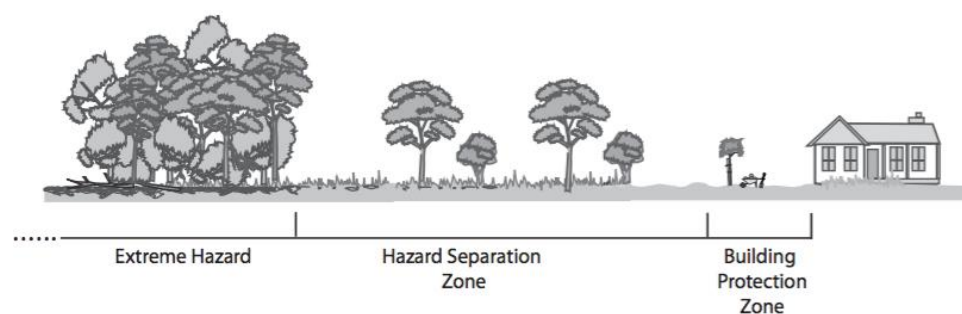


Figure 4: Differences between the building protection zone, and the hazard separation zone, before reaching the bush (extreme hazard). Retrieved from

https://www.irwin.wa.gov.au/Assets/Documents/Planning/FESA_Plant_Guide-BP_Zone-Final-w.pdf

Sources:

The information provided within the tables was retrieved from a range of resources, but a special acknowledgement is given to Jill Holland from Trillion Trees who supplied approximately half of the tables' contents. The rest was sourced from:

SERCUL <https://www.sercul.org.au/our-projects/fertilise-wise/>

R S Coleman, Bee Farming: Honey Flora of Western Australia
http://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=3361&context=journal_agriculture4

Department of Environment and Conservation, Plants used by Carnaby's Cockatoo.
https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/carnabys/Plants_used_by_Carnabys_black_cockatoo_20110415.pdf

Fire and Emergency Services Authority of Western Australia
https://www.irwin.wa.gov.au/Assets/Documents/Planning/FESA_Plant_Guide-BP_Zone-Final-w.pdf

Nursery and Garden Industry Western Australia
<http://www.growmeinstead.com.au/public/GMI-brochure-Western-Australia.pdf>

Water Corporation <https://www.watercorporation.com.au/-/media/files/builders-and-developers/building/select-the-right-tree.pdf>

Florabase the Western Australian Flora by the Department of Biodiversity, Conservation, and Attractions <https://florabase.dpaw.wa.gov.au>

Gardening with Angus <https://www.gardeningwithangus.com.au>

Benara Nurseries <https://www.benaranurseries.com>

Kings Park Botanical Gardens <https://www.bgpa.wa.gov.au/about-us/conservation/gardening-resources/754-plant-notes>

Table 1: Suggested native tree species and their attributes for the Coastal soil types (see Figure 1).

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attracting	Mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Agonis flexuosa</i>	WA Peppermint tree	12 to 15	white	Aug-Sep	Perth	?	?	?	?	F		28	33.6	22.4			6	
<i>Allocasuarina fraseriana</i>	Common Sheoak	15	Brown	May-Oct	Perth	?	?	?				30	36	24			6	
<i>Banksia attenuata</i>	Candle Banksia	5 to 8	Yellow	Sep-Oct	Perth	?	?	?	?	F		16	19.2	12.8	?		4	
<i>Callitris preissii</i>	Rottnest Island Pine	4 to 6	Brown	Jan- Dec	Perth		?	y	?	F		20	24	16	?			?
<i>Eucalyptus decipiens</i>	Redheart Moit	15	white	Aug-Jan	Perth	?	?	?				18	21.6	14.4	?	?		
<i>Eucalyptus foecunda</i>	Narrow-leaved Red Mallee	5	Cream	Jan-Feb	Perth	?	?	?				10	12	8			4	
<i>Eucalyptus gomphocephala</i>	Tuart	30	White	Jan-April	Perth	?	?	?	?	F/N/R		80	96	64	?	?		
<i>Eucalyptus marginata</i>	Jarra	30	White-Cream/ Pink	Jun-Dec	Perth	?	?	?	?	F/R		90	108	72				
<i>Eucalyptus todtiana</i>	Coastal Blackbutt	9 to 16	Creamy White	Feb	Perth		?	?	?	F		30	36	24	?	?		
<i>Melaleuca cuticularis</i>	Saltwater Paperbark	7	White-Cream	Aug-Nov	Perth	?		?				14	16.8	11.2				?
<i>Melaleuca lanceolata</i>	Rottnest Island Tea Tree	5	White	Oct-Mar	Perth	?						20	24	16				?
<i>Pittosporum phylliraeoides</i>	Weeping Pittosporum	8	White Yellow	Jun-Oct	Perth	?		?									6	
<i>Melaleuca huegelii</i>	Chenille Honey-myrtle	5	Pink/White	Sep-Jan	Perth	?	?	?				6	7.2	4.8				?
<i>Banksia ashbyi</i>	Orange Banksia	1 to 8	Orange	Dec-Feb	WA			?	?	F		8	9.6	6.4	?		4	
<i>Banksia praemorsa</i>	Cut-leaf Banksia	4	Gold	Jul-Oct	WA			?	?	F							4	
<i>Banksia sessilis</i>	Parrot Bush	6	Cream-Yellow	April-Nov	WA		?	?	?	F		8	9.6	6.4	?		4	

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attracting	Mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Banksia speciosa</i>	Showy <i>Bank¹sia</i>	6	Yellow	May-Jun	WA	?	?	?	?	?		14	16.8	11.2		?	4	
<i>Banksia tricuspis</i>	Pine Banksia	4	Orange	Mar-Jul	WA	?	?	?	?						?	?	4	
<i>Corymbia calophylla</i>	Marri	20	White/Pink	Dec-May	WA		?	?	?			70	84	56			20	?
<i>Eucalyptus caesia</i>	Caesia	12 to 15	Pink and Red	May-Sep	WA			?	?			10	12	8			6	
<i>Eucalyptus diversicolor</i>	Karri	80	White	Feb-Apr	WA	?	?	?	?									
<i>Eucalyptus erythrocorys</i>	Red Cap Gum	7	Yellow	Feb-Apr	WA		?	?							?	?	6	
<i>Eucalyptus lehmannii</i>	Bushy Yate	2 to 4	Green, Yellow	All year	WA													
<i>Eucalyptus macrocarpa</i>		5	Red, Pink	All year	WA		?	?							?	?	4	
<i>Eucalyptus preissiana</i>	Bell-fruited mallee	3	Yellow	May-Aug	WA		?	?	?									
<i>Eucalyptus utilis</i>	Coastal Moort	8	Creamy-Yellow	Sep-Jan	WA		?	?							?	?		?
<i>Hakea oleifolia</i>	Olive-leaf <i>Hakea</i>	10	White	Aug-Oct	WA			?	?									
<i>Araucaria heterophylla</i>	Norfolk Island Pine	60	Green	Non-flowering	E				?							?		
<i>Pinus canariensis</i>	Canary Island Pine	30	Brown	Nov-Dec	E	?		?	?						?	?		

¹Drought- Drought tolerant

²Frost –Frost tolerant

³Aus- Australia

⁴E- Exotic

⁵Building protection zone – an area adjacent to a building¹⁵ (see figure 2)

⁶Hazard separation zone- The area of land between the building protection zone and bush usually up to 100 meters¹⁵. (see figure 2)

Table 2: Suggested native tree species and their attributes for the Western Coastal Plain soil types (see Figure 1).

Tree	Common name	Height (m)	Flower	Flower time	Origin	Attracts insects	Attracts bees	Attracts birds	Attracts Carnaby's	Attracts Mammals	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Acacia saligna</i>	WA Golden Wattle	6	Yellow	Jul-Nov	Perth	?		?				12	14.4	9.6				
<i>Agonis flexuosa</i>	WA Peppermint tree	12 to 15	White	Aug-Sep	Perth	?	?	?	?	?		28	33.6	22.4			6	
<i>Allocasuarina fraseriana</i>	Common Sheoak	15	Brown	May-Oct	Perth	?	?	?				30	36	24			6	
<i>Banksia attenuata</i>	Candle Banksia	5 to 8	Yellow	Sep-Oct	Perth	?	?	?	?		?	16	19.2	12.8	?		4	
<i>Banksia grandis</i>	Bull Banksia	10	Yellow	Sep-Dec	Perth			?	?	?	?	16	19.2	12.8	?	?	4	
<i>Banksia menziesii</i>	Firewood Banksia	10	Pink and Red	Feb-Aug	Perth	?	?	?	?		?	16	19.2	12.8	?		4	
<i>Banksia prionotes</i>	Acorn Banksia	10	Cream & Orange	Feb-Aug	Perth		?	?	?			16	19.2	12.8	?	?	4	
<i>Callitris preissii</i>	Rottneest Island Pine	4 to 6	Brown	Jan- Dec	Perth		?	?	?	?		20	24	16	?			?
<i>Eucalyptus decipiens</i>	Red Heart Moit	15	White	Aug-Jan	Perth	?	?	?				18	21.6	14.4	?	?		
<i>Eucalyptus foecunda</i>	Narro-leaved Red Mallee	5	Cream	Jan-Feb	Perth	?	?	?				10	12	8			4	
<i>Eucalyptus gomphocephala</i>	Tuart	30	White	Jan-April	Perth	?	?	?	?	?		80	96	64	?	?		
<i>Eucalyptus marginata</i>	Jarra	30	White-Cream/ Pink	Jun-Dec	Perth	?	?	?	?	?		90	108	72				
<i>Eucalyptus todtiana</i>	Coastal Blackbutt	9 to 16	Creamy White	Feb	Perth	?	?	?	?			30	36	24	?	?		
<i>Melaleuca cuticularis</i>	Saltwater Paperbark	7	white-Cream	Aug-Nov	Perth	?		?				14	16.8	11.2				?
<i>Melaleuca lanceolata</i>	Rottneest Island Tea Tree	5	White	Oct-Mar	Perth	?						20	24	16			6	?

Tree	Common name	Height (m)	Flower	Flower time	Origin	Attracts insects	Attracts bees	Attracts birds	Attracts Carnaby's	Attracts Mammals	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Melaleuca raphiophylla</i>	Swamp Paperbark	10	white-Cream	Jul-Sep	Perth			?				16	19.2	12.8			6	?
<i>Nuytsia floribunda</i>	WA Christmas Tree	8	Orange	Oct-Jan	Perth	?	?	?				16	19.2	12.8				
<i>Paraserianthes lophantha</i>	Albizia	10	Greenish Yellow	Aug-Sep	Perth			?										
<i>Pittosporum phylliraeoides</i>	Weeping Pittosporum	8	White Yellow	Jun-Oct	Perth	?		?									6	
<i>Melaleuca huegelii</i>	Chenille Honey-myrtle	5	Pink/White	Sep-Jan	Perth	?	?	?				6	7.2	4.8			6	?
<i>Melaleuca preissiana</i>	Stout Paperbark	15	Yellow-Cream-White	Nov-Feb	Perth	?		?				20	2	16	?		6	
<i>Acacia acuminata</i>	Jam Wattle	5	Yellow	Aug-Nov	WA		?	?				24	28.8	19.2	?	?		
<i>Banksia coccinea</i>	Scarlet Banksia	8	Red	May-Dec	WA			?	?	F		4	4.8	3.2			4	
<i>Banksia littoralis</i>	Swamp Banksia	15	Red/Yellow	Jan-Aug	WA	?	?	?	?	F	?	20	24	16		?		
<i>Banksia speciosa</i>	Showy Banksia	6	Yellow	May-Jun	WA	?	?	?	?	F	?	14	16.8	11.2		?	4	
<i>Banksia tricuspis</i>	Pine Banksia	4	Orange	Mar-Jul	WA	?	?	?	?	F					?	?	4	
<i>Corymbia calophylla</i>	Marri	20	White/Pink	Dec-may	WA	?	?	?	?	F/N/R		70	84	56			20	?
<i>Dodonaea hackettiana</i>	Hop Bushes	4	Yellow/Red	Jul-Oct	WA	?						9	10.8	7.2				
<i>Eucalyptus caesia</i>	Caesia	12 to 15	Pink and Red	May-Sep	WA			?	?	F		10	12	8			6	
<i>Eucalyptus diversicolor</i>	Karri	80	White	Feb-Apr	WA	?	?	?	?	N								
<i>Eucalyptus erythrocorys</i>	Red Cap Gum	7	Yellow	Feb-Apr	WA		?	?							?	?	6	
<i>Eucalyptus preissiana</i>	Bell-fruited mallee	3	Yellow	May-Aug	WA		?	?	?	F								

Tree	Common name	Height (m)	Flower	Flower time	Origin	Attracts insects	Attracts bees	Attracts birds	Attracts Carnaby's	Attracts Mammals	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Eucalyptus pyriformis</i>	Pear Fruited Mallee	5	Red/White	May-Oct	WA		?	?							?	?		
<i>Eucalyptus spathulata</i>	Swamp Mallet	8	White	Oct-Dec	WA			?							?	?		?
<i>Eucalyptus utilis</i>	Coastal Moort	8	Creamy-Yellow	Sep-Jan	WA		?	?							?	?		?
<i>Eucalyptus victrix</i>	Smooth-barked coolibah	7	Cream	Nov-Mar	WA	?		?							?			
<i>Hakea laurina</i>	Kodjet	5	Red	Apr-Aug	WA	?		?	?	F		12	14.4	9.6		?	2	
<i>Hakea oleifolia</i>	Olive-leaf Hakea	10	White	Aug-Oct	WA			?	?	F								
<i>Xylomelum angustifolium</i>	Sandplain Woody Pear	7	Creamy White	Dec-Feb	WA			?										
<i>Corymbia maculata</i>	Spotted gum	30	White	Mar-Sep	Aus		?	?	?	F								
<i>Eucalyptus viminalis</i>	Ribbon Gum	40	White	Jan-April	Aus	?		?							?	?		
<i>Macadamia integrifolia</i>	Macadamia Nut	12	White	Jan-Jun	Aus	?	?		?	F						?		
<i>Araucaria heterophylla</i>	Norfolk Island Pine	60	Green	non-flowering	E				?	F						?		
<i>Carya illinoensis</i>	Pecan	30	Yellow	Spring	E				?	F								
<i>Jacaranda mimosifolia</i>	Blue <i>Jacaranda</i>	10	Blue/Purple	Nov-Dec	E			?	?	F		24	28.8	19.2	?		6	
<i>Liquidambar styraciflua</i>	American Sweet Gum	20	Green	Apr-May	E			?	?	F					?	?		
<i>Pinus canariensis</i>	Canary Island Pine	30	Brown	Nov-Dec	E	?		?	?	F					?	?		
<i>Prunus amygdalus</i>	The Almond	7	White-Pink	Aug-Nov	E	?		?	?	F	?				?	?		

¹Drought- Drought tolerant

²Frost –Frost tolerant

³Aus- Australia

⁴E- Exotic

⁵Building protection zone – an area adjacent to a building¹⁵ (see figure 2)

⁶Hazard separation zone- The area of land between the building protection zone and bush usually up to 100 meters¹⁵. (see figure

Table 3: Suggested native tree species and their attributes for the Central Coastal Plain soil types (see Figure 1).

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Acacia saligna</i>	WA Golden Wattle	6	Yellow	Jul-Nov	Perth	?		?				12	14.4	9.6				
<i>Allocasuarina fraseriana</i>	Common Sheoak	15	Brown	May-Oct	Perth	?	?	?				30	36	24			6	
<i>Banksia attenuata</i>	Candle <i>Banksia</i>	5 to 8	Yellow	Sep-Oct	Perth	?	?	?	?	F	?	16	19.2	12.8	?		4	
<i>Banksia grandis</i>	Bull <i>Banksia</i>	10	Yellow	Sep-Dec	Perth			?	?	F	?	16	19.2	12.8	?	?	4	
<i>Banksia ilicifolia</i>	Holly-Leaved <i>Banksia</i>	10	Pink and Cream	Mar-Jan	Perth	?	?	?	?	F		16	19.2	12.8			4	
<i>Banksia menziesii</i>	Firewood <i>Banksia</i>	10	Pink and Red	Feb-Aug	Perth	?	?	?	?	F	?	16	19.2	12.8	?		4	
<i>Corymbia calophylla</i>	Marri	20	White/ Pink	Dec-May	Perth	?	?	?	?	F/N/R		70	84	56			20	?
<i>Eucalyptus accedens</i>	Smooth Bark Wandoo	30	White-Cream	Dec-Jan	Perth						?	40	8	32				
<i>Eucalyptus marginata</i>	Jarrah	30	White-Cream/ Pink	Jun-Dec	Perth	?	?	?	?	F/R		90	108	72				
<i>Eucalyptus rudis</i>	Swamp Gum	20	White	Jul-Sep	Perth	?	?	?	?	F	?	40	48	32				?
<i>Eucalyptus tottiana</i>	Coastal Blackbutt	9 to 16	Creamy White	Feb	Perth	?	?	?	?	F		30	36	24	?	?		
<i>Melaleuca cuticularis</i>	Saltwater Paperbark	7	White-Cream	Aug-Nov	Perth	?		?				14	16.8	11.2				?
<i>Melaleuca raphiophylla</i>	Swamp Paperbark	10	White-Cream	Jul-Sep	Perth			?				16	19.2	12.8			6	?

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Nuytsia floribunda</i>	WA Christmas Tree	8	Orange	Oct-Jan	Perth	☐	☐	☐				16	19.2	12.8				
<i>Melaleuca preissiana</i>	Stout Paperbark	15	Yellow-Cream-White	Nov-Feb	Perth	☐		☐				20	2	16	☐		6	
<i>Acacia acuminata</i>	Jam Wattle	5	Yellow	Aug-Nov	WA		☐	☐				24	28.8	19.2	☐	☐		
<i>Corymbia ficifolia</i>	Red Flowering Gum	8	Red	Dec-May	WA	☐	☐	☐	☐F						☐		☐	
<i>Dodonaea hackettiana</i>	Hop Bushes	4	Yellow/Red	Jul-Oct	WA	☐						9	10.8	7.2				
<i>Eucalyptus diversicolor</i>	Karri	80	White	Feb-Apr	WA	☐	☐	☐	☐N									
<i>Eucalyptus forrestiana</i>	Fuchsia Gum	6	Yellow	Jan-Mar	WA			☐							☐	☐		
<i>Eucalyptus preissiana</i>	Bell-fruited mallee	3	Yellow	May-Aug	WA		☐	☐	☐ F									
<i>Eucalyptus pyramidalis</i>	Pear Fruited Mallee	5	Red/White	May-Oct	WA		☐	☐							☐	☐		
<i>Eucalyptus spathulata</i>	Swamp Mallet	8	White	Oct-Dec	WA			☐							☐	☐	☐	
<i>Eucalyptus torquata</i>	Coolgardie Gum	4 to 11	Pink, Red	Aug-Dec	WA	☐		☐							☐	☐	4	
<i>Eucalyptus utilis</i>	Coastal Moort	8	Creamy-Yellow	Sep-Jan	WA		☐	☐							☐	☐	☐	
<i>Eucalyptus utilis</i>	Coastal Moort	8	Creamy-Yellow	Sep-Jan	WA		☐	☐							☐	☐	☐	
<i>Eucalyptus victrix</i>	Smooth-barked coolibah	7	Cream	Nov-Mar	WA	☐		☐							☐			
<i>Grevillea robusta</i>	Silver Oak	30	Orange	Sep-Nov	WA	☐	☐	☐	☐F			20	24	16				
<i>Hakea laurina</i>	Kodjet	5	Red	Apr-Aug	WA	☐		☐	☐F			12	14.4	9.6		☐	2	
<i>Melaleuca bracteata</i>	Black Tea-tree	4	White	May-Jan	WA		☐	☐				6	7.2	4.8		☐		

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Xylomelum angustifolium</i>	Sandplain Woody Pear	7	Creamy White	Dec-Feb	WA	☑		☑										
<i>Corymbia maculata</i>	Spotted gum	30	White	Mar-Sep	Aus		☑	☑	☑F									
<i>Eucalyptus salubris</i>	Gimlet	15	White	Se-Mar	Aus		☑	☑	☑F/R						☑	☑		☑
<i>Eucalyptus viminalis</i>	Ribbon Gum	40	White	Jan-Apr	Aus	☑		☑							☑	☑		
<i>Lophostemon confertus</i>	Queensland Brush Box	25	White	Oct-Feb	Aus	☑	☑	☑								☑		
<i>Carya illinoensis</i>	Pecan	30	Yellow	Oct-Nov	E				☑F									
<i>Jacaranda mimosifolia</i>	Blue <i>Jacaranda</i>	10	Blue/Purple	Nov-Dec	E			☑	☑F			24	28.8	19.2	☑			6
<i>Liquidambar styraciflua</i>	American Sweet Gum	20	Green	Apr-May	E			☑	☑F		☑				☑	☑		
<i>Melia azedarach</i>	Cape Lilac	10	Purple	Sep-Nov	E			☑	☑F						☑			
<i>Pinus canariensis</i>	Canary Island Pine	30	Brown	Nov-Dec	E	☑		☑	☑F						☑	☑		
<i>Prunus amygdalus</i>	The Almond	7	White-Pink	Aug-Nov	E	☑		☑	☑F		☑				☑	☑		

¹Drought- Drought tolerant

²Frost –Frost tolerant

³Aus- Australia

⁴E- Exotic

⁵Building protection zone – an area adjacent to a building¹⁵ (see figure 2)

⁶Hazard separation zone- The area of land between the building protection zone and bush usually up to 100 meters¹⁵. (see figure 2)

Table 4: Suggested native tree species and their attributes for the Eastern Coastal Plain soil types (see Figure 1).

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building	Min spacing in building protection zone	Min spacing in hazard separation zone	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Acacia saligna</i>	WA Golden Wattle	6	Yellow	Jul-Nov	Perth	☑		☑				12	14.4	9.6				
<i>Actinostrobus pyramidalis</i>	Cypress Pine	4	Cone	Jan-Dec	Perth	☑		☑	☑F			7	8.4	5.6		☑		☑
<i>Allocasuarina fraseriana</i>	Common Sheoak	15	Brown	May-Oct	Perth	☑	☑	☑				30	36	24		☑	6	
<i>Banksia attenuata</i>	Candle <i>Banksia</i>	5 to 8	Yellow	Sep-Oct	Perth	☑	☑	☑	☑F		☑	16	19.2	12.8	☑	☑	4	
<i>Banksia grandis</i>	Bull <i>Banksia</i>	10	Yellow	Sep-Dec	Perth			☑	☑F	☑	☑	16	19.2	12.8	☑	☑	4	
<i>Banksia ilicifolia</i>	Holly-Leaved Banksia	10	Pink and Cream	Mar-Jan	Perth	☑	☑	☑	☑F			16	19.2	12.8			4	
<i>Banksia menziesii</i>	Firewood Banksia	10	Pink and Red	Feb-Aug	Perth	☑	☑	☑	☑F		☑	16	19.2	12.8	☑		4	
<i>Casuarina obesa</i>	Swamp She-oak	10	Brown	All year	Perth	☑		☑										☑
<i>Eucalyptus lane-poolei</i>	Salmon White Gum	12 to 15	Creamy White	Jan-Sep	Perth	☑	☑					30	36	24			6	
<i>Eucalyptus marginata</i>	Jarra	30	White-Cream/Pink	Jun-Dec	Perth	☑	☑	☑	☑ F/R			90	108	72				
<i>Eucalyptus patens</i>	Yarri	25	White /Cream	Aug-Jan	Perth	☑	☑	☑	☑ F/R			90	108	72	☑	☑		
<i>Eucalyptus rudis</i>	Swamp Gum	20	White	Jul-Sep	Perth	☑	☑	☑	☑ F	☑	☑	40	48	32				☑
<i>Eucalyptus todtiana</i>	Coastal Blackbutt	9 to 16	Creamy White	Feb	Perth	☑	☑	☑	☑F			30	36	24	☑	☑		
<i>Eucalyptus wandoo</i>	White Gum	18	Cream	Dec-May	Perth	☑	☑	☑	☑F/R	☑		60	72	48		☑		☑
<i>Melaleuca cuticularis</i>	Saltwater Paperbark	7	white-cream	Aug-Nov	Perth	☑		☑				14	16.8	11.2				☑
<i>Melaleuca raphiophylla</i>	Swamp Paperbark	10	White-Cream	Jul-Sep	Perth			☑				16	19.2	12.8			6	☑

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building	Min spacing in building protection zone	Min spacing in hazard separation zone	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Nuytsia floribunda</i>	WA Christmas Tree	8	Orange	Oct-Jan	Perth	☑	☑	☑				16	19.2	12.8				
<i>Paraserianthes lophantha</i>	Albizia	10	Greenish Yellow	Aug-Sep	Perth	☑												
<i>Melaleuca preissiana</i>	Stout Paperbark	15	Yellow-cream-white	Nov-Feb	Perth	☑		☑				20	2	16	☑		6	
<i>Acacia acuminata</i>	Jam Wattle	5	Yellow	Aug-Nov	WA		☑	☑				24	28.8	19.2	☑	☑		
<i>Acacia pentadenia</i>	Karri Wattle	5	Cream	Jul-Sep	WA			☑	☑F									
<i>Banksia littoralis</i>	Swamp Banksia	15	Red/Yellow	Mar-Aug	WA	☑	☑	☑	☑ F		☑	20	24	16		☑	4	
<i>Corymbia ficifolia</i>	Red Flowering Gum	8	Red	Dec-May	WA	☑	☑	☑	☑F									☑
<i>Eucalyptus camaldulensis</i>	River Red Gum	20	White	Jul-Dec	WA		☑	☑	☑ R			30	36	24	☑	☑		☑
<i>Eucalyptus cornuta</i>	Yate	25	Yellow-Green	Jan-May	WA		☑								☑	☑		
<i>Eucalyptus drummondii</i>	Drummond's Mallee	5	White-Cream	Jan-Feb	WA			☑				16	19.2	12.8		☑		
<i>Eucalyptus forrestiana</i>	Fuchsia Gum	6	Yellow	Jan-Mar	WA			☑							☑	☑		
<i>Eucalyptus longicornis</i>	Red Morrel	24	White	Dec-Feb	WA				☑N									
<i>Eucalyptus loxophleba</i>	York Gum	15	White	Jul-Dec	WA		☑	☑	☑ F/N		☑	20	24	16	☑	☑		☑
<i>Eucalyptus occidentalis</i>	Flat Top Yate	20	Cream White	Jun-Dec	WA			☑	☑ N						☑			
<i>Eucalyptus preissiana</i>	Bell-fruited mallee	3	Yellow	May-Aug	WA		☑	☑	☑F									
<i>Eucalyptus salmonophloia</i>	Salmon Gum	25	White	Aug-Dec	WA		☑	☑	☑F/N						☑	☑		
<i>Eucalyptus salubris</i>	Gimlet	15	White	Sep-Mar	WA		☑	☑	☑ F/R						☑	☑		☑
<i>Eucalyptus sargentii</i>	Salt River Gum	12	White	Aug-Sep	WA	☑		☑							☑	☑		☑

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building	Min spacing in building protection zone	Min spacing in hazard separation zone	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Eucalyptus spathulata</i>	Swamp Mallet	8	White	Oct-Dec	WA			☑							☑	☑		☑
<i>Eucalyptus torquata</i>	Coolgardie Gum	4 to 11	Pink, Red	Aug-Dec	WA			☑							☑	☑	4	
<i>Eucalyptus utilis</i>	Coastal Moort	8	Creamy-Yellow	Sep-Jan	WA		☑	☑							☑	☑		☑
<i>Eucalyptus victrix</i>	Smooth-barked coolibah	7	Cream	Nov-Mar	WA	☑		☑							☑			
<i>Eucalyptus x tetragona</i>	Mealy Gum	8	White, Cream	Sep-Mar	WA													2
<i>Grevillea robusta</i>	Silver Oak	30	Orange	Sep-Nov	WA	☑	☑	☑	☑F			20	24	16				
<i>Hakea laurina</i>	Kodjet	5	Red	Apr-Aug	WA	☑		☑	☑F			12	14.4	9.6		☑	2	
<i>Lambertia inermis</i>	Chittick	6	Red, Orange, Yellow	Sep-Jun	WA			☑	☑F									
<i>Acacia baileyana</i>	Cootamundra Wattle	8	Yellow	Jun-Sep	Aus		☑	☑	☑ F							☑		
<i>Casuarina cunninghamiana</i>	River She-oak	15	Red	Mar-Oct	Aus				☑F						☑			
<i>Eucalyptus globulus</i>	Blue Gum	50	White	Sep-Dec	Aus		☑	☑	☑ R		☑					☑		
<i>Eucalyptus robusta</i>	Swamp Mahogany	30	White	Mar-Sep	Aus		☑	☑	☑ F/R							☑		
<i>Eucalyptus tereticornis</i>	Red Gum	50	White	Jun-Nov	Aus		☑	☑							☑	☑		
<i>Macadamia integrifolia</i>	Macadamia Nut	12	White	Jan-Jun	Aus	☑	☑		☑F							☑		
<i>Carya illinoensis</i>	Pecan	30	Yellow	Spring	E				☑F									
<i>Jacaranda mimosifolia</i>	Blue Jacaranda	10	Blue/Purple	Nov-Dec	E			☑	☑F			24	28.8	19.2	☑		6	
<i>Liquidambar styraciflua</i>	American Sweet Gum	20	Green	Apr-May	E			☑	☑F						☑	☑		
<i>Malus domestica</i>	Orchard Apple	8	White	Oct-Mar	E	☑		☑	☑F		☑							

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attractin g	Mammal attracting	Fire resistant	Min distance from building	Min spacing in building protection zone	Min spacing in hazard separation zone	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Pinus canariensis</i>	Canary Island Pine	30	Brown	Nov-Dec	E	?		?	?F						?	?		
<i>Prunus amygdalus</i>	The Almond	7	White-Pink	Aug-Nov	E	?		?	?F		?				?	?		

¹Drought- Drought tolerant

²Frost –Frost tolerant

³Aus- Australia

⁴E- Exotic

⁵Building protection zone – an area adjacent to a building¹⁵ (see figure 2)

⁶Hazard separation zone- The area of land between the building protection zone and bush usually up to 100 meters¹⁵. (see figure 2)

Table 5: Suggested native tree species and their attributes for the Scarp soil types (see Figure 1).

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attracting	mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Actinostrobus pyramidalis</i>	Cypress Pine	4	Cone	Jan-Dec	Perth	?		?	?	F		7	8.4	5.6		?		?
<i>Allocasuarina fraseriana</i>	Common Sheoak	15	Brown	May-Oct	Perth	?	?	?				30	36	24		?	6	
<i>Allocasuarina huegeliana</i>	Rock Sheoak	4 to 10	Brown	May-Jan	Perth	?						16	19.2	12.8		?		
<i>Banksia grandis</i>	Bull <i>Banksia</i>	10	Yellow	Sep-Dec	Perth		?	?	?	F	?	16	19.2	12.8	?	?	4	
<i>Corymbia haematoxylon</i>	Mountain Marri	10	White	Oct-Mar	Perth	?	?	?	?	F		24	28.8	19.2				
<i>Eucalyptus accedens</i>	Smooth Bark Wandoo	30	White-Cream	Dec-Jan	Perth						?	40	8	32				
<i>Eucalyptus laeliae</i>	Daring Range Ghost Gum	20	White	Dec-Jan	Perth	?	?	?			?	40	48	32	?			
<i>Eucalyptus lane-poolei</i>	Eucalyptus lane-poolei	12 to 15	White/Cream	Jan-Sep	Perth	?	?					30	36	24			6	
<i>Eucalyptus marginata</i>	Jarra	30	White-Cream/Pink	Jun-Dec	Perth	?	?	?	?	F/R		90	108	72				
<i>Eucalyptus patens</i>	Yarri	25	White/Cream	Aug-Jan	Perth	?	?	?	?	F/R		90	108	72	?	?		
<i>Eucalyptus wandoo</i>	White Gum	18	Cream	Dec-May	Perth	?	?	?	?	F/R	?	60	72	48		?		?
<i>Nuytsia floribunda</i>	WA Christmas Tree	8	Orange	Oct-Jan	Perth	?	?	?				16	19.2	12.8				

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attracting	mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Paraserianthes lophantha</i>	Albizia	10	Greenish Yellow	Aug-Dec	Perth	?												
<i>Acacia acuminata</i>	Jam Wattle	5	Yellow	Aug-Nov	WA		?	?				24	28.8	19.2	?	?		
<i>Banksia littoralis</i>	Swamp Banksia	15	Red/Yellow	Mar-Aug	WA	?	?	?	?	F	?	20	24	16		?		
<i>Banksia sessilis</i>	Parrot Bush	6	Cream-Yellow	April-Nov	WA		?	?			F	8	9.6	6.4	?	?	4	
<i>Banksia verticillata</i>	Granite Banksia	6	Yellow	Jan-Apr	WA	?	?	?			F	12	14.4	9.6	?	?	4	
<i>Calothamnus rupestris</i>	Granite Net-bush	3	Pink/Red	Jul-Dec	WA		?	?				8	9.6	6.4				
<i>Corymbia calophylla</i>	Marri	20	White/Pink	Dec-May	WA	?	?	?			F/N/R	70	84	56			20	?
<i>Corymbia ficifolia</i>	Red Flowering Gum	8	Red	Dec-May	WA	?	?	?			F							?
<i>Eucalyptus camaldulensis</i>	River Red Gum	20	White	Jul-Dec	WA		?	?			R	30	36	24	?	?		?
<i>Eucalyptus cornuta</i>	Yate	25	Yellow-Green	Jan-May	WA		?								?	?		
<i>Eucalyptus drummondii</i>	Drummond's Mallee	5	White-Cream	Jan-Feb	WA			?				16	19.2	12.8		?		
<i>Eucalyptus longicornis</i>		24	White	Dec-Feb	WA						N							
<i>Eucalyptus loxophleba</i>	York Gum	15	White	Jul-Dec	WA		?	?			F/N	20	24	16	?	?		?
<i>Eucalyptus preissiana</i>	Bell-fruited mallee	3	Yellow	May-Aug	WA		?	?			F							
<i>Eucalyptus sargentii</i>	Salt River Gum	12	White	Aug-Sep	WA	?		?							?	?		
<i>Eucalyptus torquata</i>	Coolgardie Gum	4 to 11	Pink, Red	Aug-Dec	WA			?							?	?	6	
<i>Eucalyptus utilis</i>	Coastal Moort	8	Creamy-Yellow	Sep-Jan	WA		?	?							?	?		?
<i>Eucalyptus x tetragona</i>	Mealy Gum	8	White/Cream	Sep-Mar	WA												2	

Tree	Common name	Height (m)	Flower	Flower time	Origin	Insect attracting	Bee attracting	Bird attracting	Carnaby attracting	mammal attracting	Fire resistant	Min distance from building (m)	Min spacing in building protection zone (m)	Min spacing in hazard separation zone (m)	Drought	Frost	Meters from sewage pipe	Salt tolerant
<i>Hakea oleifolia</i>	Olive-leaf Hakea	10	White	Aug-Oct	WA			?	?									
<i>Lambertia inermis</i>	Chittick	6	Red, Orange, Yellow	Sep-Jun	WA			?	?									
<i>Acacia baileyana</i>	Cootamundra Wattle	8	Yellow	Jun-Sep	Aus		?	?	?							?		

¹Drought- Drought tolerant

²Frost –Frost tolerant

³Aus- Australia

⁴E- Exotic

⁵Building protection zone – an area adjacent to a building¹⁵ (see figure 2)

⁶Hazard separation zone- The area of land between the building protection zone and bush usually up to 100 meters¹⁵. (see figure 2)

Table 6: Weeds all information in this table was retrieved from Nursery and Garden Industry Western Australia

<http://www.growmeinstead.com.au/public/GMI-brochure-Western-Australia.pdf>

Weed	Alternatives
<i>Pinus radiata</i>	<i>Allocasuarina fraseriana</i> , <i>Callitris endlicheri</i> , <i>Casuarina obesa</i>
<i>Cinnamomum camphora</i>	<i>Eucalyptus sideroxylon</i> 'Rosea', <i>Tristaniopsis laurina</i> , <i>Cupaniopsis anarcardioides</i>
<i>Corymbia citriodora</i>	<i>Eucalyptus torquata</i> , <i>Eucalyptus forrestiana</i> , <i>Eucalyptus sideroxylon</i> 'Rosea'
<i>Olea europaea ssp. Cuspidata</i>	<i>Grevillea olivacea</i> , <i>Photinia x fraseri</i> ,

Discussion

Why use local rather than exotic species?

Trees that are native to the area need less fertiliser than exotic trees, as the species have evolved and adapted to grow within the soils¹⁷. Perth soils are very old and nutrient poor therefore many exotic species need more fertiliser to survive^{17,18}. Using fertiliser in excess has damaging impacts on our ecosystems and waterways¹⁰. The excess nutrients can cause eutrophication in waterways and estuaries resulting in algal blooms, which can be toxic. Algal blooms block light entering the water body reducing the growth of aquatic plants and reduce oxygen when algae decompose, potentially causing fish death events¹⁰. Furthermore, these events affect fisherman, tourism, and recreational sports, through lack of fish, discolouration, odour, and human health concerns¹⁰. Using local species contributes to avoiding these outcomes, and saves time and money spent on fertilizer application.

Exotic species need more water than local native species, unless they are drought tolerant. Perth's climate is hot and dry over the summer season, and local tree species are adapted to this¹⁹. Trees not from the local area and that are not drought tolerant will need more water to stay alive¹⁹. Exotic trees that exhibit fire resistance do so because of their high moisture content, needing more water than the local fire resistant trees²⁰. Water is a precious commodity in Perth with our groundwater resources shrinking, while our population is growing²⁰. The region's climate is predicted to get hotter and drier due to climate change, producing greater impact on our groundwater and all water resources²¹. Thus, it is crucial to use trees in the UFS that consume less water.

Over millennia, Perth's native fauna and flora have evolved together in close proximity, creating integral relationships that critically rely on each other for survival. Some relationships have become so specific that a native insect may only use one species of plant to lay their eggs². For example, *Eucalyptus gomphocephala* (tuart) now listed as critically endangered is one of Perth's most valuable biological trees²². The tree hollows attract many native fauna such as kestrels, ringneck parrots, tree-martins, red-capped parrots, sacred Kingfishers, falsistrelle bats and brushtail possums. Insects inhabit practically every part of the tree, with the bark sheltering lizards and insects. The endangered Carnaby Cockatoo also uses the tree to roost, nest, and feed they have been known to listen for the tunnelling of grubs within the branches before digging them out with their strong beaks². The buds from *Eucalyptus gomphocephala* lay on the ground where the female tuart bud-weevil carves a hole in one of the buds to lay her eggs inside. The larvae will then grow within the bud eating its way towards the base, until it becomes an adult, where it will then cut its way out². Large fungi also grow on the trees and in 1958 a one metre wide fungi, weighing over 10kg, was discovered to be yielding 27000 insects². Some native fauna however have learnt

to make use of some exotic tree species including other Western Australian species outside the Perth metropolitan area, but generally, exotic plant species are used a lot less than local natives². Therefore, it is extremely important that native trees of the Perth region are favoured over other species if our global recognised biodiversity is maintained.

Exotic plants from overseas or other areas of Australia have the potential to have a negative impact on local ecosystem function. The species can escape from cultivation and invade bushlands, competing with natives²³. Through successful invasion of natural habitats, the species then become an environmental weed, replacing native flora that native fauna rely on for survival²². The exotic trees tend to be chosen for their hardiness and speed of growth but these same characteristics are what make them so problematic²³. Exotic species often thrive being free from their natural predators¹. When invasive species become uncontrollable they have the ability to reduce ecological function, water quality, productivity and biodiversity²³. An example of a problematic environmental weed is the *Salix spp* (willow trees) on the east coast of Australia, that were once planted to stabilise river banks after clearing. Willow species have grown in huge numbers invading waterways for thousands of kilometres²⁴. The excessive growth is now having significant negative impacts economically, environmentally, and socially. The species are growing further into the water increasing flooding and erosion, the roots are then also blocking waterways for kayakers and fishermen, they drop their leaves into the water reducing flow and quality, they drink huge amounts of water reducing the water availability, and are out competing natives reducing biodiversity²⁴. The government now spends about \$ 2 million annually on the species management²⁵. Better to plant natives.

The need for biodiversity KPIs in UFS

Incorporating biodiversity monitoring in our UFS allows us to track progress towards biodiversity goals. Having key performance indicators (KPIs) that include biodiversity emphasises the commitment to this goal and ensures that native tree species are considered as an integral part of the strategy, rather than an optional extra. Having to report on a KPI of how many native trees are present, have been planted, increase in native species diversity, number, and cover will naturally progress those goals. Measuring biodiversity is also critical to understand the current extent of the existing biodiversity. Local governments need sound data of the ecological communities that exist within their area to aid in decision making²⁶. Set criteria will help in succeeding to maintain and improve already established trees. KPIs for biodiversity should set measurable goals of improving tree diversity, local representation, tree health, rarity, and biological values (e.g. what benefits they provide local fauna)²⁶. How effective the indicators are will depend on how comprehensive this baseline data is. A sound understanding of the existing urban forest is great baseline for future UFS planning.

Example KPIs

Goal: Increase biodiversity

Action	Measure	Target	Frequency
Plant native trees	Percent of number of native trees planted this year compared to last	increase	Annual
Plant different types of native trees	Percent of number of different native trees planted this year compared to last year	increase	Annual
Plant rare native trees	Percent of number of rare trees planted this year compared to last year	increase	Annual
Plant trees with strong biodiversity values	Percent of number of trees planted that attract local fauna compared to last year	increase	Annual
Monitor and assess health and survivorship of existing trees	Percent of number of trees of ill or dead compared to last year	decrease	Annual

These are only suggestions, targets will vary depending on baseline data of ecological communities identified by each local government.

Limitations and future research

This is a desk-top study and while Jill Holland from Trillion Trees generously shared her knowledge to forward the goal of increased biodiversity uptake in UFS, the data was directly collated from online sources. Sourcing secondary data has limitations, it relies on the premise that all primary information is available online and that this data is valid. Data can be kept privately or publicly and this study assumes that the most up to date data is available. Information was sourced from scientific articles, published books, government websites, credible NGO's, and plant nursery websites to aim for the most recent and accurate information. There were more websites and blogs with information but the reliability of this information was not known and so was not used in the study. Information gaps are still apparent due to limited resources and data availability. The information provided in the tables is also indicative and will vary due to fertiliser use and water availability. Nevertheless, the tables provide a good starting point on selecting trees to improve biodiversity outcomes.

The next step is the incorporation of understory vegetation within the UFS. By not acknowledging the necessity of understory in a forest, some strategies are merely a tree strategy, and do not encompass the function of an urban forest. Integrating local understory vegetation will help to further achieve the UFS goal of creating a healthy, liveable city. SERCUL already offers a list of local understory species found at <https://www.sercul.org.au/our-projects/fertilise-wise/>. Future research should provide information as to how to amend UFS to incorporate understory and illustrate the benefits this provides. Other research could seek to understand the biodiversity impacts of the exotic

trees already planted by local governments. Currently a lot greater range of exotics and trees native to outside of the Perth region are being used. The research could aim to understand if any of these species aid biodiversity outcomes in the changing environment (through the provision of food or habitat for example) or if the outside species are contributing to the multiple pressures already placed on the local trees and ecosystems.

Conclusion

Urban Forest Strategies are uniquely placed to provide biodiversity outcomes across the whole of the urban landscape, not just in conservation reserves and parks. The benefits of planting native trees are numerous, and are not only environmentally important but also socially and economically. The aim of this study was to aid local governments to increase the value of their UFS by incorporating biodiversity outcomes through selection of local native trees species and their associated biodiversity values. Incorporating biodiversity monitoring and key performance indicators (KPIs) into UFS is recommended ensuring native tree species are considered as an integral part of the strategy, rather than an optional extra. We hope that use of this resource will add value to existing UFS and enable local governments to achieve greater multiple benefits than current UFS allow.

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