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Indigenous landscaping and biophilic urbanism: case studies in Noongar Six Seasons

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Abstract

Background Indigenous landscaping has had a revival with Indigenous cultures as an important part of multiculturalism. The landscape elements are generally gleaned from Indigenous Elders and from anthropological texts and pre-invasion history texts (e.g. explorers' notebooks) that enable an understanding of the ecological, food, and medicine aspects of their propagation. The purpose of this study was to examine how Indigenous landscaping (knowledge, values, management methods, use) can assist with biophilic urbanism, the new approach to bringing natural systems into the built environment. This emphasizes the importance of place meanings in biophilic design. It will illustrate this in Western Australia using the Noongar People's Six Seasons of distinct landscape each with importance for providing a living environment (shelter, food, medicine, and spiritual nourishment) and as a basic requirement for biodiversity management over 60,000 years.

Results The study presents key reasons to include Indigenous interpretive landscaping into biophilic urbanism. Case studies in Six Seasons Gardens are used to show how integrating a cultural element into landscaping can bring many advantages. From the analysis of the case studies, we identified qualities of Indigenous Local Native Gardens. Several reasons for prioritising Indigenous landscaping in urban settings are proposed. These highlight cultural, educational, and professional values that can be achieved.

Conclusions In this paper, we presented three case studies of urban indigenous and native gardens. We highlighted implications for adding indigenous dimensions to the management of the natural and built environments and brought to attention how indigenous landscaping is a conveyor of meaning, inclusive culture, and the importance of biodiversity. The future of biophilic urbanism will depend on whether sufficient contact with historians, anthropologists, and remnant indigenous communities can be made in order to emphasize the value for all aspects of biophilic urbanism in creating a deeper sense of place.

Keywords Biophilic urbanism, Indigenous landscaping, Native garden

Introduction

In 2015, along with 192 other countries, Australia adopted the 2030 Agenda featuring seventeen Sustainable Development Goals [60]. Some of the goals concern the natural environment and urban living, for example, Goal

11 Sustainable Cities and Communities and Goal 15 Life on Land. The main objectives of these are to “make cities and human settlements inclusive, safe, resilient and sustainable” and to “protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss” [4]. Recently, the Global Biodiversity Outlook 5 report revealed that countries worldwide failed to meet even a single biodiversity target set for 2020 [52], which means

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that an estimated one million species of flora and fauna still face extinction.

This paper will set out a new approach to biodiversity management that will attempt to show how cities can play a bigger role. It will in particular try and show that the rapid growth in the indigenous landscaping movement will need to see cities as their next major focus. It will illustrate this by examining an emerging overlap between indigenous landscaping and biophilic urbanism in Australian cities with application to many cities across the planet.

Australia is one of the most biodiverse places on earth [13] but has so far had limited success in preventing this being lost. Preventing the loss of species in the past has focussed on strategic planning for conservation and rehabilitation of the land systems across the countryside but increasingly there have been calls for new approaches to making urbanised areas more sensitive to their biodiversity inside and around their built forms [16, 22]. A research study by Ives (27) suggested that Australian cities present opportunities for national biodiversity conservation. This paper examines how biophilic urbanism, a new approach to biodiversity in cities, can also integrate with the broader goal of how to be inclusive with indigenous values and communities. It examines how this is working out in Perth, Western Australia where the oldest living culture is beginning to be drawn into how their landscape knowledge can help to make better cities and how this can lead to more hopeful biodiversity gains.

Theoretical background

Biophilic urbanism and biophilic design

Biophilic urbanism is a planning and design approach that aims to systematically integrate nature into the urban environments, so they can become restorative and conducive to life. This concept is grounded in the understanding that humans possess an intrinsic affinity for nature, which should be nurtured and sustained daily [29]. The main biophilic design features enable nature to become an integrated part of roofs, walls, balconies, indoor landscaping and implementation of nature-based solutions between buildings (such as green infrastructure) [12]. A major driver in how biophilic urbanism works is the way that biophilic responses create human health outcomes through actual physiological mechanisms [1, 38]. Biophilic urbanism therefore fosters many urban resilience outcomes for better economies, better community and better natural systems [17]. As a strategic approach to urban development, it can therefore assist with achieving the SDGs.

By implementing the biophilic urbanism, cities should be able to assist with the enhancement of local

biodiversity [8, 41, 43] and meet other SDGs at the same time. Biophilic urbanism encompasses many types of ecological systems and human activities [29] instead of focusing on a single building, urban spaces, and particular human activity, as landscape design often does. Kellert and Calabrese [30] have identified principles for the effective practice of biophilic design which are compatible with the natural world:

- 1 Biophilic design requires repeated and sustained engagement with nature;
- 2 Biophilic design focuses on human adaptations to the natural world that over evolutionary time have advanced people's health, fitness and wellbeing;
- 3 Biophilic design encourages an emotional attachment to particular settings and places;
- 4 Biophilic design promotes positive interactions between people and nature that encourage an expanded sense of relationship and responsibility for human and natural communities; and,
- 5 Biophilic design encourages mutual reinforcing, interconnected, and integrated architectural solutions.

The missing link is that biophilic design has not made much yet of the need to establish an Indigenous relationship to the culture and practices of Indigenous landscaping and how this can indeed improve biophilic urbanism and hence biodiversity as well as better cities.

Indigenous landscaping

To build a nature-positive economy is a responsibility of all, and the recognition of the potential for indigenous knowledge to contribute to sustainable and regenerative development is seen to be a major new agenda. Indigenous people have a long history of deploying nature-based solutions, however, not many countries have recognised this knowledge as necessary in building a sustainable economy and sustainable living environments, especially in cities [63].

As urban public spaces increasingly accommodate diverse and multicultural societies, a better understanding of how various populations use those places and what values are attached to them could help urban planners and designers to deploy adequate design tools and solutions. Low et al. [35] argue that the most successful public spaces are those where the identities of different cultural groups are emphasized and celebrated so people of different cultural and ethnic backgrounds use the spaces without concern for being stigmatised and people learn to appreciate each other. Culturally appropriate public spaces are essential to the community's success [32] and building a sense of place

[65]. Vibrant neighbourhoods foster social interactions and have a greater level of social capital [32, 35]. It is, therefore, necessary for biophilic urbanism to address the needs of multicultural societies and provide urban places that could build social, economic and ecological capital.

Despite growing academic and practitioner research on biophilic design, there is some misunderstanding that solely introducing plants between and on buildings would trigger biophilic responses [19]. However, human responses generally require some sense of meaning as well as an attractive environment. Kellert and Calabrese [30] recognise that the expected responses from biophilic spaces can be achieved by considering many more environmental and human factors than solely the inclusion of plants. Diverse contextual, cultural and ecological needs are the factors that should be considered by the designers to trigger biophilic responses. As Lachowycz and Jones (33) pointed out, the design must be appropriate to diverse human social and ecological needs. It means that the biophilic design solutions developed for one project should not be simply recreated in other places without consideration for the local cultures, traditions and ecological context. Similarly, the conclusions from one study may not be applicable in a different context and population.

Biophilic urbanism everywhere needs to consider *place* and its meanings to provide the deepest kind of responses that can intensify the experience of nature in cities. Thus in this paper we look at how Australia can facilitate the emerging integration of local indigenous ecological knowledge from aboriginal Australians with the emerging area of biophilic urbanism. The paper attempts to do that by examining the local landscape which is part of the ancient continent of Gondwana and how the Noongar culture in South Western Australia, that has a 60,000-year continuous history, in recent times has begun to be understood and applied to how the region in and around Perth can be better managed [26, 40].

Noongar Indigenous Landscaping

Considering that Indigenous Australians have been the custodians of the lands, waters and diverse fauna and flora for at least 60,000 years [20, 46] and continue to maintain a strong connection to the natural environment, it seems important for biophilic urbanism to have a greater insight into indigenous knowledge and environmental practices in such ancient cultures that continue into today's cities and regions. It is necessary to at least begin to seek collaboration with the traditional custodians of the lands in order to deliver adequate and culturally appropriate developmental strategies and achieve inclusive biophilic outcomes in urban environments. There is evidence

that this has started but little evidence exists of how landscaping cities could use this knowledge.

Indigenous knowledge is based on spirituality which is based on their relationship with the natural world [20]. The native knowledge and spirituality are strongly tied to the natural environment and the landscapes across Australia with 32 different language groups, each with their own place for which they have had responsibility for many generations and now are in various stages of native title recognition. Indigenous spirituality emerges through the patterns and forms in natural landscapes and is reinforced by the traditional oral interpretations and song-line stories. The Indigenous artefacts and symbols reveal an alternate perception of the natural environment, and this adds another layer of meaning to particular urban localities [28, 58].

The Noongar nation has evidence of its past cultural activity going back 60,000 years and their presence in the land has begun to be recognised legally. The South West Native Title Settlement for Noongar people in Western Australia, aims to resolve native title claims in exchange for statutory recognition of the Noongar people as the traditional owners of south-Western Australia. It is the largest native title settlement in Australian history, affecting about 30,000 Noongar People and encompassing around 200,000 km² (77,000 sq mi) in south-western Western Australia. It has been described as Australia's first treaty [23].

As part of this emerging integration of Noongar culture into Western Australian life, there is a growing need for wider education, recognition and implementation of Aboriginal knowledge systems [40, 58], ecology and environmental management practices in Australian urban environments. The first reason for doing this is that Indigenous people may find it difficult to sustain traditional knowledge and practices while living in urban centres [47] as modern urban landscapes may not provide adequate places for traditional practices. The bigger picture reason is to find ways that indigenous knowledge can teach the established cities of Australia to find new and useful ways to improve biodiversity management and indeed to create better cities through their biophilic urbanism.

Some urban green infrastructure projects are beginning to incorporate local Aboriginal knowledge in their designs, for example school and public playgrounds [31, 59]. A number of gardens based on Noongar Six Seasons have been established in cultural centres, local communities and schools and even in the land managed by private companies. As outlined in this paper the collaborative design process in these emerging projects included the representatives of particular institutions, students, local Aboriginal

communities and Elders, artists, landscape designers and landscapers. The recent revival of Indigenous landscaping supports the efforts to re-wild the urban environment and enhance biodiversity, which complies with the biophilic urbanism agenda, but also provides opportunities to deliver biophilic places that facilitate Indigenous practices and restore connections with important (sacred) places. This could potentially facilitate building a deeper and more meaningful connection to the natural world for multicultural communities and hence lead to better biodiversity management.

In 'Indigenous Knowledge in the Built Environment' Jones et al. (28, p.13) state that '*Indigenous knowledge systems are particularly relevant to the Australian planning and landscape architecture disciplines as it relates to the practice of land planning, management, spatial knowledge exchange and landscape design.*' A similar statement is made regarding the Indigenous concept of time and the seasons. The statement provides a rationale for giving a particularly strong position of including Indigenous landscaping and urban nature management in the biophilic urbanism agenda:

'While Western landscape architecture practice is often driven by the crafting of places for humans and wildlife to enjoin and prosper within, the Aboriginal and Torres Strait Islander peoples' perspective places a greater emphasis upon healing, nurturing and a long-term perspective about looking after place in anticipation of the return of their ancestors.' [28], p. 35).

Indigenous knowledge, values and spirituality could be much more incorporated into the design of urban greenery – parks, private and public gardens, playgrounds, public squares, road verges, stormwater infrastructure. Also, innovative biophilic structures such as green walls and roofs could be designed to reflect Indigenous knowledge, values and spirituality [57]. This approach can be taken systematically across the urban environment to deliver important aspects of biophilic urbanism.

Indigenous landscaping delivered at the urban scale may provide appropriate space where traditional knowledge and values can be cultivated and as a learning tool for residents of different cultural and ethnic backgrounds. This paper hopes to demonstrate how it can be done.

The Noongar people of the South-West corner of Western Australia followed the Six Season calendar for time-keeping and utilizing resources [15]. The transitions between the seasons rely on the changes in plants and animals' behaviours therefore the time-span of

every season is different and doesn't follow the western calendar. For example, the flowers appearing during certain seasons were signalling the right time to move to another campsite [36, 39].

Noongar Peoples of South-West Australia maintain and use the knowledge of the Six Seasons. In the Noongar language, the seasons are Birak, Bunuru, Djeran, Makuru, Djilba and Kambarang (Fig. 1).

These Six Seasons are a landscape system used for all cultural purposes: shelter, food, medicine and spiritual nourishment and as a basic requirement for biodiversity management.

Biophilic urbanism is an urban planning and design approach that is aiming to provide cities with a coherent landscaping system that covers all aspects of the built environment. This paper seeks to examine whether the Six Seasons landscaping system could be applied across the city of Perth in Western Australia, as an example of how cities can relate more to their indigenous roots, how it can help biodiversity management, and what this could mean for the further growth of biophilic urbanism as a professional practice.

Methodology and methods

This paper examines how indigenous landscaping can assist with the place-based implementation of biophilic urbanism. Firstly, the authors proposed the three stages in the growth of awareness in Six Seasons Noongar landscaping in Western Australia to provide a historical background for the paper. Secondly, the case study methodology was applied to examine how integrating cultural elements into urban landscaping can bring many environmental and social advantages. Three gardens were selected for case studies – two Indigenous and one native – all based in Western Australia.

The first of the chosen gardens for this study is the Ballardong Noongar Six Seasons Garden, located in York. This community garden was collaboratively established by the Wheatbelt Natural Resource Management (NRM), the Ballardong Noongar community, a local high school, and various individual and corporate sponsors, as well as numerous volunteers. The second indigenous garden, Muminbulah Wilak Six Season Garden, is situated within the premises of the Jandakot-based gas company, ATCO. Although privately owned, access to this garden is granted upon obtaining the appropriate permit. The last of the studied gardens is the Bushland Garden in York which exemplifies a community-driven urban greenspace, boasting an extensive variety of native flora endemic to the Wheatbelt region.

The study has applied several qualitative research methods in order to gather data on principles, beliefs, traditions, historical and ecological significance, and the use of space in Indigenous and native gardens. Our research



Fig. 1 Noongar Six Seasons Calendar. Source: <https://www.australiassouthwest.com/south-west-inspo/six-seasons-south-west>

approach involved three main qualitative methods to gather data: site observations and analysis, document analysis, and semi-structured interviews. These methods were chosen to obtain a comprehensive understanding of the perspectives of various stakeholders involved in the design, maintenance and use of the gardens. Data collected through these methods were analysed using thematic analysis, where we identified common themes and patterns emerging from the data.

Section 6 presents the type of values that could be achieved if design professionals consider incorporating an inclusive approach to indigenous landscaping.

Stages in the growth of awareness in six season Noongar landscaping in Western Australia.

Three stages are outlined of the modern history of Western Australia focussing on how the new settlers dealt with the Noongar landscape, with illustrations of each stage.

Early setting aside

The British colony of Western Australia was established in 1826 and began settling in 1829 as a place where a

thriving agriculture was considered to be possible as the trees were so large. It did not take long to find that European perceptions were not appropriate about the nature of the landscape [53]. The eucalypts had ways of surviving on deeply leached soils even sands; and the clay soils were not as productive as Hampshire in Britain. But despite the inability to thrive agriculturally, there were early settlers who recognised the extraordinary biodiversity and began to understand the different six season flowering regimes of this biodiversity hotspot as its now known. From very early times the knowledge of where to find flowering plants (and their associated insects, birds and mammals) came from aboriginal sources. The local botany was collected and classified by Georgiana Molloy who became totally fascinated by its incredible diversity and used indigenous knowledge to find the different flowering times for each species she collected [6, 21, 34].

Although the settlers brought many foreign cultivars to their newly established farms and domestic gardens, they also started to discover and learn about the local species

and the local ecology. The different soils and climate led to significant problems just feeding themselves and little if any used indigenous food sources. Botanists often succeeded at propagating native plants, building native gardens, and sharing their knowledge with others [34].

The new colony found gold in the 1890's and the main city of Perth grew rapidly. Early planners and politicians who were planning the city found the space to set aside some special native bush in various places, including Kings Park in the heart of the central business district. Kings Park however was not turned into an English park as in Melbourne and Sydney but was left in its native state and has been managed ever since for that purpose [55] – see Fig. 2. The benefits of having an Indigenous area at the heart of a city set in motion a history of recognising that the six-season landscape management of the Noongars was something to preserve [53]. The Park was also set up as a centre of expertise on native flora.

The city was of course a place of its time in being a pioneer culture with the need to conquer the new people and place [9]. In the context of urban development, this meant that Perth was designed and built according to European models and ideals, with little input from or consideration for the indigenous population. As a result, Perth and its surrounding landscapes were shaped by the colonial desire to control and exploit the land and its resources, at the expense of the indigenous people and their connection to the environment.

This mindset influenced the establishment of cities and the treatment of both the indigenous population and the natural environment, leading to a legacy of dispossession and marginalisation of Indigenous people. But the other more sensitive side of being aware of the

indigenous people and their place-based culture was also evident though not as well developed in the practices and planning of the city during its first hundred years.

Regenerating cleared public land

By the second half of the twentieth century town planning had begun to designate the importance of natural spaces in the landscape. Joanna Seabrook, Hazel Dempster, Alex George, Stephen Hopper, and George Seddon, amongst others, became passionate about Western Australian unique flora and shared their passion by helping to discover and systematize collections of Australian plants, establish native and botanical gardens, and contribute to natural environment conservation strategies to protect the species and the local landscapes [18, 25, 54]. Seddon [53] in particular was very influential on how the city needed to incorporate nature and indigenous perspectives into its planning to create a 'sense of place'.

Several key areas of public space began to be regenerated, essentially by allowing it to regenerate itself with a little help from weed control where needed. A good example is the Wireless Hill Park which today is a thriving landscape of native plants after its role as a space for the first wireless transmissions was no longer needed and the completely cleared space was regenerated with native bush. There has been a continuing involvement of indigenous expertise in managing this space and other native bush around the city (see Fig. 3).

The largest legacy of this period is the regeneration of the Swan River foreshores. A regulation was part of the new town planning scheme in 1955 that asserted all land on the river's edge must be returned to the crown within



Fig. 2 The view to Kings Park in Perth, Australia. Source: Peter Newman



Fig. 3 Photograph of Noel Nannup in Walyunga sharing Indigenous knowledge of Noongar country. Credit: Zal Kanga



Fig. 4 The embankments of Swan River. Credit: Credit: Peter Newman



Fig. 5 Point Fraser. Credit: Peter Newman

50 m of the river’s edge. This land was revegetated mostly with native species and the occasional small park and today is a very popular continuous cycle-way/walk-way for over 80 kms on either side of the river (see Fig. 4).

These areas were considered better to be turned into green spaces resembling native landscapes was a part of the growing culture of seeing native plants as better for biodiversity and also for functional purposes such as green infrastructure in water management and slowing down erosion of river edges. This has been clearly demonstrated by the regeneration of Point Fraser where native vegetation was used to create a storm water treatment area and the reconstitution of a soft interface between land and water (see Fig. 5).

In this late twentieth century period many domestic and public native gardens emerged and helped to establish the native landscaping principles which are used in towns and cities across Western Australia to build green urban infrastructure: street verges, parks, squares, public gardens, and riverbanks. However, this continued to be in conflict with the modern global trends and gardening fashions influencing individual choices. Perth was not only influenced by British perceptions of nature but many multi-cultural perceptions of the rapidly growing population who were attracted from across the world to work in the mining-based economy and its knowledge-based centre in Perth. The deepest traditions of British landscapes meant private gardens often featured monocultures of lawns and non-native plant species, but many other garden types have emerged. Despite this multiculturalism there was

a growing sense that the indigenous plants were special and contributed to the sense of place for everyone. Thus the growth of the native plant industry and their cultural value continued to grow and to assert that for six seasons in Perth and its region, there were flowers that could be made part of any garden, street or a local park. However this was not usually done using indigenous interpreters.

Landscaping the whole city

In the twenty-first century there has been a dual increase in the role of native plants in landscaping and the role of indigenous culture in interpreting the landscape. The growth in native plant nurseries, native street tree policies as part of municipal garden strategies, and community interest in how to plant and maintain native gardens, has become a feature of urbanism in Perth. At the same time there has been an increase of interest in the use of indigenous Noongar Six Seasons interpretation of landscaping amongst educational institutions and communities; this is for both landscaping and because of an inherent interest in integrating indigenous culture that helps us better understand our place [15, 44].

A number of public and private gardens have emerged using the ecological and cultural principles of the Six Seasons [2, 14, 56, 62] some of which are outlined below. Many primary and secondary schools in Western Australia have established their own Six Seasons Gardens and use the space for educational and cultural purposes [31, 64]. A Six Seasons garden at a Primary School in Manning was established in connection with the local government's Urban Forest Strategy [14].

King's Park now offers educational programs on the Noongar Six Seasons [10]. Aboriginal presenters share their knowledge of the Six Seasons and traditional Noongar life while taking the students for a walk in the gardens of King's Park. One of the educational trails, The Boodja Gnarning Walk, captures some of the Noongar knowledge and explores Noongar use of the land. A number of culturally significant native plants can be found along the

tracks of this walk. Students are engaged in a variety of cultural activities traditionally associated with each season, such as plant uses, hunting, language, art, dance and traditional games.

Indigenous author on this paper Noel Nannup Karda, runs educational tours in Perth and its regions as outlined in Table 1.

At the same time as this increased interest in indigenous landscaping, there has been a growth in the simple use of native plants and especially trees to create an urban forest. Several new suburbs have used native plants with the new residents ensuring that in every street there were plants that would flower in all six seasons thus bringing insects and birds all year around. Some suburbs now have almost completely created a closed canopy of native forest trees that enable the city to be cooled in summer and provided with insects and birds following flowering plants at every stage of the year (see Fig. 6).

There are many local radio and TV shows on gardening that feature the importance of native plants. There are now over twenty restaurants that provide Noongar food on their menus and one 'Wildflower' has an entirely local menu that follows the Six Seasons. There are even biophilic gardens of native plants in wetlands built on top of



Fig. 6 Urban forest in Subiaco Credit: Peter Newman

Table 1 The Carers of Everything (Moondang-ak Kaaradjiny) by Noel Nannup

I have a science degree which enables me to understand how the world is understood to work by people in the tradition of modern western science. I am also an elder in the Noongar tradition and my totem 'Karda' is the race-horse goanna. I try to integrate the western knowledge and the Noongar knowledge [50]. In the Noongar tradition I have a perspective shaped by people who have lived here for so long even modern western science finds it hard to be specific. It's a long time. Multiple generations have thus been passing on their knowledge through stories and songlines and how to simply survive through the Noongar Six Seasons, using all the fruits of the landscape for this gift of life [49]

I run guided tours along songlines showing how we can gather intuitive knowledge from the bush and from listening to The Carers of Everything (Moondang-ak Kaaradjiny) [40] which are the spirits that remain from previous time and are able to give us the knowledge that enables us to care for the land and the community. We also go camping so that we can sit around a fire and yarn about the stories in the area

At the University of Western Australia I help to run a gathering at the start of each of our Six Seasons, for staff and students that helps to orient ourselves to the next two months of weather, plant flowering and related stories. This is held in the Business School. It attracts considerable interest as people are looking for a better understanding of our place and how to be more respectful of those who went before us



Fig. 7 Cultural Centre Wetland in Northbridge, WA. Credit: Peter Newman

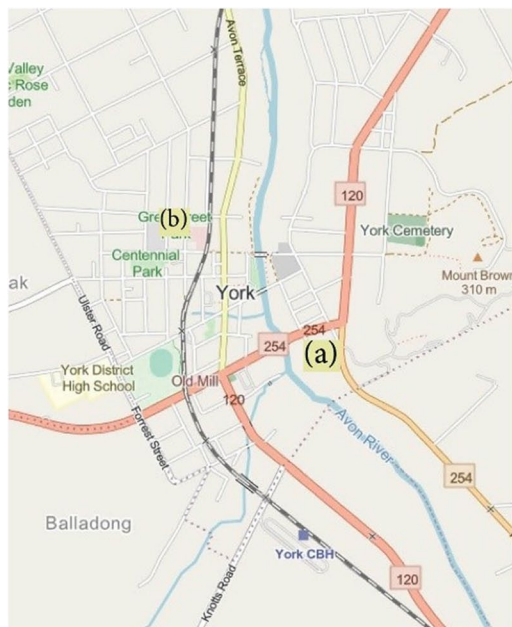
car parks (Fig. 7) where once Indigenous wetlands were used as a major food source [11].

The biodiversity of Perth itself is very high and includes over 200 endemic species of orchid [24] and this movement to increase the use of native plants in landscaping has been extremely popular. However it has not yet been fully integrated into indigenous culture so this may be the next phase for the city.

Six season case studies

The paper examines some indigenous landscape case studies to illustrate the concepts presented. The gardens have been studied to derive principles that would then inform and facilitate the delivery of biophilic urbanism based on indigenous landscaping.

The selected case studies are based in Western Australia. Two case studies are Aboriginal Six Seasons Gardens—Ballardong Noongar Six Seasons Garden in York (31°53’33.5”S, 116°46’32.7”E) that occupies the area of 2500m² (Fig. 8) and Muminbulah Wilak Six Season Garden in Jandakot (32°06’49.1”S, 115°51’32.0”E) built



- (a) Ballardong Noongar Six Seasons Garden
- (b) The Bushland Garden



Fig. 8 The location of the case studies in York, Western Australia: **a** Ballardong Noongar Six Seasons Garden, **b** The Bushland Garden. Maps derived from ArchGIS database by ESRI Australia Pty. Ltd. Credit: Agata Cabaneek

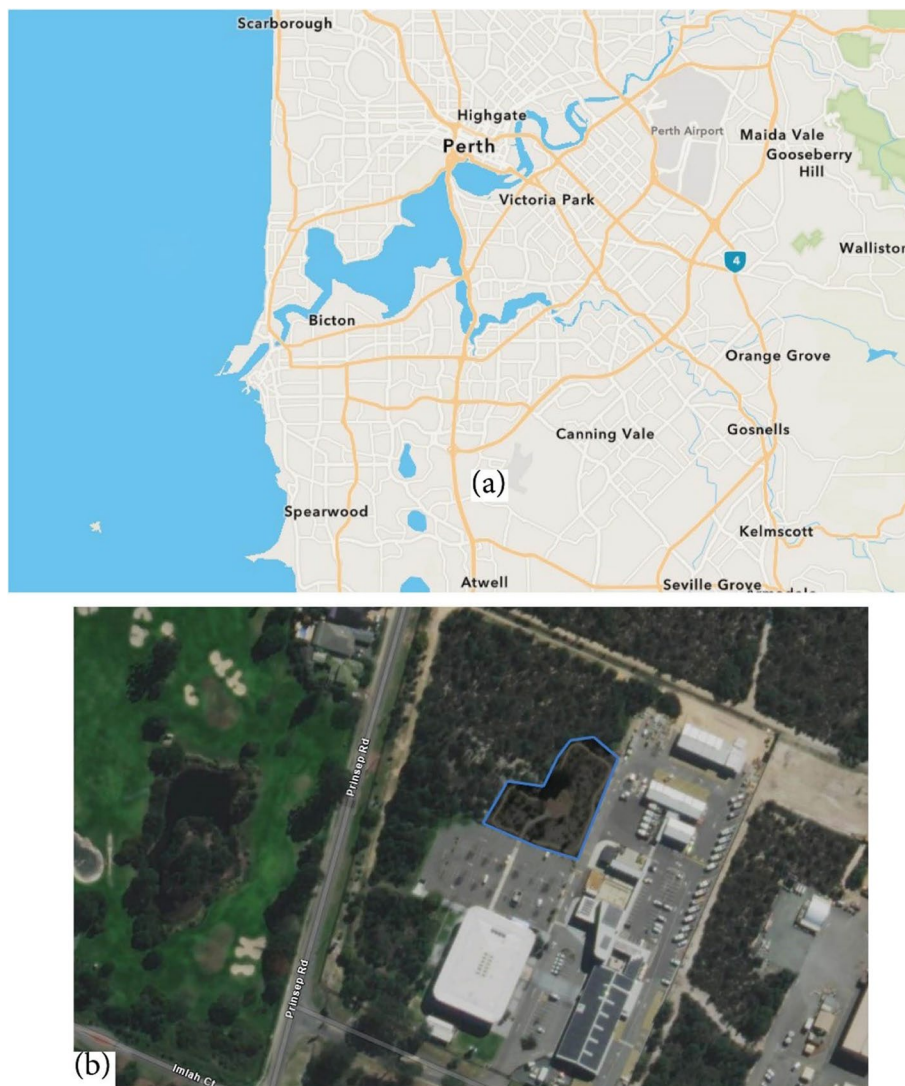


Fig. 9 The location of the case study in Jandakot, Western Australia: **a** The Muminbulah Wilak Six Seasons Garden, **b** The ATCO Gas Depot site with the Garden outline (in blue). Maps derived from ArchGIS database by ESRI Australia Pty. Ltd. Credit: Agata Cabaneck

on the grounds of the ATCO Gas company (Fig. 9). The area of this garden is approx. 3000m². The third garden is a native urban garden—The Bushland Garden in York (31°53′05.5″S 116°45′55.4″E) that occupies the area of approx. 12000m² (Fig. 8).

Ballardong Noongar six seasons garden

The garden was established in 2009 on the grounds of the Residency Museum in York, Western Australia. The project was founded through a Wheatbelt Natural Resource Management Network Incentive Development and Support Grant and the Shire of York [64]. The garden was a collective effort of the Wheatbelt NRM, the Ballardong Noongar community, a local high

school, individual and corporate sponsors and volunteers. The design concept is based on Noongar Six Seasons which are characterised and divide by natural changes in weather conditions and seasonal cycles of flora and fauna. As per the information provided by the Residency Museum, the project is a symbolic garden walk and it represents koora-korra [the past], yey [the present] and mila [the future] of Ballardong Noongar Budjar and its meaning to the Ballardong Noongar people [5].

The main feature is the bidi (path) which is divided into six sections (Fig. 10). Each section is marked with symbolic boya (river-stones) painted by the local high



Fig. 10 The bidi [path] and native shrubs and trees. A corten-steel model of waitj [emu] and its young can be seen in the centre. Symbolic camp circles in the bottom-right corner. Credit: Agata Cabaneck



Fig. 11 The boya (symbolic ceramic river-stones) decorated with pressings of local plants. The stones form the word for the Noongar season Djeran. Credit: Agata Cabaneck

school students (Fig. 11). The boya depict local plants and form the Noongar names for each seasons [56].

The native flora and fauna bear traditional meaning and importance in this garden. When the visitors follow the footpath, they learn about the plants, animals and activities occurring in particular seasons. The particular plants would serve as the season changing indicators, food, medicine or water source. Animals depicted in the garden were traditionally valuable food sources in particular seasons but also important spiritual and cultural symbols and totems. The animals hunting for food and gathering fruits and berries were done in the correct seasons in line with traditional Knowledge passed on by each generation [15].

The main feature—the bidi (path)—is divided into six sections. The bidi (path) symbolises Bilya [the Avon River] winding through the Avon Valley. The Six season

garden in York plays a symbolic role in order to educate the visitors on spiritual, ecological and cultural level. The garden is a ‘living narrative’ undergoing transformations with the seasons and years passing.

There are another two symbolic gardens within the grounds of the Residency Museum. A small kitchen garden near the cottage is named Settlers’ Kitchen Garden and it was established in 2006 in memory of Phillis Rogers, a Museum volunteer (Fig. 12). Also, there is the Waterwise Garden established in 2006 which includes a variety of native and non-native plant species.

The symbolic placement of the Six Seasons Garden (Fig. 13) enforces its ecological and educational importance. The Settlers’ Kitchen Garden established near the cottage symbolises the knowledge that arrived with first European settlers. Next is the Waterwise Garden which symbolises the embrace of native flora and Indigenous



Fig. 12 The Settlers' Kitchen Garden established in 2006. Credit: Agata Cabaneq



Fig. 13 Mapping of the three gardens adjacent to Residency Museum in York: **a** The Settlers' Kitchen Garden, **b** The Waterwise Garden, **c** The Ballardong Noongar Six Seasons Garden (not to scale). Credit: Agata Cabaneq

knowledge of the plant species and their use. The Ballardong Noongar Six Seasons Garden comes as the last one established (2009) and symbolises a wider embrace of the Indigenous knowledge, culture and spirituality. Every plant, stone, symbol has its cultural and spiritual meaning.

Muminbulah Wilak Six Seasons Garden

Muminbulah Wilak Six Season Garden, built in the Jandakot Operation Centre, is the company's private garden, a cultural education tool, telling the story of Noongar Culture and the role the seasons, local native vegetation and animals played in the history,

and traditions of the Noongar people [61]. The idea of establishing the garden at the ATCO depot in Jandakot was one of the Reconciliation strategies (actions) adopted by the company in 2018 [3].

Jandakot is based on the Banksia Sand Plains where many species of Banksia can be found. It is a plant of high significance to the Noongar people who traditionally used it as food or for fire starting. The Six Season Garden is surrounded by the remnant Banksia bushland that provides backdrop for the garden area (Fig. 14).

The design was inspired by a painting from a local Indigenous Artist Deborah Bonar [3]. The painting was presented to the ATCO representatives and a detailed garden design was later developed by Denice Kickett in consultation with the local Elders and was named after her Nyoongar name – Muminbulah Wilak – Spirit of the Land. The painting symbolises the Six Seasons and the

flora, fauna and human activities characteristic to those seasons. The garden was installed by appointed local Indigenous landscaping companies (J. Scriven, personal communication, June 20, 2018).

The design of the Muminbulah Wilak Six Seasons Garden was based on the knowledge of the Noongar Six Seasons. The plants palette correlated with the plants that are available for food, medicine, shelter and other resources during each season.

The entry to the Garden is marked by two sculptures resembling boomerangs and a welcome message engraved in them (Fig. 15).

The footpath directs visitors to the central point of the garden with a circular water feature (Fig. 16). The space around the water feature serves for gatherings and events. The pavement resembles a map of Noongar Boodjar (Noongar Country) and the Fourteen Tribal



Fig. 14 The footpath and planting beds (left). The remnant Banksia bushland forms the backdrop to the garden. Credit: Agata Cabaneek



Fig. 15 The entrance to the Garden marked by two boomerang sculptures. Credit: Agata Cabaneek



Fig. 16 The central water feature and the wavy wall symbolising the Wagyl (Serpent). The pavement based on the map showing the residing sites of the 14 clans in South West Australia. Credit: Agata Cabaneek

Language Groups [15]. This central contemplation area is bordered by sculptured walls (seating) which symbolise the Wagyl, the rainbow serpent—the creator from of the Aboriginal dreamtime [3].

The garden is divided into six sections. Starting from the water feature the division marks radiate towards the garden beds symbolising each season. A circular footpath guides the visitors through the garden where they learn about the landscapes, plants, animals, weather and activities characteristic to each season. The Audio Garden Tour is available for visitors via their smartphone as they walk through the Garden. The tour was developed and recorded by Aboriginal Productions and Promotions and music was supplied by Dr Richard Walley ([2]; J. Scriven, personal communication, June 20, 2018).

The garden serves as a cultural and educational tool. A space for sharing stories and history of the oldest living culture in the world. A tool to educate those who seek a better understanding and appreciation of Culture and Country. The ATCO Company uses this space to welcome guests to their centre. As a part of the community engagement plan, school groups are often invited to visit the Six Seasons Garden and participate in special educational program (J. Scriven, personal communication, June 20, 2018).

The bushland garden

The Bushland Garden in York (Western Australia) is a community-driven urban open space featuring a wide range of native plants naturally growing in the Wheat-belt region. The site was once a clay pit for brick making and became an eye-sore wasteland after the Meckering earthquake in 1968 when rubble from the demolished

York Royal Hotel was buried there. Two local residents—Joanna Seabrook and Adelphe King – decided to turn this vacant lot into a bushland garden. Between 1993 and 2002 the local volunteers planted native species, constructed the footpaths, shelters and a Memory Corner dedicated to one of late volunteers (Fig. 17). However, due to lack of external funding, the garden deteriorated and in 2005 the York Branch of the Wildflower Society decided to assume responsibility for the ongoing maintenance and development of the existing garden (E. Ayling, personal communication, April 22, 2021). Since the transition, the garden attracted many groups and local authorities, including Wheatbelt Natural Resource Management, York LCDC, Green Corps, the York Garden Club, the LEAP scheme, and the York Shire Council that contributed to its maintenance, and promote as an important green urban space in York.

One of the main objectives for the establishment of the garden was to promote and encourage the growing of local plants with a particular focus on native species from York Shire. It was not set up as a demonstration of six seasons flowering but is so extensive in its collection of native plants it does in fact have many features of a Six Seasons garden. However it is not making the most of this cultural connection [62].

The Bushland Garden is an example of a successful grassroots initiative which could be replicated anywhere but it misses the opportunity to bring a cultural dimension of Indigenous landscaping. How important is this?

Results

Why enable Indigenous landscaping?



Fig. 17 A memory corner and new plantings. Credit: Agata Cabaneck

Table 2 Historic preservation, reclamation and conservation efforts to acknowledge Indigenous and European heritage

	Indigenous Gardens	Local Native Garden
Purpose	<ul style="list-style-type: none"> •Cultural expression; •Profound connection with land, fauna and flora, abiotic elements of landscape; •Stewardship of indigenous culture and environmental and spiritual knowledge; •Places for gatherings, cultural and spiritual events, and healing; •Providing educational space for students, children and adults; •Providing space for memorials and acknowledgments and recognitions; 	<ul style="list-style-type: none"> •Promoting native flora to expand use in private gardens; •Natural environment conservation efforts; •Educating about native plants, planning, display arrangements to encourage the transformation of landscaping and gardening practices; •Regeneration of urban wasteland; •Providing a recreational and educational green space in the urbanised environment; •Providing educational space for students – engaging in maintenance, creating a bush-tucker garden; •Providing space for memorials and acknowledgments and recognitions;
Design	<ul style="list-style-type: none"> •Designs are based on Aboriginal Dreaming and Aboriginal Six Seasons. They often include a motif of a journey; •Fauna, flora, and abiotic elements of landscape (rocks, soil, land formations, water) are all significant parts of a garden; •Inclusion of cultural artefacts (sculptures, paintings, weapons); •Symbolic representations of local indigenous history, culture, values and beliefs; •The biological changes occurring in plants and animals during Noongar Six Seasons inform the garden visitors about important events and milestones; 	<ul style="list-style-type: none"> •Planting arrangements are experimental; •Designs are based on Western classical garden display techniques and practices (elements such as garden beds, layered planning arrangements, winding footpaths, pergolas, benches, picturesque views); •Less emphasis on abiotic landscape elements; •Strong emphasis on creating a waterwise garden;
Flora, fauna and abiotic elements	<ul style="list-style-type: none"> •Plants and animals and abiotic landscape elements bear cultural and spiritual significance in an indigenous garden; •Use of plants and planting arrangements are based on Indigenous environmental, cultural and spiritual knowledge; •The plant species are chosen for their medical and nourishing qualities, practical use, cultural and spiritual meaning and values; 	<ul style="list-style-type: none"> •Plants are selected for their aesthetics and ecological qualities; •Plants arrangements to create a waterwise garden that is easy to maintain;

The results from the analysed case studies are presented in Table 2. The table sets out the qualities of Indigenous Gardens (Ballardong and Muminbulah Wilak Six Seasons gardens) and Local Native Gardens (the Bushland Garden in York).

There are many reasons for including both approaches into any city but there are good extra reasons for prioritizing Indigenous landscaping. There are several reasons why biophilic urbanism would want to try and incorporate this inclusive approach to indigenous landscaping:

1. **Cultural value.** Cultural immersion into landscapes enables a range of important benefits to the whole city as it is the foundation of a sense of place [53]. When native plant projects are seen as the realm of those with exclusive technical knowledge or the money to build monuments to their exclusive source of enjoyment, then the native plant movement is not going to be able to touch people in the same ways as one that features more meaningful interpretation of the plants in their use over deep history.
2. **Educational value.** To have inclusive landscaping where Indigenous cultural uses of plants are integrated into every part of a planned project will involve a range of educational outcomes on planting local plants and promoting knowledge on how they can be used as food, spices, medicine, production of clothes, utensils, and tableware. New inclusive projects will provide insights as to how such applications of indigenous landscaping can assist with fire management and water management as well as the critically important facts as to what enabled the biodiversity to be so rich for so long.
3. **Professional value.** Landscaping throughout a city can enable the whole design profession to have a role in creating a more biodiversity-centred city. The potential for the whole city of Perth to return to its original status as a place that thrives around its six seasons of plants in their cycles of flowering would provide a new vision for the design professions. This will depend on the extent to which Indigenous landscaping is actually understood and transferred into landscape design and practice as a new kind of biophilic urbanism related to Perth and all its cultures, especially the one that understood its local plants for millennia.

Such an approach could be used in any city so we return to discussing why this more inclusive approach to indigenous cultures can assist in biophilic urbanism, based on the insights from the case studies and the above conclusions.

Discussion

How does indigenous landscaping help biophilic urbanism?

Biophilic urbanism has developed an approach that shows how urban vegetation in, on and between buildings has multiple benefits especially for the economic benefits of green infrastructure, the human health and welfare benefits from being closer to nature, and the deeper motivation for many which is to increase the potential for saving and regenerating biodiversity [7, 37, 51]. So where does indigenous insight fit into this? The discussion

focuses on key reasons to include indigenous interpretive landscaping into biophilic urbanism.

Three key reasons can now be given:

1. The importance of place

Biophilic urbanism stresses the importance of place in its rationale. There is a strong rationale for sense of place and belonging to be a major part of how communities are able to thrive and develop the social capital so critical for creating economic capital [45, 48]. This is also the basis of thriving cities [42]. The sense of place in a city is bound up in a combination of the physical/natural environment and the social/cultural environment. As Low et al. [35] show, this combination means that the most successful public spaces combine both of these features so the best ones are always multicultural. Biophilic urbanism therefore needs to be inclusive if it is to be successful.

2. The importance of inclusive culture

Plants are used in landscaping to create biophilic urbanism. But plants that are there to show off the history of landscape design or a foreign country like Britain's interpretation of this (in the case of Australia) are not going to give the cultural meanings so necessary for a successful sense of place. This also applies to the perceptions of other migrants coming from Europe, Asia, the Americas and Africa in more recent times. Plants that are used in landscaping not just for aesthetics but for cultural and spiritual meanings that are designed to create place, are likely to create a more meaningful and successful biophilic urbanism in the new place where people are now developing a different sense of place. Indigenous meanings are the deepest meanings for a place, especially if they go back as long as they do in Australian history.

3. The importance of biodiversity

The deeper level of biophilic urbanism, the need to conserve and regenerate biodiversity, is also a critical element in why Indigenous landscaping needs to be integrated into biophilic design. The need for indigenous insights will gather momentum when the design professions take this on in all services they provide. As well as that the commitment to biodiversity management -funding and jobs- are always hard to generate. However, when the sense of place is brought to life in a city through involvement of indigenous landscaping in a community-based biophilic project, the chances of success are greatly increased. This is because indigenous communities possess a wealth of knowledge on local ecosystems

and sustainable land management practices that have been honed over generations. By incorporating indigenous landscaping, biophilic projects benefit from this unique expertise, leading to more effective biodiversity conservation and regeneration strategies. Biodiversity needs inclusion if it is to be given a chance of reversing its global decline.

4. The importance of decolonising urban landscapes

Biophilic urbanism aims to incorporate nature into urban environments, promoting the well-being of residents and fostering a connection with the natural world. For biophilic urbanism to be successful and culturally inclusive, it is necessary to engage with colonisation and decolonisation to ensure that diverse perspectives, including those of Indigenous peoples, are considered and integrated into urban design.

In the literature and design practice, biophilic urbanism has not yet started to engage with issues of colonisation and decolonisation. There is much work to be done to ensure that the theorists and practitioners of biophilic urbanism embrace the principles of decolonization and meaningfully engages with Indigenous perspectives.

Beyond Indigenous landscaping, there are several opportunities for Indigenous people to take a greater role in shaping and nurturing urban spaces in the context of urban Perth. One such opportunity is through the integration of indigenous knowledge and land management practices into the planning, design, delivery, and maintenance of urban green spaces led by local governments. This could involve the incorporation of traditional ecological knowledge into conservation, regeneration and management of urban ecosystems and the use of indigenous landscaping techniques that are culturally significant and ecologically appropriate.

However, there are also barriers to Indigenous involvement in shaping and management biophilic urban spaces. These may include a lack of resources and capacity within indigenous communities. Additionally, the dominant planning paradigms and development pressures in urban environments can often prioritize economic growth and private interests over the cultural and ecological values of Indigenous communities.

There are both opportunities and barriers for Indigenous people to take a greater role in shaping, nurturing, and inhabiting urban spaces in Perth, and addressing these challenges will be critical to ensuring the success and inclusiveness of biophilic urbanism in the city.

Conclusions

This paper has suggested that biophilic urbanism and Six Seasons landscaping can inform each other and could help to promote and mainstream Indigenous

and native landscaping strategies. This extra human dimension to managing the environment can lead to the enabling of local policies advocating green urban infrastructure and biodiversity management. This is at the heart of biophilic urbanism and can give the delivery of this new and more holistic approach to landscaping, a real boost.

In this paper, we have presented a case study of a bushland community garden in York (Western Australia) that has become a showcase example of how to promote native flora and landscaping techniques that can build more resilient and biodiverse urban landscapes. However, if it were to add an indigenous landscaping component, it would likely have a much deeper impact on the application of native plants to every area of biophilic urbanism in the associated communities who use the area. This is not an isolated example but is symptomatic of many new opportunities that are now appearing for the application of Six Seasons interpretive landscaping as part of biophilic urbanism in the future of Perth.

The future of biophilic urbanism in other cities will depend on whether the design professionals have made sufficient contact with the historians, anthropologists and remnant communities from their indigenous past. They will then need to begin making programs that can dramatize the value for all aspects of biophilic urbanism in creating a deeper sense of place for all residents using the same land as those from deep history. As for the Indigenous people, they will need to take a greater role in shaping, nurturing, and inhabiting urban spaces in Perth to begin the process of decolonising planning and design of the city.

We believe this will make a better city but also play a major role in biodiversity management for the planet.

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Availability of data and materials

The dataset used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The research presented and reported in this paper was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research – updated May 2020. The proposed research study received human research ethics approval from Curtin University Human Research Ethics Committee, approval Number: HRE2016-0258.

Consent for publication

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References

- Alexandra J, Norman B. The city as forest - integrating living infrastructure, climate conditioning and urban forestry in Canberra. *Australia Sustainable Earth*. 2020;3(1):10. <https://doi.org/10.1186/s42055-020-00032-3>.
- ATCO. (n.d.). Muminbulah Wilak – Six Season Garden. Retrieved September 4, 2020, from <https://www.atco.com/en-au/our-commitment/community-engagement/community-indigenous-relations/six-seasons-garden.html>.
- ATCO. ATCO's vision for reconciliation is building a better Australia, by building better relationships, understanding and trust in partnership with Aboriginal and Torres Strait Islander peoples. 2018. <https://www.atco.com/en-au/our-commitment/community-engagement/community-indigenous-relations.html>.
- Australian Government. Sustainable Development Goals. 2015. <https://www.dfat.gov.au/aid/topics/development-issues/2030-agenda/Pages/sustainable-development-goals>.
- Ballardong Noongar Six Seasons Garden Walk. (n.d.). Retrieved December 4, 2018, from http://www.avonnrm.org.au/documents/nyungar_nrm_dictionary.
- Barry B. Georgiana Molloy: The Mind That Shines. Picator Australia; 2016.
- Beatley T, Newman P. Biophilic Cities Are Sustainable. *Resilient Cities Sustainability*. 2013;5(8):3328–45. <https://doi.org/10.3390/su5083328>.
- Birkeland JL. Net positive biophilic urbanism. *Smart and Sustainable Built Environment*. 2015;5(1):9–14. <https://doi.org/10.1108/SASBE-10-2015-0034>.
- Bolton GC. Land of vision and mirage: Western Australia since 1826. Crawley: UWA Press; 2008.
- Botanic Gardens and Parks Authority. (n.d.). Gnarning Walk. Retrieved August 31, 2020, from <https://www.bgpa.wa.gov.au/kings-park/events/walks-and-tours/self-guided-walks/boodja-gnarning-walk>.
- Byrne J. The green gardener : sustainable gardening in your own backyard. Camberwell: Viking; 2006.
- Cabaneck A, Zingoni de Baro ME, Newman, P. Biophilic streets: a design framework for creating multiple urban benefits. *Sustain Earth*. 2020;3:7. <https://doi.org/10.1186/s42055-020-00027-0>.
- Chapman AD. Number of Living Species in Australia and the World. 2009. <https://www.environment.gov.au/system/files/pages/2ee3f4a1-f130-465b-9c7a-79373680a067/files/nlsaw-2nd-complete.pdf>.
- City of South Perth. New seedlings to represent Noongar seasons. 2019. <https://southperth.wa.gov.au/about-us/news-and-publications/news-and-public-notices/news-detail/2019/08/14/new-seedlings-to-represent-noongar-seasons>.
- Collard L, Harben S, Berg S van den, Nidja Beeliar Boodjar Noonookurt Nyinyiny: A Nyungar interpretive history of the use of Boodjar (country) in the vicinity of Murdoch University. Perth; 2004.
- Connop S, Nash C. Blandscaping that Erases Local Ecological Diversity. *Nat Cities*. 2018. <https://www.thenatureofcities.com/2018/01/09/blandscaping-erases-local-ecological-diversity/>.
- Daniels P, El Baghdadi O, Desha C, Matthews T. Evaluating net community benefits of integrating nature within cities. *Sustainable Earth*. 2020;3(1):1–15. <https://doi.org/10.1186/s42055-020-00025-2>.
- Dempster HE. Weeds or wildflowers. In Spafford Jacob H, Dood J, Moore J, Jacob HS, Moore JH (Eds) Thirteenth Australian Weeds Conference papers & Proceedings (pp. 685–688). Perth: RG and FJ Richardson; 2002.
- Downton P, Jones D, Zeunert J, Roös P. Biophilic Design Applications: Putting Theory and Patterns into Built Environment Practice. *KnE Engineering*. 2017;2(2):59. <https://doi.org/10.18502/keg.v2i2.596>.
- Gammage B. The Biggest Estate on Earth. Crows Nest: Allen & Unwin; 2012.
- Hasluck A. Georgiana Molloy: Portrait with Background. Oxford: Oxford University Press; 1955.
- Hes D, Du Plessis C. Designing for Hope: Pathways to Regenerative Sustainability. Oxfordshire: Routledge; 2015.
- Hobbs H, Williams G. The Noongar Settlement: Australia's First Treaty. *Sydney Law Rev*. 2018;40(1):1–39. <https://go.gale.com/ps/i.do?p=AONE&sw=w&issn=00820512&v=2.1&it=r&id=GALE%7CA545146876&sid=googleScholar&linkaccess=fulltext>.
- Hoffman N, Brown A, Brown J. (Orchid enthusiast), & Scott Print. *Orchids of South-West Australia* (4th ed.). Orchids WA; 2019.
- Hopper SD, Gioia P. The Southwest Australian floristic region: Evolution and conservation of a global hot spot of biodiversity. *Annu Rev Ecol Evol Syst*. 2004;35(Figure 1):623–50. <https://doi.org/10.1146/annurev.ecolsys.35.1.12202.130201>.
- Hopper S, Harvey MS, Chappill J, Main AR, Main BY. The Western Australian biota as Gondwanan heritage - a review. In: Hopper S, Chappill JA, Harvey MS, George AS, editors. *Gondwanan Heritage*. Surrey Beatty & Sons; 1996. p. 1–46.
- Ives CD, Lentini PE, Threlfall CG, Ikin K, Shanahan DF, Garrard GE, Bekessy SA, Fuller RA, Mumaw L, Rayner L, Rowe R, Valentine LE, Kendal D. Cities are hotspots for threatened species. *Glob Ecol Biogeogr*. 2016;25(1):117–26. <https://doi.org/10.1111/geb.12404>.
- Jones DS, Choy DL, Tucker R, Heyes S, Revell G, Bird S. *Indigenous Knowledge in The Built Environment A Guide for Tertiary Educators*. Victoria; 2018.
- Kellert S. Biophilic urbanism: the potential to transform. *Smart Sustain Built Environ*. 2016;5(1). <https://doi.org/10.1108/SASBE-10-2015-0035>.
- Kellert S, Calabrese E. The Practice of Biophilic Design. 2015. In www.biophilic-design.com. www.biophilic-design.com.
- Kirk E. Cornerstone Christian College Dunsborough. Six Season Garden. Busselton Mail; 2017. <https://www.busseltonmail.com.au/story/5027766/students-plant-six-seasons-garden/>.
- Knapp C. Making Multicultural Places. 2008. <https://www.pps.org/article/multicultural-places>.
- Lachowycz K, Jones AP. Towards A Better Understanding Of The Relationship Between Greenspace And Health: Development Of A Theoretical Framework. *Landsc Urban Plan*. 2013;118:62–9. <https://doi.org/10.1016/j.landurbplan.2012.10.012>.
- Lines WJ. An all consuming passion: origins, modernity, and the Australian life of Georgiana Molloy. Crows Nest: Allen & Unwin; 1994.
- Low SM, Taplin D, Scheld S. Rethinking urban parks: public space & cultural diversity. Austin: The University of Texas Press; 2005.
- Lullfitz AK. Vegetation Responses to Noongar Land Management Practices in Old and Young Landscapes of South Western Australia. Crawley: University of Western Australia Crawley; 2019.
- Marinelli J. Urban Refuge: How Cities Can Help Solve the Biodiversity Crisis. 2021. <https://e360.yale.edu/features/urban-refuge-how-cities-can-help-solve-the-biodiversity-crisis>.
- McDonald RI, Beatley T, Elmquist T. The green soul of the concrete jungle: the urban century, the urban psychological penalty, and the role of nature. *Sustainable Earth*. 2018;1(1):1–13. <https://doi.org/10.1186/s42055-018-0002-5>.
- Meagher SJ. The food resources of the Aborigines of south-western Australia. *Records of the Western Australian Museum*. 1974;3:14–65.
- Nannup N. Moondang-ak Kaaradjiny. Northern Territory: Batchelor Press; 2006.
- Newman P. Biophilic urbanism: a case study on Singapore. *Australian Planner*. 2014;51(1):47–65. <https://doi.org/10.1080/07293682.2013.790832>.
- Newman P, Kenworthy J. Sustainability and cities : overcoming automobile dependence. Island Press; 1999.
- Newman P, et al. Considering the application of biophilic urbanism: A Sustainable Built Environment National Research Centre (SBEnrc) Briefing Report. 2011.
- NRM P. (n.d.). Perth NRM invites comment on The New Normal. Retrieved September 18, 2020, from <https://www.perthnrm.com/blog/2019/11/05/perth-nrm-invites-comment-on-the-new-normal/>.

45. Nuryani NNJ, Satrawan DPR, Gorda AANOS, Martini LKB. Influence of Human Capital, Social Capital, Economic Capital towards Financial Performance & Corporate Social Responsibility. *Int J Soc Sci Humanit.* 2018;2(2):65–76. <https://doi.org/10.29332/ijssh.v2n2.128>.
46. Pascoe B. *Dark Emu: Aboriginal Australia and the birth of agriculture*. Broome; Magabala Books: 2018.
47. PHAIWA. *The West Australian Indigenous Storybook: Celebrating & Sharing Good News Stories, The Perth & Peel Edition*. 2015. internal-pdf://0337610048/PHAIWA 2015 The-WA-Indigenous-Storybook-7th-Edition2.pdf.
48. Putnam RD. Social capital and public affairs. *Bulletin of the American Academy of Arts and Sciences*; 1994. p. 5–19.
49. Robertson F, Nannup N, Barrow J. *Great Journeys undertaken by Aboriginal people in ancient times in Western Australia*. Northern Territory: Batchelor Press; 2019.
50. Robertson F, Nannup N, Stasiuk G, Hopper S. *Nyoongar Boodja: Koomba Bardip Kooratan*. Northern Territory: Batchelor Press; 2017.
51. Sanderson EW, Walston J, Robinson JG. From Bottleneck to Breakthrough: Urbanization and the Future of Biodiversity Conservation. In *BioScience* (Vol. 68, Issue 6). Oxford University Press; 2018. p. 412–6. <https://doi.org/10.1093/biosci/biy039>.
52. Secretariat of the Convention on Biological Diversity. *Global Biodiversity Outlook 5*. In Montreal, Canada. 2020.
53. Seddon G. *Sense of Place. A response to an Environment, the Swan Coastal Plain, Western Australia*. University of Western Australia Press; 1972. <https://philpapers.org/rec/SEDSOP>.
54. Seddon G. *The Old Country: Australian Landscapes, Plants and People*. Cambridge University Press; 2005. https://books.google.com.au/books/about/The_Old_Country.html?id=cvxm3-7iH2oC&source=kp_book_description&redir_esc=y.
55. Seddon G, Ravine D. *A city and its setting : images of Perth*. Western Australia: Fremantle Arts Centre Press; 1986.
56. Shire of York. (n.d.). *Ballardong Noongar Six Seasons Garden Walk*. Retrieved August 27, 2020, from <https://www.york.wa.gov.au/museum/visit/museum-ballardong-noongar-six-seasons-garden-walk.aspx>.
57. The Fifth Estate. *Redfern's new indigenous rooftop teaching communities about place*. 2019. <https://www.thefifthestate.com.au/innovation/building-construction/redferns-new-indigenous-rooftop-teaching-communities-about-place/>.
58. Tucker R, Low Choy D, Heyes S, Revell G, Jones D. Re-casting terra nullius design-blindness: better teaching of Indigenous Knowledge and protocols in Australian architecture education. *Int J Technol Des Educ.* 2018;28:303–22. <https://doi.org/10.1007/s10798-016-9389-5>.
59. Turner A, Wilson K, Wilks JL. Aboriginal Community Engagement in Primary Schooling: Promoting Learning through a Cross-Cultural Lens. *Aust J Teach Educ.* 2017;42(11):42. <https://doi.org/10.14221/ajte.2017v42n11.7>.
60. United Nations. *United Nations General Assembly. Transforming our world: the 2030 Agenda for Sustainable Development (A/RES/70/1)*. Resolution adopted by the General Assembly on 25 September 2015. 2015. <https://doi.org/10.1163/157180910X12665776638740>.
61. WA Parks Foundation. *Muminbulah Wilak – ATCO's six seasons garden*. 2021. <https://www.ourwaparks.org.au/muminbulah-wilak-atcos-six-seasons-garden/>.
62. Watkins B. *York Bushland Garden*. Wildflower Society WA. 2017. <https://www.youtube.com/watch?v=VgOi4Jg8DO4&t=13s>.
63. WEF. *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy* (Issue January). 2020.
64. Wheatbelt NRM. *Establishing the 'Six Seasons' Garden*. 2016. <https://www.wheatbeltnrm.org.au/whats-happening/news/aboriginal-nrm/establishing-six-seasons-garden>.
65. Yazdani N, Lozanovska M. Representation of multiculturalism in urban green spaces: a review of immigrants' experiences in Australia. *UHPH 2014: Landscapes and Ecologies of Urban and Planning History: Proceedings of the 12th Australasian Urban History Planning History Conference*. 2014;851–64. <http://dro.deakin.edu.au/view/DU:30061642>.

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