Science for Policy

Research findings in brief

Project 6.3

Threatened Species Recovery Hub

National Environmental Science Programme

Biodiversity sensitive urban design

Background

Restoring and maintaining diverse urban nature with a wide range of animals and plants is beneficial to both people and the environment. Exposure to nature in cities has been found to deliver a remarkable range of health and wellbeing benefits, including stress reduction, reduced mortality, and improved cognitive development in children. Research has even shown that biodiverse green spaces may deliver greater benefits than less diverse green spaces. Ensuring people experience "everyday nature" in the places where they live and work is vital for human health and wellbeing and can further contribute to biodiversity conservation by creating positive interactions for people with the nature around them.

Cities can be important places for conserving biodiversity and support a wide range plant and animal species. They can also play a key role in the conservation of many of Australia's threatened species – research has shown that cities are important hotspots for many threatened species which occurred in the region prior to urbanisation.

Urbanisation can have a major impact on biodiversity through habitat loss and fragmentation, introduction of exotic species, alteration of local climates via the urban heat island and increased levels of chemical, light and noise pollution. However, the design and construction of new developments and retrofitting of old developments can provide an opportunity to greatly reduce these impacts.

Local governments are beginning to recognise the value of urban biodiversity and ways in which nature can be included in transparent planning processes. However, planners and developers have little guidance about which design elements to implement or how to balance biodiversity considerations with other objectives.

Native temperate grasslands of the Victorian volcanic plain. Photo: Ryan Chisholm

Research aim

The research aimed to create a set of principles which can be used to guide local governments, urban planners and architects in creating biodiversity-friendly developments. These principles will work to ensure a net benefit for nature and to encourage the inclusion of biodiversity from the beginning of the design process by making biodiversity-friendly design simple for a range of different sectors.

In brief

Cities are increasingly recognised for their importance to biodiversity conservation, and can be home to many species of plants and animals, including threatened species. The impacts of urbanisation can be catastrophic for native species, and while improvements to urban design and development can reduce those impacts, take-up of such practices has been slow.

There is an urgent need for planners and developers to consider biodiversity in decision-making processes, and to access ecological information to support this. We distilled the urban biodiversity literature into five principles for biodiversity sensitive urban design (BSUD). We present a framework for implementing BSUD that is aimed at delivering onsite benefits to biodiversity.

The BSUD framework is applicable across a range of urban development types and densities, and will allow developers and planners to create urban areas that bring a net benefit to both people and nature by providing a way to communicate ecological requirements as urban design actions. BSUD has the further advantage of offering a flexible framework in which biodiversity benefits can be transparently traded off against other environmental, social and economic goals.

BSUD has the potential to shape a new conception of urban landscapes, where species can thrive and residents reap the broad range of benefits that biodiversity can deliver.

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Principles of biodiversity sensitive urban design (BSUD)

The team reviewed existing ecological knowledge and information on urban threats to biodiversity to create five biodiversity sensitive urban design (BSUD) principles:

1. Maintain existing and create new resources for nature

New developments can be planned to avoid habitat loss by prioritising development in areas of low ecological value. Retaining and protecting existing vegetation during the development process will also be beneficial for biodiversity. Habitat can be enhanced or created in existing urban areas by using native plant species and increasing vegetation complexity, adding green infrastructure, or incorporating critical resources and habitat analogues, such as habitat walls. Residential gardens can be significant habitat, so resident-led wildlife gardening programs can make a valuable contribution to biodiversity

2. Support animal movement across the landscape

Dispersal can be facilitated by adding animal movement infrastructure, or establishing habitat connectivity corridors through private and public land. Care should be taken to avoid inadvertently facilitating the spread of invasive weeds and pests.

3. Reduce threats to and disturbance of nature

The impact of weeds and exotic predators can be reduced by landscaping with indigenous plants and establishing pet containment programs. Increased runoff and nutrient loads can be mitigated by vegetated swales and rain gardens, which also deliver biodiversity benefits. The impact of noise and light pollution can be mitigated by sound barriers (although take care that this does not affect dispersal), temporary road closures and dimming or reconfiguring street lights.

4. Protect natural cycles and ecological communities

The disruptive effects of urbanisation on natural cycles, ecological processes and disturbance regimes can be mitigated by providing adequate resources for target species, protecting and enhancing pollinator habitat, and planning to safely enable natural disturbance events such as fire and flooding.

5. Create opportunities for positive interactions between people and nature

Cities are human environments and public engagement is key to successful conservation. Urban design can help facilitate local stewardship of biodiversity by providing "cues to care", creating opportunities for positive interactions with nature, and addressing conflicts between biodiversity and safety objectives or potential ecosystem disservices.

Striped legless lizard, *Delma impar*.
Photo: Peter Robertson/Wildlife Profiles Pty Ltd

A framework for implementing BSUD in new and existing urban developments

We used these principles to create a new and flexible design framework to help local government, architects and urban planners to:

- overcome important barriers to urban biodiversity conservation
- encourage local communities to engage with the BSUD process ensuring better/more reliable development outcomes for nature and people
- create a net benefit for biodiversity.

This framework is designed to be used to identify BSUD actions that align and work with development objectives as well as managing any trade-offs. The BSUD framework begins with an evaluation of native animals and plants present on a site, key landscape features and any potential threats. This information is then used to identify biodiversity objectives for the site, which inform the BSUD actions or recommendations. Users then quantify the potential impact of these actions and use the data to decide which designs best meet the biodiversity and development objectives (see Figure 1).

The framework is designed to be used during the early stages of a new or retrofitted development, but can be applied to developments of any size, from individual houses to large-scale urban redevelopments. The general underlying ecological principles also hold across all habitat types and geographic regions.

To test its efficacy, we applied the framework to two hypothetical but realistic case studies. Through these case studies, we demonstrated two different examples of how to generate the BSUD actions and quantify their impact, and how ecological knowledge can be converted into design elements for a development.

Case study one: BSUD to protect native grasslands in greenfield development

The first hypothetical case study involved protecting a 5 ha remnant vegetation patch of Critically Endangered grassland within a new 35 ha low-density housing development. This type of development is common in the urban fringes of northern or western Melbourne. The primary ecological objective was to improve the viability of the native grassland remnant.

Potential BSUD actions were identified in the design, construction and inhabitation phases of development, and primarily address key threats to native grassland viability associated with disruption to fire disturbance regimes, introduction of invasive weeds and changes to site conditions. (See table 1)

Experts estimated that if the grassland was initially in good condition, applying BSUD could more than double the probability of the grassland persisting without deteriorating; from 0.28 under a non-BSUD development to 0.59 with BSUD.

All BSUD actions were considered to contribute to an improvement in the viability of the grassland remnant; however, in practice, decisions about which actions to take will involve trade-offs between the biodiversity benefits provided and other factors (including financial costs and other social and environmental objectives). In this case, it is impossible to compensate for losses associated during construction via any other means, so protection and management during this stage should be prioritised to ensure an improvement in the long-term viability of the grassland. Planning for appropriate buffers and adjacent land uses, and seeking to promote active stewardship through thoughtful design are also recommended to achieve biodiversity objectives in this case.

Table 1 Potential BSUD actions to enhance native grassland viability in low-density greenfield development

		BSUD Action	Description
Development Phase	DESIGN	Appropriate adjacencies	Housing, infrastructure not immediately adjacent to grasslands to reduce conflict with management.
		Effective buffers	Buffers should be allocated OUTSIDE the grassland, be of sufficient width and resistant to weed invasion. Buffers graded away from grassland to minimise run-off and pollution.
		Water sensitive urban design	Employ water sensitive urban design to reduce impact of abiotic hydrological and temperature changes
		Fire-resistant construction	Use fire-retardant construction for housing & infrastructure on the leeward boundary of the grassland.
		Biodiversity sensitive public landscaping	Indigenous plants with low nutrient and water requirements used in local public open spaces.
	CONSTRUCTION	Early protection	No disturbance of grassland remnant during construction. Grassland remnant is protected by appropriate fencing and buffers early in the construction process.
		Clean construction	Sterilisation of vehicles and equipment, and appropriate selection of materials to minimised introductions of weeds, nutrients and other pollutants.
		Appropriate management	Sterilisation of vehicles and equipment, and appropriate selection of materials to minimised introductions of weeds, nutrients and other pollutants.

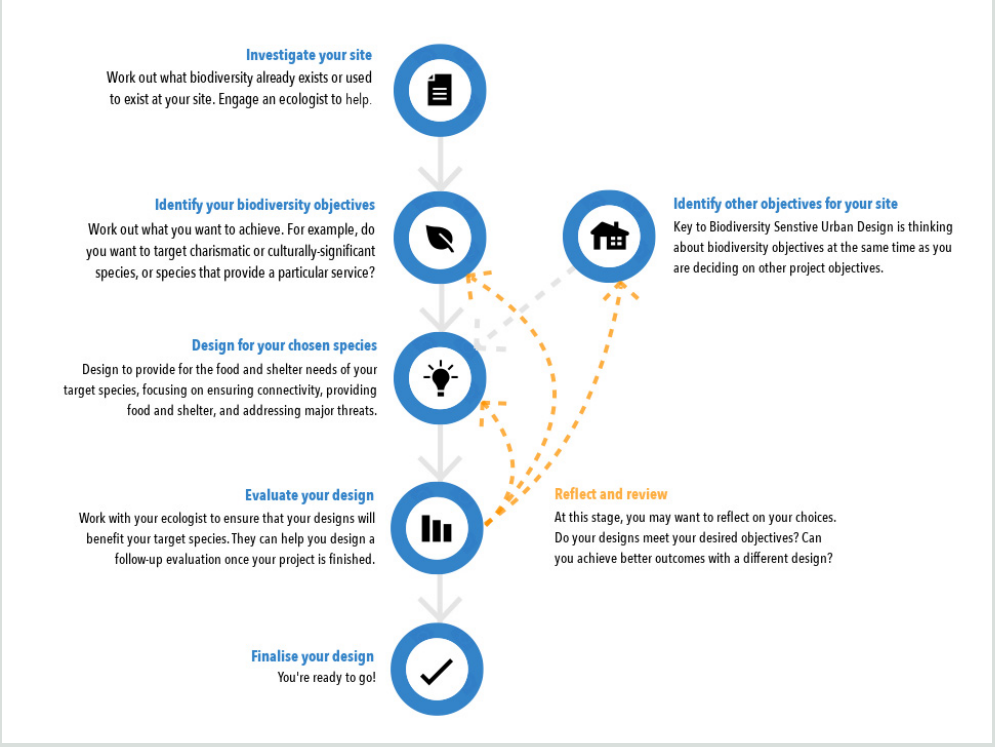

Figure 1. A framework for implementing biodiversity sensitive urban design.

Case study two: BSUD for a threatened reptile in an established urban environment

The second hypothetical case study considered options for retrospectively applying BSUD to improve the persistence of an Endangered reptile (Striped legless lizard, *Delma impar*) in an established urban environment containing grassland remnants.

In this example, two species experts identified three potential BSUD actions: 1) creating habitat corridors to facilitate dispersal; 2) improving habitat quality in existing patches; and 3) restricting domestic cats to indoors or confined outdoor runs. Simulation of these BSUD actions assessed the contributions of BSUD to the viability of the lizards, showing that the largest benefits were gained when all three BSUD actions were applied. Considered in isolation, decreasing predation by cat containment delivered the biggest benefit, increasing the probability of persistence from 0.06 to 0.88 over a 25-year time horizon. The other two actions, habitat improvement and creating habitat corridors, also contributed to substantial increases in abundance and occupancy, when considered separately in combination with cat containment.

Cited material

Garrard, G.E., Williams, N.S.G., Mata, L., Thomas, J. and Bekessy, S.A. (2018), Biodiversity Sensitive Urban Design. *Conservation Letters*, 11: e12411. doi:10.1111/conl.12411

Implications and recommendations

This work provides much-needed innovation to the field of sustainable urban development by focusing on creating onsite biodiversity gains; it looks for synergies between development and biodiversity objectives and provides a way to measure the success of the nature-based designs. Ultimately this improves transparency for all the factors considered during the design process of an urban development.

This research has important cross-disciplinary applications in urban design, planning and conservation, and will be particularly valuable to people involved with urban planning and development, including urban planners, architects, landscape architects, local government, developers and urban conservation practitioners.

BSUD involves a fundamental shift in thinking from current practice, where biodiversity losses are "offset" somewhere else. Biodiversity offsetting delivers questionable ecological outcomes because retained patches face continuing threats from the surrounding environment, and the offset is unlikely to ever adequately compensate for the losses incurred. Furthermore, offsetting ignores the place-based value of nature, and results in an unmitigated loss of nature in the places where urban residents live, work and play.

The implications of BSUD for biodiversity and, in particular, threatened species conservation are significant; around half of Australia's threatened species and ecological communities occur in urban regions, with some found only in cities. The BSUD framework seeks to reduce the impact of urbanisation on these species by providing for their needs within the built environment, ensuring that cities of the future are those where both people and other species can thrive.

To maximise urban biodiversity conservation outcomes, the BSUD framework should be implemented alongside strategic land planning, including specification for housing densities that minimise the urban footprint. Alone it will be insufficient to conserve biodiversity in cities while they continue to densify and expand: land sparing will continue to be important for protecting remnant habitat and maintaining some ecosystem services; and some species will require large, well-connected habitat patches to survive.

Critical next steps for BSUD include establishing regulation for minimum standards, and identifying responsible authorities, appropriate bridging organisations and project champions to help build cross-sectoral relationships and a trusted body of science. Further opportunities include incorporating BSUD into holistic performance tools, such as the Green Building Council of Australia's Green Star Communities and US Green Building Council's Leadership in Energy and Environmental Design.

Further Information

Georgia Garrard - georgia.garrard@rmit.edu.au

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