



Clean Air and Urban Landscapes Hub

National **Environmental Science** Programme

Conservation of urban biodiversity: a national summary of local actions

Research Report

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 under the National Environmental Science Program of the Australian Government's Department of the Environment and Energy. 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 biodiversity, and with a focus on applying research to develop practical solutions.

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1. EXECUTIVE SUMMARY AND KEY FINDINGS

The purpose of this research report is to identify current approaches to urban biodiversity conservation in Australian cities and identify opportunities and challenges for undertaking future actions. This project forms the first Australian assessment of its kind, where findings can be used to facilitate improved practice.

This report forms Part I of the project, which aims to:

- Develop a national inventory of local actions undertaken for urban biodiversity conservation in Australian cities;
- Use case studies to showcase the breadth of actions for successful urban biodiversity conservation;
- Summarise common barriers to and enablers of urban biodiversity conservation;
- Document the extent to which Indigenous perspectives are currently considered in urban biodiversity conservation; and
- Highlight future opportunities to conserve urban biodiversity.

Part I was developed via interviewing land managers, conservation organisations and community groups about their current and desired approaches to urban biodiversity conservation and Indigenous engagement in urban biodiversity projects.

From this process we documented a range of current approaches to urban biodiversity conservation, including numerous innovative actions aimed at improving, expanding or creating habitat, re-introducing species or natural processes, extensive community programs to consult, engage and empower communities to undertake conservation, including Indigenous communities, and various activities to mandate and regulate biodiversity conservation on urban land. We highlight several of these innovative approaches using case studies from across Australia.

Several barriers to and enablers of urban biodiversity conservation were identified, many of which also applied to Indigenous engagement. These included: 1) the need to fight to gain support for conservation actions; 2) a lack of capacity and resources; and 3) the need to implement long-term approaches. Factors that were described as enabling conservation efforts included: 1) celebrating small wins and acknowledging achievements; 2) sharing information and knowledge among organisations and communities; and 3) developing deep and strong relationships and partnerships, which was identified as especially critical for appropriate and effective Indigenous engagement.

Finally, we summarise the desires of land managers for future action in urban biodiversity conservation. These include a desire to substantially improve current ecological outcomes via a range of yet to be implemented initiatives, including those that better connect people to Nature in cities. A range of future initiatives surrounding improved legislation and policies for urban biodiversity conservation are also identified, in addition to improved administrative processes that currently hinder local action.

Part II of the project includes a report developed by Indigilab Pty Ltd, outlining recommendations for future Indigenous engagement on issues of biodiversity conservation, specifically to enhance future opportunities to integrate Indigenous knowledge and practice in urban biodiversity conservation.

2. BACKGROUND

The current state of urban biodiversity conservation

Nature in cities is under constant threat from urban expansion and the growing human population. This threat will increase with increasing global urban land cover, resulting in severe loss of natural habitats. Despite the trend of biodiversity decline, urban Nature provides many benefits to city dwellers, from clean air and reduced heat to increased workforce productivity, lower rates of heart disease, and improved mental health. Hence, there is an urgent need to enhance and return Nature back into cities to make them more sustainable and liveable. To this end, city governments, scientists and citizens worldwide are increasingly engaging in popular initiatives, including widespread tree planting (e.g. ‘million trees’ programs), encouraging backyard wildlife gardening, and installing nest boxes or shelter sites.



An urban Banksia woodland restoration site in Perth. Credit: Cristina Ramalho.

However, there is currently little guidance for land managers on how to implement conservation actions targeted to urban environments, with no coordinated evidence base documenting opportunities and indicators of success for urban conservation projects. Further, cities occur and always will occur on Indigenous land, and hence cities are important places to acknowledge past, present and future connections to natural and cultural heritage, Indigenous knowledge and identity. Importantly, Indigenous perspectives and knowledge are crucial for long-term, sustained biodiversity conservation, land and water management. Yet, there is little guidance on ways to better acknowledge, represent and collaborate with Indigenous communities on issues of urban biodiversity. In this research project we seek to redress these issues by evaluating the types of biodiversity conservation actions currently undertaken, examining what species they target, their desired ecological outcomes, the level of Indigenous engagement currently occurring and documenting indicators of success.

Our project

This project aims to identify current approaches to urban biodiversity conservation, understand the range of conservation actions currently implemented in Australian cities, including those involving engagement with Indigenous peoples and communities, and identify opportunities and challenges for undertaking future actions. We seek to build momentum and encourage local action for biodiversity conservation in urban environments, by highlighting the value of such actions to decision-makers working in this space. This project forms the first Australian assessment of its kind, where findings can be used to facilitate improved practice.

The aim of this report

This research summary has been specifically written for urban land managers or groups who implement actions for biodiversity conservation in urban areas. This report aims to:

- Develop a national inventory of local actions undertaken for urban biodiversity in Australian cities;
- Use case studies to showcase the breadth of successful urban biodiversity conservation actions;
- Summarise common barriers to and enablers of urban biodiversity conservation actions;
- Document the extent to which Indigenous perspectives are currently considered in urban biodiversity conservation; and
- Highlight future opportunities to conserve urban biodiversity.



Carnaby's black cockatoo is one of three threatened cockatoo species in Perth. Credit: Laurie Boyle via flickr (CC BY-SA 2.0).

3. METHODS

We used a semi-structured interview approach to ask land managers, conservation organisations and community groups about their approach to urban biodiversity conservation and hence gain an understanding of the range of biodiversity conservation actions implemented in Australian cities.

Participants were recruited from our current network of professional stakeholders involved in the Clean Air and Urban Landscapes Hub (CAUL) research program, in addition to participants being recommended due to their implementation of conservation actions.

During an approximately 60-minute interview, participants were asked to detail and provide their perspective on:

- 1) The range of activities, projects or actions they undertake to support urban biodiversity;
- 2) The motivations, challenges and opportunities they perceive in implementing those activities;
- 3) The extent to which the community, including Indigenous communities, are engaged in the process;
- 4) Key lessons they have learnt about how to implement projects and what makes them successful; and
- 5) Their aspirations for future urban biodiversity conservation.

The research design sought to generate qualitative, in-depth data because there is little existing research on this topic. This approach was used to develop detailed knowledge around the range, type and breadth of biodiversity conservation actions, and the perceived challenges and opportunities for their implementation in a range of contexts.

We interviewed 27 participants from four states including NSW, VIC, ACT and WA, from a range of local and state government agencies, non-government organisations and community groups across a range of urban contexts, from inner city to outer peri-urban locations. Interviews were audio-recorded and then transcribed for analysis. The major themes emerging surrounding current and future actions, and the challenges and opportunities to their implementation are summarised below.

This research was conducted under ethics approval 1851835.1 from The University of Melbourne. All participants were voluntary and anonymous except where express permission was granted to identify participating organisations or projects. The list of questions used during the semi-structured interviews are provided in the Appendix.

4. FINDINGS

Types of actions

Participants described a range of actions and projects they have undertaken to support and promote urban biodiversity. These can be grouped under the following overarching themes:

- Habitat improvement, restoration or expansion
- Direct threat mitigation
- Installation of artificial structures or habitats
- Ecological recycling or re-use of natural materials
- Re-introduction of species or natural processes
- Community programs
- Policy, strategy, regulation
- Operational capacity building
- Land acquisition and conversion
- Monitoring and benchmarking
- Environmental quality improvements

Table 1 describes examples of actions under each of these themes and lists the threats participants felt were being addressed by the implementation of such actions. The majority of participants across all organisation types engaged in actions that improved habitat, restored or expanded existing habitat, such as planting and bush restoration. These activities were supported by direct threat mitigation (feral animal control, fencing, weeding), in addition to adding new habitat where no habitat previously existed, for example via the installation of artificial structures or via recycling natural materials and re-purposing them in new locations.

The second most discussed action type was the implementation of community programs to engage, educate and raise awareness for biodiversity conservation. This included a wide range of activities, often targeting schools or home owners with the intent of raising the profile of biodiversity and improving the capacity of the general public to act to conserve urban biodiversity on private land.

Other commonly mentioned actions included: capacity building, such as activities that enhanced the capacity of an organisation to implement conservation action, or activities that enhanced partnerships with community or other agencies (e.g. Universities); development of policies or strategies that enable the implementation of conservation actions; and collecting baseline or monitoring data on the status of biodiversity in an area.

Table 1: Inventory of actions for urban biodiversity conservation, grouped by theme, from Sydney, Canberra, Melbourne and Perth. Examples of each action type are given, in addition to the major threat each action is aiming to mitigate.

| Action type | Examples | Purpose or threat being addressed |
|---|--|---|
| Habitat improvement, restoration or expansion | | |
| Restoration of an ecological community | Revegetation, restoration of a threatened plant population and/or plant community Ecological burns | Habitat degradation |
| Targeted planting | Planting to expand a patch of remnant vegetation Planting food resources for particular animal species (e.g. threatened birds) Creating planting palettes for biodiversity | Fragmentation Habitat loss Creation of new habitat with appropriate plant species |
| Design or management changes | Changing pathway width or edge type to be more compatible with biodiversity requirements Adding no mow zones Road verge planting programs Removing vegetation to promote habitat use for a particular species Adding/changing infrastructure to encourage use and appreciation of Nature Cutting-in hollows and/or cavities to existing trees | Habitat loss Meeting dual outcomes for people and biodiversity Enabling access to Nature Creating new habitat in areas where no habitat occurred |
| Aquatic habitat | Converting backyard pools to wildlife ponds Adding artificial substrates to increase structural complexity to intertidal habitats Fish passages | Creation of aquatic habitat Connectivity/movement |
| Direct threat mitigation | | |

| Action type | Examples | Purpose or threat being addressed |
|---|---|---|
| Fencing, weeding, pest species management | Gambusia fish fence Fox and cat control | Mitigating threats (e.g. exotic predators) |
| Artificial structures | | |
| Wildlife boxes, bark, burrows, nesting structures | Wildlife boxes, clay pipes, artificial bark, Osprey pole | Lack of nesting and shelter resources |
| Over/underpasses, culverts | Rope bridges, structures within culverts, tunnels and under bridges that create refuge or shelter | Connectivity/movement/refugia |
| Ecological recycling | | |
| Dead limb, dead tree relocation | Relocation of entire intact trees Collection of parts of trees and re-purposing as habitat (salvage hollows) | Lack of key habitat structures |
| Rocks, logs, coarse woody debris | 'Boulder (rock) fields' for reptiles | Lack of nesting and shelter resources |
| Creation of seed production areas | 'Seeds from the Street' – using seed generated from one place to plant into another location | Lack of seed production and recruitment |
| Re-introduction of species or process | | |
| Species reintroduction | Mistletoe, threatened animal reintroduction | Missing critical species |
| Water management | Re-flooding floodplains, reinstating natural water regimes | Improve water cycle |
| Community programs | | |
| Consult, engage the community | Feedback survey Park naming competition Planting days | Increasing awareness and engagement |
| Education and awareness raising | Sustainability festival Walk and talks | Improving public knowledge and participation in biodiversity conservation |

| Action type | Examples | Purpose or threat being addressed |
|--|--|---|
| | Bioblitz events School programs Demonstration sites Art installations | |
| Enhancing community capacity and stewardship | Gardens for Wildlife program Bee hotel building workshops | Improving environmental stewardship and connection to nature Improving habitat on private land |
| Citizen science | Backyard bird count | Increase public participation in biodiversity activities |
| Policy, strategy, regulation | | |
| Biodiversity Strategy | Site specific, local government or city-wide Connectivity Strategy | Provide a framework and policy direction for implementation of actions for biodiversity |
| Offset, land acquisition schemes, strategic zoning | Bushland buy-back scheme Re-zoning land for wildlife/conservation Purchase of land for new greenspace Habitat offset scheme | Acquire new land for the purposes of conservation |
| Habitat enhancement policy | Dead tree removal and stockpile scheme (for repurposing of dead wood as habitat) Biodiversity planting guide | Policy creation to enable very specific habitat resources are retained or created |
| Operational/capacity building | | |
| New position within an organisation | Wildlife gardening officer | To enhance capacity of residents to create backyard habitat |
| Grant schemes for community | Conservation on private land grants | To enhance capacity of residents to create backyard habitat |

| Action type | Examples | Purpose or threat being addressed |
|---|---|---|
| Data capture and storage | Purchase of monitoring equipment Development of biodiversity database | To enhance capacity of land managers to monitor their biodiversity assets |
| Partnership development | Partnerships across regions, or with Universities, community groups, or across entire organisations (engineers, designers, ecologists working together) | To enhance capacity of all stakeholders to implement conservation action |
| Land conversion | | |
| Converting under-utilised space to conservation space | Former golf course to bushland reserve | |
| Stream/waterway renewal | | |
| | Converting a drain to a natural creek | |
| Monitoring and benchmarking | | |
| Vegetation and fauna surveys | Birds, bats, frogs, threatened plants, weeds | Obtaining baseline and ongoing data on the plants and animals within a specific place |
| Survey of habitat attributes | | |
| | Hollow tree survey | Obtaining data on habitat quality |
| | Coarse woody debris survey | |
| Monitoring environmental conditions | Urban heat island mapping Water quality assessment | Obtaining data on environmental condition of different assets or sites |
| Environmental quality improvements | | |
| Water quality | Waterway renewal, WSUD features | Improve environmental quality |

5. CASE STUDIES OF URBAN CONSERVATION PROJECTS

The actions listed above are examples of the range of activities undertaken to conserve biodiversity through various means. Below we give specific detail on how a range of these action types have been implemented and what their outcomes to date have been. The case studies were selected to highlight a range of actions that can be implemented, large- and small-scale projects, new and innovative ideas, in addition to highlighting actions ongoing in different parts of the country.

The case studies include actions highlighting:

- Habitat expansion (Case study 1)
- Ecological recycling (Case study 2)
- Species re-introduction (Case study 3)
- Community programs (Case studies 4, 5 and 6)
- Land conversion (Case studies 7, 8 and 9).



Urban Nature Board Walk over Herdsman Lake, Perth. Credit: Cristina Ramalho.

CASE STUDY 1

Habitat expansion: Creation of a Fairy Tern breeding sanctuary



Fairy Tern with a chick. Credit: Claire Greenwell.

What: The Perth and Peel Region is one of the most important for the threatened Fairy Tern (*Sternula nereis nereis*). Few secure breeding sites remain in the Mandurah-Rockingham area due to coastal development, higher water levels in the Peel-Harvey Estuary and other coastal management issues. As a result, breeding failure is a recurring problem. Over the summer of 2016/17, a small colony formed on a development lot in the Mandurah Ocean Marina. Fairy Tern colonies typically establish in the same locations over consecutive years, and sites close to river mouths and inlets are favoured due to their high productivity and reliable supply of baitfish. According to the WA Fairy Tern Network, the species is conservation-dependent and without tailored management to preserve colony sites, its populations will almost certainly decline. Target management approaches include the establishment of ‘managed sites’, areas set aside in locations that satisfy the species’ resource needs and that can be used to overcome the lack of secure, natural nesting habitat.

Where: Mandurah, Western Australia.

How: ‘Ternologist’ Dr Nic Dunlop (Conservation Council WA), along with BirdLife Peel, the Peel Harvey Catchment Council and the City of Mandurah, identified a space within the Mandurah Ocean Marina as a potential managed site. With funding from the Coastwest initiative, the site was cleared of vegetation and fenced, and white shell donated by Cockburn Cement was spread across the surface to replicate the successful nesting sanctuary at Rous Head by Fremantle Ports. The ‘Mandurah Fairy Tern Sanctuary’ was completed in time for the 2017 breeding season. However, while the Fairy Terns appeared to observe the site, they did not land or nest. In 2018, Murdoch University PhD researcher, Claire Greenwell, trialled the use of social facilitating methods and their

effectiveness in attracting Fairy Terns to the sanctuary. With the help of volunteers, decoys (models of nesting terns) and audio-playbacks of recorded colony sounds were deployed.



Sanctuary site completed in 2017. Credit: City of Mandurah.

Outcome: The use of social attractants, particularly the audio cues, was successful and at its peak, the colony had more than 140 breeding pairs, including an overflow onto the adjacent beach. After three weeks of the colony being established, chicks began to hatch. Unfortunately, around this time, a single stray cat killed six adults and some forty chicks over three nights. The high predation level triggered an escape response and most terns abandoned the site. The beach-nesting terns also faced threats, including rapid beach erosion, dogs and people walking through the fenced off nests. The drastic predation event generated much discussion in the media and an outpouring of community support, which helped to raise the terns' profile and the many threats they face as a beach-nesting bird.

Strong discussions on cat ownership and feral cat management have been sparked in Mandurah and the wider community. A 'cats working group' has since been formed to better mitigate the impact of cats on local wildlife and lobby with other LGAs for State legislative support of more effective control methods. As to the Sanctuary, targeted cat control will be conducted prior to the 2019 breeding season and social attractants will be trialled again, further down the length of the sanctuary to see if this encourages maximal use of the nesting area, avoiding beach nesting.



*A Fairy Tern standing beside a decoy.
Credit: Claire Greenwall.*

CASE STUDY 2

Ecological recycling: Hollow and mature tree salvage and relocation



A 160-year-old yellow box street tree. Credit: Dr Darren Le Roux, ACT Parks and Conservation Services.

What: Hollow-bearing trees provide critical habitat for a range of biodiversity, however they can be scarce in urban landscapes. Dead and decaying trees that contain hollows are routinely removed in public parks and residential developments due to the perceived risks they pose to public safety. The ACT Parks and Conservation Service has established a large-scale project to re-use hollows and entire trees that would otherwise be lost, pioneering methods to salvage and re-locate trees to mitigate the loss of critical hollow resources in the areas they manage.

Where: Relocation of salvaged hollows and entire trees has been employed to restore 50 ha of degraded land in Barrer Hill in the Molonglo River Reserve back to box-gum grassy woodland. To replace lost habitat resources, such as old large and hollow bearing trees, the ACT Parks and Conservation Service has installed habitat trees, including five repurposed utility poles and five dead street trees.

How: Relocation of trees has involved the use of heavy machinery, structural engineers, ecologists and arborists working together. In the case of the ACT Parks and Conservation Service, they have capitalised on their City Services '*Dead Tree Removal Program*' that operates in streets and parks, and two dedicated wood stockpiling areas to salvage and store appropriate hardwood tree species that otherwise would be destroyed, finding new locations for their installation.



Outcome: Monitoring of the habitat trees in the Molonglo River Reserve has shown a significant and immediate increase in the number of native bird and microbat species in the area, with observations of animals using the habitat trees to nest, breed and move through the landscape. The community are also very positive about the project, and general engagement with Nature has been improved in the area.

A utility pole, that was secured in underground concrete pads and enriched with cross perches, carved log hollows and artificial bark. Credit: Dr Darren Le Roux, ACT Parks and Conservation Services.

CASE STUDY 3

Species re-introduction: Re-introduction of mistletoe



"Look up and Pucker up" – signage placed at the bottom of London Plane trees highlighting the naturally occurring mistletoes to the community. Credit: Lee Harrison, City of Melbourne.

What: In many cities, critical habitat resources for wildlife are missing, including species that provide food and sheltering resources for birds and insects, such as mistletoes. Mistletoes specifically provide foraging resources for the Mistletoe bird and can provide a host plant for the larvae of many native butterflies. Mistletoes are commonly removed when found on urban trees, including in parks and streets, as they are perceived to harm the tree. However, healthy host trees can support a low density of mistletoes without influencing their growth, whilst providing for a range of biodiversity (Griebel et al., 2017, Mathiasen et al., 2008).

Where: In the City of Melbourne, mistletoes in the urban forest are routinely removed. Despite this requirement, the Urban Forest and Ecology team noticed mistletoes in some of their street trees, with no ill effects to the tree noted. To trial whether mistletoe could be successfully re-introduced to more locations in the city, they have trialled the planting of mistletoes for the purposes of providing biodiversity habitat.

How: The City of Melbourne engaged a mistletoe specialist, Prof Dave Watson (Charles Sturt University) to co-develop their program. Council staff observed that *Muellerina eucalyptoides*, a creeping mistletoe, had naturally colonised species of deciduous trees in the city. Because of this, and the low risk to tree health posed by this species, Council decided to trial the re-introduction of this species to London Plane trees. To do this they mapped potential locations and assessed tree health and human safety criteria to determine suitable trees for mistletoe re-introduction. To establish the



Mistletoe fruits collected from the local area. Credit: Lee Harrison, City of Melbourne.

mistletoe, they used cherry pickers to plant collected fruit into the branches on 27 London Plane trees.

Outcome: Monitoring of the mistletoes themselves suggests that they have successfully germinated in their new location. A bird monitoring program has been established to observe changes in the bird community and use of the mistletoe through time. A tree health monitoring program has also been established to monitor the impact of the mistletoes on the host plants. Anticipated ecological benefits include the provision of food resources for particular species of birds and butterflies. In addition, it is anticipated that mistletoes will provide foraging resources for other animals (birds, possums, insects) as well as potential refuge habitat from extreme heat conditions that urban trees experience, via the provision of extra foliage.



*Sown mistletoe fruits that were placed in London Plane trees *Platanus × acerifolia* around the city. Credit: Lee Harrison, City of Melbourne.*

CASE STUDY 4

Local field guides: Providing resources to raise awareness about local fauna



HUME CITY COUNCIL
FAUNA OF HUME
A guide to identifying local animal species



HUME CITY COUNCIL
BIRDS OF HUME
A guide to identifying local bird species

Hume City Council "Birds of Hume" and "Fauna of Hume" field guides.

What: Urban residents are often unaware of the native wildlife species they share their cities with. To combat this, Hume City Council created two local field guides – “Birds of Hume” and “Fauna of Hume” – which are made available to residents as hard copies or online. These guides include tips for bird and wildlife watching, and information about helping these species to thrive in Hume. The aim is to “encourage residents to explore the amazing diversity of native birds, mammals, reptiles and frogs found in Hume’s waterways, woodlands and grasslands.”

Where: The City of Hume is a local government area in the northern growth corridor of Melbourne.

How: Council Biodiversity Officers realised there was a need for tailored information on local species to help engage its diverse multicultural community with urban nature. Images for each species were sourced from local community members, such as camera clubs and ‘Friends’ groups, as well as larger environmental societies. Following a public launch to distribute printed copies, both field guides were made freely available online. The guides are promoted at environmental workshops and Council events, school visits and outreach activities, and as part of larger events such as the Aussie Backyard Bird Count.



A primary school student ticking-off the species he has seen in his booklet while his father takes him to different bird-watching spots around Hume. Credit: Hume City Council.

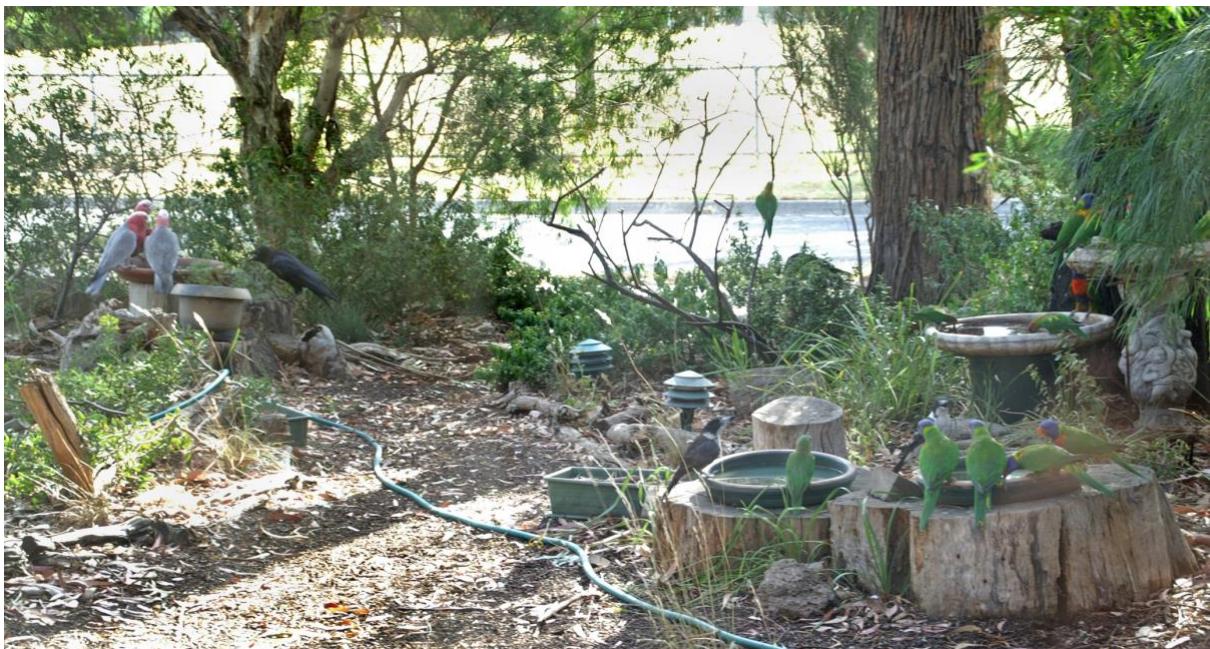
Outcome: The field guides have been well-received by the local community, with more than 9,000 fauna guides and 12,000 bird guides distributed to date. The Council encourages the community to contact them to share stories of how they have used the guides to identify unknown species, or to go on their own local ‘Nature watching’ expeditions to tick species off their lists. The field guides have clearly helped the community to engage with urban Nature in a positive way.



A primary school ‘Bird Watching Club’ undertaking a bird survey. Credit: Hume City Council.

CASE STUDY 5

Wildlife gardening: Community action for urban wildlife



Native birds enjoying a garden as part of the program. Credit: Knox City Council.

What: '*Gardens of all shapes and sizes can be wonderful places for wildlife'*

It can be hard to find enough space for wildlife in urban areas, where large parks or tracts of conservation land are scarce. The Gardens for Wildlife program address that problem by harnessing collective community action, providing guidance and support to residents to create 'wildlife friendly' gardens in a coordinated way.

Where: The Gardens for Wildlife program originated in Melbourne's eastern suburbs with the Knox City Council in 2006. It was formalised into a state-wide network in 2016 and has been rolled-out in 29 municipalities across Victoria. The approach is suited to a wide range of ecosystem and habitat types and can be tailored to the wildlife of the surrounding area.

How: Gardens for Wildlife is founded on community-agency partnerships – the program is co-designed and co-led by the community, local government agencies, and other environmental groups, to ensure that the approaches suit the needs of the community and local wildlife. For example, in Knox, the program is supported and coordinated by the city council and Knox Environment Society, a local environmental group. Residents interested in participating are first led on a guided visit of their own garden, noting the species present and opportunities for future action. These garden visits are also used to show residents just how much biodiversity is already present, often pointing out species that they may have previously overlooked. Residents are then provided with information on planting and other habitat supplementation methods (e.g. nest boxes, bird baths) that could attract native wildlife to their yards, a voucher for 23 plants from the local native nursery, and put in contact with a network of other local participants. The council also holds regular workshops to guide various aspects of wildlife gardening.

Outcome: The program fosters a sense of community among residents, who actively network and report on the animal species observed in their yard, and advise each other on new actions that can be taken. There are now over 800 individual participants and twelve businesses involved in creating wildlife-friendly yards across a single municipality. A key strength is that it is driven both from the ground up, as well as supported from the top down. The success of the program is also supported by recent scientific research, which highlights the value of collaborative wildlife gardening programs both for engagement and conservation outcomes.



Neighbourhood letterboxes displaying membership to the Gardens for Wildlife program. Credit: Knox City Council.

CASE STUDY 6

Raising community awareness through installations: Pollinator feature



The pollinator arch installed in Glebe foreshore. Credit: Sydney City Council.

What: The City of Sydney has installed a large wooden arch to meet the dual purpose of raising awareness for pollinators in urban landscapes in addition to providing greater pollinator habitat. The City's Urban Ecology Strategic Plan identified the need to increase habitat features across the LGA for local wildlife. The community interest in pollinators and the understanding that pollinators are in need of attention fuelled efforts for the City to investigate what could be done. Based on other case studies, the pollinator habitat feature was considered a great opportunity to meet community interest and habitat outcomes.



Close-up of the pollinator arch installed in Glebe foreshore. Credit: Sydney City Council.

Where: Along the Glebe Foreshore, Sydney.

How: Based on the space available, knowledge of the bee species known to occur in the area, and examples seen around the world, the pollinator arch was designed and constructed out of wood, mud bricks, lantana, bamboo and other materials, to provide habitat for a range of different native solitary bee species. It has been placed in a designated bush restoration site that is easily seen by passer-by's.

Outcome: Monitoring of the feature shows that it is being used by Blue Banded bees (*Amegilla* species), the Masked bee (*Hylaeus honestus*) in addition to other insects (native wasps such as the Cuckoo wasp).

It also features in regular walk and talks run by The City in the area, serving to raise awareness of pollinators and their habitat requirements in urban areas.

CASE STUDY 7

Land conversion: It should have been impossible! Recreating urban wetlands



The recreated biodiverse park and wetlands. Credit: Westgate Biodiversity Bili Nursery and Landcare

What: A neglected drainage ditch in a small urban park converted into a chain of biodiversity-friendly wetlands in the heart of Melbourne.

Where: The wetlands run along the southern boundary of Westgate Park – a services reserve for critical sewerage, water, gas, and electricity infrastructure. In 2012 it was a steep sided open drain densely covered in weeds. The Friends of Westgate Park saw an opportunity to expand the park and create more direct access to the river.

How: The challenges were immense. The project needed agreement from all the service providers. The Port of Melbourne would need to make a path through their land and bring their stormwater into the wetlands. Parks Victoria and the State Government would need to be on board. The Victorian Parliament would need to pass a bill to transfer the land! The group also needed a lot of money for earthmoving.

By 2013 negotiations were underway. The services routes were identified and pegged, plans were drawn up to splay the edges of the drain and create a series of shallow ponds linked by meandering watercourses along its length. A new, shared walking/cycling path would open up a once-hidden part of the Park. Plant lists of grassland, sedges and other wetland species were prepared. Large trees were avoided to protect pipework.

Earthmovers started work in October 2015, clearing debris, constructing clay liners and shaping the landscape naturally and for best water retention. Uncovered timber and rocks would be put to clever use. Thousands of volunteer hours by members, corporate groups and Work for the Dole teams went into spreading truckloads of mulch and putting plants in the ground over the next three years.

Outcome: The abundance of several species of dragonflies indicate a healthy ecosystem in these wetlands. The shared pathway is well used by commuters moving between the River and bayside suburbs.



The transformation of a drainage ditch into a biodiverse park and wetlands before (left), during (right), and after (above)
CreditL Westgate Biodiversity Bili Nursery and Landcare.

CASE STUDY 8

Land conversion: From a golf course to native habitat



The site of the old golf course years after restoration works. December 2013. Credit: Heidi Hardisty.

What: In the past, many wetlands in Perth were drained for agricultural development, and farming, market gardening and dairying took place around their edges. The lakes and flooded areas were often used as rubbish tips, as a mean to 'reclaim' land. In the 1950's, rapid urbanization of the inner and western suburbs saw these areas being valued for recreation and sport, which led to the conversion of the landfill areas into islands, golf courses and lawned parkland. This is a common history of many wetlands in Perth, including Lake Claremont (Simpson and Newsome, 2017).

Where: In 2009, the town of Claremont closed one of the two golf courses located in the lake's margins, a move that was advocated by the Friends of Lake Claremont, a community group established by local residents. A concept plan was put in place to safeguard 21 ha as parkland, half of it to be revegetated back to native vegetation, including a narrow buffer strip around the wetland.

How: The Friends of Lake Claremont applied for multiple grants to support the restoration project, and coordinated a yearly increasing number of volunteers to



Restoration works in July 2011. Credit: Heidi Hardisty.

help with the restoration works, including planting and weeding, as well as other habitat enhancement activities in the park.

Outcome: Since 2010, nearly \$600,000AUD worth of grants were invested in the restoration project, over 340,000 native seedlings have been planted, and more than 1,000 volunteers per year were engaged, in a total of over 35,000 volunteer hours. Ten hectares of golf course and wetland margins were successfully revegetated, and a small 3 ha degraded bushland, which was the only remnant vegetation left in Claremont, was restored. Today the park is visited by hundreds of people daily, and several bird species have returned to the area according to a Birdlife Australia quarterly survey conducted in the area for the past 15 years. Some of these include habitat specialist species, such as the variegated fairy-wren, spotted pardalote, western gerygone, spotless crake, and the Australian spotted crake. The pink fairy and common minion orchids have been recently found in the bushland.



*Left) Aerial photograph of the old golf course in August 2009; Right) Aerial photograph of the same area in June 2015.
Credit: NearMap.*

CASE STUDY 9

Land conversion: From urban drains to living streams



*Since restoration, Western long-necked turtles (*Chelodina colliei*) have been spotted at Bannister Creek. Credit: SERCUL.*

What: Conversion of drains into living streams can have immense positive transformational effects on the local and regional environment, local communities and biodiversity. Living streams provide habitat and connectivity for a diverse range of flora and fauna; provide natural spaces for recreation, relaxation, and connection with Nature; they are also pivotal in erosion control, water quality improvement and microclimatic amelioration. The Urban Waterways Renewal Project led by the South East Regional Centre for Urban Landcare (SERCUL) in collaboration with several community groups and government agencies saw the successful restoration of several sites into living habitat.

Where: Eleven different drain sites in the Canning River catchment, located in the LGAs of Canning, Gosnells and Armadale (Perth, Western Australia), were restored through a diversity of approaches.



Left) Bannister Creek in November 2000, prior to restoration works; Right) the same site in September 2013, after living stream restoration works. Credit: SERCUL.



(Left) Third Avenue Basin (Kelmescott) during site works and installation of bio-filtration base in 2012; Right) Third Avenue Basin after planting in 2013. Credit: SERCUL.

How: The first stage of the project consisted of community consultation, concept designs, engineer's plans and approvals, as well as site preparation, weed control and upland planting. Then earthworks took place with construction of wetlands, swales and basins, installation of rock riffles, treatment media and pollution traps. The third stage focused on planting, weeding and maintenance.

Outcome: The project restored 3.3 km of old urban drainage into living streams and bio-filtration swales, planted over 424,400 plants, installed five gross pollution traps, created eight bio-filtration systems in previously weed infested floodplains and old drainage basins, removed 18 hectares of weeds, constructed 12 riffles, three with trial water treatment media structures, removed 4,600 m³ of sediment and rubbish, and engaged over 1,600 volunteers, volunteering 6,953 hours. One of the sites, Bannister Creek, has had several sections already restored and is one of the most mature Living Streams in Australia. Over 11 ha of the Bannister Creek Reserve have been restored. Some sections were grassed open drains and are now thriving ecosystems where long-necked turtles have returned to. Other riparian areas, previously covered with noxious weeds, are now healthy riparian ecosystems. Bannister Creek was a finalist in the International River Foundation Awards 2014.



*Motorbike frog (*Litoria moorei*). Credit: SERCUL.*

6. COMMON BARRIERS TO AND ENABLERS OF URBAN BIODIVERSITY CONSERVATION

When discussing barriers to and enablers of urban biodiversity conservation actions, several main themes emerged. These included: 1) the need to fight to gain support for conservation actions; 2) a general lack of capacity and resources; and 3) the need to implement long term approaches. Several factors were also described as being very influential in enabling urban conservation to occur, these included: 1) celebrating small wins and acknowledging achievements; 2) sharing information and knowledge among organisations; and 3) developing deep and strong relationships and partnerships. Often these themes were described as both a barrier and an enabler and are discussed in more detail below.

Fighting for urban biodiversity conservation

Many interviewees described their efforts to gain support to implement urban biodiversity conservation actions as a battle. Practitioners often talked about the need for persistence, patience and tenacity. These sentiments were expressed in reference to convincing external funding bodies or partners of the value of urban conservation, and convincing other team members to adopt biodiversity friendly practices. Often, the interviewees described being exasperated or disappointed at how hard they have to fight for something that is clearly worthwhile in their eyes. For example "*I thought it'd be easier, and it's harder than I thought. ...It's harder than I thought to convince funders that what we do is good and worthy. And to me, it should be self-evident* ¹²".



Matilda Bay Reserve, Perth. Credit: Cristina Ramalho.

Others noted that it can be easier to start by identifying ‘low-hanging fruit’, learning to ‘pick your battles’ or identify the ‘path of least resistance’ in the first instance, as a way to help establish evidence of success, community buy-in and good will, before moving onto more novel or complicated projects. “... *Anything you do for the first time is going to be a little bit more challenging... It means that you’re scaling back your experiments a little bit sometimes, just to make them feasible* ⁵”.

Overcoming limited capacity and resources

Figuring out how to achieve outcomes for biodiversity within the financial and political capacity of the organisation was noted as a key skill for practitioners. Limited budgets, political will, and staffing resources were all cited as common barriers to conservation action. To overcome these issues, interviewees stated the importance of knowing how your system works and working it to your advantage, for example by being “*smarter about how to use policy and drivers to get stuff done* ¹¹”.

This included taking advantage of external partnerships which may bring new sources of funding, being aware of other groups operating in the same region that could assist with resources or on-ground works or being agile and responsive to opportunities as they present themselves. “...*it’s about preparedness...rather than us requesting money for actual projects, we’re requesting budget to do the investigations and the research to be able to be ready to go when those opportunities come up* ¹⁹”.

Many groups benefited from grants and partnerships external to their organisation, but noted that having to constantly rely on and seek this external support for conservation action was a strain on resources. For example, “*Our levy is coming to an end. That’ll put an end to half of my role and all three of my staff* ⁹” and “*I can’t believe the paperwork they have to do to get \$1,000* ¹²”.

The need for long-term approaches

Most interviewees recognised the need for long-term strategies in urban biodiversity conservation, and acknowledged that while long-term approaches were difficult to plan and implement, they were critical for successful impact. This thinking was applied to project funding cycles, baseline ecological data, and evaluating a project’s success, to “*understand threats and baseline so you can measure success, look back on the data and learn* ¹²”. However, interviewees also acknowledged that current funding or employment models were not suited to long-term approaches. This is a key gap limiting the implementation of urban biodiversity actions, because “*Surviving and remaining employed is sometimes a key barrier* ¹²”.

Celebrating small wins and acknowledging achievements

Celebrating and communicating successes was identified as a key factor to maintain momentum and morale. Taking time to recognise when things have been successful or when people have worked really hard on an outcome is really important to help keep people going, because “*It’s really nice to get the odd compliment* ¹⁶”. Interviewees noted that publicly validating and acknowledging success can work to encourage future involvement and investment in urban conservation. “*Focus on the small wins...or you’ll quickly lose heart. Realise that every little win is something that you wouldn’t have got otherwise* ²⁶”, and “*Be solution focused and not problem focused, be as engaging as possible, validate and acknowledge the good stuff that people do. People love to tell a story and make themselves feel better about the things that they are doing, so validate and respect the things that people are currently doing* ¹¹”.

Sharing information among organisations

The importance of sharing information about the kinds of actions underway, and the effectiveness of these actions was a common theme. This was thought to be particularly important within local networks - knowing what other organisations are operating within your local area, or being aware of the work of neighbouring councils. *“Never underestimate how many opportunities can be lost just by not chatting and talking to people¹⁵”*. Interviewees highlighted that while there were some formal networks available, the approach to information sharing is somewhat scattered, and there may be a need for a central system that incentivises information sharing, for example *“There’s a real lack of information sharing. Lots of gaps between organisations and councils¹⁵”*.



Volunteers at an urban Banksia woodland restoration site. Credit: Cristina Ramalho

Developing deep, strong relationships

The importance of strong relationships was identified a key factor in facilitating successful actions for urban biodiversity, and was often presented as a means of overcoming some of the challenges highlighted above. This included relationships within organisations (e.g. among biodiversity teams, maintenance teams and councillors), with other land managers or organisations operating within the area (e.g. between council and utilities managers or environment groups), with research organisations, and with the broader community. *“It is really, really important to build a good working relationship with your council, which is sometimes extremely difficult. But we were really lucky that those foundations were laid, and that we have that relationship. But we work really hard at it, to make it work²¹”*. Building these kinds of relationships inevitably takes time and can sometimes be challenging but was overwhelmingly described as worthwhile. For example, *“everything takes time because it is, I think because everything is relationship-based and basically people are craving connection and attend to purpose if we can, if we can provide those things, it's a slow burn and because it does take a long time for our relationships to build, but I think the longer term outcome is going to be stronger¹⁷”*.

7. INDIGENOUS ENGAGEMENT IN URBAN CONSERVATION PROJECTS

When discussing biodiversity projects, we asked interviewees if any projects (current, past or future) sought to consult or engage Indigenous communities or embed an Indigenous perspective. They were prompted to identify such projects, comment on issues they perceived to prevent or limit such engagement and identify opportunities they perceived for future engagement. Indigenous engagement was often nested within broader projects, of which the Indigenous perspective was only one engagement initiative. In other cases, interviewees identified projects that were collaboratively designed specifically to engage the Indigenous community in their local area. We identified seven main focal themes discussed during the interviews. The focal themes described were:

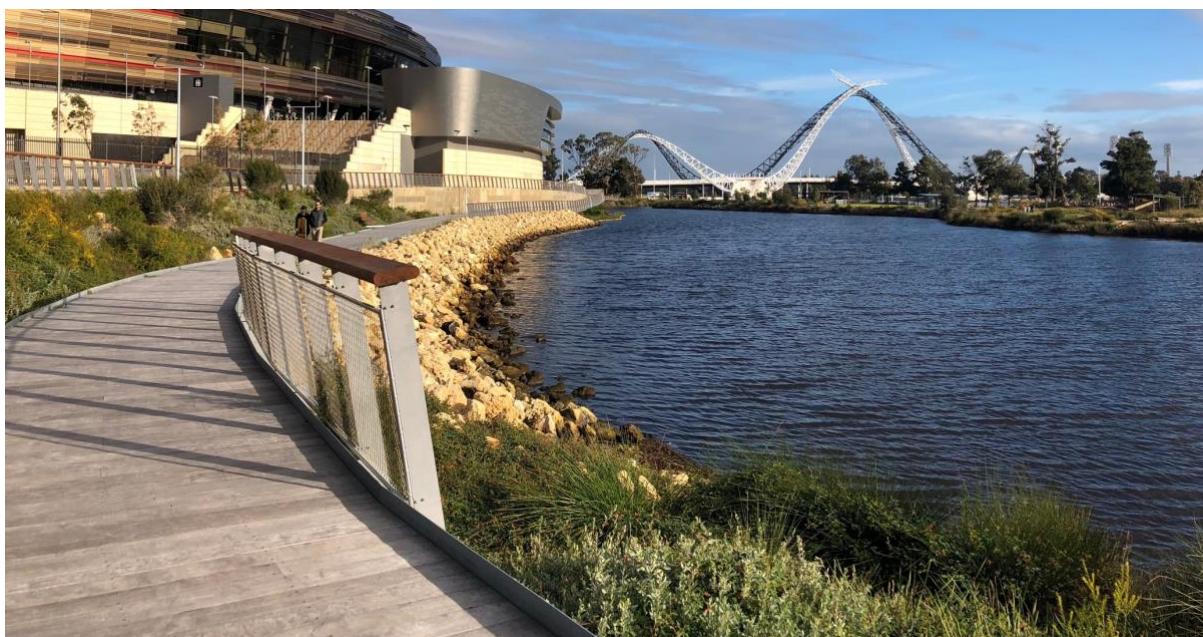
- Types of engagement
- Modes of engagement
- Groups consulted
- Motivations for engagement
- Perceived opportunity for engagement in the future
- Perceived constraints to increased engagement or consultation
- Differences in engagement by location

Below is a brief description of each focal area.

Types of engagement

Responses showed a broad diversity in the types of engagement used by land managers, with many interviewees volunteering responses that combined the below types of engagement (Table 2).

When broad scale or complex initiatives were articulated, they were often combined with common approaches, described as '*just the really basic stuff, which is welcome to countries*'²⁰. Interviewees often acknowledged a spectrum of engagement opportunities available.



The award-winning project of the Optus stadium parkland in the Burswood Peninsula, Perth, involved extensive engagement with the local Noongar community and features multiple Indigenous elements in the built infrastructure, plant pallets, local materials, art and education signage. Credit: Cristina Ramalho

Table 2: Inventory of ongoing and desired Indigenous engagement types, grouped by theme, from Sydney, Canberra, Melbourne and Perth. Examples of each action type are given, including the number of projects identified within each of these forms (in brackets).

| Engagement type | Specific initiative examples |
|---|--|
| Public acknowledgement/formal proceedings | Acknowledgement of country (5) Engaging Indigenous elders to speak at event openings (3) Naming of sites in local Indigenous languages (4) |
| EIA/development related engagement | Ecological surveys to identify areas or sites of Indigenous significance (4) Consultation with Aboriginal land councils for approval of developmental projects, and/or engagement with local elders to identify strategies to manage significant sites within proposed areas for development (3) |
| Community education | General cultural programs e.g. Indigenous storytelling nights (2) Engaging third party organisations to deliver mentoring to Indigenous youth (1) Engaging educators/elders to run guided ecological knowledge tours with an Indigenous lens, or deliver educational material (5) Developing Indigenous outreach programs to local groups (5) |
| Signage (informational or interpretive) | Collaborating with Indigenous artists to create interpretive ecological signage (6). For example, collaboratively designed signage was described as ' <i>palindromic sort of art- ..., where on the one side you have the artwork describing the connections to country, ... and then on the other side you have an ecological description</i> '. |

| Engagement type | Specific initiative examples |
|----------------------------|--|
| Provision of information | <p>Creation of brochures or pamphlets about Indigenous ecological knowledge and use of sites (historical and present)</p> <p>Integration of local Dreaming stories into project proposals (1)</p> |
| Indigenous employment | <p>Development of Indigenous training programs or Indigenous employment within the organisation e.g. Indigenous Liaison Officers (6)</p> <p>Indigenous procurement/service supply e.g. Indigenous owned nurseries (3)</p> |
| Policies/programs | <p>Events planned around Reconciliation Day or NAIDOC e.g. planting days, cultural heritage events (2)</p> <p>Development of a Reconciliation Action Plan (2)</p> <p>Consultation with an Indigenous reference group/advisory panel on projects that are deemed relevant (2)</p> |
| Land management strategies | <p>Informal engagement on bush management strategies (3)</p> <p>Replacement or planting of species Indigenous or native to the local area (5)</p> <p>Adopting Indigenous burning practices (1) and collaborative, sustained Indigenous involvement in cultural burns (5)</p> <p>Development of an Indigenous community garden (1)</p> <p>Providing opportunity for sustained Indigenous involvement in land management including</p> |

| Engagement type | Specific initiative examples |
|-----------------|------------------------------|
| | naming sites/reserves (1) |

Modes of engagement

We analysed the above engagement types based on the ‘mode’ or way in which the engagement was facilitated. Overall, many of the organisations adopted multiple ways of engaging, which evolved and grew over time.

Some interviewees described engagement that was mostly procurement based. This refers to engagement that was heavily reliant on external organisations, groups or individuals for facilitation, consultation or approval. This mode of engagement was often short-term and involved contracting external agencies to deliver education programs and projects that required the involvement of outsourced Indigenous consultancy firms, such as those requiring approval for development works and consultation for land management. The responses of some interviewees suggested that this type of engagement ended up occurring indirectly, or was nested within larger projects, with no direct project objective centred around engagement. This form of engagement also included employment and service procurement that contracted external Indigenous owned businesses. Many expressed a desire to increase employment both internally and externally, and that they hoped the opportunities for such engagement increase in the future, *‘hopefully there are more owned, or majority owned Indigenous organizations out there that are providing these services’²⁰*.



An example of urban design which incorporates Indigenous elements. Credit: Cristina Ramalho

In contrast, some engagement initiatives described by interviewees were heavily shaped by long term involvement and engagement of Indigenous groups. These initiatives were collaborative in nature and built upon sustained and strong relationships between the organisations interviewed and local Indigenous communities. Some of these initiatives were founded upon sustained informal conversations, and across all interviews, it appears that this mode of engagement is increasing.

Some interviewees reflected on past engagement experiences and provided insight into desired future practices. They acknowledged the benefits of engaging in partnership with the Indigenous community early during project development, whereby projects have *‘got to be delivered together’⁴* to create meaningful and significant outcomes. Many also acknowledged that their engagement

practices are or have changed, to adopt a more long-term collaborative approach. While some of this sustained and collaborative engagement is documented formally, some interviewees expressed a desire to have this engagement that is otherwise informal and conversational, more formally recognised or mandated by their organisation.

Groups consulted

We categorised engagement based on what groups were involved (if named). Named groups included specific individuals (artists, educators, Indigenous consultants and liaison officers), representative families, elders, nations, regional and local councils, Indigenous organisations (boards and councils) and Indigenous owned businesses (nurseries). Many interviewees specifically commented on the formation of primary relationships with specific Indigenous families and individuals. There was also emphasis placed on how a sustained relationship was cultivated over time, and how this was central to facilitating broader Indigenous engagement and community connections.

Motivations for engagement

Several motivations for engagement were communicated by interviewees. The two main motivations described were:

- 1) Policy-led engagement, e.g. environmental assessment processes or approval for works and engagement directed under a 'Reconciliation Action Plan'. For example, '*We've got a policy that really encourages us to engage with Indigenous organisations, the city has an Indigenous reference group, who we can go to and raise and discuss things with, but also they drive a lot of the outcomes* ²⁰'.
- 2) Individually driven engagement, which was driven either by the Indigenous community or by the land manager. Motivations described here included a general want to engage and acknowledge cultural importance of land, and a desire to develop a sustained relationship with Indigenous communities.

Some interviewees commented on how some engagement within their existing programs was unintentional, whilst others described a desire to actively engage the Indigenous community in a sustained and long-term manner, '*we were keen to learn more, and to develop links and to... find ways to work with the (named Indigenous group)* ⁷'.

Many interviewees actively acknowledged that they wanted their efforts to engage to be genuine and not at risk of appearing as a '*box ticking exercise* ⁸'. This desire was expressed by a large proportion of interviewees. Others expressed a level of confusion or uncertainty as to how to move forward or build their level of engagement, that they or their organisations desire, often acknowledging that past efforts were '*not enough* ²³'.

Perceived constraints to increased engagement or consultation

During the discussions, several perceived constraints were expressed that interviewees felt hindered past engagement, or that they perceived may hinder increased engagement or consultation in the future. While many interviewees articulated specific constraints they perceived, others found it difficult to verbalise their thoughts in a culturally sensitive manner. In some instances, Indigenous

engagement was not part of the interviewees job description, and hence they felt they were not the best person to discuss Indigenous engagement in urban biodiversity projects.

Of the types of perceived constraints discussed, the following main themes emerged:

- 1) Capacity to engage. Some interviewees described constraints around limited funding, and differing priorities of their organisation, which limited their capacity to engage. In some cases, interviewees also perceived Indigenous communities to be limited in their capacity to reciprocate engagement, due to perceptions of being understaffed, or having their '*resources... quite stretched*'⁵.
- 2) Cultural competency. There appeared to be a level of hesitation about how best to engage, and what approaches, strategies and methods to use. Interviewees felt unequipped to develop adequate strategies to effectively facilitate Indigenous engagement successfully and on a long-term basis. This included acknowledging that there are multiple ways of engaging, and interviewees expressed uncertainty as to how to decide which mode of engagement to undertake.
- 3) Conflicts outside the control of the land manager. Many interviewees described challenging politics surrounding engagement in general, and the challenge to navigate difficult relationships both within organisations, and between organisations and Indigenous groups. Many described their experiences with Indigenous engagement as a challenge, especially in relation to developing ongoing relationships. A major challenge expressed by many is the contested nature of urban land in general, the multiple uses it needs to serve, and the multiple land managers that are currently responsible for different pockets of land.

Perceived opportunities for future Indigenous engagement

While many interviewees had consulted and engaged their local Indigenous community in relation to development approvals and environmental impact assessments, the majority also commented on the broader opportunity for engagement with biodiversity conservation, and that this type of engagement was something '*to improve on*'¹⁴. Opportunities for future engagement that were expressed included: 1) a desire to better understand past land management practices and the potential to reinstate these to address current urban environmental issues, including more specifically linking this to biodiversity conservation; 2) a desire to better understand different elements of ecosystems and how they shape the bushland present; and 3) a desire to broaden participation by young people in the management of urban nature.

8. FUTURE ACTIONS TO CONSERVE URBAN BIODIVERSITY

We asked interviewees if they had 'dream' projects for urban biodiversity conservation. We prompted them to think of projects they would like to pursue in the absence of major challenges or resource limitations. Each interviewee provided one to three 'dream' projects. These projects were often an expansion of the type of actions they are currently undertaking or have undertaken in the recent past, although they tended to be more encompassing and holistic. Importantly, 'dream' projects often addressed or provided a vision on how to address key environmental or social concerns held by the interviewees. These projects often had several aims, although one focal aim could generally be identified. The focal aim of the 'dream' projects captured during the interviews included (in brackets, the number of projects within each of these categories):

- Increase ecological connectivity (8)
- Create and enhance habitat in the urban matrix (3)
- Educate and raise awareness, enhance community capacity and stewardship (3)
- Promote multi-functionality in urban parks and reserves (3)
- Enhance Human-Nature connection and combat extinction of the experience (2)
- Re-introduce species to remnant ecosystems (1)
- Understand how to manage and restore remnant ecosystems in a climate change context (1)
- Promote biodiversity sensitive urban design in new developments (1)
- Improve planning and biodiversity legislation (2)
- Increase legal protection of urban reserves (1)
- Buy land for conservation (1)
- Improve administrative processes that have impacts on environmental deliverables (1)

Below is a brief description of these projects. They provide a vision and insight for future pathways to be explored in urban biodiversity conservation.

Increase ecological connectivity

Several interviewees mentioned 'dream' projects whose main key aim was to increase ecological connectivity in the urban areas. Often, there was a clear concern to increase not only structural but also functional connectivity and, therefore, enhance the landscape in different ways and at different scales, so to cater for different species or biological groups. Three different types of projects were suggested to enhance ecological connectivity:

- Habitat creation and restoration along transport routes (i.e., rail and road corridors);
- Identification of roadkill hotspots and minimization of road impacts by building wildlife crossings and retrofitting roads;
- Large-scale conversion of drains into living streams.

Create and enhance habitat in the urban matrix

Another major group of 'dream' projects focused on the creation and enhancement of habitat in the urban matrix, outside reserves. These projects included:

- Use of bushland restoration techniques in the urban matrix to create and enhance habitat for biodiversity. Several restoration methods are often only used in natural settings, but

their use could be expanded to the urban settings. For example, woody debris restoration, vertical structures and mid-story shrub plantings can all be used in the urban settings, with biodiversity, but also social, economic and environmental benefits. The social acceptability for some of these techniques is still low in Australia, according to the interviewee, but in other countries, such as Singapore, acceptance is more generalized. "*If the tree falls, you keep the log, it's just ... it's just the practice that's done, you know⁴?*"

- Creation of a large woody debris bank, to which developers would send their debris piles and then landholders and offset projects could access when they needed debris to their sites;
- Restoration of a creek that was buried during a University Campus development, and interpretation of the new precinct, for the benefits of students and staff.



*The Quenda (a sub-species of Southern Brown Bandicoot) has been reintroduced to some urban bushland reserves in Perth.
Credit: Cristina Ramalho*

Educate and raise awareness, enhance community capacity and stewardship

While the previous group of projects focused on on-ground actions, a group of related projects aimed to create capacity within the community to undertake and deliver such actions, while educating, raising awareness, and fostering stewardship. These projects included:

- Creation of a non-for-profit organization for urban biodiversity and sustainability education, which would educate schools, community groups and professionals how to implement different types of actions enhancing urban biodiversity. This organization would target a diversity of positions within organizations, including management and leadership positions;
- A project promoting a broad range of actions to enhance biodiversity, from bird baths to amenity plantings, nest boxes and green roofs. This project would target the local community and LGAs and aim to create a network of biodiversity resources and habitat

homes, with an associated online mapping interface that would allow participants to see where the resources they had implemented were and how they could add on to it;

- A project involving more the community in citizen science projects "*because I don't think you can get people involved in science until they've actually connected in some way*"¹⁷.

Promote multi-functionality in urban parks and reserves

Some projects reflected a concern about being able to enhance visitor's experience in urban parks and reserves, while enhancing the biodiversity conservation capacity of those same places. Two different types of parks were at the basis of this concern, those largely covered by lawn, and which could be enhanced to provide more functions and benefits to the local community and environment; and those remnant ecosystem parks with sensitive biodiversity and environmental assets, and which are being affected by unregulated visitation. Three different projects shared this main aim:

- Development of an evidence-informed matrix tool that would support the decision-making process in the planning and design of urban parks towards multi-functionality. Multiple functions would be spatialized through a mosaic of different spaces, vegetation types, and amenities. The idea is to create parks where "*There's a space, there's a place for everyone*"¹⁵;
- Transformation of an urban park along a creek, with restoration of the plant communities that once existed there, enhancement of the river corridor for biodiversity and people, implementation of facilities for different community uses, and education signage. "*There's enough space, a lot of space up there. So you could have a new soccer and footie ovals, playgrounds and barbecue areas, but also have enough space for grasslands and biodiversity and, you know, using the creek as a really nice corridor for people, as well as the flora and fauna. The other thing is interpretation, having a lot more opportunities for education*"¹⁶;
- Development of a recreational management plan to accommodate visitation through a sensitive wetland and estuary reserve, while minimizing impacts on the local environment.

Enhance Human-Nature connection and combat extinction of the experience

Two projects were suggested that aimed to enhance Human-Nature connection and combat the extinction of Nature's experience (Miller, 2005). These two projects reflected a concern perceived more broadly across the interviews, about how remnant ecosystems in urban reserves are often managed for biodiversity protection, which necessarily requires limiting what visitors are allowed to do in those areas. In these reserves, the experience of Nature is regulated, with limited opportunities for wandering, discovering, playing and interacting with the natural environment. Such is especially concerning for children, who no longer have the opportunity of such experience, although this is known to underlie life-long commitment towards Nature protection, and is part of the collective memory of many of those that today are stewards of natural places (van den Born et al., 2018).

According to the interviewee, "*I think one of the biggest problems we have is that we have all these bush reserves but we can't lock people out of them. I grew up building cubbies in the bush, playing in the sand, you know. And grew up to really love and cherish those spaces, but now the poor kids, they build a cubby house we come along and take it down the next day, waggle our fingers at them and get all crossed. (...) I think it's key that we recognize that while our reserves are really important ecologically, they're also really important for people - not just in a passive way when they walk around, but to little kids, as places to play, throw sticks, run around, and build a cubby out of branches... We talk about this within our teams, about how we can identify those areas, because I think it's different from the nature playgrounds, which are really great, but expensive too and still in some ways, artificial. (...) It's something we have to do because otherwise we are going to have a whole generation of people that don't care. Who is going to manage it if they don't care about it?*"¹⁹

The projects suggested were:

- To create a wildlife sanctuary with a predator proof fence around it, where some wildlife species could be reintroduced, and with the right facilities that people could camp overnight and experience the bush and wildlife. It would also have an education centre;
- To identify areas in reserves for children's play (i.e., to build cubby houses and BMX tracks), and that would shift every so often so that those areas could be restored.



Citizen scientists looking for tree hollows and hollow-using fauna, during the City of Melbourne Hollowblitz event.

Credit: City of Melbourne

Re-introduce species to remnant ecosystems

Another project focused on bringing fauna and flora that are near extinction or have gone locally extinct back to urban reserves capable of supporting them. Such would involve threat mitigation actions (i.e., feral animal control, fencing), restoration and, potentially, a breeding program. This project, as explained by the interviewee, really had two main aims, one to restore remnant reserves to some historical reference (which included vegetation but also wildlife); and the other, to promote Human-Nature connection by increasing the chances of visitors to come across and observe native wildlife. According to the interviewee, the latter "*does so much to enrich people's lives and instil a sense of positive ownership. And I think seeing that has more effect than any signage we could put up - being able to see these species brought back. And it makes them more protective and appreciative of the bush - and appreciative of the job we are doing.*"²⁴

Understand how to manage and restore urban remnant vegetation in a climate change context

One project focused on the management and restoration of remnant vegetation in an urban park, in a climate change context. This project would try to understand whether it is possible to identify areas of the park that have the potential (i.e., water availability, soil type) to be managed and

restored to a historical reference. Then it would identify other areas where management and restoration would need to shift based on projections of the effects of climate change on the plant communities and flow-on impacts on fauna. New tailored actions would also be needed to enhance habitat for the fauna able to persist under changing climatic conditions. *"If we're losing particular species and functions, how might we supplement the ecosystem with other species that can adapt to the changing structure and provide similar services, so that we have a healthy functioning bushland that still has some historical reference but is maintainable into the future? (...) Whether or not we can be doing something different to minimize the impacts and soften the change."*¹⁸

Promote biodiversity sensitive urban design in new developments

The idea that the urban matrix can offer opportunities for conservation was captured several times on our interviews. One interviewee suggested the engagement of multidisciplinary teams in the planning and design of new developments to deliver good quality ecological sensitive urban design. *"This opportunity that we have now with these new developments, where (...) villages are practically popping up on the outskirts of our major cities. (...) If there's proper planning, and the right ecologists are involved, and social scientists are involved, and the right people are involved, you can actually build something kind of amazing, because we're not going to stop it [urban development]. And we don't necessarily need to stop it. It doesn't have to be a bad thing if it's done sensitively."*



Rope bridge for the threatened Western Ringtail Possum and other arboreal marsupial species in Mandurah. Credit: Bouvard Coastcare Group.

Improve planning and biodiversity legislation

Improvement of legislation for urban planning and biodiversity, from federal, to state and local government level, was mentioned by two interviewees. According to one interviewee, *"All these projects are wonderful to enhance biodiversity, but we're losing the war (...) The environment comes in too far down the process of the development, mining and forestry. And there are too many loopholes and exemptions (...) If we cannot put an end to clearing, right now, in our city, it is gone. And we have one of the most biodiverse cities in the world."*²¹

Increase legal protection of urban reserves

One project aimed to increase the legal protection offered to urban reserves in regards to cats and dogs. Such protection, which comes through the Companion Animals Act 1988, would not allow dogs and cats, or dogs but no cats on reserves. Community education would also be required.

Buy land for conservation

One interviewee suggested buying private land that has good quality remnant vegetation and that is dispersed in the peri-urban landscape, but that is bound to be subdivided and developed. One possibility would be through a State Conservation Trust Fund, which would allow land to be acquired for a competitive market price. According to the interviewee, "*I think that the problem that we have now is that it's all well and good to do restoration projects here, there and everywhere. It's all good, it all contributes to the greater benefit, but I think you got to lock up the land. I think you've got to have, if you want to talk about long term conservation, long term resilience, long term biodiversity, you have to have the habitat (...) The State could set up a State Conservation Trust and say here's an allocation of money [to purchase land for conversation] (...) I think that's where we ultimately want to go with urban conservation. I think we have to have a mechanism where we can acquire land efficiently for a competitive market price, because otherwise there's no incentive at all to retain it in the conservation estate.*"²⁰ These comments reflected a sentiment of discontentment that was expressed by other interviewees about what can be achieved through restoration and habitat-enhancing projects, and that more protective measures are needed to secure remnant habitat.

Improve administrative processes that have impacts on environmental deliverables

One interviewee aimed to review how contracting and quality control processes within the organization have an impact on the environmental outputs contractors deliver. "*How we assess them [contractors on how well they're doing their job] affects how they choose to manage the city, which affects how ground nesting bees survive in the landscape. Whether or not dead branches are allowed to sit on the ground and all that sort of stuff (...) boring stuff that might have far ranging impacts.*"²⁵



Enhancing general urban wildlife habitat in a residential yard. Credit: Knox City Council

9. FINAL REMARKS

Overall this report demonstrates the enormous range of activities currently undertaken to conserve biodiversity in urban areas, including many novel and innovative solutions to overcome the challenges urban environments impose. There is a clear need to facilitate improved connections with Indigenous communities and knowledge systems, and several promising suggestions for future activities that bridge ecological and cultural knowledge.

Further analysis and results from this project will be communicated via scientific papers and conferences presentations. The project team are also working alongside practitioners to implement research projects that examine the effectiveness of select on-ground actions in cities. Please contact the Clean Air and Urban Landscapes Hub if you wish to remain updated on research activities:

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11. APPENDIX

Interview questions

- 1) Can you tell me your job title and what your responsibilities are in your current role?
- 2) We're interested in understanding the range of things you do for urban biodiversity (for example for threatened species, or common species). Can you tell me some of the things you doing that you are most proud of?
- 3) What species or habitats do you aim to target with these?
- 4) How did you get the idea for this? For example, do you refer to scientific papers, or talk to other practitioners etc?
- 5) What triggered this action?/Why did you do these projects/why were they important?
- 6) How do you know if these things have been successful? What indicates a successful project to you?
- 7) Do any projects engage, consult or embed Indigenous peoples, organisations or perspectives? If so, can you describe this aspect of these projects?
- 8) We're trying to understand the costs or barriers to implementing urban conservation. Can you give us an example of a project that couldn't go ahead? and why?
- 9) What do you think would enable you to carry out further actions or initiatives for biodiversity conservation?
- 10) What are the main lessons you've learnt from trying to implement urban conservation projects?
- 11) If you could start one project to enhance urban biodiversity, what would it be? Be specific
- 12) Is there anything else you would like to tell me about how providing habitat etc in your role/area?
- 13) Do you have any questions about this research? And are you interested in receiving a report on the findings?