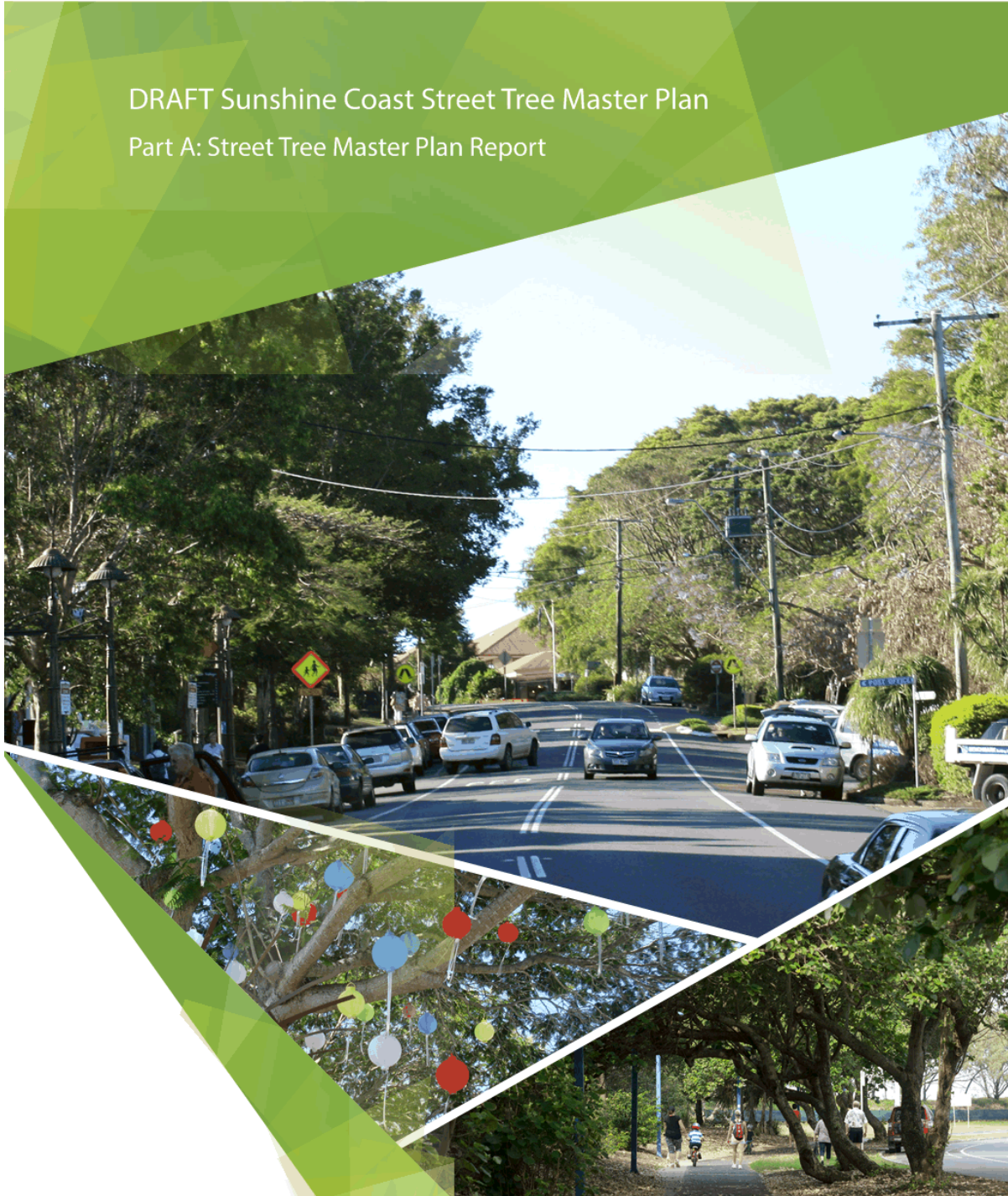




DRAFT Sunshine Coast Street Tree Master Plan
Part A: Street Tree Master Plan Report





© Sunshine Coast Regional Council 2009-current.
Sunshine Coast Council™ is a registered trademark
of Sunshine Coast Regional Council.
www.sunshinecoast.qld.gov.au
mail@sunshinecoast.qld.gov.au
T 07 5475 7272 F 07 5475 7277
Locked Bag 72 Sunshine Coast Mail Centre Qld 4560

Acknowledgements
Council wishes to thank all contributors and stakeholders
involved in the development of this document.

Disclaimer
Information contained in this document is based on
available information at the time of writing. All figures and
diagrams are indicative only and should be referred to as
such. While the Sunshine Coast Regional Council has
exercised reasonable care in preparing this document,
it does not warrant or represent that it is accurate or
complete. Council or its officers accept no responsibility
for any loss occasioned to any person acting or
refraining from acting in reliance upon any material
contained in this document.

Table of contents

Foreword	5	Existing views	58
Plan structure	7	Tree supply, monitoring and maintenance	60
Introduction	9	The availability and quality of nursery stock	61
Executive summary	11	Young street tree maintenance	60
Purpose of the plan	12	Tracking 'no net loss'	62
Key objectives	12	Species selection and community preference	64
Plan scope	12	Food trees as street trees	64
How to use the plan	13	Flying foxes and street tree species	64
Who will use the plan	13	Analysis	67
Context	15	Vegetation mapping	68
Legislative and policy framework	16	The existing street tree network	76
Planning framework	16	Strategic directions	83
Strategic context	16	Guiding principles	85
Legislation and standards	18	'Adopt a street tree' planting program	91
Sunshine Coast landscapes	21	Positioning guidance	92
Trees in the urban landscape	23	Street tree planting priorities	95
The benefits of trees	23	Species selection guidelines	97
Environmental benefits	23	Tree species selection	99
Visual benefits	23	Street tree palettes	100
Social benefits	25	Implementation	109
Economic benefits	27	Funding	110
Trees and temperature	29	Monitoring and review	110
Shade	29	Action plan	112
Cooling	29	References	115
The urban heat island effect	29	Glossary	121
Trees and ecosystem services	31	Appendix	127
Urban forests	31		
Trees and climate change	31		
Adaptable and resilient landscapes	33		
Key issues, challenges and opportunities	37		
Growth and development	41		
Tourism	41		
Population growth	41		
Development impacts	42		
Infill development and street trees	42		
Greenfield development and street trees	44		
Major infrastructure	49		
Existing transport networks	49		
Future transport networks	49		
Competition for space	52		
Footpaths	52		
Electrical infrastructure	54		

"... one of the most desirable places to live, work, invest, play and visit (*Sunshine Coast Council Corporate Plan 2017-2021*)."



Foreword

The Sunshine Coast is best characterised by its natural assets. From the unique rock formations of the world heritage listed Glass House Mountains to the 130 km stretch of coastline and pristine beaches, the region's distinct and often dramatic land form, and all of the trees plants and water associated with it, are fundamental to the region's liveability. The stunning natural surroundings don't just contribute to the enviable Sunshine Coast lifestyle, they're central to it.

Along with the region's warm sub-tropical climate, this natural capital is also a major draw-card for holiday makers, with the diversity of landscapes and experiences on offer attracting millions of local and international visitors to the coast every year, significantly contributing to the local economy.

The network of green spaces that frame, shade, link and cover the region are responsible for the lush sub-tropical setting that the Sunshine Coast is known for. Street trees are integral to these green spaces, performing a critical environmental role as well as providing many visual, social and economic benefits. Trees are biological systems. At a very basic level, they produce oxygen, store carbon, and shade and cool their surroundings. Trees also help to make places. They contribute to local character and improve the appearance and feel of our immediate environment and the places we go.

The *Sunshine Coast Council Corporate Plan (2017- 2021)*, council's key strategic document, presents council's vision for the Sunshine Coast to be "Australia's most sustainable region - healthy, smart, creative." With the "importance of vibrant, green, diverse as attributes of sustainability now well embedded within council and our communities" the plan identifies the need to "continue to balance our economic, social and environmental objectives."

The plan highlights the region's "unprecedented growth and the rapidly evolving digital age" as significant drivers of council's strategic direction as well as the major regional projects which will make the region "an even better place to live, work and play for present and future generations." The plan acknowledges the link between the Sunshine Coast landscape and the Sunshine Coast way of life, the critical role the region's environment continues to play in supporting our economy and community and the importance of "maintaining and enhancing the region's natural assets, liveability and environmental credentials" into the future.

The *Draft Sunshine Coast Street Tree Master Plan* seeks to complement the vision and goal's of council's *Corporate Plan*, ensuring the region's future street trees are attractive, functional and resilient.

The plan outlines council's approach and commitment to sustaining and enhancing the region's existing street tree canopy cover over time, by planting the right trees in the right locations and planting more of them.



"... An environment that is central to the Sunshine Coast way of life, and critical to supporting our economy and community (Sunshine Coast Council Corporate Plan 2017-2021)."



6 DRAFT Sunshine Coast Street Tree Master Plan Part A

Plan structure

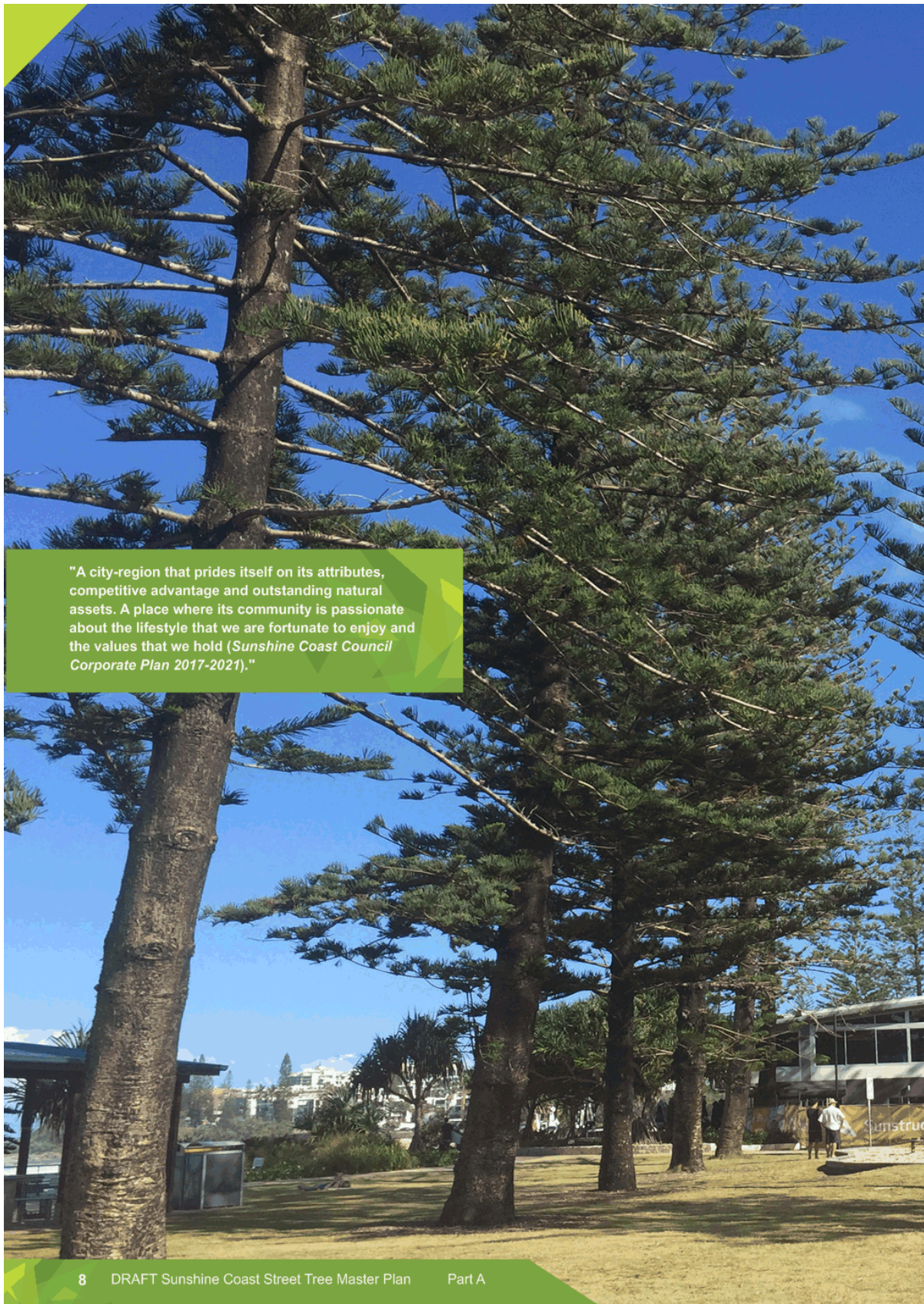
This plan is presented in two parts:

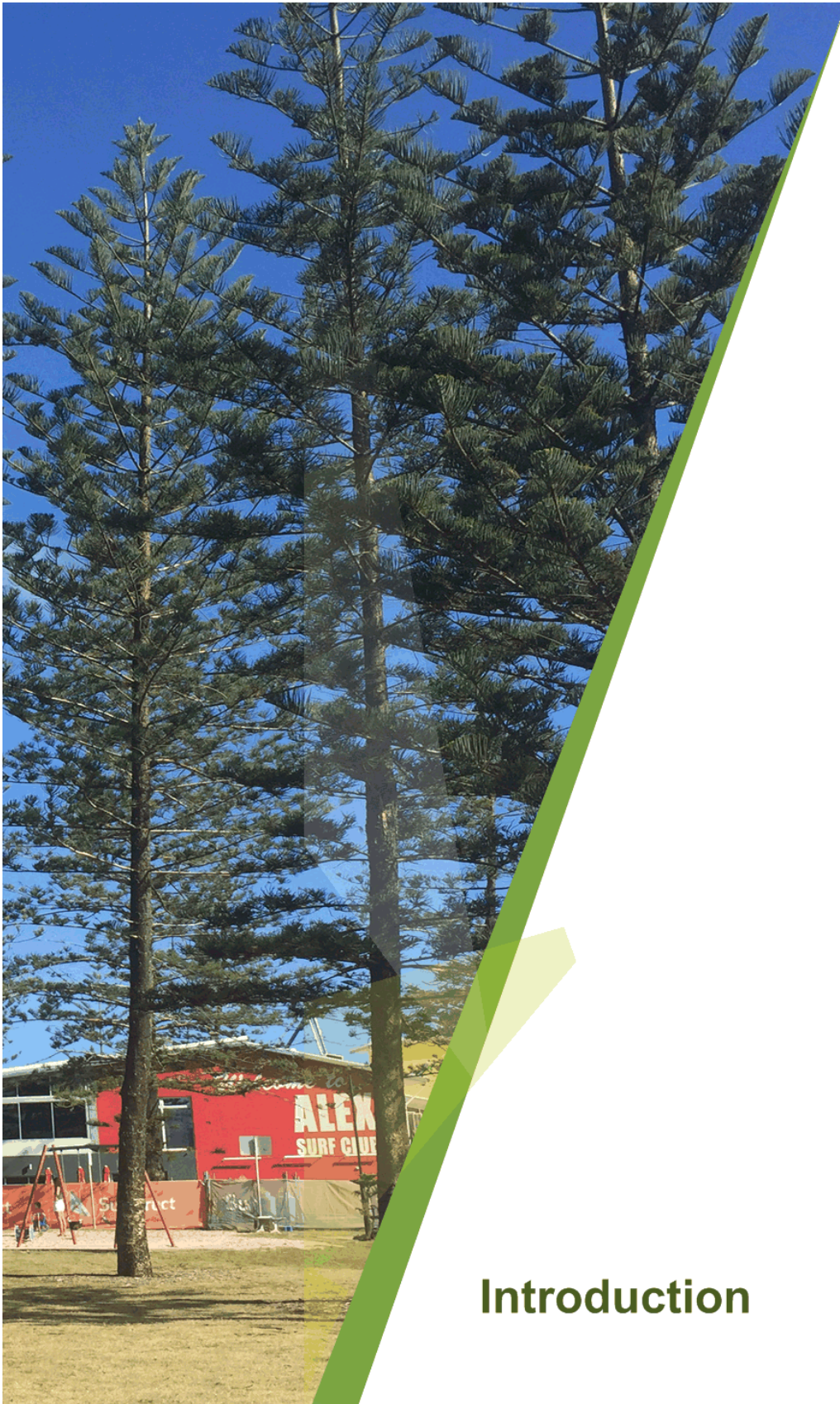
Part A:

A *Street Tree Master Plan Report* outlines the purpose of the plan, its key objectives and relevant street tree issues, and sets out council's strategic approach to addressing these in future street tree planting programs.

Part B:

A series of *Street tree strategies* identifies future street tree planting opportunities in each of the region's 27 *Local Plan Areas (LPAs)* and presents palettes of suitable street tree species. These strategies are accompanied by *Priority planting plans* (maps) highlighting priority locations for street tree establishment over the next 5 years.





Introduction



10 DRAFT Sunshine Coast Street Tree Master Plan Part A

Executive summary

Trees shade, cool and balance the built environment and contribute to the health, character and prosperity of our communities.

Trees provide an array of environmental, social and economic benefits. They sequester carbon, produce oxygen, filter pollutants, reduce run off and prevent erosion. When strategically positioned they can significantly reduce energy requirements through the provision of shade and cooling. Trees feed and shelter wildlife. They are instrumental in the conservation of biodiversity. Trees make our streets more attractive. They buffer the built environment and provide a sense of vertical scale. Trees act as landmarks and meeting points. They make our towns vibrant living places by providing quality spaces for day to day life. Shady streets bring urban life outdoors and encourage people to meet and socialise, improving the health and well-being of our communities and helping to drive the local economy.

The Sunshine Coast is presently in a major phase of development. New and upgraded infrastructure is constantly required to support the ever-expanding urban footprint as well as the densification of existing residential areas. In a landscape that continues to grow and change, council must manage trees in a way that not only sustains the existing level of benefits provided, but maximises these benefits in the future. If we are realistic and smart about where and how we establish new street trees, we can safeguard the Sunshine Coast's urban amenity and outstanding liveability while embracing the growth necessary for the region's future prosperity. This will not only require cooperation and commitment from all involved, but a proper understanding and appreciation of the role street trees play on the Sunshine Coast; what the physical barriers to successful tree establishment are, and how these can be overcome.

The plan's *Context* describes its fit within the legislative, planning and strategic frameworks of council and details exactly why trees are so important to our everyday lives (and how they will become even more important in the future). The *Key Issues, Challenges and Opportunities* section of the plan considers the juxtaposition of street trees and a rapidly growing, ever-changing region, and considers ways that the Sunshine Coast's existing and future street trees can better integrate with the changing landscape.

The *Analysis* section takes a much closer look at the existing street tree canopy and shade cover network across the region and helps identify trends and priority planting areas.

With a vision to *Protect, sustain and enhance the region's existing and future street tree network through better selection, placement and management of street trees*, the end goal of the plan is the provision of a street tree network that is attractive, functional and resilient. A street tree network that is compatible with the wishes and expectations of the local community, as well as visitors to the Sunshine Coast.

The plan seeks to achieve this goal through priority based implementation of the following key strategies, detailed in the *Strategic Directions* of the plan. These are to:

- prioritise the planting of new street trees in locations where they will provide the most visual, environmental, economic and social value
- build canopy in vacant 'plantable' spaces
- lessen the impacts of development on the Sunshine Coast by filling existing and creating new spaces that can accommodate large canopy trees
- reduce the costs of early tree losses, tree-infrastructure conflicts and recurring maintenance by growing, selecting and planting quality trees, and selecting species suited to the specific conditions of the planting site
- increase resilience within the Sunshine Coast street tree population through species diversification and ongoing renewal or replacement of street trees
- improve street tree establishment rates through extension of young tree maintenance programs and establishment of partnerships between council, developers, local businesses and residents to help care for new trees.

Council aspires to the provision of a street tree network that is not only sustainable, but one that celebrates the rich diversity and uniqueness of the region. Tree planting priorities, selection guidelines and species palettes suited to the diversity of areas within the region are provided in a separate section of the plan.

Purpose of the plan

The *Draft Sunshine Coast Street Tree Master Plan* sets the direction for future street tree planting in the Sunshine Coast Council region.

It details why trees are so important, communicates the region's tree planting priorities and provides guidance for locations, layouts and species to use. The plan also provides a staged action plan to guide implementation of street tree planting strategies over-time.

In essence, the plan serves to identify where and how street trees can provide the greatest benefits to the Sunshine Coast. In setting the direction for street tree planting, the plan also seeks to facilitate a more co-ordinated approach to the maintenance and delivery of new infrastructure and street trees in the future, and as such, better balancing natural and built capital as the region continues to grow.

Key objectives

The *Draft Sunshine Coast Street Tree Master Plan* seeks to:

Sustain

- Existing **regional and local character** by planting the right trees in the right locations and more of them.
- The current **extent of tree cover** through ongoing replacement and succession street tree planting programs and improved tracking and monitoring of new trees.
- Our **future street tree population** by building diversity and resilience in the existing street tree network.

Enhance

- The **local and visitor experience** by planting more trees in more places.
- The **distinct character of the region's various localities** by infilling existing avenues on major thoroughfares, and planting feature trees in key locations.
- The **region's visual amenity** by planting new trees in locations where potential conflicts are low and potential benefits are high.
- The **existing level of street tree benefits** through better selection, monitoring and maintenance of future street trees.

Reduce

- **Conflicts and long-term maintenance requirements** through appropriate selection and placement of new trees, and ongoing stakeholder consultation.
- **Solar glare and ambient temperature** by planting trees to shade and cool major pedestrian routes and 'hot spots' in built-up urban areas.
- **Energy consumption** and the financial burden of cooling 'hot spots' by planting trees in strategic locations.
- **Our carbon footprint** with new tree plantings that will both absorb carbon emissions and store carbon to lessen the impacts of climate change, and mitigate heat as temperatures rise.
- **Poor plant establishment rates and high young tree maintenance costs** through improved tracking and maintenance of new trees and the establishment of community and corporate partnerships to help care for young trees.

Engage and partner

- With the **Sunshine Coast community** to help council decide what types of trees are planted where.
- With the **Sunshine Coast community** and **business sector** to help care for new trees while they are establishing.
- With the **Sunshine Coast community** to encourage more private tree planting and raise awareness of trees as a community resource.

Plan scope

The plan applies to 'street trees' defined as trees that grow within road reserve spaces (land not associated with a title deed reserved for the transport of vehicles). Street trees are generally found as individual specimens or groups, along formed footpath and median spaces within the urban footprint of the Sunshine Coast. However, road reserve trees in rural townships and rural residential areas are also addressed in the plan.

The plan addresses street trees associated with all levels of the road hierarchy (see *Sunshine Coast Planning Scheme 2014 Schedule 6: Planning scheme policies, SC6.17 Planning scheme policy for the transport and parking code*). This includes those under the control of both state and local government.

How to use the plan

The vision for sustaining and enhancing the Sunshine Coast's street tree network and strategies formulated to achieve this vision, are presented within *Part A* of the plan – *Street Tree Master Plan Report*.

In recognition of the diversity of Sunshine Coast landscapes, and the vital importance of retaining character in our community of communities, council's specific approach to delivering local street tree planting initiatives are detailed in individual *Street tree strategies*.

These strategies (*Part B*), have been tailor-made to the subject local area considering land use, function, community values, priorities, existing opportunities and constraints for sustaining and building tree canopy cover in the future.

Short-term street tree planting priorities are highlighted in a separate set of maps – *Priority planting plans* – which have been developed for each local area and are presented in *Part B* of the plan.

The plan has been designed to be used in conjunction with the *Sunshine Coast Open Space Landscape Infrastructure Manual* which contains associated technical content including guidelines for the selection of street tree stock and specifications for the planting and maintenance of new trees.

Planning horizon

The *Street tree master plan report (Parts A & B)* are intended to have a twenty year span of influence but will be reviewed as required to respond to changes in legislation, and the wishes and needs of the community. The *Street tree strategies (Part B)* will require review after five years to determine whether priorities have changed as an outcome of strategy implementation and ongoing monitoring of the street tree network. Species lists will be reviewed periodically and may be subject to change over time due to taxonomic re-classification (changes in plant names), release of new and/or improved species varieties or cultivars, pest or disease outbreaks; or as an outcome of current or future street tree trials.

The *Priority planting plans* have been prepared with a five year time frame for delivery in mind. This implementation period may be shorter or longer depending on council's wider program priorities and available budgets. Community consultation as a part of the plan's development is also expected to result in the inclusion of additional streets for priority planting, to be delivered as a part of council's 'Adopt a street tree' program.

Who will use the plan

Council

The plan will support a range of council officers involved in the planning, design and delivery of open space and infrastructure, as well as officers responsible for maintaining existing networks. The plan provides a platform for cross-council collaboration – an opportunity for street tree network objectives and priorities to be realised through capital projects and operational programs.

Community

Engagement with the Sunshine Coast community in the development of this plan will provide opportunity to help determine future tree planting strategies. There are also opportunities for direct community involvement in growing the 'urban forest' of the Sunshine Coast through the development of tree care partnerships.

Once finalised, the *Street tree master plan report*, *Street tree strategies* and *Priority planting plans* will be available on council's web site for all to use. A suite of fact sheets and resource materials will also be made available to encourage landowners to enhance and strengthen the region's 'urban forest' by planting more trees on private land.

Developers/landowners

The plan aims to guide street tree selection and placement in new residential developments by identifying desired landscape character and street tree network structure, as well as advocating species for use. The plan aspires to encourage land developers to incorporate appropriate spaces for large growing trees in all urban residential developments. With specific reference to dual occupancy and smaller assessable development, the plan aims to encourage retention and the proper protection of existing street trees (especially the protection of spaces that will help support their future growth and stability in accordance with *AS 4970-2009 Protection of trees on development sites*). See also the *Sunshine Coast Open Space Landscape Infrastructure Manual – Preliminaries – Vegetation Management*.

External bodies/service providers

Collaboration with external bodies and service providers in the development of this document will allow formulation of strategies to address potential conflicts, while ensuring the Sunshine Coast's street tree network continues to thrive and grow.



14 DRAFT Sunshine Coast Street Tree Master Plan Part A



Context

Legislative and policy framework

Planning framework

The *South-East Queensland Regional Plan 2009-2031* and *Sunshine Coast Planning Scheme 2014* are the principal planning documents for the region, stating planning intent and guiding development into the future.

These documents have been used to help build local strategies for street tree planting by defining local character and provide planning context around existing and future land use.

South East Queensland Regional Plan 2009-2031

The *South-East Queensland Regional Plan 2009-2031* is the over-arching document governing planning in the region and takes precedence over all other planning instruments. The purpose of the plan is to sustainably manage growth and change in South East Queensland to protect and enhance quality of life for residents of the region.

The plan's vision is for South East Queensland is for **"...a future that is sustainable, affordable, prosperous, liveable and resilient to climate change."**

Sunshine Coast Planning Scheme 2014

The *Sunshine Coast Planning Scheme 2014* is the local planning instrument for the Sunshine Coast guiding development in the Planning Scheme Area until 2031. The strategic intent of the *Sunshine Coast Planning Scheme 2014* is **Green space for Generations** "...in 2031 the Sunshine Coast is one of the most biologically diverse areas in Australia and is renowned for its natural environmental values and leafy, sub-tropical urban environments."

Strategic context

The *Draft Sunshine Coast Street Tree Master Plan* plan seeks to both reflect and align with various Sunshine Coast Council strategic documents. These include but are not limited to the:

Sunshine Coast Council Corporate Plan 2017-2021

The *Sunshine Coast Council Corporate Plan 2017-2021* is council's principal strategic document and sets the strategic direction for council for the next five years according to five identified goals.

- A smart economy
- A strong community
- Service excellence
- An outstanding organisation

Sunshine Coast Environment and Liveability Strategy

The purpose of the *Sunshine Coast Environment and Liveability Strategy* is to provide long-term strategic direction to guide growth and shape the Sunshine Coast for future generations to 2041. It focuses on the natural environment and how it can be preserved and enhanced, as well as the liveability of the region – enabling a good quality of life for all residents in an accessible and well-connected built environment.

Sunshine Coast Regional Economic Development Strategy 2013-2033

This strategy provides a 20-year vision and blueprint for sustainable economic growth. It will help to ensure the region actively participates in the global economy and deliver the lifestyle and opportunities for local residents and businesses alike.

Sunshine Coast Social Strategy 2015

The *Sunshine Coast Social Strategy 2015* provides the long term social aspirations for the region.

Sunshine Coast Affordable Living Strategy 2010-2020

The *Sunshine Coast Affordable Living Strategy 2010-2020* identifies the actions needed to make the Sunshine Coast local government area a more affordable and sustainable place to live.

Sunshine Coast Biodiversity Strategy 2010-2020

The Sunshine Coast Biodiversity Strategy 2010-2020 aims to ensure the region's biodiversity is protected, enhanced, healthy, resilient to climate change and valued by the entire community by 2020.

Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020

The goal of the Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020 is to guide the transition to a low carbon, low oil, and resilient future for the Sunshine Coast local government area.

Sunshine Coast Major Events Strategy 2013-2017

The Sunshine Coast Major and Regional Events Strategy 2013-2017 is the long term planning document for major and regional events in the region.

Sunshine Coast Open Space Strategy 2011

The Sunshine Coast Open Space Strategy 2011 aims to ensure the community's need for recreation parks, sports grounds, recreation trails are planned for into the future.

Sunshine Coast Positive Aging Strategy 2011-2016

Council has developed the Sunshine Coast Positive Ageing Strategy 2011-2016 to address the changing needs of older people on the Sunshine Coast.

Sunshine Coast Social Infrastructure Strategy 2011

The Sunshine Coast Social Infrastructure Strategy 2011 provides a framework to ensure that existing and future communities have access to a full range of social infrastructure for the next 20 years.

Rural Futures Strategy 2013

The Rural Futures Strategy 2013 contributes to council's vision by setting out a unified strategy for the hinterland areas and provides a regional framework for rural communities.

Sunshine Coast Sustainable Transport Strategy 2011-2031

The Sunshine Coast Sustainable Transport Strategy 2011-2031 identifies what is required to provide a sustainable, integrated and safe transport system.

Sunshine Coast Waste Strategy 2015-2025

The Sunshine Coast Waste Strategy 2015-2025 has been developed to shape council's future waste management infrastructure needs and develop strong resource recovery markets. This strategy aims to also ensure that this essential community service remains both cost effective and customer focused whilst protecting the health of the public and the natural environment.

Sunshine Coast Waterways and Coastal Management Strategy 2011-2021

The Strategy provides council with direction and a management framework to ensure the region's natural waterways, constructed water bodies and coastal foreshores are ecologically healthy and well managed.

Additional plans of relevance include the:

- Sunshine Coast Active Transport Plan 2011-2031
- Sunshine Coast Energy Transition Plan 2010-2020
- Sunshine Coast Heritage Plan 2015-2020
- Sunshine Coast Local Government Area Pest Management Plan 2012-2016
- Sunshine Coast Reconciliation Action Plan
- Sunshine Coast Road Safety Plan 2016-2020
- Sunshine Coast Sport and Active Recreation Plan 2011-2026.
- Sunshine Coast Council Unsealed Roads Upgrade Plan 2015 – 2035
- Sunshine Coast Reconciliation Action Plan.

The Sunshine Coast Open Space Landscape Infrastructure Manual

The draft plan has been designed to be used in conjunction with the *Sunshine Coast Open Space Landscape Infrastructure Manual* (2013). The manual provides technical reference materials directly relating to street tree planting including guidelines for the selection of street tree stock, and specifications for tree planting and young tree maintenance. The manual also provides the background detail (how trees function and what they require for good growth) to support many of the discussion and recommendations of the plan.

The manual details council's specific requirements for the protection of trees on development sites. The manual also provides a range of tree sensitive and/or alternative design treatments to enhance growing conditions or extend the space available for tree root growth.

Other council documents that the plan aligns with include the:

- Sunshine Coast Centres Design Palettes (Draft)
- Sunshine Coast Strategic Tree and Native Vegetation Management Policy 2012 (Draft, endorsed in principle)
- Energex–Sunshine Coast Council Memorandum of Understanding (MOU) 2013.

Legislation and standards

There are many different legislation and standards also considered relevant to the development of this plan. These include, but are not limited to:

National legislation

- Aboriginal and Torres Strait Islander Heritage Protection Act 1984
- Disability Discrimination Act (DDA) 1992
- Environmental Protection and Biodiversity Conservation Act 1999
- Native Title Act 1993.

Queensland Legislation – acts and subordinate legislation

- Aboriginal Cultural Heritage Act 2003
- Anti-Discrimination Act 1991
- Environment Protection Act 1994 and regulations
- Land Protection (Pest and Stock Route Management) Act 2002 and regulations
- Local Government Act 2009
- Native Title (Queensland) Act 1993
- Nature Conservation Act 1992 and regulations
- Queensland Heritage Act 1992
- Soil Conservation Act 1986
- Sustainable Planning Act 2009 and regulations
- Torres Strait Islander Cultural Heritage Act 2003
- Vegetation Management Act 1999 and regulations
- Work Place Health and Safety Act 2011 and regulations (such as Work Health and Safety Regulation 2011)
- Water Act 2000 and regulations.

Australian Standards

- AS 2303-2015 Tree stock for landscape use
- AS 4970-2009 Protection of trees on development sites
- AS 4373-2007 Pruning of amenity trees.

Local laws

This document is to be used in conjunction with *Local Law and Subordinate Local Law No. 4 (Local Government Controlled Areas, Facilities, Infrastructure and Roads) 2011* which provides the framework to determine how local government controlled land, facilities, infrastructure and roads may be used for the benefit of everyone.

It is an offence to plant, clear or damage vegetation in a local government controlled area unless prior written approval has been granted by council. Council regulates planting in road reserves to ensure unobstructed and safe pedestrian movement and adequate sight-lines for vehicular traffic. Inappropriate streetscape plantings can reduce visibility and pose a risk to both pedestrians and motorists. Inappropriate streetscape plantings can also damage underground services such as water, sewerage, power and telecommunication cables (see Sunshine Coast Council Fact sheet - *Planting, clearing or damaging vegetation in a local government controlled area*).



Figure 1: Diagram showing key Sunshine Coast Council strategies and plans closely consulted in the development of the Draft Sunshine Coast Street Tree Master Plan.



The Sunshine Coast LGA boasts a population of approximately 287,000 people spread over an area of 2291 square kilometres.



20 DRAFT Sunshine Coast Street Tree Master Plan Part A

Sunshine Coast landscapes

The Sunshine Coast encompasses an area of 2,291 square kilometres containing a diverse range of geological and geographic features. The Sunshine Coast Council Local Government Area (LGA) extends from Emu Mountain in the north to the Pumicestone Passage in the south, and as far west as the Conondale Ranges. The LGA is blessed with natural capital comprising a stunning 60 km stretch of coastline and 78,000 hectares of open space in the form of foreshores, amenity reserves, bushland and road reserve. It is one of the largest LGAs in Australia. It is also one of the most biodiverse.

Natural landscape

The region's rich biodiversity is attributed to its complex geological origins and range of resulting rock types, topography and soils (Wilmot 2007). The natural landscape reflects this diversity. Seventy two regional ecosystems are present comprising, but not limited to:

- coastal and floodplain wallum
- mangrove
- paperbark and woodland forests
- tall open and closed eucalypt forests
- sub-tropical rainforests
- montane, wet and dry heath.

This plan intends to integrate with the vision, objectives and future directions of the *Sunshine Coast Biodiversity Strategy 2010* where the intricacies of our natural plant communities and strategies for their protection and management are detailed.

Rural landscape

The distinct character of many of the region's hinterland towns reflects the rich history of the region. Nambour and Beerwah are the major economic hubs of the hinterland both earmarked for further growth and expansion (South East Queensland Regional Plan 2009-2031) while the Blackall Range offers a hinterland tourist experience with 12% of the coast's visitors also staying in the popular hinterland locations of Mapleton, Flaxton and Montville.

The major agricultural industries of the Sunshine Coast hinterland consist of dairy and poultry farming, cattle grazing, forestry and agriculture.

Urban landscape

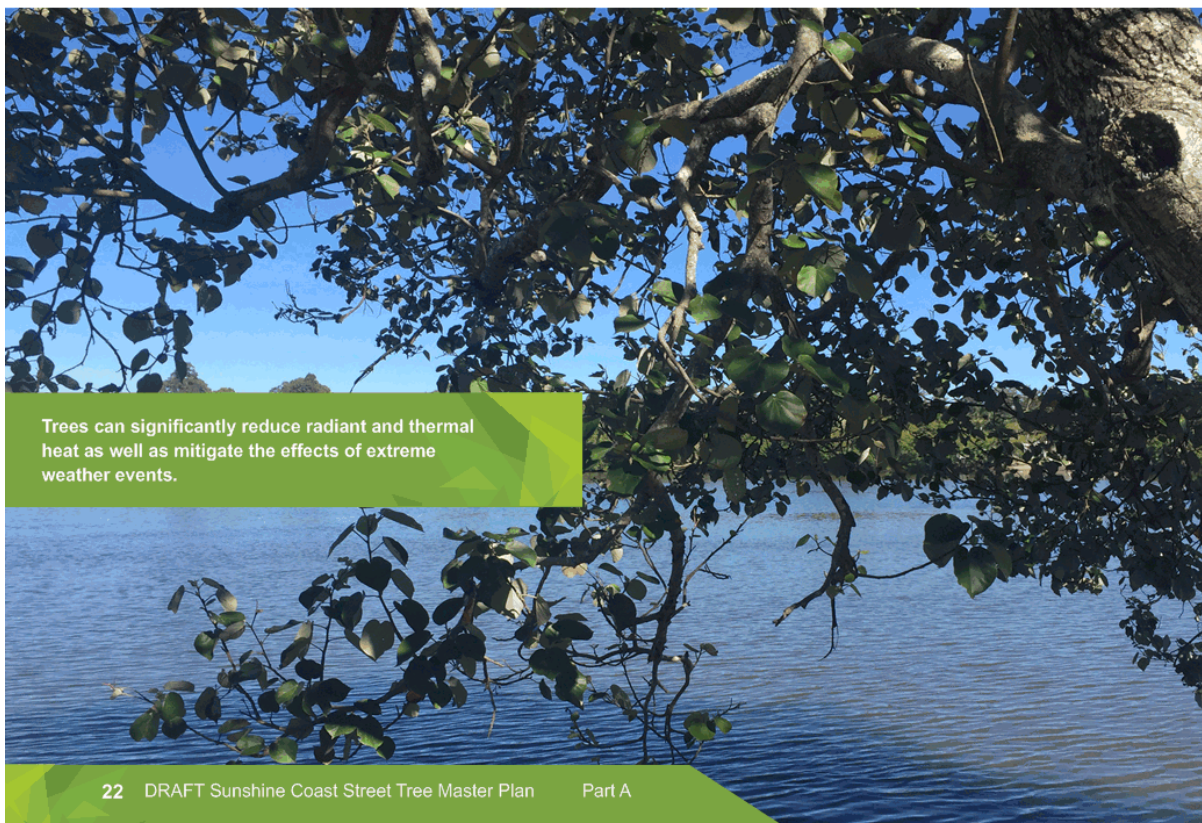
The Sunshine Coast's urban coastal character blends casual urban environments and tourist precincts with a strong focus on coastal foreshores and beaches. 70% of the Sunshine Coast's residents live on the urban coastal belt. Tourism precincts are mostly confined to the coastal strip with Golden Beach, Caloundra, Kings Beach, Mooloolaba, Cotton Tree, and Coolum key tourist areas.

The region's largest urban centre and the principal activity centre of the Sunshine Coast is Maroochydore and the creation of the new Maroochydore City Centre – Australia's only green field CBD – is currently under way.

Other major coastal centres include Caloundra, Mooloolaba and Coolum. Urban intensity is highest south of the Maroochy River between Caloundra and Maroochydore.

Major industrial areas are generally found in the urban belt but further inland (west) while farmland, rural and rural residential land use is typical of our hinterland locations.

Key rural landscapes are 'maintained for their natural beauty, ecological integrity, conservation value, landscape connectivity and ecosystem services' (*Sunshine Coast Rural Futures Strategy*).



Trees in the urban landscape

The benefits of trees

Trees provide many environmental, visual, social and economic benefits. They have the potential to locally reduce the severity of climate change and in a warming climate, will help to mitigate and manage increased heat with their shady and cooling canopies.

Environmental benefits

Trees perform critical 'ecosystem services' and help to maintain biodiversity. They regulate sunlight to our houses and streets and reduce ambient temperature through the provision of shade and cooling.

The many environmental benefits of trees are summarised in *Table 1: The environmental benefits of trees*.

Table 1: The environmental benefits of trees

Provision of shade (reflection and absorption of solar radiation). Strategically positioned trees can significantly reduce energy consumption for cooling of buildings (air conditioning) (McPherson et al. 2016). Shaded pathways can help increase 'walkability' (Sarker et al. 2015) reducing motor vehicle dependency and as such, greenhouse gas emissions.

Cooling the surrounding air as an outcome of evapotranspiration. Temperature differentials of between 4.1 °C and 18.7 °C can be experienced beneath clusters of shady trees (Thom et al. 2016).

Sequestration and storage of carbon (carbon dioxide is the main greenhouse gas contributing to enhanced greenhouse effect and climate change).

Production of oxygen (trees convert carbon dioxide to oxygen which is released) and carbon (which is stored in wood as an outcome of respiration).

Absorption and biofiltration of storm water (reducing peak flows, nutrient content and level of pollutants in storm water run-off, helping to mitigate floods, reduce erosion and drainage infrastructure requirements). In low intensity rain events, street trees can capture and reduce rainfall runoff by up to 20% (Livesley 2013).

Tree roots bind soils and restrain bank edges, reducing erosion.

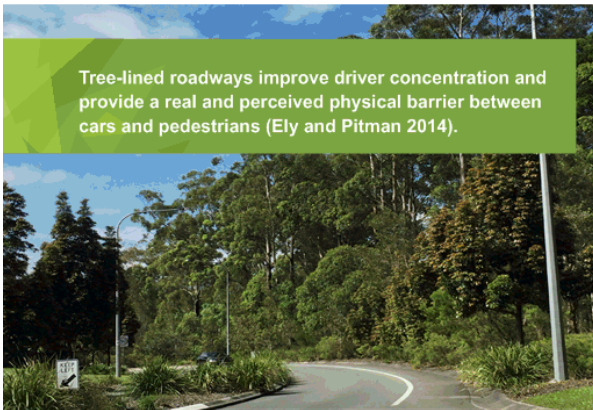
Air quality improvement through pollutant filtration (ozone reduction, dust and chemical particulate removal).

The provision of food and shelter for wildlife (including insects).

Improving soils through decomposition of matter and nutrient cycling and symbiotic relationships with soil micro-organisms.

Wind breaks.

Brisbane City Council reported that in 2011/12 its 575,000 trees sequestered 7300 tonnes of carbon to the value of \$168,000, air pollution removal to the tune of 87,200 tonnes annually (valued at \$44,200) and 653,733 m³ of rainfall interception valued at \$1,444,533 (estimated using i-Tree ECO V5 National Urban Forest Alliance 2014).



Visual benefits

Street trees are well recognised as essential elements of high quality and inviting urban spaces.

Healthy, attractive trees add identity and visual interest to the appearance of our local streets and neighbourhoods. Conversely, neighbourhoods with less tree cover, small or poor quality street trees can undermine an area's image and sense of community pride.

Larger trees can act as landmarks and provide critical 'first impressions' when planted as entry statements. They create attractive, inviting landscapes leading us into our major centres and local towns through gateway and avenue plantings.

Trees can complement or provide relief from the built form. They lend interest to the sides of buildings and can mask the negative effects of development and expansion as our region grows.

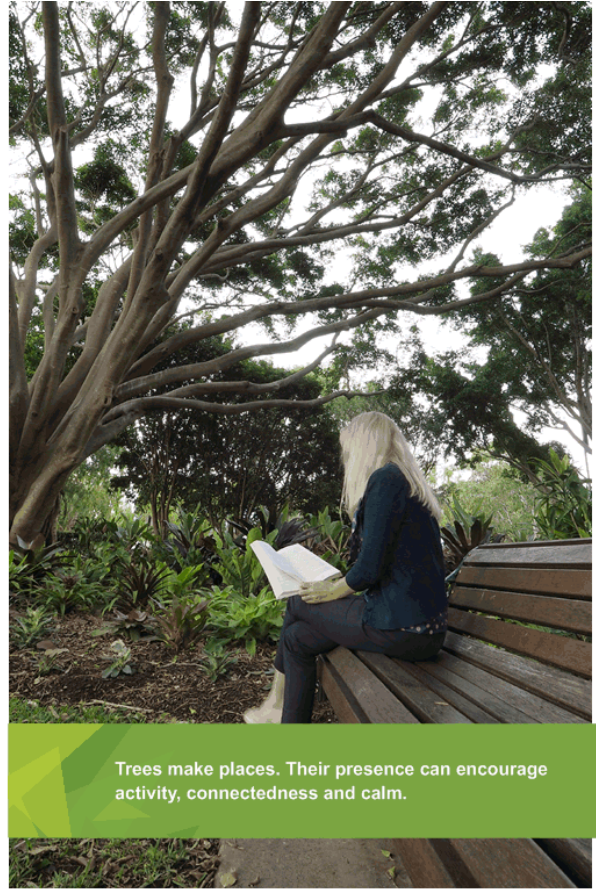
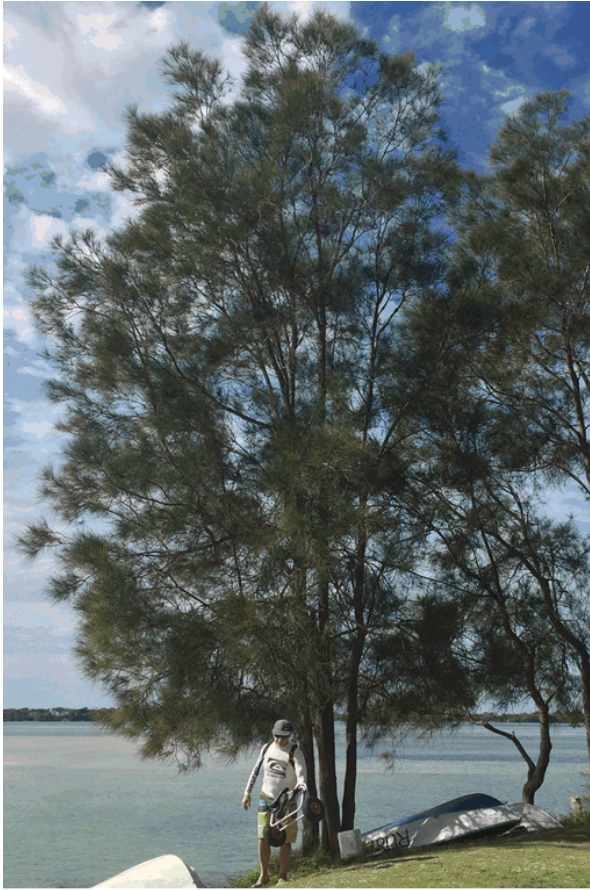
'Liveable' street treatments, including trees planted between the footpath and roadway, have been found to increase road safety, including fewer collisions and pedestrian or cyclist injuries (Dumbaugh 2006).

Some of the visual benefits of trees are summarised in *Table 2: The visual benefits of trees*.

Trees make the places we live, visit and travel through more attractive.

Table 2: The visual benefits of trees

Visual amenity.
Place-making and local character.
Privacy through screening.
Buffer and soften the built environment.
Mask or moderate the impacts of development.
Frame views.
Provide vertical scale and spatial definition to our streets and high rise localities.
Define paths of travel delineating curves and changes in the road (legibility of routes).
Act as landmarks and legacies from the past.
Provide sub-tropical ambience.
Contribute to community identity.
Seasonal change and interest.
Enhance cultural events.
Bring nature into our urban environments.



Trees make places. Their presence can encourage activity, connectedness and calm.



Leafy streets have been linked to reduced rates of domestic violence, less incidence of road rage and lower crime rates in general (Kuo and Sullivan 2001).

Social benefits

Trees significantly contribute to the health and well-being of our communities. They connect us to nature and to each other.

Street trees contribute to healthier urban lifestyles (Astell-Burt et al. 2014). The shade they provide makes it easier for us to exercise and walk, encouraging outdoor lifestyles and physical activity. People living in greener areas are 40% less likely to be overweight or obese (Planet Ark 2016). Leafy settings have been shown to reduce stress, foster recovery and enhance concentration. Participation in tree planting and stewardship activities has also been shown to strengthen local communities (Svendson 2009).

The social benefits of trees are summarised in *Table 3: The social benefits of trees*.

Table 3: The social benefits of trees

Psychological well-being (trees can provide a sense of peace and calm and reduce stress).

Help create walkable spaces.

Act as links to the past, enhance community identity and social connectedness.

Encourage feelings of connectedness to nature.

Decrease blood pressure (studies have found traffic calming, reduced domestic violence and crime in general can be an outcome of environments containing good tree cover).

Encourage outdoor lifestyles, activity and participation in community life (health and well being for the older members of the community and play for young children).

Encourage productivity in workers and the study habits of female students (see information box below).

Minimise noise pollution and extreme heat which have been linked to aggression.

Treed outlooks have been linked to faster rates of recovery for hospital patients and improved mental health.

Street trees provide a buffer between vehicles and pedestrians and can increase safety, or the perception of safety for pedestrians.

Tree-lined streets surrounding parks, recreation and community facilities encourage people to walk rather than drive to these facilities.

Both the quality and quantity of streetscape greenery has been strongly associated with self-reported reductions in stress and positive feelings of belonging in adults (de Vries et al. 2013). Office workers may need as little as 5 minutes walking amongst nearby leafy streetscapes to deliver a 'dose of nature' that improves productivity back at work (Largo-Wight et al. 2011). Even more importantly, safe, inexpensive and accessible doses of nature for children can improve learning and reduce symptoms of attention deficit disorder (Kuo and Faber Taylor 2004).



Economic benefits

Trees make places. They improve the appearance, economic value and liveability of our towns. Trees create atmosphere and encourage activity. They offer increased vibrancy and comfort to commercial areas. Businesses on tree-lined streets have been shown to be more profitable than non-tree lined streets (Wolf 2005) with shoppers in our warm climates likely to spend more time and money in leafy locations.

Houses in leafy streets also attract higher sale prices. When separated from other house, property and location features, Brisbane residential home-buyers preference for houses in leafy streets attracted property prices up to 3.73% higher than comparable non-leafy streets (Plant et al. 2017).

Yet the strongest case for leafy streets may come from the energy saving benefits of cooler, tree-shaded streets and neighbourhoods in our warming climate. Reducing peak summer temperature by 1 °C is estimated to reduce energy usage (through reduced cooling load) by 5% (Norton et al. 2013).

See Table 4: *The economic benefits of trees* for a summary of cost savings associated with trees.

Table 4: The economic benefits of trees

Reduced energy consumption for cooling through the provision of shade to buildings and lowered ambient air temperature via evaporative cooling.

Enhanced economic activity – commercial centres shaded by trees are more attractive and comfortable to shoppers (more frequent and longer trips have been recorded in tree-lined streets).

Increased streetscape amenity and higher property values.

Extended life of hard surfaces (i.e. asphalt) as an outcome of shading.

Reduced loading on storm water infrastructure and associated cost savings.

Enhanced community well-being resulting in lowered health service costs.

30,500 urban trees located along a 19 km stretch of the Pacific Highway in Northern Sydney store an estimated \$1.65 million of carbon (based on a carbon value of \$23 per tonne) and have been shown to deliver annual benefits worth \$97,770 from just four of many environmental services - carbon sequestration, air pollution removal, building energy savings and avoided carbon emissions (Amati 2013).

Summary of street tree benefits

Street trees are critical to the future sustainability of the Sunshine Coast. They are directly linked to social well-being and positively contribute to the look, feel and prosperity of our region.



Trees can significantly improve thermal comfort and relief from summer heat stress at the street and local neighbourhood scale (Norton et al. 2013).

Brisbane City Council targeted 'shade hungry' footpaths along popular pedestrian routes in their 'Neighbourhood Shadeways' program developed in 2006/07. On a summer day, surface temperatures of tree shaded pathways were found to be up to 7°C cooler than unshaded pathways (National Urban Forest Alliance 2014). Temperature differentials of between 14.1 °C and 18.7 °C have been forecast beneath clusters of shady trees in heat wave conditions in Adelaide (Thom et al. 2016). While McPherson et al. (2009) reported that the interior of cars in tree shaded car parks can be 22 to 28 °C cooler than carparks without trees.

Trees and temperature

A well-established body of evidence supports the role of trees in temperature modification. This section of the plan details the science behind the cooling benefits of trees and documents some of the research findings and applications to urban policy and practice in warming Australian cities.

The temperature under the shade of a medium to large sized tree can be several degrees cooler than ambient temperature. Trees reduce temperature by absorbing radiant heat from the sun and shading the spaces beneath or adjacent (depending on the time of day and angle of the sun). Trees reduce ambient temperature through evaporative cooling.

By mitigating excess urban heat, tree canopy cover and its shade can play a critical role in reducing both heat related health costs and summer home cooling costs in our subtropical region.

Shade

A direct relationship exists between areas shaded by trees and cooler land surface temperatures (Ali-Toudert & Mayer 2007; Kurn et al. 1994, Shashua-Ba et al. 2010). Street trees can help manage the impacts of heat, especially in densely populated communities and along popular pedestrian routes. Studies have confirmed that older and younger members of our communities are the most vulnerable to extreme heat. UV exposure during a person's first 18 years of life is also the most critical for cancer-causing skin damage (Norton et al. 2013; Kimlin and Guo 2012).

Shading homes and buildings also reduces heat gain during hotter days. In South East Queensland trees provide optimal shade benefit when planted on the east and west sides of homes and alongside east-west orientated streets (Norton et al 2015). In the summer months high angled sun on the south side of buildings is also a priority for shading (Doick and Hutchings 2013).

Cooling

The process causing trees to cool the surrounding air is termed evapo-transpiration and occurs while a plant is photosynthesising (converting sunlight to usable energy). The by-product is cooling of the leaf surface (evaporative cooling) which effects a reduction in the temperature of the surrounding air. The denser the tree canopy, the greater the surface area from which evaporative cooling can occur.

Rainforest species provide more cooling benefits on account of their leaf size, leaf arrangement and higher water use than low-water users such as eucalypts (gum trees) which have adapted strategies to slow or halt evapo-transpiration (and as such conserve water use) as a response to drought.

Large single specimens of broad-leaved species have the potential to provide far more cooling benefits than a group of smaller trees with sparser canopies and less total leaf surface area (City of Melbourne, 2012).

The urban heat island effect

Temperatures in urban areas are significantly higher than in undeveloped or rural areas due to the 'heat island effect' where hard surfaces high in thermal conductivity and heat storage capacity and low in reflectivity not only increase ambient temperature but also retain heat (Norton et al. 2013).

Urban areas are hotter than rural areas as an outcome of vegetation removal and a higher volume of impervious surfaces and buildings to permeable spaces. Highly urbanised areas tend to get hotter because of the lack of breeze. The heat is exacerbated by hard surfaces reducing water availability for trees and lowering rates of evaporative cooling. Structured drainage systems also deplete soil moisture levels (Norton et al. 2015). Heat production from cars and air conditioners, and air pollutions also contribute to the 'urban heat island effect'. Built up areas are generally 2°C hotter than rural areas. International research indicates that localised temperature increases associated with the urban heat island effect already exceed those predicted by climate change models over coming decades (Grimm et al. 2008; McCarthy et al. 2010).

A key driver of the 'urban heat island effect' (especially with reference to private land) is new or replacement tree planting not keeping pace with the amount of vegetation removed as a part of the urban consolidation process. The problem is circular – the more permeable space is replaced with hard surfaces, the more trees are needed to shade and cool these places.

The City of Melbourne has estimated that one of the many benefits of a plan to increase tree canopy cover from 22% to 40% by 2031 (predominantly on public land) is a forecast reduction of up to 2 degrees in average daytime summer temperature (NGIA 2012).

Trees and ecosystem services

Modelling tools are now being used to equate the 'ecosystem services' provided by trees with the cost savings they provide.

Trees absorb the first 30% of precipitation reducing run off rates and filtering storm water. Brisbane City Council reported that in 2010 the city's 575,000 street tree population was providing an estimated \$1.65 million in annual benefits from air pollutant removal, carbon sequestration and rainfall interception (National Urban Forest Alliance, 2014). More recently, in locations where their 'Neighbourhood Shade-ways' projects and storm water treatment priorities coincided, modelling was used to estimate the value of trees in storm water treatment. The modelling forecast annual reductions of 3,240 tonnes for suspended solids, six tonnes for total phosphorous, 20 tonnes for total nitrogen and 1,070 tonnes for gross pollutants across around 22,000 tree planting sites (State of Australian Cities 2013).

Urban forests

Our future tree planting priorities, like those of other leading Australian cities, need to emerge from a 'whole of forest' or 'urban forest' planning approach.

'Urban forest' is a term describing the sum total of green spaces in an urban environment both within public and private land including trees, shrubs, grass, climbing plants on the walls and roofs of buildings (and the soil and water in and around them). Parklands and streetscapes have the greatest influence over the extent and quality of urban forests.

The City of Melbourne has taken the lead in evidence-based urban forest planning in Australia and the *City of Melbourne Urban Forest Strategy 2012-2032* is recognised as a blue print for how to grow an urban forest (2020 Vision 2013).

Along with Brisbane City Council and Sydney City Council, the City of Melbourne has shared valuable and compelling data on the state of their urban forests, developing urban forest strategies and setting targets for planting programs that will increase not just the amount of future tree cover but the diversity and resilience of their tree populations (making them more sustainable) for other LGAs to follow. Many of the same principles of growing a sustainable urban forest are applicable to the Sunshine Coast Council region.

The premise is that for an urban forest to be sustainable it must be resilient. To be resilient it must be diverse (in the types, shapes, ages and locations of plantings). To be resilient an urban forest must be 'climate change ready'.

Trees and climate change

In 2010 council adopted the *Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020* in response to climate change and peak oil issues (refreshed in 2016).

The expected consequences of climate change in Queensland include increased drought, storm and cyclone intensity, biodiversity and ecosystem impacts on tropical rainforests, wetlands, terrestrial vertebrates and marine life; and damage to coastal infrastructure (as a result of storm surge-related flooding). South East Queensland has been identified as a 'hot spot' increasingly vulnerable to climate change due to its ever-growing population and coastal location (Choy et al. 2010).

The cause and effects of climate change are reciprocal. Carbon emissions are linked to rising temperatures. Rising temperatures cause us to burn more fossil fuels to help to cool the built environment. Trees help reduce the impact of greenhouse gas emissions. They sequester (capture) and store carbon in their wood and provide oxygen in return. The quantifiable direct benefits of trees on a population level in carbon capture and storage at a regional scale are significant. Yet indirect benefits of tree shaded footpaths and cycleways which support the uptake of active and public transport, reducing single vehicle travel also reduce greenhouse gas emissions.

Tree shade can also reduce peak summer energy demands in our warming climate. The Sunshine Coast's mean surface air temperature increased by about 1 °C between 1910 and 2013 (Dowdy et al. 2015). Locally relevant climate projections indicate further increases in mean surface temperature of between 0.7°C to 1.3°C by 2030, with mean surface temperature expected to increase by 2.7°C to 4.7°C by 2090.

Increasing tree canopy coverage is one of the most cost-effective strategies for cooling buildings and local neighbourhoods (Norton et al. 2013). Carefully positioned shade trees can reduce household energy demand in Sydney's climate change scenarios by 2 to 5% (Lin 2016). The City of Melbourne's work suggests that increasing urban canopy cover by 10% could reduce daytime surface temperature by more than 1°C (Norton et al. 2015).

The capacity for trees to play their part in mitigating urban warming will depend on their own resilience to changing climate. Not all trees currently adapted to local conditions will necessarily tolerate a warmer climate. Many of the Sunshine Coast's naturally occurring rainforest (closed forest) species have a low tolerance to extreme heat and may not effectively grow here the future. In a worst case scenario we are likely to see a significant change in the composition of plants in our natural environments with species adapted to warmer conditions moving in, and species preferring cooler conditions moving out. The southern migration of species for example is already occurring, impacting the natural habitable range of some species traditionally confined to the warmest parts of the continent.

A recently released study (Kendal et al. 2017) determines the heat vulnerability risk of the most commonly represented tree species in a number of LGAs across Australia, including Brisbane City Council. The study which considers the known temperature limits of various species and extreme scenarios in the latest temperature increase projections, suggests that a number of species currently well-represented on the Sunshine Coast may not be able to tolerate local temperature increases projected for South East Queensland in the future. The list of the most at risk includes species from the genus *Flindersia* (Queensland maple for example), species from the genus *Syzygium* (syn. *Acmena*) (lilly pillys); *Lophostemon confertus* (Old brush box); *Brachychiton acerifolia* (Illawarra Flame tree), *Callistemon salicina* (syn. *salignus*) (white bottle brush) as well as Brisbane City Council's most commonly planted species of eucalypts (*Eucalyptus* sp). While the authors are careful not to advocate wholesale selection against these species (which would be an extreme reaction on the basis of this early research), they do suggest that where important species have been identified as heat vulnerable, that strategies of resistance based on greater intervention (improving general growing conditions, increasing pest management programs, irrigating trees more frequently and for longer durations) should be employed (in addition to the diversification of species palettes in general).

Conversely, some of the best represented exotic trees and species hailing from Northern Australia were identified as low heat-vulnerability risk in worst case climate change scenarios. These include *Delonix regia* (poinciana), *Peltophrum pterocarpum* (yellow poinciana), *Caesalpinia ferrea* (Leopard tree), *Tabebuia* sp (trumpet trees) and *Corymbia ptychocarpa* (swamp bloodwood).

Adaptable and resilient landscapes

Lack of diversity within a tree population makes an urban forest vulnerable in the event of mass pest or disease breakout, or changes to the growing environment. The more diverse a tree population, the more resilient it is. Ensuring an assortment of species within a street tree population increases adaptability potential and resilience.

Species diversity

The Sunshine Coast landscape is characterised by its natural plant palette. Council ensures a high proportion of locally native (naturally occurring) species to non-indigenous natives or non-native plants are cultivated in the landscape and will continue to advocate the use of the Sunshine Coasts' indigenous suite of plants in the first instance (especially in relation to supporting our naturally occurring birds, insects and arboreal mammals). Biotic homogenisation (reduced diversity in composition of plant populations) however threaten resilience. Exotic and native (not locally native) trees which have proven adaptability to locations outside their natural origin may be the most successful tree types if weather extremes start to impact on natural plant communities. Including some exotic and non-local native trees in the street tree mix helps build resilience.

Given the likelihood of a southern migration of non-native species (Williams et al. 2012) Sunshine Coast landscapes are likely to benefit from greater use of species from Northern Queensland and the Northern Territory in the future. There are also benefits to the ongoing use of some exotic trees as accent plantings or as a part of landscapes with a heritage character. Deciduous exotic trees in some locations also offer seasonal change and light filtration in the winter when the sun's arc is lower.

Within-species diversity (genetic diversity) can also be enhanced through the utilisation of a range of species 'ecotypes'. Some tree species have a very wide natural range and relative tolerances can vary according to the ecotype, (i.e. geographic origin) of the propagating source. Ensuring that a range of sources of seed or mother stock (where propagation is from cuttings) are used in production can increase resilience within a species.

A temperature rise of over 5°C could result in the loss of over 90% of core habitat (plants and trees) for most native species of fauna (Sunshine Coast Climate Change and Peak Oil Strategy 2010–2020).



Urban heat island effects will be exacerbated by predicted climate changes. Based on analysis of temperature data for the period 1986-2005, the average number of days per annum over 35°C at Caloundra, Nambour and Kenilworth were: 0.6, 2.2 and 4.0 respectively. Climate change projections for 2030 indicate an expected increase to 1.4, 4.3 and 9.2 extreme heat days by 2030 and to 4.7, 13.3 and 24.1 extreme heat days by 2090 respectively (Clark, Wilson & Heady 2016). These projections are for the high emissions scenario consistent with the current global emissions trend. They also highlight that we have a significant challenge ahead to reduce extreme heat exposure for our communities.





Urban forests with limited species diversity are vulnerable to changing climates and pest and disease outbreaks. As a 'rule of thumb' Santamour (1990) suggested that no more than 10% of urban tree populations should be of one species (the specific tree, for example *Melaleuca quinquinervia* – broad leaved paperbark), no more than 20% of any one genus (related species are grouped into genera for example the genus *Melaleuca* represents all paperbark types) and no more than 30% of any one plant family (related genera are grouped into families for example the Myrtaceae family includes genera *Melaleuca*, *Eucalyptus*, *Callistemon* and *Leptospermum*). Kendal et al. (2014) suggests a move away from the 10-20-30 rule of thumb towards home-grown species diversity targets based on the level of existing diversity and vulnerability.

This is especially applicable where the relative tolerances of the species (to drought or periodic inundation for example) come under strong genetic control.

A diversity of broad-leaved species in a street tree population is ideal for heat mitigation because of increased shade and cooling function as an outcome of greater leaf surface areas. Conifers (pines and related plants with needle-like foliage) and eucalypts are not as efficient as broad-leaf rainforest tree types when cooling their surroundings. The ecological value of eucalypts (gum tree types including all species within the genera *Eucalyptus*, *Corymbia* and *Angophora*), Australian conifers (*Araucaria bidwillii* – bunya pine, *Araucaria cunninghamii* – hoop pine and *Agathis robusta* – kauri pine) and sheoaks (*Casuarina* and *Allocasuarina*) however is significant. These species are synonymous with the Sunshine Coast character. They are also going to be more tolerant to changes in temperature, especially in significantly reduced precipitation scenarios. Rainforest type trees and those that come from moist environments have higher rates of evapo-transpiration and greater output in terms of cooling because they are physiologically adapted to wetter environments. The higher rates of evapo-transpiration and cooling are a result of higher water use.

This means that for rainforest trees to provide maximum rates of cooling, aside from temperatures needing to be within their natural range of adaptation and tolerance, soil water must not be a limiting factor.

Where soil water is a particularly limiting factor, irrigating trees will increase evapo-transpiration rates and cooling (and shade and reduce temperature in our urban environments) however the cooling benefits must be weighed against the cost of supplying additional water to the site.

While some rainforest species originate from drier rainforest sites (*Brachychiton acerifolius* – Illawarra flame for example), rainforest trees are not suitable for cultivation in many Sunshine Coast locations, even where additional water can be provided.



Species selection must balance the desired character and function of the vegetation with the specific growing conditions of the site. Good species selection matches the species to the site, rather than attempting to alter the site to suit the requirements of a desired species.



Trees sequester carbon. Actively growing trees have higher rates of carbon sequestration than declining trees or specimens that have reached a plateau in growth.

Diversity of form

Formal avenues of the same species are often more typical of temperate climate cities. In the subtropics, mixtures of species reflect our milder climate and more diverse landscapes. Cooling potential is also greatest where a diversity of tree form exists. While a closed canopy or arched canopies over a street provide unbroken shade, they also prevent escape of trapped heat overnight when cooling generally occurs. There is potential for greater air flow for cooling through a more diverse tree structure and spacing. Consideration therefore needs to be given to the design of streetscapes among higher density built form and in centres supporting both daytime and night time activity.

Age diversity

A mixed-aged street tree population not only supports a succession of maturing trees for future generations, it also provides more ecosystem services.

Young, actively growing trees absorb more greenhouse gases than over-mature or declining trees. The potential a street tree population has for making a significant impact on climate change through carbon capture and storage is dependent on the age balance within the population.

In the development of their Urban Forest Strategy (2012- 2032), the City of Melbourne mapped the useful life expectancies of their street and park tree population with startling results. The study found that 30% of their highly valued trees were either in decline or nearing decline. It concluded that if significant steps weren't taken to remedy the situation, not only would the current look feel and of the city change significantly, it would become increasingly hotter.

The City of Melbourne has since developed a program of street tree planting to enhance canopy coverage and sustain all of the environmental, visual, economic and social benefits so integral to the LGA.

Future directions

Transitioning towards a broad range of tree species, and as such, a more diverse street tree palette may not only 'future-proof' our street tree network from the potential impacts of climate change but also respond better to the diverse range of growing conditions in our 'Community of Communities'. A greater emphasis on the use of mixed planting themes and a higher ratio of trees from warmer climates or local species with greater adaptation potential (local dry rainforest species for example) is recommended.

Growing sites for potentially heat-vulnerable street tree species (species currently near their limit of heat tolerance) need to be selected carefully. Resilience of locally important yet potentially heat vulnerable species should be promoted through greater cultural intervention to ensure the best possible conditions for growth are provided (irrigation, soil nitrification and active programs of pest control for example).

The average age and estimated useful life expectancies of the existing Sunshine Coast street tree population is currently unknown. Further analysis would allow council to determine how many new trees will be required, and to set canopy cover targets to optimise future benefits of our street tree population. In the meantime, council needs to be aware of potential species over-use; to ensure that every tree removed is replaced with at least one new tree; and to plan for the future by planting succession trees where stands of even-aged mature trees grow.

Summary of the role of street trees in temperature modification and the need for increased population adaptability and resilience.

Trees have a critical role to play in shading and cooling our region. Solar glare, ambient temperature and energy use can be reduced in urban 'hot spots' through strategically placed trees that shade and cool their immediate surroundings.

Council needs plant more trees in more spaces in general, plan for succession trees, and increase population diversity to grow the street tree population resilience required for the future. Wider use of exotic (tropical climates) and non-indigenous native trees (naturally occurring in Northern Queensland and the Northern Territory) is encouraged, as is the greater use of local dry rainforest species to combat the increased periods of drought and warmer temperatures predicted for the future.

Council needs to be 'climate change ready' in order to mitigate the impacts of projected temperatures increases including careful site selection for potentially heat-vulnerable species and the integration of strategies of resistance (increased intensity and frequency of maintenance) for all new street tree plantings.





Challenges and opportunities



"The Sunshine Coast is viewed by many as the 'playground' for South East Queensland due to the diversity of leisure, tourism and recreation opportunities available. While this influx of visitors and holiday makers contributes significantly to our economy, it drives an increased demand for infrastructure, tourism and recreation opportunities that potentially compromise the region's environmental value (*Sunshine Coast Biodiversity Strategy 2010–2020*)."

Growth and development

Tourism

Tourism is one of the Sunshine Coast's largest industry sectors in terms of profile, employment and output. While our natural and cultural landscapes attract visitors to the Sunshine Coast (and are integral to ongoing visitation), the seasonal influx of tourists places a heavy load on our existing infrastructure and green assets. Renewal of assets in tourist precincts in response to expectations and use can also affect the existing street tree network.

The flow-on effects of the ever-growing population of permanent residents on the Sunshine Coast also impacts street trees.

In 2015/16 there were 2.9 million visitors to the Sunshine Coast Council region up 2% on 2014/2015 figures. 10.9 million visitor nights were recorded for the same period with \$1.8 billion in expenditure.

Population growth

The Sunshine Coast is one of the fastest growing regions in Australia. With 52.3 km of open coastline, the coast attracts many sea changers as well as tourists. Over 57,000 new residents have moved to the Sunshine Coast in the last ten years – a population growth of 25% (ABS 2016).

The current population of the Sunshine Coast LGA is 293,000. With a population density of 1.26 persons per hectare on average, and an annual growth rate sitting at 1.6% in 2016 (expected to increase to 2.82% by 2026), the population is expected to reach 380,649 by 2026 (Sunshine Coast Council 2016). Recently released projections suggest the population will swell to over 500,000 people by 2040.

The South East Queensland Regional Plan 2009-2031 forecasts that a further 98,500 new dwellings will be needed to accommodate the coast's population in the year 2031. Infill development will account for around 3500 of these dwellings with some 65,000 to be accommodated within green field developments of Palmview and Caloundra South and other urban-zoned land developments (Department of Infrastructure, Planning and Local Government 2009).

Council has identified the Beerwah to Caloundra South corridor (Beerwah East) as the preferred IGA (Identified Growth Area) for future greenfield development, estimating another 20,000 dwelling targets can be met in this area between 2031 and 2041.

Demographics and human heat vulnerability

The region's stunning environment and sub-tropical climate is linked to a skew in population demographics, with a higher percentage than the national average of retirees residing on the Sunshine Coast (ABS 2016). Older and younger members of our community (those greater than sixty-five and younger than five years of age) are the most vulnerable to heat (Norton et al. 2013).

Older and younger members of our community are also more likely to walk to community facilities and local shopping centres or to spend time walking for passive recreation. 'Hot spots' which generally have low vegetation cover and a high proportion of impermeable surfaces within vulnerable communities are priority areas for the provision of shade. These include pedestrian spaces around schools and child care centres, aged care facilities and community centres.

"The challenge for the Sunshine Coast is to accommodate growth while preserving, and ultimately enhancing, the natural environment. Population growth and development pose a number of serious threats to the region's biodiversity, specifically: vegetation clearing, habitat loss and fragmentation, introduction of pest species, pollution and storm water run-off (Sunshine Coast Biodiversity Strategy 2010-2020)."

Development impacts

The Sunshine Coast Council region is currently in a phase of major growth and development. Despite ongoing efforts to protect existing trees, vegetation losses on private land are expected as the urban footprint of the region continues to increase. Offsetting vegetation losses by optimising tree cover on public land and a greater emphasis on 'tree sensitive' design as a part of development assessment will help to minimise the negative impacts of development on existing and future street tree networks.

14,292 development related applications were received by council in 2016 and with \$1.44 billion worth of construction approved, building approvals reached an eight year high.

The following key development 'hot spots' have been identified in council's Building Approvals: Heat Map and Activity Heat Map and Hot Spots (Sunshine Coast Council 2016) for the period between 2012 and 2016:

- Maroochydhore including Sunshine Cove
- Buddina, Mooloolaba and Mountain Creek including the Brightwater development and University precinct of Sippy Downs
- Kawana and surrounds including Birtinya (home of the new health precinct) Meridan Plains and the new Creekwood residential development
- The Caloundra area including Pelican Waters Caloundra West and Bells Reach
- Peregian Springs and Peregian Breeze

Between 2013 and 2016 there were high levels of activity within the Sunshine Coast Enterprise Corridor which stretches from Maroochydhore to Caloundra South. This corridor has also been designated the key zone for commercial and residential growth over the next 20 years. It is likely to accommodate approximately 70% of the region's projected population growth and a substantial level of new business investment in the region's high-value industries (Invest Sunshine Coast 2012).

As residential and commercial development increases on the Sunshine Coast, it will be more important than ever to retain natural features that enhance urban amenity and influence the look, feel and function of our communities and landscapes (Sunshine Coast Biodiversity Strategy 2010-2020).

The loss of large trees from urban areas

The Sunshine Coast's urban forest includes all of the trees growing on private land as well as land under the care and control of council (either as landowner or trustee for the state). The removal of large shade trees from private land significantly impacts the overall volume of trees providing ecosystem benefits to the region.

A study of the urban forest of the greater Melbourne area (Block, Livesley & Williams 2012) reported that although most local government bodies are planting more trees on public land than they are removing, the quality and extent of urban tree cover is still declining due to the clearing of trees from private land. Infill-development and densification in Melbourne's long-established inner suburbs has specifically resulted in the loss of large mature trees from the landscape. The trend is for these large trees to be replaced with smaller scale plantings, which provide reduced environmental benefits and alter landscape character.

Smaller lot sizes also limit the planting of large growing trees on private land. A typical outcome of urban intensification is reduced permeable spaces and lowered volumes of soil available to support large-growing trees. A minimum of 30 m³ of available soil volume (Leake and Haeger 2014) is necessary to sustain a large growing tree yet the majority of new housing blocks do not reserve anywhere near this amount of unsurfaced outdoor space.

Infill development and street trees

While 'greenfield' development threatens the extent and connectivity of tree cover across all land types, 'infill' development specifically threatens street trees. Sub-division and development, and re-development for dual occupancy/urban intensification can significantly impact the presence and quality of the region's streetscape plantings.

Realignment of existing driveways or the creation of new (additional) accesses is one of the most significant causes of premature removal of street trees in the region. The self-assessable nature of many of the application requirements compounds the problem. Trees that are retained are frequently constrained as an outcome of the resulting reduction in growing space. In worst-case scenarios they are irreparably damaged. Where existing street trees are in direct conflict with the construction envelope, and cannot be replaced in situ, removal of the tree results in the permanent loss of a street tree location.

Increasingly, new infrastructure conditioned for installation in road reserve spaces as an outcome of private land development is causing the loss of, or damage to, existing street trees or future tree planting sites.

This includes footpaths, above or below-ground electrical infrastructure and improved road treatments (kerb and channel for example).

Indirect impacts to planting sites, specifically changes to soil conditions, presents another set of challenges to street tree establishment. Disturbance of road reserve land adjacent to development sites (for access, site storage and other construction-related activities) can have long-term impacts on soils in urban areas. Significant disturbances to soil structure, fertility and moisture regimes (including structured drainage systems removing additional water from the soil) impact the potential establishment of new trees, as well as the health of existing trees.

Soil compaction, which most commonly occurs as a result of heavy equipment moving through a site, is the most common form of construction-related soil damage. Compacted soils have significantly reduced pore spaces (necessary for air flow and water infiltration as well as root extension). Removal of the top soil horizon (the most fertile, friable and biologically active layer of soil where tree roots naturally proliferate) during 'soil stripping' results in direct loss of micro-organisms (that work in symbiosis with tree roots) loss of soil nutrients and reduced water holding capacity of soils. Inversion of soil profiles which often occurs when excavations are backfilled has the same, if not more of an impact. Inverted soils are notorious along the coastal plain of the Sunshine Coast.

Moreover, the incorporation of foreign materials in soil profiles (building rubble or dried concrete slurries for example) also affects soil structure, pH and nutrient availability. Many plants are sensitive to soil pH changes and only function properly within normal ranges. Poor nutrient availability has numerous effects with slow, stunted growth and yellowing foliage common indicators of nutrient deficiencies in plants. Liming of soils can occur as an outcome of concrete leachates (run off) raising soil pH (making soils more alkaline) and affecting tree growth. Conversely, acid wash down of exposed aggregate pathways can lower soil pH (acidifying soil). Disturbance and dispersal of marine clay/acid sulphate soils during excavation work is another risk that must be controlled in many Sunshine Coast landscapes.

With enforced exclusion and general protection of street trees growing adjacent to development sites (see the *Sunshine Coast Open Space Landscape Infrastructure Manual - Preliminaries - General - Site set up including tree protection*), unnecessary damage to street trees and street tree soils as an outcome of infill development losses can be prevented. Other mechanisms to potentially reduce street tree losses as an outcome of infill development are listed in Table 5: *Options for better street tree outcomes adjacent to infill development sites*.

Table 5: Options for better street tree outcomes adjacent to infill development sites

Review documentation and check lists to include triggers for privately certified development assessments to seek referral advice from council officers where street trees are located within a nominal setback/zone of impact.

Explore the potential for existing tree and/or ground protection to be conditioned in development approvals (with no commencement authorised until a council officer signs-off on satisfactory exclusion of tree protection/ground protection zones). Investigate the potential for a nominal fee for tree protection services to be included in development assessment fees and charges to help council resource monitoring of tree protection sites (for more information regarding council's standard tree protection requirements see the *Sunshine Coast Open Space Landscape Infrastructure Manual - Preliminaries - General - Site set up including tree protection*).

Investigate options for all privately certified or council assessed infill development approvals to include street tree planting conditions, or charges for council to plant new trees on the adjacent nature strip on works completion. Such a program could serve to counter-act the visual impacts of development on the region and value-add to the upgraded property. Explore potential for council to charge property developers a nominal 'tree offset' fee where an approval results in the permanent loss of a tree growing site in the adjacent road reserve.

Investigate the potential for conditioning of soil remediation at the completion of works as a part of a development approval (in instances where ground protection cannot occur during construction due to site access requirements or other limitations).

Where the installation of new road reserve infrastructure is to be conditioned as a part of a development approval (for example a new footpath), a referral is made to a suitably qualified council officer to determine whether there will be any street tree impacts as an outcome. Potential conflicts may then be mitigated through tree sensitive design or realignment of the infrastructure before construction.

Greenfield development and street trees

Young tree losses in large-scale housing developments are particularly high and costly to both council and land developers. Prudent maintenance of street trees planted early to enhance land sales is often counter-acted by inadequate protection and death of trees during construction. Many young trees in new residential developments are illegally removed or irreparably damaged during the building process. Young residential estates have a very high proportion of stunted, damaged or missing street trees in general when they should be the thriving urban forests of the future.

This unnecessary waste of plant material could be overcome if developers were to delay soft streetscaping works until the built landscape is complete. A mutually beneficial arrangement whereby council plants and establishes street tree plantings on behalf of developers would allow council to control the quality of planting stock, and amount of maintenance received in order to achieve desired standards and lower long-term maintenance needs. Such an arrangement would benefit developers by transferring the responsibility for stock quality and establishment maintenance to council, as well as removing the need for on/off maintenance inspections and the requirement for developers to replace street trees that have failed or are not worthy of retaining. This has often occurred several times before street trees are considered adequately established or acceptable for handover.

The ever-shrinking spaces for street trees in new housing developments is a more complex problem. The majority of new developments maximise lot yield and provide minimal space for street tree amenity. Small lots of adjoining narrow streets is the typical streetscape formation. These narrower roads have narrower road verges. Coupled with increasing footpath widths, the amount of space available for street trees in modern residential developments has drastically decreased.

Within these retracting spaces there is competition below the road verge with an ever increasing network of pipes and cables including electricity, sewage, water and telecommunications cables. A higher proportion of driveways as an outcome of smaller lot sizes, indented parking to compensate for loss of traditional on street parking options and even bin set down points are other infrastructure elements competing for space in the road verge.

In many recently developed housing estates, space that could have been used to establish feature trees has been used instead for the creation of biopods / water sensitive urban design treatments (WSUDs).

While planning codes may intend for street trees to promote amenity in new residential streetscapes and to be given priority over other infrastructure elements (see *Sunshine Coast Planning Scheme 2014, Part 9: Development codes, 9.4.2 Landscape Code* for example), less space and greater competition in today's multi-use road verges means that many residential developments will simply not have the capacity to support the growth of healthy, large or long-lived street trees.

It is suspected that an adequate tree canopy may fail to establish in many of the local streets of currently under-construction and future residential developments if the situation doesn't change. Accidental or wilful damage to young street trees during construction, or as an outcome of the lack of on-road parking opportunities in these newly emerging estates will account for some establishment failures.

It is more likely however that the majority of trees failing to reach a size where they can provide any measurable benefit to the local community will be directly related to inadequate soil volumes and the basic needs of street trees not being met (especially where the natural soils no longer exist). For a full description of tree growth requirements see the *Sunshine Coast Open Space Landscape Infrastructure Manual - Trees - Overview*.

Trees are often extremely resilient because by nature they are opportunistic. In the absence of opportunity however trees will simply adapt to their growing environment. Root systems in confined spaces without opportunity for natural egress (especially where root barrier is used) will have less biomass and therefore less capacity for water (which drives the processes attributed to growth) and nutrient (also essential to plant growth and development) uptake.

Heavy shading (sunlight is another basic tree growth requirement) as an outcome of higher density living, can further restrict the ability for street trees to thrive.

While little can be done to change the maximum lot yield philosophy in the short-term, ongoing monitoring of street tree development in these newer residential estates is likely to prove the case for more space for street trees over-time.

In the meantime, significant opportunity still exists for new residential estates to make space for some strategically positioned larger growing street trees and some consideration for integrating roadside bioretention with street trees (such as 'Water Smart Street Trees' being trialled in Brisbane). Taking small steps to compensate for the limitations of today's standard residential streetscape layout (with minimal impact to lot yield) will have a significant impact on the extent and quality of tree cover in residential estates in the future.

Purpose-built tree planting sites for larger canopy trees can include nodes at slightly increased intersection setbacks (see Figure 2: *Sketch showing a large canopy tree planted on a truncated corner below*) or mid-block blisters/ build-outs or centre medians, reserving smaller trees for smaller verge spaces.

With appropriate site preparation (soil ripping and amelioration) and design elements (flush kerbs, swale grading and sub-soil drainage) customised centre road medians can also support feature and avenue trees of a scale and quality that will compensate for the limited potential of street trees in standard locations.

Table 6: *Options to secure better street tree outcomes in new residential developments* lists some options to improve street tree outcomes in greenfield development sites for further exploration.

Where larger areas of garden bed / deep soils simply cannot be preserved or created due to competing demands for the space, permeable surface treatments (that better provide for root growth beneath) or alternative methods of extending spaces for root growth can be employed (see the *Sunshine Coast Open Space Landscape Infrastructure Manual - Vegetation management* for further information).

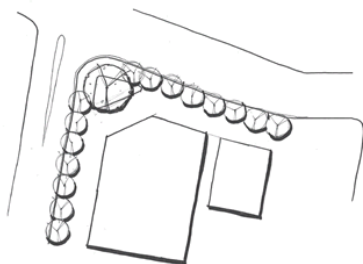


Figure 2: Sketch showing a large canopy tree planted on a truncated corner.

Table 6: Options to secure better street tree outcomes in new residential developments

Investigate the potential for council to deliver street tree planting in new housing estates on behalf of the developer (via developer contributions) at construction completion to avoid tree removal or damage during construction. Provide opportunity under such a system for developers to plant fast growing temporary trees if desired (for example pioneer species such as *Macaranga tanarius* or a nitrogen fixing species such as those belonging to the genus *Acacia*) to assist with land sales.

Encourage the incorporation of customised planting spaces or large canopy tree nodes to accommodate feature or boulevard trees in all new residential streetscapes. These include creating enlarged spaces on the corners of intersections (truncated intersections), mid block cluster or build-out style planting sites, and creating deep soil zones in roundabouts and median strips. Best horticultural practice should be used to create optimum conditions for tree growth within these purpose built planting sites (including soils, drainage and passive watering).

Embed tree sensitive design practices into new development, including soil preparation methods and treatments that extend zones of potential root growth (for example the creation of root trenches within the road verge) (see *Sunshine Coast Open Space Landscape Infrastructure Manual - Vegetation management* for further information).

Integrate water sensitive urban design treatments (WSUDs) with streetscape planting to deliver both storm water management and spaces for healthy tree growth, rather than single purpose large scale retention basins.

Monitor and document street tree development in standard verge spaces of new residential developments.

Amend drawings in applicable Planning Scheme codes (via formal Planning Scheme amendments) to show increased minimum road widths in local streets.

Prepare a Planning Scheme amendment to recognise the *Draft Sunshine Coast Street Tree Master Plan* once adopted by council.

Careful consideration should be given to the use of artificial soil environments (root cells for example) that may become sterile/devoid of nutrients over-time. Engineered spaces beneath pavements, such as structural cells or tree vaults, allow for root extension, however offer no potential for replenishment of soil media. Organic content of the filler soil in engineered spaces needs to be low to avoid shrinkage of soils following break-down of organic content. If filler soils are too sandy and the required cation exchange capacity (clay content) cannot be achieved, the trees may become nutrient deficient over time requiring ongoing manual applications of liquid fertiliser. Additional watering of engineered spaces may also be necessary during prolonged drought. Council is committed to ongoing trials of such systems, especially in conjunction with development in urban business centres.

Careful consideration should also be given to the routine installation of root barrier as a part of bulk street tree planting works (See *Sunshine Coast Open Space Landscape Infrastructure Manual - Embellishments - Planting*). Root barrier should never completely encircle a planting site unless it is especially large. Root deflector which directs tree root growth lower into the soil profile is preferred by council.

Future directions

A co-ordinated approach to canopy building on public land to off-set the unavoidable loss of trees in urban areas is critical if the existing level of benefits is to be sustained into the future.

Increased tree planting will also help screen and soften the impacts of the ever-expanding built environment on the region.

Appropriate sites for large canopy trees should continue to be secured. Existing road reserve sites where ample soil volume still exists and no apparent conflicts or competition for use of the space, are considered high priority locations for the planting of new street trees.

Making space for large canopy trees in all future housing estates and redeveloped streetscapes is also critical – including at intersections, within roundabouts and centre medians.

The planting of large canopy trees in local park locations where they can contribute to the amenity of residential streetscapes should also be considered. Compact trees should provide visual relief where existing spaces simply don't afford establishment of larger specimens with large canopy trees to be planted in nearby parks, community facilities, medians, and at intersections.

Short, medium and long-term analysis of street tree development in maximum lot yield residential developments should be commenced.

Mechanisms to ensure no unnecessary loss of existing trees or damage to soils and tree planting sites occurs as an outcome of development should be explored including surveys and tree protection plans for worthy existing trees, enforceable TPZs (tree protection zones) and the requirement for road reserve protection bonds.

Recommendations

Identify opportunities for the planting of new street trees and prioritise protection of existing street trees in the high growth Sunshine Coast *Enterprise Growth Corridor*.

Secure sites where large growing trees will provide the greatest benefits in the future, and potential for future conflict is low, for the planting of new street trees. Priority sites for investigation include the interface of streetscapes and local parks and council managed community facilities.

Encourage 'Tree sensitive design' including:

- the use of tree planting nodes to accommodate large canopy trees in high density residential areas where larger trees would make a significant landscape contribution and standard verge spaces are insufficient
- mechanisms to improve tree retention rates and protection of existing street trees adjacent to development sites by embedding tree protection planning into the development approval process
- alternative street design treatments to reverse the proliferation of narrowing verge widths, relaxation of building setbacks and competing interests for above and below ground road reserve space.

Analyse street tree development in local streets of new residential estates to develop an evidence base for the case for more spaces for street trees.

Encourage Sunshine Coast residents to plant large growing trees on private land to help sustain the region's urban forest.



"There's a growing body of evidence suggesting that the inclusion of trees and other streetscape features in the roadside environment may actually reduce crashes and injuries on urban roadways" (Nadeiri 2003). The author examined the safety impacts of aesthetic streetscape enhancements placed along the roadside and medians of five arterial roadways in downtown Toronto. Using a quasi-experimental design, the author found that the inclusion of features such as trees and concrete planters along the roadside resulted in statistically significant reductions in the number of mid-block crashes along all five roadways, with the number of crashes decreasing from between 5 and 20 percent as a result of the streetscape improvements. The author concluded that the presence of a well-defined roadside edge may lead drivers to exercise greater caution.



Major infrastructure

Existing transport networks

There are 3,343 kilometres of sealed and unsealed roads with the Sunshine Coast LGA. A total of 372 kilometres (12%) are state controlled (declared under Section 24 of the *Transport Infrastructure Act 1994*) and managed by the Department of Transport and Main Roads (DTMR). The Sunshine Coast Council manages a balance of 2,971 kilometres (88%) of roads, 601 kilometres of which are currently unsealed.

Constraints to the establishment of street trees in designated road reserves largely depend on who controls the road (state or council), and are primarily based on road safety.

Clear zones and frangibility

Provision for adequate line of sight, sight distance to signs and CPTED (Crime Prevention Through Environmental Design) principles for passive surveillance and street lighting, are some of the factors that affect the presence and positioning of street trees on major road corridors. Where roads are high speed, clear zones (the distance from the edge of the road carriage that must remain clear of fixed infrastructure in the event of a vehicle coming off the road) or frangible vegetation (vegetation that does not impede the impact of a vehicle) requirements also apply. Most tree species cannot be classified as frangible.

While it has been suggested that the presence of trees may encourage safer driver behaviour where clear zone requirements apply, planting trees behind safety barriers (guard rail) is the only option available to establishing trees (as opposed to shrubs) on major transport corridors).

The median strip in a lengthy section of Caloundra Road, the major gateway to the southern Sunshine Coast, for example is surrounded by guard rail. A significant opportunity for establishment of a gateway planting in this location may exist. This and other potential opportunities to work within clear zone limitations and increase amenity in such locations will be examined further.

State Controlled Roads and new tree planting

While only 12% of the potential space available to grow street trees within road reserve is under state control, the extent and quality of plantings in these high profile locations has a significant impact on Sunshine Coast amenity.

Survey work undertaken as a part of the development of this plan suggests that a good proportion of currently vacant, priority planting locations (high visibility, deep planting zones - see the *Strategic directions* section of the plan for further detail) occur on the region's major thoroughfares, most of which are managed by the state (DTMR) with varying levels of road safety constraint.

Some of these low tree occupancy rates can be attributed to road safety requirements. A number of these vacant sites however may simply reflect the difficulties council faces when attempting to plant or protect trees located in areas under formal state control. Or in the case of previously existing trees, limited budgets for tree replacement in state managed programs.

While the safety of road users is the top priority for council, considerable loss of amenity will continue to occur along our major thoroughfares if street trees are not renewed in extensive sections of vacant road reserve on state managed roads.

Future transport networks

New transport infrastructure priorities for the region are centred around inter-linking and connecting new population growth areas. The *South East Queensland Regional Plan 2009-2031* identifies three priorities for the provision of new public transport (rail) networks:

- Beerwah and the region's coastal activity centres
- Caloundra and Maroochydore
- Palmview and the Sunshine Coast University and Kawana Hospital precincts.

The *Sunshine Coast Planning Scheme 2014 Strategic Framework Map 1 Land Use Elements* presents these priority transit corridor as the *Maroochydore to Caloundra Priority Transport Corridor* (light rail) and the *Dedicated Public Transport Corridor (CAMCOS)* as well as identifying future transit hubs.

The Beerwah-Coastal connection including Kawana and Sippy Downs) is planned to be addressed through a new heavy rail line offshoot at Beerwah (linking Beerwah, Caloundra South, Caloundra and Kawana). New sections of rail line will have minimal impact on existing street tree networks as the transport corridor exists mostly outside of the street tree network. Locations where the rail line is to be duplicated however will impact existing street trees and the potential for planting new trees in the meantime. Proposed transit hubs may also impact the potential for street tree establishment in some of these areas.

Priority links between Caloundra and Maroochydore are planned to be addressed through a light rail network. Route options for this network are currently under investigation with the preferred route encompassing Nicklin Way, Brisbane Road and Aerodrome Road.

Street tree plantings in areas of potential conflict with the preferred light rail alignment should be postponed in the short term and integrated into the project once plans have been finalised.

Future directions

Council should strengthen relations with the Department of Transport and Main Roads (DTMR) the body governing control of State managed roads to discuss:

- opportunities for street trees plantings in currently vacant, high profile locations
- potential for new maintenance agreements for council to plant and maintain desired street tree plantings in key locations on DTMR controlled roads
- opportunities for the establishment of trees behind key sections of existing guard rail on distributor and collector roads.

Recommendations

Ensure tree planting programs are compatible with the requirements of future transport networks and major projects.

Continue to work with internal and external partners to better balance road safety needs with town and streetscape amenity.

Ensure new street trees are integrated in place making and urban renewal projects, infrastructure upgrades and expansion of networks.

Develop and strengthen partnerships to ensure street tree planting, major projects and/or infrastructure upgrades occur simultaneously.

Identify potential tree planting nodes on major arterial roads and connections and negotiate council managed maintenance agreements for the establishment of new vegetation in high profile areas.

Explore options for the placement of trees behind existing guard rail and the installation of new lengths of guard rail to facilitate safe tree establishment in high speed environments where tree benefits may be required.



Competition for space

Trees must share what is typically very limited space within the road reserve with many other infrastructure elements. Power poles, overhead wires, street lights and signs present some of the above-ground challenges to new tree establishment. Water, sewerage, underground power and telecommunication conduits present below ground challenges.

Added to these challenges are new infrastructure projects and ongoing programs of renewal. Expansion of the existing footpath network, road widening, kerb and channel with other drainage works, new cycle lanes, crossings, pram ramps, intersection works, indented parking, upgraded infrastructure for access and inclusion (for example bus stop upgrades) are just some of the activities that can both threaten existing road reserve trees and impact on the potential establishment of new trees. Where road reserve interfaces with coastal infrastructure, street trees may also be impacted by construction or renewal of revetment walls, seawalls, groyne erosion control and beach access structures.

However amongst these many constraints for space, there are opportunities to integrate new street tree planting with infrastructure installation and renewal.

Footpaths

New footpath installation programs present excellent opportunities for streetscape renewal and infill or extension of existing street tree plantings in local streets. Strengthening general comfort and sun protection along the region's major pedestrian routes with shade tree plantings is in-line with council's vision to "get people out of cars and into more sustainable modes of transport (*Sunshine Coast Active Transport Plan 2011-2031*)."

Shading pathway networks along routes to local parks or between recreation facilities may also encourage local residents to use active transport to visit these places (i.e. people may chose to walk to a park rather than drive if the route is shaded). The *Sunshine Coast Planning Scheme 2014* (see *Sunshine Coast Planning Scheme 2014, Part 9: Development codes, 9.4.2 Landscape Code*) directs developers to provide unbroken shade to footpaths (where a development is assessable under the code) by planting trees at 6 m intervals.

Pedestrians have been reported to perceive themselves to be safer when trees form a protective barrier between the pathway and road corridor. Motorists have been shown to exercise more caution where trees delineate the road carriageway from adjacent pedestrian zones (Naderi 2003).

Opportunities for planting future street trees can be lost when footpath widening or installation works fail to retain sufficient space for future tree establishment between the back of kerb and footpath edge. Street trees generally require less maintenance over their lifetime when planted in the section of road verge between the back of kerb and footpath edge. Where set backs are narrow, street trees positioned between the footpath and property boundary are likely to require future property overhang pruning works. There's also a greater potential for conflict with underground services (often located nearer to the property boundary) or private property. In many cases minor pathway realignment or incorporation of designated planting sites through local narrowing/scalloping of pathways can make a world of difference to the potential for a tree to establish and shade the pathway in the future.

One of the key challenges with respect to planting trees in conjunction with footpath works is safeguarding the infrastructure from future tree root damage. While ensuring adequate provision of space for both trees and essential infrastructure is the easiest way to reduce future conflicts, increasingly this is becoming impractical.

Trees are living biological systems that require light, oxygen and water – as well as sufficient above and below ground space – for growth and development. When space for root growth is limited, and conditions conducive to root growth are created below or in close proximity to infrastructure, damage often occurs. Tree roots travel the path of least resistance and gravitate toward moisture gradients. Moist areas created as a result of condensation at the interface of the soil layer and traditional footpath slab for example, provide an ideal environment for tree root growth.

The likelihood of new trees causing damage to adjacent infrastructure is an outcome of factors such as the:

- existing conditions of the site
- available soil volume for tree growth
- distance between the footpath and new tree
- species of tree for planting and inherent characteristics
- size of trees on maturity (large growing trees are generally more likely to cause pathway damage and fast growing trees will generally cause more damage in a shorter period of time)
- watering methods and cycles (frequent shallow watering will encourage root growth nearer to the surface while deep irrigation will encourage roots to stay deeper in the soil profile).

Soil type (clay soils, shallow top soil profile with hard pan beneath for example will encourage root growth nearer to the surface). Selecting trees that will remain small and compact through their lifetime is one option to address this issue. 'Tree sensitive design' is another. The *Sunshine Coast Open Space Landscape Infrastructure Manual* (see the *Vegetation management* section) details some of the factors that lead tree root growth in the direction of hard surfaces, and provides guidance for designing treatments and spaces compatible with trees. The manual also details how to protect existing trees from construction damage. This is naturally the most sustainable approach to delivering new infrastructure in locations where trees already exist.

Table 7: *Treatments to minimise tree damage to footpaths* lists some of the treatments available to support tree root growth while minimising the risk of damage occurring in the future.

**Table 7:
Treatments to minimise tree damage to footpaths**

Construct pathways with thicker concrete and extra reinforcing to combat the force of root heave and prevent lifting of the pathway surface.
Include specialised trip prevention treatments in pathways.
Undertake tree root trenching parallel to the footpath to create a preferred path of travel for tree roots thereby encouraging root extension parallel to the footpath rather than underneath it.
Create structured tree root pathways below footpaths to areas of greater soil volume beyond (for example within the sub base 100 mm wide by 300 mm deep).
Irrigate where roots are wanted, compact soils where they are not wanted.
Use permeable surface treatments (that do not create a condensation layer beneath) and aggregate bedding layers below non-permeable treatments to encourage roots to stay deeper in the soil profile.
Install root cells within or adjacent to the planting site (where appropriate) and incorporate root deflectors (where appropriate).
Locally reduce width or realign pathways where possible to accommodate future street trees.



Electrical infrastructure

The electrical infrastructure network presents many challenges to tree establishment. Services located both above and below-ground severely limit the space available for growing trees. Management of the required clearances between lines and vegetation reduces the level of environmental and visual benefits trees are able to provide in these locations, if trees are present at all.

While power is installed underground in new developments, a significant above-ground network remains elsewhere which detracts from the overall amenity of our streets and towns. Establishing new trees beneath overhead wires is complex, as the necessary maintenance of required clearances (to avoid outages and service disruption) is the responsibility of the energy provider and a significant financial burden.

Vegetation clearance pruning programs also present a significant threat to the long term viability and useful life expectancies of existing trees with structural integrity compromised by lopping or pruning works outside of the acceptable realms of modern pruning. Power companies do not wish to perpetuate a network of sizeable trees under over-head wires, an understandable position, but with limited funds available for the high cost of under-grounding power in established urban areas (where greening is needed the most) council must often forgo the opportunity establish new trees where overhead wires are present. This is a poor outcome for council and our community, as power poles and naked wires are infrastructure elements that could benefit from visual screening or softening.

A memorandum of understanding (MOU) between Energex and Sunshine Coast Council has been established which document the needs and obligations of each party with regard to vegetation management. A commitment to resolving areas of conflict by both parties is expressed within the MOU. Strategies for reducing conflict between tree canopies and electrical infrastructure including cost-sharing for reconfiguration of the network where high-value trees grow are described.

There are several options available to council where required tree benefits cannot be fully realised as an outcome of existing overhead infrastructure in place including:

- under-grounding power is the most expensive option. The appropriateness as well as availability of funding for this purpose is a key consideration. Trenching for underground power may also impact on existing trees and the potential for this needs to be considered when exploring options for minimising conflicts between vegetation and the electrical services network
- the replacement of traditional overhead spanned structures with aerial bundled cables (ABC) reduces the clearance requirement significantly. Young trees can be formatively pruned so that clearance pruning does not destroy future form or function
- re-routing or relocating spans of the network to move away from planting sites where there is a need for trees to provide benefits (for example shading of a major pedestrian route in an area identified as vulnerable) is another option
- raising power poles or tensioning slack wires may be possible in some circumstances, allowing more room for a tree of a standard size to growth beneath. Sleeving or insulating wires (for example service to property wires) to prevent the need for maintenance of any clearances is another potential solution
- the establishment of council managed clearance or formative pruning programs for selected new plantings, where council has established a need for vegetation (of an appropriate scale) in areas where overhead power lines exist.

The MOU states that the tree selection options as listed in *Table 8: Tree selection options to avoid tree-electrical infrastructure conflicts* should be explored to avoid future conflicts. Increasing planting densities may also effectively compensate for the lack of vertical scale provided by vegetation beneath wires.

**Table 8:
Tree selection options to avoid tree–
electrical infrastructure conflicts**

Select trees that are small sized on maturity (in some situations large shrubs may be suitable) or normally crown below the height of the low voltage wires (tree species with weeping habits for example).

Select trees that are slow growing so that mature dimensions are not reached for many years and/or the specimen reaches its useful life expectancy prior to conflict with overhead wires.

Select trees that have a de-current (without a clear leading stem) or multi-branched structure which are more tolerant of directional pruning or can be effectively shaped, in early growth stages, through formative programs to minimise future conflict with overhead services. For example *Melaleuca* (paperbark) or *Leptospermum* (tea tree).

Select trees that exhibit a framework of fine branching and are therefore tolerant of hedge type pruning undertaken at a higher frequency, such as *Syzygium* (lilly pillly).

Reduce planting centres (from 6-8 m to 3 to 5 m for example) when using smaller trees to compensate for loss of vertical scale.



Service compounds

Pump stations and similar land parcels or compounds annexed for the purpose of service provision offer some potential for the establishment of trees to both build tree canopy, and screen unsightly structures. Potential locations for the establishment of low conflict plantings in such spaces warrants further investigation.

Solar collectors

With battery technology improving all the time, a much higher proportion of energy is likely to be generated by solar collectors in the future. Street tree planting placement is already respectful of the presence of solar panels within adjacent properties with council electing to be a good neighbour and not position trees in a manner that may reduce the efficacy of solar collectors as a tree matures. Trees however are also solar collectors, and their role in carbon sequestration and mitigating heat in urban areas is critical and will become even more so as time goes on. It should be noted therefore that the placement of future solar panels, especially large scale urban installations, will need to appropriately consider potential impacts to existing or future street tree infrastructure.

Future directions

Council's Parks and Gardens Branch will continue to work closely with internal and external partners to ensure new and existing trees are integrated into all future footpath programs.

Tree-infrastructure conflicts are reduced over time with larger trees reserved for larger planting sites (purpose built if necessary) and compact street tree species used for standard verge spaces within the local street network.

Sensitive footpath design treatments including up-scaled reinforcement and specialised dowel joints are used wherever possible to allow for larger growing trees to be planted alongside footpaths in priority sites (such as high use pedestrian routes and bikeways as well as significant links between town centres, parks and community facilities to take the pressure off roads).

Council will continue to work with Energex to ensure compatibility of electrical infrastructure and trees. Such initiatives for better outcomes to be explored include identification of sections of the network for under grounding or conversion to ABC wires and partnerships between council and Energex to establish shade tree plantings in alternative locations to compensate for the limitations of other sites.

Opportunities to plant large growing trees in suitable locations within service compounds (pump stations and mobile phone towers on council land leased to service providers for example) to both build canopy and mask what is often unattractive infrastructure are explored.

The foreseeable impacts of future large scale solar panel installation on existing and future street trees is properly considered and strategies to reduce impacts devised.

The case for street trees (in urban environments especially) continues to be strongly communicated.

Recommendations

Pro-actively plant trees to provide shade to all key pedestrian networks. Plant trees in conjunction with new footpath works wherever possible to create shadier pedestrian networks.

Select trees with a compact form for planting near existing or new infrastructure and where verge space is limited.

Ensure sufficient verge width remains between the road and footpath edge to accommodate existing or future trees.

Utilise specialised treatments and pathway alignments to accommodate existing or future street trees.

Continue to work in partnership with Energex to ensure that risks to the network remain low, while striving to achieve a better balance between streetscape amenity and electrical infrastructure networks.

Select appropriate trees for planting beneath wires and incorporate five year formative pruning programs into operational programs where appropriate.

Collect data on sites and service easements where canopy building can occur without conflict.

Consider how future street trees can best be addressed when exponential increases in solar collector installations occur.

Existing views

The region's scenic amenity helps make the Sunshine Coast an outstanding place to 'live, work, invest and play'. Coastal and hinterland views however present considerable challenges to creating and sustaining street tree cover.

The value of the Sunshine Coast's scenic amenity is detailed in the *Sunshine Coast Planning Scheme 2014* and 'significant views' for preservation as an outcome of development are presented in the *Local plan codes* associated *Local Plan Elements* maps (see Part 7: *Local plans*, 7.2 *Local plan codes*).

The vast majority of the region's views and vistas (from both public and private locations) are not documented. Patterns of change in the extent of vegetation framing view lines, and hierarchies of view importance (considering the quality, setting, accessibility and visitation for example) are also largely unknown.

Sustaining vegetation cover in our esplanade locations is extremely difficult. While council has resolved not to position trees in a manner that may restrict scenic amenity, many of our streets that interface with foreshores suffer from lack of re-invigoration, with decline of many even-aged tree stands. New and even replacement tree planting in many of these locations has simply not occurred on account of the expectations of existing and/or pre-existing views.

These environments comprise some of the highest visitation and use in the region, and the amenity offered by mature trees at the street-level is also a key factor for consideration. Moreover, vegetation often plays a critical role in erosion or sand-blow protection in coastal environments.

Our foreshore streetscapes are some of the most difficult environments to establish new trees, with exposure and vandalism compounding view-line challenges. Lack of natural recruitment solidifies the unsustainable nature of the situation at present.

The dune vegetation from Alexandra Headland through to Cotton Tree for example, is in a clear state of decline.

While council is committed to taking a cautious and site responsive approach to the planting and management of street trees in locations where scenic amenity (both coastal and hinterland) may be threatened, further work is required to establish a hierarchy of values and community priorities with regard to both public and private scenic amenity.

Future directions

Every effort should be made to ensure that new trees are positioned with respect to the preservation of existing public and private views. In relation to distant views, a wider program of consultation should be undertaken before new street trees are planted.

Replacement trees should be returned to the exact location of the previously existing tree in areas where new trees may impede existing open views as they develop. In the case of the installation of critical coastal infrastructure, this may not always be possible. In these situations replacement trees should be planted as near to the previous location as possible, with respect to the preservation of existing views. Replacement trees should be planted as soon as practically possible to avoid the development of personal attachment to the creation of temporary views.

Opportunities to proactively plant succession trees inside existing informal clumps and stands of trees in streets that intersect with foreshores (and do not currently afford views to the water) should be explored further.

The potential for mapping existing tree canopy extents in and around the region's major public view points to allow the development of vegetation management plans in consultation with the community should also be investigated.

Recommendations

Ensure new tree plantings are located in a manner that is respectful of the preservation of existing views.

Consult with all relevant parties when creating shade and amenity in foreshores or locations where coastal or hinterland views may exist.

Explore the potential to map existing vegetation/tree canopy extents in and around public view points and view-sheds and develop vegetation management plans in consultation with the community. Plan for succession tree plantings outside of agreed view sheds.

Investigate causes of decline in vegetation and factors impacting recruitment of new trees at the streetscape-foreshore interface areas in a visible state of decline between Cotton Tree and Mooloolaba.



Tree supply, monitoring and maintenance

The availability and quality of nursery stock

To achieve the vision of the *Draft Sunshine Coast Street Tree Master Plan* to 'protect, sustain and enhance the region's street tree network' and 'plant more of the right trees in the right locations', the supply of quality advanced tree stock that can keep pace with demand is required.

Growing trees with properly developed root systems capable of providing sufficient structural support and nourishment requires technical precision. Seedlings develop quickly in our sub-tropical climate and if not potted-on at the right time, will often not recover the required root system health and structure to either survive initial planting shock, be self-supporting or achieve the required vigour for a long and healthy life.

An Australian Standard (*AS 2303-2015 Tree stock for landscape use*) guides selection of tree stock for landscape use. This standard forms the basis of selecting trees of an acceptable quality for landscape plantings. Species substitutions are increasingly being made as an outcome of stock of the chosen species, selected for the characteristics of a specific site, not meeting the standard. The outcome is often unsuccessful, especially where substitute species do not match the growing conditions of the subject site.

There has also long been a supply and demand short-fall with regard to less commonly used tree species. Many of the region's indigenous species that may be selected based on their suitability for a site are simply unavailable through external tree supply networks. With tight delivery time frames for most capital work projects, there are usually insufficient lead times for purpose or custom grown tree stock of the preferred species to be developed. Again, species substitution is frequently the outcome which sees plants that are not suited to the specific conditions of the planting site utilised, with a less than satisfactory outcome.

Reactivation of council's nursery

Council has recently identified significant opportunity to grow quality stock of desired species via re-activation of its internal operational nursery, with the goal of supplying trees for operational and future capital programs. Programs aim to produce high quality specimens of Sunshine Coast signature local native and commonly used species as well as making desirable but elusive native and exotic tree species available for wider use. It is hoped that reactivation of council's nursery will also promote the use of high quality nursery trees in all Sunshine Coast landscapes, raising awareness of the fundamental influence of stock quality on the appearance, resilience, longevity and short, medium and long-term maintenance requirements of street and park trees.

Council's nursery also has the capacity to produce appropriate species to provide free shade trees to local residents and encourage planting of large growing trees on private land.

Young street tree maintenance

Newly planted trees require care and a schedule of maintenance for initial survival and ongoing growth and development. Advanced trees of the standard 45 litre size generally take one to two years to establish post planting. Without proper early care, many young trees fail to establish. Insufficient maintenance during the establishment phase of a tree is one of the leading causes of early tree loss.

The currently limited operational programs of young tree maintenance, as well as insufficient duration of contractor 'on maintenance' periods for street trees planted as a part of capital programs and in new residential developments are evident across the Sunshine Coast.

The quality of the tree at the outset, planting technique used, and general care and attention provided in the first year of development is strongly linked to the health, vigour and form of the tree in the future. A tree that struggles through establishment either as an outcome of a poorly developed root system at the time of planting, or lack of care during establishment, may die before it is able to support itself, or have a high maintenance requirement throughout its lifetime.

The cost of ensuring young trees receive frequent watering and mulching (and the application of soil stimulants or fertiliser where necessary) during the critical first year of life is significant, and well above the purchasing and planting costs. Council has found that where residents specifically request the planting of a tree adjacent to their property and agree to help care for it in the early stages of its life, the tree has a far greater chance of successful establishment. Such programs of stewardship also significantly reduce maintenance costs allowing redirection of funds to plant more trees in more places.

Council has also found that where trees are planted as a part of a contract arrangement, establishment success rates are much higher where there is at least a 12 month maintenance period associated with the plantings. Success is also greater where contract documents specifically detail the frequency of maintenance visits required.



Tracking 'no net loss'

The environmental, aesthetic, social and economic benefits provided by an individual street tree (either open-grown or forming a part of a group or avenue planting) is lost when removed without replacement.

Streets trees lost from locations where they play a critical role as a part of an intricate urban ecosystem can have a significant impact on the functioning of the ecosystem and the plants, animals, insects and micro-organisms relying on complex symbiotic relationships and natural balance for their very survival.

'No net loss' in the existing population of trees on council controlled land in the Sunshine Coast Council region is one of the guiding principles of the *Draft Tree and Native Vegetation Management Strategic Policy* (Council controlled land - adopted in principle October 2014). Despite systems of tracking replacement trees or tree offset requirements as a part of operational and capital programs, collating an inventory of all required tree replacements to achieve a 'no net loss' is difficult.

Historically, there has been little success tracking council's performance with regard to replacement tree planting works. New systems of capturing data relating to all new street tree plantings delivered operationally are now in place, with plans to add new plantings delivered as an outcome of capital works programs to the dataset at the end of the contractor maintenance period.

Council strives to ensure all trees removed as an outcome of natural attrition, damage, construction or maintenance of critical infrastructure; are replaced at a minimum ratio of 'one for one'. Vegetation of high retention value is offset according to council's 'no net canopy loss' formula which requires replacement tree numbers whose growth in three years would replace the canopy area of the high value tree(s). Tree removal due to poor condition is frequently site related (soils, drainage, exposure, conflict, damage, potential risk). In the case of the installation of critical infrastructure for example, trees cannot always be returned to the same planting location and should be planted as close as possible nearby to retain the functional value of the original trees.

Succession/recruitment planting programs

The currently limited operational program of proactive tree planting is also evident in the existing street tree network of the Sunshine Coast, specifically the planting of succession trees to key open space–streetscape interfaces.

Foreshore landscapes of principally an amenity rather than conservation function, are high priorities for recruitment planting so that much needed shade and visual amenity can be sustained in these areas for future generations.

Future directions

Poor plant establishment rates and high young tree maintenance costs can be reduced with improved planting stock quality, availability of species suited to the specific conditions of the subject planting site, using improved systems of recording and monitoring new tree plantings (in capital and operational programs as well as new residential developments), scheduled maintenance of young trees for longer periods, and the establishment of community and corporate partnerships to help care for young trees.

Activation of council's internal nursery is a positive step towards ensuring quality trees are grown, including those species that have been difficult to obtain, but offer great potential for the region.

Improved systems of tracking of all newly planted trees allow council to better track its total 'no net loss' target and also allow analysis of condition and survival rates across a variety of site conditions, planting types and priority planting locations.

A pro-active planting program for streetscape–foreshore interfaces will be scoped in conjunction with public viewpoint / view shed analysis and community consultation.

The development of formal programs of street tree stewardship / 'Adopt a street tree' should be explored.

Proactive maintenance programs for revisiting young street trees will be investigated to help ensure that the Sunshine Coast's street tree population is stronger and healthier in the future.



Recommendations

Produce a higher volume of street trees through council's nursery. Grow alternative species identified for wider use or trial plantings and desired species that are generally unavailable through standard tree supply networks.

Encourage production of quality trees through external supply networks from leading by example. Promote council's preferred street tree species lists to encourage local suppliers to grow a wider range of street tree species.

Expand council's free tree program to provide a free tree of an appropriate species to all receptive local residents in order to enhance the region's urban forest.

Ensure young tree maintenance programs of a sufficient duration and frequency are contractually secured, monitored and audited. Explore the potential for council to deliver street tree planting and maintenance in development sites via a developer contribution system.

Form partnerships with the community and corporate sector to care for or provide support for new tree plantings in the development of 'Adopt a street tree' planting programs. Prioritise programs for local streets with low canopy cover and a high capacity for planting where local residents indicate they will assist.

Monitor existing tree cover over-time to track council's performance in sustaining the existing street tree network.

Expand council's centralised system of data capture to incorporate all new tree plantings in the region.

Continue to ensure that every tree removed is replaced at 'no net loss' and 'no net canopy area loss' for high-retention value trees.

Species selection and community preference

Food trees as street trees

A desire for the planting of fruit trees in standard road reserve spaces is evident in some of the Sunshine Coast's local communities. Fruit trees can cause significant slip-hazards if fruits fall onto hard surfaces before they are harvested. Many varieties also exhibit thorns or spines which may compromise pedestrian safety.

Council is committed to establishing nature strip trees in local streets that are compatible with the wishes of local residents (see *Strategic Directions: Adopt a street tree planting programs*) however equitable and safe access and the proper control and management of potential risks takes precedence. Maintenance which is funded by the entire region's ratepayers is also significantly higher with these types of plantings requiring a greater frequency of pruning and watering, netting of fruits, removal of shoots below grafts and so fourth.

Council is also conscious of the creation of fruit tree plantings in spaces where street trees are traditionally grown impacting the potential for the many visual and environmental benefits of street trees as outlined in this plan (shade, cooling, carbon sequestration, storm water load reduction for example - see *Context - Trees in the urban landscape - The benefits of trees*) to be achieved. Popular fruit producing plants (lemons for example) are generally small and spreading or at least very slow growing if they are able to reach a size where they can provide a measurable visual or environmental benefit.

Council's preference is for edible tree plantings to be established inside council's many community gardens where public spaces for the community to grow food plants have already been designated.

The process and criteria for obtaining council permission for the planting of these types of verge gardens is outside of the scope of this plan however a permit process for planting low-growing edible plantings in street verges is currently under development..

Future directions

Council should explore other initiatives that could potentially contribute to edible gardening, such as the development of an 'Adopt a street tree' program option where street tree species encourage the presence of pollinators (to assist residents with gardening for food in their own properties). For example, bee attracting bottlebrush type species (*Callistemon* sp, *Melaleuca* sp) or ivory curl (*Buckinghamia celcissima*).

Opportunities for the establishment of fruit trees in local parks (to be cared for in partnership with the local community) or within town squares of major centres and precinct areas where a higher level of monitoring and frequency of maintenance is provided should also be explored.

Flying foxes and street tree species

Flying foxes are attracted to trees that produce soft fruits or flowers containing a high concentration of nectar. Trees that develop white or yellow flowers on the ends of branches and can be readily seen at night are particularly attractive.

The palette of preferred foraging trees for bats includes figs, palms, lilly pillys, paperbarks, bottle brushes, grevilleas, most eucalypts and coastal banksias. Flying foxes are nocturnal and travel significant distances to forage therefore avoiding the planting of desirable foraging trees is neither practical nor effective in keeping flying foxes out of certain areas despite council's aspiration to reduce their presence and impact in urban residential areas.

Flying foxes do however cause significant concern for a number of local communities directly affected by their presence.

Risks of additional foraging time or spill-over of roosts into surrounding streets can be reduced through thoughtful street tree species selection in these areas.

Urban roosts of concern in the Sunshine Coast Council region are located in Coolum, Maroochydore, Mooloolaba, Moffat Beach, Landsborough and Palmwoods.

Future directions

Street tree selection strategies to avoid expanding existing roosts into surrounding urban residential streetscapes should be detailed in local *Street Tree Planting Strategies* for each of the localities with significant flying fox roosts.

A list of street tree species that are not preferred foraging food for flying foxes (including conifers with inconspicuous or no flowers or fruits and low nectar producing flowers) should be developed for use in high risk locations.

The planting of avenues and species that form closed canopies should also be avoided in these areas.

Recommendations

Canvas interest in council's 'Adopt a street tree' program through consultation with the Sunshine Coast community.

Consider the use of fruit trees in appropriate sites in major centre upgrades (town squares for example) or in the local park network as a part of community partnerships.

Develop a non-preferred foraging plant list for street tree planting in high risk areas (near existing flying fox roosts).

Develop local street tree planting strategies for flying fox affected localities.





Analysis

This section of the *Draft Sunshine Coast Street Tree Master Plan* details analysis of the Sunshine Coast's vegetation cover, in particular the existing street tree network, to help identify street tree planting priorities for the region.

Vegetation mapping

Assessment of the extent of vegetation cover across the urban footprint and rural townships of the Sunshine Coast Council LGA (as at 2014) was undertaken using the Sunshine Coast Council's existing LiDAR derived dataset for analysis. Multi-spectral imagery was used to evaluate patterns of change in vegetation cover in the region over the past ten years (see the plan's *Appendix* for detailed methodology and results).

Study area

The study area includes the entire Sunshine Coast Council LGA (Local Government Area). This encompasses the 2,291 square kilometres of land from Emu Mountain in the north to Beerburrum in the south, and as far west as Conondale (see *Figure 2: LiDAR generated map of Sunshine Coast Council LGA*).

Local study areas follow the *Local plan area* (LPA) urban land area divisions established in the *Sunshine Coast Planning Scheme 2014* (see *Part 7: Local plans, 7.2 Local plan codes*). These LPA s include urban landscapes and rural town centres of the Sunshine Coast Council region and are shown in *Figure 4: Map of Sunshine Coast Council region Local Plan Areas (LPAs)*.

Areas of the region that fall outside of these LPA divisions are generally located within the rural landscape and are not immediately applicable to this plan. These areas are however addressed within the local *Street Tree Planting Strategies* developed for each area (*Part B* of the plan).

Summary of statistical methods

LiDAR mapping data captured in 2014 was used to generate statistics surrounding the coverage and structure of vegetation across the whole Sunshine Coast Council region, allowing for comparison with available data from other LGAs across Australia. More detailed assessment within the Sunshine Coast Council LGA, allowed comparison between the extent, quality and shade value of existing vegetation in each LPA.

Measures of canopy cover, height, shade projections in mid-summer, and foliage density, were calculated per square metre of land within each of the twenty seven LPAs of the Sunshine Coast Council region.

These are defined as:

- **canopy cover:** the percentage of land covered by vegetation greater than 2 m in height (how much vegetation is present?)
- **foliage density:** the percentage of sunlight being blocked by leaves, branches and fruit (how effective is this vegetation at shading and cooling the environment?)
- **canopy height:** the average height of vegetation across defined land areas, including all vegetation greater than 30 cm in height (what is the average height of the vegetation?)
- **canopy shade:** the total area of land directly covered by vegetation greater than 2 m in height plus the extent of land shaded by this vegetation in mid-summer at both 9 am and 3 pm (what is the shading value of the vegetation?).

Two datasets were generated and analysed:

- the first includes all vegetation greater than 2 m in height within the subject LPA regardless of ownership or tenure
- the second includes only vegetation within areas of road reserve (all land that is not associated with a title deed and is formally reserved for the transport of vehicles).

Tables of statistics presented in the Appendix of this report show the average values generated. The higher the figure, the greater the amount of vegetation cover.

Summary of key findings

In June 2014, the Sunshine Coast Council LGA (Local Government Area) as shown in *Figure 3: LiDAR generated map of Sunshine Coast Council Local Government Area (LGA)* was made up of 57% vegetation (above 30 cm) 28% ground, 7% low vegetation (below 30 cm), 2% buildings and 6% water. The map shows that the Sunshine Coast is a very 'green' LGA and that the most urbanised areas of the region are from the Pumicestone Passage to the Maroochy River.

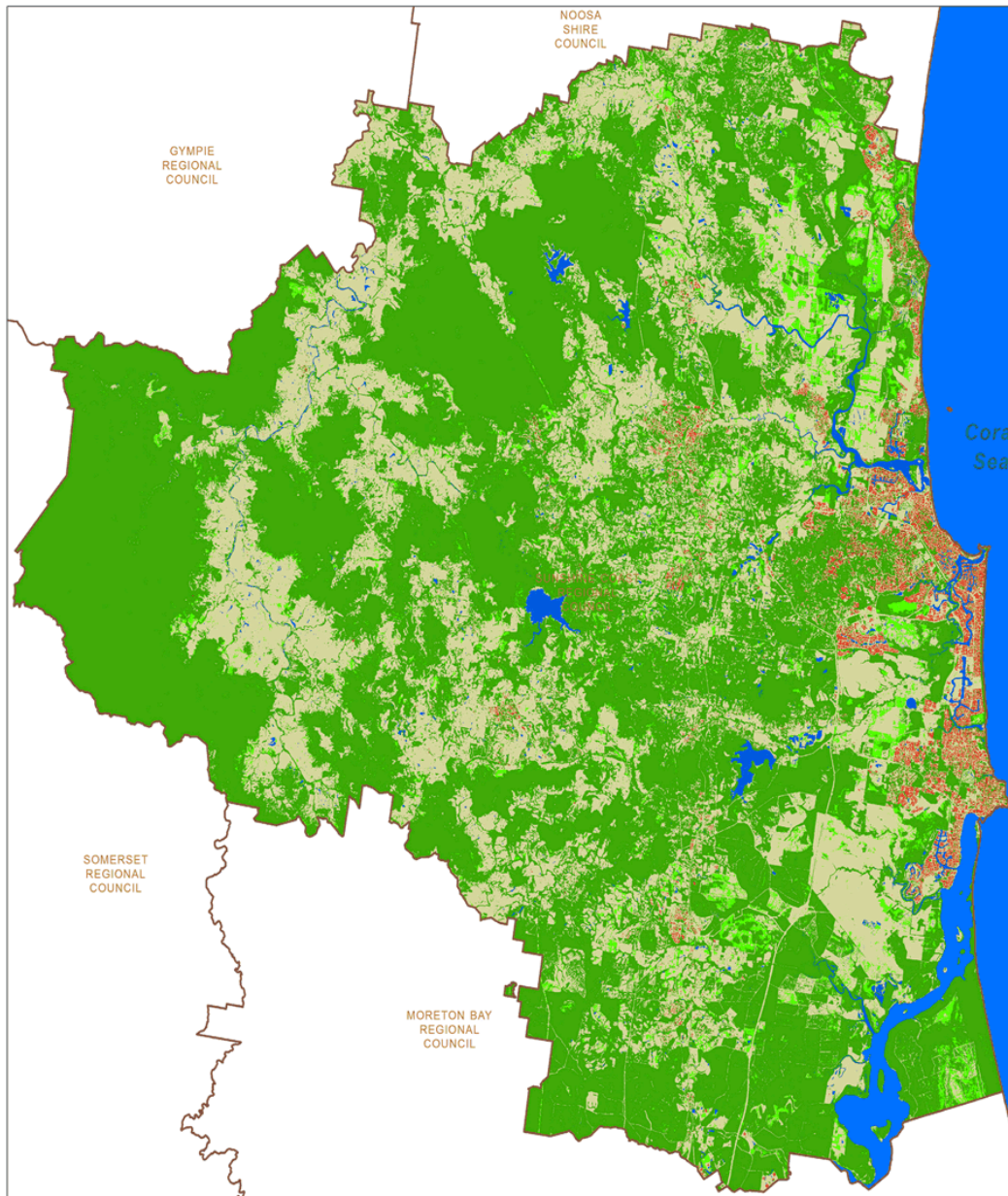


Figure 3: LIDAR generated map of Sunshine Coast Council LGA. Vegetation is shown in green, buildings in red and water in blue.



Figure 4: Map of Sunshine Coast Council region Local Plan Areas (LPAs).

These results are consistent with those presented in a nation-wide canopy modelling study undertaken in 2012 (Jacobs et al 2014). The study found the national average to be 39%. With 57% of all lands within the Sunshine Coast LGA containing vegetation greater than 2 meters in height, the Sunshine Coast was found to be one of the greenest LGAs in Queensland (placing equal second with Redland City LGA). The percentage cover reported for the Brisbane City Council LGA was 49%.

In a regional context the Sunshine Coast is performing very well. Vast tracts of vegetation growing in state forest, council managed bushland or national park help account for this good result. Statistics generated for the Sunshine Coast's more densely populated areas provide greater insight into the Sunshine Coast's 'urban forest', street tree cover specifically. The graph in *Figure 5: LPA comparisons of vegetation value between all lands and road reserve only* plots foliage scores for each LPA with all lands shown in blue and road reserve lands only in red. Foliage score is a combination of canopy cover, height, shade in midsummer, and foliage density measures which best represents the value of the vegetation, beyond simply its percentage cover in plan view.

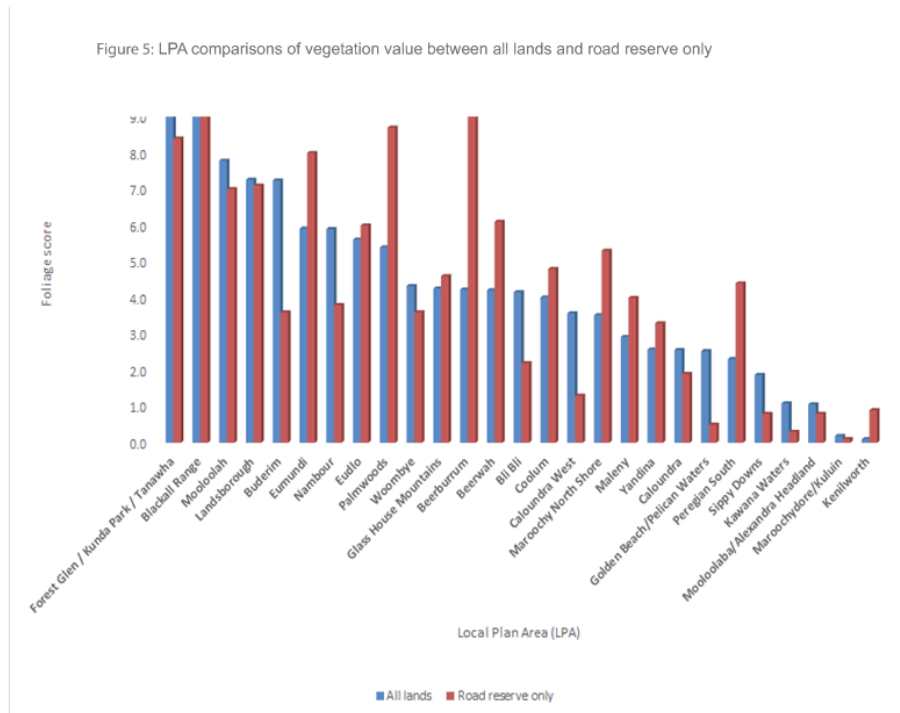
The Sunshine Coast LPAs with highest foliage scores across all land types, where vegetation could be said to provide greatest value are:

- Blackall Range
- Forest Glen / Kunda Park / Tanawha
- Mooloolah
- Landsborough
- Buderim
- Eumundi
- Nambour
- Eudlo
- Palmwoods.

With the exception of the Forest Glen / Tanawha / Kunda Park and Buderim LPAs, all of these localities occur within the Sunshine Coast's hinterland. Not surprisingly, the Blackall Range with its rich and fertile soils, cooler climate and large expanses of forest tops the list. This area contains vegetation cover over 62% of all lands and 48% of road reserve.

The Forest Glen / Tanawha / Kunda Park LPA also performs very well despite the large industrial area within (and the newer residential estates of Forest Glen showing substantially less vegetation volumes than parts of Mons and Tanawha).

Figure 5: LPA comparisons of vegetation value between all lands and road reserve only



Significant differences between vegetative cover and foliage score across all land types and statistics generated for road reserve areas only were found for:

- Beerburrum
- Maroochy North Shore
- Buderim
- Nambour.

Statistics reported for all land types for Buderim and Nambour showed above-average values, yet slightly below-average values were reported for road reserve areas in each. Conversely, figures generated for the Beerburrum and Maroochy North Shore LPAs showed above-average extents in road reserve spaces (in the case of Beerburrum this was very high), but average to below-average cover for all land types.

Local Plan Areas within the Sunshine Coast *Enterprise Growth Corridor* scored the lowest for all of the vegetation parameters analysed (with the exceptions of Kenilworth and Golden Beach / Pelican Waters which also shows comparatively low cover overall). Twenty percent or less of road reserve spaces were reported to contain vegetation of significance in the areas of:

- Maroochydore / Kuluin
- Kawana Waters
- Golden Beach / Pelican Waters
- Sippy Downs
- Mooloolaba / Alexandra Headlands
- Kenilworth.

Bli Bli, Caloundra and Caloundra West reported only marginally better statistics for road reserve canopy cover.

Statistics generated for all land types also showed that the coastal strip from Golden Beach to the Maroochy River (Maroochydore) contains the least amount of urban canopy cover or 'urban forest' for the entire region (with the addition of Kenilworth, Sippy Downs and Peregian South). Canopy cover percentages are shown in *Figure 6: Info-graphic showing Sunshine Coast Council region Local Plan Areas (LPAs) and canopy cover percentages (all lands)*. Average vegetation height ranges from 2.2 to 3.6 meters in these localities. In contrast, vegetation growing in Forest Glen / Tanawha / Kunda Park, Blackall Range, Mooloolah, Landsborough and Buderim averaged between 8.5 and 12.7 meters tall.

Discussion and conclusions

These results confirm that our most densely populated areas contain the least amount of vegetation and small trees across all land types, including streetscapes. Results suggest opportunities to provide greener, cooler streetscapes by prioritising shade tree planting programs in the areas of Golden Beach / Pelican Waters, Caloundra, Kawana Waters, Mooloolaba / Alexandra Headland and Maroochydore.

Results also show the harsher and more modified the environment, the lesser the extent of tree canopy. Tree establishment is notoriously difficult within the coastal plain of the Sunshine Coast due to infertile and/or modified landscapes and soils. These results may also indicate that more work is required to ensure the right conditions are provided for young establishing trees in these areas, that greater intervention is needed with regard to soil health and nutrition, and that cyclic maintenance needs to occur at greater frequencies.

In most situations, land use and context can explain canopy extents and foliage scores that may seem at odds with landscape character. Kenilworth for example contains a very high proportion of grazing pastures and many areas where there is no formal road verge to accommodate street trees. The figures for the Maleny LPA tell the same story. In the Maroochy North Shore LPA, statistics reported for all land types are far lower than those reported for road reserve areas only. The Sunshine Coast Airport and vast stretch of lowland vegetation within the Mt Coolum National Park occurring north of the plan area are likely to impact the overall volume of vegetation reported for the LPA.

Young, still establishing trees that have been planted in newer residential developments also need to be considered. Stocking rates are generally high in such areas but trees are too small to have a meaningful impact on vegetation cover statistics. Peregian Springs and a good proportion of Sippy Downs and Bli Bli are comprised of younger residential estates. The newer residential estates of the Beerburrum plan area for example are also believed to be responsible for the low figures reported for canopy cover across all land types, despite the forest feel of the area.

Vegetation cover statistics in the older established areas of the region perhaps provide the most meaning with reference for where we need new trees the most.

LPAs where the low scores for road reserve cover should be seen as a cause for concern include Buderim and Nambour. These areas are less likely to have significant patches of young still developing street trees as the bulk of residential living is long established.

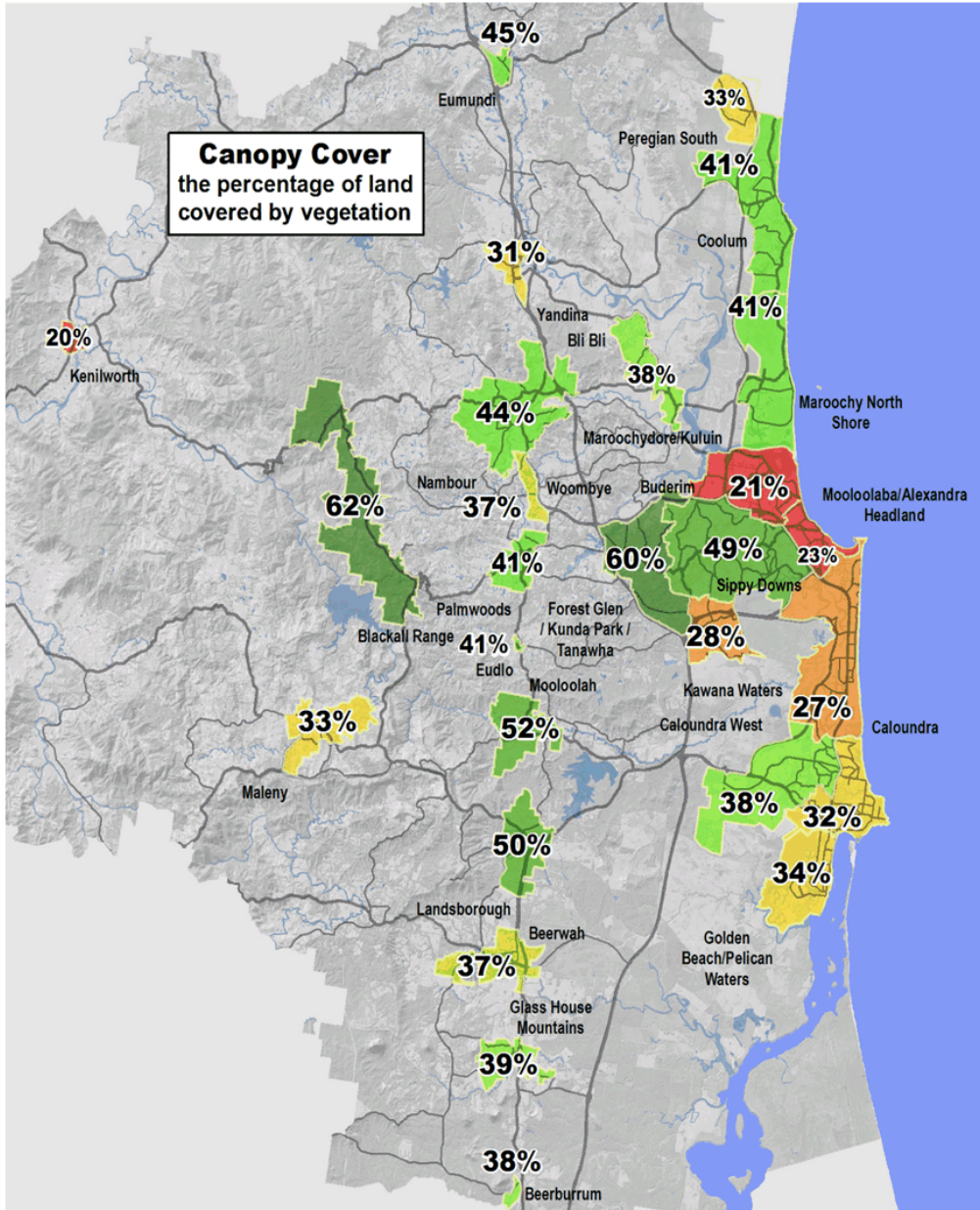


Figure 6: Info-graphic showing Sunshine Coast Council region Local Plan Areas (LPAs) and percentage canopy cover (all lands).

Change in canopy extents over-time

Changes in percent canopy cover between 2005 and 2015 were examined for each local plan area using multi-spectral imagery as detailed in the *Appendix* to this report.

Trends show most areas have lower vegetation indexes (on average 2% less tree cover) in 2015 than in 2005. These results reflect the ever-growing nature of the region but also suggest that increased rates of street planting may be required to compensate for vegetation clearing.

Despite highest cover overall, losses of road reserve cover between 2005 and 2015 were found for the Forest Glen and Blackall Range LPAs. The greatest reductions in vegetation cover within road reserve lands over the ten year period were in Eudlo (down by 5.5% on the 2005 figures) and Glass House Mountains (down by 5.2% on the 2005 figures).

Eumundi showed the greatest decline in overall tree cover (all areas) for the 10 year period, a decrease of 6.83%. A significant decrease was also shown for Woombye with statistics reporting a decrease of 5.39% over the period. In contrast, Peregrine South showed an increase in vegetation cover by 3.98% over the same period (across all land types). Kawana Waters also showed a very positive increase with a growth of 7.8% across all land types over the reporting period.

Future directions

Despite validation of areas that actually need new street tree plantings as opposed to where trees are perhaps still young and small, the early analysis would suggest that council should prioritise funding for street tree planting in:

- The Sunshine Coast *Enterprise Growth Corridor* specifically the localities of Caloundra, Maroochydore / Kuluin, and Mooloolaba / Alexandra Headland which are old established areas with few new housing estates showing significant vegetation losses over time as well as low levels of existing canopy cover and shade across all land types as well as in road reserve spaces only.
- Kenilworth where low canopy cover is coupled with the greatest number of extreme heat days projected for the future for the entire region.
- Buderim and Nambour where canopy cover within road reserve spaces is significantly less than all land types.

Results suggest that more detailed investigation into the structure and age of street tree populations should be carried out in the areas of Sippy Downs, Caloundra West and Bli Bli.

Vegetation statistics for all land areas indicate that council should also target the *Enterprise Growth Corridor*, Beerburrum, Kenilworth, Eumundi and Woombye for the promotion of planting of trees on private land. Free tree programs may assist. If determined there are few opportunities for the planting of trees in private land in these areas (for example in the case of Maroochy North Shore) council should perhaps then turn its attention to growing the urban forest in these areas by increasing tree plantings on public land.

Detailed *Foliage and Shade Cover* plans have been generated for each local plan area. These maps have been used to further detail potential for tree planting at the local level and are presented within the *Street tree strategies* that comprise *Part B* the *Draft Sunshine Coast Street Tree Master Plan*.

Potential for using council's existing and future *LiDAR* dataset to drill down further to identify 'hot spots' within localities and to the street level to help engage local communities and prioritise future planting programs for local residential streets now exists and should be utilised in the future.

These results should be examined against successive *LiDAR* data capture (fresh *LiDAR* data is to be captured in 2017) and ongoing annual assessment of Multispectral Seasonal Fractional Cover to allow for tracking and monitoring of extents of cover over-time.

The preliminary statistics generated do tell us a great deal about the current state of our urban forest and provide all-important benchmarks to measure ongoing progress against. Using these figures to measure increases / decreases against forecasts from tree planting activities will also help us to develop local canopy cover and foliage score targets for street tree planting. Our goal is to sustain existing regional canopy extents over time yet enhance local shade tree coverage to support cooler, greener communities.

Recommendations

Conduct investigations within well-established local plan areas with poor tree canopy cover as opposed to new estates where young trees exist, to identify barriers or opportunities for enhancing street tree coverage.

Prioritise street tree planting in suitable locations within the *Sunshine Coast Enterprise Growth Corridor* and, Golden Beach / Pelican Waters, Kenilworth, Nambour, Buderim, Eumundi and Woombye.

Utilise mapping products to engage local communities in developing their own tree planting plans and to overlay progress with planting programs.

Explore methodologies and funding opportunities to build upon tree canopy mapping including using the technology to map view sheds, to prioritise heat-vulnerable community areas, identify visibly declining tree populations or to develop future shade targets.

Continue to monitor annual change in canopy extents with Multi-spectral imagery and re-evaluate road reserve extents with fresh *LiDAR* capture in 2017.

Develop local tree planting targets to sustain existing canopy extents.

The existing street tree network

Field observations were carried out to both ground-truth statistical analysis of vegetation cover and to provide greater insight into the types of trees used for street tree planting in the region and their current performance.

Further detail is contained within the individual precinct plans developed for each LPA (*Part B - Street tree strategies*), some commentary is provided below to help form future directions and the *Species selection guidelines* of the plan.

Street tree species suitability and performance

Dominant species

Considering the wide range of species that naturally occur within the region (especially the vast suite of under-utilised rainforest plants), a relatively narrow street tree palette predominates.

The best represented street tree species in the region, used in a range of applications, is *Cupaniopsis anacardioides* (tuckeroo) which naturally occurs in foreshore plant communities of the Sunshine Coast. The species performs very well as an urban street tree with a rounded crown, dense canopy and wide range of tolerances.

Syzygium hemilamprum (syn. *Acmena hemilampra* - blue satinash) is also fast becoming another of the most commonly planted species in urban streets of the Sunshine Coast. Again, this tree (the broad-leaf form offers a good alternative to the more widely represented crinkle leaf form) is both attractive and reliable.

Other street tree species that dominate streetscapes include *Buckinghamia celcissima* (ivory curl), *Xanthostemon chrysanthus* (golden penda), *Grevillea baileyana* (white oak), *Backhousia citriodora* (lemon myrtle), *Tristaniopsis laurina* 'Luscious' (water gum), *Harpulia pendula* (tulipwood) and *Elaeocarpus obovatus* (hard quandong). These species are also consistent in appearance and remain relatively compact when mature.

While there is good justification for the selection of reliable street tree species – and in many cases, specifically with regard to the coastal plain where poor soils dictate the available species palette – over-reliance on a narrow set of species increases risk of losses across the region in the event of significant changes to climate and specific growing environments, or pest and disease outbreaks.

A fine line also exists between selecting species with proven success and the risk of creating repetitive streetscapes. This narrow street tree base palette has the potential to result in uninspiring landscapes rather than those of a lush, vibrant, sub-tropical character that the Sunshine Coast Council aspires to. Our field research also showed that these common compact species have been planted in many locations where larger trees may have been grown.

More problematic is over-representation of species that are unreliable or in the case of *Grevillea baileyana* (white oak) species that are too successful and are now under question due to their potential for self establishment (see *Weeds and environmental weed species*).

Lophostemon confertus (Queensland brush box), has been over-used as a street tree in recent times, especially in newer urban residential developments. As an urban street tree on the Sunshine Coast, the species has proven to be unreliable. Young trees are especially vulnerable if not hardened off before planting into open situations. Juvenile specimens have also been found to require a higher frequency of maintenance compared to other species, and are slower to establish. The tree can be sizeable on maturity if it does establish well, but is often inappropriately selected for new housing developments where there is only space for smaller trees. A close relative of the species, *Lophostemon suaveolens* (swamp box) is generally under-utilised despite its widespread natural occurrence on the Sunshine Coast (especially in low-land areas) and compact form.

Backhousia citriodora (lemon myrtle) and *Tristaniopsis laurina* (water gum) local rainforest species are compact with dense, luxuriant canopies. These species thrive when water is not a limiting factor but are frequently selected for use in sites where the existing soils simply cannot support their water requirements, especially in large-scale residential developments.

Araucaria heterophylla (Norfolk island pine) has cemented its place along Sunshine Coast (along with its close relative *Araucaria cookii* - Captain Cook's pine) foreshores despite not being a native tree (the species is endemic to Norfolk Island but is generally accepted to be naturalised in Australia).

The species is synonymous with coastal landscapes across the eastern seaboard of Australia and provides a distinct and valued character to many of the Sunshine Coast's front-line coastal sites. While the tree is a consistent performer in exposed coastal landscapes, the species is also widely used inland, when other local natural character species (hoop pine for example) could have been used.

Species with undesirable traits

Species once planted widely on the coast that are now notorious for their especially vigorous root growth or surface rooting characteristics (as evidenced in the existing Sunshine Coast street tree network), include

Melaleuca leucadendra (weeping paperbark) and *Syzygium tierneyanum* (river cherry). These attractive trees are inappropriate for standard street tree use and are best reserved for planting in parks, sufficiently set back from areas of potential conflict.

Other species noted to have inherent problems or performance issues include the range of grafted flowering gums - *Eucalyptus* 'Summer red' and 'Summer beauty' purpose made hybrids (crosses) of *Corymbia ficifolia* (flowering gum) of assured colour grafted onto reliable *Corymbia ptychocarpa* (swamp bloodwood) root stock. Since development of these hybrid species, they have frequently been used in place of the pure swamp bloodwood species (a highly attractive compact tree native to the Northern Territory) selected for their promise as even smaller trees with guaranteed flower colour. These hybrids however, are more often than not, shrub-like in habit, have proven to be extremely slow to establish and may be brittle.

Elaeocarpus reticulatus (blueberry ash) once widely planted in the region (in Beerwah especially) more closely resembles the habit of a shrub than a tree (and is therefore difficult to maintain due to a spreading rather than upright habit). This species should be reserved for use in garden bed or natural character grouped plantings.

Melaleuca (syn. *Callistemon*) *viminalis* (bottle brush) is widely represented due to extensive planting of the species from the 1970s onward. Despite its attractiveness to nectar feeding birds, the species often has an untidy appearance, retaining dead twigs and seed capsules. Its crown also tends to open-up over time which can detract from landscapes rather than enhance them. A range of successful bottle brush cultivars with a more compact form are now available and recommended for use instead.

Species for special planting treatments

Other attractive or character species poorly suited to standard road verges as evidenced in streets of the Sunshine Coast Council region include *Callitris columellaris* (Bribie Island pine). This locally important species can create a dusty environment beneath as an outcome of needle drop. This species requires good set backs from areas of high public use.

Delonix regia (poinciana) and a range of other species listed in the *Species selection guidelines* of the plan also provide a strong character element to many Sunshine Coast streetscapes. With structural traits better suited to large open sites however, these are not recommended for introduction into new streets.

Some of the larger, more prolific fruiting lilly pillys (*Syzygium oleosum*, *Syzygium forte* and *Syzygium moorei*) are proving to be better suited to parks or large mulched areas than adjacent to footpaths.

All species of the genus *Ficus* (fig) (which make a stunning contribution to the landscape are ecologically important and provide a high level of ecosystem benefits) require ample room to remain trouble free as they mature.

Other species that also require ample room and are better suited to garden bed style plantings include:

- *Araucaria bidwillii* (bunya)
- *Caesalpinia ferrea* (leopard tree)
- *Castanospermum australe* (black bean)
- *Commersonia bartramia* (brown kurrajong)
- *Grevillea robusta* (silky oak)
- *Mangifera indica* (mango)
- *Melicope elleryana* (pink euodia)
- *Pandanus tectorius* (screw pine)
- *Peltophorum pterocarpum* (yellow flame tree)
- *Terminalia catappa* (Indian almond)

Species for performance monitoring

Elaeocarpus eumundii (Eumundi quandong) appears to have strong mycorrhizal (beneficial soil fungi) associations and performs better when grouped with other rainforest plants. This species is widely used as a street tree however its variable performance (particularly in the coastal plain) is also evidenced in the existing Sunshine Coast street tree network and further monitoring of the species is required. It is recommended that this species is reserved for hinterland areas or where its use is necessary to perpetuate the existing landscape character of an area.

Jacaranda mimosifolia (commonly known as blue jacaranda) has been listed as a weed by several other LGAs. This species, while no longer planted as a standard street tree in the region, is a signature species of a number of Sunshine Coast localities (Beerwah, Buderim and Landsborough for example) and a distinctive feature of avenues or town centres. Use of this species should be restricted to infill character plantings only (to replace avenue plantings in Beerwah for example) until further information becomes available.

Species formally classified as environmental weeds are listed below.

Weed and environmental weed species

Plants classified as environmental weeds will either have, or threaten to have, an impact on the existing biodiversity values of the region or local area. These plants can out-compete native species and can alter the composition of vegetation communities. A number of these species have been planted in the past for amenity, cultural or commercial purposes and some as original homestead planting provide an important link to that time. As circumstances have changed and knowledge has increased regarding the adaptability that these plants have within these new environments, a number of these trees are now listed as environmental weeds or weeds of national significance.

Cinnamomum camphora (camphor laurel) and *Celtis sinensis* (Chinese elm) are listed as *Class 3 Environmental Weeds* under the *Pest and Stock Route Management Act 2002*.

Other weeds of note, while not declared, include *Syagrus romanzoffiana* (cocos palm), *Pinus elliottii* (slash pine), *Acacia baileyana* (Cootamundra wattle), *Syagrus romanzoffiana* (cocos palm), *Koelreutaria elegans* (golden rain tree) and *Spathodea campanulata* (African tulip tree).

The golden rain tree features strongly in the Blackall Range and Kenilworth localities and is to be phased out of streetscapes through natural attrition. Camphor laurel remains an identifiable feature of streetscapes of the Buderim and Glass House Mountains townships however this plan supports its eradication from environmental areas due to the impact it has on natural plant communities.

An emerging trend is that of species from Tropical Queensland which have long been used successfully in cultivation in sub-tropical Queensland now spreading from cultivated to natural environments. These include *Corymbia torelliana* (cadaghi), *Ficus benjamina* (weeping fig), *Grevillea baileyana* (white oak) and *Millettia pinnata* (pongamia). These species have been shown to not only compete with natural populations as an outcome of their ability to self-propagate but also threaten to pollute gene pools by interbreeding with locally native species (Navie 2014). The species *Corymbia torelliana* (cadaghi), *Ficus benjamina* (weeping fig) and *Millettia pinnata* (pongamia) are not recommended for use in future amenity tree plantings on the Sunshine Coast. *Grevillea baileyana* (white oak) however is a strong character tree in several localities including Bli Bli and is not considered a significant threat in areas where soils are poor (for example the coastal plain as opposed to hinterland areas). This species is not recommended for use in the Sunshine Coast hinterland or for introduction into new areas but should be monitored rather than removed from planting palettes for localities along the region's coastal strip.

Current pest and disease issues

Pests and diseases are natural components of a functioning ecosystem. The impact they have on trees can vary depending on the extent of the infestation and the role that the specific organism plays. Impacts can be minimal and therefore not noticeable within large and densely vegetated natural areas, but within developed areas, where there is generally less diversity and a more contrived growing environment, the impacts can be substantial.

In environments that have undergone minimal disturbance, pests and diseases are generally held in balance. Within changing or constructed environments however, natural processes that help maintain the balance may be lost, or pests and diseases that were never part of the local environment may out-compete the local populations of plants and animals. Key pests and diseases found within the region are described below.

Phellinus noxius

Phellinus noxius is a soil-borne fungal pathogen that causes the disease 'brown rot' in trees. When there's an ecological imbalance it begins to feed on living as well as dead tree tissue, can cause significant die-back and may eventually lead to the death of a tree. The fungus targets certain species, and generally specimens in a reduced state of health although this is not always the case.

Susceptible hosts include species of the genus *Ficus* (figs) *Araucaria* (South-Pacific conifers especially Norfolk Island pine), species of the *Eucalyptus* genus (gum trees), the coast's signature *Pandanus tectorius* (pandan or screw palm) as well as other coastal species. Its presence is generally indicated by a white mycelium stocking (fungal strands) at the base of an infected tree. This stocking is only present seasonally and may not be evident at all.

Tell-tale rust/brown streaks may also be found on the trunk of an infected tree but in many situations visual indicators of its presence do not appear at all until the tree is in an advanced state of decline. *Phellinus noxius* can, in many cases, be tolerated by a tree if the specimen is cared for properly (generally with a seasonal reduction in health followed by a period of recovery). A tree can however be completely overcome by the fungus when its defences are low and may ultimately die as a result. Prevention of infection is the only present method of control.

Myrtle rust

Myrtle Rust (*Puccinia psidii sensu lato*) is a relatively recently described fungus that is closely related to the eucalypt or guava rusts. These rusts are serious pathogens which affect plants belonging to the plant family Myrtaceae which includes well-known Australian natives such as species belonging to the *Melaleuca* or *Callistemon* genera (paperbark and bottle brush), *Syzygium* (lilly pilly) and *Eucalyptus* (eucalypts/gum trees).

Myrtle rust is distinctive in appearance producing masses of powdery bright yellow or orange-yellow spore-filled lesions on young actively growing leaves.

The pathogen requires warm, moist conditions for production of fungal spores and thrives in the wet season. Repeated infection of highly susceptible plants may result in plant death. Early evidence from the Sunshine Coast's amenity landscapes is showing most species temporarily recover, however long-term impacts are not yet known.

Several species have been shown to be particularly susceptible. These include the non-native lilly pilly *Syzygium jambos*, *Rhodomyrtus psidioides* (native guava) and *Gossia bidwillii* (python tree). While the species *Rhodosphoera rhodanthema* (deep yellow wood) is not in the Myrtle family and therefore not a host for Myrtle rust, another rust is having a devastating affect on the species with almost identical symptoms.

The rust is very difficult to control as the fungal spores are carried by wind from one plant to another. Ensuring that highly susceptible species are not used, Myrtaceous (belonging to the Myrtaceae family) species are not planted as monocultures and that infected stock is not brought into new landscapes (especially those that interface with natural areas) are some of the ways Council is using to keep the problem under control to prevent future mass infection.

Leaf hopper and Cane weevil

The Sunshine Coast's signature plant species *Pandanus tectorius* (pandan/screw palm) is presently susceptible to two significant pests. The first, a leaf hopper (*Jamella australiae*) that is believed to have been inadvertently introduced to the region numerous years ago, causes die back of the crown of the plant. Severe infestation can lead to death if left untreated.

A natural wasp predator was introduced to the region in the late 1990s and has kept the pest in-check for some time. In cases of severe infestation however, an integrated pest management program is necessary to eradicate the insect from the plants.

A second boring pest yet to be formally identified is also causing similar symptoms of crown die back, but is not restricted to sheltered parts of the canopy as is usually the case with the leaf hopper. With infestations more severe in sugar cane growing areas, it is believed that the responsible pest may be the sugar cane weevil borer (*Rhadoscelus obscurus*) which is major pest of the sugar cane industry. Early trials to treat heavy infestations have been conducted with soil injection. Populations will continue to be monitored in conjunction with a suitable integrated pest management program where required.

Future directions

Opportunities to diversify the existing palette of Sunshine Coast street trees should be taken wherever possible expanding use of uncommon Sunshine Coast native species (for example rainforest trees) and native (not naturally occurring within the local area but native to other parts of Queensland or Australia) trees. The ratio of exotic trees used for accent and highlight plantings in local and regional activity centres should also be increased.

Mixed species planting themes are encouraged for use wherever appropriate. Diversity within formal avenues of trees should be increased to minimise the threat of substantial impact of pest, disease or warming in the future.

A more distinct and identifiable street tree character should be established for the Sunshine Coast Council area through reinforcement and greater use of signature plants as feature and gateway trees. The hoop pine (*Araucaria cunninghamii*) naturally occurring in many Sunshine Coast landscapes for example is a key character species that should be targeted for wider use.

The use of *Lophostemon confertus* as a street tree should be minimised. *Syncarpia glomulifera* (turpentine) and many species of the *Diploglottis* (tamarinds), *Diospyros* (persimmons), *Cryptocarya* (laurels), *Angophora* (apple or rose gums), *Syzygium* (lilly pillys) and *Flindersia* (Bennett's ash for example) genera growing successfully on the Sunshine Coast are some of the possible alternatives to commonly used yet unreliable species (*Lophostemon confertus* – brush box for example) or species identified as having with undesirable traits for street tree use. These species also show great potential for providing greater cooling benefits to the region (in sites that can either naturally support the specific requirements of rainforest trees or be readily irrigated).

Corymbia torelliana (cadaghi), *Syagrus romanzoffiana* (cocos palm), *Ficus benjamina* (weeping fig), *Millettia pinnata* (pongamia), *Melaleuca leucadendra* (weeping paperbark), *Syzygium tiermeyanum* (river cherry), *Tipuana tipu* (rosewood), *Elaeocarpus reticulatus* (blueberry ash), *Syzygium jambos* (rose apple), *Rhodomyrtus psidioides* (native guava) and *Rhodosphoera rhodanthema* (yellow wood) should not be planted in any streetscapes of the Sunshine Coast due to their weed potential, extreme pest or disease susceptibility or undesirable developmental traits.

The performance of *Elaeocarpus eumundii* (Eumundi quandong) should continue to be monitored. While an important local species of the Sunshine Coast, the tree is not recommended for use in sections of the region's coastal plain where its performance has been noted to be particularly inconsistent.

Jacaranda mimosifolia (blue jacaranda) should not be introduced into any localities or streetscapes where they are not already an existing character tree.

Bottle brush species for use should be selected from one of the many cultivars (with improved visual and functional characteristics) available through the local nursery industry (see *Species selection guidelines for more information*).

Phellinus noxius susceptible species should not be used in locations with a known history of infection, or where the risk of infection is high. Monocultures of Myrtaceous trees should be avoided wherever possible to reduce the spread and potential impact of the Myrtle Rust disease, and despite the iconic status of *Pandanus tectorius* (pandanus palms) on the Sunshine Coast, numbers should be reduced to combat the species' maintenance intensity and on-going pest and disease threats.

Recommendations

Ensure on-going site responsive street tree plant selection (select the right tree for the right location) and widen street tree palettes to reduce dominance of potentially over-used species.

Sustain Sunshine Coast regional and local character via the development of pre-defined signature and character palettes for the whole region and each local area.

Undertake performance-based assessment of the existing Sunshine Coast street tree population composition to build an evidence base for species over-use and to determine appropriate compositions for the future.

Reduce the potential impact, spread and severity of pest and disease on street tree populations through selection against susceptible species where possible, quality control of tree stock, the use of natural predators and organic soil tonics and stimulants to enhance the health of susceptible species, and avoidance of monoculture street tree plantings wherever possible.

Formulate an integrated pest management plan to control the spread of *Phellinus noxius* from infected sites and plant succession trees in areas that are not currently infected or in conjunction with biological soil inoculates to ensure currently impacted plant communities can be sustained.

Extend young tree maintenance programs and provide on-going irrigation wherever appropriate.

Encourage the use of organic soil stimulants and soil enriching products as a part of integrated pest management programs and in all establishment maintenance programs for young trees.





Strategic directions



“Australia’s most sustainable region – smart, healthy, creative.”

Guiding principles

Region-wide responses to key issues and challenges for street trees on the Sunshine Coast and evidence of the need to improve the planning, design, planting and care of future street trees across the region were discussed in previous sections of the Master plan report (summarised under the headings *Future Directions* and presented in the *Recommendations* provided). These responses have been incorporated into eight Guiding principles and associated Strategic outcomes reflecting council's vision to 'protect sustain and enhance the region's existing and future street tree network through better selection, placement and management of street trees'.

The eight principles developed to guide future street tree planting on the Sunshine Coast are to:

- Ensure locally responsive species selection and placement that reflects or complements existing character and design intent.
- Plant large canopy trees and groups of trees to build canopy wherever space permits and conflict potential is low.
- Plant large canopy feature/anchor trees in strategic locations (specifically engineered for tree planting if necessary) to enhance the sub-tropical look and feel of the region.
- Shade and cool major pedestrian routes, cycle ways, connections between community facilities and recreation reserves, and urban hot spots with street tree plantings.
- Create attractive and coherent streetscapes through infill and extension planting in avenues along major thoroughfares, lead-ins and entry ways.
- Reduce conflict potential through better tree selection and placement of street trees and ongoing partnerships with internal and external stakeholders.
- Sustain the existing extent of canopy cover across the region through continued planting of off-set trees, planning for succession trees and building population resilience through diversification of species, life stage, form and layouts of future street trees.
- Partner with the local community and corporate sector to determine future tree locations, and to help establish and care for new trees.

Principle 1:

Ensure locally responsive species selection and placement that reflects or complements existing character and design intent.

Strategic outcomes

Design intent and landscape function

- Street tree selection and placement reflects the purpose of the planting (shade provision, cooling, place making) and the conditions of the planting site.
- Street tree plantings integrate with the built form and the natural character of the area and reflect the design intent of structured landscapes.
- In urban areas, plantings are consistent with building styles and considerate of solar and pedestrian access requirements.
- Street tree layout is respectful of community safety, ongoing visibility of signs and commercial entities, existing views and vistas.
- New lighting and solar panel installations are considerate of existing and future street tree locations.

For further guidance on street tree layout see *Positioning Guidelines*.

Character

- Regional character is enhanced through use of key signature species in high profile locations.
- Local character is respected through the use of precinct based street tree planting strategies reflecting the individuality of local places in the Sunshine Coast's 'community of communities'. See *Part B: Street Tree Strategies*.
- Avenue plantings are considerate of established local streetscape character and contribute to streetscape continuity (unless existing trees are performing poorly).
- Where no planting theme exists, streets may be suitable for the introduction of mixed native, sub-tropical planting arrangements or the introduction of exotic feature trees to reduce the dominance of over-used species, enhance population resilience and increase visual amenity.
- Feature tree selection and placement complements and reflects the natural and/or cultural landscape, existing views and natural land form.

Figures 7 (adjacent), 8 (right) and 9 (far right): Artists impressions of sites where large trees or groups of trees can be planted to build canopy where conflict potential is low.

- Natural character blends into the surrounding streetscape where appropriate.
- Where natural character planting themes are used the original regional ecosystem forms the base for plant selection where practicable.
- Planting nodes with a natural character design intent aim to enhance the ecological function of the site.

Scale and buffers

- Scale of plantings reflects use, design intent, and function of trees (shade and cooling for example).
- Plantings are of an appropriate scale where used as buffers. Plantings are of appropriate widths when framing or complementing views.
- Where trees are to provide landscape screening, tree selection ensures a minimum of 30% of the building elevation is screened when the planting reaches mature dimensions.
- Landscape buffers are used to provide distinction and separation between incompatible land use areas.
- Where planting spaces are not sufficient to support the establishment of large-growing trees, palm species (*Livistona*, *Archontophoenix* for example) are used to provide vertical scale in built up areas.

For further guidance on species selection see *Species selection guidelines*.



Principle 2:

Plant large trees or groups of trees to build canopy wherever space permits and conflict potential is low.

Strategic outcomes

Large trees for large spaces

- Large maturing trees are planted in spaces where existing conflict potential is low and impact potential is high (see *Figures 7 and 9* for examples).
- In new residential land developments, deep planting environments that can accommodate large-growing trees are preserved wherever possible and used as feature tree locations.
- Trees are planted to build canopy in public open space areas that intersect with streetscapes (see *Figure 8*). Positioning of new plantings should not compromise the potential for passive surveillance of play areas.
- Large canopy trees are planted in council controlled lease areas as appropriate (i.e. service compounds) or in appropriate locations along state controlled sections of the road network under special maintenance agreements.
- Foreshore landscapes (at street interfaces) are enhanced through the addition of large trees to existing stands (where there is no potential for loss of water views).
- Existing guard railed sites are used to establish large growing trees in centre medians and adjacent to high speed roads where 'frangible' trees are otherwise required.

For large growing species lists see *Signature and Natural Character palettes* in *Part B: Street Tree Strategies*. See also the *Sunshine Coast Open Space Landscape Infrastructure Manual (Embellishments - Planting - Landscape - Index)*.



Principle 3:

Plant large canopy trees in strategic locations (specifically engineered for tree planting if necessary) to enhance regional and local character.

Strategic outcomes

Entry statements

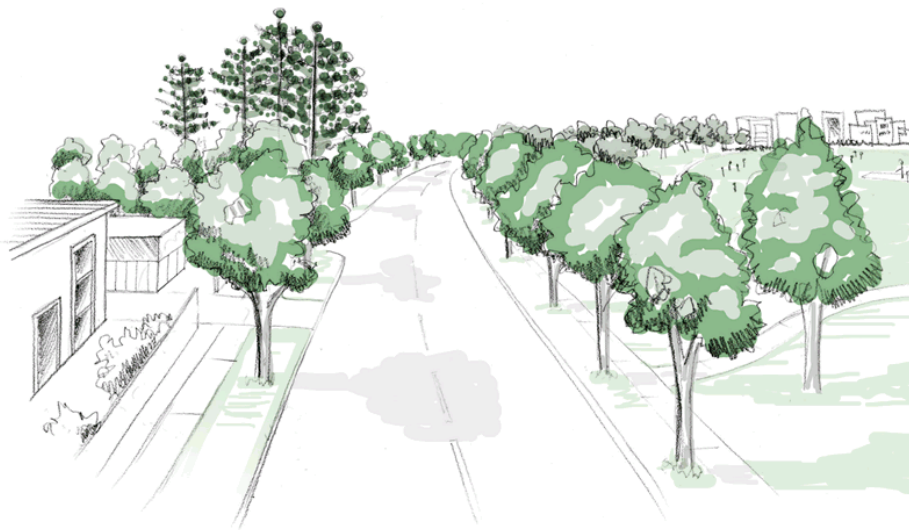
- All regional and local gateways are signified by multi-layered /sub-tropical landscape treatments (with large crowned / broad-leaved /dense canopy species as key features, see *Species selection guidelines: Local rainforest trees* for further information).
- Embed 'tree sensitive' design into all developments, including spaces for feature trees in new residential developments.
- Key cultural and commercial sites are highlighted with character or signature plantings. Existing feature and significant street trees are surveyed and added to protection overlays.
- Community facilities are enhanced with the planting of large growing trees in appropriate spaces.
- Engineered tree planting sites are constructed to accommodate new trees in streetscape upgrades and new urban residential developments where insufficient space for large trees exists.
- Council's nursery purpose grows feature trees according to signature palettes devised for local street tree planting strategies.

For more information see *Species selection guidelines*.





Figure 10 (above): Artists impression of trees providing shade a cooling to key pedestrian networks. Figure 11 (below): Artists impression of enhancing and extending existing avenues of street trees along major thoroughfares.



Principle 4:

Shade and cool major pedestrian routes, cycle ways, connections between community facilities and recreation reserves, and urban 'hot spots'.

Strategic outcomes

Shade and cooling

- Prioritise trees to deliver shade and cooling to key pedestrian networks (see *Figure 10*) in priority locations.
- Species are selected and positioned so as to achieve maximum shade and cooling benefits in urban hot spots (see *Species selection guidelines*).
- Plantings are placed at 6 m centres to maximise the potential for uninterrupted shade.
- New street tree plantings to the south side of footpaths on east-west orientated streets, and west side of footpaths on north-south orientated streets are given planting priority.
- Plantings aim to shade walls and outdoor areas from the western sun, reduce shading potential on the north side of properties; and aim to provide maximum solar radiation to existing solar collectors for the middle six hours of the day.
- Reduced over-night cooling in built-up areas is taken into consideration before creating streets with continuous canopy.
- Major pedestrian travel paths leading to amenity and bushland reserves, and community and sports facilities are provided with street trees planted at 6 m centres to be provide unbroken shade.



Figure 12 (above): Artists impressions of increasing street tree diversity through changes in species where natural or intuitive section breaks occur.

Principle 5:

Create attractive and coherent streetscapes. Infill and extend avenues of street trees along major thoroughfares and town lead-ins

Strategic outcomes

Avenues

- Existing avenue plantings on major thoroughfares are enhanced and extended.
- Existing themes are respected (see *Figure 11*).
- Avenues plantings reflect formal species composition and layouts.
- Species diversity is enhanced with a change in species where natural or intuitive section breaks occur (see *Figure 12*).
- Where infrastructure inhibits planting of large trees on both sides of the road, compact species are planted to one side of the road, larger growing trees to the other.
- Blister plantings are used where infrastructure inhibits planting of continuous avenues.
- Layouts and selection of trees that will ultimately develop overarching canopies considers the requirement for night time cooling in areas of high urban intensity.
- Major boulevard verges and medians should be constructed according to best horticultural practice to support large canopy trees.
- Guard rail is incorporated into locations where set-backs and clearances cannot be achieved otherwise and a critical need for tree benefits has been identified.
- Alternative sites are made available to accommodate trees in purpose designed planting nodes in places where trees cannot be incorporated into standard verge spaces.

For street tree layout options see the *Sunshine Coast Planning Scheme 2014, Part 9: Development codes, 9.4.2 Landscape Code* for further guidance.

Principle 6:

Reduce conflict potential through better tree selection and placement of trees as well as ongoing partnerships with the community, corporate sector and external service providers.

Strategic outcomes

Street tree and infrastructure compatibility

- Compact street trees are used to shade and provide amenity to local residential streets and constrained spaces (see *Species selection guidelines*).
- Community values and priorities influence tree species selection and placement in local streets.
- Pathway alignment protects existing trees and/or retains adequate space for the establishment of future trees.
- The placement of street tree plantings considers existing infrastructure networks, future transport corridors and priority development areas, existing street and commercial signs and existing solar collectors.
- Partnerships between council and service providers are maintained and enhanced to ensure integrity of landscape design intent and the provision of essential services.
- Design of new infrastructure accommodates existing or future trees. Trip stop and other sensitive design treatments are incorporated where appropriate to allow for large trees to be planted.
- Where tree retention or planting options have been exhausted in favour of infrastructure, alternative sites (across the road, in the median, nearby nodes) are secured for the provision of street tree benefits.
- Unless a formal, site specific arrangement is entered into, trees incompatible with formative or hedge type pruning are not planted below existing overhead electrical infrastructure.
- Underground or overhead bundled electricity cable is favoured.
- Identified existing public view points and vistas are retained with respect to the placement of new trees.

For further species selection guidance see *Species selection guidelines*. See also *Sunshine Coast Planning Scheme 2014, Part 9: Development codes, 9.4.2 Landscape Code*. For further information on council's standard tree protection requirements see the *Sunshine Coast Council Open Space Landscape Infrastructure Manual* (2013).

Principle 7:

Sustain the existing extent of canopy cover across the region. Build resilience and enhance diversity in the region's street tree network through the use of a range of species and on-going succession planting.

Strategic outcomes

Sustainability

- The protection and retention of existing trees takes precedence over tree removal and replacement in programs of streetscape renewal. Tree retention rates are increased.
- The quality and quantity of the region's urban forest is enhanced with a diversity of species used and diversity of ages of trees as an outcome of proactive tree planting.
- Every tree removed is replaced at a minimum ratio of one for one to achieve a 'no net loss' (*Sunshine Coast Strategic Tree and Native Vegetation Management Policy 2012* - endorsed in principle).
- All new and replacement street tree planting is recorded to enhance maintenance scheduling, monitoring and recognition in council's asset register.
- Detailed succession planning is undertaken for aging roadside foreshore trees.
- Under-utilised locally native and native tree species and non-invasive exotic species are used as feature trees in appropriate urban settings to both increase population diversity and provide contrast to existing standard palettes. Trial sites are set up to explore the potential of under-utilised rainforest species as street trees.
- Quality tree stock and increased maintenance frequencies ensure longer-lived and more sustainable street tree populations.
- Tree population health studies are undertaken to establish population life expectancy and prioritise succession trees.
- Landscape buffers are created with street tree plantings to protect the existing edge of bushland and recreational parkland.



Principle 8:

Engage and partner with the community and corporate sector to determine future tree locations and help establish new trees.

Strategic outcomes

Planting in residential streets

- Local street and feature tree planting and protection plans for high priority locations are developed with local communities. Tree planting in residential areas is undertaken in close consultation with local residents. Community values and priorities influence tree species selection and placement.
- Street tree planting programs are prioritised in local streets where residents elect to help care for trees as they establish.
- Planting programs where local businesses elect to support and partner with council in the delivery of tree planting initiatives in commercial precincts are given priority.
- Street tree placement in local streets is consistent with an affected property owner's desire for natural light (see Figure 13).
- A higher proportion of trees significantly contributing to the Sunshine Coast urban forest grow on private land.

'Adopt a street tree' planting program

Council is committed to partnering with local residents to establish and care for new street trees in locations where they are wanted the most. It is well understood that young street trees that are desired and nurtured by adjacent residents have the best chance of surviving and thriving in urban landscapes.

Council is able to prioritise requests for street trees where residents elect to be the custodians of young trees. As a part of council's 'Adopt a street tree' program, local residents will be given opportunity to nominate their nature strip (or street where a number of residents come together to request street trees) to be included in the program. Local businesses are also encouraged to express a desire for new tree establishment in adjacent areas, as well as indicate whether they are able to partner with council in their early care and maintenance.

Council will work with local communities to identify where residents would like to see new street trees established as a part of community engagement in the development of this plan. Priority planting plans for residential streets will be developed as an outcome, and integrated into future funding arrangements.

Figure 13: Artists impression of street tree planting in residential streets.



Positioning guidance

Technical street tree planting guidance is outside of the scope of this document with the *Sunshine Coast Open Space Landscape Infrastructure Manual* containing all relevant specifications and technical guidelines. Street tree setbacks, centres and layouts (acceptable outcomes depending on the type of planting) are however briefly discussed below.

For standard advanced tree planting detail, maintenance specifications and guidelines for the selection of tree stock see also the *Sunshine Coast Open Space Landscape Infrastructure Manual – Embellishments – Planting Landscape*. For specific species information including expected dimensions and preferred growing conditions see *Palettes – Planting – Planting index*.

For tree growth requirements, including required soil volumes, structure and drainage (see *Preliminaries – Vegetation Management*).

Planting setbacks

In standard situations it is preferable that new street trees are planted centrally between the kerb and footpath (as opposed to footpath and property boundary). For specifications for planting setbacks (including to kerb and channel, pathways, driveways, street lights and underground services) see the *Sunshine Coast Open Space Landscape Infrastructure Manual – Embellishments – Planting – Landscape – Specifications – Table 7: Positioning of trees*. See also the *Ausroads Guide to Road Design* and *DTMR Road Landscape Manual* for setback requirements according to road speed (clear zones) and the *Sunshine Coast Planning Scheme 2014, Part 9: Development codes, 9.4.2 Landscape Code*.

The width of the verge – specifically the available soil volume – as well as how well the species is matched to the soil type will have the greatest impact on the mature dimensions and longevity of a street tree as well as its general health throughout its life. For basic tree and tree growth requirements (including required soil volumes) see the *Sunshine Coast Open Space Landscape Infrastructure Manual – Preliminaries – Vegetation Management*.

Planting centres

Planting centres should be selected according to the expected size of the tree on maturity, the design intent of the planting and the type of street in question.

Standard street trees are recommended for planting at 8 m centres. Where shade is to be provided to footpaths, it is recommended that street trees are planted at 6 m intervals (see *Sunshine Coast Planning Scheme 2014, Part 9: Development codes, 9.4.2 Landscape Code*).

Where overhead power exists, the plan recommends planting smaller trees at closer centres. In these situations a street tree is recommended to be located every 5 m.

Where large trees are being planted, for example as a part of the rural road network, larger centres may be considered appropriate, for example 10 to 15 m centres may be suitable.

Street tree configurations

With respect to street tree configurations and mixed or formal planting themes, the plan recommends that in the first instance existing themes are followed. This is especially important when infill planting formal avenues of trees on major thoroughfares (where plantings are traditionally configured symmetrically). Naturally if the existing species is not performing, species changeover should occur. Where diversification of existing formal avenues is desirable, opportunity to retain a formal, symmetrical configuration and introduce new species in block plantings, where natural breaks occur, is recommended.

Where no existing themes exist, mixed species and informal (asymmetric) layouts may be used. It is important however to ensure that clumped plantings consider the mature dimensions of the species used and allow enough space between each tree for proper structural development. It is also important that the planting layout does not affect the potential for the planting to achieve its intended outcome.

Evenly spaced, continuous plantings for example are best for the delivery of shade to footpaths. Clumped plantings with large spaces provide only intermittent shade to footpaths.

Gateway and feature plantings at intersections and within centre medians occurring on major thoroughfares provide good opportunity for multi-layered, sub-tropical style planting arrangements and the use of a mixed species palette. A sub-tropical planting outcome can also be achieved through the use of under-plantings.



Figure 14: Sketch showing typical layout of street trees in an urban residential street

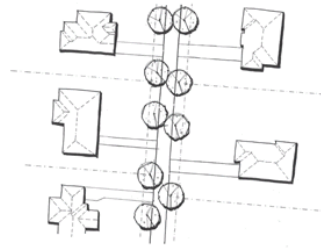


Figure 15: Sketch showing typical layout of street trees in a rural residential street

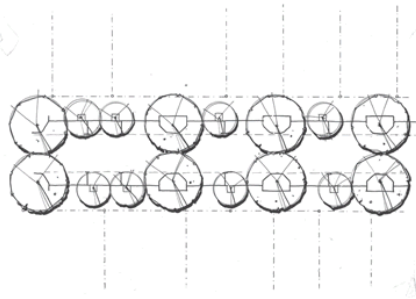


Figure 16: Sketch showing centre / precinct street tree layout (with large trees as the primary canopy structure and smaller secondary trees at closer centres).

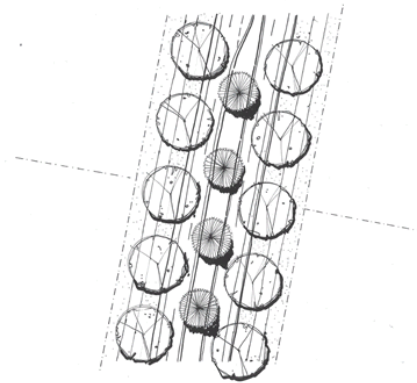


Figure 17: Sketch showing a formal avenue of street trees and centre median typical of a major thoroughfare.



Figure 18: Sketch showing street tree planting layout that is respectful of the preservation of existing views.

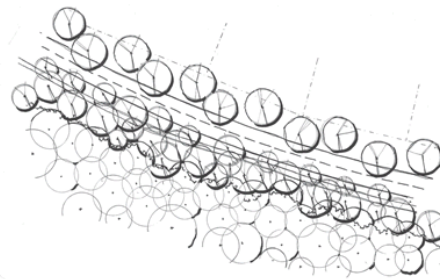


Figure 19: Sketch showing a street tree planting configuration to buffer a natural area.



Street tree planting priorities

The plan identifies the numerous advantages to the presence of trees in our streets. It also establishes that in order to sustain and increase the benefits trees provide, new trees must be continually planted.

The plan outlines the many challenges to the establishment of new trees (and protection of existing trees) as an outcome of an ever-growing population, greater urban densities and the increasing extent of the urban landscape. Street trees are not only contending with less available permeable space as an outcome of these factors, they must also compete with essential services (water and sewer, power and telecommunications) within these shrinking spaces as demands continues to grow.

Despite this, many spaces in road reserve corridors that could potentially accommodate large growing trees without conflict are empty. Planting trees into as many of these spaces as possible is considered the primary street tree planting priority for the region. Potential planting locations (nodes) for investigation include intersections, roundabouts, centre medians, wide road verges, public open space areas that intersect with streets and unused areas of land around community facilities, car parks and service compounds (see *Figure 20*).

Providing shade to pathways and popular pedestrian routes is the second street tree planting priority for the region. Shading pathways around schools and community facilities and pedestrian links between shopping precincts, recreational areas and residential zones are the greatest priorities (see *Figure 21*).

The third priority for street tree planting in the short-term is to enhance the general amenity and function of major avenue plantings. By infilling (planting gaps) and extending street tree avenues, regional and local gateways can be reinforced and strengthened (see *Figure 22*).

Once new trees have been planted into existing vacant spaces and priority locations, council can turn its attention to more complex issues such as; how to ensure adequate provision of space for trees in new residential developments, how to ensure consideration is given to all essential infrastructure including street trees, and what possible alternative treatments can be used to ensure the Sunshine Coast's built and natural landscapes are better balanced in the future.

Priority locations for proactive planting of street trees include the *Enterprise Growth Corridor*, Golden Beach / Pelican Waters, Nambour, Buderim, Eumundi, Kenilworth and Woombye, where council will work with local communities to build locally relevant tree planting plans.



Figure 20: Example of tree planting priority 1: Plant trees where space permits and conflict potential is low.



Figure 21: Example of tree planting priority 2: Shade major pedestrian routes.



Figure 22: Example of tree planting priority 3: Infill and extend tree avenues on major thoroughfares.



96 DRAFT Sunshine Coast Street Tree Master Plan Part A



Species selection guidelines



Tree species selection

This section of the plan provides guidance around the selection of species for use as street trees in the Sunshine Coast Council area and includes region-wide street tree palettes for specific functions and settings. More specific guidance on signature and natural character palettes and lists of trees suitable for use in residential streets for each of the region's 27 Local plan areas are contained within *Part B – Street tree strategies* of the plan.

Street tree palettes will be periodically reviewed as an outcome of street tree trials, the development of new species varieties and cultivars, or the advent of new pest or disease threats that may alter the performance and reliability of currently listed species.

The plan is to be used in association with the *Sunshine Coast Council Open Space Landscape Infrastructure Manual* where guidance for tree stock selection (in-line with AS 2303-2015 *Tree stock for landscape use*) and tree planting and maintenance specifications can be found. The manual's *Plant Index* contains a comprehensive list of all plant species deemed suitable for cultivation in Sunshine Coast amenity landscapes.

Tree nomenclature

The names of trees in this document follow the *International code of botanical nomenclature* (2012) with genus and species given, followed by the plant's common name. While species is the principle taxonomic unit used, sub-species, varieties and cultivars that are recognised taxonomically may also be provided where distinction is required (for example a more superior cultivar such as *Tristaniopsis laurina* 'Luscious'). Where more than one plant name is in existence, the names given are in accordance with the *Census of Queensland flora* (Jessup 2015) and current as at January 2017.

Lilly pillys previously belonging to the genus *Acmena*, are now recognised as a part of the *Syzygium* genus. *Callistemon* (bottle brush) trees have mostly been incorporated into the *Melaleuca* (paperbark) genus.

To avoid confusion, the plan lists the synonym adjacent to the most widely accepted species name (abbreviated to syn.) as well as providing a common name for the species.

The term 'eucalypt' is used throughout the plan as a generic term or common name for all eucalypt-type (gum) trees that were once included in the *Eucalyptus* genus but have since been split into three separate genera – *Eucalyptus*, *Corymbia* and *Angophora*.

Guiding principles

- Select the right species for the location (match the species to the site, not the site to the species).
- Use a diverse palette of species with local native species forming the basis of planting plans with native or exotic trees used for accents.
- Plant quality tree stock with well-formed root systems and appropriate root to shoot (root ball volume to height) ratios in all public open space areas.

Selection outcomes

- Trees are selected by suitably qualified and experienced practitioners.
- Tree selection is locally responsive and is cognisant of local conditions and individual site characteristics including soils, drainage, services and biological factors.
- Trees are selected and situated so as to reduce the risk of conflict and lower maintenance requirements over the life of the tree.
- Local native trees are predominately used for landscape plantings.
- A greater proportion of rainforest origin trees and species reflecting the region's sub-tropical design intent are used in streetscapes and as feature plantings (where they can be supported by the existing site soils).
- Exotic and non-native species have a greater presence in activity centres and provide colour and contrast in strategic locations.
- In constrained sites and many residential areas where smaller trees are desired, trees are selected from a base palette of compact trees.
- Tree selection ensures no species or plant families are over-used where feasible alternatives exist.
- Commonly used as well as under-represented species are propagated and grown in council's nursery and available for use in operational and capital programs.
- Care is taken not to use species that have a short life span (less than 15 years) or for the most part have an untidy appearance.
- Complementary species are selected for street trees plantings adjacent to council bushland reserves where appropriate (in consideration of any associated risk to wildlife).

Street tree palettes

While preference should be given to use of local Sunshine Coast species, Sunshine Coast native (naturally occurring local species), Australian native (species that are native to Australia but not the local region) and where appropriate, exotic (of non-Australian origin) tree species may be planted in streets of the Sunshine Coast to ensure population diversity and resilience as well as visual interest.

Signature species for feature plantings

Signature trees of the Sunshine Coast should be planted at gateways and in high profile locations in general to help create a distinct, identifiable Sunshine Coast character. The hoop pine (*Araucaria cunninghamii*) for example is a prominent feature tree in the region, synonymous with the Sunshine Coast landscape character. The visually appealing tree provides a strong vertical element to Sunshine Coast landscapes and with a wide natural distribution, performs consistently across a range of soil types. This plan recommends the use of this species wherever possible to create a common thread between the Sunshine Coast's 'Community of Communities' as well as a recognisable regional landscape character.

The culturally significant bunya pine (*Araucaria bidwillii*) is also a key Sunshine Coast character species. Unfortunately the large fruits that were so important to the traditional owners of the land (and the subject of large gatherings and celebrations) are potentially hazardous. Use of this species therefore is limited to very large spaces where falling fruits can cause no harm.

The iconic Pandanus or screw palm (*Pandanus tectorius*) features strongly in coastal landscapes as do the coast banksia (*Banksia integrifolia*) and introduced yet naturalised Norfolk Island and Captain Cook's pines (*Araucaria heterophylla*, *Araucaria cookii*).

Other signature species include the suite of local fig tree species (best represented by the Moreton Bay fig - *Ficus macrophylla*) and their use in appropriately sized high impact locations is strongly encouraged; local eucalypts including the adaptable blue gum (*Eucalyptus tereticornis*) and ever-present pink bloodwood (*Corymbia intermedia*) and key rainforest species represented by the *Elaeocarpus*, *Flindersia* and *Syzygium* genus'.

Signature species recommended for planting as specimen trees or in groups in key Sunshine Coast locations are listed below.

Sunshine Coast signature species:

- *Agathis robusta* (kauri pine)
- *Angophora leiocarpa* (rust barked apple)
- *Araucaria cunninghamii* (hoop pine)
- *Araucaria heterophylla* (Norfolk Island pine)
- *Banksia integrifolia* (coast banksia)
- *Brachychiton acerifolia* (Illawarra flame)
- *Callitris columellaris* (Bribie Island pine)
- *Corymbia citriodora* (lemon-scented gum)
- *Corymbia intermedia* (pink bloodwood)
- *Corymbia tessellaris* (Moreton Bay ash)
- *Cupaniopsis anacardioides* (tuckeroo)
- *Elaeocarpus eumundii* (Eumundi quandong)
- *Elaeocarpus grandis* (blue quandong)
- *Elaeocarpus obovatus* (hard quandong)
- *Eucalyptus bancroftii* (tumbledown gum)
- *Eucalyptus crebra* (narrow-leaved iron bark)
- *Eucalyptus propinqua* (mountain grey gum)
- *Eucalyptus racemosa* (scribbly gum)
- *Eucalyptus tereticornis* (blue gum/forest red gum)
- *Eucalyptus siderophloia* (northern grey iron bark)
- *Ficus macrophylla* (Moreton Bay fig)
- *Ficus obliqua* (small-leaved fig)
- *Ficus superba* (strangler fig)
- *Ficus virens* (White's fig)
- *Flindersia brayleyana* (Queensland maple)
- *Flindersia bennettiana* (Bennett's ash)
- *Flindersia schottiana* (cudgerie)
- *Gmelina leichhardtii* (white beech)
- *Grevillea robusta* (silky oak)
- *Hibiscus tiliaceus* (cotton tree)
- *Lophostemon confertus* (Queensland box)
- *Lophostemon suaveolens* (swamp box)
- *Melaleuca quinquenervia* (broad leaf paperbark)
- *Pandanus tectorius* (pandanus palm)
- *Podocarpus elatus* (brown pine)
- *Syncarpia glomulifera* (turpentine)
- *Syzygium francissii* (giant water gum)
- *Toona ciliata* (red cedar)

Local rainforest trees

Local rainforest trees with their dense canopies are an under-utilised shade tree resource. These types of trees also have the greatest capacity for cooling and are recommended for wider use (in appropriate locations with good soil moisture or where irrigation can be supplied) on the Sunshine Coast. Drier rainforest trees and those naturally occurring on forest margins need to be more adaptable and therefore have a wider range of environmental tolerances (specifically a greater tolerance to drier soils due to lower rainfall or topographical conditions in their natural environments). Dry rainforest species include hoop pine (*Araucaria cunninghamii*), lace bark (*Brachychiton populneus*), Crow's ash (*Flindersia australis*), jackwood (*Cryptocarya glaucescens*), native tamarind (*Diploglottis australis*), many local species of fig (*Ficus* sp), wild quince (*Guioa semi-glauca*), yellow wood (*Flindersia xanthoxyla*), tulipwood (*Harpulia pendula*), silky oak (*Grevillea robusta*), and brown pine (*Podocarpus elatus*). Lesser known or cultivated species include brush bloodwood (*Baloghia inophylla*), native quince (*Alectryon subcinereus*) and white tamarind (*Ellatostachys xylocarpa*). Some dry rainforest species may still be vulnerable to the impacts of rising temperatures especially in extreme future climate scenarios, and careful selection of species and sites (as well as the integration of strategies for resilience in maintenance regimes) are strongly encouraged.

Many of the more compact local rainforest species may be appropriate for use in local residential streets and offer good potential for diversification of the existing street tree species palette (see *Trial species for residential streets overleaf*).

Rainforest plants for wider use:

- *Acronychia oblongifolia* (white aspen)
- *Acronychia wilcoxiana* (silver aspen)
- *Alectryon subcinereus* (native quince)
- *Alectryon subdentatus* (hard alectryon)
- *Argyrodendron trifoliatum* (white booyong)
- *Argyrodendron actinophyllum* (black booyong)
- *Backhousia subargentea* (syn. *Choriocarpa subargentea*) (giant ironwood)
- *Baloghia inophylla* (brush bloodwood)
- *Beilschmiedia obtusifolia* (blush walnut)
- *Castanospora alphanthii* (brown tamarind)
- *Cinnamomum oliverii* (Oliver's sassafrass)
- *Commersonia bartramia* (brown kurrajong)
- *Cryptocarya bidwillii* (yellow laurel)
- *Cryptocarya glaucescens* (jackwood)
- *Cryptocarya hypospodia* (northern laurel)

Rainforest plants for wider use (cont.)

- *Cryptocarya obovata* (pepperberry)
- *Cryptocarya triplinervis* (three-veined laurel)
- *Diospyros australis* (yellow persimmon)
- *Diospyros geminata* (scaly ebony)
- *Diospyros pentamera* (ebony)
- *Diploglottis australis* (native tamarind)
- *Diploglottis campbelli* (small leaved tamarind)
- *Dysoxylum fraserianum* (rose mahogany)
- *Ellatostachys xylocarpa* (white tamarind)
- *Endiandra globosa* (black walnut)
- *Endiandra pubens* (hairy walnut)
- *Endiandra sieberii* (cork wood)
- *Eremophila mitchellii* (false sandalwood)
- *Eurochinus falcata* (ribbonwood)
- *Ficus coronata* (creek sand paper fig)
- *Ficus fraserii* (sand paper fig)
- *Ficus macrophylla* (Moreton Bay fig)
- *Ficus microcarpa* var. *hillii* (Hill's fig)
- *Ficus obliqua* (small leaved fig)
- *Ficus rubiginosa* (Port Jackson fig)
- *Ficus virens* (White's fig)
- *Flindersia schottiana* (cudgerie)
- *Flindersia australis* (Crow's ash)
- *Flindersia bennettiana* (Bennett's ash)
- *Flindersia xanthoxyla* (yellow wood)
- *Glochidion sumantrum* (cheese tree)
- *Gossia bidwillii* (python tree)
- *Guioa semi-glauca* (wild quince)
- *Jagera pseudorhus* (foam bark)
- *Litsea australis* (southern brown bolly gum)
- *Litsea leefeana* (brown bolly gum)
- *Mischarytera lautereriana* (corduroy tamarind)
- *Nauclea orientalis* (leichhardt tree)
- *Notolea longifolia* (mock olive)
- *Olea paniculata* (native olive)
- *Planchonella australis* (black apple)
- *Santalum acuminatum* (quandong / native peach)
- *Sloanea woollsii* (yellow carrabeen)
- *Syncarpia glomulifera* (turpentine)
- *Syncarpia hillii* (Fraser Island turpentine)
- *Syzygium crebrinerve* (purple cherry tree)
- *Syzygium francissii* (giant water gum)
- *Syzygium leuhmannii* (small leaved lilly pilly)
- *Syzygium oleosum* (blue lilly pilly)
- *Syzygium paniculatum* (magenta lilly pilly)
- *Toona ciliata* (red cedar)
- *Waterhousia floribunda* (weeping lilly pilly).

Exotic and non-indigenous native trees

Exotic trees from warmer climates are likely to withstand future temperature increases and are encouraged for use as feature trees and for colour and contrast in town centres or precinct areas. Council's preferred species include *Magnolia grandiflora* (bull magnolia), *Albizia* (syn. *Samanea*) *saman* (silk tree), and *Tamarindus indica* tamarind).

Trumpet trees (*Tabebuia argentea*, *Tabebuia pallida*) and the tree waratah (*Alloxyylon flameum*) are some of the exotic or non-indigenous native species that are providing visual diversity and value to Sunshine Coast landscapes.

Exotic trees for feature plantings

- *Caesalpinia ferrea* (leopard tree) (where existing only)
- *Delonix regia* (poinciana) (where existing only)
- *Jacaranda mimosifolia* (jacaranda) (where existing only)
- *Lagerstroemia indica* (crepe myrtle)
- *Liquidambar styraciflua* (sweet gum)
- *Magnolia grandiflora* (southern magnolia)
- *Peltophorum pterocarpum* (yellow flame tree)
- *Samanea* (syn. *Albizia*) *saman* (rain tree)
- *Tabebuia argentea* (silver trumpet tree)
- *Tabebuia chrysantha* (syn. *Handroanthus chrysanthus*) (yellow trumpet tree)
- *Tabebuia pallida* (trumpet tree)
- *Tabebuia palmeri* (pink trumpet tree)
- *Tamarindus indica* (tamarind)

Species for accents and highlights

Architectural plants that provide accents to streetscapes should be used to enhance the vibrancy and lush character of the Sunshine Coast. These include species that can be planted as under-story to large growing trees or grouped in sub-tropical garden beds, as well as species that can be planted as stand-alone features. Illawarra flame trees (*Brachychiton acerifolius*), lace barks (*Brachychiton discolor*) and firewheels (*Stenocarpus sinuatus*) are key local species recommended for continued use as accent plants. *Corymbia ptychocarpa* (swamp bloodwood) a signature tree of many of the coast's localities (although not native to the local area, naturally occurring in the northern most regions of Australia) also offers significant visual amenity when selected for use in the right location.

Species for accents and highlights

- *Alloxyylon flameum* (tree waratah)
- *Brachychiton acerifolius* (Illawarra flame tree)
- *Brachychiton bidwillii* (little kurrajong - Maroochydore form)
- *Brachychiton discolor* (lace bark)
- *Brachychiton populneus* (kurrajong)
- *Brachychiton rupestris* (bottle tree)
- *Corymbia ptychocarpa* (swamp bloodwood)
- *Magnolia* 'Little gem' (little bull magnolia)
- *Melicope elleryana* (euodia)
- *Pandanus tectorius* (screw palm)
- *Stenocarpus sinuatus* (fire wheel)
- *Tabebuia argentea* (Caribbean trumpet tree)
- *Tabebuia palmerii* (purple trumpet tree)
- *Tabebuia rosea* (pink poui / pink trumpet tree)

Fan palms (*Livistona* sp), flax (*Dianella* sp) and palm lillies (*Cordyline* sp), even the native ginger (*Alpinia* sp) can add colour to rainforest themed plantings. The use of cycads (*Zamia* and *Macrozamia* species), grass trees (*Xanthorrea australis*) and wallum grass trees (*Xanthorrea fulva*) (adapted to periodically inundated sites) provide striking ground cover features in natural character plantings or wherever low vegetation is appropriate for incorporation.

Palms and signature under-story plants for group plantings

- *Archontophoenix cunninghamiana* (piccabeen palm)
- *Atractocarpus* (syn. *Randia*) *fitzalanii* (native gardenia)
- *Cordyline petiolaris* (broad-leaved palm lilly)
- *Cordyline stricta* (slender palm lilly)
- *Cordyline rubra* (red-fruited palm lilly)
- *Hymenosporum flavum* (native frangipanni)
- *Livistona australis* (fan palm)
- *Livistona decora* (syn. *Livistona decipiens*) (ribbon fan palm)
- *Livistona muelleri* (northern cabbage palm)
- *Xanthorrea australis* (grass tree)
- *Xanthorrea fulva* (wallum grass tree)

Species for local streets

Tried and tested compact species should form the base palette of trees for local streets. Species over-use should be controlled by reserving standard species for standard locations and using signature palettes for higher impact plantings including entry statements, anchors and accents; and/or sites that can accommodate larger growing trees (wide verges, deep soils, truncated corners, park-street interfaces).

Base street palette for local/residential streets

- *Backhousia citriodora* (lemon myrtle)
- *Banksia integrifolia* (coastal banksia) (coastal areas)
- *Buckinghamia celcissima* (ivory curl)
- *Cupaniopsis anacardiodes* (tuckeroo)
- *Elaeocarpus obovatus* (hard quandong)
- *Elaeocarpus eumundii* (Eumundi quandong) (where existing only)
- *Grevillea baileyana* (white oak) (coastal and coastal plain locations)
- *Harpulia pendula* (tulipwood)
- *Melaleuca* (syn. *Callistemon*) *viridiflora* (broad leaved bottle brush)
- *Melaleuca* (syn. *Callistemon*) 'Wild fire' (bottle brush)
- *Syzygium hemilamprum* (syn. *Acmena*) *hemilampra* (blush satinash) (broad leaf or crinkle leaf form)
- *Tristaniopsis laurina* 'Luscious' (water gum)
- *Xanthostemon chrysanthus* (golden penda)

Cultivars and substitute species

It has been determined that more superior varieties of a number of commonly planted street tree species exist and should always be selected over standard species. The species cultivar *Tristaniopsis* 'Luscious' (water gum) should be given preference over the standard species (*Tristaniopsis laurina*) unless the planting site is particularly wet. The cultivar does not seem to respond to drought as severely as the straight species which can be a maintenance burden with prolific production of suckers/water sprouts as a response to dry soils. *Syzygium paniculatum* 'Southern Form' (magenta lilly pilly) has also proved to be a far superior street tree to the standard version of the species.

Accepted substitute species for the standard bottle brush *Melaleuca* (syn. *Callistemon*) *viminalis* include the more compact bottle brushes *Melaleuca* (syn. *Callistemon*) 'Wild fire' and *Melaleuca* (syn. *Callistemon*) *viridiflora*.

Melaleuca viridiflora is also known to have wide tolerance range including coastal exposed sites and its shorter stature offers potential for planting beneath overhead wires.

Syncarpia glomulifera (turpentine), and many species of the *Diploglottis* (tamarinds), *Cryptocarya* (laurels), *Diospyros* (ebonys) and *Angophora* (apple or rose gums) are good substitutes for the over-planted Queensland box (*Lophostemon confertus*).

Street tree trial species

Where no planting themes exist, trial species may be introduced to help enhance visual and genetic diversity over time.

Litsea leefeana (brown bolly gum), and *Cryptocarya glaucescens* (jack wood) native species that do not naturally occur locally for example have been identified as good candidates for trial sites. A whole suite of local rainforest species with a compact form on maturity (especially in cultivation) exist and are recommended for use in trial locations.

Trial species for residential streets

- *Acronychia oblongifolia* (white aspen)
- *Acronychia wilcoxiana* (silver aspen)
- *Alectryon subdentatus* (hard alectryon)
- *Alphitonia petriei* (white ash)
- *Athertonia diversifolia* (Atherton oak)
- *Barklya syringifolia* (leather jacket)
- *Castanospora alphanthii* (brown tamarind)
- *Cryptocarya glaucescens* (jackwood)
- *Diospyros australis* (black plum)
- *Diospyros germinata* (Queensland ebony)
- *Diospyros pentamera* (myrtle ebony)
- *Diploglottis campbellii* (small-leaved tamarind)
- *Endiandra sieberi* (corkwood)
- *Ellatostachys xylocarpa* (white tamarind)
- *Euroschinus falcata* (ribbonwood)
- *Guioa semi-glauc* (wild quince)
- *Leptospermum madidum* (weeping tea tree)
- *Litsea australis* (southern brown bolly gum)
- *Litsea leefeana* (brown bolly gum)
- *Mallotus discolor* (yellow kamala)
- *Mallotus philippensis* (red kamala)
- *Notolea longifolia* (mock olive)
- *Olea paniculata* (native olive)
- *Planchonella pohmaniana* (yellow boxwood)
- *Syzygium crebrinerve* (purple cherry tree)

Local and hinterland forms

Using alternative varieties or hinterland forms of more commonly used species is another way to diversify the coast's street tree population. Examples include using *Cupaniopsis parvifolia* (small leaved tuckeroo) instead of the standard species of tuckeroo (*Cupaniopsis anacardioides*), *Xanthostemon oppositifolius* (southern penda) instead of the much used golden penda (*Xanthostemon chrysanthus*), a hinterland alternate to *Grevillea baileyana* (white oak) – *Grevillea hilliana* (white silky oak). *Harpulia pendula* (tulip tree) may also be substituted for *Harpulia hillii* (blunt-leaved tulip) in appropriate hinterland locations while the Whitsunday's local form of the hoop pine (*Araucaria cunninghamii*) may prove to be the most successful ecotype for near-coastal locations.

A red foliated variety (*Hibiscus tiliaceus* var. 'Rubra') of the common cotton tree (*Hibiscus tiliaceus*) offers an alternative to the regular species. The 'Hawaiian' form of the Norfolk Island / Cook's pine is sad to have a far superior appearance with shorter internodes (spaces between branches) that the standard Norfolk Island pine and a straighter trunk that the Cook's pine.

A local form of the tumbledown gum *Eucalyptus bancroftii* is also superior to standard strains and preferred for use on the Sunshine Coast.

Brachychiton bidwillii could potentially be used in place of the lace bark (*Brachychiton discolor*) or Illawarra flame tree (*Brachychiton acerifolius*). A 'Maroochyodore' form of this species warrants further investigation.

Hinterland variations for residential street tree palette

- *Arbutus X andrachnoides* (Greek strawberry tree)
- *Cupaniopsis parvifolia* (small-leaved tuckeroo)
- *Grevillea hilliana* (white silky oak)
- *Harpulia hillii* (blunt-leaf tulip)
- *Leptospermum brachyandrum* var. *longifolia* (weeping tea tree)
- *Melaleuca bracteata* (black tea tree)
- *Syncarpia hillii* (turpentine)
- *Xanthostemon oppositifolius* (southern penda)

Species for coastal (exposed) sites

Streetscapes that interface with foreshore areas of the Sunshine Coast have been identified as key areas for rejuvenation. While the palette of suitable street tree species is justifiably limited (due to the nutrient poor, freely draining soils, heavy exposure and salt-laden winds of these environments), species of non-local origin may offer alternatives and visual contrast in appropriate areas (where conservation value is not significant).

In addition to the *Cocos nucifera* (coconut palm) the native but not indigenous *Calophyllum inophyllum* (beauty leaf) is another species currently being trialled by council in heavily exposed coastal locations.

Base coastal front line/exposed street tree palette

- *Araucaria heterophylla* (Norfolk Island pine)
- *Athertonia diversifolia** (Atherton oak) (trial species)
- *Banksia integrifolia* (coastal banksia)
- *Calophyllum inophyllum** (beauty leaf) (trial species)
- *Cocos nucifera** (coconut) (trial species)
- *Casuarina equisetifolia* (horse tail sheoak)
- *Casuarina glauca* (swamp sheoak)
- *Hibiscus tiliaceus* (cotton tree)
- *Leptospermum laevigatum** (coast tea tree) (trial species)
- *Pandanus tectorius* (pandan/screw palm)
- *Terminalia catappa* (beach almond) (where space permits)



Species to consider carefully before use

Several species have been identified as inappropriate for standard street tree planting situations. These either have a propensity for the development of large surface roots, a shrub-like form that is not suited to restricted road verges or extreme susceptibility to the Myrtle Rust disease.

Species not recommended for planting as street trees on the Sunshine Coast

- *Eucalyptus* 'Summer red' and 'Summer beauty'
- *Elaeocarpus reticulatus* (blueberry ash)
- *Melaleuca leucadendra* (weeping paperbark)
- *Rhodospaera rhodanthema* (tulip satinwood)
- *Rhodomyrtus psidioides* (native guava)
- *Syzygium jambos* (Malabar plum)
- *Syzygium tierneyanum* (river cherry)

See also *Analysis: Weed and environmental weed species*.

Other species have been identified for performance monitoring. These includes species that may have weed potential but there is not enough evidence to discontinue use, or species that are highly inconsistent in performance. These species should only be used to carry existing themes and should not be introduced into new streetscapes until more is known.

Species to use sparingly or only where existing

- *Grevillea baileyana* (white oak)
- *Elaeocarpus eumundii* (Eumundi quandong)
- *Jacaranda mimosifolia* (blue jacaranda)
- *Lophostemon confertus* (Queensland brush box)

Other species are highly attractive but have large falling fruits, fronds or other associated debris or have a branching structure that is not conducive to pruning. These species should only be located in garden beds.

Species for use in garden beds only

- *Araucaria bidwillii* (bunya)
- *Caesalpinia ferrea* (leopard tree)
- *Callitris columellaris* (Bribie Island pine)
- *Castanospermum australe* (black bean)
- *Commersonia bartramia* (brown kurrajong)
- *Grevillea robusta* (silky oak)
- *Ficus* sp (fig trees - all species)
- *Mangifera indica* (mango)
- *Melicope elleryana* (pink euodia)
- *Pandanus tectorius* (screw pine)
- *Peltophorum pterocarpum* (yellow flame tree)
- *Syzygium forte* (white apple/flaky barked satinash)
- *Syzygium moorei* (coolamon)
- *Syzygium oleosum* (blue lilly pilly)
- *Terminalia catappa* (Indian almond)

Flying foxes and street tree species

It is well understood that flying foxes are nocturnal and travel some distance to forage therefore avoiding planting preferred foraging species as street trees (which is a considerable palette) is not a viable management option. In streets immediately adjacent to identified urban roosts however, low fruiting or low nectar producing species may be used to avoid foraging as well as roosting where flying fox roosts are causing concern for local residents. Species that are not preferred foraging food for flying foxes include conifers which have no or inconspicuous fruits and flowers or low nectar producing flowers. Species suited to the Sunshine Coast are listed below.

Low fruiting or low nectar producing species for localities with flying fox roosts

- *Allocasuarina littoralis* (swamp sheoak)
- *Agathis robusta* (kauri pine)
- *Araucaria heterophylla* (Norfolk Island pine)
- *Brachychiton acerifolius* (Illawarra flame tree)
- *Brachychiton discolor* (lace bark)
- *Brachychiton populneus* (kurrajong)
- *Brachychiton rupestris* (bottle tree)
- *Backhousia citriodora* (lemon myrtle)
- *Callitris columellaris* (Bribie Island pine)
- *Casuarina equisetifolia* (horse tail sheoak)
- *Casuarina glauca* (swamp sheoak)
- *Delonix regia* (poinciana)
- *Hymenosporum flavum* (native frangipanni)
- *Leptospermum petersonii* (lemon-scented tea tree)
- *Leptospermum polygalifolium* (yellow tea tree)
- *Notolaea longifolia* (mock olive)
- *Petalostigma triloculare* (long leaf bitter bark)



Sunshine Coast Council Draft Street Tree Master Plan Part A 107



108 DRAFT Sunshine Coast Street Tree Master Plan Part A



Implementation

Funding

Reactive street tree planting and maintenance is currently funded through the operational street tree maintenance budget which allows for replacement of trees removed, new trees plantings on request (where local residents are asked to help care for trees) and an annual program of 'whole street' plantings which focuses on residential areas where tree cover is especially low. A new operational proactive street tree planting program budget was provided in 2017/18 in order to implement the street tree planting priorities identified in this plan.

Where community members are interested in partnering with council in the care and maintenance of new trees, significant cost savings can be made. Community engagement as a part of the development of this plan and council's 'Adopt a street tree' program will provide opportunity for the Sunshine Coast community to provide feedback on the plan and nominate residential streets for new street tree plantings. This will allow council to finalise street tree planting priorities and determine appropriate budgets and time frames for the plan's implementation.

Monitoring and review

Programs of data capture for all newly planted trees currently in place will facilitate tracking and monitoring of council's 'no net loss' approach to street tree management as well as assist in the management of young tree maintenance programs and surveys of street tree survival.

New tree data capture, as well as data collected during both reactive (as a response to customer requests for maintenance) and proactive tree inspection, will allow council to develop species composition and performance profiles to further develop tree selection requirements for the future.

Council intends to monitor patterns of change in vegetative cover in the region through on-going analysis of spatial data. Fresh *LiDAR* data capture is scheduled for 2017. Generation of new vegetation statistics and comparison with existing data will allow tracking of council's performance.

Ongoing collection and assessment of multi-spectral seasonal fractional statistics as well as *LiDAR* derived data will allow council to continue to monitor patterns of change in vegetative cover in the region over time and develop street tree planting targets for sustaining the environmental, aesthetic social and economic benefits of street trees.

The *Master plan report* and series of *Precinct planting strategies* (Parts A & B) have a 20 year planning horizon but will be reviewed as required to respond to changes in legislation and the wishes and needs of the community.

The *Priority planting plans* have been prepared with a five year time frame for delivery in mind. This implementation period may be shorter or longer depending on community support and interest in council's 'Adopt a street tree' planting program, council's wider priorities and available program budgets.

Once implementation is completed a review of planting priorities for each of the Sunshine Coast's distinct local areas will be undertaken.



Action plan

A three-staged action plan has been developed for short, medium and longer term implementation of the plan. Stage one actions are intended for implementation within the short term. Stage two actions are intended for implementation within two years and Stage three action items have been developed according to a five year implementation time frame.

Stage one

Action	Timing
Prepare master plan report and develop key street tree planting priorities.	Complete
Develop local street tree planting strategies for the region's 27 Local Plan Areas.	Complete
Prepare a 'plantable spaces' inventory to address short term street tree planting priorities.	Complete
Consult with key stakeholders (tree suppliers, Department of Transport and Main Roads, Energex, Unity Water) and local residents. Finalise master plan report and street tree planting strategies.	November 2017
Enhance and extend young tree maintenance programs.	Ongoing
Capture and track all new street tree plantings.	Ongoing
Secure program funding for implementation of precinct based street tree planting priorities, including community engagement.	Complete
Commence implementation of street tree priority planting program focusing on sites with high impact and low conflict potential.	Ongoing
Grow species specified in planting palettes at council's nursery.	Ongoing
Review Energex-SCC MOU with a view to securing better street tree outcomes to counteract requirements for protection of the electrical network.	2017
Incorporate street tree planting priorities and 'Tree sensitive design' into capital works program.	Ongoing
Prepare fact sheets describing the traits, required care and general performance of the best represented species in the region.	November 2017
Provide free appropriate shade tree species to local residents for planting on private land.	Ongoing
Commence street tree planting trials of new or under-utilised species.	Ongoing
Develop agreements for council delivery of new trees in all estates and investigate capacity and options for council to supply and maintain all new plantings in residential estates.	2017-2018
Landscape designs (including street trees) are developed for all intersections mapped in the Sunshine Coast Planning Scheme 2014 as Regional and Local Gateways	2017-2018

Stage two

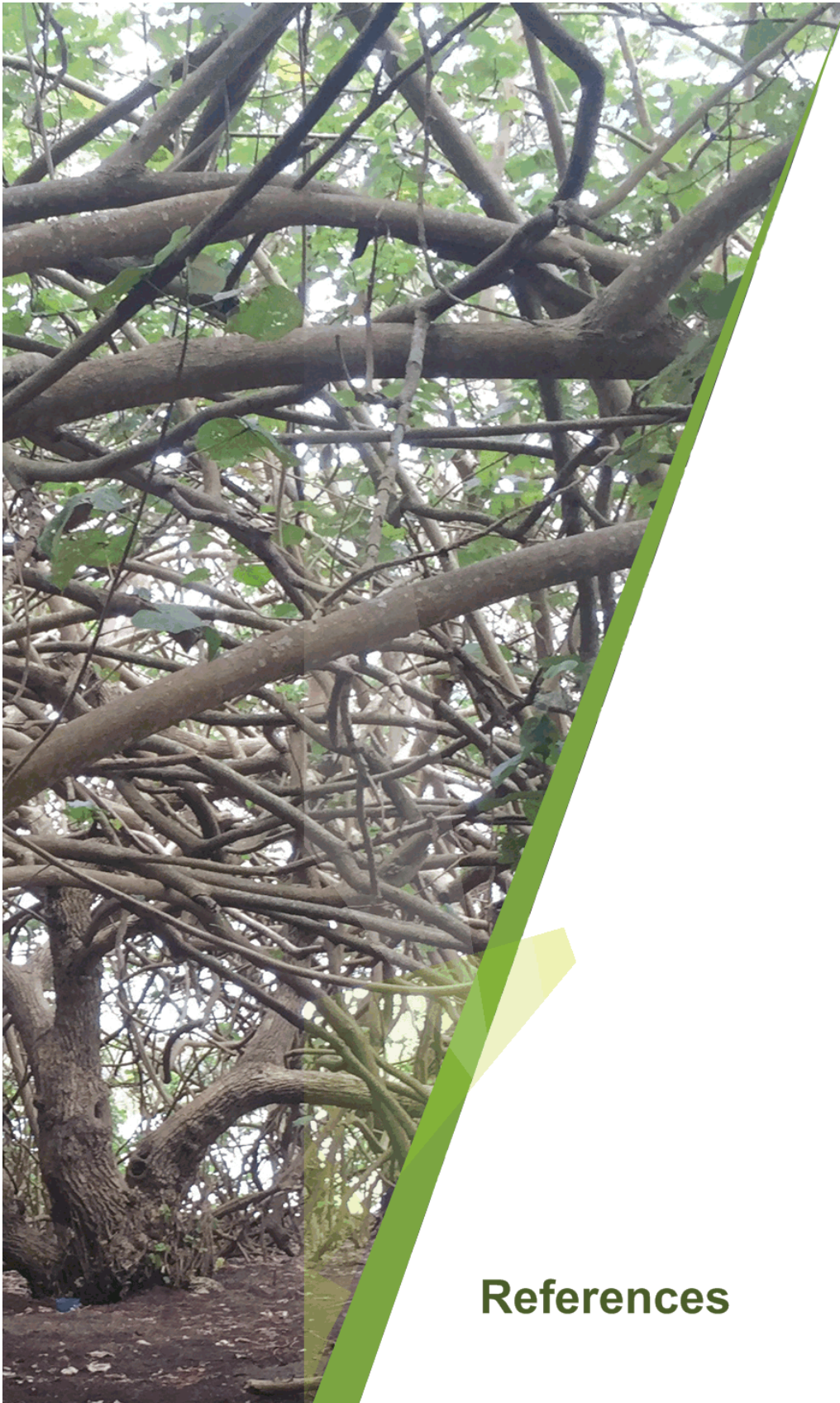
Action	Timing
Develop priorities for residential street tree planting programs through community engagement. Prioritise planting in streets where residents will act as 'tree stewards'.	2017-2018
Commence implementation of the 'Adopt a street tree' program.	2017-2018
Undertake localised heat/vulnerability studies to further refine priority streets for tree planting. Incorporate further analysis of council's existing <i>LiDAR</i> derived dataset to map 'hot spots'. Prioritise street tree planting programs in identified 'hot spots' that coincide with areas where heat vulnerable community members live and congregate. Prioritise street tree planting in 'hot spots' within the Sunshine Coast <i>Enterprise Growth Corridor</i> .	2017-2018
Enter into partnerships with external service providers to create streetscape feature plantings away from infrastructure.	Ongoing
Identify declining or vulnerable vegetation in streets that interface with foreshore areas. Undertake succession tree planting in conjunction with view shed mapping in close consultation with the community.	2017-2019
Analyse fresh <i>LiDAR</i> capture and correlate against existing canopy coverage data to identify patterns and track progress.	2017-2018
Develop shade targets for heat exposed activity areas such as near schools, shops, bus stops, hospitals, child care and aged facilities) across LPAs.	2017-2019
Commence a program of street tree data collection in new residential estates specifically targeting local streets with narrow road and verge widths to determine whether the establishment and growth potential of street trees are significantly compromised.	2018-2030
Identify opportunities for research partnerships with Sunshine Coast University and citizen science schemes to assist with monitoring UHI effects and developing urban biodiversity enhancement. Develop an award scheme for 'Tree sensitive design'.	2018-2020

Stage three

Action	Timing
Determine street tree planting priorities for connecting habitat or biodiversity corridors and providing buffer plantings to natural area reserves.	2018-2020
Undertake street tree population health (useful life expectancy) studies and develop strategies for succession planning and tree planting sustainability targets.	2018-2020
Report on relationships between tree canopy cover and socio economics, health, crime and weather data to further develop tree planting priorities for the region.	2018-2020
Create structured spaces for trees in key locations in conjunction with council partners.	2018-2020
Undertake analysis of tree survival, maintenance and customer request data to determine whether species patterns exist that can be remedied through tree selection.	2018-2020
Develop street by street species recommendations for the region.	2018-2020
Review the impact of projects in the last 5 years.	2018-2020
Set 2030 and 2050 resilience and tree cover targets.	2018-2020



114 DRAFT Sunshine Coast Street Tree Master Plan Part A



References

References

- Australian Bureau of Statistics (2016) *Regional Population Growth. Australia, 2014-15*, cat. no. 3218.0. Available at <http://www.abs.gov.au/Population> Accessed 10 May, 2016.
- Ali-Toudert, F. and Mayer, H. (2007) *Thermal comfort in an east-west oriented street canyon in Freiburg (Germany) under hot summer conditions*. Theoretical and Applied Climatology 87: 223 - 237.
- Akbari, H. (2001) *Energy saving potentials and air quality benefits of urban heat island mitigation*. Heat Island Group. Lawrence Berkeley National Laboratory. Research Paper. Available at <http://www.osti.gov/scitech/servlets/purl/860475> Accessed 27 April, 2016.
- Amati, M. (2013) *Understanding the carbon and pollution mitigation potential of Australia's urban forest*. Final Report - Project Number: NY11002. Melbourne, La Hilliana University.
- Astell-Burt, T., Feng, X. and Kolt, G.S. (2014) *Neighbourhood green space is associated with more frequent walking and moderate to vigorous physical activity (MVPA) in middle-to-older aged adults. Findings from 203,883 Australians in the 45 and up study*. British Journal of Sports Medicine 2014; 48(5):404-06. Available at <http://www.ncbi.nlm.nih.gov/pubmed/23632744> Accessed 9 May, 2016.
- Astell-Burt, T., Feng, X. and Kolt, G.S. (2014) *Greener neighbourhoods, slimmer people? Evidence from 246,920 Australians*. International Journal of Obesity 2014; 38(1):156-59. Accessed 9 May 2016. Available at <http://www.ncbi.nlm.nih.gov/pubmed/23732654> Accessed 10 May, 2016.
- Block, A., Livesley, J. and Williams, N. (2012) *Responding to the urban heat island: a review of the potential of green infrastructure*. Report available at <http://www.vccar.org.au>. Accessed 6 September, 2016.
- Burden, D. 2006 22 *Benefits of urban street trees*. Walkable communities, Inc. Port Townsend. Accessed 9 May 2016. Available at https://www.michigan.gov/documents/dnr/22_benefits_208084_7.pdf Accessed 10 May, 2016.
- City of Melbourne (2012) *Urban forest strategy: making a great city greener 2012-2032*. Accessed 11 January 2016. Available at <https://www.melbourne.vic.gov.au/SiteCollectionDocuments/urban-forest-strategy.pdf> Accessed 11 January, 2016.
- Clarke J., Wilson L., & Heady, C. (2016). *Future Climate of the Sunshine Coast, Queensland*. CSIRO, Australia Department of Infrastructure and Planning (2009) *South East Queensland Regional Plan 2009-2031*. Brisbane, The State of Queensland.
- de Vries, S., S. M. van Dillen, P. P. Groenewegen and P. Spreewenbergen (2013). *Streetscape greenery and health: Stress, social cohesion and physical activity as mediators*. *Social Science & Medicine* 94: 26-33.
- Doick, K. and Hutchings, T. (2013) *Air temperature regulation by urban trees and green infrastructure*. Research Note FCRN012. Accessed 29 April 2016. Available at <http://www.forestry.gov.uk>
- Dowdy, A. et al. 2015, *East Coast Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions*: Cluster Reports, eds. Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia. http://www.climatechangeinaustralia.gov.au/media/ccial/2.1.5/cms_page_media/172/EAST_COAST_CLUSTER_REPORT_1.pdf accessed on 27th April 2016
- Dumbaugh, E. (2006). *Design of safe urban roadsides: An empirical analysis*. Transportation Research Record: Journal of the Transportation Research Board Vol. 1961: 74-82.
- Ely, M. and Pitman, S (2014) *Green Infrastructure: Life support for human habitats. A review of research and literature*. Prepared for the Green Infrastructure Project, Botanic Gardens of Adelaide.
- Faber-Taylor, A., Kuo, F. E., & Sullivan, W.C. (2002) *Views of nature and self-discipline: evidence from inner city children*. Journal of Environmental Psychology, 22, 49-63.
- Grimm, N.B., Faeth, S.H., Golubiewski, N.E., Redman, C.L., Wu, J., Bai, X., Briggs, J.M. (2008) *Global change and the ecology of cities*. Science, 2008 319 (5864): p 237-254. Available at <http://www.public.asu.edu/~nbg/rim/USEL/CV2008> Accessed 27 April, 2016.
- Hartig, T., Mang, M., and Evans, G.W. (1991) *Restorative effects of natural environment experience*. Environment and Behaviour, 23, 3-26.
- Invest Sunshine Coast (2012). *Sunshine Coast Council - Business Sunshine Coast*. Available at <http://invest.sunshinecoast.qld.gov.au/> Accessed 30 June 2016.
- International Association for Plant Taxonomy (2012) *Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. Available at <http://www.iapt-taxon.org/nomen/main.php> Accessed 4 September, 2016.
- Jacobs, B., Mikhailovich, N. and Delaney, C. (2014) *Benchmarking Australia's urban tree canopy: An i-Tree Assessment*. Prepared for Horticulture Australia Limited by the Institute for Sustainable Futures, University of Technology, Sydney. DOI: 10.1016/j.scitotenv.2012.02.080
- Jessup, L.W. (2015) Ebenaceae. In P.D. Bostock & A.E. Holland (eds), *Census of the Queensland Flora 2015*. Queensland Department of Science, Information Technology and Innovation: Brisbane. <https://data.qld.gov.au/dataset/census-of-the-queensland-flora-2015>. Accessed 4 September, 2016.
- Kendal, D., C. Dobbs and V. I. Lohr (2014) *Global patterns of diversity in the urban forest: Is there evidence to support the 10/20/30 rule?* Urban Forestry and Urban Greening 13(3): 411-417.
- Kendal, D., A. Farrar, L. Plant, C.G. Threlfall, J Bush, J Baumann (2017) *Risks to Australia's urban forest from climate change and urban heat*. School of ecosystem and Forest Sciences, The University of Melbourne, Victoria, Australia.

- Kuo, F.E., and Faber Taylor, A. (2004). *A potential natural treatment for attention deficit/hyperactivity disorder: evidence from a national study*. American Journal of Public Health, 94(9), 1580-1586
- Kuo, F.E. & Sullivan, W.C. (2001) *Environment and crime in the inner city: Does vegetation reduce crime?* Environment and Behavior, 33(3), 343-367.
- Kimlin, M. G. and Guo, Y. (2012) *Assessing the impacts of lifetime sun exposure on skin damage and skin aging using a non-invasive method*. Science of the total environment, 2012; 425: 35 *reduce crime?* Environment and Behaviour, 33(3), 343-367.
- Kurn, D.K., Bretz, S.E. & Akbari, H. (1994) *The potential for reducing urban air temperature and energy consumption through vegetative cooling*. Proceedings of the 1994 Summer Study on Energy Effects in Buildings, Pacific Grove, CA.
- Largo-Wight, E., Chen, W. W., Dodd, V. & Weiler, R. *Healthy workplaces: The effects of nature contact at work on employee stress and health*. Public Health Reports 126, 124 (2011).
- Leake, S. and Haegi, E. (2014) *Soils for landscape development*. CSIRO Publishing, Collingwood. Victoria.
- Lin, B, Meyers, J, Barnett, G. (2016) *The role of vegetation for climate change adaptation in cities*. Treenet Symposium Proceedings 2016.
- Livesley, S. J., B. Baudinette and D. Glover (2014). *Rainfall interception and stem flow by eucalypt street trees – The impacts of canopy density and bark type*. Urban Forestry & Urban Greening 13(1): 192-197.
- Low Coy, D., Baum, S., Serrao-Neumann, S., Crick, F., Sano, M. and Harman, B. (2010) *Climate change vulnerability in South East Queensland: a spatial and sectoral assessment*. A report for the South East Queensland Climate Adaptation Initiative. Griffith University. June 2010.
- Miller, R.W. (1997) *Urban Forestry: planning and managing urban green spaces*. 2nd Edition. Prentice-Hall, New York, N.Y.
- McCarthy, M.P., Best, M.J., Betts, R.A. (2010) *Climate change in cities due to global warming and urban effects*. Geophysical research letters, 2010. 37 (9):p.n/a
- McPherson, G. (2009) *Urban Forest impacts on carbon, water and urban heat islands*. Centre for Urban Forest Research, USDA Forest Service.
- McPherson, E. G., N. van Doorn and J. de Goede (2016). *Structure, function and value of street trees in California, USA*. Urban Forestry and Urban Greening 17: 104-115.
- Naderi, J.R. (2003) *Landscape design in the clear zone: The effects of landscape variables on pedestrian health and driver safety*. In Transportation Research Board, 82nd Annual Conference Proceedings. Transportation Research Board, Washington DC.
- National Urban Forest Alliance (2014) *Australian partnership plan 2014-2020*. Available at <http://www.campbelltown.sa.gov.au/webdata/resources/files/NUFA%20Partnership%20Plan%202014-2020.pdf>. Accessed 11 January 2016.
- Navie, S. (2014) *Plants from tropical Queensland becoming environmental weeds in sub-tropical Australia: an emerging threat*. Proceedings of the 19th Australasian Weeds Conference 2014, Hobart, Tasmania.
- NGIA (2012) *Mitigating Extreme Summer Temperatures with Vegetation*. Nursery Papers 5, Nursery and Garden Industry Australia.
- Norton, B., Bosomworth, K., Coutts, A., Williams, N., Livesley, S., Trundle, A., Harris, R. and McEvoy, D. (2013) *Planning for a cooler future: green infrastructure to reduce urban heat*. Victorian Centre for Climate Change adaptation response. October 2013.
- Norton, B.A., Coutts, B.A., Livesley, S., Harris, R., Huntera, A., Williams, N. and McKeon, A. (2015) *Planning for cooler cities: A framework to prioritise green infrastructure to mitigate high temperatures in urban landscapes*. Available at <http://www.vcccar.org.au/responding-to-urban-heat-island-optimising-implementation-green-infrastructure>. Accessed 9 January 2016.
- Office of Environment and Heritage (NSW) (2013) *Save power: what can you do in your world?* Available at <http://www.savepower.nsw.gov.au/business/power-saving-tips/increase-the-temperature-setpoint-when-cooling.aspx> Accessed 17 April 2016.
- Oke, T. R. (2009) *The need to establish protocols in urban heat island work*. Eighth Symposium on Urban Environments, 10-15 January, Phoenix, Arizona.
- Planet Ark 2016. *Adding trees: a prescription for health, happiness and fulfilment*. A research report commissioned by Planet Ark and sponsored by Toyota Australia.
- Plant, L., A. Rambaldi and N. Sipe (2017). *Evaluating Revealed Preferences for Street Tree Cover Targets: A Business Case for Collaborative Investment in Leafier Streetscapes in Brisbane, Australia*. Ecological Economics 134: 238-249.
- Plant, L. and N. Sipe (2016). *Adapting and applying evidence gathering techniques for planning and investment in street trees: A case study from Brisbane, Australia*. Urban Forestry & Urban Greening 19: 79-87.
- Sarkar, C., C. Webster, M. Pryor, D. Tang, S. Melbourne, X. Zhang and L. Jianzheng (2015). *Exploring associations between urban green, street design and walking: Results from the Greater London boroughs*. Landscape and Urban Planning 143: 112-125.
- Santamour, F. S. Jr. (1990) *Trees for Urban Planting: Diversity, Uniformity, and Common Sense*. Procedures of 7th Conference of Metropolitan Tree Improvement Alliance (METRIA), 1990. Forestry Sciences Laboratory, Athens GA.

- Shashua-Bar, L., Oded, P., Arie, B., Dalia, B. & Yaron, Y. (2010) *Microclimate modelling of street tree species effects within the varied urban morphology in the Mediterranean city of Tel Aviv, Israel*. International Journal of Climatology 30: 44 - 57.
- Steffen, W., Hughes, L., Sahajwalla, V. & Hueston, G. (2012) *The Critical Decade: Queensland climate impacts and opportunities*. The Climate Commission. Commonwealth of Australia.
- Sunshine Coast Council (2016) *Sunshine Coast development indicators*. January to March 2016 quarterly highlights and heat map. Available at <https://www.sunshinecoast.qld.gov.au/Development/Development-Tools-and-Guidelines/Development-Indicators-Report>. Accessed 9 May, 2016.
- Wolf, K. L. (2005). *Trees in the small city retail business district: comparing resident and visitor perceptions*. Journal of Forestry 103(8): 390-395.
- Sunshine Coast Council (2016) Fact sheet: *Sunshine Coast Population and Household Forecasts 2011 to 2026*. Available at <https://www.sunshinecoast.qld.gov.au/Experience-Sunshine-Coast/Statistics-and-Maps/Population-Forecast>. Accessed 4 January, 2017.
- Svendsen, E. (2009). *Cultivating resilience: Urban stewardship as a means to improving health and well-being*. Restorative commons: Creating health and well-being through urban landscapes: 58-87.
- Thom, J. K., Coutts, A. M., Broadbent, A. M. and Tapper, N. J. (2016). *The influence of increasing tree cover on mean radiant temperature across a mixed development suburb in Adelaide, Australia*. Urban Forestry and Urban Greening, 20, 233-242.
- Ulrich, R.S. (1984) *View through a window may influence recovery from surgery*. Science 224:420-421.
- Williams, K.J., Dunlop, M., Bustamante, R.H., Murphy, H.T, Ferrier, S., Wise, R.M., Liedloff, A., Skewes, T., Harwood, T.D, Kroon, F., Williams, R.J., Joehnk, K., Crimp, S., Stafford Smith, M., James, C. and Booth, T. (2012) *Queensland's biodiversity under climate change: impacts and adaptation – synthesis report*. A Report Prepared for the Queensland Government, Brisbane. CSIRO Climate Adaptation Flagship, Canberra.
- Willmot, W. (2007) *Rocks and Landscapes of the Sunshine Coast*. Second edition. Geological Society of Australia, Qld Div, Brisbane.
- Yamamoto, T. (1999) *Urban ecosystem analysis; measuring values of urban trees in terms of carbon storage and sequestration, energy conservation for buildings and urban heat island mitigation using GIS in Brisbane City*. University of Queensland, Master's Thesis.
- Ziemer, S., Martin, R.M., Ratick, D.G., and Delauer, N (2013) *The impact of tree cover loss on land surface temperature: A case study of central Massachusetts using Landsat Thematic Mapper thermal data*. Applied Geography 45:49–57.
- 2020 Vision (2013) *How to grow and urban forest*. Available at <http://2020vision.com.au/media/53149/urban-forest-strategy> Accessed January 11, 2016.



120 DRAFT Sunshine Coast Street Tree Master Plan Part A



Glossary

Glossary

Ambient temperature	The temperature of the surrounding air in a particular setting - i.e. inside a house or room, outside a particular public space.
Amenity tree	Trees with a primary purpose of providing social, economic, visual or environmental benefits to humans (in contrast with trees with primary production purposes such as timber or fruit). Street trees are predominately amenity trees.
Biodiversity	The variety of plant and animal life on a global or local scale.
Canopy cover / tree cover	The area occupied by tree foliage when seen in plan view (i.e. 'Birds eye view') either estimated in square metres for individual trees from field measures of the tree canopy spread or measured from aerial, satellite or <i>LiDAR</i> imagery analysis and expressed as square metres or percentage of land cover within a defined area such as road reserves, suburbs or local areas.
Carbon emissions	Every time fossil fuels such as gas, coal or oil are burnt, carbon dioxide is released into the atmosphere. These emissions, which are the predominant source of greenhouse gas emissions if not reabsorbed by plants and trees, trap and hold solar radiation (heat) in the atmosphere (plants and trees directly absorb carbon dioxide and can indirectly reduce carbon emissions by reducing air-conditioner use from shading and cooling effects or vehicle use through greater uptake of walking, cycling and public transport).
Carbon sequestration	A natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form. In the case of trees, carbon removed from the air is stored in wood.
Clear zone	The distance from the edge of the road carriageway that must remain free of any elements including vegetation that a vehicle could collide with in a high speed situation that could otherwise have potentially recovered control of the vehicle and returned to the road. Actual clearance distances are set in accordance with the speed limit, traffic volume and road geometry.
Climate Change	A long-term change in climate (weather and temperature) patterns on a global or local level, directly or indirectly linked to human activity, and over and above natural climatic variability recorded for similar time periods.
CPTED	Crime prevention through environmental design.
Deciduous	Refers to types of trees or shrubs that lose their leaves at one time during the year.
Ecosystem	A natural unit consisting of all plants, animals and micro-organisms in an area, functioning together with abiotic (non-living) features (soil, water, minerals etc.).
Ecosystem services	Ecosystem services (ES) are the direct and indirect goods and services provided by ecosystems for human well-being. They range from clean air and water, carbon storage and sequestration, production of food, recycling of soil nutrients, biodiversity, control of pests, to liveable climates, cultural and educational values. Those that impact negatively on human well-being are termed disservices. The urban forest is one of the main suppliers of Urban ES.
Ecotype	Geographic origin. Tolerance to drought, soil types or temperature can vary when a single species of vegetation grows naturally across a broad range of ecotypes.

Greenhouse gas emissions	Any gaseous compound that is capable of trapping and holding infrared radiation (heat) in the atmosphere. Generally carbon dioxide (CO ²).
Foliage score	Foliage score is a rating from 0 to 10, used in the analysis of Sunshine Coast vegetation, derived from a combination of measures of canopy cover, vegetation height, projected shade cover in midsummer, and foliage density, across defined areas, which provides a representation of the value of the vegetation.
Frangible vegetation	Vegetation that breaks on impact.
Evaporative cooling	Reduction in temperature resulting from the evaporation of a liquid. In reference to trees, evaporation of leaf water from pores in the surface of leaves (transpiration) effecting a temperature reduction.
Exotic	Refers to a non-native plant originating or naturally occurring in another country.
Genetic diversity	The total number of genetic characteristics in the genetic makeup of a species. Genetic diversity serves as a way for populations to adapt to changing environments.
Greenhouse gas emissions	Any gaseous compound that is capable of trapping and holding infrared radiation (heat) in the atmosphere.
Heat island effect	An urban environmental phenomenon whereby hard surfaces high in thermal conductivity and heat storage capacity, and low in reflectivity, increase ambient temperature and retain heat compared to surrounding areas less dominated by built form.
LAI (Leaf area index)	A measure of canopy density determined by the ratio of total leaf area to area of the canopy extent. Dense canopied trees have high LAI.
LGA	Local government area.
LIDAR	Light Detection And Ranging. Technology that uses millions of laser pulses to analyse the earth's surface in three dimensions at very fine scales. Laser light pulses penetrate through vegetation canopies and therefore provide a way to accurately measure the location, height and density of vegetation as well as the form and location of surrounding ground surfaces, buildings and infrastructure.
Native	Belonging to a country. In Australia, native plants naturally occur in Australian landscapes.
Photosynthesis	The process whereby a plant turns water and carbon dioxide into usable energy when the plant is exposed to sunlight. Oxygen is generally released as a by-product.
Radiant heat	Heat created by invisible electromagnetic infrared waves. Each element in the urban environment absorbs and reflects heat from sunlight to varying extent during a 24 hour period. There are consequent effects which are measurable in both ambient air temperature changes and radiant heat changes. Radiant heat changes are captured using a thermal infrared cameras and other micro-climate equipment.

Regional Ecosystem	Regional ecosystems were originally described by Sattler and Williams defining vegetation communities within bioregions with a particular and consistent combination of associations including geology, land type and soil.
Respiration	A series of chemical reactions occurring in all living organisms to produce usable energy out of sugar. Oxygen is generally consumed and carbon dioxide released.
Street trees	Trees that grow along streetside footpaths (or verges).
Sunshine Coast Native	A species that naturally occurs (originates) on the Sunshine Coast. A locally native tree.
Thermal conductivity	Capability to transfer heat. Materials such as bricks, bitumen and concrete have high thermal conductivity, absorbing large quantities of solar radiation, and consequent heat, during the day, and then release it at night to contribute to urban heat island effects.
Tree	A woody perennial plant generally over five meters in height and more or less with branches radiating outwards from a single trunk.
Urban forest	All vegetation, planted or naturally grown, on public and private land within towns and cities including backyards, parks, natural area reserves, waterways, plazas, etc. Urban forest management most commonly refers to the tree component.
Urban canopy layer (UCL)	The layer of air between the ground and the top of roofs/trees. The micro climate around buildings and vegetation, within the UCL is the zone which directly effects humans experience of urban climate.



126 DRAFT Sunshine Coast Street Tree Master Plan Part A



Appendix

Assessment of mapped existing vegetation cover

Method

The detailed vegetation mapping and statistics reported for Local plan areas (LPAs) are created using GIS mapping software, by performing calculations on advanced imagery captured from planes and satellites. Two light based imaging sensors were utilised in this study. The first is called *LiDAR* (Light Detection And Ranging) and uses lasers and precise 'time-of-flight' measurements. The second is called multispectral imaging, and uses cameras that are sensitive to light in non-visible wavelengths, i.e. beyond the red, green, and blue that a human eyes sees. These special light sensors have been proven as a dependable source of information for measuring the biophysical environment. Recent lowering of costs have provided opportunity for government and industry to increase their use of these technologies for consistent measurement, and for long-term monitoring of vegetation.

LiDAR Mapping

Aerial Laser Survey is a mapping technique that uses laser pulses to map objects in three dimensions (see Figure 1: Profile view of *LiDAR* mapping technique). The technology can create 3D maps of vegetation, buildings, and the ground. The Sunshine Coast Council captured its most recent Aerial Laser Survey in 2014 using a combination of light aircraft, high precision GPS satellite receivers, lasers and intelligent software.

More than 27 billion laser survey strikes captured over the entire region were converted into mapping outputs at 20 cm accuracy, and at one metre resolution. This aspect of the technology provides a way to accurately measure the location, height and structural properties of urban, horticultural and natural forest vegetation including topographic contours, building heights, and vegetation densities.

LiDAR Vegetation Statistical Methods

LiDAR pulses in Aerial Laser Mapping penetrate through the tree canopy and often reach the ground. This aspect of the technology provides a way to accurately measure the location, height and structural properties of urban, horticultural and natural forest vegetation in both two (plan) and three dimensions (height and density). Using GIS software, the 2014 *LiDAR* mapping data has been used to generate statistics surrounding the coverage and structure of vegetation across the chosen reporting area.

Canopy cover, height and density, shade projection in mid-summer, were measured per square metre of land, averaged for each of the localities of study and used to calculate a Foliage Score.

- **Canopy Cover** is the percentage of land covered by vegetation (greater than 2 m in height)
- **Canopy Height** is the height of vegetation (including all vegetation greater than 30 cm in height)
- **Canopy Shade** is the total area of land directly covered by vegetation as well as land shaded by vegetation in mid-summer at 9 am and 3 pm. Shade is calculated using vegetation height and time of day within mapping software.
- **Foliage Density** is the percent of sky view being blocked by leaves, branches and fruit determined by the *LiDAR* pulse penetration analysis.
- **Foliage score** is a rating from 0 to 10, derived from a combination of measures of canopy cover, vegetation height, projected shade cover in midsummer, and foliage density, which provides a representation of the value of the vegetation.

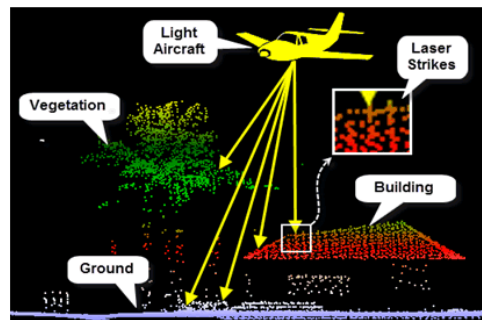


Figure 1: Profile view of *LiDAR* mapping technique

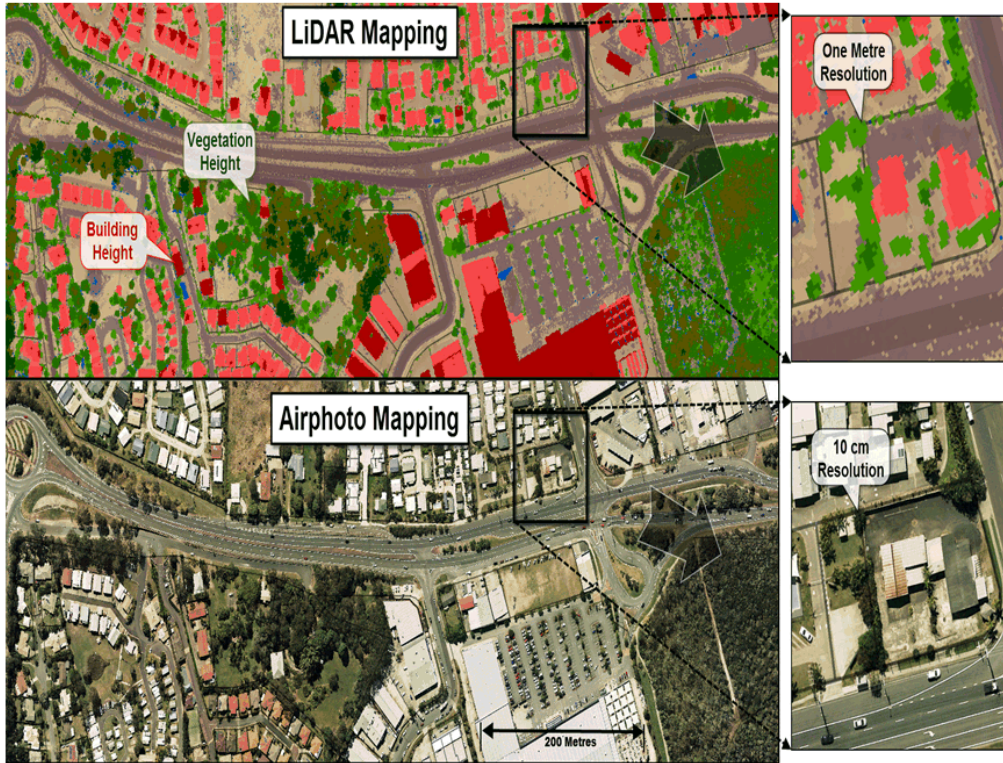


Figure 2: A comparison of standard aerial photography and *LiDAR* mapping. In the *LiDAR* mapping, buildings are represented by reds and pinks, vegetation in light and dark greens, and the ground in light browns and greys. The inset box (right side) shows the difference in mapping resolution when the view is zoomed in to a finer mapping scale. Whilst the *LiDAR* mapping has a lower one metre resolution, the vertical survey data can be exploited to automatically map many things, including topographic contours, building heights, and vegetation densities.

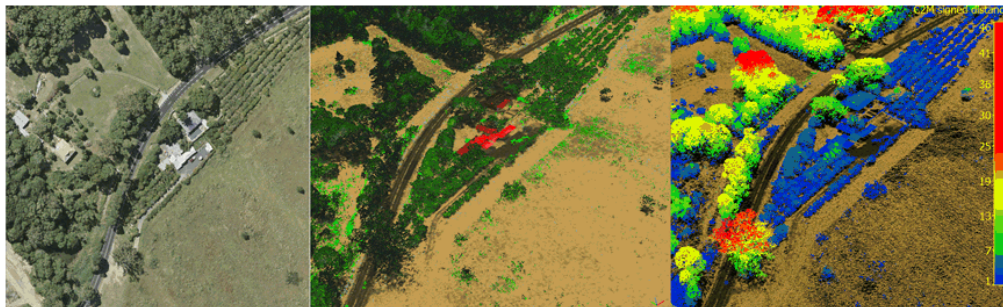


Figure 3: pictured from left to right: Aerial Orthophoto of a semi-rural area containing open grassed areas, regularly spaced fruit trees, a rural road and some natural vegetation; (MIDDLE) an oblique view of a colourised *LiDAR* data point cloud showing tree vegetation in green, buildings in red, and the ground in brown and black; and (RIGHT) the same *LiDAR* point cloud coloured according to height above ground in a range of colours from blue (shortest) through green, yellow and red (tallest).



Figure 5: Shade is calculated using tree height and time of day within mapping software. The left image shows standard aerial photography, the right image, a *LIDAR* derived vegetation map with trees (non-ground vegetation) in dark green, and the 9am/3pm summer shadows in light green.

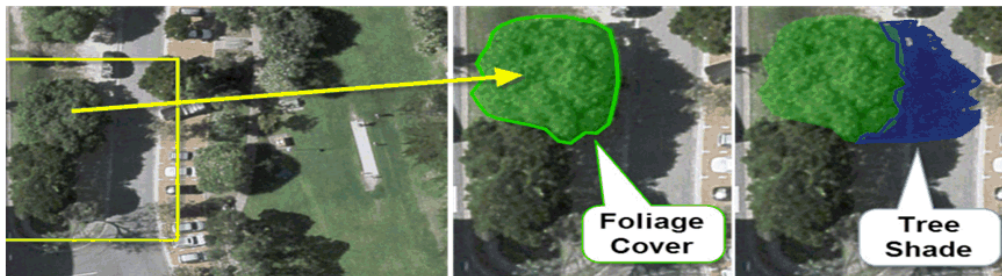


Figure 5: Depiction of shade statistics generated

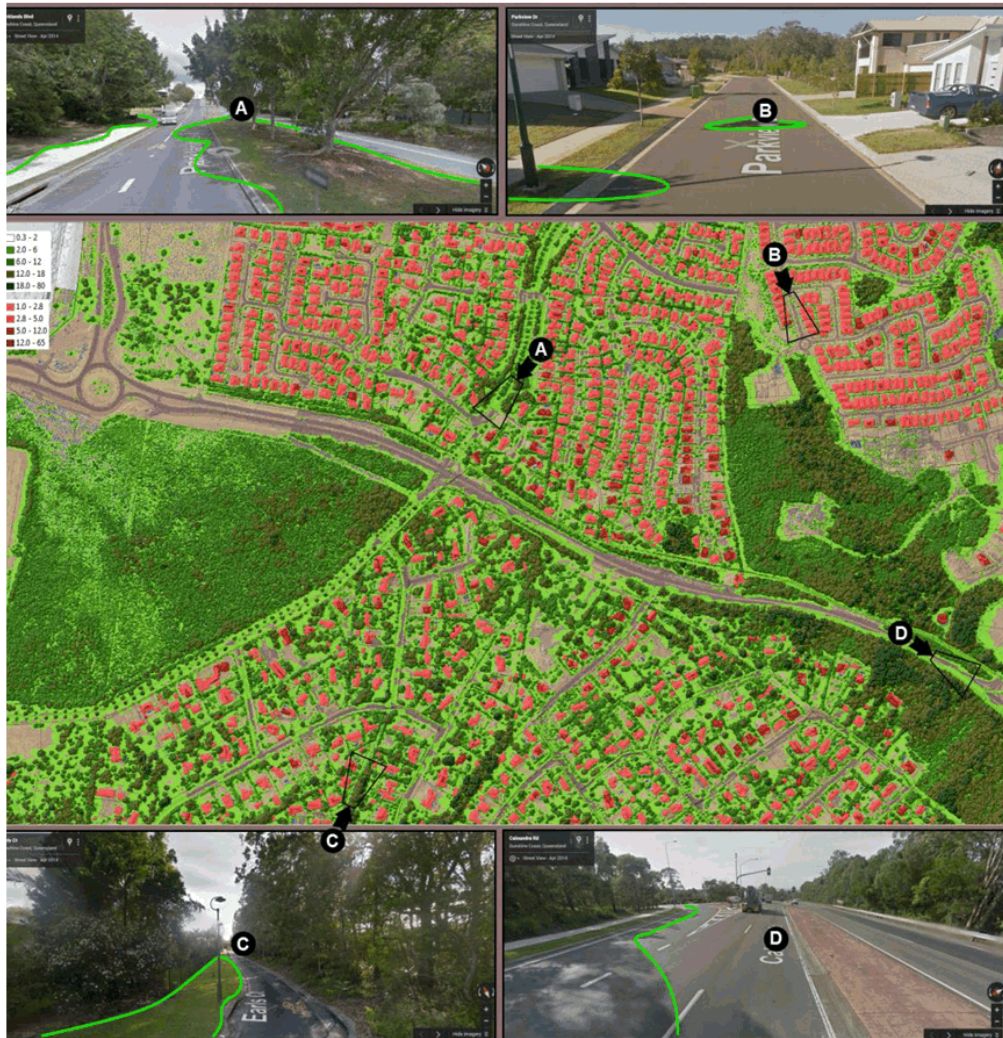


Figure 6: (above) Four sites (A, B, C and D) chosen from LiDAR mapping to cross check modelled canopy shade projection data. Google street views at each site were used to superimpose and estimate actual canopy shade extent.

Results - LiDAR derived statistics

The following table of statistics for each LPA is an average percentage foliage cover calculated from LiDAR data collected in 2014. The higher the number, the more vegetation, trees or foliage an area has. There are two primary statistics provided for each LPA – road reserve, and all areas. The 'Road Reserve' numbers are calculated by including only the public road reserve areas, whilst the 'All Areas' number is calculated by assessing foliage cover for all land within the LPA regardless of tenure (i.e. it includes private tenure areas).

LiDAR Foliage Score - Local Plan Areas (LPA)						
Local Plan Area		Foliage Score	Canopy Cover	Foliage Density	Canopy Volume	Canopy Shade+
1	Forest Glen / Kunda Park / Tanawha	9.8	60%	49%	12.7	82.9%
2	Blackall Range	9.6	62%	49%	11.0	82.8%
3	Mooloolah	7.8	52%	39%	9.0	82.3%
4	Landsborough	7.3	50%	35%	8.5	81.7%
5	Buderim	7.2	49%	38%	8.5	79.3%
6	Eumundi	5.9	45%	32%	6.6	77.1%
7	Nambour	5.9	44%	33%	7.2	73.6%
8	Eudlo	5.6	41%	33%	5.2	79.5%
9	Palmwoods	5.4	41%	32%	6.4	72.7%
10	Woombye	4.3	37%	29%	5.1	68.5%
11	Glass House Mountains	4.3	39%	28%	5.3	66.4%
12	Beerburum	4.2	38%	26%	5.5	67.2%
13	Beerwah	4.2	37%	27%	5.9	65.6%
14	Bli Bli	4.2	38%	26%	5.6	66.0%
15	Coolum	4.0	41%	26%	4.2	65.5%
16	Caloundra West	3.6	38%	25%	4.5	62.2%
17	Maroochy North Shore	3.5	41%	25%	4.2	59.7%
18	Maleny	2.9	33%	26%	4.1	58.0%
19	Yandina	2.6	31%	22%	4.2	58.3%
20	Caloundra	2.6	32%	22%	3.3	59.4%
21	Golden Beach/Pelican Waters	2.5	34%	21%	3.6	57.2%
22	Peregian South	2.3	33%	20%	3.6	56.3%
23	Sippy Downs	1.9	28%	20%	3.5	54.5%
24	Kawana Waters	1.1	27%	18%	3.2	46.9%
25	Mooloolaba/Alexandra Headland	1.1	23%	15%	2.2	56.3%
26	Maroochydore/Kuluin	0.2	21%	14%	2.2	45.8%
27	Kenilworth	0.1	20%	13%	2.8	45.3%
Averages			38%	28%	5.5	66%

Table 1: Foliage score statistics for each LPA (all lands) (2014 LiDAR derived statistics).

LiDAR Foliage Score - (within Road Reserve)						
	Local Plan Area	Foliage Score	Canopy Cover	Foliage Density	Canopy Height	Canopy Shade+
1	Blackall Range	9.9	46%	38%	7.5	85%
2	Beerburum	9.3	46%	33%	7.8	82%
3	Palmwoods	8.7	41%	34%	7.0	82%
4	Forest Glen / Kunda Park / Tanawha	8.4	40%	32%	7.7	77%
5	Eumundi	8.0	41%	29%	6.5	81%
6	Landsborough	7.1	37%	27%	5.9	79%
7	Mooloolah	7.0	35%	28%	5.3	81%
8	Beerwah	6.1	33%	25%	6.4	68%
9	Eudlo	6.0	32%	27%	4.5	77%
10	Maroochy North Shore	5.3	39%	25%	3.0	69%
11	Coolum	4.8	34%	23%	3.0	69%
12	Glass House Mountains	4.6	30%	22%	4.6	65%
13	Peregian South	4.4	33%	21%	3.5	65%
14	Maleny	4.0	27%	23%	3.1	67%
15	Nambour	3.8	26%	21%	3.5	67%
16	Woombye	3.6	25%	21%	3.2	66%
17	Buderim	3.6	24%	20%	2.8	70%
18	Yandina	3.3	25%	18%	3.1	64%
19	Bli Bli	2.2	20%	16%	2.1	64%
20	Caloundra	1.9	22%	17%	2.1	56%
21	Caloundra West	1.3	20%	13%	1.9	55%
22	Kenilworth	0.9	17%	14%	1.9	53%
23	Mooloolaba/Alexandra Headland	0.8	17%	12%	1.4	56%
24	Sippy Downs	0.8	18%	12%	1.5	54%
25	Golden Beach/Pelican Waters	0.5	18%	13%	1.3	51%
26	Kawana Waters	0.3	17%	12%	1.5	48%
27	Maroochydore/Kuluin	0.1	15%	11%	1.3	50%
	Averages		29%	22%	3.8	67%

Table 2: Foliage score statistics for each LPA (road reserve areas only) (2014 LiDAR derived statistics).

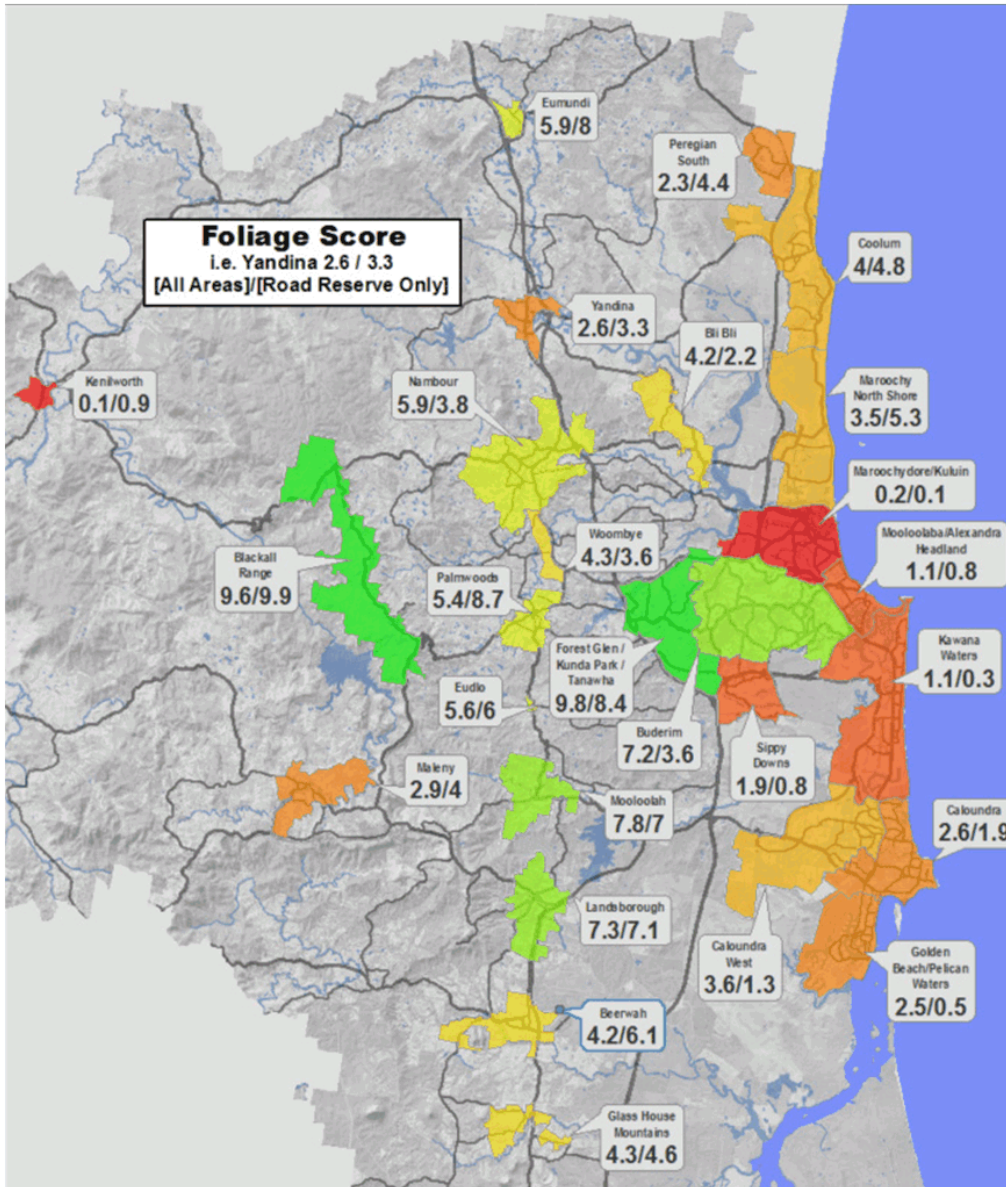


Figure 7: Info-graphic showing Foliage scores for All Lands and Road Reserve spaces for each LPA.

Multi-spectral imagery analysis

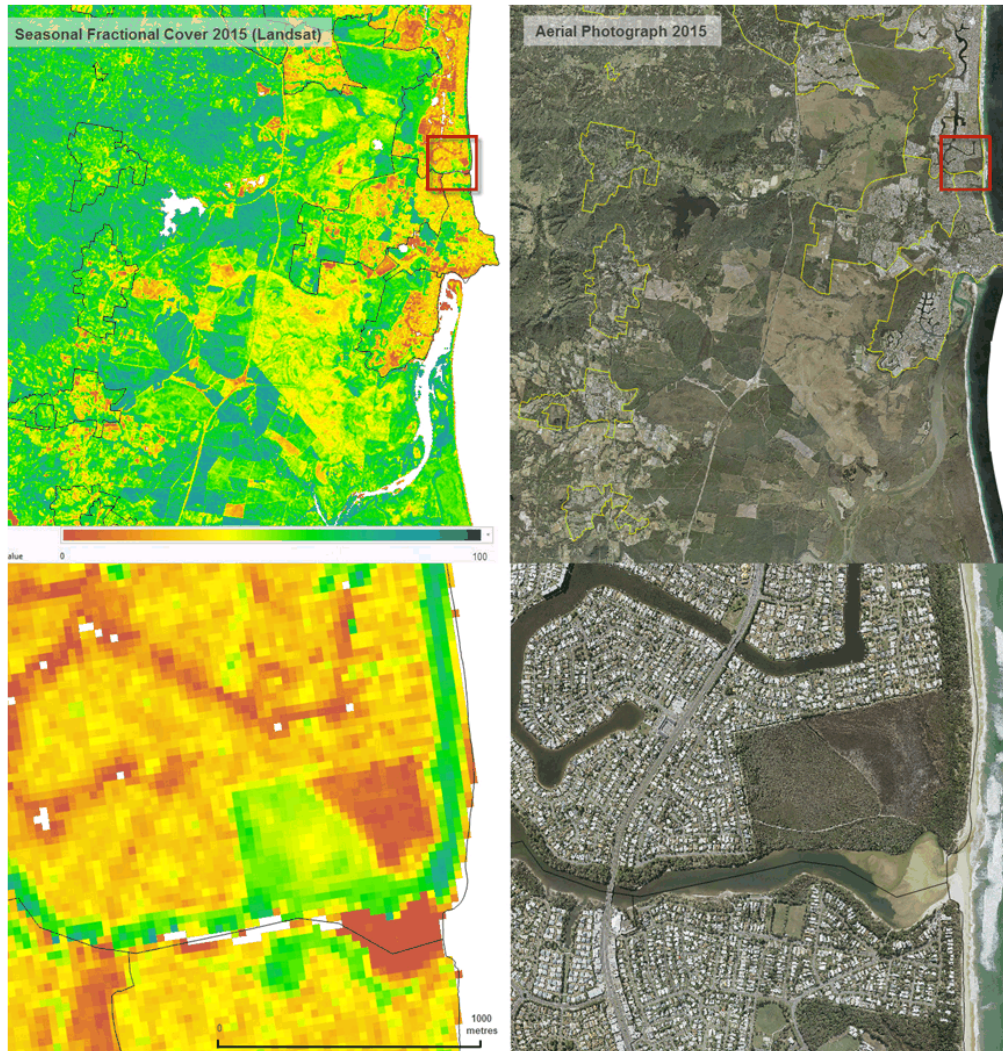


Figure 8: Mapping with multi-spectral imagery is a technique that uses both visible and non-visible light wavelengths. For example, calculations for each pixel within an image compare the spectral response (or intensity of light) from objects like vegetation, dirt, water, etc. Each type of object has a particular 'signature'. The response observed across a number of different wavelengths, including Red-Green-Blue and others such as Infrared, provide opportunity to determine what the object is most likely to be. Using this technique, scientists from the Queensland Government Remote Sensing Centre (DSITIA) have created a series of products that provide an indication of vegetation land cover in an area. The product used in this study is referred to as 'Seasonal Fractional Cover' and is derived from the 30 metre resolution Landsat-5 TM and Landsat-7 ETM+ sensors, through the automated prediction of over-storey foliage projective cover (FPC) from a large volume of Landsat imagery. The algorithm uses a comparison of parametric (Multiple Linear Regression, Generalized Linear Models) and machine learning (Random Forests, Support Vector Machines) regression models.

Results - Multi-spectral seasonal fractional cover statistics

Statistics generated using multispectral imagery provide an indication of woody vegetation land cover (vegetation index cover), and the following tables are a summary of average values for the Apr-May-June period of each year, for each Local Plan Area (LPA). Two tables are provided, firstly for all areas within the LPA (Table 3 below), and Table 4 opposite showing vegetation index cover statistics generated for the areas within road reserve only for each LPA.

All Public Areas Vegetation Index Cover												
Local Plan Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Avg
Forest Glen / Kunda Park / Tanawha	69.32	68.16	66.14	62.32	66.13	67.06	67.39	69.87	70.77	69.03	69.05	68
Blackall Range	65.17	63.89	63.14	63.67	64.84	66.57	64.71	65.57	68.14	65.05	65.97	65
Mooloolah	64.63	61.6	58.65	60.76	59.61	64.6	60.71	63.07	65.36	62.79	63.31	62
Eudlo	60.02	58.62	56.53	59.49	57.78	62.5	57.82	59.38	61.09	58.07	59.55	59
Maleny	60.26	60.05	54.97	61.4	57.59	61.91	57.04	57.42	61.51	57.04	59.25	59
Landsborough	58.23	56.73	55.53	56	57	59.88	56.17	58.95	61.2	58.77	59.34	58
Eumundi	63.83	58.03	49.53	54.29	55.38	58.53	55.35	58.86	59.42	57.46	55.9	57
Glass House Mountains	56.29	53.55	52.27	54.11	53.84	56.49	55.15	57.78	59.06	55.59	56.8	56
Beerburum	53.38	50.79	50.1	52.46	52.46	56.95	55.48	53.33	55.59	52.52	54.27	53
Nambour	55.35	53.56	51	51.05	52.43	54.81	53.27	54.78	55.03	52.67	52.63	53
Yandina	55.01	50.65	49	52.23	51.78	55.04	49.93	53.83	55.91	53.41	52.6	53
Kenilworth	51.79	44.62	47.27	55.82	51.78	60.04	51.81	52.65	58.59	49.69	51.29	52
Palmwoods	51.92	50.99	48.19	49.89	50.53	54.96	52.61	54.43	54.64	52.1	53.44	52
Bli Bli	53.12	50.14	49.17	49.44	50.35	52.14	51.16	52.63	52.78	51.07	50.45	51
Woombye	56.39	51.4	48.79	49.49	47.44	52.6	49.2	52.01	52.46	49.73	50.82	51
Beerwah	51.53	52.58	47.58	46.78	47.01	52.13	49.52	51.9	52.86	48.9	51.43	50
Buderim	50.81	49.49	48.79	47.89	49.98	50.56	50.41	52.06	51.52	50.13	50.09	50
Coolum	51.64	50.4	48	47.13	49.5	49.92	49.72	51.13	50.53	49.8	48.16	50
Caloundra West	43.7	39.92	37.51	39.16	39.36	43.89	40.48	42.82	42.97	42.01	42.62	41
Maroochy North Shore	40.5	39.85	39.2	39.54	40	43.28	42.35	42.76	42.5	41.29	40.4	41
Caloundra	42.28	40.55	39.42	40.01	39.71	42.66	40.98	42.31	40.25	40	40.44	41
Maroochydoore/Kuluin	42.94	40.57	39.12	39.76	39.94	41.79	40.54	41.86	41.41	39.13	39	41
Sippy Downs	38.73	35.06	34.98	37.42	35.27	42.08	37.53	40	41.27	40.46	41.41	39
Mooloolaba/Alexandra Headland	38.4	36.72	35.42	35.66	36.75	38	37.24	37.82	36.29	34.35	34.75	36
Golden Beach/Pelican Waters	35.92	32.75	31.63	32.89	33.42	37.34	34.74	35.25	34.8	34.04	34.87	34
Peregian South	29.02	30.91	32.21	30.63	31.86	35.33	32.59	34.97	35.53	35.28	35.6	33
Kawana Waters	35.58	32.59	32.67	32.1	32.28	34.55	33.01	33.62	32.25	30.93	32.63	33
Grand Total	47	45	44	44	45	47	45	47	47	45	46	50

Table 3: Annual vegetation index for each LPA (all lands) 2005-2015

Road Reserve Areas Vegetation Index Cover												
Local Plan Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Avg
Forest Glen / Kunda Park / Tanawha	67.4	66.03	63.9	58.9	65.3	64.9	66.3	69.8	70.2	68.5	68.8	66
Blackall Range	61.8	58.88	56.4	58.6	57.3	63.3	59.2	61.8	64	61.5	62	60
Mooloolah	61.4	60.52	60.2	59.6	61.9	62.6	61.9	63.1	64.7	61.8	62.8	62
Eudlo	59.5	55.81	45.2	51.2	52.4	55.8	52.7	57.3	56.2	55.3	53.8	54
Landsborough	57.5	57.1	53.9	54.9	55.3	59	55.4	57.3	59.5	57	57.8	57
Maleny	57.1	56.7	52	58.5	53.9	59.2	54.3	54.6	59	54.6	56.3	56
Beerburum	56.5	54.49	53.6	53.4	55	57.7	54.8	57.9	60.1	57.7	58.3	56
Eumundi	56	53.49	51	51.6	52.4	60.3	55.2	55.6	56.5	53.2	53.9	54
Glass House Mountains	54.2	48.09	44.9	46.5	45.4	50.7	47.7	51.2	51.4	48.5	50	49
Palmwoods	52.4	50.18	47.3	49.8	50.4	53.5	50.4	53.7	55.1	53.9	52.8	52
Yandina	52.1	49.39	48.9	50.4	50.3	53	52.4	55.5	56.9	52.9	54.3	52
Kenilworth	51.8	50.48	48.1	49	50.6	54.4	52.8	55.1	55.6	52.7	54.5	52
Nambour	50.6	48.88	46.2	46.9	47.8	50.5	49.3	51.1	51	48.6	48.6	49
Woombye	49.6	46.51	46.3	46.4	47.8	49.4	48.6	49.9	50.2	48.1	47.4	48
Beerwah	49.6	48.28	45.6	45.2	47.6	48.6	48.6	50.1	49.4	48.8	47.4	48
Bli Bli	48.9	40.24	44.3	54.4	48.1	57.1	48.2	50.6	55.9	46.2	48.7	49
Coolum	48.8	50.96	46.6	44.4	45	50	47.9	51	52	47.5	50	49
Buderim	48.4	46.91	45.9	45.3	47.4	48.1	48.4	50.4	49.5	48	48.1	48
Maroochy North Shore	43.5	39.41	36.1	38.4	39.1	43.6	41	43.8	44.4	43.3	44	42
Caloundra West	42.4	41.57	40.8	40.2	41.8	44.4	44.5	45.4	45.3	44.3	43.7	43
Caloundra	42.1	40.31	39.3	39.4	40	42.5	41.3	43.6	41.2	40.9	41.5	41
Maroochydhore/Kuluin	42	39.28	37.5	38.3	38.8	40.8	40.3	41.6	41.6	38.7	39	40
Sippy Downs	39.3	35.34	34.6	35.3	35.4	41.4	38.3	41.3	42.6	42	42.6	39
Golden Beach/Pelican Waters	37.4	33.92	34.3	33.1	33.5	35.7	34.5	35.7	34.9	33.9	35.7	35
Peregian South	37.1	35.41	34.1	34.7	35.9	37.1	36.3	37.4	35.8	34	34.5	36
Mooloolaba/Alexandra Headland	36.2	33.14	31.9	33.7	34.9	38.6	37.4	38.6	38.3	37.6	38.7	36
Kawana Waters	28.2	29.64	31.4	32.2	33.8	39.1	38.3	40.2	41.3	41.1	40.8	36
Total Averages	46	44	42	42	43	46	45	47	47	45	46	45

Table 4: Annual vegetation index for each LPA (road reserve only) 2005-2015



