THE UNIVERSITY of ADELAIDE

treenet

Proceedings of the

18th National Street Tree Symposium

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TREENET Proceedings of the 18th National Street Tree Symposium 2017
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INSTITUTIONAL MEMBERS OF TREENET 2017

ASSOCIATIONS

Arboriculture Australia Ltd

Council Arboriculture Victoria

Institute of Australian Consulting Arboriculturists (IACA)

Local Government Tree Resources Association (NSW)

Nursery & Garden Industry SA Inc (NGISA)
Queensland Arboricultural Association Inc. (QAA)
Victorian Tree Industry Organisation (VTIO)

GOVERNMENT

Albury City Council

Campbelltown City Council

City of Belmont

City of Burnside

City of Charles Sturt

City of Glen Eira

City of Holdfast Bay

City of Melbourne

City of Melville

City of Mitcham

City of Newcastle

City of Onkaparinga

City of Playford

City of Port Adelaide Enfield

City of Sydney

City of Unley

City of West Torrens

District Council of the Copper Coast

Inner West Council

Ipswich City Council

Georges River Council

Hume City Council

Lake Macquarie City Council

Maribyrnong City Council

Moreland City Council

Mount Barker District Council

Naracoorte Lucindale Council

National Capital Authority

Toowoomba Regional Council

Transport Canberra and City Services

Wagga Wagga City Council

Whyalla City Council

CORPORATE

Active Tree Services
ArborCarbon
Arbor Centre
Arborgreen
Arborman Tree Solutions
Arbor Operations QLD Pty Ltd
Arbortrack Australasia Pty Ltd
Austral Tree Services
Botanix Plant Supply Pty Ltd
Citygreen
C&R Ryder Consulting
Enviro Frontier
Greenwood Consulting
Homewood Consulting
HR Products
Metro Trees
Mt William Advanced Tree Nursery
Quantified Tree Risk Assessment Limited (QTRA)
Remote Area Tree Services
Sevron Environmental Contractors
Terra Cottem Australasia Pty Ltd
Tree Dimensions
Tree Preservation Australia
Tree Sales
Trentcom APS Pty Ltd
Urbanvirons Group Pty Ltd

Click here to visit the TREENET website to find out more about our Institutional Members

TREENET MANAGEMENT COMMITTEE AND ADVISORY BOARD 2017

TREENET MANAGEMENT COMMITTEE

Chairperson:	Dr Greg Moore OAM
Director:	Glenn Williams (ex officio)
Treasurer:	Darryl Gobbett *(ex officio)*
Members:	David Lawry OAM
	Judy Fakes
	Dr Jennifer Gardner OAM / Dr Kate Delaporte
	Tim Johnson
	Cameron Ryder
	Rob Bodenstaff
	Lyndal Plant

TREENET ADVISORY BOARD

Glenn Williams	Director TREENET	SA
David Lawry OAM	Founder, TREENET & Avenues of Honour	SA
Darryl Gobbett	Honorary Treasurer TREENET / 1915- 2015 Avenues of Honour Project	SA
Educational and Research Institutions		
Prof Chris Daniels	Professor of Urban Ecology University SA	SA
Dr Jennifer Gardner OAM	Curator, Waite Arboretum, TREENET Management Committee	SA
Dr Kate Delaporte	Acting Curator, Waite Arboretum, TREENET Management Committee	SA
Dr Greg Moore OAM	Research Assoc. Burnley School of Resource Management & Geography, Chair, TREENET Management Committee	VIC
Dr Dean Nicolle	Director, Currency Creek Arboretum	SA
John Zwar	TAFESA Urrbrae Campus, TREENET Management Committee	SA
Dr Lyndal Plant	The University of Queensland, TREENET Management Committee	QLD
Nursery Industry		
John Fitzgibbon	Metro Trees	VIC
Hamish Mitchell	Specialty Trees	VIC
Community		
Hon Michelle Lensink	Liberal Member Legislative Assembly	SA
Landscape Architects and Urban Planners		
Michael Heath	Chair National Trust SA Significant Tree Team	SA

Arboricultural & Allied Professions

Jan Allen	Terra Ark	QLD
Peter Bishop	Bunya Solutions	QLD
Rob Bodenstaff	Arbor Centre, TREENET Management Committee	WA
David Galwey	Tree Dimensions	VIC
Peter Lawton	Trentcom	VIC
Ben Kenyon	Homewood Consulting	VIC
Phillip Kenyon	Kenyon's Quality Tree Care	VIC
Cameron Ryder	C & R Ryder Consulting, TREENET Management Committee	VIC
Kym Knight	Tree Environs	SA
Mark Willcocks	Active Tree Services	NSW
Quentin Nicholls	Arbortrack	QLD
Sue Wylie	Tree Talk Arboricultural Consulting	NSW
Lee Anderson	Tree Technique	SA

Local Governments

Tim Johnson	City of Mitcham	SA
Christopher Lawry	Mount Barker District Council	SA
Jason Summers	Hume City Council	VIC
Karen Sweeney	City of Sydney	NSW
Vic Bijl	City of Belmont	WA

State Governments

Judy Fakes	Commissioner (retired), Land & Environment Court NSW, TREENET Management Committee	NSW

TREENET INCORPORATED CONSTITUTION

1. NAME

The name of the Association is "TREENET Incorporated"

2. DEFINITIONS

2.1 "The Act" means the Associations Incorporations Act 1985.

2.2 "Association" means the above named Association.

2.3 "Management Committee" means the committee referred to in Rule 11.

2.4 "Advisory Board" means the Board referred to in Rule 12.

3. VISION AND AIMS

3.1 Vision

The vision of the Association is to enhance the role of trees in the urban forest and to engage the community in this endeavour.

3.2 Aims

The aims of the Association are:

3.2.1 To develop and maintain an interactive web application to facilitate the exchange of information relating to urban forests.

3.2.2 To promote research and education relating to urban forests including holding symposia.

3.2.3 To broaden the body of knowledge that exists about street trees and foster research, distribute applicable information, facilitate cooperation and enlist community support concerning the protection, preservation and enhancement of the urban forest.

3.2.4 To establish and maintain a public fund to be called *TREENET Fund* for the specific purpose of supporting the environmental purposes of TREENET Inc. The Fund is established to receive all gifts of money or property for this purpose and any money received because of such gifts must be credited to its bank account. The Fund must not receive any other money or property into its account and it must comply with subdivision 30-E of the Income Tax Assessment Act 1997.

4. POWERS

The Association shall have all the powers conferred by Section 25 of the Act.

5. Membership

5.1 Membership

When an organisation or person has agreed to become a member of the Association and has paid the Association's membership fee where it applies, then that organisation or person will be admitted to membership pursuant to the Constitution, and their name shall be entered in the Association's Register of Members.

5.2 Classes of Member

There shall be five classes of member:

5.2.1 Management Committee Member

This class shall consist of all members of the Management Committee as described in Rule 11.1. Management Committee Members will have the right to receive notice of and attend all meetings.

5.2.2 Advisory Board Member

This class shall consist of natural persons who have been invited by the Management Committee to be on the Advisory Board and agreed. Advisory Board Members will have the right to receive notice of, and attend, the Annual General Meeting and other General Meetings as called. The term of appointment will be for the calendar year.

5.2.3 Associate Member

This class shall consist of natural persons who register an interest in joining the Association and who subscribe to the aims of the Association.

5.2.4 Institutional Member

This class shall consist of research and educational institutions, government bodies, businesses and associations who are financial members. Institutional Members will have the right to receive notice of, and attend, the Annual General Meeting and other General Meetings as called.

5.2.5 Honorary Life Member

This class shall consist of natural persons who have been granted Honorary membership at the discretion of the Management Committee. Honorary Life Members will have the right to receive notice of and attend the Annual General Meeting and other General Meetings as called.

5.3 Votes

Members may exercise the following voting entitlements:

5.3.1 Management Committee Member – 1 vote

5.3.2 Advisory Board Member – 1 vote

5.3.3 Associate Member – members of this class shall have no votes

5.3.4 Institutional Member – financial members – 1 vote by representation or proxy

5.3.5 Honorary Life Member – 1 vote

5.4 Register of Members

A Register of Members shall be kept which contains the name, postal or electronic address, class of membership and subscription details of each Member and the date of joining the Association.

5.5 No Transfer of Rights

The rights and privileges of a Member shall not be transferable and shall cease upon such an organisation or person ceasing to be a Member.

6. MEMBERSHIP FEES

The Management Committee shall from time to time set the terms and conditions of membership fees, if any, for the different classes of membership.

7. CESSATION OF MEMBERSHIP

Membership may cease by resignation, expulsion or non-payment of fees.

7.1 Resignation

Members shall cease to be a member by notifying the Association by whatever means the Management Committee might direct from time to time.

7.2 Expulsion

If any Member wilfully refuses or neglects to comply with the provisions of the Constitution, or is guilty of any conduct which in the opinion of the Management Committee is unbecoming to a Member or prejudicial to the interests of the Association, the Committee shall have the power to expel the member from the Association PROVIDED THAT at least one month before the Committee Meeting at which a resolution for the Member's expulsion is to be considered, the Member shall have been given notice of such meeting and what is alleged against them and of the intended resolution for their expulsion, and they shall at such meeting and before the passing of such resolution have had an opportunity to give oral or written explanation for their defence.

7.3 Non-payment of Fees

If a Member has not paid fees as agreed in the terms and conditions and has been notified in writing by the Association of this failure, then the Member shall cease to be a Member of the Association unless the prescribed fee is paid by the date as notified.

8. PROPERTY AND FINANCE

8.1 The funds and other property of the Association shall be managed and controlled by the Management Committee and shall be used only for the vision and aims of the Association.

8.2 All cheques, negotiable instruments and orders drawn by the Association shall be signed by two persons designated by the Management Committee.

8.3 Subject to Rule 8.1, the surplus funds of the Association may be invested in such manner as the Management Committee sees fit, except direct equities.

8.4 The accounts of the Association shall be audited annually.

8.5 The financial year of the Association shall be from 1 July to 30 June.

8.6 The Association shall prepare financial accounts at the end of each financial year.

9. NOT-FOR -PROFIT

The assets and income of the Association shall be applied solely in furtherance of its above-mentioned vision and aims and no portion shall be distributed directly or indirectly to the members of the Association except as bona fide compensation for services rendered or for reimbursement for expenses incurred.

10. MEETINGS OF THE ASSOCIATION

10.1 The Annual General Meeting shall be held at such time as the Management Committee shall determine.

10.2 Any Motion that any voting Member proposes to move at the Annual General Meeting including a proposal to alter the Constitution shall be given in writing to the Management Committee at least four weeks before the meeting.

10.3 At least 21 days before the Annual General Meeting or any other General Meeting, notice shall be given by written or electronic form sent to all members of the Association entitled to vote, but any accidental omission to give notice to any voting member shall not invalidate the meeting.

10.4 At the Annual General Meeting, ordinary business shall be the presentation of the audited financial accounts, election of the Management Committee and the appointment of an auditor.

10.5 Each voting member present shall be entitled to one vote. In case of an equality of votes, the Chair shall have a second or casting vote.

10.6 A Special General Meeting may be requested by ten voting members presenting an agenda to the Management Committee, the agenda being signed by all ten members. The Management Committee must within 14 days give notice of a Special General Meeting to be at least 21 days from the notice date. The Special General Meeting will be limited to the agenda items plus other items of which the Committee gives notice. Once the agenda items have been resolved by consensus, resolution or vote they cannot be used again to call a Special General Meeting for 52 weeks from the meeting date.

10.7 An Advisory Board Member shall be entitled to appoint in writing a natural person, who is also an Advisory Board Member of the Association, to be his or her proxy, and to vote on his or her behalf at any general meeting of the Association.

11. MANAGEMENT COMMITTEE

11.1 Membership of the Management Committee

The Management Committee will comprise six elected members drawn from education and research, business and government sectors of the community and three *ex officio* members as follows:

11.1.1 An academic from a tertiary educational institution

11.1.2 A member of Local Government

11.1.3 Four other members

11.1.4 The Director of Waite Arboretum will be a member *ex officio* and may also represent The University of Adelaide with consent from the University

11.1.5 The Directors of Treenet and the Treasurer of Treenet will be members *ex officio*.

11.2 Elections

11.2.1 The elected members of the Management Committee shall be elected annually by voting members of the Association at the Annual General Meeting.

11.2.2 Where the number of candidates for membership of the Management Committee exceeds the maximum number, elections shall be held by secret ballot of members at the Annual General Meeting entitled to vote. In the case of an equality of votes, the Chair shall have a second or casting vote.

11.2.3 The nomination of a candidate for membership of the Management Committee must be in writing, signed by a proposer (who must be an Advisory Board member) and by the nominee. The nomination must be delivered to the Director of the Association before such time as the Management Committee shall determine.

11.2.4 Subject to Rule 11.1, the Management Committee shall have the power to co-opt further Committee members and to fill casual vacancies.

11.3 Office Bearers

The Office Bearers of the Association shall be:

Chair

Directors & Public Officer *ex officio*

Treasurer *ex officio*

11.4 Procedures Generally

The Management Committee may meet in person or confer by video or telephone conferencing, email or by other electronic means for the dispatch of business and subject to the Constitution, otherwise regulate its meetings as it thinks fit.

11.5 Calling of Committee Meetings

11.5.1 The Management Committee shall meet or confer at least four times per year as described in 11.4. Notice of the meeting or conference shall be given in writing to each Committee Member.

11.5.2 The position of any Committee member absent for three consecutive meetings or conferences without leave of absence shall automatically become vacant. Acceptance of an apology shall be deemed grant of such leave.

11.6 Chair

The Chair shall take the chair at meetings. In his or her absence, the Committee shall appoint a member of the Committee to chair the meeting.

11.7 Decisions of Questions

Questions arising before a meeting of the Committee shall be decided by a majority vote. In case of an equality of votes, the chair shall have a second or casting vote.

11.8 Reporting

The Management Committee shall be responsible to the Association and shall present an annual report, including the audited financial accounts, to each Annual General Meeting.

11.9 Auditor

The Management Committee shall appoint an auditor of the Association, who will hold office until the next Annual General Meeting of the Association.

12. ADVISORY BOARD

12.1 There shall be an Advisory Board of the Association.

12.2 The Advisory Board will comprise persons who are competent and willing to provide advice to the Association in their individual areas of expertise, and to liaise with other bodies and institutions for the purpose of facilitating the flow of information between the Association and those other bodies and institutions, and facilitating the implementation of projects which the Association undertakes in furtherance of its aims.

12.3 Members of the Advisory Board shall have no power or authority to represent the Association in any dealings between the Association and third parties.

12.4 The Advisory Board shall meet at such times and places as the Management Committee shall determine.

12.5 The Chair of the Management Committee will take the chair at meetings of the Advisory Board.

13. QUORUMS

13.1 The quorum at general meetings of the Association shall be six members entitled to vote.

13.2 The quorum at Management Committee meetings shall be three members.

14. AUTHORITY TO ENTER INTO CONTRACTS OR AGREEMENTS

The Association shall not be committed to any binding contract or Agreement except pursuant to a resolution of the Management Committee and the instrument shall be signed by at least two members of the Committee.

15. DISSOLUTION

15.1 The Association shall be dissolved if a resolution to this effect is carried by a three-quarters majority voting in person or by proxy at a general meeting, 21 days' notice of the proposed resolution having been given to all members entitled to vote.

15.2 In the event of the Association being dissolved, the amount that remains after such dissolution and the satisfaction of all debts and liabilities shall be transferred to the University of Adelaide, for expenditure on the Waite Arboretum only.

16. ALTERATION TO THE CONSTITUTION

This Constitution may be altered by resolution of a majority of three-quarters of members entitled to vote and who cast a vote in person or by proxy at a general meeting. Written notice of amendments shall be posted to all members entitled to vote at the same time as the notice of the meeting.

17. REQUIREMENTS OF THE PUBLIC FUND

The organisation must inform the Department responsible for the environment as soon as possible if:

- it changes its name or the name of its public fund; or
- there is any change to the membership of the management committee of the public fund; or
- there has been any departure from the model rules for public funds set out in the Guidelines to the Register of Environmental Organisations.

18. MINISTERIAL RULES

The organisation agrees to comply with any rules that the Treasurer and the Minister with responsibility for the environment may make to ensure that gifts made to the fund are only used for its principal purpose.

19. CONDUIT POLICY

Any allocation of funds or property to other persons or organizations will be made in accordance with the established purposes of the organisation and not be influenced by the preference of the donor.

20. WINDING-UP

In case of the winding-up of the Fund, any surplus assets are to be transferred to another fund with similar objectives that is on the Register of Environmental Organizations.

21. STATISTICAL INFORMATION

Statistical information requested by the Department on donations to the Public Fund will be provided within four months of the end of the financial year.

An audited financial statement for the organisation and its public fund will be supplied with the annual statistical return. The statement will provide information on the expenditure of public fund monies and the management of public fund assets.

22. RULES FOR THE PUBLIC FUND

22.1 The objective of the fund is to support the organization's environmental purpose.

22.2 Members of the public are to be invited to make gifts of money or property to the fund for the environmental purposes of the organisation.

22.3 Money from interest on donations, income derived from donated property, and money from the realisation of such property is to be deposited into the fund.

22.4 A separate bank account is to be opened to deposit money donated to the fund, including interest accruing thereon, and gifts to it are to be kept separate from other funds of the organisation.

22.5 Receipts are to be issued in the name of the fund and proper accounting records and procedures are to be kept and used for the fund.

22.6 The fund will be operated on a not-for-profit basis.

22.7 A committee of management of no fewer than three persons will administer the fund. The committee will be appointed by the organisation. A majority of the members of the committee are required to be 'responsible persons' as defined by the Guidelines to the Register of Environmental Organizations.

SPEAKER AND PANELIST PROFILES

David Lawry OAM

David is responsible for co-founding TREENET (Tree and Roadway Experimental and Educational Network) in 1997 with Dr Jennifer Gardner, curator of the Waite Arboretum. David is also responsible for founding TREENET's Avenues of Honour Project, officially launched in 2004.

With a Degree in Agricultural Science and a long horticultural history in the nursery and landscaping industry, David is a respected champion for the emerging science aimed at improving the establishment and retention of trees in urban settings, particularly street trees.

Dr Jennifer Gardner OAM

Jennifer recently retired as Curator of the Waite Arboretum at the University of Adelaide's Waite Campus – a position she held for 31 years.

She assisted David Lawry to co-found TREENET in 1997.

For Jennifer the Waite Arboretum represents a valuable experimental collection, a repository for rare and endangered species, an educational facility, a resource for landscape architects, planners, arboriculturalists and the nursery industry and a tranquil green space for the enjoyment of the wider community.

As well as playing in the Arboretum, Jennifer continues to volunteer in the Gardens of Urrbrae House Historic Precinct, as well as undertaking conservation activities to restore the Waite Conservation Reserve - 121 ha of remnant Grey Box Grassy Woodland.

Mayor Lorraine Rosenberg

Ms Lorraine Rosenberg has been the Mayor of the City of Onkaparinga since 2006 and is the current President of the Local Government Association of SA.

In addition to the Mayor's 22 years in Local Government, Lorraine has worked in management, small business and research.

In State politics Ms Rosenberg was elected the member for Kaurna in the House of Assembly of the Parliament of South Australia from 1993 until 1997.

Ms Rosenberg was also General Manager to the Alinytjara Wilurara (Aboriginal Lands) Natural Resources Management Board and the South Australian Fishing Industry Council.

She has a degree in Agricultural Science, Honours in Biochemistry, Masters in Soil Conservation and other qualifications in Environmental Management Systems.

Her Bio-Chemistry qualifications led her to a 15 year career in the research industry.

The Mayor currently sits on the boards of the Metropolitan Local Government Group, Ranges to River Natural Resources Management Advisory Group, and the Stormwater Management Authority.

She is also a deputy member of the Aquaculture Advisory Committee.

Dr Greg Moore OAM

Greg Moore was Principal of Burnley College of the Institute of Land Food Resources at Melbourne University from 1988 to 2007. Prior to this he was a Senior Lecturer and Lecturer in Plant Science and Arboriculture at Burnley from 1979. He was Head of the School of Resource Management at the University from 2002 to 2007.

Apart from a general interest in horticultural plant science, revegetation and ecology, Greg has a specific interest in all aspects of arboriculture. He has contributed to the development of Australian Standards in pruning and amenity tree evaluation and continues to be a major speaker at conferences worldwide and in Australia.

He was the inaugural president of the International Society of Arboriculture, Australian Chapter. He is a much sought after guest for talk-back radio and regularly invited to contribute comment for television and print media. He has been a member of the National Trust of Victoria's Register of Significant Trees Committee from 1988, chairing the committee since 1996. He has chaired TREENET since 2005.

Greg continues to supervise post-graduate students and pursues an active research profile in any matters that relate to trees in the urban environment and revegetation.

Professor Jamie Kirkpatrick AM

Jamie Kirkpatrick lives in Sandy Bay, Hobart with Christina, Tor and Pippin and a passing population of many other animals and birds most of whom appreciate the tall trees in the half acre garden that surrounds the small blue wooden Edwardian house.

He is Distinguished Professor of Geography and Environmental Studies in the School of Land and Food of the University of Tasmania where he teaches Space, Place and Nature, Natural Environment Field Techniques and Fire, Weeds and Ferals; researches and supervises honours and postgraduate projects.

He is presently obsessed with the geography of place attachment, the genesis of alpine rush circles and ponds and testing the role of change in property ownership on the demise of large garden trees.

He has published more than 300 papers and book chapters and more than 40 books/monographs in ecology, physical geography, social/cultural geography and humour. His most recent books are *The Ecologies of Paradise, People, Sheep and Nature Conservation,* T*he Tasmanian Development Calendar and Conservation Worrier*.

Among many other awards and honours, he is a member of the Order of Australia for his contribution to world heritage and forest conservation.

Professor Michelle Leishman

Professor Michelle Leishman is an internationally recognised plant ecologist, with over 120 publications in the peer-reviewed scientific literature. Her work focuses on understanding the success of invasive plants, plant and vegetation responses to climate change, plant conservation and adaptation under climate change.

Michelle leads the Green Cities research consortium with Western Sydney University, NSW Office of Environment & Heritage and Horticulture Innovation Australia on the Which Plant Where, When & Why Database for growing urban green space.

She is also the Co- Director of the MQ Centre for Green Cities which focuses on sustainable energy innovations and urban greening, and the Deputy Director of the Biodiversity Node of the NSW Adaptation Hub. She sits on several boards and external committees, including Bush Heritage, Royal Botanic Gardens & Domain Trust, and the Australian Flora Foundation.

Jeff Lugg

Jeff was born in Ballarat, Victoria in the early 60's. He joined the Navy at the ripe old age of 15 to "see the world". His final posting was to South Australia where he decided that after years of traveling it was time for a career change and having come from a rural background he looked towards a career in Horticulture.

On leaving the Navy, Jeff undertook studies as a mature age apprentice and was fortunate enough to be given an opportunity by the Adelaide Zoo to work in their Horticulture department whilst undertaking his apprenticeship. On completion of his training he was able to take up a full time position within the Zoo Horticulture Department.

During his time at Adelaide Zoo Jeff continued to study in the various fields of Horticulture and currently hold qualifications in both Arboriculture and Horticulture – specialising in Animal Exhibit design. Through this field of work he has enjoyed many opportunities for travel, the most recent to the Middle East to assist with the design of a new Zoo Safari Park and to undertake training of Horticulture staff.

Jeff has seen many changes being directly involved in the management of the changing landscape of the Adelaide and Monarto Zoos.

Jeff's larger Adelaide Zoo's projects have included The South East Asian precinct, Giant Panda and Nature Playground all of which have been able to showcase the work of the small but highly skilled horticulture team at Adelaide Zoo.

With over 30 years' experience of living and working at Adelaide Zoo and through his contribution to the grounds and exhibits Jeff hopes the animals and visitors get the same joy in these surrounds as he does.

Georgia Vitale

Georgia Vitale is an experienced city planner, urban policy maker, strategist and renewal specialist with 18 years professional experience gained in projects throughout Australia, Sri Lanka, the Middle East and the UK.

Georgia leads Arup's Integrated Cities Planning team and Sydney and holds an honours degree in urban planning and post-graduate qualifications in urban design.

Georgia has led major planning and community regeneration projects with emphasis on public benefits and was a contributing author to the recent publication *Cities Alive: Towards A Walking World.*

Nola Hancock

Nola has worked in various capacities within the Restoration Ecology, Ecological Restoration and Bush Regeneration industries for the past 17 years and is currently a research fellow at Macquarie University, Sydney.

Nola's current research focuses on improving ecological restoration practices and biodiversity conservation in the face of climate change and she was recently lead author of *Climate-ready Revegetation. A Guide for Natural Resource Managers.*

Whilst restoration ecology under climate change is Nola's focus, she also has an interest in the taxonomy of the Mallee species of the Murraylands in South Australia and recently self-published: *Mallees of the Southern Mallee District of South Australia. A Ute Guide.*

Professor Mark Tjoelker

Professor Mark Tjoelker is a plant physiological ecologist with expertise in the impacts of global environmental change on trees and forests.

His research expertise includes the physiology, structure and function and climate adaptation of trees. His research engagement includes the nursery tree industry and the "Which Plant Where Project," in support of the 202020 Vision goals for urban greening. He is based at the Hawkesbury Institute for the Environment at Western Sydney University.

Sarah Priestley

Sarah Priestley is an arborist with extensive experience in Local Government and managing trees in the public realm. She is currently teaching a subject on urban tree management at Melbourne University and is the director of Arbor by Design, an arboricultural consultancy that seeks to provide innovative solutions to tree management issues.

Sarah studied arboriculture at Melbourne University, obtaining an Advanced Diploma and Bachelor of Applied Science, majoring in arboriculture and is currently studying for her Masters in Entrepreneurship and Innovation at Swinburne.

Bob Kearney OAM

Bob Kearney was born in Adelaide and is proud to say that he grew up in Kilburn. At the age of 17 by his own admission he made the streets of Kilburn safer by joining the Army and completed 2 tours of duty in Vietnam.

This was followed by a period in the Army Reserves; in the SA Corrective Services (he says he was one of the ones with the keys) and as a Senior Leadership Consultant for the CFS, SAPOL and other organisations. He has also been pivotal in a number of very important initiatives - Operation Flinders and Trojans Trek.

He was awarded a Commendation for Brave Conduct for the actions he took during a riot in Yatala Prison (1996) and The Order of Australia Medal in 2016 for services to military history preservation and the community.

Since his retirement in late 2014 he has been a Volunteer with the RSL Virtual War Memorial in addition to continuing his work with Trojans' Trek. An avid reader he is an exacting researcher, historian and the author of a number of books including *Crossfire* (based on his time in Vietnam) and *Fallen Saints*.

OPENING ADDRESS

18th National Street Tree Symposium

Thursday 7 September 2017

Sanctuary Function Room, Adelaide Zoo

Mayor Lorraine Rosenberg

Mayor, City of Onkaparinga, SA & President Local Government Association SA

Welcome to the TREENET Symposium.

A special congratulations and Happy Birthday to TREENET for celebrating its 20th Year.

I would like to recognise the Kuarna people as the traditional owners of this country.

I also recognise Dr Greg Moore – our Keynote Speaker today and congratulate him on his well-deserved OAM from the Queen's Birthday Honour list 2017.

I recognise Glenn Williams Director, TREENET.

I recognise David Lawry OAM and Lyn Such.

I especially congratulate Dr Jennifer Gardner for her fantastic service as curator of the Waite Arboretum for 30 years following on from Dr David Symon. She retired this year and her achievement in putting the Arboretum at the forefront of Urban Forestry in Australia was appropriately rewarded in this year's Australia Day Honours also with an OAM.

I spent many an enjoyable hour wandering through the arboretum and grounds during my student days at Waite.

I was a graduate of Agricultural Science – one year behind David Lawry.

This is such an important asset for Adelaide and South Australia more broadly.

My studies were in Animal Physiology and Biochemistry but surprisingly it is my enjoyment of botany and native plants that led to my purchase of garden centres and eventually my farm with its 2½ acres of garden.

I want to acknowledge with thanks the kind invitation to me to open the proceedings.

On reflection I want to make the connections both as President of the Local Government Association and as Mayor of the City of Onkaparinga

Firstly as President of the LGA, I reflect back to a speech given by Major John Dyer OAM – then President of the LGA and Mayor of the City of Hindmarsh and Woodville. He gave the opening address to the Royal Australian Institute of Parks and Recreation at the Waite in September 1995.

In that presentation he reflected on the growth of our urban areas and the pressure on the natural treed environment. Nothing has changed, he reflected on the urban expectation that trees should not drop leaves, flowers, limbs and should not need water –nothing has changed. And he predicted an ecological approach would dominate the future of the urban environment.

As it turned out that seminar on Trees in the Urban Environment proved to be a watershed moment in the birth of TREENET.

Following on from a presentation by a well-respected civil engineer on the damage to infrastructure caused by tree roots, Greg Moore set aside the paper he had prepared and generously provided him and the enthralled audience with a lesson on tree root biology. He blamed poor engineering as the principal cause of the conflict between tree roots and the built environment and that shift in momentum carried on to the co-founding of TREENET by Jennifer and David in February 1997.

Well although some things remain the same, I am pleased that the emphasis for local government and community planning today does reflect sustainable water use, recycled and reuse of resources and trees as a focal point of landscape (especially in the broader context).

However with ever-increasing densification, the challenge will continue to find the tree space in a front or back yard.

That is why it is so important to support maintenance of open space, nature play opportunities and appropriate plantings along our creek lines and streets.

Which brings me to my role as Mayor of the City of Onkaparinga and work being done there.

The City of Onkaparinga has ~ 680,000 trees on our roadsides, reserves and streets. This means a continual challenge of replacement, pruning, protection of significant trees and maintaining biodiversity through the region.

Ongoing challenges of climate change make this process increasingly difficult. However we are an innovative Council.

Recently major upgrades of roads around our Civic Centre incorporated TREENET Inlets and SPACE structural soil in the design by our WSUD savvy staff. They learned much about this emerging practice from regular attendance at TREENET Symposia.

Also the City of Onkaparinga is extremely proud to have collaborated with TREENET and Willunga National Trust to deliver the Willunga Avenue of Trees Gallipoli Commemoration planting. This saw 100 Canary Oaks planted on the sweeping triangular entrance to Willunga, one for each year since the Gallipoli landing. I am pleased to say this is a very successful project and all the trees are doing well.

My other great pleasure is to introduce our Bob Such Keynote speaker. I feel honoured to be doing this as Bob was a parliamentary colleague and a friend. His seat of Fisher sat within the City of Onkaparinga and our Council, with the support and agreement of Lyn, commemorated him by naming a Reserve in Aberfoyle Park in his honour.

Bob and I had a few laughs together and enjoyed a shared love of the environment and children. We even competed once at a tree planting exercise on Frank Smith Reserve with the aid of the Coromandel Primary School students.

The Bob Such Keynote presenter role recognises Bob's long time management committee role for TREENET.

Dr Greg Moore will give the Keynote address today.

TAKING IT TO THE STREETS: CELEBRATING A TWENTY YEAR HISTORY OF TREENET – Responding to the Urban Forest Challenge

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Abstract

In celebrating twenty years since the founding of TREENET (**T**ree and **R**oadway **E**xperimental and **E**ducational **NET**work) and eighteen National Street Tree Symposia, it becomes clear that TREENET has been both follower and leader in providing a forum for the discussion of urban street tree management and has been effective in getting quality, data-rich information to those managing urban trees. In reviewing the content of symposium papers, water and water sensitive urban design is the clear dominant topic, followed by papers focusing on trees managed by local government authorities (LGAs), tree selection, hazard and risk, and climate change.

TREENET has tried to build bridges with disciplines, such as engineers, architects, planners, demographers, the medical profession, politicians and bureaucrats amongst others, but with questionable success. TREENET has urged the appropriate retention of street trees, but on a national basis 97% of the tree removal requests made to LGAs are approved and the canopy cover of the urban forest in most Australian cities is diminishing at a rate of about 1.0-1.5% per annum. Those interested in managing urban trees cannot claim success if the tree canopy cover in cities is declining.

If cities are to have appropriate canopy cover to meet the demands of climate change private open space must be part of the solution, despite the pressures of urban development. TREENET has rarely entered the territory of canopy cover on private open space – perhaps there is a vacuum of leadership that TREENET might fill. Often the most impoverished sectors of societies are the most disadvantaged in their access to treed open space. Accessibility to treed open space should be a right of all people living in urbanised areas and societies need to meet this right. It is possible that in not seeing the trees for the urban forest, the removal of specimen trees reduces the forest and so puts at risk the services that the trees provide.

In the future, climate change will probably be the greatest challenge to the urban forest in the next fifty years. It would be wiser to plan and pay for changes in canopy cover over a period of decades rather than try and retro fit an urban forest during a crisis. Popular cultivars may have narrow ranges of climatic tolerances, but the larger populations from whence they came often have a far greater diversity, range of tolerances and resilience. The target canopy cover for urban cities in Australia towns and cities, under climate change scenarios should not be less than 30%.

Introduction

It is now twenty years since the founding of TREENET (Tree and Roadway Experimental and Educational NETwork) and this is the eighteenth National Street Tree Symposium. We have had a great many papers and field day demonstrations over that time as TREENET pursued its dual themes of research and education. It is tempting to use such an occasion to look back at what has been done and achieved, but while this paper does some of that, its focus is to look critically at the present and perhaps more critically to the future.

For those interested in trees growing in cities, it soon becomes clear that in dealing with urban horticulture and arboriculture, the science is as much about people and politics as it is about the plants and trees. As you look back over the proceedings, it is not surprising that talks are overwhelmingly positive about the roles and benefits that trees provide in cities (Table 1). Allocating presentations to simple topics is fraught as some papers cover several topics and the allocation is subjective, but it does provide an overall sense of content.

As the review looks in greater depth at topics covered, water and water sensitive urban design is the clear dominant topic, and then come papers focusing on trees managed by local government authorities (LGAs), tree selection, hazard and risk, and climate change.

Other popular and recurring themes are heritage trees and Avenues of Honour (AoH), benefits of street trees, roots systems, trees and the law, safety and tree health. Some topics such as arboriculture, trees and water and LGA tree issues, appear in the symposia over the years and others such as climate change, sustainability, biodiversity, ecological services and trees and human health make their appearances on the programs from about half way through the period. It would appear that TREENET has been both follower and leader in providing a forum for the discussion of these important matters. TREENET has in any case been very effective in picking up trends and getting quality, data-rich information to those managing urban trees.

Table 1. A summary of topics presented at TREENET symposia and the year of their first and most recent appearance.

Topic	Number of Papers	Year of first appearance	Year of last appearance
Water and WSUD	25	2000	2016
Trees Managed by LGAs	22	2000	2016
Tree selection	20	2000	2016
Hazard and Risk	13	2002	2013
Climate change	15	2006	2016
Arboriculture	14	2000	2016
Heritage Trees and Avenues of Honour (AoH)	14	2004	2015
Benefits of Trees	10	2000	2016
Root systems	10	2001	2015
Trees and soils	9	2000	2016
Sustainability/biodiversity	9	2007	2016
Planting and establishment	9	2000	2016
Trees and human health	9	2006	2016
Trees and the law	8	2006	2016
Tree health	8	2001	2016
Ecological Services	7	2003	2016
Trees and safety	7	2002	2013
Engineering and pavement surfaces	7	2000	2015
Tree production systems	7	2001	2016
Trees and urban design	7	2000	2016

It would seem that TREENET has been at the vanguard of matters to do with water, water-sensitive design and permeable pavements and that the interest has been both regular and consistent. Soils, root systems and protection of trees on development sites have been other areas affecting street trees in which TREENET has played a leading role. The mantra of “right tree, right place, right time” has been a perennial focus of TREENET papers, especially in relation to LGA urban forestry.

It is interesting to note that the first papers on the benefits of street trees and human health and climate change in 2006 were followed by papers on sustainability in 2007, but that the first paper on ecological services was delivered in 2003. It is not a coincidence that the significant numbers of papers on climate change, sustainability and ecological services appeared as the party-political approach to climate change, prefaced on beliefs rather than data-led evidence dominated the climate change debate in Australia. TREENET can be proud of its role in taking a lead on these matters and making sure that climate change has been part of the agenda for urban forestry decision makers and planners.

TREENET has through its history tried to build bridges with other disciplines – not easily done between professions that are essentially silos. The symposia show these attempts with engineers, architects, planners, demographers, the medical profession, politicians and bureaucrats amongst others. There is clear evidence of effort, but little proof of success. However, it is gratifying to see whole sessions devoted to engineering, soils and pavements, where experts from other professions took both the lead and the symposium floor. It was delightful to see the first TREENET paper on the roles of trees in human heath dating back to 2006 and then the whole first session devoted to the topic in 2016 – real leadership! While TREENET educates and publishes research, the last presentation on education, arboriculture and urban trees was in 2005, which provides an opportunity for future leadership.

The fate of specimen trees and the state urban Forest

It is worth considering the states of individual specimen trees and of the urban forests in Australia after 20 years of TREENET. The quality of urban forest management, arboriculture and tree surgery has clearly improved in most, if not all States. There is a much greater degree of research based management than there was 20 years ago, but this is to be expected, as it has happened in most fields of human endeavour. TREENET has been an effective part of communicating on topics related to street trees and the urban forest more generally, as the symposia proceedings and in recent times the podcasts attest. Under its themes of education and research, access to these valuable TREENET resources remains freely available to anyone.

One of the questions that comes to mind at this time is whether the fate of individual specimen trees and the state of the urban forest have improved over the past twenty years and how improvement or progress might be measured. In the case of individual trees managed by LGAs the data are quite depressing. On a national basis 97% of the tree removal requests made to LGAs are approved; not necessarily at the first request, but eventually. The commonly voiced assertion that LGAs prevent citizens/owners from removing trees is not supported by the data, and many people assume that they will be denied a tree removal permit and so don't apply. They then claim that they have not been able to remove a tree. Success in protecting important urban trees in general seems to be mixed at best.

In Victoria an all too familiar scenario unfolds when significant trees are threatened with removal for urban development or are poorly managed during such development. The first hint of an impending issue is public awareness of the imminent removals that is often followed by local community objection to the responsible LGA. However, if the tree is not protected by inclusion under a planning overlay or other relevant LGA ordinance, there is little that can be done to protect the tree, even if the LGA and its officers are supportive of retention. In Victoria, and it is similar in some other states, a planning overlay (or equivalent) is the first step in the legal protection of urban trees and without it higher legal redress is usually unavailable.

The legal framework that affects trees during urban development has changed several (many) times over the past 30 years, but urban trees are still being lost at an alarming rate. Local government registers only protect trees when they are included in planning codes and overlays. Heritage legislation in Victoria and some other states affords good protection to trees if they are listed, but there are only a small number of trees protected in this way (in Victoria there are about a dozen nominations, but some have many trees such as Avenues of Honour).

Attempting to protect a tree after development has been approved usually fails because appeals tribunals such as the Victorian Civil and Administrative Tribunal (VCAT) can only adjudicate on whether procedure has been followed not on the merits of protecting the trees, or for that matter on the quality of the trees. In Victoria, the best way of protecting trees is to protect them by inclusion on council planning overlays, but very few, if any LGAs take this action.

The chair of the National Trust of Australia's (Victoria) committee of the Register of Significant Trees has on several occasions over the past decade written to the Mayor and Chief Executive Officer of every local government in the State of Victoria advising them of the significant trees growing within their jurisdictions and requesting that significant trees should be protected under the planning instruments available to LGAs. There have been no responses to these requests. However, it is worth noting that while there is no legal protection afforded trees classified by the National Trust, by regularly sending lists of significant trees to relevant authorities such as those dealing with roads and services such as water, gas, electricity and communication inadvertent damage by those undertaking works, who may not be aware of the significance of the trees can be minimised. Furthermore, once classified there is a level of political protection and moral persuasion that sees significant protection given to many specimens such that there have only been seven known cases of classified trees being removed for development works in over thirty years (Table 2).

Table 2. Trees lost due to property development
from the National Trust of Australia's (Victoria) Register of significant Trees (from Moore and Hughes 2014)

Total number of registered entries	1300		
Total number of trees	23000		
Number of entries removed due to tree death	1007	Known Natural Cause	40 (40%)
		Property Development	7 (7%)
		Cause of death unknown	53 (53%)

Another mechanism for the protection of trees growing in private open space that may be available is through the placing of a statutory covenant on the property title. These covenants provide a security mechanism over land rather than the trees per se but could be used to protect defined areas of land which contain significant trees, where that meets the statutory objectives of the covenanting body. In this way there is protection of the open space in perpetuity and so the green space would be protected beyond the life span of the trees. This mechanism has long been possible, but is rarely used, probably for two reasons. The first is a fear that it could reduce property value, as buyers tend to be wary of covenants and second is a lack of precedent for using conservation covenants in this way, as they have conventionally been used to protect intact bushland. Linked to this is a concern that they may be legally ineffective in this circumstance.

Regarding this latter point, it is worth noting that in Victoria, Trust for Nature has been placing covenants on private land to protect environmental values for over thirty years, and thus far they have stood the test of time. A national investigation into covenants and other binding agreements on title found that less than 1% had been released (Hardy et al. 2016). There is evidence from overseas that clusters of properties under covenant (easement) in urban and semi-urban settings may attract a premium value, but this is untested in Australia. Perhaps TREENET might provide future leadership in private open space tree management.

In terms of the broader urban forest, one measure used in the assessment of urban forest success is tree canopy cover. A benchmarking study commissioned by Horticulture Australia was undertaken in 2014, using i-Tree of tree canopy cover in major Australian LGAs (Table 3),(Jacobs et al. 2014). It shows a disappointingly and unacceptably low cover in many cities, often with about half of the LGA managed regions having less than 20% cover and with the range for the greater cities often beginning as low as 3% to 10%.

Table 3. Tree cover in Local Government Areas (LGA) of Australian cities (modified from Jacobs et al. 2014)

	# of LGAs	# < 20% cover	Range of cover (%) for City
Greater Sydney	20	8	12.1 – 59.3
Greater Melbourne	19	10	3.1 – 77.2
Greater Perth	19	12	9.1 - 62.8
Greater Adelaide	17	9	11.9 – 43.7
Greater Brisbane	5	1	16.3 – 78.9
Canberra	7	3	10.3 – 75.5
Hobart and Launceston		0	31.4 – 65.7
Darwin		0	27.7 - 28.8

In the benchmarking study, Jacobs et al. (2014) identified a number of LGAs with the potential to increase canopy cover through conversion of hard surfaces (Table 4). They also identified LGAs with the opportunity to increase canopy cover through the conversion of land that was grassed or bare ground. In several, if not many instances the same LGAs appeared in both lists. The data presented here excludes, the central city and peri-urban LGAs, but several are older and/or inner city suburbs. A number of these LGAs also present with higher rates of heat wave related mortality and poorer health status of residents. The low canopy cover and higher hard surface/bare ground characteristics could be used by TREENET and other organization to target areas of cities for programs for increasing tree canopy cover. The data can also be used to prioritize tree planting in LGAs or sections of cities with low canopy cover and to establish funding allocations within budgets.

Table 4. Selected Local Government Areas (LGA) of Australian cities with high hard surface, grass and bare ground cover with a high potential for increasing canopy cover (modified from Jacobs et al. 2014)

LGAs	State	Hard Surface Cover (%)	Grass-Bare Ground Cover (%)	Potential for increasing canopy cover
Maribyrnong	Victoria	58.2	30.8	High
Moonee Valley	Victoria	52.8	31.0	Very high
Port Adelaide	South Australia	55.1	30.4	High
Charles Sturt	South Australia	54.8	27.5	Very high
Rockdale	New South Wales	58.1	25.0	High
Botany Bay	New South Wales	55.4	29.7	High
Freemantle	Western Australia	65.1	18.4	Medium-High
Vincent	Western Australia	65.9	16.6	Medium-High

It is clear from these and other data that the tree cover of Australian cities is by no means as dense as many people might think, or perhaps wish.

Even in places such as Brisbane, Hobart or Launceston where canopy cover is higher and ranges begin at higher minimums, there are significant parts of the city with less than 20% cover. By comparison, it is worth noting that London has been classified as a forest by United Kingdom authorities. Its canopy cover is approximately 20%, but other vegetation cover is about 32% which give a total of vegetated cover of about 52% (Mayor of London 2015). Australian vegetation classification systems would describe the city as woodland (Specht 1970; Auslig 1990). The City of Greater London has a goal of raising its cover to 25% by 2025.

Tree canopy cover has varied little (<1%) in London over the period 2003-2015. It is interesting to see if things are similar in Australian cities (Table 5). The work of Mullaly (2000) in Balwyn and Richmond, Victoria reported a decline in canopy cover between 1993 and 2000 of about 8% in Balwyn but little change in Richmond. The loss of cover in Balwyn was predominantly from private open space, particularly developed land, while in Richmond the loss of tree canopy cover of about 2% on private land was compensated for by an increase in canopy cover of about 2% on public land. In revisiting these two sites, using Google maps rather than the stereo-microscopy of aerial photographs that Mullaly (2000) used, estimates of canopy cover were made based on 2017 images. In Richmond, the area surrounded by Victoria, Church, Somerset and Burnley streets was selected and in Balwyn, the area bounded by Severn Street, Doncaster, Burke and Belmore roads. They were chosen as they were part of Mullaly's (2000) study.

Table 5. Changes in tree canopy cover in Balwyn and Richmond, Victoria (modified and expanded from Moore 2009).

LAND TYPE	OWNERSHIP OF LAND	BALWYN		RICHMOND	
Developed Land		CHANGE 1993-2000	CHANGE 2000-2017	CHANGE 1993-2000E	CHANGE 2000-2017
	PRIVATE	-8.24	-15.0	-1.84	-6.0
	PUBLIC	1.20	-1.0	-0.43	0.0
	TOTAL	-7.04	-16.0	-2.27	-6.0

The estimates of canopy cover and loss are by no means as accurate as those undertaken by Mullaly (2000), and they should be seen as being no more than indicative. The canopy cover in Balwyn appears to have continued to decline over the period 2000 to 2016 with cover being about 15% less on private land and up to 1% less on public land (Table 5). Richmond too has lost canopy of about 6% on private land but cover on public land appears to have remained unchanged for the areas sampled. These data cannot be extended to the loss of canopy cover for the suburbs overall without further and more detailed sampling. They do suggest a loss of canopy, however, and the need for more extensive research and data collection which might be facilitated TREENET, perhaps in collaboration with other organizations.

From these data, it seems reasonable to conclude that in terms of urban forest management, the battle for the minds of LGA officers in defending and extending the urban forest on public land is being won, but the same cannot be said for LGAs in dealing with development and planning on private land. The canopy cover on private open space is diminishing at an alarming rate as urban development and renewal takes place. Backyards have disappeared and front yards are often so small that they cannot accommodate a tree. Roads are so narrow that nature strips are now essentially car parking infra structure and trees planted in them soon disappear. The battle between tree cover and development seems to be a losing one.

In many cities tree management officers in LGAs realize only too well that if they are to have an appropriate canopy cover to meet the demands of a changing climate, they cannot achieve the target on public land – there is simply insufficient space.

Private open space must be part of both the solution and the future, but how do you maintain canopy cover in the face of increasing urban development where house blocks are smaller, houses bigger and houses on larger sites are being demolished for multiple dwellings. TREENET has rarely entered the territory of canopy cover on private open space – perhaps there is a vacuum of leadership in this space that TREENET might fill.

While the benefits of street trees and the urban forest on the sustainability of cities, the importance of urban trees in human health and the economic benefits that urban trees provide seems to be better understood by more people in decision making positions in society, the tree canopy cover is being lost in the course of urban development at a rate of about 1.0-1.5% per annum. Those interested in managing urban trees cannot claim progress, let alone success, if the tree canopy cover in cities is declining. There is a great need to protect what cover there is in LGAs and to provide more cover in the LGAs that are currently deficient but again this seems to be a battle that is being lost.

Citizens, arboriculture and the urban forest

It is usually assumed that the benefits of the urban forest are shared equally by the citizens of a city, region or town: But this far from the reality. In many Australian cities different parts of the city are differentially affected by the heat island effect (UHI) due to significant differences in tree canopy cover. In Melbourne, for example, the UHI is more pronounced for those living in the west and north-western parts of the city and this correlates with higher rates of heatwave related deaths, generally poorer health and shorter life expectancies in these places.

Accessibility to treed open space is a multidimensional construct (Wang et al. 2013) that is affected by the physical distance that people live and work from the treed open space, and other variables such as socio-economical status, educational background and population density among others. Often the most impoverished sectors of societies are the most disadvantaged in their access to treed public and private open space, which in turn is associated with problems such as obesity, physical and mental health and social problems (De Vries 2003; Maas et al. 2006; MacIntyre et al. 2008).

It seems logical that accessibility to treed open space should be a right of all people living in urbanised areas and that to be both economically and environmentally sustainable societies need to ensure that they meet this right. To realise the recreational, health, environmental, social and other benefits that people can derive from the use of the open space, LGAs have to ensure access to it (Ahendt 2004; Giles-Corti et al. 2005; Cohen et al. 2007). The paradox is obvious in that the sectors of society most in need of treed open space to counter their general disadvantage are those least likely to have access to it.

In Australia, the field of arboriculture has developed within the broader discipline of horticulture, and particularly amenity, environmental or ornamental horticulture. In other parts of the world and notably the United States of America, arboriculture has its roots within the discipline of forestry. Over the past decade the terms arboriculture and urban forestry have often been used as synonyms in Australian urban tree management, but arboriculture and urban forestry come from different traditions that are underpinned by different, and sometimes conflicting, philosophies (Moore 2009). Urban forestry comes from a forestry tradition of managing groups of trees for their production values, while arboriculture comes from a horticultural tradition that focuses on the tree as a specimen.

Both arboriculture and urban forestry present valid and important frameworks within which to manage urban trees. On some issues relating to urban trees the objectives of both frameworks are identical, on others they are different but complementary and on yet other matters, such as the importance of an individual specimen tree they may be quite different.

The concept of urban canopy cover is a classic application of an urban forestry paradigm as well as a classic forestry analytical technique. However, there is need for caution as in focusing on the urban forest it is easy for the importance of the individual specimen to be minimized and undervalued, which could see the removal of individual trees as long as the forest is maintained.

In focusing on the services and functions that trees provide as part of the urban forest, it is important that the individual specimen tree is neither forgotten nor over-looked. In not seeing the trees for the urban forest, it is possible that in failing to see the removal of specimen trees the forest as a whole is reduced as a consequence. The arboricultural focus on the specimen ensures that the forest is undiminished, but the reverse is not necessarily true in that focusing on the urban forest does not guarantee the preservation of individual trees. While the semantics of the meaning of arboriculture and urban forestry may not be of interest to urban tree managers, the consequences for tree management and urban tree populations could be. The differences in the philosophies supporting arboriculture and urban forestry are important and while the disciplines often aspire to the same goals in the face of climate change and urban development, the approaches should be applied knowledgeably and in the appropriate environmental context.

It is interesting to consider the TREENET Avenues of Honour (AoH) project in terms of it symbolism in linking citizens and the urban forest. Right from its inception, the AoH project was lauded as being timely and relevant to the commemorations surrounding World War One (1914-1918). The project uncovered hundreds of unknown, forgotten and decrepit AoH and communities rallied to protect and restore these heritage treasures. Communities in rural towns and suburbs came together to commemorate and to celebrate the purposes of the AoH.

David Lawry OAM worked tirelessly and innovatively to fulfill the vision of the project and would have been unable to do so without the support of one individual and generous sponsor, but TREENET was unable to attract one cent of government spending to allow the full completion of the project. Apart from the annual symposia, the AoH project represents TREENET's greatest expenditure of its funds to an activity. The expenditure provided some wonderful resources including knowledge of many forgotten AoH and a popular and very useful website. But the question has to be asked, "How could such a worthy project fail to attract funding?" Was it because it involved trees? How often are trees and open space sacrificed in the name of development, the economy or higher priorities?

Looking to the Future – TREENET and the Urban Forest

In looking to the future, it is clear that climate change and its many and varied consequences will probably be the greatest challenge to the urban forest and those managing it in the coming fifty years. In the parts of Australia hardest hit by climate, the urban forest and public open space will play a major role in contributing to the resilience and sustainability of the urban ecosystems and the communities dependent upon them. It would be wiser to plan and pay for the changes in canopy cover required over a period of decades rather than to try and retro fit an urban forest at a time of crisis. If the record of the past is anything to go on the latter is the more likely scenario – change will be too little and too late and of course the economic costs will be much greater.

In the face of climate change, there is great interest and speculation about the future of urban trees and the urban forest. How important to urban infrastructure will canopy cover be? What species will be capable of surviving and thriving during climate change? Should urban tree managers be proactive in shaping tree planting lists for climate change? In considering some of these questions, it is important to remember that while many urban trees have been bred and selected for city use, they often come from species with much broader natural ranges. Popular cultivars may have narrow ranges of climatic tolerances, but the larger populations from whence they came often have a far greater diversity, range of tolerances and resilience.

Table 6: Characteristics of a eucalypt displacement series from wetter to drier environments (Pate and McComb 1981)

Characteristics of eucalypt species altered as the environment dries
Greater root:shoot ratio
Increasing root:shoot ratio in response to water stress
Slower stomatal response to decreasing xylem water potential
Slower decline in leaf turgidity with increased water stress
Lower rate of transpiration in wetter soils

It is important to consider the role of the normal distribution curve as it relates to plant characteristics and the contribution that it plays in the resilience of species through natural selection and subsequent evolution. Many common urban trees come from populations that have wide and extensive natural distributions, suggesting a wide range of species characteristics and tolerances. Some eucalypt species, *Acmena smithii, Lophostemon confertus* and *Tristaniopsis* species show a wide-range of environmental tolerances. Careful provenance selection and breeding, which source specimens growing on appropriate soils but from lower rainfall and/or warmer regions could ensure that there are suitable intraspecific selections to meet urban planting demands.

For genera, such as Eucalyptus and Acacia, there may be the option of selecting different but closely-related species from within the genus where displacement series of species exist that occupy a broad range of habitats. A displacement series consists of related species, which replace each other over an ecotone that could be related to aridity, rainfall, soil nutrition, altitude or temperature (Figure 1),(Pate and McComb 1981; Fensham and Holman 1999; Shepherd et al. 2008; Holman, Hughes and Fensham 2011). Of particular interest for informing tree selection for climate change are displacement series of increasingly arid or warmer environments. Species show characteristics (Table 6) that adapt them to the drier conditions or generally more stressful environments, which could then be used as a guide for which species might be successful for urban planting in drier conditions.

It is clear that urban trees will continue to be a vital component of urban infrastructure. Tree selection will be increasingly important in ensuring that the species and varieties and selected will be successful not only in establishing but in persevering over the appropriate time spans demanded of urban trees. Tree breeding and selection have been recurring themes of TREENET symposia, but leadership will be required if the full potential of native and exotic tree species for urban forest use is to be realised. The temptation to use what is available and easily produced must be resisted, and resources will have to be allocated to breeding and selection programs, especially for native tree species.

Figure 1. Displacement series for eucalypt genera/subgenera and some Acacia species (after Moore 2016).

Characteristic	Milder Environment	Harsher Environment
Eucalypt Subgenera/genera	Monocalyptus →	Corymbia → Symphyomyrtus
Monocalyptus Displacement series in Victoria's Central Highlands	*E.regnans* →	*E.obliqua* *E.sieberi* *E.radiata*
Monocalyptus Displacement series in Victoria's Southern Highlands	*E.delegatensis* →	*E.fastigata* *E.radiata* *E.dives* *E.pauciflora*

Characteristic	Milder Environment	Harsher Environment
Tolerance of soil moisture levels within *Acacia* species	*A dealbata* → *A. mearnsii* dense canopy → sparse/open canopy	
Tolerance of aridity within *Acacia* species	*A catenulata* → *A. aneura* larger phyllodes → smaller phyllodes	

The history of human intervention in ecosystem management, especially over longer time frames has not been characterized by success. While the idea of pre-selecting species for urban use with climate change in mind has real appeal, it must be based on comprehensive data for particular species and undertaken with great caution.

In concluding a question that might be posed to all interested in TREENET and its themes of research and education "Is 30% is an arboricultural magic number for those looking for some simple messages in relation to the urban forest?"

- In the Australian Vegetation Community Classification systems, a forest is defined by a tree canopy cover of, or greater than 30% (Specht 1970; Auslig 1990).
- To maximise the benefits of tree cover in terms of the many and varied environmental and other services provided a canopy cover of, or greater than, 30% is required.
- When people are considering the purchase of a suburban house there is an increase in property value when trees are present, until the cover is 30% or greater. Higher than 30% sees a decrease in value of the property (Plant 2016).
- The target canopy cover for urban cities in Australia towns and cities, under climate change scenarios should not be less than 30%.

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Using an Integrative Theoretical Framework. Final Paper Submitted to State of Australian Cities Conference

ARBORISTS AND ARGUMENTS IN THE URBAN FOREST: A SYNTHESIS

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Abstract

The framing of urban trees has shifted from adornment or obstruction to a key asset in the delivery of ecological, economic and social services. This transition has been interwoven with the rise of the profession of arboriculture from the ashbed of tree lopping and naive nativism. Arborists are working to improve the sustainability of Australian cities by integrating the management of grey (built) and green (living) infrastructure in a context in which space for trees is in a severe decline and different segments of the population vary in their attitudes towards them. On-ground tree managers and residents are more emotionally engaged with trees than planners. While the general public barely notices the existence of publically employed arboricultural professionals, the professionals have strong opinions about public attitudes and behaviours related to trees, in particular believing that the public over-estimates risk. There are four types of potential conflict within and between the public, the arborists and the planners: between those who see trees as cost-effective machines for achieving urban goals and those in love with them; between those who have ideological attachments to different types of trees; between those scared of trees and those sanguine about their risk; and, between adjacent land owners. Our interviews with tree professionals suggest that the first type of conflict could be avoided by appropriate selection and management of trees, the second mitigated by consultative planning processes, the third by education of the public and the fourth by arboricultural advice and legal means. Most tree professionals felt that there was considerable room for improvement in tree management in cities, but they disagreed strongly on the effectiveness of different options for tree conservation. The relative effectiveness of the wide variety of mechanisms used to maintain and enhance tree coverage in Australian cities needs to be determined.

Introduction

The present paper provides a synopsis of the results of the work that we have been involved in during the last two decades, with each other and many colleagues and students, on urban trees, the urban forest and tree professionals in Australia. First, we address the history of Australian urban trees, including the history of the arborist profession, followed by a discussion of the desirability, or otherwise, of trees in cities, the variation in attitudes between private tree owners, arborists and planners, the way that attitudes of people affect tree planting and removal, including the roles or risk perception and taste in fashioning the urban tree estate, and, the planning and management implications of our observations.

In many places in the following discourse, we repeat or paraphrase sentences or paragraphs from books and papers of which we have been author or co-author without cluttering up the text with quotation marks.

History of urban trees

The only temporally comprehensive account of the European history of trees in any Australian city pertains to Melbourne [1]. In a series of cameo chapters, Anna Wilson documents the removal of trees as obstacles as Melbourne was established, their widespread planting for disease prophylaxis in the nineteenth, subsequent disillusionment with trees as machines, the interwar planting of trees for beauty and romance, the sidelining of trees by post-war development and the protective reaction of tree lovers.

Rapid suburban expansion from the 1950s onwards resulted in enormous tree loss [2]. Although Robin Boyd [3] characterized postwar suburban pioneers as vehement arboriphobes, my own recollections of childhood in the fifties in the expanding Melbourne working class suburb of Moorabbin was of ubiquitous tree planting irrespective of individual socio-economic status [1], and of people fighting to retain native trees where suburbia infiltrated bush [4].

British-style tree preservation orders were imposed by local governments in Victoria [4] and New South Wales [5] during the 1960s and 1970s. These local orders placed restrictions on the removal of specified amenity trees in both public and private land, and were adopted as environmental planning instruments in the 1979 NSW Environmental Planning and Assessment Act [5].

An attachment to native trees and bush became politically powerful with the Green Bans of the early 1970s [6]. In the 1970s and 1980s, large native trees were planted in public areas in a chaotic fashion [7] and native gardens became fashionable [8]. Over the next decade, the Landcare movement involved local community groups in the rehabilitation of urban bushland [9].

Between the 1960s and the 2000s, the density of trees increased dramatically in Australian cities, in both gardens and streetscapes [10]. The increasing cover of hard surfaces in the twenty-first century has probably reversed this tendency, on private land at least, with leafy gardens and spreading houses replaced widely by tightly packed neo-brutalist or faux-Georgian two story units.

At the same time as trees were being replaced by ugly units, they were being increasingly positively perceived, as in the nineteenth century, as machines; this time for economic benefit as well as prophylaxis. Software was developed to economically value urban trees. One council [7] calculated its trees to have a replacement value of over 22 million dollars and a net annual return in benefits of over 3 million dollars [5]. Machines needed tenders, who are largely the modern arborists.

The scientific profession of arboriculture originated in the US and Canada in the 1960s and 1970s, representing a significant break from prior focus on both nonurban forests associated with cities and individual trees in urban environments [5]. The defining mission of this new profession was the scientific management of trees and tree populations as an integral component of the urban system [5]. Influenced by developments in North America, CSIRO forester John French developed a vision of urban areas of productive forest was grounded in traditional forestry practices, chiefly timber harvesting [5]. French [11] anticipated compact city arguments in envisaging dense housing clusters embedded within public forest [5].

While there was considerable interest in planting and retaining urban trees during the 1970s and 1980s, urban tree management was not thought to require special skills [12]. During the 1980s, tensions began to emerge between those trained in modern arboriculture in North America, Europe and elsewhere and those they characterized as ‘tree-loppers’, ultimately resulting in the 1989 formation of the lopper-free National Arborist Association of Australia (NAAA), and the contemporary dominance of the arborist in maintaining ‘green infrastructure.

Desirability of urban trees

There is social and cultural variation in perceptions of the benefits and disadvantages of trees in cities [10,13–16]. There are places within Australian cities where any tree plantings are first resisted then vandalised [10]. Trees induce nervousness in places exposed to bushfire and cyclone [15], often resulting in the post-disaster felling of trees that actually help mitigate disasters [17].

Variation in attitudes

Among Australian city gardeners, we have those who predominantly perceive urban trees as sacred, utilitarian, decorative or hazardous and those who are indifferent to urban trees, or see most of them as growing out of place [14, 18].

Some gardeners are 'aesthetes' who plant trees to improve the beauty of their house and garden and who may respond to the cultural dictates of fashion [14]. They are the least likely people to plant trees for food production or remove them for firewood, to appease neighbours, or because they are shady. They do not like dense trees in streets [14].

The 'tree huggers' [14] value trees for everything and see them as a problem for nothing. They know their tree species and like streets full of trees. They place a high value on the intrinsic worth and spirituality of trees [14, 18].

The 'practical tree lovers' [14] are equally as fond of the aesthetic qualities of trees as aesthetes and tree huggers, but are more practically than spiritually inclined, having the highest propensity to plant trees for food, to plant for a windbreak, to plant to minimise garden maintenance, to remove environmental weeds and to remove trees to prevent damage to infrastructure. They also highly value trees as wildlife habitat, for recreation and as contributors to the resale value of properties [14].

The 'arboriphobes' [14] are the least likely to plant trees to attract birds and animals, and the most likely to remove trees for most reasons. They want to remove trees that block light, messy trees, dangerous trees and trees that are a traffic hazard. They are the least likely to value trees, except for recreation and property values, and are the most likely to see trees as a problem, except in relation to fire hazard [14].

The 'native wildlife lovers' [14] have the highest propensity to plant to encourage native wildlife, and are not inclined to remove trees because of fire hazard or other dangers. They are especially fond of native street trees [14].

The 'tree hazard minimisers' [14] plant trees to attract birds and animals, but remove trees that interfered with powerlines or infrastructure, are diseased or have potential or actual tree or limb fall. They do not use trees for privacy and remove trees they perceive to constitute a fire hazard. They place a low value on trees for recreational use and to improve property values. A lack of regard for the aesthetic qualities of trees also distinguishes this group [14].

The 'tree indifferents' [14], have a low opinion of the spiritual value of trees, are among the most inclined to see trees as a fire hazard, dislike eucalypts as street trees, and think that there are too many street trees in general [14].

There is no significant variation between the above seven attitude groups in propensity to remove trees. There is significant differentiation in tree planting, with the greatest deviations expected from a random distribution being for the tree huggers, few of whom had planted no trees in the last five years, and the arboriphobes, a large proportion of whom had planted no trees in the same time period [14].

Age, country of birth, ownership status, housing type, block size and time at present address do not differ between the above attitude groups [14]. The best discriminator between these attitude groups is median household income, with income declining in the order: aesthetes, tree huggers, practical tree lovers, arboriphobes, native wildlife lovers, the risk averse and the indifferent [14]. The proportion of the tertiary-educated and the proportion of females are higher among the tree huggers, practical tree lovers and native wildlife lovers than among the rest [14].

Our classification of tree professionals across all Australian States except Western Australia on the basis of their statements in qualitative interviews indicates five attitude groups [19]. One group of passionately critical Queenslanders state that they: 'fight for/protect trees', 'infill/densification/development is destroying trees' and that 'trees are valuable for biodiversity'.

This group has the highest average number of negative statements (critical of present conditions), the lowest percentage of positive statements (approving of present conditions) and the equal lowest positive/negative ratio. The group also had the equal highest average percentage of emotional statements (containing words denoting strong feelings) [19].

The second group largely consists of local government employees from Melbourne. The statements 'Trees irrationally removed because of fire risk', 'maintaining old trees is an important management challenge', 'water/drought issue important' and 'trees need to be in the right place' best distinguish this group from the others [19].

The professionals in group 3 are largely strategists and planners. They have the highest percentage of positive statements and the lowest percentage of both negative and emotional statements. The statements that best distinguish the members of this group from others are utilitarian, such as: 'trees mitigate urban heat island effect' and 'trees important for storm water' [19].

Privately employed arborists constitute most of group 4. They have the equal lowest positive/negative statement ratio and the equal highest percentage of emotional statements. 'Developers try to corrupt arborists' and 'problems with effectiveness of some tree protection mechanisms' are statements that distinguish this group from others [19].

The professionals in group 5 are concentrated in Brisbane and Hobart. They are mainly tree managers. They are equal lowest on the positive/negative statement ratio with those in groups 1 and 4. The statements that best distinguish them from other groups were: 'risk aversion makes for more careful tree management', 'people scapegoat innocent trees', 'some people/councils exaggerate tree risk' and 'old people do not like trees' [19].

The most common opinion of urban residents held by urban tree professionals is that some people hate trees, or, at least, some tree species, an attitude that did not vary among groups, although there was much disagreement about the reasons for arboriphobia, the demographic correlates of arboriphobia and the species most likely to provoke arboriphobia [19]. The next most commonly expressed opinion, that people exaggerated tree risk, discussed in depth in Davison and Kirkpatrick [17], does vary, with a strong peak in group five [19]. Two other opinions about people that varies between groups are also most strongly held by those in group 5; that older people do not like trees and that people scapegoat innocent trees. The opinion that 'trees were irrationally removed as scapegoats for fire or for fear of fires' also varies between groups. This opinion peaks in group two, which was dominated by Melbourne arborists who were interviewed within months of the 'Black Saturday' fire that devastated parts of peri-urban Melbourne in 2009 [19].

More than a fifth of the tree professionals held the views that 'people irrationally fear trees', 'people need educating about trees', 'immigrants do not like ornamental trees', 'immigrants no different to anyone else in attitudes to trees', 'people do not like trees because they are messy', 'street trees improve social/community relationships, 'most people love trees', 'low income people do not like trees', and, the 'public are increasingly aware of the value of trees' [19].

Variations in Actions

Attitudes do not necessarily translate into practices [e.g. 20–22], and practices thought to be consistent with attitudes do not always achieve outcomes consistent with attitudes [23].

The aesthetes are more likely than expected by chance to neither remove nor plant trees and less likely than expected to have done both. The tree huggers well exceed expectation in planting, but are markedly in deficit for removal. The practical tree lovers plant and remove and plant more than expected, the mirror image of the arboriphobes and the tree indifferents. The wildlife lovers removed trees less than expected, while the tree hazard minimisers conformed to expectations [14].

The aesthetes, tree hazard minimisers and tree indifferents remove many more eucalypts than they plant, while tree huggers plant many more than they remove. Tree huggers are most likely to plant wattles, while native wildlife lovers are the least likely to have done so. The arboriphobes and tree indifferents plant no scleromorphic native trees while the practical tree lovers are most inclined to plant them. There is no differentiation between groups in the planting or removal of broad-leaved natives. More people plant fruit trees than remove them in all groups except the aesthetes, with the excess of planting over removal being greatest in the tree huggers. There is no differentiation between attitude groups in planting and removal behaviour for deciduous exotics, evergreen exotics, arboreal monocots or gymnosperms.

The differences in attitudes to trees and action related to attitudes is manifest in a highly variegated suburbia, in which adjacent gardens are highly unlikely to share species or type of trees, unlike the situation in North America, where there is a high degree of spatial contagion [24].

The motivations for the planting of trees are very different between private landowners, on the ground arborists and planners [19]. Although all recognize beauty and shade as primary motivations for tree planting, the planners emphasise the attributes of trees as green infrastructure, as in storm water management, the on ground arboriculturalists recognize effects on property values, and residents largely have motives related to desired appearance and nature conservation [19].

The role of risk and taste in tree death

Although it is yet to be properly tested, circumstantial evidence suggests that much tree death on private land in Australian suburbs is related to change of ownership every decade or so interacting with different preferences for types of trees among consecutive owners [15]. A size class analysis at the species level [25] was able to detect species no longer planted, and those presently fashionable, indicating that preferences change through time as well as differing between contemporary attitude groups.

Tree-related risk has, in part, worked against urban greening activities by reducing tree size and age. Conversely, the rise of cultural concern about risk has encouraged the development of the profession of arboriculture, which, in turn, has pioneered sophisticated ways, familiar to neither engineers nor ecologists, of ensuring the cohabitation of people and trees [17]. Risk is only one of the problems associated with big and old trees. The cost of their maintenance is considerable, compared to smaller and younger trees. For example, cheap access to crowns for pruning of dangerous branches has a height limit, and morbidity, and therefore the cost of treatment, increases with aging [19].

Implications for conflict management and planning

Our data suggest that there are several types of conflict about trees in cities. The most common conflict seems to be between those who are emotionally, morally or spiritually attached to trees and those who see trees as a subject of cost-benefit equations. The former will fight hard to save trees that are considered cost-ineffective by the latter. The second type of conflict is between those who want an urban forest with very different dominant strata or structures, for example, those who would rather have local native street trees versus those who would rather have elms versus those who do not want street trees. A third type of conflict is between those whose knowledge of trees allows them to realistically appraise tree risk, and the balance of tree risk with tree benefit, and those who disproportionately associate risk with trees. The latter will fight to destroy the ‘dangerous’ trees that the former wish to protect. The fourth type of conflict is territorial, with trees on adjacent properties, parks or roads perceived to have negative effects on the territory and/or life of the complainant.

Thus, people fight with their local government or neighbors to get trees removed that they perceive, among many other possibilities, to crack their paths, block their drains, cut off their light, drop messy leaves, cause allergic reactions or suck goodness from their lawns.

Planners and strategists see the solution to their conflicts with tree lovers to be not to plant trees that could create conflict. Many residents suggest that trees needed to be selected to suit particular locations, an option they believed that had not been adopted in the past.

By itself, the above strategy tends to exacerbate the second type of conflict, in that the trees that are likely to get large and brittle are less liable to be chosen than trees so diminutive that they almost do not deserve the name. Small exotic trees are not likely to produce public spaces that appeal to the more romantics, nativists, or contribute to the architecture of urban landscapes in a way comparable to large trees.

The majority of arborists and planners saw the solution to such conflicts to lie in an improvement of planning and governance processes. One quarter of the tree professionals saw a need for better governance and planning structures for trees within and between municipalities and one third thought that there was a need to improve planning processes to protect trees and increase tree cover. Participatory planning processes require tree professionals to listen to the concerned public and the public to listen to the tree professionals, theoretically allowing widespread acceptance of solutions that are necessarily compromises.

The major solution offered by tree professionals to conflicts about risk was better education of the public. They saw their role to be 'changing people's attitudes to trees'. However, exaggerated fear of risk is difficult to shift when it is constantly reinforced by media and other cultural representations of tree-related risk. Improved arboricultural education and better communication between tree professionals was advocated by many.

Arborists see themselves as effective mediators of disputes between neighbours. The legal process for tree conflict resolution developed in New South Wales is highly approved of by many arborists and planners. However, there are major differences of opinion on the effectiveness and appropriateness of legislative and regulatory mechanisms for tree protection. These differences of opinion may relate to the different tree protection mechanisms adopted by different local government areas and States, varying from laissez-faire to rigorous and expensive tree removal permission processes [19]. This variation offers the possibility of future tests of effectiveness for particular goals of different options. Our research suggests that there will be few options suitable for all groups of people in all places, but that locally derived approaches that recognise diversity in attitudes and behaviour will be required.

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WHICH PLANT WHERE? SPECIES SELECTION FOR URBAN GREENING

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Abstract

Australia is a highly urbanized nation and the success of our cities will depend on how we adapt and design our urban regions to deal with population growth and future environmental change. Green infrastructure is an asset that is integral to the way our cities function, providing ecosystem services to their inhabitants through local climate regulation, pollutant reduction, storm water management, thermal comfort, improved human health and wellbeing, as well as aesthetic and biodiversity benefits (Tzoulas et al. 2007a, Taylor & Hochuli 2015, Davies & Corkery et el., 2017). While green infrastructure can contribute to the liveability of a city through its economic, social and environmental benefits, the success of an urban green space is not always realised. Incorrect species selection can result in considerable cost to public and private realms, especially if there are low survival rates or perceived co-benefits are not integrated into the design (Staas et al. 2017). Further, time pressures and low budgets often lead to inclusion of poor quality plant stock based on availability rather than suitability for the site. Notably, the tools and resources for plant selection vary from state to state and are generally used for specific purposes based on the organisation. There is no one tool that planners, practitioners and specifiers can use to support plant selection in urban regions across Australia. The *Which Plant Where* project will develop a database to allow decision makers to use location-specific factors for optimal plant selection. The online tool will be underpinned by rigorous research and industry knowledge, with the aim of expanding the diversity of plants to create living cities.

Urbanisation

Two-thirds of Australia's population are living in our capital cities and our population is expected to increase to 36.8 million by 2061 (ABS). Urban intensification and expansion is changing the shape and composition of our urban matrix and influences the microclimates we experience within cities. Changes of microclimates are complex and can be manifested in increased temperatures, as well as changes to wind patterns, humidity and rainfall (Grimm et al. 2008, Davies & Corkery et. el 2017). In addition our cities are dominated by hard or impermeable surfaces such as buildings, rooftops, footpaths and roads, creating issues of increased stormwater runoff as well as increased temperatures due to the urban heat island effect. The urban heat island effect is created when heat is trapped due to the thermal mass of highly urbanised areas, resulting in significantly higher temperatures compared to peri-urban or rural areas (Oke 1982, Sharifi and Lehmann 2014). Studies demonstrate that the urban heat island effect in highly urbanised areas can increase temperatures by 2 - 12 degrees C (Voogt, 2003).

Urban heat island effects will be compounded by climate change and will continue to impact our cities. Over the last five years Australia has experienced increasing record breaking temperatures in the summers of 2012/13, 2013/14 and 2016/17 (Climate Council 2017). In just 90 days of 2016/17, more than 205 temperature records were broken around Australia (Figure 2 – 2016/17 Angry Summer). The relationship between heat and mortality has long been recognised (Haines et al., 2006), with heatwaves resulting in the deaths of more Australians that any other natural hazard (Chen 2013). Heatwaves contribute to the deaths of over 1000 people aged over 65 each year (Osmond, 2017) and this number is expected to rise with an aging population.

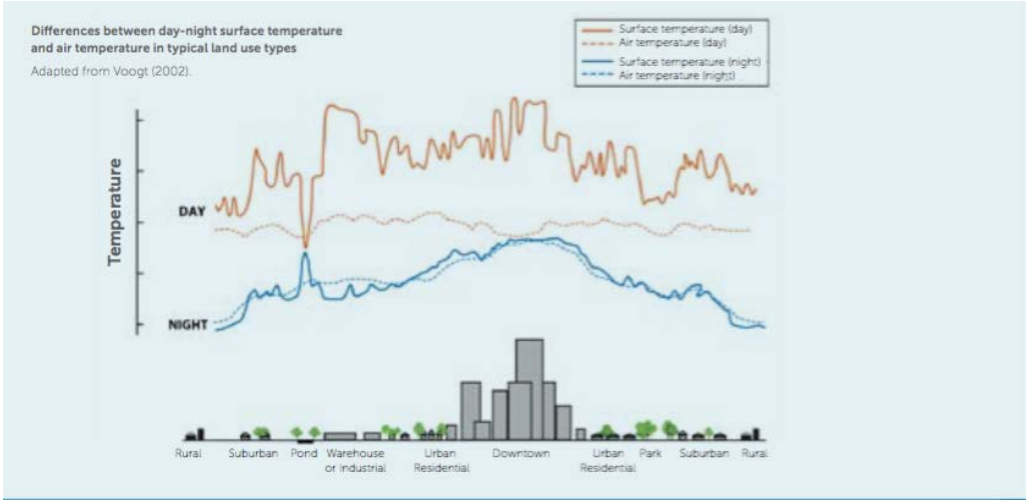

Figure 1 - Differences between day-night surface temp and air temp in typical land use types (Osmond & Sharifi 2017)

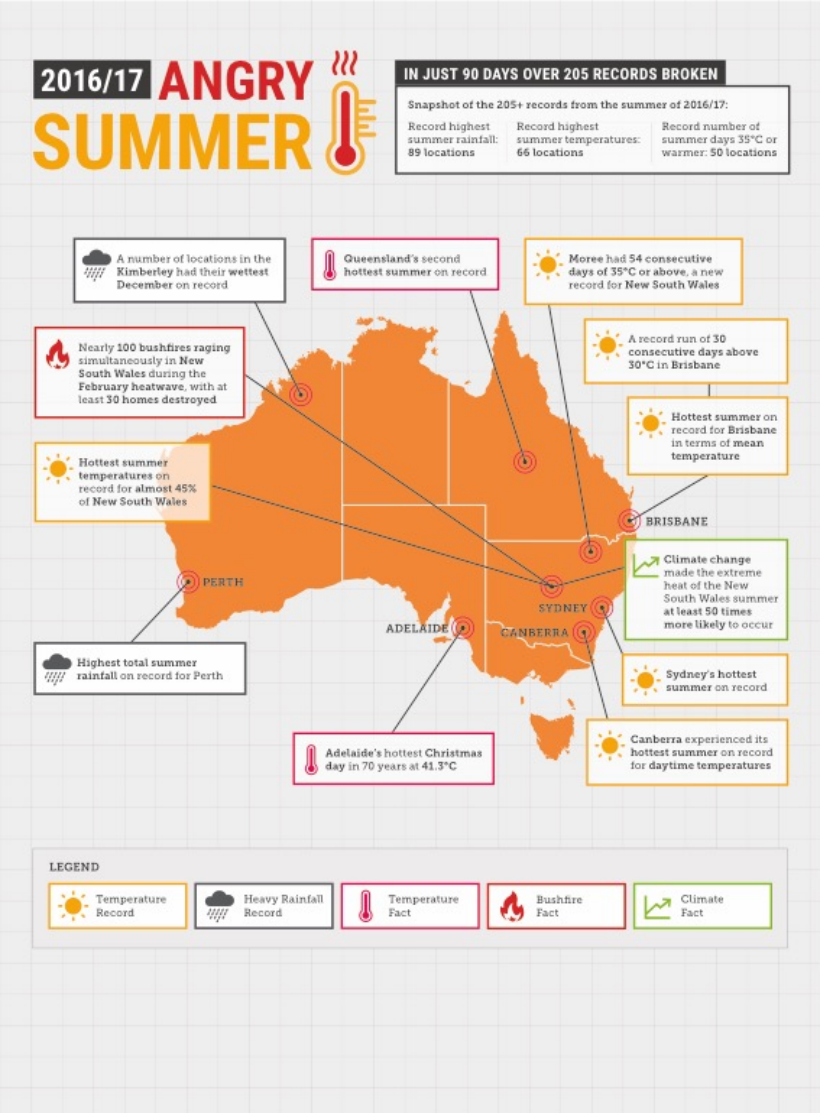

Figure 2 - 2016-2017 Angry Summer (Climate Council 2017)

Urban development significantly modifies hydrological systems in urban areas. Changes to the natural environment, such as creek channelization, increased impervious surfaces and topographic modification, result in changes to the quantity, speed and direction of storm water (Barbosa et al. 2012, Davies et al. 2017). As urbanisation continues, and impervious surface cover increases, flash flooding and increased levels of urban stormwater runoff become more likely (Walsh et al. 2012). Given that the majority of Australian cities are situated on or near watercourses, stream health will become compromised (Walsh et al. 2007). Stormwater quality is affected by pollutants such as solids, heavy metals, nutrients, pathogenic microorganisms and organic micro-pollutants (Barbosa et al. 2012).

Green infrastructure

Urban greening plays a significant role in contributing to temperature regulation in urban areas and can moderate and cool the microclimate through shading and evapotranspiration by humidifying the air. Informed selection and strategic placement of trees and green infrastructure can provide dense canopies to reduce the urban heat island effect and reduce air temperatures by between 2°C and 8°C (Pitman & Ely 2015, Norton et al. 2015, Davies & Corkery et. el. 2017). Based on the relationship between the ambient weather conditions and heat related mortality rate, it is estimated that a 10% increase in surface reflectivity from urban vegetation coverage can result in an average 7% reduction in mortality during heat waves (Kalkstein et al. 2014).

Several types of green infrastructure have emerged for the purpose of stormwater management including raingardens, bioswales and green roofs. Much research has gone into the impact of different design considerations, including plant performance, that affect water management outcomes of these spaces (Berndtsson 2010). Green infrastructure has been a popular solution for water management due to its multifunctional capacity (Lovell and Taylor 2013) – e.g. vegetated water retention basins can also be places for recreation or social meeting places within cities.

> Green infrastructure is the network of green spaces and water systems that deliver multiple environmental, economic and social values and benefits to urban communities. These benefits include health and wellbeing, cooling the environment, mitigating flooding, improving air quality and enhancing biodiversity and ecological resilience.

The co-benefits of green infrastructure are increasingly being realised and there is increasing evidence that supports green infrastructure as a means for mitigating the impacts of climate change. In order to maximize the economic and social return of our natural assets there needs to be an integrated approach to planning, design, construction and maintenance phases of urban greening. A key issue for the development and implementation of successful green infrastructure is the suitable selection of plant species. Many urban plantings have low survival (Monterusso et al. 2005, Durman and Rowe, 2007, Thuring et al. 2010) or poor performance (MacIvor and Lundholm 2011), resulting in reduced outcomes for green infrastructure.

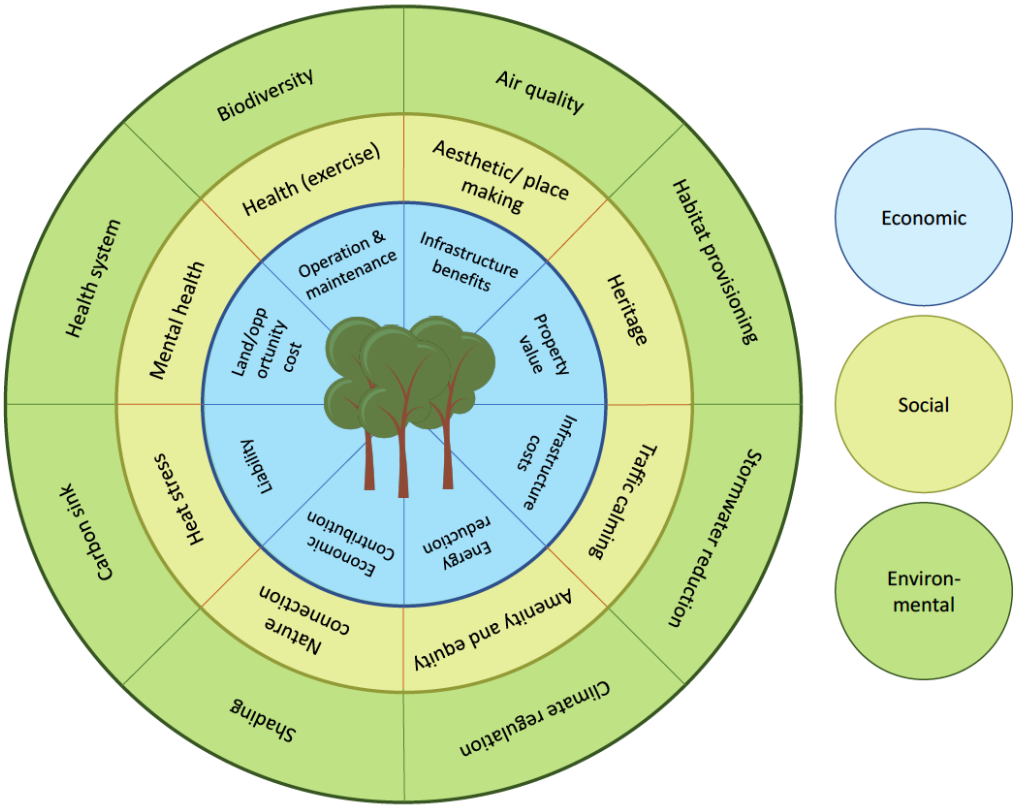

Figure 3 - Economic, social and environmental benefits of green infrastructure

Which Plant Where project

The Which Plant Where project (WPW) is a five-year program that brings together a consortium of researchers, government agencies, industry partners, nursery and turf growers to facilitate sustainable green cities across Australia. Throughout the life of the project, selected species will undergo rigorous testing in laboratories and in real-world settings across Australia, with the aim of creating confidence for growers and practitioners about which plant they should use where, when and why.

As part of our research agenda and consultation, the research team will:

- identify climatic tolerances and traits of the selected species and build spatial maps of suitable areas for planting under current and future climates.
- assess success and failures of urban plantings across a range of contexts and regional areas.
- assess the selected species for heat and drought tolerance in the context of soil and moisture availability.
- combine the research data obtained into an online interactive tool with supporting guidelines to guide species selection for urban plantings across Australia

Stakeholder engagement

The success of this project requires collaboration across sectors and the project team has undertaken intense consultation with key stakeholders. A national roadshow was held during the beginning of 2017 to promote the project, engage with stakeholders, receive guidance on industry needs and to ensure our project remains relevant to the needs of the nursery and turf industries. Workshops were held in Melbourne, Adelaide, Brisbane, Perth and Sydney. These workshops attracted over 111 people from 86 organisations, bringing together a diverse group of stakeholders including nursery and turf growers, practitioners, developers, landscape planners and designers, as well as state and local government representatives.

Key findings from the roadshow workshops

Plant selection decisions for urban spaces are complex and continually influenced by multiple factors depending who is making the selection. There were however consistent themes that arose in every workshop and the most common factors influencing species/plant selection for an urban space include:

- Professional experience
- Nursery stock availability
- Cost
- Ongoing maintenance considerations
- Site location and size - often competing against existing services/infrastructure (e.g. water, sewerage, power lines), the built environment and limited land availability
- Aesthetics such as “order” and/or “uniformity”
- Plant size, shape, form and purpose - windbreaks, shading, biodiversity, health and wellbeing, crime prevention
- Master plans of a local council
- Current trends and cultural values

Numerous successful urban spaces were identified in all major cities, most of which was attributed to correct species selection, well thought out planning, good site condition and preparation and ongoing maintenance regimes. Inversely, participants identified that if there is a disconnect between the design, construct and maintenance process, success of an urban green space is either limited or may lead to failure. There are various points at which failure becomes imminent:

Tender phase: cost of the initial design may be too expensive and selected plants are replaced with cheaper lower quality plants.
Construction phase: removal of good quality top-soil, soil compaction, restricted growth space.
Planting phase: availability of stock in nurseries, wrong soils used, species/plant substitution due to overspend on project.
Maintenance phase: in the past, plantings were generally watered for the first year. This is now being extended to up to 3 years to ensure the plants survive.

It is important to note that the success or failure of an urban green space is not necessarily defined by whether a species survives or not, but rather if the right plant has been used for the context of the site. Many participants highlighted that a site could be deemed unsuccessful if the species selected does not provide multiple benefits. For example, shrubs planted along roads may be successful if measured by survival, but unsuccessful if success is measured in terms of providing enough shading for temperature mitigation.

Workshop participants also identified ongoing tensions that arise during this decision making process, for example the competition between grey infrastructure and green infrastructure, the lack of professional knowledge during the construction phase and the difference between aesthetically pleasing species for the public versus council maintenance requirements. This too can influence species selection and success of a site.

All workshop participants agreed that demonstration sites provide an outstanding opportunity for collaboration and engagement, including trialling of different species to measure performance in the landscape. They are also an important part of public education and engagement. There should be a focus on the site, its use and its overall function. When asked to identify what would constitute a good demonstration site, the following attributes were suggested:

- Street trees and urban forest
- Urban open space and parks
- Urban renewal sites
- New housing development sites
- Transport corridors, including roads, rail and nature strips
- Green roofs and walls
- Scientific complexity vs aesthetic
- Passive irrigation and water sensitive urban design

Participants of the workshops were asked about the tools and resources they use for species selection in urban spaces. Some of the most common tools that are used include:

- Google
- Websites such as PlantSelector+, iTree,
- Australian Plant Society (Australia)
- Specifying Trees
- Books, including international, national and local
- Local council list
- Expert advice
- Nursery websites
- Local guides and fact sheets

Notably there was no one tool that was used for plant selection and more often than not tools and resources varied from state to state. This demonstrates the need for an online tool that can be used across Australia.

Which Plant Where project outline

The Which Plant Where project is a consortium of researchers from Macquarie University, Western Sydney University and NSW Office of Environment & Heritage, working with Hort Innovation Australia. The project consists of three separate but interlinking modules that form the evidence-base for the development of an online species selection tool for urban green spaces.

Module 1: Species attributes and climatic tolerance

To be able to predict which species will be most resilient in urban settings we need to understand both their traits and climatic tolerances. Plant traits are the physiological, phenological, and morphological adaptations which underpin their ecological strategies and performance. For example, leaf size and plant growth form can determine the amount of shade provided by a street tree, whilst also being a useful indicator of the potential water use needs in drier environments. This illustrates how we might use the traits of species to filter potential horticultural species to specific urban settings, providing a data-driven process for deciding where to put which plant, and why.

It is equally important to understand how the suitability of species may change across different climate zones. Species adapted to warmer, wetter environments may have reduced survivorship or performance in dry or cold environments. We will use bioclimatic and hybrid species distribution/physiological models to understand the extent of the climatic tolerances of species under both current and future climate scenarios. These models use data on the occurrence of species from herbarium collections and, where available, growth trials to build a spatial map of the potential distribution of a species.

Module 2: Successes and failures

Understanding and learning from past plantings in a variety of environments is critical. We will collate information on successes and failures from urban greening projects from across Australia. We will also develop field testing sites for a range of plant species and environmental conditions. Understanding what contributes to success or failure of urban plantings will enable the identification of good practice for species selection and planting.

Module 3: Heat and drought tolerant species and soils

Plants in urban environments face a range of unique stresses, and thus a thorough understanding of plant tolerance to environmental stresses such as heat and drought is critical for successful urban greening. In this module we will use a systematic screening approach using a combination of glasshouse and field trials for a wide range of species to assess plant species suitability under a variety of environmental and planting conditions and develop a predictive framework based on plant attricutes.

Bringing it all together – development of a Species selection online tool

The final output of this project will be to create an interactive online tool that will guide species selection for urban plantings across Australia. The tool will build on research data obtained throughout the life of the project in Modules 1, 2 and 3. Stakeholder engagement will ensure that the needs of the end-users are understood and incorporated. The online tool will support decision making for species selection for planting within urban spaces under current and future climates. The tool will include site characteristics and natural distribution, tree appearance, ecosystem services, required management activities, risks and interferences and will also include such things as

- urban site conditions (space, microclimate, soil conditions, water supply and light regime)
- biodiversity and ecosystem services aspect (diversity, native vs exotic, wildlife interactions)
- human requirements (shading, health and wellbeing, management, risk).

The development of this tool will be an important contribution to the facilitation and enhancement of urban green space across Australia, providing multiple benefits for human health, ecosystem services, biodiversity and the liveability of our urban areas.

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PRIORITIES FOR ARBORICULTURE MANAGEMENT IN A ZOO SETTING

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Abstract

Have you ever wondered what goes on in a Zoo when the public have left for the day and the animals are off limits sleeping?

I hope to give you an insight into what Horticulture activities actually occur to enable the standard of grounds that you see to be presented in the best possible ways for both the animals and publics enjoyment.

These grounds and exhibits don't just appear overnight, there is a lot of meticulous planning and hard work involved in the design and construction of each area.

Consideration needs to be taken into account for the animals health and welfare, are the plants toxic? Will the animals be able to use the plant material for escape? A host of issues that most landscapers would never have to consider, but are part of the planning that is undertaken in every single exhibit within the zoo.

I will also discuss the considerations we have to take into account with maintaining our large amount of significant trees, how do they integrate into animals exhibits and what extra care is required to maintain their health.

Introduction

Steeped in more than 135 years of history, Zoos SA has long been established as an integral part of the South Australian community's heritage and social history and is one of the state's oldest conservation organisations.

The original name chosen was The Acclimatisation Society of South Australia. It later became known as the SA Acclimatisation and Zoological Society and the government granted land for a zoological garden on eight hectares obtained from the Botanic Gardens of Adelaide. In 1882, the name changed again to SA Zoological and Acclimatisation Society.

In 1937, to celebrate the society's Diamond Jubilee, King George VI granted the society a Royal Charter and with it came the right to use the prefix 'Royal'. At this time the opportunity was taken to remove 'Acclimatisation' and we became 'The Royal Zoological Society of South Australia'. While we officially retain this name we're today more commonly known as Zoos SA.

Adelaide Zoo is Australia's second oldest zoo and was opened to the public in 1883. The zoo retains many of its original buildings, significant trees and landscape features, some of which are state heritage listed.

It was established at a time of great resurgence and interest in natural history and was modelled on the major European zoos of that time, particularly, Regents Park Zoo in London.

The Zoological gardens were laid out with the assistance of J.L Sterling and George Boothby and the work was done taking care not to compromise the existing plantings laid out by the Botanic gardens, in fact without removing a single shrub or tree of importance according to the Annual Report.

My current role as one of the custodian of the grounds, like the Zoo over the past 135 years has evolved considerably, no longer is it acceptable to display animals in concrete and steel boxes, devoid of any vegetation purely for the entertainment of the general public.

Zoos are now far more accountable to the way we house and display animals, large amounts of time and money is invested to ensure the exhibits try to replicate the animals natural habitat as much as possible.

One of my key responsibilities is to design and construct world class exhibits combining all the elements of nature animals require to exist in their new habitats, to incorporate features that provide as many natural features as possible which will allow animals to move through the exhibit and display to the public as they would in the wild.

As you can imagine these challenges test our skills to the very limit, who here as landscapers/arborists developing suburban blocks of land would have to consider things like “can this tree enhance the mating of a particular critically endangered animal species”? “Will the plants in the exhibit provide all the habitat requirements of the individual animal”? Also one of the most critical questions is “are these plants toxic” and if so can they still be used in the exhibit?

Research in Japan has shown a troop of chimps lived amongst toxic plant species without any health issues, did they know the plant had toxicity through evolution or is the poisonous sap bitter enough to stop them from eating it.

All of these questions are discussed in every exhibit developed or built within he Zoo grounds, often influencing what we can plant and where we can plant it.

Along with the responsibility of managing the landscaping of exhibits our team of Horticulturist manage the extensive grounds that make up the Adelaide Zoo site. We have over 8 hectares of land situated in a unique site bounded by a Adelaide Botanic Gardens of which we were originally part of prior to our succession and the River Torrens on our Northern boundary.

Distributed throughout these grounds are over 200 Genera of trees with in excess of 500 species and several thousand trees, some within the exhibits and some in the landscape surrounding, there are significant trees from the original Botanic gardens plantings of 1865 which must be managed to ensure their health and vitality remains good and with pressures from animals living amongst the canopy this places added stress on some of these trees and requires individual health programs to be put in place.

This can also bring a variety of complexities that are very unique to our situation at the Zoo, trimming trees to ensure the minimum jumping distance for a Sumatran tiger is maintained to ensure we don’t have potential escape.

Planting a large specimen tree in our Giant Panda exhibit to enable the female Panda to carry out her natural mating ritual where the female Panda climbs a large tree and male Panda’s circle at the base fighting for the right to mate with the female, to providing large live trees to replace historic zoo exhibits of steel and concrete where primates can bracteates through the branches exhibiting naturalistic behavior.

All of these complexities are day to day problems posed to our team of horticulturists and which makes our role in the Zoo a vital link in the chain that has the Zoo displaying animals in world class Naturalistic exhibits.

GREEN INFRASTRUCTURE DESIGN FOR LIVEABLE CITIES

Georgia Vitale
ARUP

ARUP CITIES ALIVE

Summary

1. Driven by the need to create more liveable communities and sustainable development, governments are rethinking the very structure and function of their cities. At the heart of this movement is a focus on creating more sustainable urban communities and healthier places. A way forward is to rethink the design process and redefine the functions and vital role that walkability and urban greening can play in achieving this goal.

2. Cities Alive takes a human-centred approach to rethinking how we should design and manage cities in the future. It provides an integrated focus on the experience of cities and the global challenges that are impacting the lives of everyday citizens. We recognise the importance of a city's inhabitants and we explore the relationships between design, processes, spaces and people. Cities Alive is an invitation to collaboratively shape our urban future.

3. A liveable city is one that provides for the wellbeing of its communities. It provides affordable and diverse housing and has a movement network that is underpinned by public and active transport, provides access to high quality employment, education, social infrastructure and other facilities that support daily needs1 – a city of short distances2.

4. A GI-led design approach aims to create a network of healthy and attractive new and upgraded city environments, sustainable routes and spaces. The approach would build on, strengthen and link existing GI components I've just described. Over time this resilient and networked "city ecosystem" will be capable of generating a substantial range of social, environmental and economic benefits for urban citizens, whilst also providing protection against the effects of climate change. A key component is also the promotion of multifunctional design (where a range of benefits are provided in one area through careful planning, integrated design and management) to deliver an array of substantial social, environmental and economic benefits.

5. Vision

All delivery should be underpinned by and contribute to a large-scale strategic vision. This vision should identify the assets, opportunities, risks and vulnerabilities for a given context.

This vision should:

- Be driven by what is required in that particular city and context rather than by arbitrary standards,
- Consider what should be delivered where, and how the needs of different users and delivery agencies can be satisfied spatially,
- Set priorities and achieve an optimal balance of complementary functions,
- Be a core planning policy requirement and integrated into all planning policy themes, rather than a separate initiative or strategy,
- Contribute to housing, transport, employment, climate change and other policies,
- Address the needs of a range of stakeholders who have contributed to its development,
- Be clear how different interests can benefit and play a role in delivery, and
- Set an appropriate scale, considering the network of existing and future assets.

6. Collaboration

Increasingly, GI is being seen as a concept which unites a range of disciplines and interests, and that facilitates collaborative working. Crucially, in the context of green infrastructure, competing priorities can often complement each other.

- Strengths, priorities, opportunities, and requirements of different actors must be considered in order to acknowledge the political nature of delivery, in particular across local boundaries.
- Local authorities, developers, clients, landowners, utility providers, the community and built environment professionals should communicate, share knowledge and educate others in the benefits of GI.
- All actors should contribute to the vision for GI, with the aim of identifying interventions that are able to adapt to changing contexts and the needs of the different actors involved.
- Planners should always negotiate, allowing new opportunities to be delivered as they emerge. Crucial to any negotiation is the ability to promote the case for GI to those responsible for delivery in a way that is appropriate to their needs.

7. Evidence

Preparation of a GI framework should be underpinned by evidence. The aim is to ensure that interventions are appropriate to their context. Evidence is particularly important to understand the value of a city's natural resources to enable future planning for enhancement potential.

- Existing studies and local information should be used, including relevant planning policy evidence.
- Evidence should identify what functions and connections are needed, and where to strike an effective balance in the delivery of the network.
- Data relating to GI should be collected and shared to inform future projects, including surveys of existing assets, new connections and functions, assessment of the quality, and what other functions could be integrated.
- Variables of interest to the quality of the external environment, eg, air temperature, surface temperature, air pollution and levels of comfort, should be monitored. Monitoring can be carried out over time to gauge the progress of improvements to the urban environment.
- The use of GIS should be considered as an increasingly effective tool to identify spatial priorities for an area and to understand and respond to a range of issues such as heat risk, flood risk and development pressures.
- GIS should act as a tool to monitor assets and track the implementation of the vision.

8. Tools

Planning plays a vital role in the delivery of projects, and will be triggered in many interventions involving new and existing development. Mechanisms which should be considered include the following:

- GI should be a core requirement for local authorities, including a clear strategic vision and policy considerations that are integrated throughout spatial objectives and planning themes.
- Developer obligations should include mechanisms that contribute directly to the delivery of the overarching vision. Planning agreements could also secure long term funding for the management of projects.
- Mitigation should be linked to delivering the strategic vision and locked in through the use of planning conditions.
- Where a strong GI framework exists, it is possible for planners to respond to opportunities as they arise both with new development and redevelopment projects, and with building refurbishments. A robust evidence base will be key to securing effective contributions to the vision.

9. Management

Management and maintenance of GI should always be a key consideration from the outset of a project. This is crucial for the longevity of a project and for securing the full potential of interventions.

- Clear responsibilities for maintenance and management should be set to ensure their effective operation and durability.
- For smaller developments or infrastructure projects, it is important to avoid "leftover" spaces that do not have clearly defined management responsibilities. While local authorities might once have taken over this management role, there are now other models, as described in the following section.

10. Funding

Traditionally, local authorities provided funding for the delivery and management and coordination of GI. Increasingly this type of funding is more difficult to secure, leading to new, creative and innovative ways for funding and use of available resources.

Here, considering funding for maintenance and management from the outset will help deliver long term benefits. Cost reduction and recognition of the value of existing assets are also important. Examples include the following:

- Local social enterprises set up by residents and local bodies to provide long-term management — bolstering social capital can be a powerful funding mechanism. Potential for further benefits should be considered such as training and education opportunities, school involvement, apprenticeships — and building community cohesion.
- Involving the voluntary sector this sector could apply for funding, where other actors are not eligible.
- Funding and delivery by third-party organisations — that can implement new ways of maintaining open space and identify appropriate solutions dependent on the approach needed for a particular project. Risks and liabilities associated with projects can also be better managed, something that community groups may be concerned about when delivering projects.
- Self-funded initiatives that can pay for themselves — This could include temporary interventions such as local festivals or events, food production, energy production, childcare facilities or commercial use of a development.

11. Importance of city leadership

Throughout all of these recommendations, demonstrating the value of GI and the variety of scales and types of interventions possible is crucial. Political champions will be important in setting and promoting a vision whereby GI adds to the quality of a city and differentiates its offer by attracting investment. Professionals negotiating to achieve new or improved assets should understand the economic context in which they are working and promote the multiple benefits of green infrastructure to applicants.

Designers working in multidisciplinary teams should seek to ensure that GI and its subsequent maintenance are integral to individual projects, and always linked into the wider vision and framework for that city.

A TOOL KIT FOR CLIMATE-READY REVEGETATION

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[1]Macquarie University, [2]Antarctic Climate Ecosystems CRC, University of Tasmania, [3]CSIRO

Rapid environmental change presents many challenges and uncertainties for planners and decision makers of both urban and natural vegetation. Changes to current practices are needed, based on understanding conditions expected in the future, rather than relying on historical conventions. But how should decision-making be managed when the magnitude and direction of projected climate change are uncertain and the conditions projected for local sites may not have been previously experienced? The presentation gives a synopsis of where to find and how to use on-line tools for climate-ready revegetation.

The climate-ready revegetation guide can be found at:

http://www.anpc.asn.au/resources/climate_ready_revegetation

INSIGHTS INTO STANDARDS FOR NURSERY-GROWN TREE STOCK

Mark G. Tjoelker, Courtney E. Campany, Remko A. Duursma, Sebastian Pfautsch, Michael J. Aspinwall, David Thompson

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Abstract

Root to shoot balance in nursery tree stock is an important quality characteristic and contributing factor to tree form, growth and planting success in the landscape. Yet specifying root to shoot balance criteria and standards has been problematic owing to a lack of critical information on biological variation among species, nursery production practices and the role of climatic influences on shoot morphology and growth. Our research addressed this knowledge gap through a field-based survey of nursery tree production throughout Australia, capturing information on 159 species and varieties and nearly 14,000 trees. Our findings revealed large natural variation in root to shoot balance across the wide range of containerised trees sold in Australian nurseries. Species differences were well captured by a simple classification into winter deciduous and evergreen categorical types. This rich data set, specific to nursery grown trees in Australia, provides insights into potential improvements in quality assessment criteria and standards for nursery-grown tree stock for landscape use.

Introduction

The *'202020 Vision'* aims to increase Australian urban green space by 20% by the year 2020. This initiative has the potential to drive market growth in tree nursery production for landscape use. Challenges may include problems in establishment and survival of newly planted urban trees (Nowak et al., 2004; Miller et al., 2015) and meeting the rising demand for tree stock that can endure increasingly harsh environments expected with climate change. Thus, nursery tree stock quality and its assessment are likely to increase in importance in the industry.

In April of 2015 the "*Australian standard: Tree stock for landscape use*" (AS 2303) was adopted as the industry standard to enable assessment of the quality of tree stock across Australian nurseries (Standards Australia Limited, 2015). This standard was designed to assess aboveground and belowground characteristics of production tree stock. AS 2303 is increasingly called upon to ensure quality at the point of sale with the aim of minimizing risks of outplanting failure or poor form and growth. At the time of its adoption, it was recognized that provisions concerning root to shoot balance assessment in the standard required further research in the Australian context.

Proper balance between root and shoot systems is critical for establishment of outplanted trees as balance encompasses the initial structural stability of a tree. Root to shoot balance also serves as an index of plant water uptake capacity (root) to water loss (shoot) at the time of planting (Ritchie, 1984; Thompson, 1985; Grossnickle, 2000; Haase & Others, 2007). However, parameters used to evaluate tree stock balance are likely affected by nursery practices such as container style, root system management, irrigation, fertilization, root pruning and growing media, as well as climate and time since re-potting. However, to date few explicit tests have been conducted on the role of natural variation among species and the role of nursery practices or climate. Field-based surveys of nursery production stock would provide insight into these potential sources of variation.

In AS 2303, root to shoot balance is assessed based on tree size and container volume. An aboveground size parameter (Size Index) is calculated as the mathematical product of stem calliper (mm) at 300 mm and total tree height (m). Aboveground Size Index is then compared to the size of the container in which the tree is grown, where container volume (measured in liters, L) reasonably represents root system size, owing to complete occupancy of the root ball. Minimum and maximum acceptable values of Size Index, generalized for all species, are specified for the large range of container volumes used in Australian wholesale tree nurseries.

If use of Size Index and its relationship with rooting volume provides an accurate assessment of tree stock balance, it offers a tool for growers and buyers of landscape trees to assess product quality and uniformity and ensure or potentially enhance the performance of outplanted trees.

If large natural variation in Size Index occurs across species, climate regions or in response to nursery practices, the currently specified acceptable values in AS 2303 may not adequately capture natural variation tree stock balance. Likewise, if variation in height and calliper and thus Size index is quantifiable in terms of tree stock type (i.e. species groupings) or climate zone, then this information may be useful in revising or tailoring acceptable ranges in the standard to provide more refined guidelines.

Survey methodology

Measurements were completed at 23 wholesale tree production nurseries across all of Australia's major continental market regions centered on capital cities in six states. Multiple nurseries were visited in New South Wales, Queensland, Victoria, South Australia and Western Australia. A single nursery was visited in Darwin in the Northern Territory. The nurseries were visited over a 10-month period between April 2016 and February 2017. Batches of tree stock that were currently ready for sale were identified with nursery production managers at each site. Priority was given to tree species that were available in multiple container sizes. Further details of this Horticulture Innovation Australia research project are described elsewhere (Tjoelker, 2017).

Visual quality assessments and testing against the standard

A two-part above and belowground visual assessment of morphological quality was completed for each pre-selected batch of tree stock deemed ready to sell. The aboveground visual testing criteria were completed as specified by AS 2303 (see Clause 2.2, Standards Australia Limited, 2015). Briefly, the sample trees were required to be self-supporting, have a symmetrical crown, have healthy leaves and crown structure and be free of injury, pests and disease. If a sample tree passed all aboveground assessment criteria, then the belowground assessment of root ball occupancy and root form (absence of woody circling roots, j-rooting) was completed as specified in AS 2303 (see Appendix B, Standards Australia Limited, 2015).

The assessments were conducted independently by the project team and thus consistently across all 23 nurseries. Root to shoot balance measurements were completed only for production batches that passed all criteria for both the above and belowground assessments. This methodology ensured that data collection was representative of trees possessing all the morphological attributes required by AS 2303 at dispatch.

Tree stock root to shoot balance assessment

Tree height and trunk diameter at 300 mm were measured on a subset of trees for each selected batch of tree stock that passed all above and belowground tests. Up to 45 trees were measured for batches in containers ≤ 45 L and up to 20 trees were measured for batches in all larger-sized containers, if available. The Size Index parameter was calculated as the product of height (m) and trunk calliper at 300 mm (mm) for each measured tree. Tree slenderness index was calculated as the ratio of height and trunk calliper.

Differences in measured tree height, calliper and Size Index with container volume were analysed using mixed-effects statistical models. In the statistical models, tree species and nursery were classified as random effects, constituting a representative sample of both the species that were grown and of the nursery sites in Australia. The effects of climate, nursery, species origin (i.e. native or non-native), tree functional type (i.e. evergreen or deciduous) were treated as either continuous or categorical fixed effects.

Mixed model analyses were performed in the statistical analysis platform R (R Development Core Team, 2016), with the 'lme4' package (Bates et al., 2015). Explained variance (R^2) of mixed models was computed as in Nakagawa & Schielzeth (2013), in which the marginal R^2 represents variance explained by fixed factors and the conditional R^2 by both fixed and random factors. All tests of statistical significance were conducted at an alpha level of 0.05.

Evaluation and Discussion

Across all nurseries, root to shoot balance of 13,820 trees was measured according to AS 2303 assessment criteria. Size Index and other data were collected for 650 ready to sell batches of containerized tree stock ranging from 18 L to 3000 L. There are 159 tree varieties represented in the database, including 113 unique tree species. Of the 650 measured batches of tree stock, 393 were classified as evergreen and 257 were classified as winter deciduous trees. Similarly, 373 batches were native Australian tree species and 277 batches were non-native tree species.

In AS 2303, tree stock balance is assessed by comparing the Size Index parameter with the nominal container volume in which the tree is grown. Specifically, minimum and maximum values of Size Index are specified for different container volumes. In this study, only 31% of all measured individual trees were within the specified Size Index range (Figure 1). Of the trees that fell outside the specified range, 45% were below the minimum range and 23% were above the maximum range. Likewise, following aggregation of measurements to batch-level means of Size Index, 62% of the measured batches of tree stock fell outside of their specified range. Measured Size Index of large container trees (> 500 L) was generally smaller than the range specified in AS 2303 (Figure 1), largely due to the reduced height growth of trees with increasing container size.

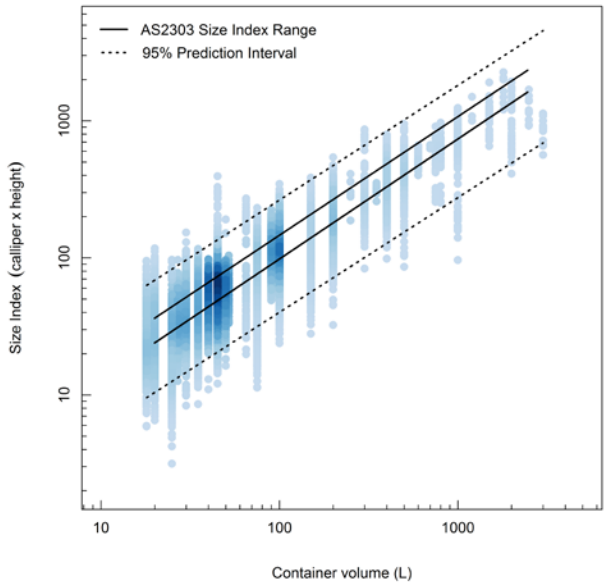

Figure 1. Aboveground Size Index in relation to a range of container sizes for trees measured across 23 Australian wholesale nurseries. Circles represent each of the 13,820 trees measured. Colors indicate local density (and overlap) of measurements (darker colours indicate more data). Solid lines represent the minimum and maximum acceptable range as specified in AS 2303. Dotted lines represent the 95% prediction interval based on the measured trees, which effectively include 95% of the data at a given container volume. Size index is calculated as calliper (mm) multiplied by tree height (m). Note that the axis scaling is logarithmic.

These measurements indicate that tree stock with otherwise standard-conforming morphological quality have a much greater variation in Size Index than specified in the current guidelines for tree stock balance. Consequently, this may indicate that the current guidelines are perhaps too general and thus overly restrictive in the context of observed variation in real-world tree production, potentially leading to buyer rejection of suitable tree stock. Alternatively, the observed variation may arise from quantifiable sources, such as species or production differences, that if taken into account may inform refined guidelines.

With this extensive database, we quantified sources of variation in tree Size Index. Overall, variation attributed to species, nursery site, climate, species origin (native vs. non-native) and tree functional type (evergreen vs. deciduous) combined to explain 43% of observed variation in standardized tree Size Index. Though variation attributed to species identity was large, species-specific differences in Size Index were also dependent on the nursery in which they were measured. Nursery effects could arise from differences in batch production history (e.g. age, irrigation, fertilization or container style) or other factors. Consequently, there is no robust way to create species-specific acceptable ranges of tree Size Index.

Aggregation of species into tree functional types of either evergreen or deciduous provided a useful categorization. Overall, Size Index values were higher in deciduous trees than evergreen trees (Figure 2). This effect was most pronounced in small to medium sized containers and less so in large container sizes. Importantly, both tree height and calliper were greater, on average, in deciduous trees than evergreen trees and this effect was consistent across all container volumes. Tree origin (native vs. non-native) had similar patterns as the tree type (evergreen vs. deciduous) classification as most measured Australian native trees were evergreen, and most deciduous species were non-native.

Thus, categorization of tree stock assessment criteria into deciduous and evergreen tree types may serve as a promising way forward to allocate the large inherent variation that is not accounted for in the current single guideline format of AS 2303. We speculate that growth rate differences could account for higher Size Index values in deciduous than evergreen species. For instance, faster height and diameter growth of deciduous than evergreen species could result in a higher Size Index values at a given container volume.

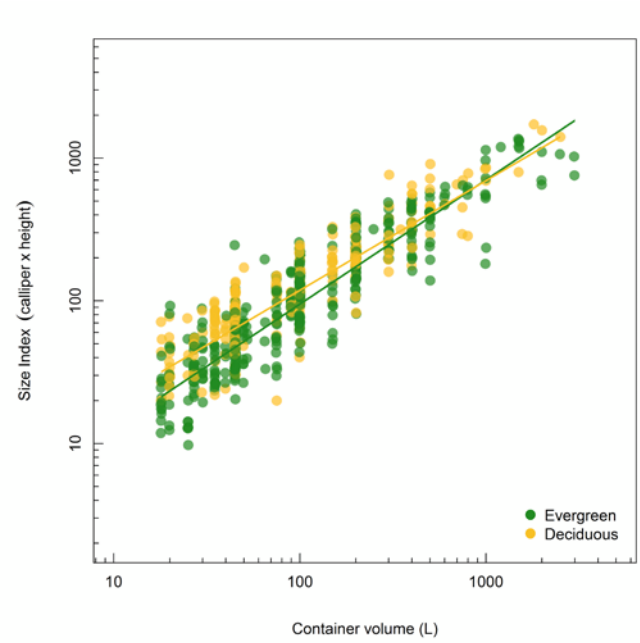

Figure 2. Differences between evergreen and deciduous tree types in measured aboveground Size Index across the range of container volumes. In contrast to Figure 1, data were averaged by tree stock batches (n = 650) for all 23 nurseries. Colored lines represent the log linear model fit for each tree type. Winter deciduous trees had higher Size Index values than evergreen trees, particularly over the lower range of container sizes.

Surprisingly, regional climate differences played only a minor role in the amount of measured variation in Size Index values. The effect of climate was assessed by both the region (i.e. state) in which tree stock was grown as well as mean annual temperature and precipitation for each specific nursery site. Neither mean annual precipitation nor mean annual temperature significantly affected measured Size Index values, despite large differences in these climatic variables among nursery sites.

AS 2303 suggests that nursery grown trees can be separated into simple stem form categories of tall-slender, general or thick stemmed (Appendix D in AS 2303). We tested whether or not slenderness categories varied depending on climate region or species and likewise determine where individual trees fit in the range of allowable Size Index values. In this study, tree slenderness was similar among climate regions and did not differ between evergreen and deciduous tree species groups. Our results suggest that use of tree stem slenderness to determine the acceptable range of Size Index has limited utility for Australian grown containerized trees.

Summary and Conclusions

As currently specified in AS 2303, the comparison of aboveground Size Index to container volume as the criterion for tree stock balance does not adequately describe existing natural variation in root to shoot balance of otherwise conforming Australian nursery tree stock ready for dispatch. A larger proportion of tree stock (45% of all measured trees), with sound above and belowground morphological quality, were below specified Size Index limits than were above (23% of all measured trees).

Specification of appropriate Size Index range values for large trees is of particular importance, owing to their comparatively high commercial value. Risk of failure is likely mitigated as a result of well-developed root systems in large container volumes. Given evidence of reduced height growth in large containers, a tailored Size Index range for large trees warrants further consideration.

In order to ensure that tree stock has not outgrown its container size, it is recommended that a maximum range of Size Index values be specified. If the specified range in the current version of AS 2303 is to be revised, the available database could be used to determine the upper range of Size Index values to include as a single generalised specification for all species or separation by species type into evergreen and deciduous (e.g. 75% prediction interval).

As expected, variation in Size Index values attributed to tree species was very large. As species-specific differences were also dependent on the nursery, it is recommended that either a broad categorization (e.g. evergreen or deciduous) or a single generalised specification for all species be used for assessing tree stock balance. Differences in evergreen and deciduous tree stock were widely detected in the height and calliper components used to calculate Size Index as well as canopy structural parameters. This suggests that different patterns in growth rates likely occur between these two broad categories in containerized Australian tree stock. This provides a viable alternative to redefine acceptable ranges of Size Index, using the available database, according to either an evergreen or deciduous category to better encompass variation across a large range of tree species.

Acknowledgements

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AN INTRODUCTION TO INNOVATION FOR ARBORICULTURE

Sarah Priestley

Arbor by Design

Introduction

Innovation has become the buzzword of the decade, with politicians, CEO's, business leaders, universities and consultants all using it. The arboricultural industry itself is adopting innovative technologies and approaches such as using drones to assist with inspections, holistic urban forest approaches to tree management, and the promotion of innovation through symposiums and tree climbing competitions.

But what is innovation and how can a business be innovative?

Innovation itself, is a word that can mean different things to different people. Definitions often include creativity, ideas, inventions and implementation. Searching for a 'definition of innovation' in Google, brings up nearly 180 million results, with thousands of definitions. While there is no consensus on definition, there is a consensus that to be a successful innovator, a business needs to develop its own understanding of what innovation means for them.

To assist in defining innovation, a business should understand the seven different areas of innovation that can provide a competitive edge in the market.

Areas of Innovation

Product Innovation

Product innovation is the development of a good or service that is either new, redesigned or significantly improved. (Williams 1999, World Bank & OECD 2013). Product innovation can include the invention of a new product, or changes in the design, construction, materials, technology, or quality of an existing product.

Successful product innovation is a process, one that starts with understanding what the business's core competencies are, is the product or service something people want, what is the benefit the product provides and how will the product be utilised or commercialised (Lanyan 2014, Lapan 2017).

To develop a product that people want, good quality customer research is critical. Engage with customers early and often about their needs and avoid assuming you know what the customer wants (Lanyan 2014). Continual testing of the market also allows a business to learn fast and fail fast, minimising costly errors and through research and concept design (Liedtka & Oglivie 2011).

Product innovation is evident throughout all areas of arboriculture. With the introduction of new tools, such as ascenders for accessing trees, new tree cultivars to meet changing environmental needs, structural cells and soils to modify the below ground environment and technology such as GIS data capture and the resulting tree inventories.

Technology Innovation

Often associated with computers or electronic products, technology innovation is actually the implementation of new scientific and technical knowledge to create value. This can result in the technology improving methods and processes as well as the physical tools, equipment and machinery used (Williams 1999).

Technological innovation is a result of a business's ability to conceptualise a marketable use for a new technology and its willingness to take ownership and develop the technology for market (Perez, Popadiuk & Coelho Cesar, 2017). The adoption of GIS technology for data capture is a good example of the need to be willing to develop the technology. Early adopters of GIS data capture had to learn how to manipulate cadastres, build forms for data capture specific to trees and correct GPS data to achieve accurate locations as the technology had not been developed to collect tree data.

Technological advances can also be incremental in nature, as with battery operated chainsaws. The advances in lithium ion technology in batteries has enabled the introduction of battery operated chainsaws into the commercial market and changes in processes for some tree pruning works. Steve Watt (2017, 17 Aug) confirmed that the increased capacity of battery chainsaws has led to the City of Stonnington being able to conduct some vegetation clearance works at night, minimising traffic disruptions and noise pollution for nearby residents.

Process Innovation

Process innovation involves new or significantly improved methods of delivering a product or service. A process is a structured set of activities designed to produce a specific output, therefore innovation of a process can involve the use of new techniques, equipment or skills to improve either production or delivery activities (World Bank & OECD, 2013, Davenport, 1993).

Process innovation is a discrete initiative that is intended to achieve radical improvement for the business. Without a structured approach and a guiding vision, process innovation is often reduced to streamlining existing processes, resulting in incremental efficiencies and savings, but no significant improvement or change to the business (Liedtka & Oglivie 2011).

Process innovation involves identifying the processes that will enable significant change and require innovation; mapping and understanding existing processes, developing a strategic vision and objective for the process change and then developing a prototype of the process for testing (Davenport, 1993).

A recent example of process innovation is the work that Banyule City Council is doing with its Occupational Health and Safety processes. In teaming with the Physiotherapy and Human Movement Clinic and Deakin University, Banyule has utilised human movement technology and research to map the stresses on the body when performing arboricultural works.

Banyule has then integrated this technology innovation with its Occupational Health and Safety processes. Utilising the technology to assess base line fitness of job applicants, develop preventative strength training programs and improving manual handling training within the staff (Francis Pester, 2015). Paul Fitzgerald of the City of Banyule (2017, 14 Aug) also confirmed that this work on human movement has influenced standard operating procedures, procurement of plant and manual handling aides and improved self-management and recovery times with staff.

Service Innovation

Service innovation is changing the way you serve or interact with your customers to deliver more revenue and create greater value for your customers. This can occur through the creation of a new service, or a shift in focus to the customer and their experience. Service innovation must align with the core purpose of the company and meet the needs of both current and future customers. (Bradt 2013)

One technique for service innovation is to create a service blueprint. This technique focuses on a particular customer group or experience that the business delivers, and models the business interactions from start to completion. The blueprint maps five areas; customer actions, employee actions front of house, employee actions back of house, support processes and physical evidence of interactions (Bitner et al 2008). Successful blueprinting can lead to innovations that improve accessibility, responsiveness, convenience or encourage greater customer engagement.

An example of a service innovation is the adoption of policy allowing economic compensation for the removal of publicly owned trees. With an increase in focus on high density housing there has been a growing conflict between developers and public tree managers, as the presence of existing trees can impede, or even halt, a proposed development. At the same time, many communities were protesting the removal of trees for private development.

To facilitate a solution, a number of Local Governments have adopted amenity valuation methods (City of Melbourne 2016, City of Bayside 2016) to place an economic value on trees that inform decisions on whether a tree is to be retained or can be removed, if compensated for economically.

This has improved the outcome for customers by enabling developers to remove trees if the compensation is paid, or alternately justify a case for redesign of a project if the value of the tree is too high. The wider community has also gained greater confidence that the removal of the tree will not result in a net loss of urban forest and that revenue exists to sustain the tree population.

Marketing Innovation

Marketing Innovation is the implementation of a marketing method, for new or existing products, that represents a significant departure from the firm's existing methods (OECD, 2005). This can include changes in product design, packaging, placement, pricing or promotion. Marketing innovation requires, and ensures, brands are customer-centric and enables customer relationships and experience to be improved (Hong, 2015).

There are two areas of marketing innovation that are being embraced today, these are relationship building through content marketing and looking to turn a crisis into an opportunity.

Content marketing is about moving beyond the traditional sales pitch and publishing or sharing relevant information, ideas and entertainment. Social media has enabled the rapid uptake and success of content marketing, providing accessible platforms to connect with customers and build relationships in real time, while reinforcing the business's brand and message (Jutkowitz, 2014).

A fantastic example of building relationships and engaging the public is the City of Melbourne's emails to the trees. Initially developed as a service innovation to enable the community to email in reports of ailing trees or vandalism (Ley, 2015), the community responded unexpectedly, engaging on a personal level with the trees, emailing individual trees with their thoughts and observations around the tree. This enabled the City of Melbourne to improve community engagement with trees and raise awareness of the goals of the city's Urban Forest Strategy (Ley, 2015).

The second area, turning a crisis into an opportunity, is not easy. Based on the concept that 'companies can't control what people do with their products, but they can control how they respond' (Hunkler, 2017, Liedtka, J Oglivie, T 2011) it involves thinking of creative, innovative responses that done well can build brand loyalty, educate and engage your customers.

The City of Melbourne again, provides an example of turning a crisis into an opportunity. In 2013 the City of Melbourne was confronted with a case of a tree being poisoned to facilitate a private development.

To highlight the issue, and gain public support to implement stringent new charges for trees removed for private development projects, the City of Melbourne engaged two artists to create an installation with a prominent city tree after it had been poisoned. The artists created the 'Triage Tree', bandaging the entire tree to emphasise the damage done.

The Manager of Arboriculture, Ian Shears, confirmed that the initiative proved successful in engaging the community, with members of the public leaving condolence cards and flowers at the tree and ultimately providing support for the adoption of a policy that allowed for the amenity value of the tree to be collected in such instances (2014, July).

Business Model Innovation

A business model describes how a business creates, delivers and sustains profit margins and growth (Osterwalder & Pigneur, 2010). Business model innovation is about creating a new market or disrupting the competitive advantage of key competitors by aligning your resources, processes and profit formula with a new value proposition (Euchner & Ganguly, 2015, Rosen 2016). Done well it can create new revenue streams and result in a new way of engaging with customers.

To provide clarity when thinking about a business model, the business model canvas was created. The business model canvas (Figure 1) identifies nine components to a business model, with each component offering opportunities for innovation and the creation of new value for a company (Osterwalder & Pigneur, 2010).

Examples of business model innovations within arboriculture were not easy to find, however one of the most successful business model innovations in recent years is Nespresso.

In 2000 Nespresso set about redefining their business model canvas. Starting with customising their product to enable individual tastes to be catered for, customers would buy a machine and then purchase individual portions of coffee in a range of flavours, creating a unique product for the market. Nespresso developed new partnerships to manufacture and retail the espresso machines, retaining the production and marketing of the coffee in line with their core competencies. The company then redefined their distribution system, moving orders on line and reducing their emphasis on retailers to exclusive boutiques. (Osterwalder & Pigneur, 2010).

Nespressos's new business model was unique, difficult to imitate and aligned with the company's core competencies, which provided the company with a sustainable market positioning. This created a clear value creation and capture system for the company that has resulted in gross margins of around 85% and an average annual growth of over 35% (Osterwalder & Pigneur, 2010).

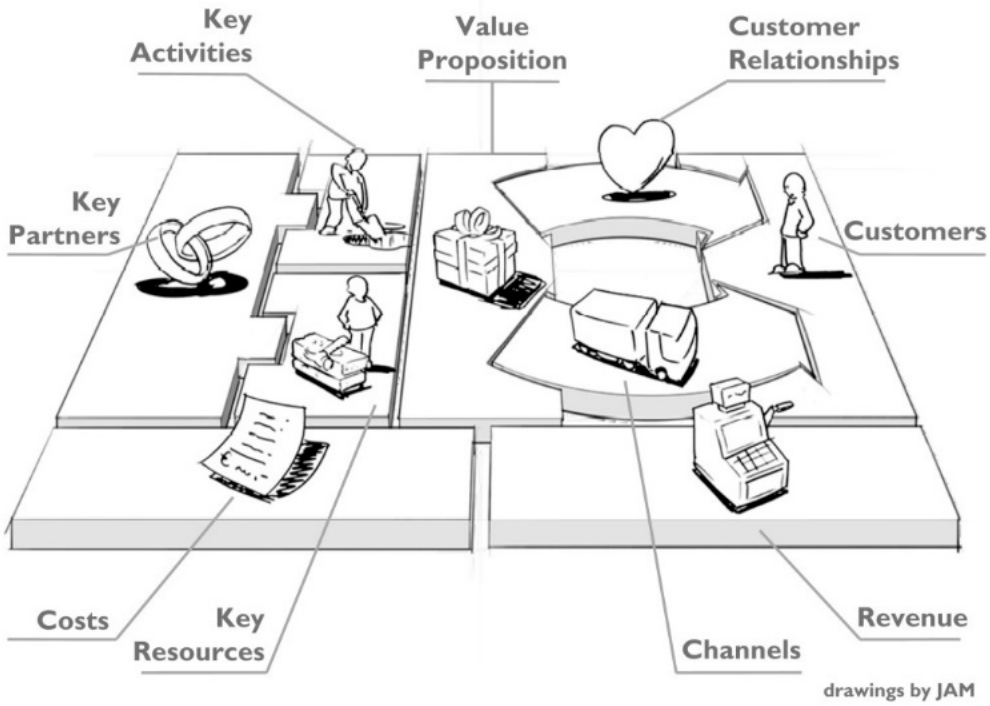

Figure 1 Business Model Canvas (Osterwalder & Pigneur, 2010)

Organisation/Management Innovation

Innovation in the organisation or management arena can be interpreted in two ways, the creation of a workplace that fosters innovation, or the introduction of management techniques to create value. Long lasting advantage can be created when innovation is systemic and challenges management orthodoxy (Hamel 2006).

The creation of a workplace that fosters innovative organisational culture starts with a willingness to be flexible with the business strategy. Innovation has the capacity to disrupt long term business strategies, therefore an organisation should have the capacity to review and adjust a business strategy in response to change (Hamel 2006).

Another component is to build innovation into everyday work. To build an organisation that is not resistant to change; to create an environment where all insights are heard, regardless of seniority; to promote employee engagement with innovation through incentive schemes and staffing strategies.

And finally, to encourage managers to consider creative and innovative approaches to traditional management principles, processes, and practices. To challenge 'the way things have always been done' and think of how they might change what they do (Hamel 2006).

Conclusion

Successful innovation requires a business to have a clear understanding of their core business and competencies, to understand the market, to have a clear definition of what innovation means to them and to create a culture of organisational innovation.

There are a number of tools and resources that will support a business when considering innovation within the company, however the greatest asset is an openness to ideas and an agile business structure that can explore, develop and respond to innovation.

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A CALL TO ACTION – THE VIRTUAL WAR MEMORIAL & TREENET PARTNERSHIP

Robert (Bob) Stanley Kearney OAM

Virtual War Memorial - South Australia

Believe it or not you and me and my mates at the Virtual War Memorial have a lot in common - but we have to dig a bit to understand why.

TREENET's life's work is about all aspects of caring for and protecting trees and mine has been about working with people who made a decision to serve and protect South Australians and the nation in many different ways. For the last few years I have been supporting the Virtual War Memorial by capturing and preserving the personal experiences of **all** those who have served the nation in times of conflict.

Way back in 1914 on 29 August, just 25 days after Britain declared war on Germany, a group of notable citizens gathered to plant an oak tree on the edge of Creswell Gardens adjacent to Adelaide Oval. It is believed to be the first commemorative object to the Great War anywhere in the world.

Images courtesy TREENET Avenues of Honour Project 5/11/2015

It was a gesture - full of meaning: a living commemorative offering for an event where lives would inevitably be lost. However, no-one at that ceremony would have anticipated the unrivalled loss of life. Eleven million military personnel and 7 million civilians died.

The centre piece of the ceremony on 29 August 1914 was a long-living English Oak tree (*Quercus robur).*This magnificent tree stands proud today and is likely to do so long after we have all shuffled off this mortal coil. From that single gesture communities throughout this state and the nation, adopted living memorials as the major commemorative gift honouring those who served and lost their lives.

Avenues of Honour, as the nation has come to know living memorials, link what TREENET does with what we at the Virtual War Memorial do.

My call to action is to ensure that in terms of honour and remembrance, we will all have a better idea what we do and why. I have no doubt that our combined efforts and the integration of living memorials into the Virtual War Memorial, will result in more people hearing the call and responding with action.