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The social and ecological values of native gardens along streets

A socio-ecological study in the suburbs of Perth
Clean Air and Urban Landscapes Hub

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About the Clean Air and Urban Landscapes Hub

The Clean Air and Urban Landscapes Hub (CAUL) is a consortium of four universities: the University of Melbourne, RMIT University, the University of Western Australia and the University of Wollongong. The CAUL Hub is funded by the Australian Government's National Environmental Science Program. The task of the CAUL Hub is to undertake research to support environmental quality in our urban areas, especially in the areas of air quality, urban greening, liveability and on applying research to develop practical solutions.

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Acknowledgement of Country

We would like to acknowledge that this paper, and the research it reports conducted as part of the Clean Air and Urban Landscapes Hub, has taken place on Country belonging to the Whadjuk Noongar people of the Noongar Nation in Whadjuk Boodja (country), metropolitan region of Perth.

We respectfully acknowledge the sovereignty of all of Australia's first peoples, their Ancestors, and Elders, past, present and emerging and that their lands and waters of Australia have never been ceded.

Foreword

This publication has arisen from [Project 6](#), one of the seven projects conducted within the Clean Air and Urban Landscapes Hub, which aimed to establish a network of urban greening study sites across Australian urban centres to understand and measure the multiple benefits of urban greening, focussing on outcomes for biodiversity, culture and human health and wellbeing. An important output from this project is to share the methods and approaches that can be adapted by researchers and practitioners for future use at urban greening projects at a range of different sites and scales. The use of a network of study sites has provided opportunities to study the process of how urban greening initiatives are implemented, how to study them from a socio-ecological perspective, and how or why they are successful. This knowledge can inform future urban greening projects and research designed to understand the benefits and outcomes. In doing so it will provide an evidence base and methodology for measuring and understanding social, cultural and biodiversity benefits of urban greening initiatives according to landscape context, and scale.

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Executive Summary

This report documents research on suburban street verge gardens in metropolitan Perth. In this report, we refer to street verges, or nature strips, as those areas of land that lie between the road reserve, and the front boundary of a residential property. Roadside vegetation on street verges can play a key role in providing greenspace and ecosystem services.

There is an emerging trend for residents in Perth to convert the street verge in front of their home to garden spaces, which often feature waterwise and native plants. These spaces represent an interface between the public and private realm. The land is vested in public authorities and is used for the provision of utilities, and public services such as footpaths, lighting, and access to public transport. Street trees are planted and maintained by local governments. However, the responsibility for management of the lower strata of vegetation lies with the adjacent resident.

The overall aim of this research was to gather empirical data on the social and ecological values of street verge gardens in Perth, to better support decision making by local authorities and local residents. This report fills an important knowledge gap, as there is very little quantitative or qualitative data available to identify the ecological and social impacts, benefits and challenges of ‘verge transformations’. The research used an explicit socio-ecological approach, integrating both social and ecological concerns.

The research focussed on 22 street verge gardens that were self-nominated and classified by participating resident as ‘native’ gardens. In practice, several gardens mixed exotic plantings with Australian native plants, while retaining an overall focus on Australian and local endemic plants.

The major objectives of the research were to:

1. Understand, through qualitative data, the motivations and challenges for native verge transformations from the perspective of the residents who have undertaken these transformations, highlighting the potential social impacts of verge gardening activities.
2. Quantify potential ecological values by sampling a selection of transformed verge gardens for plants, birds, and flower-visiting insects.
3. Provide recommendations for decision makers (including local authorities and local residents) to ensure that the social and ecological potential of native verge gardens can be realised, and highlight the particular challenges that are associated with this activity.

We have distilled 18 key findings from our research, which are provided overleaf. The findings are interspersed throughout the text of the report, adjacent to the information from which we have largely drawn the finding.

Our intention was to focus on key findings that may be new or unexpected, rather than draw attention to commonly held conceptions of street verge gardens as a source of conflict between neighbours, or sites of neglect, or improper use. Rather, we discuss the potential ways in which well-designed verge gardens and programs can contribute to social and ecological processes, given that the trend towards verge transformation is likely to continue in Perth, given climate change, water availability, shrinking domestic gardens and interest in sustainability.

Key finding 1: Many verge gardeners are willing to participate in research

Verge gardeners can be reached via LGAs, through newsletters or targeted (e)mailouts. They can also be reached via traditional media and social media. There are a number of dedicated social media pages around verge gardening. A call out to social media pages may result in a very high number of potential respondents; researchers must have clear selection methods and be prepared with a standard response to interested participants.

Key finding 2: Visual appeal is just as important to verge gardeners as reducing water use

Perth verge gardeners may be primarily interested in either saving water or in creating a more visually appealing street frontage. Those who are less interested in water conservation may still choose plants that require regular irrigation, or might overwater plants that are actually waterwise. To achieve both water conservation and aesthetic improvement, practical information and visual examples of how to achieve a beautiful, waterwise garden are required.

Key finding 3: Knowledge of native plants is not essential to start a verge garden – but it helps

Verge gardeners may start out with limited knowledge of native plants – such as which species are local to the area, their ecological characteristics, and where to buy them. Gardeners gain knowledge through experience, trial and error, speaking with others, and information from third-party sources. Photographs of the foliage and flowers of native plants may help guide plant selection. Information on how to garden with native plants (e.g. water, nutrition, and pruning) will be highly valuable.

Key finding 4: Personal beliefs, incentives, life milestones provide impetus for verge gardening

The research developed a typology of motivation for verge gardeners, which can be related to policy decisions. ‘Early Adopters’ are motivated by a combination of a sense of environmental responsibility and interest in ecology and conservation, and rarely access incentive programs, but could act as sources of inspiration. ‘On The Fence’ residents had toyed with the idea, but made the final decision to start because of incentive programmes. Residents in the ‘About Time’ category timed verge transformations with events such as retirement, moving, building and renovating.

Key finding 5: Participating residents hold positive views of local government incentive programs

Residents who had taken part in incentive and rebate programs delivered by local governments were generally appreciative and espoused positive views of “the council”, often to their neighbours. Residents who had not taken part in incentive programs were often more wary or circumspect in their views as to “the council’s” approach and attitude towards verge transformations, sometimes being concerned about potential punishment or lack of acceptance of residents’ plans or ideas.

Key finding 6: Existing verge gardens are the main source of inspiration for verge gardeners

People with an interest in verge gardens may decide to act on their ideas through the process of seeing other verge gardens. In suburbs where verge gardens are uncommon, examples in other forms such as landscaping around commercial and government buildings, nursery displays, books, photographs, websites and social media pages can provide inspiration.

Key finding 7: Verge gardeners need information on street trees

Some residents who undertake verge transformations subsequently plant unsanctioned street trees of their own species preference. Waterwise verge information should include clear detail on street tree policy, including the requirement to contact the local authority if additional street trees are desired. The safety and utility reasons should be clearly highlighted, as well as the potential cost to the resident. Information should be provided on webpages and with incentive or rebate packages.

Key finding 8: Many verge gardens receive regular watering

Two-thirds of the verge gardens in our study received regular water through summer. The volume of water used on verge gardens was not quantified in this research, nor was it compared to the volume of water used on lawn or other substrates. Advice on watering schedules for native plants would be valuable for many residents, as well as information on the adaptations that allow locally endemic species to survive long dry periods, and the effect of particular gardening practices on retaining soil moisture. Future research should monitor the water balance of different types of verge treatments.

Key finding 9: Residents find personal satisfaction and connection to nature by verge gardening

Households gain a variety of benefits from verge gardening, including personal satisfaction, shade and cooling, privacy from the street (if desired), connection to nature, and social interaction. The benefits vary widely by household, depending on individual preferences. A neighbourhood streetscape and network approach can help verge gardens act as connectors between neighbours, as well as appropriately develop habitat for small animals and invertebrates.

Key finding 10: Confident verge gardeners make great champions of community change

Verge gardeners who feel confident in their knowledge of policy, support by council, and garden success (and overcoming failures) spend time in their garden connecting with others and championing the verge transformation process. Champions will amplify accessible policy communication materials and designated LGA champions (who are active in and known to the community) as they will help socialise the value of verge transformation, and reinforce gardener confidence that they are sharing accurate and timely information to novice and established gardeners.

Key finding 11: Verge gardeners want to encourage bees, but are largely unaware of native bees

Verge gardeners often wish to provide habitat for bees and nectar-feeding birds, motivated by a desire to contribute to the local ecosystem. However, the large majority of residents were unaware of the diversity of native bees, nor that European honeybees (*Apis mellifera*) are not native to Australia. Verge gardening information should include information on habitat requirements, preferred species and the biology and ecology of common native bee species.

Key finding 12: Childhood experiences influence gardening practices

Many verge gardeners reported positive childhood experiences with gardening and nature, which had influenced their views and practices as adults. Having access to gardens and nature in early life may play an important role in fostering ongoing interest in the environment and gardening. We need to understand the long-term consequences of a lack of access to gardening and nature in childhood.

Key finding 13: Tailored, practical information on waterwise verge gardens is essential

Workshops, local government websites, booklets and 'how-to' videos are valuable sources of information for verge gardeners. Street verges present challenges that set them apart from other domestic garden zones, including poor soil, depleted nutrients, persistent weeds, higher temperatures and sometimes full shade. Many verge gardeners are novices with native plants, and require specific information on soil preparation, local endemic species and where to buy them, and watering needs.

Key finding 14: Residents on corner blocks may be particularly interested in verge gardening

Our sample size is small, however, it seems possible that residents with large verges that are on corner blocks may be more interested in verge gardening than residents with smaller verges. Possible reasons include: wanting to reduce time spent maintaining a larger verge; getting better 'value-for-money' from incentive schemes due to the larger area; and preferential purchase of houses with greater potential gardening area. More research and information is needed to confirm this trend. Larger verge gardens may provide greater habitat area for wildlife and hold potential for forming habitat corridors.

Key finding 15: On average, suburban verge gardens contain between 15 and 40 plant species

It seems most native verge gardeners like to plant a range of species for visual appeal and sometimes, to mimic natural habitats, rather than focussing on a small number of species planted in repetitive arrangements. Having a diverse range of plants available may appeal to participants in verge gardening programs.

Key finding 16: Verge gardeners plant predominantly local Swan Coastal Plain, and WA species

Few of the verge gardeners in our study were familiar with the flora of the Swan Coastal Plain. However, the most popular plants and horticultural varieties originated in the Perth region, with the next most popular category being plants from elsewhere in WA. The most commonly encountered species closely reflected those that were provided by LGAs. Verge gardens can be an opportunity to expand and normalise the use of locally endemic species in gardening and landscaping throughout Perth. With the impact of climate change, hardy species that have evolved to survive on coastal sand dunes and other difficult environments may provide clear advantages for horticultural use.

Key finding 17: Verge gardeners need information on weeds and invasive plant species

Some species that were planted in verge gardens have the potential to spread beyond the verge garden and into bushland, where they could become established as environmental weeds. Verge gardeners may not know that some garden plants can also act as weeds. Grassy weeds such as *Ehrharta* spp. and *Eragrostis* spp. may also grow larger in verge gardens and set seed, if undetected amongst other plants. Common garden plants that should be avoided on street verges should be described and added to information provided to prospective verge gardeners.

Key finding 18: Verge gardens can help support native bee populations

Native bee species were encountered in verge gardens and street trees. Verge garden information packs and websites should include recommended, hardy native plant species to provide food for native bees over the warmer months of the year (September to April), as well as advice on 'bee hotels' and the importance of leaving some areas of the garden unmulched for ground-nesting bees. Preservation of extant bushland is vital to act as a source population for native bees visiting verges.

1 Introduction

The vegetation alongside city streets and road corridors plays a key role in providing habitat for wildlife and green space benefits for urban dwellers. Roadside vegetation occurs within the ‘road easement’, ‘nature strip’, or ‘street verge’¹, that can be defined as the area of land between the roadway and the front property boundary. These strips of land serve a largely utilitarian purpose, as apportioned space for services such as electricity, gas, water and telecommunications, and facilities such as footpaths and bus stops. Beyond this, nature strips can play a key role in providing a wide range of social, economic and ecological services (Davison and Kirkpatrick 2014, Brown et al. 2013). They contribute to human wellbeing by enabling opportunities for passive recreation, food production, connection with nature, and social interaction. They provide benefits such as shading and microclimatic amelioration, water infiltration and run-off management, and provision of habitat for wildlife.

With increasing urban housing density and greater attention given to urban forests and canopy cover, the way that nature strips are managed and used in Australian cities is a rapidly evolving area of policy change and community interest. To date, much of the existing research on vegetation along road corridors has focussed on the role of street trees in the urban forest. However, the lower vegetation strata should also be conceived as part of the urban forest. Further, while street trees are managed by local authorities, the ground cover and lower vegetation strata are generally maintained by residents, making an interesting case study of the intersection of public and private interests in urban greening.

In the city of Perth, Australia, many local government authorities now permit residents to convert the publicly owned land along the street in front of their dwelling from ‘traditional’ verge treatments² such as grass (Figure 1) to low growing, native gardens, providing certain conditions are met. ‘Verge gardens’ are perceived to require less water and better reflect a local sense of place by using plants endemic to the biodiversity hotspot in which Perth is situated. While interest in native verge gardens is growing rapidly within the community (and also receives regular attention in the media), there is relatively little information on the social and ecological roles of native verge gardening in metropolitan Perth. Comprehensive new research has recently been published on nature strips in Melbourne (Marshall, Grose and Williams 2020, Marshall, Grose and Williams 2019a, Marshall, Grose and Williams 2019b), however there has been limited research in Perth so far (Uren, Dzidic and Bishop 2015, Bolleter 2016). Existing Perth-based research has focussed either on the social, planning or environmental roles of street verges, rather than taking a combined, socio-ecological approach.

In this research project, we set out to understand the socio-ecological benefits and challenges of planting native gardens on nature strips in Perth suburbs. Nature strip gardening is a form of citizen-led urban greening, involving residents planting and caring for understorey vegetation (and even trees) along the road verge (Marshall et al. 2019a). Perth presents a particularly interesting case study for the research, due to its location in a biodiversity hotspot, and public policy initiatives to lower water consumption as a consequence of long-term declines in precipitation observed since the 1970s, which have placed pressure on water supply. Residential gardens consume a large proportion of domestic water supply.

¹ The phrases ‘street verge’ and ‘verge gardens’ are more commonly used in Perth than the term ‘nature strip’, which is more prevalent in other parts of Australia and understood globally. ‘Road easements’ and ‘easement gardens’ are equivalent terms, most commonly encountered in the US. Much of this report, and the quotes from residents included within, will use the terms ‘street verge’ and ‘verge gardens’ rather than ‘nature strip’.

² In Perth, residential street verges on the Swan Coastal Plain are typically covered with lawn, or a mix of grasses and weeds. Some verges may have no grass and be covered with mulch, while in the Perth hills, a common substrate is lateritic gravel. Although most LGAs do not permit residents to pave or convert to ‘hardstand’ more than one-third of the total area of the verge (except where the dwelling is adjacent to an arterial road) there are also many verges that have been paved or have synthetic turf.



Figure 1: A selection of grassed verges in suburban Perth

These verges in the suburb of Churchlands cover the spectrum of 'typical' nature strip treatments on the Swan Coastal Plain in Perth, from manicured front lawns (L) to patchy grass (C), to swathes of weeds and grasses (R).

1.1 Governance, planning context, and significance of street verges

Across Australia, managing street verges is typically a land use development function of local government authorities (LGAs). Although nature strips are typically considered 'Crown' land that is vested with LGAs, their management requires compliance and cooperation from land-owners or residents with verges abutting their property. In Perth, while LGAs generally assume responsibility for the planting and maintenance of street trees, maintenance of ground-covers and low-growing vegetation are generally the responsibility of the householder of the property adjacent to the verge. Therefore, nature strips can be seen as 'liminal' or boundary spaces that intersect public and private space, and 'informal urban green space' (Rupprecht and Byrne 2014a). Combined, the area classified as street verge or road reserve can be significant. While there is no estimate available for metropolitan Perth, a recent study indicated that street verges comprise 7% of total land area, and 36% of public green space in Melbourne (Marshall et al. 2019b).

Specific statutory oversight and planning of verges is variable. In WA, under the *Local Government Act 1995* (WA), LGAs establish and update local laws for public lands within their jurisdiction. In these gazetted laws, street verges are often classified under 'Works in Thoroughfares', which includes defining verges, permissible verge treatments, obligations of owners and occupiers; enforcement; powers for carrying out public works; vehicle crossings; and protection of the footpath, verges and street trees. Using the Town of Cambridge as an example, there is a cascade from local law to guidelines and policies on street verges: the [Local Government and Public Property Local Law 2017 \(WA\)](#); [Street Verge Landscape and Maintenance Guidelines](#); and policies including [Policy 107 Verge Landscaping Maintenance and Cleaning](#). Within Perth, each LGA maintains their own policies on permitted uses of street verges.

Contemporary norms and strategies of governance reflect tension between prescriptive regulation via representative democratic systems, and the rise of collaborative participation in devolved decision making. Concurrently, three significant trends in Australian suburban development are relevant to nature strip management: (1) The increasing devolution of responsibilities to LGAs, which tests their responsiveness and responsibility for urban development arising from planning system reform and development pressures; (2) The rise in household level awareness and responses to socio-ecological

need and/or (inter)personal beliefs and practices for sustainable development; and (3) The uneven legacies and impacts of changing urban form via infill, gentrification, and greenfield development. The humble nature strip exists at the intersection of these three trends, and is garnering greater visibility due to concerns over declining urban forest canopy cover (and the pressure placed on street trees to fulfil canopy targets) (Saunders et al. 2020), and increased pressure to more densely populate the suburbs, resulting in the loss of width³ and depth⁴ of vegetated street verges.

1.2 The movement towards street verge gardening

Trees and vegetation on nature strips are increasingly important to maintain the 'urban forest' as vegetation on private land disappears (Bolleter 2016, Hall 2010, Pandit, Polyakov and Sadler 2014, Pandit et al. 2013). In cities around the world, interest in urban greening and gardening activities on unused pockets of land is growing (Säumel, Weber and Kowarik 2016, O'Sullivan et al. 2017, Rupprecht and Byrne 2014b). This is a result of the growing recognition of the human health benefits arising from interacting with nature (Ward Thompson et al. 2012, Fuller et al. 2007, Kahn and Kellert 2002, Ulrich 1981), and growing urban density that is reducing the opportunity for private gardening space (e.g. Hall 2010). In addition, access to green space is not distributed evenly among city residents (Wolch, Byrne and Newell 2014). For these reasons, access and engagement with green space is increasingly becoming an environmental justice issue (Ernstson 2013, Wolch et al. 2014).

Residential street verge gardening has the potential to produce significant social, community and environmental outcomes while incorporating a wide spectrum of personal gardening preferences: from those interested in edible and ornamental plants through to gardening using largely native or wholly endemic, native species (Figure 2). Edible gardens are often interspersed with flowering favourites for pest management as well as aesthetic enjoyment. Gardeners with interests in growing affordable, fresh produce, particularly where access to fresh food is limited or expensive have focused on gardening of edible species on public verge spaces, and have often had to act outside existing local administration's verge policies. Such gardeners have come to public prominence attracting labels like 'guerrilla' or 'gangsta gardeners' (Young 2018, Weston 2020), and have successfully pushed to change local administrative policy. Not all initiatives have changed local policy: the highly publicised 'Urban Food Street' in Buderim, Queensland has had mixed results, with a number of fruit trees planted along a street removed by the local council for insurance and liability reasons, despite resident objections (Gaffney, Atkinson and Bartholomew 2017).

The interest in ecosystem 'rewilding', where native species previously lost from particular areas are encouraged to return through deliberate management strategies, has recently become more prominent in urban areas (Perino et al. 2019, Sweeney et al. 2019). For example in the UK, deliberate roadside ecological management strategies such as less frequent, seasonally timed cutting, has encouraged a return to rich, biodiverse native 'meadow' vegetation (Greenfield 2020). Gardeners with interests in encouraging urban biodiversity likely prioritise gardening with native species on their verges as one means of engaging with biodiversity sensitive design (Garrard et al. 2017). The species selection may range along a spectrum of native species; ranging from those naturally occurring across the country (e.g. a mix of east or west coast species), to only planting local endemic species.

³ The width of vegetated street verges can be compromised by increased density and size of 'cross-overs' for driveways associated with sub-division and the construction of larger houses with provision for multiple car spaces.

⁴ The depth of vegetated street verges is often narrower in newer subdivisions and infill developments, and may be further compromised with off-street 'cut-out' carparks. In some cases, there is no room for a street tree within narrow verges.



Figure 2: Examples of street verge gardens in suburban Perth

*There is a growing trend for households in Perth to install native and waterwise gardens on nature strips. Kangaroo paws (*Anigozanthos spp.*) are a popular choice (top L), and some gardeners mix native species with exotic species (top R). In the example at the bottom, the gardener has installed a raised bed for growing herbs and vegetables.*

In Australia, some councils, up until recent years, enforced verge policies to restrict unapproved verge gardening. Growing community interest has meant that some local governments are adapting their policies to permit local verge gardening. The City of Bayswater, in Western Australia, led the way in LGA policy reform, becoming the first LGA in Australia to completely remove restrictions on residential verge gardening, provided that safety and water management requirements were met (Young 2017, Ligtermoet et al. 2021). Community verge gardening groups have been springing up and mobilising through social media (e.g. the Facebook Verge Gardening Australia community group). National and state-based gardening television programs have also recently featured ‘verge gardening’ segments, highlighting a range of gardening options suitable for the verge, as well as the environmental and social benefits of gardeners extending their green thumbs into this space.

In Perth today, the usual view of street verges as an under-utilised space occupied by grasses, weeds, sand or gravel (Figure 1) Figure 1 is being challenged by more novel approaches that include greater plant structural and species diversity. In addition to the 2020 movement to establish urban ‘forests’ of street trees (Bun et al. 2015), an increasing number of Perth metropolitan LGAs are encouraging residents to plant low-growing, waterwise gardens on the nature strip in front of their property, with a number of popular subsidy, rebate, and incentive programmes in place. The Water Corporation WA’s water partnerships program has played a significant role in encouraging this trend by combining community education and support for council verge conversion incentives (Ligtermoet et al. 2021). Gardening with native plant species has also become somewhat easier as the range of species available through local nurseries has grown, with some even marketing a ‘verge suitable’ range of plants. Environmental consultants are increasingly incorporating water sensitive design elements in new greenfield developments, such as swales and other features, to manage stormwater run-off in-

situ which encourages novel biophysical design on the verge (Ligtermoet et al. 2021). While verge gardens are still very much the exception rather than the norm, it is very likely that they will become more abundant in Perth (and in other Australian cities) over the coming decades. Indeed, some new urban greenfield and infill developments explicitly include landscaped nature strips (such as seen in Figure 3 and Figure 4), even forming part of marketing campaigns.



Figure 3: Streetscape landscaping within Fraser’s Landing development in Mandurah

This greenfield development includes verges landscaped with native and waterwise plants, as well as private pedestrian strip parks that can only be accessed by residents. The verge at right includes features to manage stormwater in-situ.



Figure 4: Perry Lakes infill development in Floreat

Street verges in this infill development in the western suburbs of Perth are landscaped with low-growing plants (a mixture of native and on-native species), particularly areas in front of multi-dwelling buildings such as those shown here. This area was once a sports stadium (image shows retained heritage-listed part of the stadium).

1.3 The social drivers and outcomes of verge gardening

In an era where it is increasingly easy for city residents to feel disconnected from nature, gardening along nature-strips can provide a means of redressing the loss of experiences in nature, as well as opportunities for nature education, whether growing vegetable gardens, flower beds or native species. The decision to create a native garden on a street verge is influenced by a range of social drivers, and has analogies with practices such as ‘gardening for wildlife’ (common in the UK and Europe) and ‘guerilla gardening’ (where community member install and maintain plants in informal urban greenspace in urban centres worldwide). European studies show that the decision to garden for wildlife is influenced by a sense of moral responsibility to the environment, with this type of behaviour often linked with childhood activities and/or present-day involvement with children. The behaviour may promote a personal sense of well-being (Goddard, Dougill and Benton 2013, Weber, Kowarik and Säumel 2014). The type of species planted in gardens is often strongly linked with personal values, with gardeners holding conservationist views more likely to plant native species (Zagorski, Kirkpatrick and Stratford 2004).

The act of gardening on the nature-strip, at the private/public interface becomes a means of connecting with other residents on the street and the wider neighbourhood. While an uncommon practice, verge gardening may become ‘contagious’ and more socially acceptable over time as examples appear in a neighbourhood (Marshall et al. 2020, Marshall et al. 2019a). A survey of easement gardens in Ann Arbor Michigan showed clear spatial patterns in easement gardening, where it was 2.4 times more likely for a property to have an ‘easement garden’ if there is another within 30 metres (Hunter and Brown 2012). Recent reporting in Australia has highlighted the potential for neighbours to get to know one another by the simple act of being present and gardening on the front verge (Dillon 2020).

Much of the existing work on nature strip gardening has come from northern European climates, where meadows and grasslands are found in nature, and where turfgrass may be easy to maintain with year-round rainfall, lower summer temperatures and heavier-textured soils that retain moisture. In metropolitan Perth, lawn remains a very popular groundcover, but requires considerable maintenance in terms of watering, fertilising, weeding and mowing in order to maintain the appearance of a ‘green carpet’ that might come more easily to lawns in the British Isles (for example). This element of maintenance introduces a third set of more prosaic ‘logistical’ drivers for converting nature strips from lawn into native gardens. For example, a study on verge gardens in the Perth local government areas of Melville and Fremantle highlighted that gardeners simply found it easier to grow native plants on poor sandy soils than it was to grow lawn (Uren et al. 2015). The Water Corporation in Perth has promoted the creation of ‘waterwise verges’ for residents to reduce water use, by choosing low-growing native plants over turf⁵. At present, there is limited information on whether ‘waterwise’ verges actually reduce water use, nutrient use, or residents’ time in maintenance.

1.4 Environmental values and ecosystem services of nature strips

The Millennium Ecosystem Assessment described the ‘ecosystem services’ framework to demonstrate the societal benefits and values provided by ecosystems, which provide a range of services that underpin human health and well-being (MA 2005). **Provisioning services** include the products obtained from ecosystems such as food, fibre, fuel. **Regulating services** are the benefits obtained from regulation of ecosystem processes such as a stable climate and clean water. **Supporting services** include ecosystem processes such as nutrient cycling, primary productivity and soil formation. **Cultural services** are the nonmaterial benefits obtained from ecosystems such as recreation, aesthetics,

⁵ See: <https://www.watercorporation.com.au/Waterwise/Waterwise-advice/Garden/Creating-a-waterwise-verge>

spiritual values and cultural heritage (MA 2005). All ecosystem services are underpinned by biodiversity. Recent work has applied the ecosystem services framework to examine the values and services provided by urban green spaces (e.g. Bolund and Hunhammar 1999, Elmqvist et al. 2013, Luederitz et al. 2015).

The contribution of roadside vegetation, including nature strips, to the provision of urban ecosystem services can be significant (O'Sullivan et al. 2017, Säumel et al. 2016, Rupprecht and Byrne 2014b, Rupprecht and Byrne 2014a, Jansson 2013), particularly in vulnerable neighbourhoods with limited green space. In terms of ecosystem services, nature strips can play a key role in regulating local environmental characteristics such as air quality (filtration, shielding), noise reduction, temperature regulation, and water cycling through stormwater management allowing infiltration and reducing run-off (Säumel et al. 2016, O'Sullivan et al. 2017). Provisioning services include local food production, maintenance of genetic resources (e.g. heritage trees), and groundwater recharge. Biodiversity benefits can include habitat provision and the function of an ecological corridor to aid movement and dispersal, although poorly designed or managed road reserve vegetation can also act as a dispersal corridor for invasive species and pests (Säumel et al. 2016). The potential for ecosystem 'disservices' have also been noted, where some trees have found to produce biogenic volatile organic compounds or create allergen problems from wind-borne seed or pollen dispersal. Such 'disservices' can be managed through appropriate species selection.

Cultural services provided by roadside vegetation remains understudied, however, benefits include perceived improvements in quality of life (Sheets and Manzer 1991, Weber, Schnier and Jacobsen 2008), and fostering less car-dependent, healthier lifestyles by making urban streets more welcoming (e.g. shaded, visually appealing) for walking or cycling (Cervero and Duncan 2003, de Vries et al. 2013). Roadside trees and understorey vegetation can contribute to a city's cultural heritage, where iconic trees are celebrated for their age, physical features or cultural significance (Säumel et al. 2016), or specific designs enhance local attachment through shaping cultural identity and sense of place. Green streetscapes have been shown to enhance property values (Pandit et al. 2013).

Some of the key gaps in knowledge about the ecosystem services provided by roadside vegetation include the role of understorey species and the potential significance of small patches of native vegetation as habitat for species in fragmented urban environments, as much existing research has focussed on trees. Further, there is a need for research on the socio-ecological aspects of informal green space (including nature-strips), as well as the advantages of applying ethnographic approaches (e.g. collaborative map making, participant observation) and mixed methods research (Rupprecht and Byrne 2014b). Finally, much of the existing research on the environmental values and ecosystem services provided by nature strips has taken place in northern Europe, where conditions are quite different to the Mediterranean climate and poor soils of south-western Australia.

1.5 Objectives of this research

Nature strips can play a key role in providing greenspace and ecosystem services through shading and reducing heat, allowing for water infiltration and reducing run-off (for example, through rain gardens), giving habitat for wildlife, providing an amenity for residents including social contact and connection with nature. There is a rapidly expanding body of work on the uses, values, distribution, management, and typology of street verges (Marshall et al. 2020, Marshall et al. 2019a, Uren et al. 2015, Meenach-Sunderam and Thompson 2007, O'Sullivan et al. 2017, Hunter and Brown 2012), and explicit discussion of street verges within urban planning and greening strategies. However, there has still been limited integrated research on the social and ecological values of native gardening on street verges.

The overall aim of this research was to gather empirical data on the social and ecological values of street verge gardens in Perth, to better support decision making by local authorities *and* local residents. This report fills an important knowledge gap, as there is very little quantitative or qualitative data available to identify the ecological and social impacts, benefits and challenges of ‘verge transformations’. The research used an explicit socio-ecological approach, integrating both social and ecological concerns (see Pauli et al. 2020). The research focussed on street verge gardens that were nominated and classified (by the resident) as ‘native’ gardens. In practice, several gardens mixed exotic plantings with Australian native plants, while retaining an overall focus on Australian and local endemic plants.

The major objectives of the research were to:

1. Understand, through qualitative data, the motivations and challenges for native verge transformations from the perspective of the residents who have undertaken these transformations, highlighting the potential social impacts of verge gardening activities.
2. Quantify potential ecological values by sampling a selection of transformed verge gardens for plants, birds, and insect pollinators.
3. Provide recommendations for decision makers (including local authorities and local residents) to ensure that the social and ecological potential of native verge gardens can be realised, and highlight the particular challenges that are associated with this activity.

The results drawn from Objectives 1 and 2 are presented in separate sections in this report (i.e., the two results chapters). Recommendations that form part of Objective 3 are interspersed throughout the text as highlighted ‘Key Findings’ and are expanded in the final chapter.



Native everlasting daisies (Rhodanthe sp.) form a blanket of spring colour on a street verge in Shenton Park, Perth

2 Methods

2.1 A socio-ecological approach

This research followed an integrated, socio-ecological approach, as described in detail by Pauli et al. (2020). This approach is particularly relevant to urban greening initiatives that focus on increasing biodiversity through habitat improvement or habitat creation, while at the same time supporting improved human use and access. These kinds of urban greening projects seek to maximise the amount of greenspace and habitat in cities by occurring in either ‘leftover’ or ‘informal’ areas such as urban drainage corridors (Farahani and Maller 2019), or in more formal urbanised spaces such as nature strips that are not typically considered as greenspace (Rupprecht et al. 2015). Such projects can achieve multiple socio-ecological outcomes, over and above the ‘traditional’ focus on single outcomes (such as recreation in urban parks at the expense of biodiversity, or bushland conservation at the expense of human access).

Projects that aim to achieve both social and ecological benefits from urban greening are distinct from those that emphasise one over the other, and require an approach that gives equal consideration to social and ecological values. A core part of socio-ecological urban greening is to understand the complex relationships between the social and ecological dimensions and how these relationships can enhance or hinder outcomes. Developing this understanding requires interdisciplinary research. The field of integrated research that includes consideration of both social and ecological elements is still relatively small (Pauli et al. 2020). The research presented in this report adds to this work, through using a mix of qualitative and quantitative research techniques to elicit information human research subjects, and measure certain dimensions and dynamics of the ecological setting. The research presented in this report forms part of a broader portfolio of socio-ecological research projects that have been undertaken as part of the Clean Air and Urban Landscape Hub, and are informed by an interdisciplinary approach to the multiple values and meanings of ‘bringing nature back’ into cities (Mata et al. 2020). Many of these examples are illustrated detailed on the [CAUL Network of Integrated Sites website](#).

2.2 Study area

2.2.1 Biophysical and cultural setting

Climatically, Perth enjoys a Mediterranean-type temperate climate with hot, dry summer periods (Köppen classification Csb (Kottek et al. 2006)). Most rain falls between May and October, and July and August are the coolest and wettest months. Annual rainfall has declined since the mid-1970s, with a continued drying trend projected under future climate change scenarios (Bates et al. 2008, Hope, Drosdowsky and Nicholls 2006).

Most of the Perth metropolitan area lies on the Swan Coastal Plain, a region that with distinct physiographic and biogeographic characteristics. The coastal plain is of low elevation and gently undulating. The sediments of the coastal plain were laid down through marine, alluvial and aeolian processes; the sediments are oldest in the east, and youngest in the west (Commander 2003). Three major ancient dune systems run roughly parallel to the coast. The Quindalup dunes are the youngest, and are closest to the present-day coastline. The Spearwood dune system is intermediate in age, with the older Bassendean dunes lying furthest to the east. The dune-derived sands are generally nutrient-poor with low clay content and consequently low moisture-holding capacity. The verge gardens sampled in this research were all located on one of the three dune systems described above.

Wetlands and rivers are integral to Perth's setting. The Swan River-*Derbal Yerrigan* is the largest river in the Perth region. The river holds great spiritual and cultural significance to the Noongar people as the link between the land and sea, and as the location of a sacred sites recognising the activity of the *Waugul*, a giant serpent who created waterways and valleys along the length of the river (Graham-Taylor, 2009) (Graham-Taylor 2009). Prior to European colonisation, the Swan Coastal Plain contained an enormous diversity of basin and plain wetlands (Davis and Froend, 1999). Chains of lakes occur along the interdunal depression between the Quindalup and Spearwood dunes, and between the Spearwood and Bassendean dunes. Many of these wetlands are surface expressions of the unconfined superficial aquifers. These aquifers are also drawn on for supplying Perth's drinking water.

The Perth Metropolitan Area is located in the South West Australian Floristic Region, a global biodiversity hotspot with exceptionally high plant species diversity and endemism that is also under significant threat (Hopper and Gioia 2004, Myers et al. 2000). Within this biogeographic region, the Perth Metropolitan Area is one of the richest (Gioia and Hopper 2017), with over 2,000 species of vascular plants recorded (Environmental Protection Authority 2015).

Banksia woodlands are the predominant plant community type across the metropolitan area and within the studied suburbs. *Banksia* woodlands of the Swan Coastal Plain have recently been recognised as Threatened Ecological Communities under the EPBC Act, given the extent of clearing for urban and agricultural development (Threatened Species Scientific Committee 2016). These woodlands have an open canopy dominated by *Banksia attenuata* and *B. menziesii*, and other less-abundant tree species, including *Eucalyptus marginata* (jarrah) and *Allocasuarina fraseriana* (sheoak). The species-rich understory is dominated by sclerophyllous shrubs and perennial herbaceous plants. *Banksia* woodlands are also the habitat of a diverse range of birds, insects, reptiles, and even amphibians (Threatened Species Scientific Committee 2016).

Urbanization has been the main driver of *Banksia* woodland fragmentation in recent decades. These woodlands persist in a few large conservation and Crown Land areas on the current metropolitan boundaries, and in urban reserves (most of which are small and isolated), linear strips on roadside verges, and rural private properties (Ramalho et al. 2014). Remarkably, Kings Park and Bold Park are two large *Banksia* woodland remnants located in the inner suburbs of Perth, with Kings Park being adjacent to the City of Subiaco. The extensive and rapid fragmentation of these woodlands has had large impacts on its plant communities and wildlife, through habitat loss, introduction of non-native species and plant diseases, introduction of predators, and alteration of the disturbance regimes (Ramalho et al. 2018, Ramalho et al. 2014, Stenhouse 2005)

Over 500 species of vertebrate animals are found in southwest Western Australia (more than 330 species have been recorded in the Perth metropolitan area), with a high degree of endemism recorded for reptiles and frogs in particular (Mittermeier et al. 2005, Valentine 2009, Environmental Protection Authority 2015). Invertebrate biodiversity is also high, particularly in eucalypt woodland and forest vegetation, however it is largely undocumented (Majer et al. 2001), as is common for invertebrates worldwide (Clark and May 2002). Around 200 species of native bees have been recorded from the Perth metropolitan region.

Perth's bushlands, wetlands, and coastlines embody important cultural and social values. The natural spaces that remain in Perth hold great cultural, social and economic importance for Noongar people (McDonald, Coldrick and Christensen 2008, Collard and Bracknell 2012) and for non-Indigenous residents of the Perth metropolitan area. Perth has a distinct 'Sense of Place' (Seddon 1972), which has influenced urban planning and landscaping, as well as decisions around which species are planted in public streets and parks, and in private gardens.

2.2.2 Suburban Perth study areas

The study area within Perth was primarily guided by the ability to reach verge gardeners, as there was some concern amongst the research team and advisors as to how best to recruit participants. The research team decided to request participation from four LGAs throughout Perth that had been running existing incentive programmes for several years at the time of the commencement of the study (2018), as this would enable contact with a range of verge gardeners with differing experiences. Three of the LGAs (Town of Vincent, City of Subiaco, City of Stirling) passed on our request for participation (see Section 2.3.1) to previous participants in verge gardening programmes. Responses were received primarily from residents in Subiaco and Stirling (Figure 5).

The City of Subiaco is a small, inner-city LGA with a long history of supporting verge gardening, which has lately included covering the complete cost of transforming verges for a small number (~25) of households per year. Over the ten years to 2018, the City has provided direct support to transform 250-300 residential verges, and subsidised the provision of over 100,000 native plants to residents⁶. The City of Stirling is a large, diverse LGA in the middle-ring of suburban Perth, which has offered a variety of initiatives since 2015 to residents interested in verge gardening, primarily focussed on the provision of free plants for a larger number of households. In 2018, the City ran a dual program, offering residents a rebate for removing irrigated grass from street verges, or the free provision of 20 native plants that could be planted on front verges, with around 400 households receiving support that year. The plants that have been selected for offer by the City of Stirling have varied from year to year; iterations have included hardy plants, plants for wildlife, and 'colour-themed' plant packs⁷.

Some key facts on the City of Stirling and City of Subiaco are outlined in Figure 6 and Table 1. The City of Stirling comprises ~220,000 residents with a density of around 21 people per hectare, while the City of Subiaco houses approximately 17,000 residents at a higher density of 31 people per hectare.

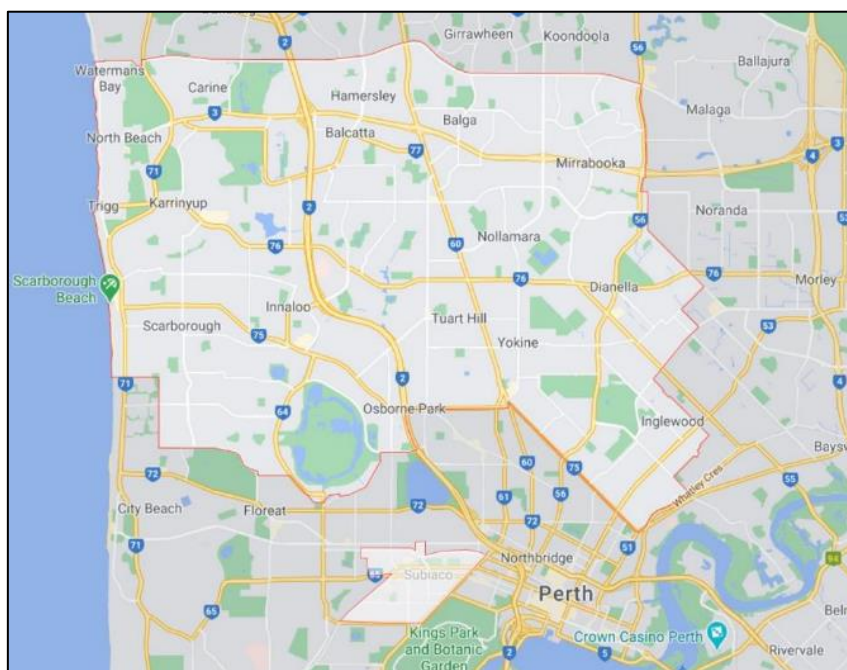


Figure 5: The location of the City of Stirling (north) and City of Subiaco (south) within Perth
Sourced from Google Maps. The boundaries of the Local Government Areas are lighter than surrounding areas.

⁶ Giles Pickard, former Environmental Project Officer / Landscape Architect, City of Subiaco, personal communication, March 2018.

⁷ Joanne Burgess, Urban Forest Senior Project Officer, City of Stirling, personal communication, April 2018.

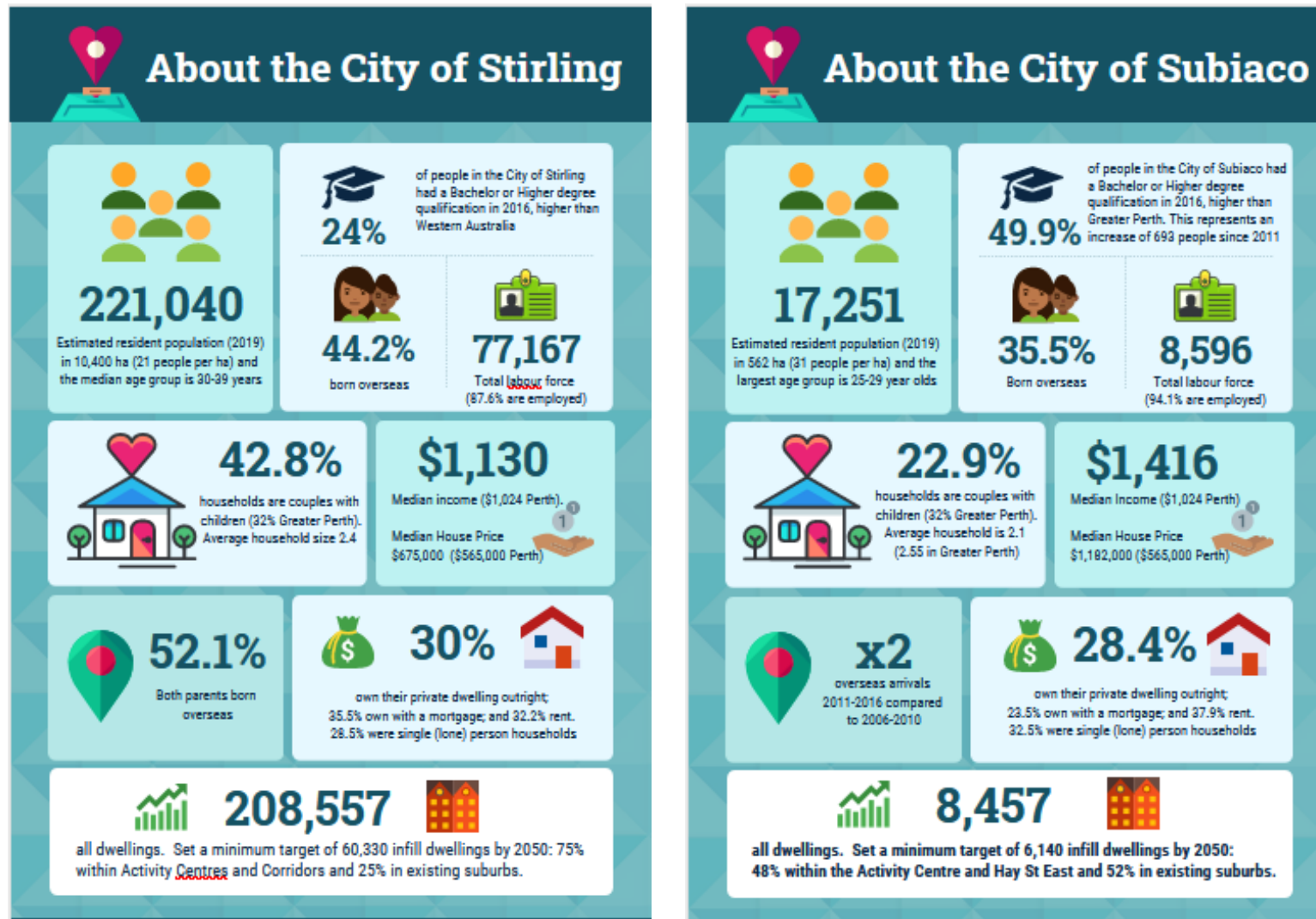


Figure 6: Comparative demographic information for City of Stirling (L) and City of Subiaco (R)

Information is from 2016 unless otherwise noted. Sources: (Compelling Economics 2020a, Compelling Economics 2020b, NationMaster 2020a, NationMaster 2020b, profile.id 2020, City of Subiaco 2020c)

The City of Stirling is dominated by separate dwellings, comprising 62% of all houses, with 36% of dwellings classified as ‘medium density’. Meanwhile, the City of Subiaco’s housing stock comprises around 42% separate houses, with 32% of dwellings classified as medium density, and 26% as high density. *The City of Stirling* has an ageing population, with population projections indicating a decline in household size due to the increase in single person households. Increased density will be needed to meet targets and this will mean changing the housing choice especially for culturally-diverse and down-sizing populations. Notably, the City of Stirling already recognises that residential development has caused significant canopy loss. In contrast, the City of Subiaco was settled early in Perth’s development; it is close to the CBD and recent increases in medium and higher density developments have occurred around the transport hub and corridors.

In both cities, the challenge of protecting green space from the new and expansive forms of urban development is a contested topic. Density rezoning in many suburbs of the City of Stirling has seen the loss of trees on private land as multiple dwellings are constructed on what was originally a single housing plot. The City of Subiaco has no natural remnant bushland, but lies close to the large remnants of Kings Park, Shenton Bushland and Underwood Avenue bushland and areas of restored native vegetation in recreational parks such as Herdsman Lake and Lake Monger. The City of Stirling includes a number of significant large bushland areas, including Star Swamp, Trigg Bushland Reserve, Mirrabooka Regional Open Space, and Dianella Regional Open Space.

Table 1: Comparison of green spaces, amenities and characteristics: Cities of Stirling and Subiaco

Sources: *City of Subiaco (2018, 2015, 2016, 2020a, 2020b)*, *City of Stirling (2020a, City of Stirling 2020b)* and *WALGA (2015)*

	CITY OF SUBIACO	CITY OF STIRLING
GREEN SPACES	71.5 ha of parks and reserves 30 parks categorised as district, neighbourhood or local parks 66 ha of irrigated garden beds and turf and 12.7 ha of green corridors	627 ha of parks, gardens and developed reserves
TREES	Approximately 15 000 street, park, and reserve trees 3 800 park trees with significant community value catalogued	Almost 100,000 street trees, and verges have room for about 100,000 more. Street trees are estimated to cover 3.4% (3.57 km ²) of the City area and provide 12.65 km ² of leaf area.
ROADS	89 km (Streetscapes with 92 kilometres of road reserve)	1 118 km
FOOTPATHS	132.8 km	984 km
SUBURBS	4 Suburbs: Daglish, Jolimont (part), Shenton Park (part) and Subiaco (part).	30 suburbs, from Railway Parade, Mount Lawley in the east, to Scarborough, Trigg, North Beach & Watermans Bay in the west
RATED PROPERTIES	7 813 Note that the 2016 change in boundaries shifted about 3000 residents along with assets and infrastructure (including The University of Western Australia) into the City of Perth	98 000
NATURAL BUSHLAND	N/A	616 ha
COASTLINE	N/A	6.5 km

2.3 Interviews with verge-gardening residents

2.3.1 Recruitment and logistical considerations

Before commencing the research, approval was sought from the UWA Human Research Ethics Office to ensure that Australian ethical guidelines were met from recruitment through to publishing (NHMRC 2018, NHMRC and Universities Australia 2018). In order to recruit potential participants, local government partners in the research circulated an electronic flyer to selected residents (such as those who had registered for verge assistance programmes in previous years) with a link to an online 'expression of interest' portal, where those interested in the research could read the participant information forms (see Appendix 1), consent forms, and register their interest to participate in the social and ecological elements of the research (Figure 7). Additionally, a local newspaper article (Warriner 2018) drew further interest from residents in the City of Subiaco, and a call for participants appeared in LGA newsletters. One respondent who heard of the study, lived slightly north of the City of Stirling boundary, in the City of Joondalup; this respondent was included due to the geographic location falling within the desired 'middle-ring' of the northern suburbs of Perth. To preserve anonymity, quotes from this respondent are attributed to a resident in the 'City of Stirling'.

Initially, the team were unsure of the level of potential interest in participation, and so had kept the option open for people to register for *either* the interviews *or* the ecological surveys. As the level of interest was far higher than anticipated for the City of Stirling in particular, the team decided to select from interested participants who wanted to participate in both studies, encompassing a range of socio-demographic characteristics to ensure a diverse sample. Although verge gardens are technically situated on public land and no permission to access these areas is 'officially' required, it is best practice to treat these areas as if they were private property, and seek permission of both the landholder (i.e., the local government area), and the resident to conduct any kind of survey on a nature strip.

Key finding 1: Many verge gardeners are willing to participate in research

Verge gardeners can be reached via LGAs, through newsletters or targeted (e)mailouts. They can also be reached via traditional media and social media. There are a number of dedicated social media pages around verge gardening. A call out to social media pages may result in a very high number of potential respondents; researchers must have clear selection methods and be prepared with a standard response to interested participants.

2.3.2 Demographic questionnaire

A short demographic questionnaire (Appendix 2) was administered at the commencement of each interview. The questions covered key demographic characteristics such as age bracket, gender, number of people in the household, cultural background, income bracket, education and employment status. All questions were optional.



Would you like to know more about how transforming your verge to a native garden can bring nature back to your neighbourhood and support the wellbeing of you and your neighbours?

Researchers at the University of Western Australia are studying the environmental and social values of using native and waterwise plants on street verges. The research team is actively seeking residents who would like to: **volunteer their street verge** as a location for surveys of plants, birds and insects, and/or **be interviewed** about their motivations for transforming their street verges, and their experiences of verge transformation.

If you would like more information on this research, or you would like to volunteer to be included, please follow this link: <https://bit.ly/2s2aqE5>, or contact the lead researcher, Dr Natasha Pauli, directly (natasha.pauli@uwa.edu.au).

Approval to conduct this research has been provided by the University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time. In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Ethics office at UWA on (08) 6488 4703 or by emailing to humanethics@uwa.edu.au. All research participants are entitled to retain a copy of any Participant Information Form and/or Participant Consent Form relating to this research project.



THE UNIVERSITY OF WESTERN AUSTRALIA

Figure 7: Recruitment flyer used to advertise the research.

Image credits: Natasha Pauli (left) and Luis Mata (all others)

2.3.3 Interview themes

Semi-structured interviews with residents were centred on the drivers, challenges and opportunities encountered during verge gardening. The themes covered in the interviews are outlined in

Box 1, and the full question guide is provided in Appendix 3.

The initial part of the interview covered the practical process of transformation, while the remainder of the interview questions were derived from themes that have emerged from the literature. In terms of residents' motivation for verge transformation, three overlapping sets of reasons have been put forward: 1) logistical and practical considerations that make growing native plants easier or less resource-intensive than alternative verge 'treatments' such as grass (Uren et al. 2015); 2) a connection with emotions such as a sense of moral responsibility to non-humans and to the environment, or to personal enjoyment, or a sense of wellbeing (Goddard et al. 2013, Weber et al. 2014); or 3) social norms and societal values (Hunter and Brown 2012). With regard to the impacts of the transformation, the interviews encompassed: 1) whether the transformation altered the way they use resources such as water, nutrients, time and energy; 2) whether the transformation has altered the way non-humans use the environment; and 3) whether the transformation has influenced the way the resident interacts with the local community. Finally, respondents were asked about the future – whether they would change anything in their verge garden, and what their ideal streetscape would look like.

Box 1: Interview themes explored with native verge gardeners in Perth

The themes were developed based on available research in the literature and place-based information.

Theme 1: The reasons behind transformation of a verge to a native garden

- Is there a **practical** or **logistical** reason why growing native plants is preferred over grass?
- Is it connected to **emotions** such as a sense of a moral responsibility to the environment/non-humans, personal enjoyment, or sense of wellbeing?
- Is it connected to **social norms** or societal values?

Theme 2: The process of verge transformation

- **What happened**, and how does it look now?
- What were the **enabling factors**?
- What were the **opposing factors**?

Theme 3: The impacts of the verge transformation

- Has the transformation **altered the use of resources** such as water, nutrients, time and energy?
- Has the transformation **altered the way non-humans use the environment**?
- Has the transformation **influenced the way the resident interacts with the local community**?

Theme 4: Perceptions of nature, gardening and community

- Does the resident spend **time in nature** now? What was the role of **nature in their childhood**?
- How is the **garden used**?
- What does **'neighbourhood'** and **'community'** mean?

Theme 5: The future

- Does the resident intend to **maintain** or **change** native gardening efforts?
- What would an **ideal streetscape** look and feel like, and how could this be achieved?

2.3.4 Data analysis

Summary statistics were prepared from the quantitative data obtained from the demographic questionnaires. For the qualitative data derived from interviews, thematic analysis was used to identify, analyse and report patterns (or themes) within the data, towards interpretative analysis for policy and practice, following the protocols of Braun and Clarke (2006). Thematic analysis balances robust theoretical foundations with responsiveness to real-world contexts found within the data. A number of themes were pre-defined, based on the structure of the interview (see

Box 1), while others emerged from the research participants themselves during the course of the interviews. Specific efforts (following Braun and Clarke 2006) were taken to ensure themes were: systematic across the data set; precise and meaningful to the research aim and audience; illustrative of the analytic focus and key patterns across the data; sufficiently distinctive from other themes, and consistent with the actual data (to avoid overreaching claims).

Thematic analysis of interviews was done using NVivo software, following Braun and Clarke's (2006) protocols for searching across the data set for repeated patterns of meaning (themes) by 1) formalising the analytic themes and revealing sub-themes to be drawn out and analysed based on how street verge transformations play out across the data items (interviews); 2) providing rich thematic description across the entire data set of interviews (which sacrifices some depth and complexity but emphasises important themes for the reader); 3) a realist emphasis on describing and interpreting from the semantic level of what participants explicitly expressed as valid and meaningful of themselves (rather than digging into 'the underlying ideas, assumptions, conceptualisations, and ideologies' beyond what was said). These assumptions and constraints were practical and consistent with best practice when working in an under-researched area and participant views are unknown (Braun and Clarke 2006). The analysis followed Braun and Clarke's (2006) six guiding phases (Table 2). Preliminary engagement with leading theory and policy concerns sensitised the research to both subtle and critical features of the data sought and the basis for analysis and reporting (of interest to researchers, participants, funders, plus public and policy audiences). This sensitisation was revisited at the data coding stage following the phases shown in Table 2 below.

Table 2: Phases of thematic analysis

Source: Redrawn and rephrased from Braun and Clarke (2006).

Phase	Description of the process
1 Researchers familiarise themselves with the data	Transcribe data, read data, note initial ideas
2 Generation of initial codes	Code features of the data in a systematic fashion across whole data set, collating data relevant to each code
3 Search for themes	Collating codes into potential themes
4 Review of themes	Check if the themes work in relation to coded extracts and the whole data set
5 Definition and naming of themes	Ongoing analysis to refine the specifics of each theme, and the overall story of the analysis, generating names and definitions for each theme
6 Reporting	Selection of extract examples, analysis of selected extracts, relating the analysis to the report objectives, and producing final report

Particular care was taken for reliability of transcription; generating, applying, and successive mapping of coding overall and between researchers; and in maintaining security of the data and analysis using University-approved ethical and IT protocols surrounding the project including the shared use of NVivo. NVivo is particularly helpful because it records the processes and allows textual and graphic mapping which aids researcher analysis, interpretation, and effective communication. It must be noted that NVivo is only a tool, and as such requires sound input and thorough analytical protocols for the outputs to be meaningful. Secondary visualisation of data was undertaken in Excel, using information extracted from the NVivo analysis.

2.4 Plant, bird and pollinator surveys

2.4.1 Verge plant mapping

For each of the residential verges in the study area, the plants occurring on the verge were mapped, with note made of species and the approximate extent of coverage. As the verges were effectively gardens, there were a combination of locally-occurring native species, native species from elsewhere in Western Australia, horticultural varieties where the original native species may be drawn from other parts of Australia, introduced garden species, and weeds. In some cases, the residents had kept the plant tags denoting the species name, created their own maps of which species had been planted (Figure 8), or had detailed knowledge of all plants on their verge and provided this information to the surveyors. In other cases, there was limited to no information on the plant species present, so that the surveyors had to identify the species present as closely as possible. In some cases this was limited to genus or even family level.

The initial plant species map was prepared at the time of the initial interview with the resident. As the verges were visited three further times for bird and insect surveys, the plants present on the verge were checked each time to update identifications (for example, if the plant was flowering or had grown sufficiently to be identifiable), or note new or dead plants. The smallest and least diverse verges could be mapped easily in 15 minutes or less, while large and/or diversely planted verges required 30-45 minutes to map (Figure 9). Schematic diagrams were drawn for display purposes (Figure 10) and plant species lists compiled.



Figure 8: Example of a hand-drawn map compiled by a research participant



Figure 9: A diverse verge garden with around 60 species of native plants

A diverse, densely planted verge garden such as this one could take nearly one hour to map, with guidance provided by the resident to aid in identifying all the plants. Credit: R. McDowell

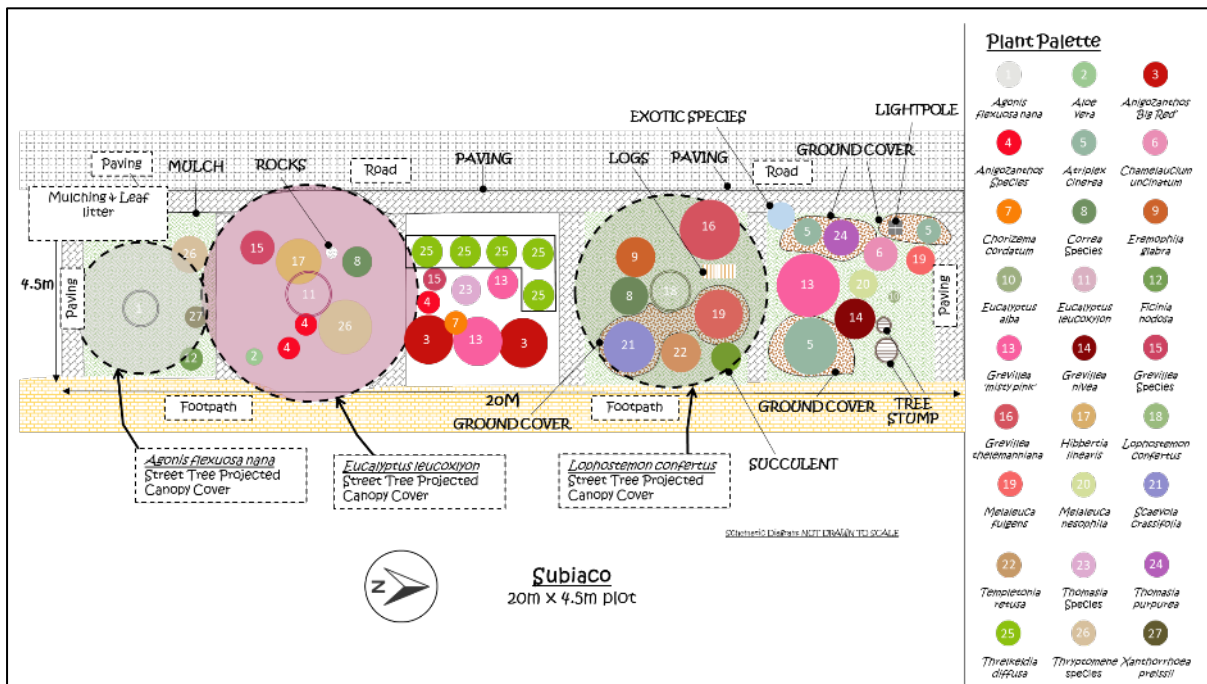


Figure 10: Example of a schematic illustration of a nature strip garden

Credit: Elisha Chu

2.4.2 Insect pollinators and bird activity

Nineteen of the original 22 verge gardens⁸ were subsequently visited three times in the period between October 2019 and March 2020 for fauna surveys (representing the first field season following completion of all interviews). Native bee activity is greatest in Perth between the months of October and March⁹. Repeated sampling is required to gather information on plant-pollinator links for a variety of species, and allow for imperfect detection during each visit. Verge gardens were surveyed for bird-habitat and bird-flower interactions, as well as visits by insect pollinators (chiefly bees, hoverflies, wasps, butterflies and moths) to flowering plants in the understorey. Photographs were taken of insect pollinators (e.g. native bees, wasps and hoverflies, and the introduced European honeybee *Apis mellifera*) and identified to the finest taxonomic classification possible from a photograph. Species of plants that were flowering during each survey were noted. Insect surveys were undertaken on sunny, calm days between the hours of 9am-4pm (peak activity period) to allow for maximum possibility of detection (Pille Arnold et al. 2019). Flowering plants were observed for a minimum of five minutes per plant, to a maximum of two individuals of the same plant species (if a pollinating insect was recorded within the first five minutes, a second period of a further five minutes' observation was added on). Evidence of native bees nesting in verge gardens, or visiting flowering street trees, was recorded. Due to personnel limitations, bird observations were noted during the same time period; ideally, birds would be observed early in the day, or late in the afternoon during their peak activity period.

The bird and insect survey protocols were very similar to those used in the Upper Stony Creek survey (see case study described in Pauli et al. (2020) and on the [CAUL Network of Integrated Sites website](#)), with a couple of notable exceptions. First, rather than using a transect walk in four directions, all plants in flower on each verge were observed for a set period of time to detect insect pollinator visits, to a maximum of two plants from the same species¹⁰. Second, sweep nets were not used to sample herbivorous insects nor to collect samples of pollinating insects. Trial sampling undertaken in May 2018 demonstrated that residents were often very protective of the plants growing in their verge, and many would likely not react well to the sight of sweep nets being vigorously applied to clumps of plants. Future studies could explicitly seek permission from residents to use sweep nets to sample invertebrates, making them aware of the potential for slight damage to plants.

2.4.3 Data analysis

For the purposes of this synthesis report, data analysis was limited to descriptive statistics of the numbers of plants occurring within verge gardens (i.e. species richness), summary information on the birds and pollinating insects (focussing on native bees) that were found within verge gardens. The geographic distribution of plant species was summarised for each species. Ongoing analysis will build on these base data to encompass plant diversity indices, development of a native bee habitat suitability index, and multivariate analysis of verge gardens to derive patterns of similarity and difference across social and ecological characteristics.

⁸ All interviewees were contacted by email in spring 2019 to seek permission for fauna surveys; all interviewees had already stated during the interview that these surveys could occur, however, the research team felt it pertinent to reconfirm with residents as well as provide general time windows when the surveys would occur. All respondents affirmed that fauna surveys could occur, with the exception of: 1) one resident who moved house; 2) one resident who did not respond; and 3) one resident who responded in the affirmative after two rounds of surveys had already been completed, due to not seeing the email.

⁹ Kit Prendergast, native bee scientist, ecologist and zoologist and co-author of this report, personal communication 2018.

¹⁰ For spreading ground covers and clumping species, it was not always possible to distinguish individual plants. In these cases, two discrete patches of ground cover at different locations on the verge were observed.

3 Results of interviews with verge gardeners

3.1 Characteristics of verge gardeners

Interviews were undertaken with 22 households. Almost all interviews were with a single respondent, and two interviews were with couples. Overall, 14 women and 10 men were interviewed. The age ranges of the participants are shown in Figure 11. Three respondents had no children, and nine households had children living at home, divided amongst primary school age and younger, teenagers, and adult children. Three respondents lived alone. Respondents had lived in their houses for between 2.5 to 44 years; seven respondents had lived in their homes for 20 years or more, six for between 10-20 years, and another six for between 5-10 years. The majority of households (14) owned their house outright. Six households had a mortgage and two held rental tenancies. The income range of households is shown in Figure 12.

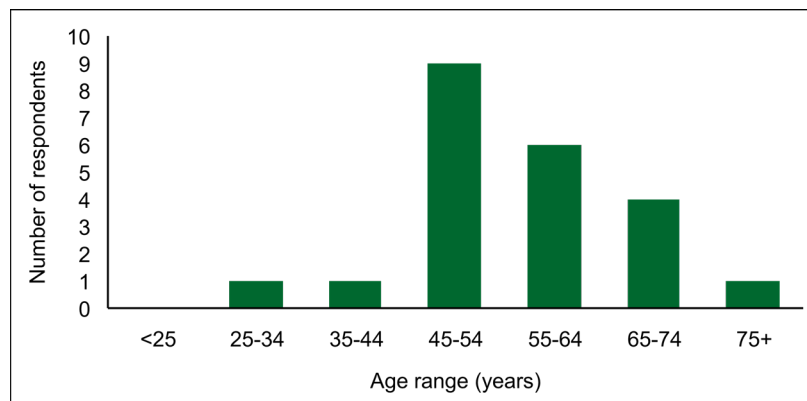


Figure 11: Age range of participants

Data from demographic questionnaires administered to all households. One respondent declined to report their age.

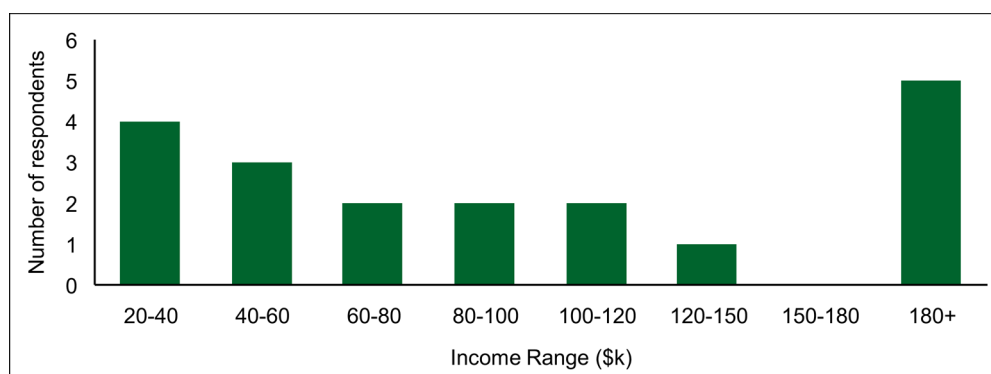


Figure 12: Participant household incomes

Six households declined to state their income range. Note that on the demographic questionnaire, households responded to non-overlapping categories (i.e., \$20,000 to less than \$40,000).

Interviewees had mostly completed tertiary education. Ten had completed postgraduate studies, with a number of those reporting having attained a PhD qualification or higher. Nine had completed up to an undergraduate degree, two had completed a certificate, one had attained a diploma and one had done no further formal studies after the completion of high school. Almost all respondents were of European-descent and English-speaking background. Fifteen reported an Australian cultural background, while seven had been born or raised in the United Kingdom and moved to Australia

between 15-49 years ago. One participant was of culturally and linguistically diverse (CALD) background, having been born overseas and living in Australia for over three decades.

Participants were asked to self-nominate for the research, and provided a small amount of information on their verge garden (and not on their household), on which the research team based the final selection of interviewed households (in order to cover a range of locations, and sizes and ages of verge gardens). Due to the small sample size, generalisations cannot be made as to the demographic characteristics of verge gardeners elsewhere in metropolitan Perth. However, it is clear that people of CALD backgrounds are under-represented in this research compared with general population characteristics, and people with tertiary education are over-represented.

3.2 Initial impetus for verge transformation

In terms of initial motivations for undertaking verge transformations, the most common reasons reflected practical motivations to reduce time, expense, water use and maintenance on the nature strip. Figure 13 highlights the major reasons given for converting verges to native gardens. Other reasons not displayed in Figure 13 (due to three or fewer responses on these topics) included a dislike of lawn, a lack of free space to garden inside the property, retirement or underemployment, discouraging people from parking on the verge, and removal of street trees and other vegetation.

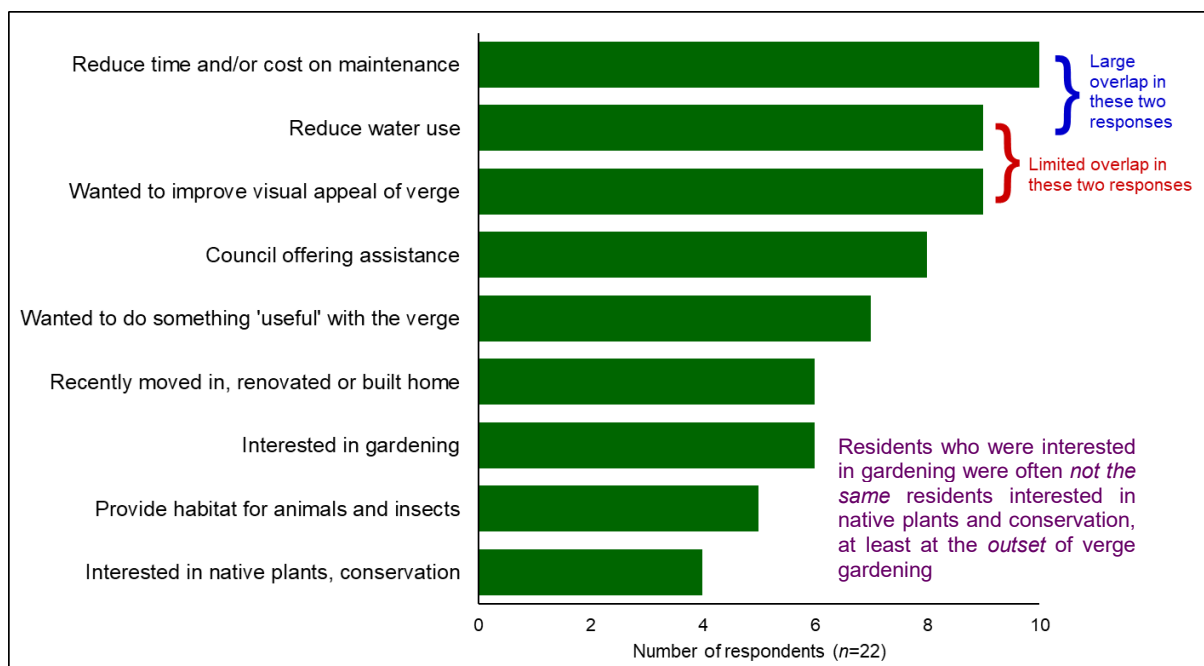


Figure 13: Initial impetus for verge transformation

Note that many respondents provided more than one reason for their initial decision to transform their verge. Excluded from the graphic are reasons with three or fewer responses. Responses were classified by the authors based on respondents' answers to interview questions.

While some respondents had an initial interest in native plants, most people interviewed had limited initial knowledge, and learnt more about native species and ecology through the process of verge gardening. There was limited overlap between respondents who stated that they were interested in gardening, and those who were interested in native plants and gardening, although over time, as the verge garden progressed, many of the interested gardeners became more knowledgeable about native plants.

Two of the most common reasons given for installing a verge garden were to reduce the time (and cost) involved in maintaining a grassed verge (10 interviewees), and to reduce water use (nine respondents). Seven respondents nominated both water-saving and time-saving as reasons to convert the verge, particularly where the cost of water was factored into the rationale. Some examples of responses are provided below (note, all names have been changed).

“The main reason was the water issues. We hate wasting water and we were wasting like gallons of water on our grass. That was the main one. Well, secondly, we found that it was a time issue maintaining a grass verge of that size, took a long time and money, which we didn't have. Those are two main issues, and unauthorized parking. We found that we were maintaining our grass verge for all and sundry to park on and break our sprinkler heads and et cetera, and the angst that it used to bring. Those are the three reasons.” (Dawn, City of Subiaco)

“Purely, purely to save water. The verge, as you know, belongs to the council and they did regularly water that one peppermint that's there, which stayed actually, it was planted by council, but apart from that, it's up to me. So I try to do it without water, if possible.” (Catherine, City of Stirling)

“I didn't like the idea of grass, a lawn growing and having to mow it and I just felt there was a better use for the verge, so I gradually put in more and more native plants. There is one or two ferns in there, but basically it's natives....Well, we use bore water, and it concerns me that we're potentially drawing on a resource, so having the natives there helps. Okay, they do get a bit of watering in the summer, but they don't get a lot.” (Sarah, City of Subiaco).

“Well I suppose I've always thought that grass on the verge is waste of money because you don't use it for anything. Apart from maybe parking a car on. So it was water saving really. That was the idea. And low maintenance.” (Delilah, City of Stirling).

Another major reason for deciding to convert the verge to a waterwise garden was to improve the visual appeal of the verge, which was often viewed as ‘weedy’, ‘messy’, or ‘ugly’. Interestingly, there was relatively little overlap between residents nominating water-saving, and residents wanting to improve the visual appeal as the impetus for undertaking a transformation. This perhaps suggests that aesthetic concerns and norms are another key driving factor for verge conversions, which has potentially been overlooked in the research to date.

“So I just suppose it was something that was a big area of ugliness, and I didn't want it to be a lawn, and I didn't want it to look like the weedy expanse over the road or further down the street.” (Thomas, City of Subiaco)

“My garden wasn't a grassed verge. It had been sadly neglected by me. So I was aware every day that it was messy, really. Not a credit to me and not doing anything positive at all. So when I read about verges being redone with native plants that really really appealed to me, especially getting help to do it and guidance from the council. It seemed to be absolutely a win win situation for everyone involved.” (Margaret, City of Stirling)

Key finding 2: Visual appeal is just as important to verge gardeners as reducing water use

Perth verge gardeners may be primarily interested in either saving water *or* in creating a more visually appealing street frontage. Those who are less interested in water conservation may still choose plants that require regular irrigation, or might overwater plants that are actually waterwise. To achieve both water conservation and aesthetic improvement, practical information and visual examples of how to achieve a beautiful, waterwise garden are required.

Around one half of the participants had received some form of assistance from their LGA; this was a ‘tipping point’ in terms of motivation for eight respondents, as highlighted in the preceding quote. Further quotes in this vein are provided in the text around a ‘typology’ of verge gardeners.

A number of residents were primarily interested in conservation, providing habitat for birds and insects, and showcasing local native plants. The proportion of residents falling into this category was relatively low, perhaps indicating that limited knowledge of native plants and ecology is not a barrier to undertaking native gardening. Some indicative quotes are provided below, demonstrating a sense of ‘moral responsibility’ towards nature.

“And I guess there's a couple reasons going and one is, I think, I don't think conservation is restricted to the bush. I think we've got the best, I think we've got some of the best plants in the world and we don't recognize that.... I think we've smashed the [expletive] out of our environment in 200 years and I don't think we're very good at looking after it and this is a tiny, tiny, tiny, little thing to...[show] it can be done.” (Matthew, City of Stirling)

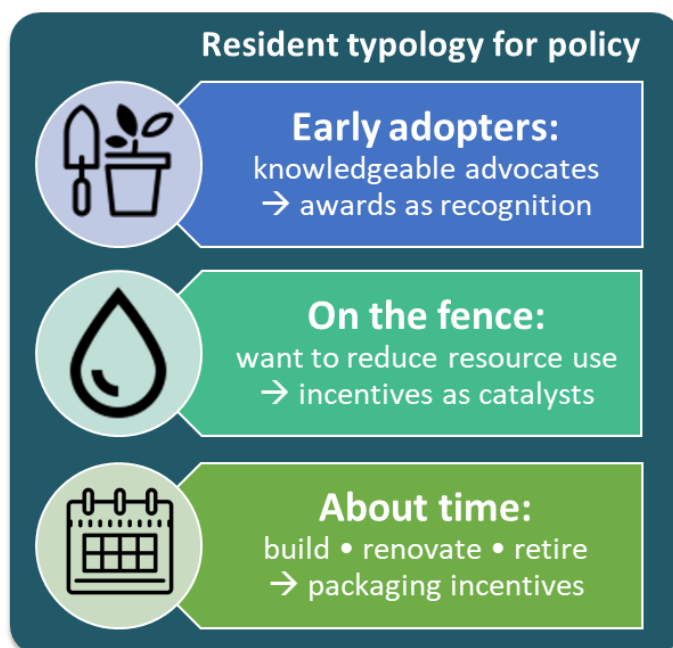
“I was learning about a lot of procedures in conservation, revegetation, with the mining industry as well come into it. I had access to material [seeds] at that time. And that was building and building as an interest.” (David, City of Stirling)

“So it was planted for the birds, primarily. We were both on and off volunteering with what was then Men of the Trees, so we had access to local or regional native plants.” (William, City of Stirling)

Key finding 3: Knowledge of native plants is not essential to start a verge garden – but it helps

Verge gardeners may start out with limited knowledge of native plants – such as which species are local to the area, their ecological characteristics, and where to buy them. Gardeners gain knowledge through experience, trial and error, speaking with others, and information from third-party sources. Photographs of the foliage and flowers of native plants may help guide plant selection. Information on *how* to garden with native plants (e.g. water, nutrition, and pruning) will be highly valuable.

3.2.1 Towards a typology of verge gardeners



A simplified typology of the interviewed verge gardeners is represented in Figure 14. The three groups represented in the typology are not intended to be exclusive; some residents would fit more than one characterisation.

Figure 14: A typology of verge gardeners
This typology illustrates three broad categories depicting the major drivers for groups of residents to undertake verge gardening initiatives, based on interviews with 22 native verge gardeners in Perth.

The first group, the ‘early adopters’, are those gardeners who have either been managing verge gardens for more than a decade, or who have recently (within the last five years) started a verge garden in an area where there are no other nearby similar gardens. The ‘early adopters’ enjoy sharing their knowledge and experience with others, and are often engaged in voluntary environmental activities. This group is likely to undertake verge gardening of their own accord, without incentives or rebates. They may appreciate recognition through awards (Figure 15) or actively participate in social media around native gardens, and could act as exemplars for others to follow.

“We both were committed to putting in a native garden when we arrived. We both decided that’s what we wanted to do...Having said that, the backyard is not native but we both wanted the front yard and the verge to be native. Because of birds, wildlife. We have so many birds, it’s fantastic.” (Monty, City of Subiaco)

“...I did plant it for my father about 20 years ago. So it's evolved a bit since then. But we both had an interest in native plants and revegetation...So the verge wasn't used for anything. So it went into native plants because that's what our interest was.” (William, City of Stirling)

“...I always wanted to do it....I'm the only one on the whole street.” (Matthew, City of Stirling).

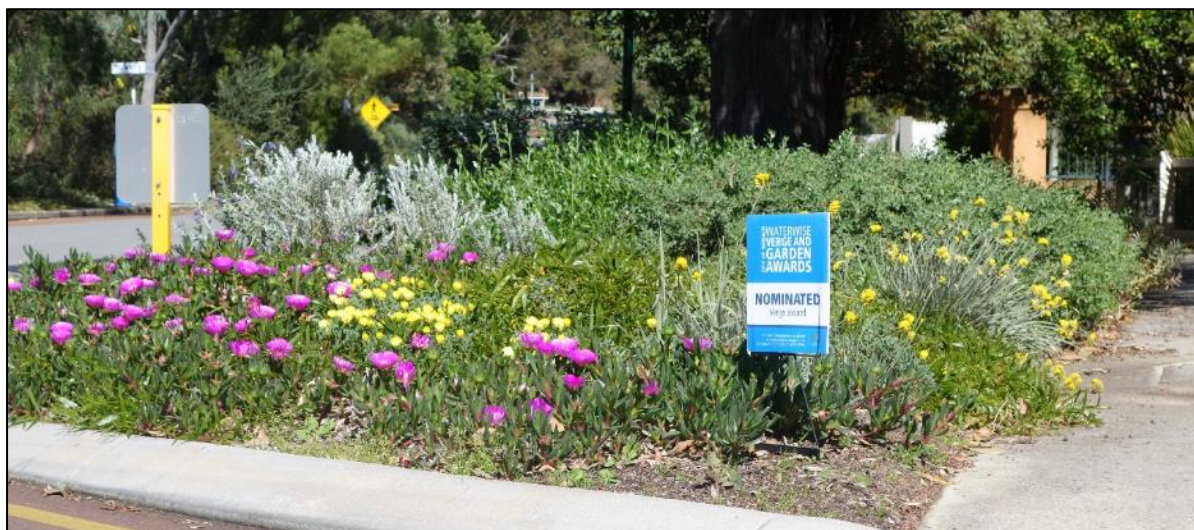


Figure 15: Signage for the City of Subiaco’s annual ‘Waterwise Verge and Garden Awards’

Nominated verge gardens have visible, street-facing signage for several weeks, reinforcing the City’s support for waterwise gardens and recognising community members for their activities.

A second group were influenced largely by decisions about resource use and efficiency, such as not wanting to ‘waste’ water or time on maintaining lawn. For residents in this group, incentives, subsidies and rebates often acted as catalysts for action. Some residents in this group had very limited knowledge of native plants prior to starting their verge gardens, but were often interested in attracting wildlife. There were many instances of ‘trial and error’ and journeys of discovery in this group of residents, such as difficulties with controlling weeds, and uncertainty over how to find information on native plant needs.

“But, because the council was giving away plants, that was why we did the verge. We were up to the verge, anyway. We'd done patches [of the garden]. We'd done most of it. The next one was the verge, but we decided to do it at that time because they were giving away the plants.” (Narelle, City of Stirling)

“And the fact that council was offering to support people to do the verge I think was a really key motivator in going down that path. We’re on a corner block, we’ve got quite a significant verge, we’ve got two lots, the front and the side, and without them doing a lot of physical work, it would have been quite a monetary outlay I think. Both physical work that they put into it, and also just supporting the planting. They haven’t done all the plants, I’ve planted a lot myself, but that contribution was very much a motivator.” (Gertrude, City of Subiaco)

The final group tended to undertake verge gardening at particular milestone moments, such as retirement, building a house, moving into a new property, or renovating an existing house. For those residents involved in building or renovating, the front verge may have looked particularly denuded or dilapidated after building works, prompting a desire to make this area look aesthetically pleasing and aligned with the appeal of the new or renovated dwelling. For this group, incentive packages that are tied with building permits, becoming new ratepayers, or switching to seniors’ rates for ratepayers might be catalysts to start the process of verge transformation and renovation.

“The verge was an absolute wreck because it had been a building site and before that a rental house where no one cared.” (Thomas, City of Subiaco)

“I thought it was a bit of a wasteland before because it just had cooch grass and a bit of onion weed in there. It wasn’t particularly lovely so I thought...we’d done a renovation so we had to use that verge [for renovation materials and tradespeople] and we hadn’t put any love into it. So I thought, we’ll start with that as the first project that we’ll get onto.” (Katrina, City of Subiaco)

“I don’t believe in wasting water, so in the summer I’d refuse to water it, because it’s a waste of water frankly. Therefore, I determined that when I had the time, and I’d seen a couple of native verges around me, when I had the time, one of my retirement projects was to convert it to native.” (Dwayne, City of Subiaco).

Key finding 4: Personal beliefs, incentives, life milestones provide impetus for verge gardening

The research developed a typology of motivation for verge gardeners, which can be related to policy decisions. ‘Early Adopters’ are motivated by a combination of a sense of environmental responsibility and interest in ecology and conservation, and rarely access incentive programs, but could act as sources of inspiration. ‘On The Fence’ residents had toyed with the idea, but made the final decision to start because of incentive programmes. Residents in the ‘About Time’ category timed verge transformations with events such as retirement, moving, building and renovating.

3.3 The process of verge transformation

Interviewed residents followed diverse strategies to convert their verges, and incurred a range of costs. Initial costs incurred by residents ranged from nothing, to several thousand dollars for cartage of unwanted topsoil, installation of new topsoil and reticulation, plants and mulch. One interviewee contracted a landscaper to design and plant the verge garden, and of the others, around one half received assistance from their local council (in the form of information, design, materials, rebates, plants, and/or labour), and the other half did their verge transformations solely by themselves, sometimes with the assistance and advice of knowledgeable family, friends and neighbours. The majority of respondents continued to spend their own money on replacing plants and adding new plants, and some sourced free mulch from local suppliers.

Of those that did not outlay money for their initial verge transformation, many had applied for verge makeover programmes run by their local government authority (LGA). Several LGAs in Perth run programmes along these lines, some of which provide a rebate to residents up to a fixed limit for verge

transformations, others of which provide discounted plants, and a few cover almost all costs to residents. Some programmes require residents to provide evidence of having installed the plants or completed removal of grass, but most of the interviewees had not had to provide any evidence to the LGA. The response to these programmes was generally very positive, as shown by the quotes below. It should be noted that some residents were wary of engaging with such programmes, as they were concerned they might be restricted or limited in what they wanted to do, and instead decided to do their transformation independently of the LGA.

“I said [to the neighbours who walk past], do you know the City of Stirling has a sustainability officer, who is there just to facilitate this sort of thing? And a tree officer? I said the council is so helpful, and when they reply it’s a thought out, investigated response, it’s really a positive experience I’ve got to say, it is. I’m not in any way connected, apart from a lot of writing. I said really, it just happens like this, and I told them the process. So I was able to actually act like a middle person, an evangelist, and I would say, I’m...up the road, scruffy house but my verge looks ok.” (Margaret, City of Stirling)

“City of Subiaco made it very easy. I didn’t even have to be here. They were fabulous.” (Katrina, City of Subiaco)

Several interviewees had been recipients of a City of Subiaco verge makeover programme, which involved contractors spraying the existing vegetation with herbicide, removing the old topsoil, adding a layer of new topsoil, designing the layout of the verge garden with the resident, providing and planting the new plants, and provision and spreading of mulch. A small number of residents chose to remove the old soil and grass themselves at their own cost rather than having it sprayed, due to concerns around herbicide and/or losing the old soil with its potential nutrients and other elements.

In the City of Stirling, a number of respondents had taken part in a programme that provided free plants, bentonite, water crystals, compost, fertiliser and mulch, with the responsibility for preparing the verge, planting the new plants, and spreading mulch given to the resident. The number of plants was calculated based on the size of the verge, up to a maximum of 120 plants. Residents were eligible to apply for more plants in future years following the establishment of their own verge.

Methods employed by residents to remove weeds and grass included smothering with black plastic for several months, spraying with herbicide (glyphosate), and manually digging out grass by hand. Mechanical assistance in removing weeds and topsoil was rarely employed other than by those who took part in subsidised programmes; hand-removal of grass and weeds often took weeks of labour by residents, who subsequently would often recommend having this task taken care of by contractors.

Key finding 5: Participating residents hold positive views of local government incentive programs

Residents who had taken part in incentive and rebate programs delivered by local governments were generally appreciative and espoused positive views of “the council”, often to their neighbours. Residents who had not taken part in incentive programs were often more wary or circumspect in their views as to “the council’s” approach and attitude towards verge transformations, sometimes being concerned about potential punishment or lack of acceptance of residents’ plans or ideas.

3.3.1 Sources of inspiration and ideas

The interviewed verge gardeners drew their inspiration from a wide range of sources (Figure 16).

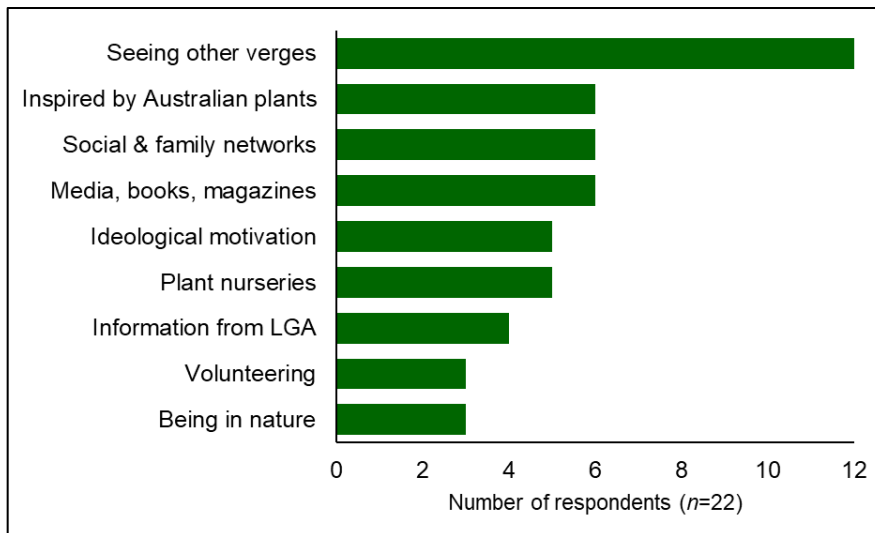


Figure 16: Major sources of inspiration and ideas for verge gardens

Some respondents drew on more than one source of information. Excluded from the graphic are sources of inspiration with two or fewer responses. Responses were classified by the authors based on respondents' answers to interview questions.

The most commonly cited inspiration (12 respondents) was seeing other verge gardens (and native gardens). These gardens were often in the resident's street or local neighbourhood, and sometimes in professionally landscaped settings adjacent to office buildings set in parkland. In the more densely populated and inner-city City of Subiaco, residents inspired by neighbourhood verges tended to be on foot when experiencing other verge gardens, whereas in the more suburban City of Stirling, residents tended to speak about driving past other verges rather than walking. Seeing examples of other verges was particularly important to those respondents who were not highly knowledgeable about Australian native plants and ecosystems (i.e., those that fit into the 'On the fence' category of the typology in Figure 14).

"But there is one garden on [name of] Road that had obviously been done many years ago. And each time I went past I thought, have they got permission from that, and I'm sure you're not meant to do these things. It was very very attractive that garden, when you drive down that street, it stands out like a beacon. The lady's always out there in her verge garden. That was the first really I ever thought about it." (Margaret, City of Stirling)

"There was a garden a few streets away that I used to drive past all the time and just sit outside and look at them. They must've thought I was stalking them because I looked at how they were doing it." (Delilah, City of Stirling)

"A lot of my neighbours have really lovely verges, across the road, and I was a bit inspired by my neighbours.... They've got a completely native garden and in spring it's just so beautiful and so lovely. And the colours are just unbelievable. So I was inspired by that. Another couple of people in the area when I walk past have beautiful verges, so I thought I gotta do something that adds to everyone's wellbeing when they walk past it, they get enjoyment out of it." (Katrina, City of Subiaco)

"Yeah, you see people's verges that are sort of just full of bees and birds all over the place. There's friends like in Subiaco, there's a whole area down in Cottesloe where the whole street practically has got native verges there, and I just thought that's the way to go." (Thomas, City of Subiaco)

"There are more of them around at the moment and there are many, many better ones than mine. So I really, what I really enjoy [is] seeing ones that actually looked pretty...I walk into Subi[aco] regularly, at least once a week and just enjoy meandering and looking at some of the great verges that are there". (Dean, City of Subiaco).

The importance of seeing and experiencing gardens in person, rather than through a car window, is emphasised by the fact that around one-quarter of the interviewees were influenced by seeing the

verge or native gardens of their family and friends, and by visiting plant nurseries with enticing displays of native plants as examples to emulate (Figure 16). Several respondents were also inspired by nature, by observing plants that would grow in nutrient-poor beach sand, local bushlands, and local wetlands. Inspiration from books, television shows, and media articles (often in 'the paper' rather than online), as well as information provided by LGAs, also factored into helping people form ideas for what they wanted to do.

Residents who were 'early adopters' tended to be more inspired by nature and a sense of stewardship for the natural environment (i.e., ideological motivation), rather than by examples of other verges. Some example quotes demonstrating these sentiments are provided below.

"I've always had this idea since I was a kid. Well not a kid. A bit older than a kid. Imagine all this verge space, if we actually used it, like if you put it into...native garden, you could have corridors if you want for bits of wildlife and stuff like that. If you put a verge garden in there ... you add up all the area in Perth, verges, put it together, that's a massive area. And it's completely neglected. People...just leave it or they drive on it or they put gravel on it or synthetic grass or something. What a waste." (Matthew, City of Stirling)

"Certainly not. I haven't got anybody that's inspired me in terms of verges. The people who inspire me in terms of native flora are...at the Wildflower Society." (David, City of Stirling)

Key finding 6: Existing verge gardens are the main source of inspiration for verge gardeners

People with an interest in verge gardens may decide to act on their ideas through the process of seeing other verge gardens. In suburbs where verge gardens are uncommon, examples in other forms such as landscaping around commercial and government buildings, nursery displays, books, photographs, websites and social media pages can provide inspiration.

3.3.2 Rationale for plant selection

Nearly half of the interviewed residents included plant hardiness as one of their main criteria when selecting the plants for the verge garden. The verge can be quite a harsh environment, reflecting heat from the road surface, with some areas receiving full sun, and others receiving dense shade beneath certain types of street trees. Perth's sandy soils also provide a challenge for plants, as does seasonal lack of rainfall in summer and dry winds.

"Also it's on a corner, surrounded by bitumen, and the sun comes directly from over there. So on a hot day it just gets so much reflected heat, it can dry out quite seriously. Not all verges are equal. Some are quite a challenge." (Monty, City of Subiaco)

"I'm not the greenest of thumb people, so I didn't want to spend lots of money, and then find out that [the plants] died." (Sarah, City of Subiaco)

In terms of choosing particular species, many residents desired to have either Australian native plants, or endemic Swan Coastal Plain plants. The motivations behind this were multiple: some residents wanted to choose species that were likely to survive, being from the local area, whereas others wanted to provide habitat for local species in a miniature replica of remnant vegetation. Additionally, a number of residents wanted to attract birds into their garden, which sometimes meant selecting horticultural hybrids with year-round flowers.

"There are three criteria: It has to be native, it has to be water wise and it has to be bird attracting. Those are the criteria to find the plants." (Dwayne, City of Subiaco)

“I definitely wanted, for the front verge, definitely wanted local natives. They're not all Swan Coastal Plain ... We just went to the nursery and said that looks nice. And there's not a huge range, so it's fairly- well there's perimeters, there's your ground covers, there's sort of under 500 [mm] ... So really, you haven't got a huge choice.” (Gene, City of Subiaco)

The quote above reflects the learning process embarked upon by many verge gardeners, whom at the outset may not have had much knowledge about local plant species, nor where to source them. Verge gardening contributed to knowledge acquisition and interest in connecting with other native plant enthusiasts.

The visual appeal of the plants was also a key concern for many interviewees, encompassing the colour of the flowers, as well as the texture, form and colour of foliage. Given that many species that were planted in the verge gardens flower seasonally and have no flowers for the majority of the year, diversity in texture, form, shape and colour of foliage became an important feature (see Figure 18 for an example of a garden where the foliage is the main feature). Interestingly, only one respondent specifically mentioned selecting a variety of plants so that something would be in flower year round on the verge (although an additional respondent had this goal for their native garden as a whole entity). On the Swan Coastal Plain, different *Banksia* species tend to flower at different times so that there is always an important floral resource available for fauna species – which is particularly important during Perth’s hot, dry summers.

Hardy plants: heat-drought-sand
Native Australian plants • Bird-attracting
Colourful, attractive flowers
Plants provided by Local Government Authority
Diversity of foliage colour and plant form
Swan Coastal Plain endemic plants • Size and form
Opportunistic planting of cuttings, seeds and plants • Available at nursery
Information and advice from Local Government Authority
Bush medicine and bushfood • Native cottage garden • Tubestock • Lush • Insect-attracting • Favourite genera
Personal connection to plants • Flowering at different times • Nursery recommendations • Threatened plants • Edible plants

Figure 17: Rationale for choosing plant species for verge gardens

The size of the text is proportional to the number of interviewees (n=22) who nominated a particular rationale. The largest text represents nine respondents, and the smallest text represents one respondent. ‘Hardy plants’ were those able to withstand heat, full sun or full shade (depending on the location of street trees), nutrient-deficient sandy soils, and seasonal lack of water during Perth’s hot, dry summers. Categorisations made by the authors based on interviewee responses to questions.



Figure 18: An example of a low-growing, 'lush' verge garden

*This verge garden uses a limited palette of species (mostly low-growing shrubs *Eremophila glabra* 'Kalbarri Carpet', *Grevillea obtusifolia* 'Gingin Gem' and creeper *Hardenbergia comptoniana*) to achieve the desired lush, green, mass-planted verge with minimal visible bare ground.*

3.3.3 Branching out from verge gardening

Many of the interviewed residents perceived their verge to be an extension of the garden within the boundaries of their residence. A number of residents had branched out from converting their own verge by planting low-growing plants on neighbours' verges (with permission) or even in nearby nature strips that were not in front of residential buildings. In one case, the resident received no remuneration or assistance from the neighbour. Some residents had planted additional trees on their verges, a practice which is generally not permitted without permission from the local authority. However, no-one had been asked to remove any trees once they had been planted.

Street trees are intended to be planted within a specific 'strip' of the street verge to avoid issues with the provision of utilities such as water, gas, electricity, and telecommunications, which all have designated alignments underneath¹¹ the verge (Utility Providers Services Committee 2018). There are also lists of approved tree species that fit requirements for safety, utility protection and other logistical concerns. Residents may not be aware that planting additional trees on the verge, based on their own species preference, may compromise the provision of services in future years.

Key finding 7: Verge gardeners need information on street trees

Some residents who undertake verge transformations subsequently plant unsanctioned street trees of their own species preference. Waterwise verge information should include clear detail on street tree policy, including the requirement to contact the local authority if additional street trees are desired. The safety and utility reasons should be clearly highlighted, as well as the potential cost to the resident. Information should be provided on webpages and with incentive or rebate packages.

3.4 The impact of the verge garden

3.4.1 Practicalities of management

The ongoing watering habits of verge gardeners are presented in Figure 19, excluding the first year of establishing plants. With Perth's very hot, dry summers, most respondents said that they watered their new plants through the first summer to help them get established. Nurseries and most

¹¹ And above the verge, in the case of street lighting and overhead electricity poles. Street trees, overhead and underground power, and street lighting all occupy the same corridor of land.

professional horticultural advice also recommend (deep/soaking) watering of tubestock and new plants through the first summer to increase their chance of survival and encourage development of taproots.

Around two-thirds of residents were regularly watering their verge gardens. For those using reticulation, watering habits ranged from pop-up and/or elevated sprinkler heads, to drip irrigation systems concealed beneath mulch. Through summer, residents with reticulation typically applied water twice per week, or three times per week, depending on whether the water used was scheme water (twice per week), or bore water (three times per week). Residents who had switched from pop-up sprinklers to drip irrigation thought they were using less water than they had been with lawn.

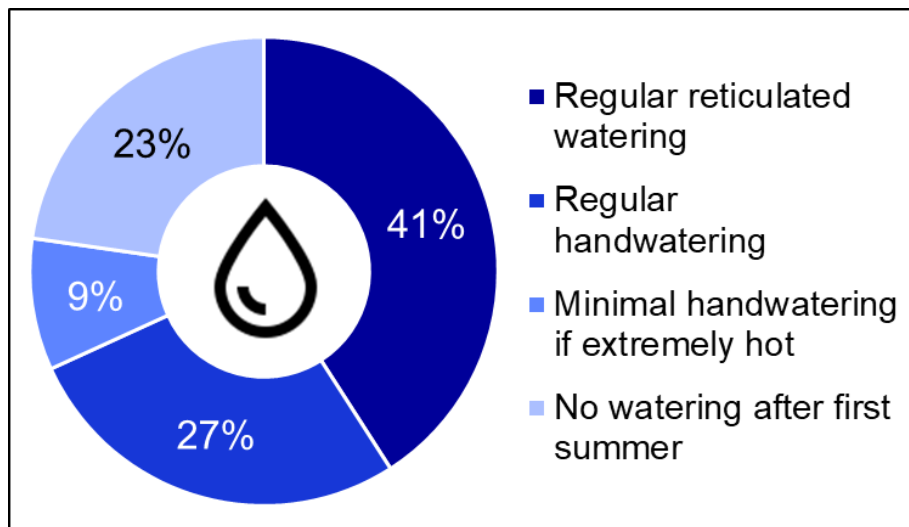


Figure 19: Verge garden watering practices

The graphic displays the proportion of respondents (n=22) according to the authors' categorisation of their watering habits after the first year of plant establishment (most respondents provided supplemental water to new plants through their first summer). Note that three gardens were newly established, and residents' watering practices may change with time.

For those using regular handwatering, this practice generally occurred once or twice per week over summer, to give supplemental water, and handwatering might be targeted to particular plants (as shown in the quote below).

(Question context: How often do you water over the summer dry period when it's quite dry):

"Probably once a week or less. It depends how hot it's been. Depends on how diligent we are, how tired we are. But not all of it. For example the [Banksia] niveas hardly ever get water. They actually survive well. They do. And even the Swan River peas, they hardly ever get water. The Hibbertias seem to be not as strong, they need a bit of water. The Calothamnus almost never needs water...so it really depends on the plant. When you water by hand, that's what you do, you look at the ones that need it, and give it to the ones that need it, and not the other ones. I think part of the reason the big Grevillea died, that first one, was because we hadn't watered it all summer, and I think it may have just been too dry." (Kimberley, City of Subiaco).

Around one-third of respondents either did not water their verge garden, or provided additional handwatering only under extreme, extended heatwave conditions. The decision not to water the verge was very much deliberate, and often tied to convictions around environmental sustainability and water conservation.

“But the common thread would be that they have to be capable of surviving without water. This is where we're 32 meters from the water table. We're on top of the sand dune. We have hot, dry summers and I don't water the verge”. (William, City of Stirling)

Some respondents who were currently irrigating their verge gardens aspired to cut down to no additional water, once the plants were more established. This aspiration demonstrates that watering practices may change over time.

“I turned the water right down to literally just five minutes twice a week. Just to help them along a bit. That's why it looks so good. But, they get very little. But the new plantings that I put in, last winter, I actually have a watering can and during the dry period I'll go out and I'll just give them a good drink twice a week. Next year they'll get weaned off until they're onto nothing.” (Dwayne, City of Subiaco).

The research team did not measure the actual volume of water used on verge gardens, nor compare water use before and after the verge conversion. However, the trends reported above give cause for consideration to future research on the volume of water that is actually used on verge gardens, as compared with other substrates (e.g. lawn), and with the volume of water that is required by plants to survive and thrive along the nature strip.

Key finding 8: Many verge gardens receive regular watering

Two-thirds of the verge gardens in our study received regular water through summer. The volume of water used on verge gardens was not quantified in this research, nor was it compared to the volume of water used on lawn or other substrates. Advice on watering schedules for native plants would be valuable for many residents, as well as information on the adaptations that allow locally endemic species to survive long dry periods, and the effect of particular gardening practices on retaining soil moisture. Future research should monitor the water balance of different types of verge treatments.

In terms of time spent on verge garden maintenance, there was a notable shift from the regular rhythm of maintaining lawn, to the more irregular pattern of maintaining garden beds. Almost all interviewees had mulched their front verges, so that annual or bi-annual spreading of mulch comprised a new task. Weeding and pruning also took up time. For some residents, spending time looking after the verge was a pleasurable, almost daily activity:

I like to walk through it. Most days I would walk through it. I kind of hover and look and watch the bees and things. If for nothing else, if I knew one bee had come in, I would be happy I'd done it. (Laura, City of Stirling)

In terms of hours per week, there's hardly a day goes by where I'm not walking around with a cup of tea and pull a couple of weeds or snip that, pruning or have a look at something or, I take a lot of photos as well. (David, City of Stirling)

For others, much of the time spent on verge maintenance was on blocks of weeding, generally considered to be fairly laborious and less enjoyable. Other residents cleared leaf litter dropped from street trees, replaced plants that had died, or pruned plants that were getting too large. Residents adjacent to busier roads also had to remove rubbish that had become entwined with roadside plantings (see for example Figure 20). Overall, the majority of residents espoused the view that the verge garden was less labour-intensive than lawn. However, regular effort is still required to maintain the plants and keep weeds at bay.



Figure 20: Rubbish trapped in a native verge garden

Advertising flyers and newspapers have become entangled in this verge garden. This particular example uses a ground cover of Hibbertia scandens but also contains a number of annual weeds.

3.4.2 Benefits to the household

Native verge gardeners overwhelmingly recognise household benefits from the verge transformation. These included privacy from the street, time savings, cooling and shade (reducing discomfort and cost), opportunities for visibility and investment in the neighbourhood, competitive pride in their garden compared to a nearby neighbour, and various opportunities for support and sharing advice about the house and garden. Even incomplete or messy gardens had benefits for the household.

The commonly stated benefits to resident households varied widely. For example, a common benefit is associated with the perceived improvement in the aesthetics of the verge. However, this might be due to the type of garden design features (“looking more natural” and artistic expression) or the presence of wildlife as the garden evolved, or relative to the previous use (lawn or messy or inappropriate surfaces, usage, or plants, such as palm trees or non-native species) of their verge, or in their streetscape. Many residents felt the benefits went deeper than appearance into sense of place and inspiring connection to nature through the transformation:

“It’s that sense of place thing. We love the bush and we’re marooned in the city for reasons of circumstance, but, so we’ve built a little micro ecology.” (William, City of Stirling)

“It’s about inspiring people to think about conservation, biodiversity, and ecology in their area. That’s really what the inspiration’s about. It’s not about having something really pretty, which it is, but there’s actually a deeper meaning for me. ... Well, probably for me, people talk about plants and nature and all that and mental health, but I can certainly agree with that. I certainly find it very therapeutic mentally and calming and whatever to come out and just putter about with it. So I guess that’s a big one just the sense of satisfaction that comes with it. The family don’t openly jump for joy about it, but I know secretly they do.” (Laura, City of Subiaco)

Some households expressed benefits for all ages from children to ageing residents:

“I think the children enjoy seeing it come along and progress, they don’t really get out there and help. My son in particular likes to talk about the plants that he’ll get. They enjoy seeing the plants, the watering hole, they love watching the birds come into the bird bath.” (Gertrude, City of Subiaco)

“As I’ve got older I spend more time being in the garden, and I love to see it, hence I’ve got huge windows. And as soon as I hear, tweet tweet, I think, you’re going to land in my garden. So the verge was making the most of ground that was absolutely of no interest to me otherwise. I don’t need it for anything else. I certainly wouldn’t be watering it.” (Margaret, City of Stirling)

“It’s part of a learning curve after retirement, to try and keep your mind active. We were talking about this recently, about learning plant names and memory. I’ve just been up the bush for a week and it’s quite good to stimulate your brain and say, ooh that’s a blah blah, and if you’re really that interested you’ll look it up. I think it’s just like any hobby that you start to be interested in, you like to learn a bit more. It’s probably nothing more than just that, really. You start to know after a while, particularly seeing things growing, the sort of things that you like, and also the sort of things that you think will grow in that area.” (Laura, City of Subiaco)

As shown in various sections throughout this report, the benefits to the household are not always site-specific; they often relate to and mutually reinforce the connections to extended family, perceptions of community, public space, and nature or ecology. This is especially evident in resident’s perceptions of ideal streetscapes and impact on the community.

Key finding 9: Residents find personal satisfaction and connection to nature by verge gardening

Households gain a variety of benefits from verge gardening, including personal satisfaction, shade and cooling, privacy from the street (if desired), connection to nature, and social interaction. The benefits vary widely by household, depending on individual preferences. A neighbourhood streetscape and network approach can help verge gardens act as connectors between neighbours, as well as appropriately develop habitat for small animals and invertebrates.

3.4.3 Impact on the community

Impact on the community was diverse: ranging from positively connecting with ‘good friends’ and (previously unknown) locals passing by while they work in the garden to hostility with neighbours (who disapprove or dislike verge gardens) or those who damage the plants in the verge garden (through theft, walking on the garden, littering, or assumed entitlements to park on the verge without asking).

An obvious trend was the opportunity to extend native verge garden benefit and knowledge beyond the household verge to the street or neighbourhood, which is captured in the ambition for extending street verges both in physical and social support. Confident and ardent gardeners either aspired to be or were champions for the verge transformation process in their street or even their suburb:

“... they all said positive things if anything. They said, ‘what are you going to do with it?’, when I wished they’d say, ‘shall I help shift that mulch?’. I explained and they said, ‘gosh that sounds really expensive’. And I’d say, ‘no’. I got that wonderful chance to spread the word about it... So I was able to actually act like a middle person, an evangelist. ...about three people have followed through since I did it, maybe four, within my dog-walking neighbourhood sort of area. When they’ve been struggling out there mowing their front verge, and I’ve said, ‘would you be interested in transforming your verge with the help of the council?’” (Margaret, City of Stirling)

“the ideal neighbourhood would be where the City comes along and pays me to do everybody’s verge and provides the funds for it and all the residents in the street are okay about it.” (David, City of Stirling)

“We also put down that we wanted our property to be an example to the community and that we needed to share it.” (Kirsten, City of Stirling)

Community impact seems to be a matter of time invested (over the garden's life from transformation to maintenance) and different perceptions of labour and value. Nearby residents, sometimes strangers, offered plants, moral support, or even food to support the gardeners. There is a multiplier effect on the social capital of transforming the garden in principle and in physical work involved.

"...being out there every weekend I had people coming up and ask what I was doing and I'd reference council. Getting to know a few people that you don't normally get to know, so there's a lady across the road that I don't know and she'd come across and talk and discuss it. I had one neighbour thought I was working so hard that he brought out scones and jam and cream. And they don't have a lot of money or a lot themselves so that was quite nice. You don't get a lot of work done...well you're constantly talking to people when you're out on your verge. Even people that I don't know where they live, where they come from, would be walking past with their dog and ask about what you're doing and said it looked really good, it looked really nice." (Gertrude, City of Subiaco)

"When I had the other [non-native] garden, that I thought was quite weedy, people thought it was beautiful, because there was lots of flowering in spring time, it was quite prolific. You don't get that sort of flowering with natives unless you get the right ones in. I think I'm in the process of doing that now. Every now and then when I'm out there people will say, I love your garden. Of course you don't get feedback unless you're there." (Laura, City of Subiaco)

Feedback from residents and council (section 3.2) tends to reinforce either the motivation or the perceived benefit for community.

3.4.4 Social interactions

At times, the process of transformation was consistently combative with neighbours (in terms of sightlines, accusations of policy breaches, and preferring lawns); other times it was a slow process of gradually winning over the neighbour.

"[The neighbour] came marching out one day actually, and he had the City's verge guideline. He printed out the first two pages of it and he came marching across and shoved it in my face and basically said, "It's all illegal. It's all illegal. It's all got to go." He hadn't actually read the guideline. He hadn't even printed out the full thing it was two pages. ... On the other hand, the neighbour on the other side, he said to me the other day, "It's wonderful." The first thing he sees when he drives around the corner is all the colour, he just gets hit with all the colour when he drives around the corner." (David, City of Stirling).

"The woman on this side for three years, the first three years were here, complained about the garden. The next two years she went pretty quiet, [and] for the last year she wanders up the path and she says, "This is so beautiful. I just love your garden." She comes and stands in the shade of pecan tree in summer and she realizes that the temperature's just gone down 20 degrees. So, we won her over. If we were hostile, we couldn't do that." (William, City of Stirling)

I suppose it [the verge garden] challenged the neighbourly relationships. And I have stood my ground on that and I had a breakthrough just two weeks ago. One of those people that had historically been quite critical of the garden, one of my neighbours, came back from the Trillion Trees nursery with a tray of plants that are the same species as one that's growing on my road verge. She came over and spoke to me about it, said she wanted something low growing, what did I recommend? I said, "Well, Do you like the look of that one? Because it doesn't get any taller than that. It's absolutely bulletproof. Next time I'm out at the nursery, I'll pick some up for you." [I] [c]ompletely forgot about it. So she took herself out there and got them. They're not on the verge, but they're in the garden. So we've started, which is really nice." (William, City of Stirling)

There are times when residents feel frustration and futility when they are unable to react to ignorance, theft, or wonton destruction by people and traffic since they do not own the land.

"[They say,] 'That's council land, what are you doing?' ... And then if you try to speak to people about what's happening and verge guidelines and all that you get a very negative sort of response." (David, City of Stirling)

"I mean you live with that and you left [with] some bugger to come and stop the car and come out and pick flowers and drive off again. You just live with that. It's all part of it. I mean I can't tell anyone not to go in the verge, because it's council ground. You can do whatever ... if they come and stomp on it or drive on it, what can I do? I can't do anything." (Matthew, City of Stirling)

"Actually we've given up planting the far corner because trucks just drive over it, all the time." (Gene, City of Subiaco)

"We have had quite a lot of plants just stolen [from the verge]... We also learnt not to plant anything with flowers. At all. I mean, on them. If they had a flower on them, it would go. It was just really weird. And we had some Dampieras just inside the gate, that had been there for about 3 or 4 years, and they'd just started to grow and look nice, and then there was a hole in the ground." (Kimberley, City of Subiaco).

Some are unwilling to engage with the community, others are opportunistic in being neighbourly:

"I don't really want to talk to people about it too much. Different people have different objectives, not attitudes I can always deal with attitudes, but objectives and if we talk to them too much, they might change your objectives for us. So I'm trying not to make it a neighbourhood conversation except for with the neighbours that are directly affected." (Cameron, City of Stirling)

"I get a lot of neighbours stop by with advice that I could probably manage without." (Catherine, City of Stirling)

"Strangely the two nearest people to me I hadn't actually ever spoken to before, just because I hadn't really encountered them. But when I did encounter them, I made a point of engaging in conversation about, I do love that plant, just to get the conversation going. I mean it's neighbourly if for no other reason. And they'd make some comment about what hard work their garden was, mowing was, and they always seem to be watering. And boom in I'd pop." (Margaret, City of Stirling).

We saw the intergenerational and intersectional impact of nature play out from observation to stewardship of the verge gardens expressed through social interaction with neighbours (refer also to Gertrude's comment earlier about the neighbour who brought her scones with jam and cream).

"The kids see it. We had a pumpkin growing in there at some point, and that was fun for the kids. They [kids] do take some ownership of it, actually, now. Now they'd say, "Oh, someone's put some rubbish in there." (Narelle, City of Stirling)

Key finding 10: Confident verge gardeners make great champions of community change

Verge gardeners who feel confident in their knowledge of policy, support by council, and garden success (and overcoming failures) spend time in their garden connecting with others and championing the verge transformation process. Champions will amplify accessible policy communication materials and designated LGA champions (who are active in and known to the community) as they will help socialise the value of verge transformation, and reinforce gardener confidence that they are sharing accurate and timely information to novice and established gardeners.

3.5 Perceptions of gardening and nature

3.5.1 Gardens and their use

Residents were asked to speak more broadly about the rest of their garden, beyond the verge. Many of the residents use their garden for mealtimes and entertaining or relaxing.

“We sit out there a lot and have our cups of tea a lot. We also entertain a lot... Meals, BBQs, drinks.” (Kimberley, City of Subiaco)

“We have breakfast and meals out here at the weekends and when we’re not at work. I just like being out here and enjoying it after I’ve spent time working in it.” (Leanne, City of Subiaco)

Gardens are also used by children for playing. Some of the residents encourage their children to go out into the garden and take a proactive role in the gardening process.

“They’re out there playing all the time. My daughter who’s seven has grown out of the sand pit and cubby house, but she’s tying ropes to things. They’ve got a couple plants that are theirs that we’ve picked up for free along the way. They watch their plants grow. We’re waiting for berries of [child’s name] plant, but it hasn’t happened yet, but that’s okay.” (Narelle, City of Stirling)

Plants grown in gardens are sometimes a mixture of what was there when the resident(s) moved in and natives, but there seems to be a common thread amongst residents of moving more towards native plants. Many of them also reported having fruit trees, vegetables and/or herbs. One of the residents also had a native peach or Quandong (*Santalum acuminatum*) and Indigenous medicinal plants. Some residents saw their garden as a whole ecosystem, and planted specifically to try and fill particular niches or create greater diversity for wildlife.

“I don’t have an aim of self sufficiency, I think it’s unrealistic, but we want to grow as much food as we can. And part of that’s that whole integration with the ecology. So I want the birds here doing the insect control. Honeyeaters eat lots of insects. So we’ve got the three species of Honeyeaters. Those are just rampaging through all the time. They’re part of my integrated pest management system... Ideally I would like to be more selective rather than reflexive... I’ve got a scattering of native plants through the garden and I’m trying to, as I replace things, as I add more native plants, I’m trying to get a flowering calendar, a specific flowering calendar for the birds. So I’m targeting gaps in the flowering calendar.” (William, City of Stirling)

Plants grown in the garden tend to have changed over time as lifestyles have changed as well. Having children or not, or having children who had moved out of home, appeared to influence plant choice, as well as how the garden was used.

“It evolved. We started off with veggie gardens and frog ponds and greywater and all that stuff. As the kids grew up, the pool became more valuable than the veggie gardens, so times had changed. Now we have the pool, we have this little patch of lawn... We’ve still got some fruit trees around.” (Dean, City of Subiaco)

3.5.2 Favoured plants, animals and insects

Birds, insects, particularly bees, and frogs, were amongst the most favoured animals that interviewees wanted to attract to their gardens. Many residents actively made planting decisions based on trying to attract desired wildlife. Flowering plants that act as a source of nectar (for example, *Grevillea* and *Callistemon*/bottlebrush)) were mentioned often.

“...we had birds before in a couple of Grevilleas already here. So then we planted more Grevilleas to try and get more birds.” (Narelle, City of Stirling)

When asked what type of bees people were interested in encouraging to their gardens, the majority of residents described the European honeybee, *Apis mellifera*, with only a handful of interviewees discussing native bees such as ‘blue-banded bees’ (*Amegilla* species - one of the easiest native bees to observe and identify in Perth, as discussed later in this report).

Key finding 11: Verge gardeners want to encourage bees, but are largely unaware of native bees

Verge gardeners often wish to provide habitat for bees and nectar-feeding birds, motivated by a desire to contribute to the local ecosystem. However, the large majority of residents were unaware of the diversity of native bees, nor that European honeybees (*Apis mellifera*) are not native to Australia. Verge gardening information should include information on habitat requirements, preferred species and the biology and ecology of common native bee species.

3.5.3 Enjoyment gained from wildlife, gardening, and being in nature

Many of the residents interviewed appeared to find gardening both enjoyable and rewarding, but reported that they were somewhat time-poor due to children or work commitments and couldn't spend as much time as they would have liked on their garden.

“...I just don't have the time. I really think gardening is awesome. I find it difficult to get out in the last few years it's been really hard.” (Katrina, City of Subiaco)

All of the residents reported having a love for being in nature. The majority reported spending time in nature in their spare time, such as on weekends or on holidays. For example, hiking through national parks and natural bush areas was reported as a popular past-time, and a few mentioned going to look at wildflowers. For many of those residents, being in nature allowed them to stop worrying or thinking about the various facets of their lives. They were able to find a sense of peace and quiet that was more difficult in the city.

“Nothing else matters. It's in the moment sort of thing, because it's there. You get into bed when the sun goes down, you get up when it comes up. You find a few birds, and suddenly it's time to go to bed again. It's extraordinary.” (Matthew, City of Stirling)

For those with native wildlife in their garden, they enjoyed the interactions that they had, or simply observing them.

“I can lie on my bed and watch birds come into the small Grevilleas. Every morning. It's lovely.” (Laura, City of Subiaco)

3.5.4 Exposure to gardening and nature as children

Childhood experiences in nature and gardening appeared to play an important role in residents' current interest in gardening and nature. Respondents reported a range of experiences, from having avid gardeners for parents, through to family holidays spent camping and foraging for wild food. Over half the respondents (13) reported that they grew up gardening, with one or both parents having taken an interest in gardening. Respondents often then attributed that experience to their own interest in the natural world and gardening.

“My mother and I were sort of joined at the hip a little bit. I was her fourth. It was just her and me really. When she would tootle in the garden, I would just tootle with her, when she would pull up a weed and so on. I quite enjoyed doing the things that she found quite hard, like do the edging and so on.” (Margaret, City of Stirling)

“We loved seeing the green and she [respondent’s mother] would always have lots of plants in the house, which I got from her. She always used to talk about, you know, it's cleaning the air, and it's this, and good for your sense of wellbeing, and this. She used to potter out there all the time. She moved plants in and out, and in and out. And I think I've just got that from her. Now I do that myself, plants go in and out, in and out, and they move all the time.” (Dawn, City of Subiaco)

Interestingly, of the residents who had been exposed to gardening in early life, all but one reported that their parents’ garden had been largely ‘productive’, having grown fruits and vegetables, whereas most of these respondents had developed their present garden more for aesthetic pleasure than for functional reasons.

“...my father and mother, my, both my parents were gardeners....We had fruit trees, lots of veggies, probably not native plants and things like that. It's more productive garden. But I've always liked the look of being under trees and rainforest...” (Laura, City of Subiaco)

“I’m from a farming family, so we had a vegetable patch and mum had her flower garden, and I had a little strip of garden that was mine, which was coming up the driveway to our farm house.” (Leanne, City of Subiaco)

“My dad is a landscape gardener, so we had fruit trees like plums, apples, lots of vegetables, lots of fruit bushes. I don't like gooseberries, but anyway. Strawberries. Yeah, we sort of had areas in the garden, so the chickens down the bottom and then there was all kind of fruit and vegetables, lots of trees. Then you had the lawn area, which was nearer the house. I just remember we were spending a lot of time outside.” (Kelly, City of Stirling)

Exposure to natural environments in early life was significant for a majority of the verge gardeners. Five reported having grown up on a farm, while a further 14 reported that they spent time in nature (other than the garden) in childhood. Activities included camping, hiking, going for walks in the bush or forest or playing outdoors. The time they spent in nature was seen as an important part of their personal development and was often associated with fond memories tied to parents, siblings and childhood friends. It was also, in some instances, seen as a spiritual or “happy” place.

“So, I grew up, I'm an only child, and my cousins and I grew up in Tuart Hill when it was Market Garden. And there was big areas of bush, so there was always bush. And Dad was very much in tune with the natural environment, and he wasn't religious. He said, "Whatever you want to know you can find the answer in nature." And so, that's how we grew up, because we were always going back to Germany to see family there. We were always going for walks in the bush, because that's just what you did, forest rather [in Germany].” (Karen, City of Stirling)

“We had a really good fun childhood... we had a ski boat and we’d go camping and camp beside a lake or a river or something. My brother and I, especially in the later years, we would be dropped off in the bush somewhere next to a river and we would camp there for the school holidays for a week. Then mum and dad would come up and on the weekend and just resupply if we needed anything. So we were all, I was always in the bush and just felt like sort of my happy place.” (Delilah, interview 14, City of Stirling)

“So we spent our childhood, this was in the '50s when children were brought up differently. You had breakfast and you went out and it was you come back at mealtime. And that's what you did. We just went off and roamed. We explored everything in the garden, the lizards and the insects and we had a pond with frogs and all that sort of stuff. And tadpoles, taking frogs ... watching it turn into tadpoles ... and all that English sort of naturalist stuff was part of my upbringing because that's what you did. You just went out and messed around in nature. Made cubby houses in the woods and chase squirrels and whatever.” (Dwayne, interview 22, City of Subiaco)

Key finding 12: Childhood experiences influence gardening practices

Many verge gardeners reported positive childhood experiences with gardening and nature, which had influenced their views and practices as adults. Having access to gardens and nature in early life may play an important role in fostering ongoing interest in the environment and gardening. We need to understand the long-term consequences of a *lack of access* to gardening and nature in childhood.

3.6 Sense of ownership of the verge

Our study focussed on those who have actively chosen to transform their verge. Across the spectrum of responses from residents, we observe a variety of territorial understandings of the verge. Respondents ranging from having an implicit assumption of usage when discussing “their” verge to a more explicit view on the symbiotic nature of verge ownership and management.

“You see my view is that the verge is council property. It’s not my verge, it’s the council’s verge. So we are joint owners if you like of the verge. And therefore I feel that the council should make everybody have a native verge, even if it means they extend slightly their generosity of creating it to provide the people to do it.” (Margaret, City of Stirling)

Participants who explicitly addressed issues around ownership and management focussed mainly on a sense of stewardship; two other aspects (which we generally coded as tenure and extension of private garden space) reinforce stewardship of people and place including through renovation of the home and/or site.

The first aspect, in terms of tenure, reveals how verge spaces give proximate access to space/outdoors unavailable elsewhere. As cities grow, access to space and ‘dirt’ is under particular pressure from infill and the ‘McMansion’ effect (of shrinking block size and increasing dwelling footprints).

So outdoors, that's what we do. With this renewal I've been encouraging my daughter to put her gumboots on and come out and play in the dirt 'cause otherwise we don't have anywhere to play in the dirt, sort of the way the pots are and gardening at home. It's a little bit different for a kid to bend over a bricked in garden bed and get her hands dirty, compared to sitting in the dirt and getting your hands dirty. (Cameron, City of Stirling)

These participant sentiments resonate with evidence that ‘reveals that issues associated with dwelling size are not represented in strategic approaches’, which has a marked impact on urban sustainability and greening (McKinlay, C. and Stevens 2019, 135). The second aspect, in terms of co-option of space, is that it enables the verge to be a platform for innovation and connection as ‘neighbourhood’ infrastructure (including physical, cultural, or community infrastructure):

“Neighbourhood is where you live, it’s the people you know, it’s how you connect and have that connection with people. It’s a support system. I work in mental health, so having neighbours, having friends, having that informal support system is very important. I don’t know too many people really around here, but for example last weekend I decided I was going to hold a garage sale, but what I did was a couple of months ago I went round and put a flyer in everybody between Thomas Road and Rokeby Road, all the houses, and said I’m going to be having a garage sale on this date, how about you have a garage sale as well and we’ll have a group garage sale. It only ended up with four of us, and it wasn’t the most successful morning, but I did get to meet other people.

“The street library has been a great success. That’s been there just over a year. If I’m out the front gardening, the number of people that have said, ‘oh we just love the street library, we put a book in, we take a book out’. And the most wonderful thing about that is the children that come along. I actually go and buy books in the op shops, children’s books, to make sure that there’s children’s books in the street library always, because I think you need to get the youngsters reading as early

as possible. I love to see the kids come along and open the street library, and go away with a book under their arm. That's been a really nice thing. I talk to people if I'm out there. ... It is registered with streetlibrary.org, it's on their map. The other one is little library, that's the other organisation." (Leanne, City of Subiaco)

Plainly, residents with native verge gardens can amplify access and infrastructure as critical infrastructure of care (Steele 2017) that complement and challenge the conventional critical infrastructures (roads, powerlines, phonelines, and similar). Though this connection is not always the case when there is a perceived lack of community spirit as a baseline.

The overarching sense of stewardship while sometimes an afterthought in the transformation process, is often a deliberate and strategic priority when renovating the residential site and/or verge:

"Where's the work that we started doing on our values and principles around the house that we did when you came back from... this permaculture course in Victoria. He came back and he said, 'Right, let's sit down and let's write out the values that we want out of this property'. Aren't they just intriguing? And we sat down and it was invaluable. ...[reads principles] 'Our home is a comfortable, peaceful and principled meeting place in a dynamic green setting where we consciously embody prosperous frugality. Come wander.'" (Kirsten, City of Stirling)

This concern extends to those who might not share this sense of stewardship (and associated effort) or see stewardship as a diverse sense of wildness versus design:

"It's people's disconnection with nature. I think that a lot of people have got to the stage that they are so disconnected that they fear it. They don't want to be anywhere near it, they want to get pest control out, they want to fog everything. If you don't have nature, you don't have life, you are a part of this system. I think that it's really sad if we don't understand our place. Dirt's not bad, natures' not bad. It's OK not to want to get dirty but it's different to want to repel everything. You must have a respect for it because without it you don't have life. I think that's what people miss, and they're getting just so, there's no connection. And I think it must be impacting people's mental health, and also the chemicals might be affecting their health." (Katrina, City of Subiaco).

"The first time I went to it and I looked at the quality of these bloody gardens I said, "Oh God, do these people have a life?" But there's lots of people out there, it's amazing some of them, unbelievable. Mine's pretty wild and that's how it should be." (Gene, City of Subiaco)

"But there's lots of people out there who are into it. If you walk around Subiaco I'm sure you see quite a high level of these. And some of them are quite well designed. Some, they just chuck a few natives in and let them go. But some of them are actually designed. This is designed, it's thought about as you can see. The plant species is varied. It's a large variety of species and they're thought about, where they are in terms of what positions they like and ... I'm trying to make it wild but cultivated wild gardens are not actually wild, they're made to look wild." (Dwayne, City of Subiaco)

"I think people have their preconceived ideas about what a front verge should look like, what a front garden should look like. We're trying to sell our house, and people keep saying, "Ah, needs a lot of work!" And I just wonder how much they look at the front garden and think, "Ah, yeah, got to put a lawn in there." I don't know." (Sarah, City of Subiaco)

3.7 Doing things differently and looking to the future

There were a number of themes that came up when residents were asked what they would do differently next time, if they were to plant a native verge again. These ranged from better and more informed plant selection through to spending more time on planting and caring for the verge garden initially. Overall, respondents displayed a high level of satisfaction with their verge. Seven said that

there was nothing they would change if they were to do their verge again in the future and that they were very happy with it.

“Would I change anything? No, I wouldn't. No.” (Dawn, City of Subiaco)

“I don't know. I don't know that I would necessarily have a planting plan or anything because I quite like...buy a native and stick it in where there's a space. No I don't think I would change anything particularly.” (Leanne, City of Subiaco)

Nine residents said that they would plan better in the future, a theme which included taking measures such as planning the plant layout, better soil preparation, weed and grass control and using more or higher quality mulch right from the start.

“If money was no object, I would get the whole lawn, Bobcat in, replace everything.” (Karen, City of Stirling)

“...I'd plan it differently... I'd probably put more Banksias in...I'd probably put that [grass tree] in a different position and bits and pieces like that.” (Matthew, City of Stirling)

“I'd get more of this soil taken away and I'd be a little bit ... I would look around a little bit harder maybe to choose the replacement soil to mix in with it.” (Thomas, City of Subiaco)

“Probably what I would do is from the start I would probably introduce a lot more mulch. Now I need to be careful in how I say that because when I talk about mulch, I'm talking about natural mulch that's come from the property, natural leaf drop, trimmings and prunings and stuff around the place.” (David, City of Stirling)

Importantly, residents who had struggled with controlling weeds (particularly couch grass, *Cynodon dactylon*) were more circumspect in their decision, highlighting that if they had known how challenging it would be to remove and/or control the couch, they may not have decided to proceed with the transformation.

A more considered approach to the plant range was another theme that came up commonly, with four respondents saying that it was an important aspect of the process that they would change the next time. In particular, respondents noted that in future, they would choose plants that were more suitable for the soil type found in their local area, and plants that could withstand heat and low rainfall.

“Maybe obviously consider the plant range a bit better for which ones are actually going to be more suitable for the soil. (Kelly, City of Stirling)

“I probably would have been a bit more selective with the species and gone for slightly tougher ones. Because the top end's very hot.” (Dwayne, City of Subiaco)

An improved or different watering regime was mentioned by several residents. Four respondents cited this as an area that they would make changes in the future. Interestingly, three said that they would have no reticulation right from the start as they found that it wasn't effective or were concerned with the amount of water that it used.

“And I certainly wouldn't reticulate it because...I have a problem with using beautiful fresh drinking water on gardens altogether, really.” (Catherine, City of Stirling)

Conversely, one respondent said that she would change to a spray irrigation system as she felt that the drip irrigation system she chose initially had been ineffective.

"I'd probably put more water on initially. Yeah. Cause you can always take them out once they're established. But yeah, I think I lost a lot of plants because the drip feed just wasn't enough for them. I was losing good, healthy plants, but I just think that the drip feed just wasn't enough for them." (Delilah, City of Stirling)

3.7.1 Advice for others

Responses to the question of what advice respondents would share with others was varied, ranging from enthusiastic encouragement to undertake the transformation to a suggestion that people get professional advice, which could be found online or through consultation with local businesses. Overall, they felt very positive about the process and recommended it as a worthwhile undertaking.

"Just do it. Without doubt." (Delilah, City of Stirling)

"Oh, absolutely do it." (Holly, City of Stirling)

"Do it! I do wax lyrical about it." (Margaret, City of Stirling)

Planning was a common theme when asked what advice respondents had for others who might be considering transforming their verge garden. Planning in general terms was cited by seven residents as an important first step to take. A number of the verge gardeners elaborated further on this theme, saying that it was important to take the time to consider things like what they wanted to achieve, what sort of plants were suited to their area and their own personal preferences, to spend time controlling weeds prior to planting, and to get advice on how to achieve their vision, either from professional gardening consultants or from local nurseries and plant sellers. Overall, plant selection came up the most frequently, and was directly mentioned by six respondents.

"Probably two key items of advice would be one, weed control before you plant. And the other one would be research your species." (David, City of Stirling)

"Probably choosing the plant range better, and consider where the plants will be suitable, like full sun or shade, because we probably didn't look so much into that." (Kelly, City of Stirling)

"The type of plants you get ... I don't know. For me, it wasn't about being as pretty. It was about that they're going to survive, and you have to water them." (Narelle, City of Stirling)

"...try and get the plants that are local to your area, for your soil, because it's difficult finding stuff to grow." (Leanne, City of Subiaco)

Some verge gardeners also recommended that anyone thinking about transforming their verge garden also have a look at other verge gardens in their local neighbourhood, not only to get inspiration about what they did and didn't like and how things grew, but also to see what plants might have a high survival rate in their area, given constraints such as soil type, temperatures and rainfall.

"I'd suggest certainly the look around the neighborhood because I think that gives you the best idea of what would look right and how things grow, and take more notice of it than I did with some of the things that grow too tall. There's a lot of advice online and so on. Probably a good idea to plan it." (Catherine, City of Stirling)

"I reckon, walk around and see what other people are doing." (Gene, City of Subiaco)

"You have to be lucky with the choice of plants. So I would say one of the best things to do would be look around, and see what is realistic to grow based on what's on other people's verges, not what's in a book somewhere for the ideal environment." (Thomas, City of Subiaco)

3.7.2 Information needs

The need for more information around how to most effectively plant a verge garden was a theme that came up commonly with respondents. A greater amount of information was available for those who were supported directly by their local government authority than for those who undertook the verge transformation by themselves. The lack of information created uncertainty for verge transformers, primarily related to achieving the right species selection specific to the local area, as poor soils, heat and lack of shade had acted as limiting factors for plant survival rates. This meant that many of the verge gardeners had learnt as they went along, through their own successes and failures.

"So if I'd known a bit more I would have gotten some slightly more robust species in the more different circumstances." (Dwayne, City of Subiaco)

"It's like people building a house. It's the second or the third house they think oh right, now I really know [how I want] the kitchen or bathroom or whatever." (Gene, City of Subiaco)

"Well this was learning by doing." (Matthew, City of Stirling)

There was also an expressed desire for technical information on factors such as how to space plants to optimise survival rates and growth, and also how to choose species that would support biodiversity.

"Technical data, I'd love that. I mean yeah, if you find out about that sort of stuff... There's certainly no info on spacing....there's no real indication of what to plant, what you should plant. How much you should water, how often you should water. There's no... technical data... If there was a little instruction booklet that comes out of this, that would be gold." (Gene, City of Subiaco)

"I think that if they ran a course like 'how to' do your verge. I do see it in the paper, they've got bee courses, and native planting to attract bees." (Katrina, City of Subiaco)

Key finding 13: Tailored, practical information on waterwise verge gardens is essential

Workshops, local government websites, booklets and 'how-to' videos are valuable sources of information for verge gardeners. Street verges present challenges that set them apart from other domestic garden zones, including poor soil, depleted nutrients, persistent weeds, higher temperatures and sometimes full shade. Many verge gardeners are novices with native plants, and require specific information on soil preparation, local endemic species and where to buy them, and watering needs.

3.7.3 The future of the verge garden

There was a varied response when asked what plans were for the future of their verge. Some of them had further plantings that they wanted to complete on their street verge, while a few felt content with what they had achieved thus far. In most cases, there were smaller bits of ongoing work to be done, much of the time based on observing what was working and what wasn't. Many respondents stated that their verge garden was still evolving, even those that had been established for more than a decade (as typified by the exchange below). Verge gardens are dynamic sites of change and experimentation, evolving with the household and the neighbourhood more broadly.

Interviewer: So, when did you start the process?
Sarah, City of Subiaco: Probably about 15 years ago.
Interviewer: Okay, and how long did it take?
Sarah: It's still evolving.

4 Results of plant, bird and insect surveys of verge gardens

4.1 Characteristics of verge gardens

The verge gardens in the study ranged in age from newly established (i.e. within the previous 12 months) to 20 years old. The largest number of gardens in the study were between one and eight years since establishment. The proportion of gardens falling within each age category was roughly similar in both surveyed geographic regions of Perth (Figure 21). The vegetated area of verge gardens (excluding hardstand zones such as driveways and footpaths) were calculated using Google Earth. Half of the verge gardens were between 50-99 m² (Figure 22) with many having similar dimensions due to the standard block sizes surveyed. The smallest verge gardens were in the inner-suburban City of Subiaco. Nine verge gardens were located on corner blocks, with over 120 m² of vegetated area. The proportion of corner blocks in the survey is greater than the proportion of corner blocks in suburban Perth. A variety of forms were encountered (ranging from mimicking nature to formal planting; full coverage of native plants and mulch, to a mixture of grass, paving and garden beds). Three verges retained some grass. Most of the verge gardens covered the entire verge with the exception of driveway crossovers.

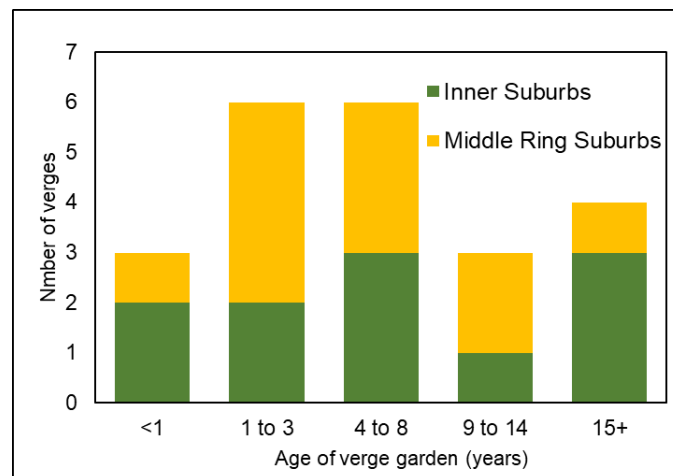


Figure 21: Age of verge gardens

The graphic depicts time since establishment at the time of interview and initial plant survey (2018).

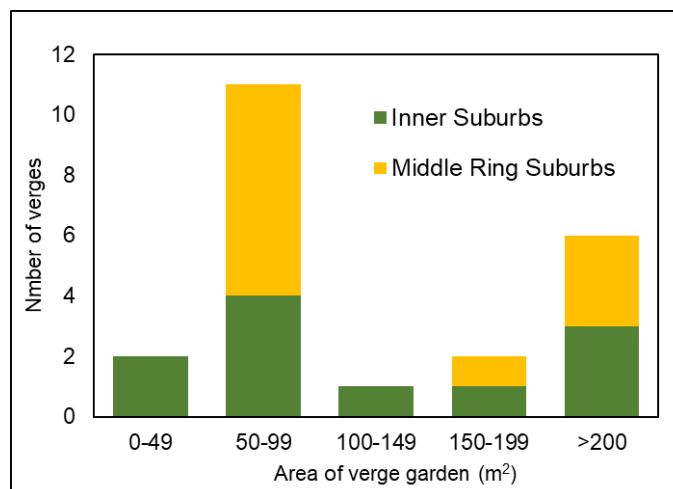


Figure 22: Area of verge gardens

Graphic depicts vegetated area, excluding hardstand such as driveways and footpaths.

Key finding 14: Residents on corner blocks may be particularly interested in verge gardening

Our sample size is small, however, it seems possible that residents with large verges that are on corner blocks may be more interested in verge gardening than residents with smaller verges. Possible reasons include: wanting to reduce time spent maintaining a larger verge; getting better ‘value-for-money’ from incentive schemes due to the larger area; and preferential purchase of houses with greater potential gardening area. More research and information is needed to confirm this trend. Larger verge gardens may provide greater habitat area for wildlife and hold potential for forming habitat corridors.

The mean distance to the nearest remnant bushland of over 1 hectare in size was just under 600 metres, with a range of 60-1200 m (Figure 23). Some gardens were located close to large remnants such as Star Swamp Reserve and Shenton Bushland, while others were roughly equidistant between two large bushlands (this was the case for many residences in the City of Subiaco, located in between Kings Park and Shenton Bushland). The residences with the longest distance to bushland remnants (over 1000 m) were generally located in built-up areas of the middle-ring suburbs; three of these properties were gardened by avid conservationists who planted locally endemic species, did not water, and were the sole verge garden in the street.

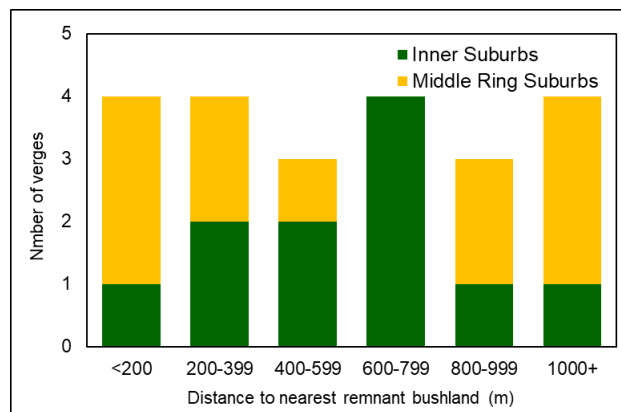


Figure 23: Straight-line distance to closest remnant bushland of over 1 ha in size

4.2 Plant species encountered in verge gardens

4.2.1 Plant species richness

The street verges surveyed for this research contained an average of 27.8 planted species per verge garden (including street trees, but not including weed species that were not deliberately planted). The number of planted species ranged between 7 and 97; these figures include spring-flowering annual species such as everlastings (*Rhodanthe chlorocephala* subsp *rosea*) that are not present year-round. The average number of species per garden was very similar for inner suburban regions, and middle-ring suburban regions. There was no apparent relationship between the size of verge gardens and the number of planted species present (Figure 24).

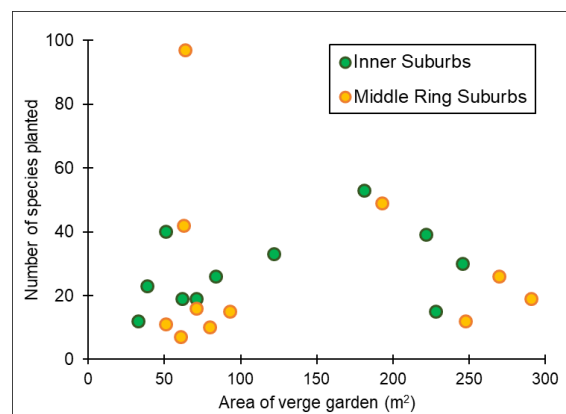


Figure 24: Comparison of species richness and size of verge gardens in suburban Perth

Each dot represents one verge garden.

Key finding 15: On average, suburban verge gardens contain between 15 and 40 plant species

It seems most native verge gardeners like to plant a range of species for visual appeal and sometimes, to mimic natural habitats, rather than focussing on a small number of species planted in repetitive arrangements. Having a diverse range of plants available may appeal to participants in verge gardening programs.

4.2.2 Plant species origin

A total of 265 different species were identified from the 22 verge gardens. This species count likely underestimates the actual number of species, as several individuals could not be identified beyond Family or Genus. See Appendix 4 for a complete species list. The geographic origin of the species identified from verge gardens are presented in Figure 25. Around 41% of the species planted occur naturally on in the Perth subregion of the Swan Coastal Plain IBRA¹² region, and a further 28% of species originated elsewhere in Western Australia.

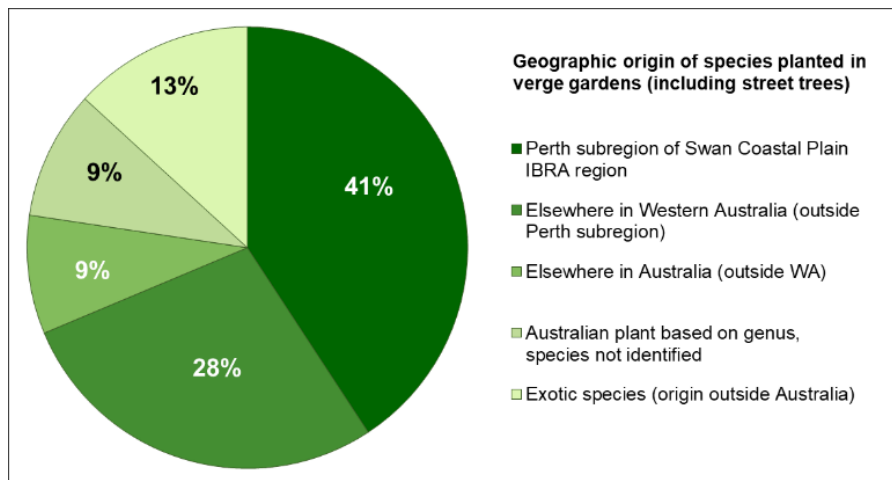


Figure 25: Location of origin for species deliberately planted in verge gardens

Horticultural varieties of a native species are treated as the same species, with the original habitat of the horticultural variety classified as the location of origin. Distribution of Western Australian species determined using records of the species mapped in Florabase (florabase.dpaw.wa.gov.au).

Figure 25 gives equal weight to each species encountered. However, of the 265 species, around 60% were ‘singletons’ that were found only in a single verge garden, and these were generally from verges where the gardener was an ‘early adopter’ who had espoused a specific goal of conservation, education and/or gardening with locally occurring species during the interview. The most common plant species encountered in verge gardens are highlighted in Table 3.

Almost all of the most commonly planted species are native to the Perth subregion of the Swan Coastal Plain, or are horticultural varieties derived from locally occurring species (Table 3). *Eremophila glabra*, often as the variety ‘Kalbarri Carpet’, was planted on nearly three-quarters of the surveyed verges. Other local favourites included *Grevillea obtusifolia* ‘Gingin Gem’, *Grevillea preissii* ‘Seaspray’, *Ficinia nodosa* (knotted clubrush), *Conostylis candicans* (grey cottonheads), *Calothamnus quadrifidus*, *Rhagodia baccata* (ruby saltbush) and *Carpobrotus virescens* (pigface). These species are hardy (some grow on coastal sand dunes) and widely available in Perth nurseries. The most commonly encountered species closely reflected those that were provided as incentives to several residents (around one-quarter of participants) by one of the LGAs in the study.

¹² Interim Biogeographic Regionalisation of Australia

The most popular species from elsewhere in Australia was *Westringia fruticosa* (coastal rosemary), which is widely available as a number of garden cultivars. The popular species *Banksia blechnifolia*, *Anigozanthos* species and hybrids (kangaroo paws) and *Rhodanthe chlorocephala* subsp. *rosea* (pink everlastings/paper daisies) originate in other regions of south-west Western Australia.

Table 3: The most commonly encountered species in surveyed verge gardens

The table below depicts species that were encountered on six or more verges (n=22).

Species/horticultural variety	Family	Locally occurring species? *	Number of verges
<i>Eremophila glabra</i> (‘Kalbarri Carpet’ and other varieties)	Scrophulariaceae	Y	16
<i>Grevillea obtusifolia</i> ‘Gingin Gem’	Proteaceae	Y	13
<i>Westringia fruticosa</i> varieties	Lamiaceae	N	12
<i>Ficinia nodosa</i>	Cyperaceae	Y	11
<i>Grevillea preissii</i> ‘Seaspray’	Proteaceae	Y	
<i>Anigozanthos</i> horticultural varieties	Haemodoraceae	Y/N**	10
<i>Calothamnus quadrifidus</i>	Myrtaceae	Y	
<i>Conostylis candicans</i>	Haemodoraceae	Y	9
<i>Banksia blechnifolia</i>	Myrtaceae	N	
<i>Carpobrotus virescens</i>	Aizoaceae	Y	8
<i>Dianella</i> sp.	Hemerocallidaceae	Y/N***	
<i>Rhagodia baccata</i>	<u>Chenopodiaceae</u>	Y	7
<i>Scaevola crassifolia</i>	Goodeniaceae	Y	
<i>Banksia dallanneyi</i>	Proteaceae	Y	6
<i>Grevillea thelemanniana</i>	Proteaceae	Y	
<i>Lophostemon confertus</i> (street tree)	Myrtaceae	N	6
<i>Agonis flexuosa</i> (street tree)	Myrtaceae	Y	
<i>Pimelea ferruginea</i> (‘Magenta Mist’ and other varieties)	<u>Thymelaeaceae</u>	Y	7
<i>Rhodanthe chlorocephala</i> subsp. <i>rosea</i>	Asteraceae	N	6
<i>Conostylis aculeata</i>	Haemodoraceae	Y	
<i>Hardenbergia comptoniana</i>	Fabaceae	Y	6
<i>Leucophyta brownii</i>	Asteraceae	Y	
<i>Olearia axillaris</i>	Asteraceae	Y	6
<i>Threlkeldia diffusa</i>	<u>Chenopodiaceae</u>	Y	

Notes

* ‘Locally occurring’ means that the species (or in the case of horticultural varieties, the species from which it is primarily derived) grows naturally in the IBRA Swan Coastal Plain bioregion, subregion Perth, based on records of the species mapped in Florabase (florabase.dpaw.wa.gov.au)

** *Anigozanthos* (kangaroo paw) hybrids have been developed horticulturally from a number of species, including *A. manglesii*, *A. flavidus*, *A. pulcherrimus*, *A. rufus* and *A. humilis*. Of these, *A. manglesii* and *A. humilis* occur naturally within the study area, while *A. pulcherrimus* is found just to the north of the study area, but still within the Perth subregion of the Swan Coastal Plain. The hybrid varieties sold for garden planting are generally not found in nature.

*** *Dianella revoluta* (blueberry flax lily) is common on the Swan Coastal Plain and available in nurseries. Other varieties of *Dianella* are also cultivated (e.g. *Dianella caerulea*) but are challenging to distinguish between species.

Key finding 16: Verge gardeners plant predominantly local Swan Coastal Plain, and WA species

Few of the verge gardeners in our study were familiar with the flora of the Swan Coastal Plain. However, the most popular plants and horticultural varieties originated in the Perth region, with the next most popular category being plants from elsewhere in WA. The most commonly encountered species closely reflected those that were provided by LGAs. Verge gardens can be an opportunity to expand and normalise the use of locally endemic species in gardening and landscaping throughout Perth. With the impact of climate change, hardy species that have evolved to survive on coastal sand dunes and other difficult environments may provide clear advantages for horticultural use.

Key finding 17: Verge gardeners need information on weeds and invasive plant species

Some species that were planted in verge gardens have the potential to spread beyond the verge garden and into bushland, where they could become established as environmental weeds. Verge gardeners may not know that some garden plants can also act as weeds. Grassy weeds such as *Ehrharta* spp. and *Eragrostis* spp. may also grow larger in verge gardens and set seed, if undetected amongst other plants. Common garden plants that should be avoided on street verges should be described and added to information provided to prospective verge gardeners.

4.3 Bird species encountered in verge gardens

4.3.1 Birds observed in urban verge gardens

The bird species encountered during verge garden surveys are listed in Table 4. In most cases, the species were observed interacting with street trees, rather than with plants at ground level or within the verge garden. These species are all common in suburban Perth, and are mostly large-bodied species. Smaller birds tend to need different habitats than is offered by street verges, such as denser vegetation and larger habitat patches. One resident had noted that they had observed 30 different species of birds in their garden as a whole over the years; that particular garden was close to a linear strip of landscaped/restored native vegetation. Another resident believed that verge gardens were not helpful for attracting diverse species of birds. Due to the constraints around the research, bird surveys were not done at the ideal time of day (early morning and late afternoon), meaning that it is possible that bird interactions with plant species in verge gardens were not recorded.

Table 4: Bird species encountered during verge surveys

Common name	Species name	Native to Perth region
Australian Magpie	<i>Gymnorhina tibicen</i>	Yes
Australian Raven	<i>Corvus coronoides</i>	Yes
Carnaby's Black Cockatoo	<i>Zanda latirostris</i>	Yes
Galah	<i>Eolophus roseicapilla</i>	Yes
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	Yes
Rainbow Lorikeet	<i>Trichoglossus moluccanus</i>	Introduced
Red Wattlebird	<i>Anthochaera carunculata</i>	Yes
Singing Honeyeater	<i>Gavicalis virescens</i>	Yes
Willie Wagtail	<i>Rhipidura leucophrys</i>	Yes

4.4 Insects encountered in verge gardens

4.4.1 Pollinating and nectar-feeding insects in urban verge gardens

The exploratory survey to determine presence/absence of pollinating and nectar feeding insects found some evidence of native bees, flower-visiting wasps, and syrphid flies (hoverflies). Native bees and wasps that could be identified to family, genus or species level are listed in Table 5. In addition to the species listed, the research team observed other native bees that were not identified, nesting in the ground and in plant stalks, and feeding on flowering street trees (in particular, Marri or *Corymbia calophylla*). A conservative estimate is that flowering plants on the street verges supported nine species of native bees. As discussed below, this is likely to be an underestimate of the total number of native bee species visiting the verge gardens in the study, particularly for those that are close to large urban bushland remnants such as Star Swamp. Some of the smallest verge gardens in the study were among those for which native bees were recorded.

Table 5: Native bees and wasps recorded visiting flowering plants on verges

Family, Tribe	Genus, species where known	Flowering plant visited
Crabronidae	<i>Tachytes</i> sp.	<i>Atriplex</i> sp.
	<i>Bembix</i> sp.	<i>Phyla nodiflora</i> *
Megachilidae	<i>Megachile</i> spp [‡] .	<i>Chorizema cordatum</i>
		<i>Corymbia calophylla</i>
		<i>Lechenaultia floribunda</i>
		<i>Rhagodia baccata</i>
		<i>Thryptomene</i> sp.
		<i>Westringia fruticosa</i>
Halictidae	<i>Lasioglossum</i> (<i>Chilalictus</i> sp.)	<i>Atriplex</i> sp.
		<i>Dianella</i> sp.
		<i>Phyla nodiflora</i> *
		<i>Rhagodia baccata</i>
	Unidentified halictid	<i>Regelia ciliata</i>
Apidae, Allodapini	<i>Exoneura</i> sp.	<i>Melaleuca</i> sp.
Apidae, Anthophorini	<i>Amegilla</i> sp.	<i>Beaufortia aestiva</i>
		<i>Dianella</i> sp.
		<i>Olearia axillaris</i>
Colletidae, Hylaeinae	<i>Meroglossa rubricata</i>	<i>Corymbia calophylla</i>

Notes:

[‡] At least three species of *Megachile* were encountered during verge surveys, but these could not be identified to a finer level of taxonomic classification from photographs or by sight.

* *Phyla nodiflora* is Lippia, an introduced species, which flowers over summer when relatively fewer floral resources are available.

Native hoverflies (Diptera, family Syrphidae) were commonly encountered in verge gardens, as were *Polistes* sp. (introduced paper wasps). The European Honeybee (*Apis mellifera*) was ubiquitous, visiting a wide variety of species in flower. *Apis mellifera* is an introduced species, which competes for food

with native vertebrate and invertebrate fauna (Chapman and Oldroyd 2020). A recently published Perth-based study found that honeybees exhibited greater dominance in the plant-pollinator networks of residential gardens, as compared with bushland remnants, which was linked with a higher abundance of exotic flowering species in home gardens that are unsuited to native bees (Prendergast and Ollerton 2021).

The species found likely represent only a small proportion of the native bees and other pollinating insects that frequent the studied verge gardens. Within Perth alone, there are around 200 species of native bees, of which 153 have previously been identified from 14 suburban gardens and urban bushland remnants over a period of 10 months spanning two years (Prendergast 2020e). Additionally, at Lake Claremont, a single bushland remnant in the heart of suburbia close to Subiaco, 44 native bee species were collected from surveys conducted three times per month over Nov-Jan (Prendergast 2020c). Lake Claremont was formerly a market garden, landfill site, and subsequently golf course, before undergoing extensive revegetation over the last decade.

Although not comprehensive, the results of this survey provide at least some record that even small, seemingly isolated patches of flowering plants can provide habitat for native bees within the suburban matrix of land uses, dwellings, gardens, trees and native vegetation remnants.

It is also important to note that native bees were recorded almost exclusively on native flora, adding to increasing evidence on the preference of native bees to native flora, and the importance of native flora in urban landscapes for supporting native insects (Prendergast and Ollerton 2021)

Key finding 18: Verge gardens can help support native bee populations

Native bee species were encountered in verge gardens and street trees. Verge garden information packs and websites should include recommended, hardy native plant species to provide food for native bees over the warmer months of the year (September to April), as well as advice on 'bee hotels' and the importance of leaving some areas of the garden unmulched for ground-nesting bees. Preservation of extant bushland is vital to act as a source population for native bees visiting verges.

4.4.2 Ecological significance of encountered native bees, wasps and hoverflies

In this section, we provide further detail on the characteristics and ecological significance of encountered native bees, wasps and hoverflies in the studied suburban Perth verge gardens. Throughout, species are referred to using scientific nomenclature, which is vital to correctly refer to these species, as common names often apply to multiple species, and can be misleading.

Native bees (Order: Hymenoptera)

Amegilla is a genus of large-bodied, robust bees in three subgenera in the tribe Anthophorini (family Apidae), comprising 21 species of *Asarapoda*, two species of *Notomegilla* and 12 species of *Zonamegilla* (Leijs, Batley and Hogendoorn 2017, Leys, Dorey and Hogendoorn 2020). In Perth there are four known species, with *Amegilla (Notomegilla) chlorocyanea* being the most common (Prendergast 2020e). *A. chlorocyanea* is one of the most common and abundant bee species in Perth (Figure 25), as well as in other urban areas in Australia (Prendergast 2020e, Makinson, Threlfall and Latty 2016). This can be attributed to their relatively large body size (somewhat larger than a European honeybee) and therefore ability to disperse between habitat fragments, but especially that they are polylectic (which means they are able to forage on a wide range of pollen hosts) (Houston 2000).

Being generalists, this means *Amegilla* can capitalise on the high diversity of flora, including exotic species, in residential areas (Prendergast 2020d, Banaszak-Cibicka and Żmihorski 2012). These traits of large body size, generalist foraging, and relatively high abundance make *Amegilla* good pollinators of many flora in urban areas. Importantly, they are excellent buzz pollinators, and can pollinate flora such as tomatoes that require sonication – a feat of which European honeybees are incapable (Hogendoorn et al. 2006, Switzer et al. 2016). Being large, cute and charismatic, they are the pandas of the Australian native bee world and are a favourite among the Australian public (Prendergast, in prep.). *Amegilla* are ground-nesting bees, and are known to like vertical or sloping silty substrates and often nest gregariously (Cardale 1968, Greco et al. 2006).



Figure 25: *Amegilla (Notomegilla) chlorocyanea* species observed with common garden plants

Amegilla species are commonly encountered in urban settings, and have gained fame as ‘blue-banded bees’ – although not all species of *Amegilla* have blue bands on their abdomen. Here, *Amegilla* are seen visiting flowers of (L) *Eremophila* sp. (*Emu bush*) and (R) *Solanum lycopersicum* (tomato) in garden settings in suburban Perth. (Images not taken as part of the verge garden study: image provided for illustrative purposes). Credit: Kit Prendergast.

Exoneura are small-bodied semi-social bees in the tribe Allodapini (family Apidae) (Cronin and Schwarz 1999, Schwarz, Bull and Hogendoorn 1998). Being semi-social they can occur in relatively high densities in an area (Prendergast 2020e). They are polylectic, visiting a diversity of floral resources (Prendergast 2020b, Prendergast 2020d, Houston 2000). They nest in pithy stems or reeds that they may hollow out themselves, of narrow diameters (5 mm or less); substrates include *Xanthorrhoea* spikes (Silberbauer and Schwarz 1995, Stow et al. 2007), blackberry stems (Prendergast 2020e), kangaroo paws, reeds and ferns (Dew, Stevens and Schwarz 2018). Their diagnostic sloping abdomen is used to block the entrance to their nests. They are generalist, adaptable bees, and can be abundant in disturbed habitats such as residential areas (Prendergast 2020e) (Figure 26), and agricultural habitats (Prendergast 2020b).



Figure 26: *Exoneura* species observed in Tuart (*Eucalyptus gomphocephala*) tree, suburban Perth

This *Exoneura* species was observed nesting (L) in tiny (1 mm diameter) borer holes (R) in the base of a mature Tuart (*Eucalyptus gomphocephala*). (Images not taken as part of the verge garden study: image provided for illustrative purposes). Credit: (image) Natasha Pauli (identification) Kit Prendergast.

Megachile are small to large, solitary native bees (family Megachilidae) (Figure 27). Species vary in their specialisation for pollen resources: many specialise on Fabaceae¹³ (Prendergast 2018, Houston 2000, Prendergast 2020d), whereas other are more generalist (Houston 2000, Prendergast 2020d). Although some species nest in the ground or in “resin pots”, the majority nest in pre-made cavities created by wood-boring beetles in nature, but will also use artificial cavities, and can be supplied with additional nesting habitat in the form of bee hotels (Prendergast 2020a). They are the main taxon to use bee hotels, with *M. erythropyga* being the most common bee to use these artificial nesting structures (Prendergast et al. 2020). Depending on the species, they seal their nests with resin, sand, chewed leaves or leaf-discs (Prendergast 2020a). One species, *Rozenapis ignita* (previously *Megachile*, recently reclassified as *Rozenapis*) collected *Banksia* cone “fuzz” to put into its nests (Prendergast 2018). The scopae (pollen-collecting hairs) are on the underside of the abdomen, making them good pollinators. They are in the “long-tongued” bee group, so can forage on flowers with longer corollas such as *Eremophila nivea*.



Figure 27: Native bees observed on verge gardens

(L) *Meroglossa rubricata*, female (C) *Megachile* (*Eutricharaea*) sp., female (R) *Lasioglossum* (*Chilalictus*) sp., male. Image credit: Natasha Pauli. Identification: Kit Prendergast

Meroglossa rubricata is a colletid bee in the subfamily Hylaeinae (family Colletidae). Like all hylaeines, they lack scopae as the females swallow the pollen then regurgitate it back at the nest. This species is

¹³ Fabaceae are the diverse legume family, including the pea-flowered subfamily Faboideae and the easily recognizable *Acacia* (wattles) in the Mimosoideae subfamily.

endemic to southwest WA . The females readily use bee hotels (Prendergast 2017, Prendergast et al. 2020), and often can be seen “guarding” the entrance to their nests. They prefer nesting diameters of 4 mm (Prendergast 2020a). Although they are a solitary species, cohabitation in a nest can occur (Prendergast 2017). *Meroglossa rubricata* prefers native flowers in the family Myrtaceae¹⁴ (Prendergast, personal obs.), but has been recorded from other plant families (Houston 1975).

Lasioglossum (Chilalictus) species are small to medium sized bees in family Halictidae (Figure 27). The genus *Chilalictus* is the most species-rich of *Lasioglossum*, with 149 described species (out of 251 described species of *Lasioglossum*). *Lasioglossum (Chilalictus)* species are predominantly polylectic (Akankunda 2020, Walker 1995), and will forage on a variety of flowers of diverse origins, including exotic horticultural and weed species (Prendergast 2020b). They are known to be adaptable and even prefer more disturbed landscapes such as urban and agricultural landscapes (Brown, Barton and Cunningham 2020, Prendergast 2020b, Prendergast et al. 2020). The most common species in the Perth region is *Lasioglossum (Chilalictus) castor* (Prendergast 2020e). Being halictids, they are ground-nesting, and so require bare substrate (Walker 1995). Many species exhibit various degrees of sociality (Kukuk, Blows and Schwarz 1990, Kukuk 2002). Being “short-tongued” bees, providing open flowers, such as those in the families Myrtaceae and Asteraceae¹⁵, is recommended.

Meroglossa rubricata is a colletid bee in the subfamily Hylaeinae (Figure 27). Like all hylaeines, they lack scopae as the females swallow the pollen then regurgitate it back at the nest. This species is endemic to southwest WA . The females readily use bee hotels (Prendergast 2017, Prendergast et al. 2020), and often can be seen “guarding” the entrance to their nests. They prefer nesting diameters of 4 mm (Prendergast 2020a). Although they are a solitary species, cohabitation in a nest can occur (Prendergast 2017). *Meroglossa rubricata* prefers native flowers in the family Myrtaceae (Prendergast, personal obs.), but has been recorded from other plant families (Houston 1975).

Native wasps (Order: Hymenoptera)

Tachytes and *Bembix* are predatory wasps in the family Crabronidae (recently split into nine monophyletic lineages), and are closely related to bees (Debevec, Cardinal and Danforth 2012, Sann et al. 2018). *Tachytes* prey on Orthoptera¹⁶ (Evans and Kurczewski 1966), and are ground-nesting (Evans and Kurczewski 1966). *Bembix* primarily prey upon Diptera (flies), but some species also prey on Neuroptera¹⁷ and Odonata¹⁸ in addition to flies (Evans, Evans and Hook 1982). *Bembix* are also ground-nesting (Evans et al. 1982).

Flies (Order: Diptera)

Syrphidae (often commonly known as ‘hoverflies’ are a diverse common family of Diptera, can reach high abundances, and have been proposed to be suitable indicators of environmental conditions (Sommaggio 1999). Syrphids play ecological roles as both potential pollinators as adults, as well as in pest management, for the larvae feed on aphids (Colley and Luna 2000). They visit many flowering species, including exotics and weeds (Robertson et al. 2020).

Rutilia are flies in the family Tachinidae. Tachinid flies are parasitoids of other insects, and often used in biological control against insect pests (Grenier 1988). *Rutilia* are known to parasitise scarab beetles (Logan 2002).

¹⁴ Myrtaceae is the myrtle family, and includes the common Australian genera *Eucalyptus*, *Corymbia*, *Melaleuca* and many more.

¹⁵ Asteraceae is often commonly referred to as the daisy family.

¹⁶ Orthoptera is an insect Order that includes grasshoppers, crickets, locusts and katydids

¹⁷ Neuroptera are the net-winged insects, including lacewings, mantidflies and antlions.

¹⁸ Odonata is an insect Order that includes dragonflies and damselflies

5 Conclusions, recommendations and further research

The research presented in this synthesis report highlights the social and ecological benefits, as well as the challenges associated with converting street verges into native gardens. In many ways, this was an exploratory study that could be used to develop the basis for future research in this area. While street verges may seem like small and insignificant pieces of land, they can add up to a significant component of public green space worthy of strategic attention. Additionally, the interest from residents in verge transformation programmes that are sponsored by local government authorities is only likely to increase in Perth over the coming years (Ligtermoet et al., forthcoming).

5.1 Key findings and recommendations

The key findings from this research have been interspersed throughout the text, and are provided as a list of hyperlinks at the beginning of the report. Our findings have relevance for:

- The design and implementation of incentive programs to promote verge gardening;
- Monitoring of the impact and uptake of verge gardening;
- Information and educational materials aimed at local residents;
- Community members seeking to transform their verge gardens.
- Understanding how different greenspaces contribute to pollinator assemblages in urban areas (e.g. Threlfall et al. 2015).

For native verge gardens to achieve their potential role in reducing water use, providing food and habitat for wildlife, socialising the concept of urban sustainability, championing native plants and providing opportunities for positive neighbourly and social interactions, we recommend the following:

- Clear demonstration and information of how much water is required by commonly grown Perth species over the summer months, based on plant species, soil type, ambient temperature, rainfall and other elements that can be easily measured by local residents.
- Example verge gardens or landscaped gardens that are visually attractive (i.e., using a variety of foliage colours and textures, and 'showy' or colourful flowering species), and showcase waterwise Swan Coastal Plain species. Videos, social media and photos can be used to assist in dissemination.
- Examples of how to create a native garden that flowers year-round, providing habitat for wildlife. This could be based on the Noongar six-season calendar, and include information about the types of insect and vertebrate species that would access flowering plants through summer and autumn.
- Information on the key features of garden design aesthetics that will also aid in providing food for wildlife – such as having large patches comprising of multiple individuals of each selected plant species rather than 'one of everything' mixed together (see for example Sih and Baltus 1987).
- Recognition of exemplary verge and/or native gardens – perhaps through the award of prizes, photo competitions, or invitations to present at workshops or lead 'verge tours'. Photo competitions could also incentivise insect or native plant photography on verge gardens.
- Incentives to 'join up' verge gardens, perhaps through award of vouchers or plants for neighbours who work together to transform verges, or 'Best Streetscape' awards where streets can compete against each other including a category that can be awarded based on meeting evidence-based criteria on what constitutes an eco-friendly verge.

- Promoting the social utility of neighbours and pedestrians being able to walk through and experience a verge garden, whether on a footpath, or through a maintained accessway through the verge garden.
- Discouraging the use of potentially invasive species in verge gardens given the less enclosed nature of these gardens, and providing information on how to monitor and remove unwanted weeds that may remain undetected for longer periods of time with higher vegetation on verges. The process of how garden plant can escape into remnant bushlands and wetlands should also be explained.
- Strategic mapping and planning of potential green corridors along streets that could provide a link between bushland remnants, or contribute significantly to the streetscape in some way (through cooling associated with vegetation), improving aesthetics, or improving walkability - and understanding how verge gardens could contribute to the green corridor.
- Sharing informative and accessible materials about policies and practice of verge gardens to avoid misunderstanding, increase resident confidence, providing realistic information (about possible costs, contributions, responsibilities, and challenges) for neighbours, novice and experience gardeners, and council staff.

5.2 Further research

Limited research has been undertaken on the social and ecological values of gardening along streetscapes in Perth. The research process has highlighted some key areas that could be developed in the future.

5.2.1 Social and planning influences on verge gardening practices

The research project encompassed only residents who had a) self-nominated in response to a call for research participants, and b) developed what they perceived as a native verge garden. While we have gained many valuable insights from this approach, future work could be extended as follows:

- Interviewing residents who do not have verge gardens, for a variety of reasons (e.g., do not approve of verge gardens, prefer lawn, have paved the area, or need the verge for other reasons such as parking), in order to understand the reasons why people maintain their verges in different ways.
- Administering a targeted online survey that is inclusive of all verge treatments from gravel to grass to native plants to vegetables, based on the responses from this work, to determine whether the trends from qualitative research are confirmed with quantitative data at a larger spatial scale.
- Develop pilot projects and associated monitoring for streetscape-scale transformations, paying attention to if and how local networks support building neighbourhood capacity and interactions over time.
- Exploring how the development of verge treatments integrates with or evolves sustainable and strategic plans and priorities (such as health and wellbeing plans or urban greening strategies) at LGA and metropolitan level.

5.2.2 Ways of effectively sharing informative and accessible materials about policies and practice of verge gardens

Sharing informative and accessible materials about policies and practice of verge gardens avoids inaccurate or incomplete knowledge. This area of research would recognise the diversity of community (based on demographics and attitudes to verge treatments), meaning that clear and reliable key messages are needed. Different expressions of media and messaging consistent with verge policy (actual or proposed reforms) plus extending to the strategic policies for local government and

metropolitan planning now and ahead could result from such research. This research area would address how to build LGA capacity for scalable community engagement and transformation. It could include:

- Infographics of LGA policy and programmes;
- Comparative study of WA and international / inter-state policy practices including best practices;
- A typology of practices and policies on verge treatments and critical case studies.

5.2.3 The spatial arrangement of verge gardens for ecological processes

The ubiquity of street verges, and their continuous spatial arrangement along residential roads, means that they have a real potential to provide ecological connectivity to wildlife in urban areas (particularly in combination with canopies of native tree species such as Marri (*Corymbia calophylla*), Tuart (*Eucalyptus gomphocephala*) and Jarrah (*Eucalyptus marginata*) and other species with abundant resources for native fauna). Given that streetscapes are such highly modified environments, residential garden verges are likely to be most important for species with high mobility, especially birds and insects, and less so for those with lower mobility (including mammals, reptiles and amphibians). Further research should focus on:

- Establishing a ‘transect’ of verge gardens with increasing distance from significant urban bushland remnants, to determine whether there is greater diversity and/or abundance of insects and birds with closer proximity to remnants.
- Using data gained from targeted surveys using an explicitly ecological design (as the research presented here used a hybrid socio-ecological approach), conduct modelling to determine how much conversion of lawn to native verges, and in which locations, would be required to create effective habitat connectivity for different species of interest across suburban landscapes containing different amounts of remnant vegetation.

Answering these question would inform LGAs of how much more effort they would need to provide in supporting native verge conversion (and maintenance), and what would likely be the wildlife benefits (and opportunities for human-wildlife connection) of those efforts. This would allow for a benefit-cost analysis to compare these strategies with other means of improving habitat connectivity.

5.2.4 The value of roadside vegetation for insects

Verge gardens, streetscape plantings, and other linear corridors of vegetation can provide valuable habitat for a range of invertebrates. There are a number of unanswered questions regarding how verge gardens, and other forms of urban roadside vegetation, can best contribute to conservation and maintaining ecological processes. For future research, we recommend:

- Collection of native bees for taxonomic identification, and a thorough implementation of standard native bee survey methods by an expert to highlight any differences in the abundance of native bee species, and potential competition with European honeybees.
- Identification of which verge plant species are preferred by native and introduced flower-visiting insects, and how verge plant species composition influences bee visitors.
- Comparison of native bee visitors to verge gardens with lawns, domestic gardens of varying sizes and species composition, streetscape plantings, biodiverse plantings in local (recreation) parks, and urban bushland remnants in the same geographic vicinity.
- Understanding landscape-scale characteristics in urban settings (e.g. proportion of builtspace in the landscape, proportion of remnant native vegetation) and patch dynamics, and how these influence visitation rates.

- Investigating if providing bee nesting habitat i.e. bee hotels can increase bee visitation to verge gardens.
- Investigating how flowering trees along verges benefit verge biodiversity, building on the focus on lower-strata flowering plants in the current report.
- Surveying herbivorous insects, to expand the information gained beyond flower-visiting insects.
- Understanding whether and how residents' knowledge and perceptions of insects changes with time as they become immersed in native gardening.

5.3 Conclusions

The exploratory research presented in this report has highlighted some of the benefits that residents receive from transforming their verges to native gardens, as well as some of the key challenges that either inhibit transformation from occurring, or may lead to sub-optimal environmental outcomes. While they may be small in size compared with other sites of urban greening and restoration, verge gardens are highly visible in neighbourhoods that are dominated by vehicle and foot traffic. This means that verge gardens have the potential to act as sites of education, socialisation, and contemplation for local residents. By providing residents with the means to improve the potential ecological and environmental values of verge gardens, these small sites may collectively contribute to habitat for wildlife, and to other sustainability goals. Further monitoring of the water balance and ambient temperatures associated with a range of verge gardens are needed to determine the potential role of these locations for suburban cooling and reducing water use.

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Appendix 1: Participant information forms for residents



THE UNIVERSITY OF
**WESTERN
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Participant Information Form – Resident Interviews

Project title: “From footpaths to ecosystems: understanding the role of the verge in delivering urban ecosystems services”

Name of Researcher: Natasha Pauli

You are invited to participate in a research project about the role of street verges (or nature strips) in the urban environment. We are interested in speaking with residents who have transformed their street verge to a ‘waterwise’ or native garden, or who are planning to do so in the near future. Your perspective is valuable to understanding how residents view street verges and their benefits for the environment and the community.

Aim of the Study (What is the project about?)

In recent years, there has been growing interest in transforming street verges from ‘traditional’ grassed surfaces, to gardens of low-growing, native species. A number of local governments in Perth now offer incentives or programmes to assist residents to undertake this type of transformation. Despite rapidly growing interest in the community, there is relatively little documented information available on the benefits and disadvantages of transforming street verges to gardens.

Our study seeks to fill this important gap in knowledge by examining residents’ views on transformed street verges. We are particularly interested in why residents have chosen to undertake a verge transformation, and any perceived benefits or challenges to the local community, wildlife and environment.

The funding for this research comes from the National Environmental Science Programme through the Clean Air and Urban Landscape Hub (<https://www.nesurban.edu.au/>). We hope that the information gathered through this research will help in the development of policy tools and planning decisions for urban green space.

What does participation involve?

Participation in this project will involve being interviewed by a researcher, at a time and location convenient to you. The interview is expected to take between 40-60 minutes. With your consent, your interview will be audio recorded. This allows the researchers to accurately document and reflect your knowledge and perspectives. We can provide you with a digital copy of your recording or in a written format if requested. We also request that you provide some outline demographic information on a separate written form – you may complete as much or as little of this form as you desire. Finally, if a member of the research team is able to interview you at your residence, we will ask if we can create a

sketch map of the street verge garden with you, highlighting features of particular interest. If you are a resident who has already undertaken a verge transformation, we additionally request to photograph your verge garden. Photos will not include any identifying markers such as street names or numbers. As a participant, you decide what information to provide and if you find any questions difficult or inappropriate, you may decline to comment.

Voluntary Participation and Withdrawal from the Study

Participation is entirely voluntary. You are free to withdraw from the study at any time, without giving any explanation. You do not need to provide any reason for this. In such cases, the information you have provided will be destroyed, unless you give other instructions.

Your privacy

Your participation in this study and any information you provide will be treated in a confidential manner. Publications arising from this project will not include identifying details.

Possible Benefits

We hope to contribute to better understanding of how urban communities can improve the environmental and community values of streetscapes. The results of this study will be made publicly available and we hope will be of interest and use to agencies, industry and community groups involved in making policy and planning decisions on urban green space.

Possible Risks and Risk Management Plan

There are no foreseeable risks associated with participation in the research.

Contacts

If you would like to participate or discuss any aspect of this study please feel free to contact Natasha Pauli on 6488 3546 (Tues-Fri) or via email on natasha.pauli@uwa.edu.au



Sincerely,
Dr Natasha Pauli *BSc (Hons), PhD*
Chief Investigator

Approval to conduct this research has been provided by the University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time. In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Ethics office at UWA on (08) 6488 4703 or by emailing to humanethics@uwa.edu.au. All research participants are entitled to retain a copy of any Participant Information Form and/or Participant Consent Form relating to this research project.



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Participant Information Form – Ecological Surveys

Project title: “From footpaths to ecosystems: understanding the role of the verge in delivering urban ecosystems services”

Name of Researcher: Natasha Pauli

You are invited to continue your participation in a research project about the role of street verges (or nature strips) in the urban environment. One or more members of our social science research team (Natasha Pauli, Clare Mouat, Mariana Atkins) has interviewed you in 2018 or 2019 on your native verge garden, and created a sketch map of your garden and the plants within it. We now seek your permission to continue the research with a non-invasive survey of the interactions among plants, birds and pollinating insects in your street verge garden. We would like to survey the verge gardens over the spring-summer of 2019-2020, and potentially in spring-summer 2020-21, so that we can understand how the environmental and habitat values of street verge gardens change over time.

Aim of the Study (What is the project about?)

In recent years, there has been growing interest in transforming street verges from ‘traditional’ grassed surfaces, to gardens of low-growing, native species. A number of local governments in Perth now offer incentives or programmes to assist residents to undertake this type of transformation. Despite rapidly growing interest in the community, there is relatively little documented information available on the benefits and disadvantages of transforming street verges to native gardens.

Our study seeks to fill this important gap in knowledge by gathering data on key components of street verge gardens: the plants, birds, and insect pollinators that live in these habitats. We are particularly interested in developing a profile of how the ecological values of these verges develop over time, from grassed verges to young plants and increasingly mature gardens.

The funding for this research comes from the National Environmental Science Programme through the Clean Air and Urban Landscape Hub (<https://www.nesurban.edu.au/>). We hope that the information gathered through this research will help in the development of policy tools and planning decisions for urban green space.

What does participation involve?

Participation in this project will involve volunteering your street verge as a site for ecological surveys. You do not need to spend any time on this research nor do you need to actively participate – there is no requirement for you to collect data or observations.

You do not need to be at home during the verge surveys, nor do you need to take any special actions (e.g. weeding, tidying, altering watering schedules or moving bins or vehicles). You are of course very

welcome to be present if you wish to do so. We will take every care with the plants on the verge, acknowledging that these are actively gardened spaces that are important to residents.

One or two members of the research team at UWA would visit your verge four times between September/October 2019 and March 2020. Each survey would be undertaken at least one month apart. During each visit, the research team member(s) would observe bird activity over a set period of time (20 minutes) and observe pollinating insects visiting flowering plants (likely to take 30-50 minutes depending on the size of the location and number of plants flowering). Birds and insects that cannot be identified on-site would be photographed for later identification. We will not take any samples of plants or insects. We may update our existing map of plants on the verge. We additionally request to photograph your verge for illustrative purposes. Photos will not include any identifying markers such as street names or numbers.

Our research team is able to commence the first survey as early as XXX DATE and we aim to complete initial surveys by XXX DATE. Ordinarily, verge surveys would be conducted on a Wednesday, Thursday or Friday. The time of day for the survey would be within the window between 7:00am and 5:00pm. The three following surveys would be conducted over the remainder of spring and summer, within the same day and time constraints.

As bird and insect surveys depend on having favourable weather, and because the length of surveys may vary between the different sites (several sites will be assessed on each field day), it may be difficult to confirm in advance on which date each survey will take place, and more difficult still to confirm an exact visit time. If this is not agreeable to you and you would prefer advanced notification, you can indicate this preference on the Participant Consent Form. Otherwise, if you give consent for the field research to be conducted, the research team will continue with fieldwork and only contact you via email regarding the bird and insect surveys once the field component has been completed in early autumn 2020. The research team member(s) will place a card confirming that the site has been surveyed in your letter box at the conclusion of each visit, along with the name and contact details of the surveyor in case of any queries.

Finally, provided you are satisfied with the research process, we would like to sample your street verge again in the spring-summer of 2020-21 to see how the plant structure and habitat values of the verge have changed and developed.

Voluntary Participation and Withdrawal from the Study

Participation is entirely voluntary. You are free to withdraw from the study at any time, without giving any explanation. You do not need to provide any reason for this. In such cases, the information you have provided will be destroyed, unless you give other instructions.

Your privacy

Your participation in this study and any information you provide will be treated in a confidential manner. Publications arising from this project will not include identifying details. The research team will not access nor photograph your private property.

Possible Benefits

We hope to contribute to better understanding of how urban communities can improve the environmental and community values of streetscapes. The results of this study will be made publicly available and we hope will be of interest and use to agencies, industry and community groups involved in making policy and planning decisions on urban green space. You may request a copy of the results of the study and specifically for your verge, when these are available.

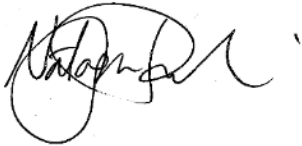
Possible Risks and Risk Management Plan

There are no foreseeable risks associated with participation in the research.

Contacts

If you would like to participate or discuss any aspect of this study please feel free to contact Natasha Pauli on 6488 3546 (Tues-Fri) or via email on natasha.pauli@uwa.edu.au

Sincerely,

A handwritten signature in black ink, appearing to read 'Natasha Pauli', written over a circular scribble.

Dr Natasha Pauli *BSc (Hons), PhD*
Chief Investigator

Approval to conduct this research has been provided by the University of Western Australia, in accordance with its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time. In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Human Ethics office at UWA on (08) 6488 4703 or by emailing to humanethics@uwa.edu.au. All research participants are entitled to retain a copy of any Participant Information Form and/or Participant Consent Form relating to this research project.

Appendix 2: Household/Resident Demographic Questionnaire

1. Surname/Family Name:
2. Email address:
3. Gender (please circle): a. Female b. Male
4. How old are you? (please circle):
 - a. <25 years
 - b. 25 to 34 years
 - c. 35 to 44 years
 - d. 45 to 54 years
 - e. 55 to 64 years
 - f. 65 to 74 years
 - g. 75 plus years of age
 - h. I prefer not to answer this question
5. What is your cultural background? (e.g. the cultural heritage of yourself and/or your parents)
6. Do you speak any languages other than English at home? a. Yes b. No
(If 'Yes', please write which one/s)
7. In which country were you born?
8. If born overseas, how many years have you lived in Australia?
9. How many children do you have?
10. Who else lives in your home?
 - i. Relationship to you Age:
 - ii. Relationship to you Age:
 - iii. Relationship to you Age:
 - iv. Relationship to you Age:
 - v. Relationship to you Age:
 - vi. Relationship to you Age:
11. What is the highest level of education you have completed?

Demographic questionnaire continued

12. What sort of work do you usually do? (Please write your answer below)

13. Which of the following best describes your current employment situation? (Please circle)

- a. Self employed
- b. Employed for wages, salary or payment in kind
- c. Unemployed and looking for work
- d. Engaged in home duties
- e. A student
- f. Retired, or
- g. Unable to work (not due to age)
- i. (other)

14. Are you happy to tell us the household income range?

 a. Yes b. No

If yes, which of the following ranges best describes your household's approximate income received by all members of your household, from all sources over the last 12 months? (please circle)

- a. Less than \$20,000
- b. \$20,000 - less than \$40,000
- c. \$40,000 - less than \$60,000
- d. \$60,000 - less than \$80,000
- e. \$80,000 - less than \$100,000
- f. \$100,000 - less than \$120,000
- g. \$120,000 - less than \$150,000
- h. \$150,000 – less than \$180,000
- i. Over \$180,000

15. What is your housing status? Do you (please circle)

- a. Rent
- b. Own house with a mortgage
- c. Own house outright
- d. Have another arrangement

16. Do you have any pets? If yes, please state what you have.

Appendix 3: Resident interview guiding questions

Let's begin by talking about **your street verge**.

- **Why** did you decide to transform your verge into a native garden?

- **How did you go about** transforming your garden?
 - When did you start?
 - How long did it take?
 - Where did you get **inspiration** and ideas from?
 - Do you know others who have done something similar?
 - Are there any neighbours who have done this?
 - Did you get any **support** from your LGA, community groups, etc?
 - What were your main reasons for choosing the **plants and landscaping**?
 - Were there any **challenges** you faced in the process of transforming your verge?
 - If you were to do it again, would you change anything?

- What **advice** would you give to someone thinking about transforming their verge?

- Let's talk about your street verge as it is **now**:
 - **How much time** do you currently spend caring for your verge each week and what do you do? [Is it irrigated/watering regime]
 - What do you think the **main benefits** [will be] of having a native garden on the street verge are to **you and your family**?
 - What has been the impact of the transformation on the **wider community**?
 - Have there been any comments?
 - Have neighbours been encouraged to do the same thing?
 - How about the impact on the **wider environment and wildlife**? Outline.
 - Have there been any **negative impacts** of the verge transformation?

- Tell me about your plans for the **future** regarding your street verge?
 - Do you intend to keep going or expand/change your native gardening efforts?
 - What would your **ideal neighbourhood streetscape** look like?
 - What do you think is needed to achieve this?

[Note degree of confidence naming plants on the verge]

*I would now like to ask you some questions about **your views on gardening and nature***

- Can you tell me about [the rest of] your **garden/yard** [backyard, frontyard]?
 - What sort of plants grow in your garden?
 - How do you and other members of your household use the garden/yard?
 - How much time would you spend in your garden in an average week?

- Are you interested in **nature and local wildlife**?
 - Are there any plants, animals or insects you particularly like to see and why?
 - Are there any plants, animals or insects you particularly dislike and why?
 - Have you observed changes in wildlife around your neighbourhood?
 - What do you most enjoy about seeing wildlife [in your garden]?
 - Are you involved in any environmental activities?

- When you were growing up, **did you spend time in nature? In the garden?**
 - What did you do and how did it make you feel?
 - Do you spend time in nature now? How does it make you feel?

*Finally I would like to ask some questions about **you, your household and your community***

- How **long have you lived** in your house?
- **Why** did you chose to move to the area?
- What does the term '**neighbourhood**' mean to you?
- What do you **think about your neighbourhood**?
 - What do you like about your neighbourhood? What do you not like?
 - Do you feel that you belong to your neighbourhood? Why/why not?
- How commonly do neighbours help each other out in your neighbourhood?
- Can you tell me about **social activities** in your neighbourhood [or street]?
 - In the last six months how many times have you taken part in activities?
- How many of your **neighbours do you know** by name?
 - How many of your neighbours do you consider as friends?
- Do you belong to any **local community or environmental groups**? [Are children attending local schools?]

Final questions

- Is there anything else you would like to share with me/us about your neighbourhood, community, environment, garden or street verges?
- Do you have any questions about this research?
- Would you be happy to be contacted in the future to participate in further research on street verges and urban gardening?

[Final note that biological surveys will be done in 2019]

Thank you very much for taking the time to participate in this research.

Appendix 4: Plant species encountered in verge gardens

The list below includes plants that were deliberately planted, including in verge gardens and as street trees. 'Occurs in Perth subregion' refers to plants with a natural distribution in the Perth subregion of the Swan Coastal Plain IBRA region, as defined on Florabase. Exotic species are those not found naturally in Australia.

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Agapanthaceae	<i>Agapanthus</i> sp.	Agapanthus					X
Aizoaceae	<i>Carpobrotus edulis</i>	Pigface (introduced)					X
	<i>Carpobrotus virescens</i>	Pigface (native)	X	X	X		
	<i>Mesembryanthemum</i> sp.						X
Amaryllidaceae	<i>Allium sativum</i>	Garlic					X
	<i>Allium schoenoprasum</i>	Chives					X
Apiaceae	<i>Petroselinum crispum</i>	Parsley					X
Apocynaceae	<i>Plumeria rubra</i>	Frangipani					X
Araliaceae	<i>Trachymene coerulea</i>	Blue Lace Flower	X	X	X		
Asparagaceae	<i>Acanthocarpus preisii</i>	Prickle Lily	X	X	X		
	<i>Agave</i> sp.						X
	<i>Lomandra confertifolia</i>				X		
	<i>Lomandra</i> sp.					X	
Asphodelaceae	<i>Aloe vera</i>	Aloe vera					X
Asteraceae	Daisies (various exotic)						X
	<i>Brachyscome iberidifolia</i>	Swan River Daisy	X	X	X		
	<i>Cephalopterum drummondii</i>			X	X		
	<i>Gazania</i> sp.	Gazania					X
	<i>Helianthus</i> sp.	Sunflower					X
	<i>Leucophyta brownii</i>		X	X	X		
	<i>Olearia axillaris</i>	Coastal Daisybush	X	X	X		
	<i>Pithocarpa ramosa</i>			X	X		
	<i>Podotheca</i> sp.			X	X		
	<i>Rhodanthe chlorocephala</i> subsp. <i>rosea</i>	Pink and White Everlastings		X	X		
	<i>Schoenia cassiniana</i>			X	X		
	<i>Senecio pinnatifolius</i>		X	X			
	<i>Senecio</i> sp.					X	
	<i>Tagetes</i> sp.	Marigold					X
	Bignoniaceae	<i>Jacaranda mimosifolia</i>	Jacaranda				
Casuarinaceae	<i>Allocasuarina lehmanniana</i>	Dune Sheoak	X	X	X		
	<i>Casuarina glauca</i> 'Cousin It'				X		

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Chenopodiaceae	<i>Atriplex cinerea</i>	Saltbush	X	X	X		
	<i>Atriplex semibaccata</i>	Saltbush		X	X		
	<i>Atriplex sp.</i>	Saltbush				X	
	<i>Enchylaena tomentosa</i>	Ruby Saltbush	X	X	X		
	<i>Rhagodia baccata</i>	Berry Saltbush	X	X	X		
	<i>Rhagodia spinescens</i>	Spiny Saltbush		X	X		
	<i>Threlkeldia diffusa</i>	Coast Bonefruit	X	X	X		
Cupressaceae	<i>Cupressaceae sp.</i>	Cypress					X
Cyperaceae	<i>Ficinia nodosa</i>	Knotted Clubrush	X	X	X		
	<i>Lepidosperma gladiatum</i>	Coastal Sword Sedge	X	X	X		
	<i>Schoenus grandiflorus</i>		X	X	X		
Dilleniaceae	<i>Hibbertia racemosa</i>		X	X	X		
	<i>Hibbertia scandens</i>	Snakevine			X		
	<i>Hibbertia sp.</i>					X	
	<i>Hibbertia subvaginata</i>		X	X	X		
Dioscoreaceae	<i>Dioscorea hastifolia</i>	Warrine, wild yam	X	X	X		
Ericaceae	<i>Erica sp.</i>						X
	<i>Leucopogon parviflorus</i>		X	X	X		
Euphorbiaceae	<i>Ricinocarpos pinifolius</i>	Wedding bush				X	
Fabaceae	<i>Acacia alata</i>		X	X	X		
	<i>Acacia ashbyae</i>			X	X		
	<i>Acacia cochlearis</i>		X	X	X		
	<i>Acacia extensa</i>		X	X	X		
	<i>Acacia howittii</i>				X		
	<i>Acacia lasiocarpa</i>	Panjang	X	X	X		
	<i>Acacia pulchella</i>	Prickly Moses	X	X	X		
	<i>Acacia saligna and varieties (e.g. 'Springime Cascade')</i>		X	X	X		
	<i>Acacia sp.</i>					X	
	<i>Acacia truncata</i>		X	X	X		
	<i>Bossiaea eriocarpa</i>		X	X	X		
	<i>Ceratonia siliqua</i>	Carob, street tree					X
	<i>Chorizema cordatum</i>		X	X	X		
	<i>Chorizema varium</i>		X	X	X		
	<i>Gastrolobium celsianum</i>	Swan River Pea	X	X	X		
	<i>Gastrolobium praemorsum 'Brown Butterfly'</i>		X	X	X		
	<i>Gompholobium tomentosum</i>		X	X	X		
	<i>Hardenbergia comptoniana</i>	Native Wisteria	X	X	X		
	<i>Hovea pungens</i>		X	X	X		
	<i>Jacksonia sericea</i>	Waldjumi	X	X	X		
<i>Jacksonia sp.</i>					X		
<i>Kennedia coccinea</i>	Coral vine	X	X	X			

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Fabaceae	<i>Kennedia nigricans</i>			X	X		
	<i>Kennedia prostrata</i>	Running Postman	X	X	X		
	<i>Leptosema</i> sp.					X	
	<i>Lotus berthelotii</i>	Trailing Lotus					X
	<i>Senna</i> sp.						X
	<i>Sophora</i> sp.	Kowhai					X
	<i>Templetonia retusa</i>	Cocky's Tongue	X	X	X		
Geraniaceae	<i>Pelargonium</i> sp.	Geranium					X
Goodeniaceae	<i>Dampiera</i> sp.1			X	X		
	<i>Dampiera</i> sp.2			X	X		
	<i>Dampiera teres</i>		X	X	X		
	<i>Lechenaultia biloba</i>		X	X	X		
	<i>Lechenaultia floribunda</i>			X	X		
	<i>Lechenaultia</i> sp.						X
	<i>Scaevola ?nitida</i>						X
	<i>Scaevola anchusifolia</i>		X	X	X		
	<i>Scaevola argentea</i>			X	X		
	<i>Scaevola crassifolia</i>		X	X	X		
	<i>Scaevola repens</i>		X	X	X		
	<i>Scaevola</i> sp.	Fanflower					X
	<i>Scaevola spinescens</i>	Maroon Bush			X	X	
	<i>Scaevola thesioides</i>		X	X	X		
Haemodoraceae	<i>Anigozanthos horticultural varieties</i>	Kangaroo Paw	X	X	X		
	<i>Anigozanthos humilis</i>	Cats Paw	X	X	X		
	<i>Anigozanthos manglesii</i>	Red and Green Kangaroo Paw	X	X	X		
	<i>Anigozanthos viridis</i>	Green Kangaroo Paw		X	X		
	<i>Conostylis aculeata</i>	Prickly Conostylis	X	X	X		
	<i>Conostylis candicans</i>	Grey Cottonheads	X	X	X		
	<i>Haemodorum</i> sp.	Bloodroot					X
	<i>Macropidia fuliginosa</i>	Black Kangaroo Paw	X	X	X		
Haloragaceae	<i>Gonocarpus</i>			X	X		
Hemerocallidaceae	<i>Dianella revoluta</i>	Blueberry Flax Lily	X	X	X		
	<i>Dianella</i> sp.	Blueberry Flax Lily				X	
Iridaceae	<i>Dietes</i> sp.						X
	<i>Patersonia occidentalis</i>	Purple Flags	X	X	X		
Lamiaceae	<i>Hemiandra pungens</i>	Snakebush	X	X	X		
	<i>Lavandula angustifolia</i>	Lavender					X
	<i>Mentha x piperita</i>	Mint					X
	<i>Prostanthera magnifica</i>			X	X		

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Lamiaceae	<i>Salvia rosmarinus</i>	Rosemary					X
	<i>Westringia fruticosa</i>	Coastal Rosemary			X		
Lauraceae	<i>Cinnamomum camphora</i>	Camphor Laurel, Street Tree					X
Lythraceae	<i>Lagerstroemia sp.</i>	Crepe Myrtle					X
Malvaceae	<i>Guichenotia ledifolia</i>		X	X	X		
	<i>Guichenotia macrantha</i>			X	X		
	<i>Guichenotia sp.</i>			X	X		
	<i>Thomasia purpurea</i>		X	X	X		
	<i>Thomasia quercifolia</i>			X	X		
Myrtaceae	<i>Agonis flexuosa</i>	Peppermint, Street Tree	X	X	X		
	<i>Agonis flexuosa nana</i>	Dwarf Peppermint	X	X	X		
	<i>Austromyrtus dulcis</i>	Midyim			X		
	<i>Beaufortia aestiva</i>		X	X	X		
	<i>Beaufortia sp.</i>					X	
	<i>Calothamnus gilesii</i>			X	X		
	<i>Calothamnus hirsutus</i>		X	X	X		
	<i>Calothamnus quadrifidus</i>	One-sided Bottlebrush	X	X	X		
	<i>Calothamnus sanguineus</i>		X	X	X		
	<i>Calothamnus sp.</i>			X	X		
	<i>Calytrix acutifolia</i>		X	X	X		
	<i>Calytrix sp.</i>					X	
	<i>Chamelaucium sp.</i>				X	X	
	<i>Chamelaucium uncinatum</i>	Geraldton Wax	X	X	X		
	<i>Corymbia calophylla</i>	Marri, street tree	X	X	X		
	<i>Corymbia citriodora</i>	Lemon Scented Gum, street tree			X		
	<i>Corymbia ficifolia</i>	Red Flowering Gum, street tree		X	X		
	<i>Corymbia sp.</i>					X	
	<i>Darwinia citriodora</i>		X	X	X		
	<i>Darwinia pinifolia</i>		X	X	X		
	<i>Eremaea sp.</i>			X	X		
	<i>Eucalyptus alba</i>				X	X	
	<i>Eucalyptus caesia</i>	Silver Princess			X	X	
<i>Eucalyptus erythrocorys</i>	Illyarrie			X	X		
<i>Eucalyptus forrestiana</i>				X	X		
<i>Eucalyptus kingsmillii</i>				X	X		
<i>Eucalyptus leucoxylon</i>	Street tree				X		
<i>Eucalyptus leucoxylon rosea</i>	Street tree				X		
<i>Eucalyptus rhodantha</i>				X	X		

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Myrtaceae	<i>Eucalyptus sp.</i>					X	
	<i>Eucalyptus torquata</i>	Coral Gum, street tree		X	X		
	<i>Hypocalymma cordifolium</i>		X	X	X		
	<i>Hypocalymma robustum</i>	Swan River Myrtle	X	X	X		
	<i>Hypocalymma sp.</i>			X	X		
	<i>Kunzea baxteri</i>			X	X		
	<i>Kunzea ericifolia</i>	Spearwood	X	X	X		
	<i>Kunzea pomifera</i>	Muntries			X		
	<i>Lophostemon confertus</i>	Queensland Box Tree, street tree			X		
	<i>Melaleuca citrina</i> 'Kings Park Special'	Bottlebrush, street tree			X		
	<i>Melaleuca fulgens</i>				X	X	
	<i>Melaleuca huegelii</i>	Chenille Honey Myrtle	X	X	X		
	<i>Melaleuca incana nana</i> 'Velvet Cushion'		X	X	X		
	<i>Melaleuca lateritia</i>		X	X	X		
	<i>Melaleuca nesophila</i> 'Little Nessie'		X	X	X		
	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark			X		
	<i>Melaleuca sp.</i>						X
	<i>Melaleuca systema</i>	Coastal Honey Myrtle	X	X	X		
	<i>Melaleuca tricophylla</i>		X	X	X		
	<i>Melaleuca viminalis</i> and varieties (incl 'Little John')				X	X	
	<i>Melaleuca viridiflora</i>				X	X	
	<i>Micromyrtus racemosa</i>				X	X	
	<i>Myrtaceae sp.</i>						X
	<i>Pileanthus sp.</i>	Copper Cups			X	X	
	<i>Regelia ciliata</i>		X	X	X		
	<i>Thryptomene baeckeacea</i>				X	X	
	<i>Thryptomene sp.</i>						X
<i>Verticordia chrysantha</i>				X	X		
<i>Verticordia halophila</i>				X	X		
<i>Verticordia mitchelliana</i>				X	X		
<i>Verticordia plumosa</i>		X	X	X			
Nyctaginaceae	<i>Bougainvillea sp.</i>	Bougainvillea					X
Oleaceae	<i>Olea europaea</i>	Olive, stree tree					X
Phyllanthaceae	<i>Phyllanthus calycinus</i>	False Boronia	X	X	X		
Pittosporaceae	<i>Billardiera heterophylla</i>	Bluebell Creeper	X	X	X		
Poaceae	<i>Austrostipa flavescens</i>		X	X	X		
	<i>Austrostipa sp.</i>			X	X		

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Poaceae	<i>Cymbopogon ambiguus</i>	Native Lemongrass		X	X		
	<i>Poa poiformis</i>		X	X	X		
	<i>Rytidosperma</i>			X	X		
	<i>Themeda</i> sp.	Kangaroo Grass				X	
Proteaceae	<i>Adenanthos cuneatus</i>			X	X		
	<i>Adenanthos sericeus</i> 'Bronze Glow'			X	X		
	<i>Adenanthos</i> sp.			X	X		
	<i>Banksia attenuata</i>	Biara, Candle Banksia	X	X	X		
	<i>Banksia blechnifolia</i>			X	X		
	<i>Banksia dallanneyi</i>	Couch Honeypot	X	X	X		
	<i>Banksia integrifolia</i> 'Roller Coaster'				X		
	<i>Banksia menziesii</i>	Mungite, Bulgalla, Firewood Banksia	X	X	X		X
	<i>Banksia prionotes</i>	Acorn Banksia	X	X	X		
	<i>Banksia repens</i>				X	X	
	<i>Banksia sessilis</i>	Pulgart, Parrotbush	X	X	X		
	<i>Banksia spinulosa</i> 'Birthday Candles'					X	
	<i>Conospermum stoechadis</i>	Common smokebush	X	X	X		
	<i>Grevillea banksii</i> × <i>bipinnatifida</i> 'Robyn Gordon'	Grevillea			X	X	
	<i>Grevillea banksii</i> × <i>bipinnatifida</i> 'Robyn Gordon'	Grevillea			X	X	
	<i>Grevillea banksii</i> × <i>bipinnatifida</i> 'Superb'	Grevillea			X	X	
	<i>Grevillea banksii</i> × <i>pteridifolia</i> 'Honey Gem'	Grevillea			X	X	
	<i>Grevillea banksii</i> × <i>sessilis</i> 'Misty Pink'	Grevillea				X	
	<i>Grevillea bipinnatifida</i>		X	X	X		
	<i>Grevillea crithmifolia</i>	Horticultural variety known as 'Green Carpet'	X	X	X		
	<i>Grevillea eriostachya</i>	Yellow Flame Grevillea	X	X	X		
	<i>Grevillea juniperina</i> 'Juniper Rose'					X	
	<i>Grevillea lanigera</i>					X	
	<i>Grevillea lanigera</i> 'Mt Tamboritha'					X	
	<i>Grevillea lanigera</i> × <i>lavandulacea</i> 'Cherry Ripe'					X	
	<i>Grevillea longistyla</i>					X	
	<i>Grevillea longistyla</i> × <i>venusta</i> 'Fire Sprite'					X	

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Proteaceae	<i>Grevillea nivea</i>	Scarlet King		X	X		
	<i>Grevillea obtusifolia</i> 'Gingin Gem'	Gingin Gem	X	X	X		
	<i>Grevillea olivacea</i>			X	X		
	<i>Grevillea preissii</i> 'Seaspray'	Grevillea Seaspray	X	X	X		
	<i>Grevillea</i> sp.					X	
	<i>Grevillea thelemanniana</i>	Spider Net Grevillea	X	X	X		
	<i>Grevillea vestita</i>		X	X	X		
	<i>Hakea costata</i>		X	X	X		
	<i>Hakea francisiana</i>	Emu Tree		X	X		
	<i>Hakea laurina</i> and varieties (e.g. 'Mini Pini')	Pincushion Hakea		X	X		
	<i>Hakea linearis</i>			X	X		
	<i>Hakea lissocarpa</i>		X	X	X		
	<i>Hakea myrtooides</i> x <i>petiolaris</i> 'Burrendong Beauty'		X	X	X		
	<i>Hakea petiolaris</i>		X	X	X		
	<i>Lambertia</i> sp.			X	X		
	<i>Stirlingia latifolia</i>	Blueboy	X	X	X		
Rutaceae	<i>Boronia heterophylla</i> 'Lipstick'	Boronia		X	X		
	<i>Citrus x limon</i>	Lemon					X
	<i>Coleonema</i> sp.	Diosma					X
	<i>Correa</i> sp.					X	
	<i>Diplolaena angustifolia</i>	Yanchep Rose	X	X	X		
Sapindaceae	<i>Diplopeltis petiolaris</i>			X	X		
	<i>Dodonaea</i> sp.	Hop bush				X	
Scrophulariaceae	<i>Eremophila calorhabdos</i>			X	X		
	<i>Eremophila decipiens</i>			X	X		
	<i>Eremophila densifolia</i> 'Purple Carpet'			X	X		
	<i>Eremophila glabra</i> and varieties (e.g. 'Kalbarri Carpet', also subsp <i>albicans</i>)		X	X	X		
	<i>Eremophila glabra</i> x <i>veneta</i> 'Augusta Storm'		X	X	X		
	<i>Eremophila hygrophana</i> and varieties (e.g. 'Silky Bells')			X	X		
	<i>Eremophila lehmanniana</i>			X	X		
	<i>Eremophila maculata</i>			X	X		
	<i>Eremophila maculata</i> subsp <i>brevifolia</i>			X	X		
	<i>Eremophila nivea</i> and varieties (e.g. 'Spring Mist')			X	X		
	<i>Eremophila scaberula</i>			X	X		
	<i>Eremophila</i> sp.				X		
	<i>Eremophila splendens</i>				X	X	
	<i>Eremophila subteretifolia</i>				X	X	

Family	Species	Common name, other notes	Perth subregion	WA species	Australian species	Australian, origin not known	Exotic species
Scrophulariaceae	<i>Myoporum insulare</i>	Boobiella	X	X	X		
	<i>Myoporum parvifolium</i>				X		
	<i>Myoporum purpurea</i>						
	<i>Myoporum sp.</i>					X	
Solanaceae	<i>Anthocercis littorea</i>	Yellow Tailflower	X	X	X		
	<i>Solanum lycopersicum</i>	Tomato					X
Stylidiaceae	<i>Stylidium maritimum</i>		X	X	X		
Thymelaeaceae	<i>Pimelea calcicola</i>		X	X	X		
	<i>Pimelea ferruginea</i>		X	X	X		
	'Magenta Mist' and other varieties						
Tropaeolaceae	<i>Tropaeolum majus</i>	Nasturtium					X
Verbenaceae	<i>Lantana sp.</i>	Lantana					X
	<i>Phyla nodiflora</i>	Lippia					X
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>		X	X	X		