



Clean Air and Urban Landscapes Hub

National Environmental Science Programme

Conservation opportunities for threatened species in urban environments

Clean Air and Urban Landscapes Hub & Threatened Species
Recovery Hub

December 2020

About the Clean Air and Urban Landscapes Hub

The Clean Air and Urban Landscapes (CAUL) Hub is funded by the Australian Government's National Environmental Science Program. The remit of the CAUL Hub is to undertake "Research to support environmental quality in our urban areas". This includes research on air quality, urban greening, liveability and biodiversity, with a focus on practical implementation of research findings, public engagement and participation by Indigenous Australians. The CAUL Hub is a consortium of four universities: The University of Melbourne, RMIT University, the University of Western Australia and the University of Wollongong.

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EXECUTIVE SUMMARY

- This report investigates the opportunities for threatened species conservation within Australian cities and towns. Previous research has identified that more than 30% of Australia's nationally listed threatened species can be found in urban environments.
- We confirmed the distribution 418 threatened species intersected with one or more of 99 cities and towns across Australia. We further interrogated this dataset to define eight categories of urban-occurring threatened species based on the degree to which their range intersects with Australian cities and the way in which the urban environments are used by the species. These categories included urban-restricted, high urban, multi-city, moderately urban, low urban, urban edge, marine-global and historically urban species.
- We interrogated the recovery documents for species currently occurring in urban environments and identified the degree to which urban environments were recognised as important for recovery, and the associated threats, challenges and management actions.
- Urbanisation was frequently identified as a threat, particularly for those species that were urban restricted, had a large proportion of their range that was urban or occurred across many cities. However, important threats that operate within the urban environment were often under-reported or absent in the recovery documents. Similarly, the importance of urban environments in the potential recovery of a species was reported less often than expected based on the species' urban distribution. This partly reflected the brief nature of many recovery documents, or the absence of detailed knowledge of a species' ecology and distribution.
- Successful conservation of threatened species within cities and towns requires consideration of the urban context – the threats that may be more prevalent, the mechanisms through which they occur, the opportunities present within the urban landscape that may facilitate conservation action, and strategies for dealing with the challenges of managing complex, multi-stakeholder spaces. Based on several years of research, we present information that can help guide the conservation of threatened species within cities and towns.
- We propose a set of six conservation approaches for threatened species in cities that consider the ways in which urban conservation can contribute to the broader recovery of the species. We further identify a range of 'urban specific' threat and action types that could complement existing approaches to recovery planning and enhance conservation opportunities within the urban locations of a species range.

Introduction and scope

Cities and towns are increasingly recognised for their capacity to support biodiversity. A growing body of research shows that this extends to species of conservation concern. Recent research estimated that more than 30% of Australia's federally listed threatened species could be found in cities and towns.

Efforts to reduce the impacts of urbanisation and new developments on biodiversity are increasing, and include spatial prioritisations, green building initiatives, and policy tools. However, practical guidance on how threatened species can be managed and recovered *within* the urban parts of their range is limited. How important are urban areas to threatened species conservation in Australia? What role can the urban environment play in a species recovery? Which species and cities present the greatest opportunities? What actions and issues need to be considered in order to devise effective conservation strategies for threatened species in cities and towns? These are the questions explored in this report, synthesising multiple investigations carried out by the CAUL and TSR Hubs throughout years of collaborative research.

This report pairs with an interactive online database of threatened species in cities which allows users to explore and interrogate the dataset, as well as download information for later use (to be publicly available by 2021 <https://nespurban.edu.au/platforms/threatened-species-map/>)



Biodiverse urban grasslands host threatened species Photo credit: Nicholas Williams.

The Threatened Species in Cities dataset

Previous research identified that ~30% of Australia's EPBC-listed species could be found in cities and towns (see Ives and Lentini *et al.* 2016). We built on this dataset, conducting additional cross-validation with other data sources to remove spurious, captive or herbaria records. This resulted in a list of 418 species whose range intersected with at least one of the 98 cities and towns in Australia (see Figure 1 for further definition). One city was removed from the analysis as no species were detected. The species were predominantly plants of the class Magnoliopsida (190), Liliopsida (69) and animals of the class Aves (41), Mammalia (26) and Reptilia (20). The list encompasses a wide range of taxonomic groupings, traits and habitat types, providing a representative and generalisable suite of species upon which to investigate urban threats, opportunities and challenges and devise urban-specific conservation strategies.

We refer to species by their accepted common name throughout this report. Where no accepted common name was available, the scientific name is provided. A full list of species, common and scientific names, and threat status is available in Appendix 2.

Interrogating the recovery documents

We reviewed the recovery documents of each species to extract information on their attributes, any recognised threatening processes and recommended management actions. Recovery documents were those available via the Australian Government's website, including text within the Species Profile and Threats database (SPRAT), listing advice, conservation advice, and adopted or draft recovery plans. We also recorded the degree to which urban factors were acknowledged and prioritised in the recovery documents for each species, identified urbanisation as a threat, identified urban areas for recovery actions, or noted the potential for artificial or novel habitats. We limited our analysis to species with a current distribution within or on the edge of an urban area, hereafter referred to as 'urban-occurring threatened species' and excluded species that were only present in historical records from further analysis. A total of 747 recovery documents were inspected across 367 species that were EPBC-listed as at October 2016.



Figure 1. The 99 urban areas investigated for urban-occurring threatened species.

Definitions	
<p>Threatened species</p> <p>Plants and animals that were listed as vulnerable, endangered, or critically endangered under the Environmental Protection and Biodiversity Conservation Act (1999) as of October 2016. Initial overlap with cities was investigated using polygons of the modelled distribution of each species sourced from the Environment Resources Information Network (Commonwealth of Australia, 2014).</p>	<p>City</p> <p>One of 99 cities and towns across Australia with a human population of > 10,000 residents and a land character described as 'urban', derived from the Australian Bureau of Statistics (Section of State Ranges classification based on Statistical Area 1 polygons, 2011) A full list of cities considered is available in Appendix 1</p>

Part 1: Spatial overlap of threatened species in cities

How urban are urban-occurring threatened species?

The degree to which cities present relevant targets for threatened species conservation depends largely on the extent to which a species' range overlaps with urban environments and the way species use these spaces. In order to determine the practical conservation opportunities for threatened species in Australian cities and towns, we first investigated the spatial overlap in more detail to ask; Just how urban are urban-occurring threatened species?

We used a variety of sources in an attempt to 'ground truth' the dataset, including: point data from the Atlas of Living Australia, descriptions of the species distribution and extant sites within the SPRAT and other recovery documents, and the spatial polygons of modelled distributions. Key factors explored were the extent of the species' range, the species mobility or migratory behaviour, and the degree to which the range overlapped with the defined urban boundaries. The data available did not allow for an accurate quantitative assessment of exactly what proportion of each species range was urban.

The result was eight categories that aimed to reflect the range of ways that threatened species use and interact with Australian cities and towns. The initial classifications for all species can be found in Appendix 2 – this could be further refined through ground-truthing in discussion with recovery teams, local agencies and taxon-specific experts.

These categories were intended to more practically reflect the opportunities for conservation gains in urban environments, the extent to which urban conservation is necessary for species recovery, and the types of conservation strategies that might be useful. We recognise that other factors are important to guide conservation decisions and this does not represent a prioritisation, but a useful starting point from which to explore a national-scale dataset.

Urban-restricted – 39 species

Urban-restricted threatened species are those which occur entirely within urban environments. They are urban residents, dependent entirely on cities and towns for persistence (Soanes and Lentini 2019). We identified 37 plants and two animals that were urban restricted, including Caley’s grevillea, Morrisby’s gum and the Sunshine diuris.

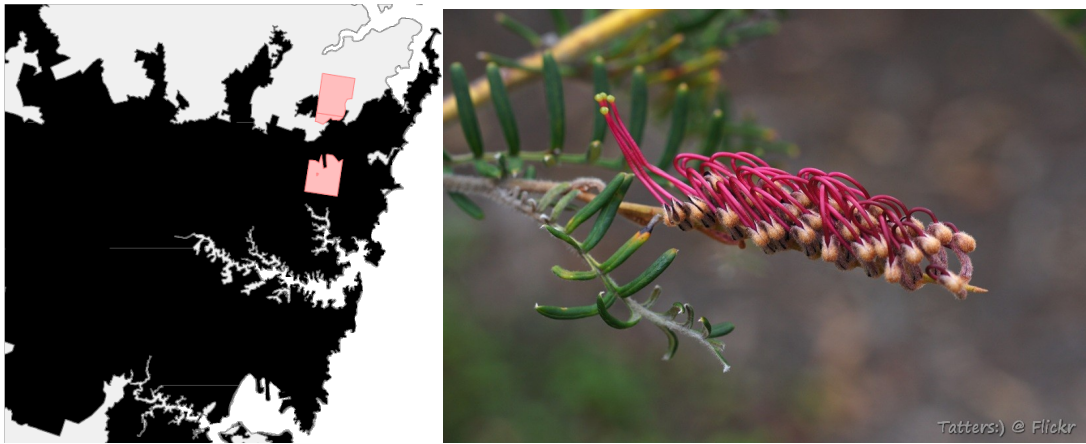


Figure 2. Modelled range of Caley’s grevillea (red) against the urban boundary of Sydney (black). Further investigations revealed this to be an urban-restricted species. Photo credit: Tatters (CC BY-SA 2.0)

High urban occurrence – 82 species

Species classified as having a ‘high’ urban distribution were typically characterised as having small ranges, with either a large proportion of this range occurring within an urban area, or the recovery documents noting that large or important populations occurred within an urban area (where such information was available). This included species that occurred within large conservation reserves that abut cities and towns but are included within the urban envelope. High urban species included 74 plants such as *Acacia gordonii*, rosella spider-orchid, veiny graptophyllum and a small number of animals including burrowing crayfish, snails, and the grassland earless dragon.



Figure 3. The modelled distribution of the small purple pea (red) against urban areas (black). Further investigation reveals it to be a high-urban species. Photo credit: John Briggs (CC BY-NC-ND 2.0)

Multi-city occurrence – 54 species

These are species with relatively widespread distributions that intersected with three or more cities and towns. Often this was because the species ranges coincided with areas of substantial urban development and multiple settlements (e.g. koala, magenta lilly pilly, Carnaby’s cockatoo, leafless tongue orchid, river swamp wallaby grass). In other cases, the species were nomadic or migratory, visiting multiple urban locations at some point in their life cycle (e.g. orange-bellied parrot, swift parrot, regent honeyeater). Some species were found in as many as 43 cities (e.g. grey-headed flying fox). This category was predominantly made up of highly mobile animals, or plants with a broad distribution (37 animals, 17 plants).



Figure 4. The modelled distribution of the swift parrot (red), a multi-city species. Urban locations in black. Photo credit: Dave Curtis (CC BY-NC-ND 2.0)

Moderate urban occurrence – 54 species

Species classed as having a moderately urban occurrence typically had relatively small distributions with some portion occurring in an urban boundary. In some cases, these species occurred in up to two cities. The group includes 40 plants and 14 animals.



Figure 5. The button wrinklewort was classed as having a moderate urban occurrence. Species distribution in red, urban areas are shown in black. Photo credit: Jo Lynch (CC BY-NC-ND 2.0)

Urban edge – 43 species

Edge species were those that do not currently occur within any Australian city but can be found just outside of the urban boundary (within 2 km). Urban edge species included the *Grevillea althoferorum*, chestnut-rumped heathwren and turnip copperburr.

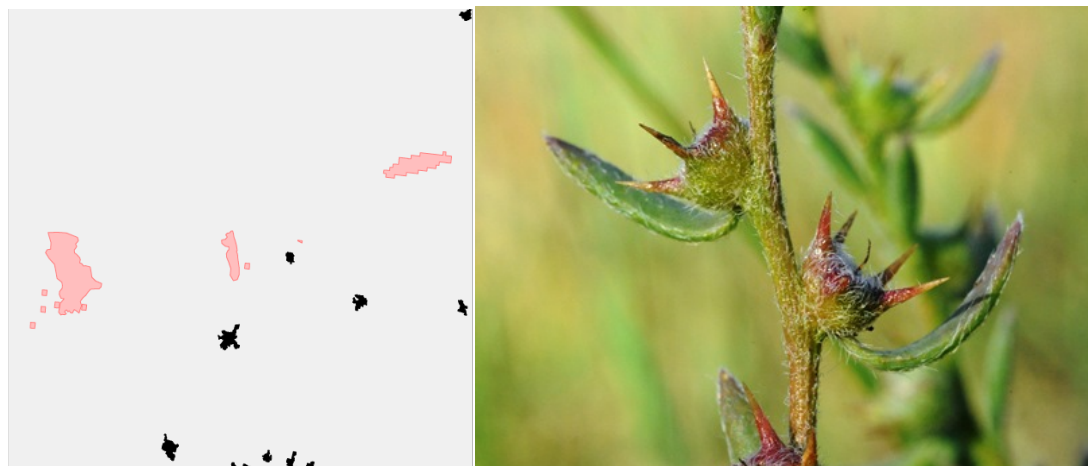


Figure 6. Turnip copperburr, an urban edge species. Species distribution in red, urban areas shown in black. Photo: Damien Cook, Rakali Consulting (CC BY-NC-ND 2.0)

Low urban occurrence – 67 species

For these species, urban areas represent only a small fraction of their extant range. “Low urban” species were characterised by large distributions, often spanning several states, with their range intersecting with only a single city. We identified 28 animals and 39 plants with a low urban occurrence, including the malleefowl and greater bilby. Further research and data interrogation is required to confirm occurrence records in urban areas.

Marine-global species – 21 species

These species included those with broad, often global, marine or coastal distributions. This category consisted mostly of marine fish, turtles and shorebirds that spend some of their lifecycle within Australian cities, either to breed or forage.

Historic urban occurrence – 58 species

We identified 58 species that had only historical records in urban environments. These species previously occurred within an Australian city or town but have not been recorded post-2000 and are thought to be locally extinct.

Which cities have the most threatened species?

Cities that contain multiple threatened species may represent areas with a greater need for urban conservation strategies. The number of threatened species present within each city ranged from cities that only had edge species (2 cities), to those with a single urban-occurring threatened species (6 cities), to others with up to 93 species within, on the edge of, or historically recorded (Sydney). The majority of cities overlapped with the range of one or more threatened species, and just over half of Australia's cities (55 out of 99) had current records of five or more threatened species within their urban boundary (see Table 1 for the top 20 cities with the most species present). Several cities also had multiple critically endangered species present, including species with high or urban-restricted distributions (Table 2).

As urban areas expand, edge species can become affected by urbanisation and the associated threats. We identified 81 threatened species with one or more populations on the edge of an Australian city, including those species that only occur as 'urban edge' species. Urban edge species were present in 53 cities. The cities with the highest number of edge species included Toowoomba (5 species), Adelaide (5 species), Gold Coast–Tweed Heads (5 species – Hairy-joint grass, Smooth Davidsonia, Floyd's walnut, Monkey nut, *Zieria collina*), Geelong (4 species – Spiny Peppergrass, Orange-bellied parrot, Spiny rice-flower, Australian Painted Snipe).

We found evidence of species that had become locally extinct within 85 Australian cities and towns. The distribution of these species previously overlapped with urban environments but have not been recorded in these locations since before the year 2000. Cities with the largest number of 'historical' species were Melbourne (14 species), Victor Harbour–Goolwa (12 species), Brisbane (11 species), Coffs Harbour (10 species), Adelaide (10 species) and Sydney (10 species).

Table 1. The Top 20 Australian cities with the highest number of threatened species

City	State	In	Edge	Historical	Total
Sydney	NSW	80	3	10	93
Melbourne	VIC	46	1	14	61
Central Coast	NSW	39	3	6	48
Gold Coast–Tweed Heads	QLD	39	5	4	48
Perth	WA	35	3	6	44
Brisbane	QLD	30	1	11	42
Newcastle–Maitland	NSW	33	2	4	39
Hobart	TAS	29	1	8	38
Adelaide	SA	22	5	10	37
Sunshine Coast	QLD	26	3	8	37
Wollongong	NSW	29	2	5	36
Coffs Harbour	NSW	20	2	10	32
Canberra–Queanbeyan	ACT	24	2	4	30
Victor Harbor–Goolwa	SA	15	2	12	29
Ballina	NSW	12	0	8	20
Morisset–Cooranbong	NSW	16	0	4	20
Nowra–Bomaderry	NSW	17	1	2	20
Port Macquarie	NSW	16	1	3	20
Toowoomba	QLD	12	6	2	20
Cairns	QLD	12	3	4	19

Table 2. Cities with the highest number of urban-restricted or highly urban-occurring species

City	Number of species
Sydney	38
Perth	13
Hobart	10
Central Coast	9
Melbourne	8
Brisbane	7
Gold Coast–Tweed Heads	7
Newcastle–Maitland	6
Nowra–Bomaderry	5
Sunshine Coast	5
Wollongong	5

Part 2: Current approach to recovery planning for urban-occurring threatened species

Currently listed threats and recovery actions

From the recovery documents of the 367 urban-occurring species we extracted and categorised 30 different types of threats (Table 3). Further detail on the threat types can be found in Appendix 3. The top five most common threats were invasive species (82.5% of species), loss or destruction of habitat (72.2%), altered fire regimes (67.8%), urbanisation (63.6%) and competition or encroachment (46.7%). Other specific threats of relevance to urban landscapes included fragmentation, chemical inputs, vandalism and the negative effects of human access, trampling by humans and death due to infrastructure. Interestingly, disturbances such as noise or artificial light at night were not identified as a threat to any terrestrial species. These threats were only identified for five marine turtles.

We also categorised 26 actions types from these documents (Table 4). Further detail on the action types can be found in Appendix 4. The most common types of actions related to monitoring and research (89.6% of species), raising the public profile of the species (70.8%), ex-situ approaches (67.5%), managing fire regimes (60.1%), and securing tenure (59.7%). Other actions relevant to urban environments included weed management, minimising the adverse impacts of development, reducing human disturbance, reducing damaging inputs, reducing sources of mortality, and inter-agency knowledge transfer.

Table 3. Threats to threatened species in cities as identified by their recovery documents. Numbers reflect the percentage of species within each group for which that threat was listed. The top 5 threats for each group of urban-occurring species are shaded green.

	Urban-restricted	High	Moderate	Low	Multi-city	Global-marine	Edge
Urbanisation-development	87.2	79.3	53.7	37.3	85.2	47.6	46.5
Invasive species	87.2	84.1	87.0	82.1	77.8	57.1	88.4
Altered fire regime	76.9	84.1	70.4	68.7	61.1	0.0	65.1
Loss or destruction of habitat	59.0	74.4	81.5	83.6	83.3	19.0	62.8
Trampling	46.2	31.7	14.8	11.9	13.0	9.5	16.3
Competition-encroachment	41.0	35.4	59.3	52.2	51.9	23.8	53.5
Herbivory	41.0	24.4	27.8	28.4	7.4	0.0	25.6
Roads-linear infrastructure	35.9	50.0	51.9	34.3	33.3	0.0	55.8
Vandalism-tourism-access	33.3	36.6	13.0	23.9	11.1	66.7	16.3
Disease	28.2	18.3	24.1	29.9	40.7	28.6	27.9
Hunting-culling-removal	28.2	19.5	24.1	23.9	38.9	85.7	9.3
Climate change	28.2	31.7	31.5	41.8	35.2	76.2	20.9
Agriculture-grazing	25.6	0.0	68.5	77.6	72.2	4.8	53.5
Soil degradation	17.9	35.4	18.5	32.8	42.6	19.0	16.3
Mechanical damage	17.9	9.8	20.4	20.9	7.4	19.0	23.3
Water-hydrological degradation	15.4	25.6	20.4	29.9	46.3	19.0	30.2
Chemical inputs	15.4	19.5	24.1	26.9	44.4	66.7	23.3
Low pollination-recruitment	15.4	15.9	11.1	10.4	5.6	0.0	0.0
Fragmentation	12.8	29.3	35.2	47.8	40.7	4.8	39.5
Mining-extraction	10.3	23.2	18.5	23.9	50.0	9.5	18.6
Unrestricted vehicles	7.7	18.3	20.4	14.9	5.6	23.8	4.7
Unintentional mismanagement	7.7	1.2	7.4	13.4	5.6	0.0	2.3
General habitat degradation	5.1	7.3	9.3	19.4	31.5	52.4	11.6
Predation-attack	2.6	3.7	14.8	25.4	50.0	57.1	11.6
Loss-removal critical habitat elements	2.6	11.0	14.8	14.9	37.0	0.0	4.7
Forestry-logging	2.6	13.4	16.7	28.4	35.2	0.0	18.6
Infrastructure collision	0.0	0.0	7.4	9.0	35.2	52.4	0.0
Dams-concreting waterways	0.0	4.9	3.7	11.9	14.8	0.0	7.0
Noise	0.0	0.0	0.0	0.0	0.0	4.8	0.0
Light	0.0	0.0	0.0	0.0	0.0	23.8	0.0

Table 4. Actions for threatened species in cities as identified in the recovery documents. Numbers reflect the percentage of species within each group for which that action type was listed. The top 5 action types for each group of urban-occurring species are shaded green.

	Urban-restricted	High	Moderate	Low	Multi-city	Global-marine	Edge
Monitoring and research	94.9	97.6	96.3	95.5	98.1	14.3	93.0
Ex-situ approaches	87.2	79.3	63.0	61.2	46.3	90.5	69.8
Weed management	74.4	65.9	70.4	53.7	33.3	14.3	72.1
Raise public profile	71.8	78.0	79.6	74.6	79.6	0.0	74.4
Appropriate fire regimes	66.7	76.8	59.3	56.7	53.7	14.3	74.4
Actions to expand or increase population size	66.7	67.1	70.4	55.2	57.4	4.8	62.8
Planning and policy instruments (e.g. recovery plans, offsets, conditions of approval)	66.7	62.2	44.4	40.3	64.8	28.6	46.5
Prohibit human access	64.1	50.0	38.9	23.9	24.1	0.0	23.3
Inter-agency knowledge transfer	59.0	43.9	44.4	46.3	68.5	57.1	46.5
Secure tenure	53.8	70.7	74.1	58.2	64.8	0.0	60.5
Manage or restrict impacts of development or land-use	48.7	59.8	61.1	61.2	68.5	19.0	55.8
Community involvement in conservation	41.0	31.7	48.1	49.3	53.7	52.4	27.9
Fence target areas	41.0	25.6	31.5	31.3	13.0	57.1	34.9
Reduce impacts from other species (predation, trampling, grazing)	35.9	40.2	63.0	53.7	55.6	4.8	48.8
Manage human recreation	28.2	12.2	7.4	11.9	9.3	33.3	9.3
Manage hydrological impacts	25.6	23.2	16.7	23.9	31.5	42.9	30.2
Signage, markers and maps	25.6	22.0	24.1	17.9	18.5	9.5	23.3
Reduce damaging inputs and pollutants	20.5	29.3	22.2	20.9	22.2	4.8	20.9
Identify priority populations	17.9	37.8	42.6	50.7	37.0	19.0	51.2
Control or manage disease	17.9	18.3	14.8	17.9	25.9	42.9	25.6
Revegetate or enhance habitats	15.4	12.2	29.6	22.4	50.0	19.0	14.0
Improve movement or dispersal	7.7	20.7	25.9	14.9	42.6	0.0	18.6
Manage human disturbance without prohibiting access	7.7	12.2	5.6	17.9	11.1	14.3	34.9
Reduce other human-caused mortality (e.g. vehicle strike, hunting, removal)	5.1	1.2	13.0	9.0	7.4	52.4	0.0
Manage the risks of cultivars and pet trade	5.1	1.2	1.9	1.5	1.9	0.0	2.3
Rehabilitate injured wildlife	0.0	0.0	1.9	0.0	5.6	19.0	0.0

Recognition of urban factors within recovery documents

Recovery documents for the urban-occurring threatened species often did not acknowledge that part or all of species distribution was in an urban area, and in turn the urban-specific nature of threats or the need for urban conservation. The threat of urbanisation was well-recognised overall and was identified as a threat to a large proportion of species (63.6% of species) — even those with low, edge or global marine distributions (Table 1). However, the potential role of urban environments in the recovery of a species was often overlooked. The species' urban occurrence was mentioned as predominant or important for 9.7% of species, the potential for the species to use novel or artificial habitat features for 19.0% of species, and the need for conservation actions to target urban areas was mentioned for 30.8% of species. In some cases, this reflected the degree to which the species distribution overlapped with an urban area. For example, the recovery documents of species that were urban-restricted or had high urban distributions more often acknowledged urban issues (Table 5). However overall, the urban issues were recognised less often than expected based on the species urban distribution.

Table 5. The degree to which urban issues were recognised for each type of urban-occurring species.

Group	Urban-restricted	High	Moderate	Low	Many cities	Global-marine	Edge
Number of species	39	82	54	67	54	21	43
% Recognised urbanisation as a threat	87.2	79.3	53.7	37.3	85.2	47.6	46.5
% Recognised the need for conservation in urban environments	61.5	34.1	35.2	16.4	31.5	14.3	20.9
% Identified the species as being common or predominantly within urban environments	35.9	15.9	3.7	6.0	1.9	0.0	2.3
% Identified the potential use of novel or artificial habitats	15.4	9.8	16.7	22.4	40.7	23.8	9.3

Part 3: Guiding the conservation of threatened species in cities

Urban conservation principles were not entirely absent from the recovery documents of urban-occurring threatened species – many presented detailed accounts of urban threats, challenges to management and the implementation of conservation actions, and how these challenges could be overcome. However, these were relatively sporadic and inconsistently applied. Urban conservation actions were described for some species that had small urban ranges, while they were overlooked for others that predominantly occurred within urban environments. This lack of acknowledgement may limit the implementation of conservation actions for threatened species in cities, or lead practitioners to believe that there are few opportunities for urban conservation.

We present information and approaches that can help address this gap and allow urban conservation principles to be applied more broadly to urban-occurring threatened species. These are synthesised from the data within the recovery documents of urban-occurring threatened species and broader CAUL research into urban biodiversity conservation. First, we identify six ways for Australian cities to contribute to the conservation of threatened species. Then, we illustrate ‘urban specific’ threats and action types that could be applied to urban-occurring threatened species.

There is significant scope to apply these proposed approaches in a range of Australian cities, as evidenced by the CAUL Hub’s ‘Practical actions for urban biodiversity’ project, which involved interviews with urban land managers across the country. The associated report details the range of actions currently undertaken for urban biodiversity, including a range of threatened species, and both the opportunities but also the many challenges practitioners face (Threlfall *et al.* 2019). Next steps for this research will be to apply the approaches detailed here and evaluate the outcomes via monitoring.

The roles for urban environments in threatened species conservation

The degree to which species ranges overlap with urban environments, the role that the urban portions of their distributions play in their life cycle, and the number of cities that they occur in can be used to identify opportunities and conservation needs in cities. While spatial ranges are not the only important factor, they can provide a useful starting point from which to identify further opportunities for urban conservation across species ranges.

We highlight six possible approaches (Figure 7) to threatened species conservation in urban environments that account for the species range and use of cities and towns, the threats that occur, and mitigation or recovery actions available. These are: when conservation action within cities and towns is critical to a species persistence; when a conservation action can be implemented across multiple cities and towns; when species ranges are not predominantly urban, but cities and towns can provide important opportunities and engage people with nature; when actions are required to accommodate species that temporarily visit or pass through cities; when a species range is not predominantly urban but could be affected by future urban expansion; and when species can be reintroduced to cities that were part of their historic range.

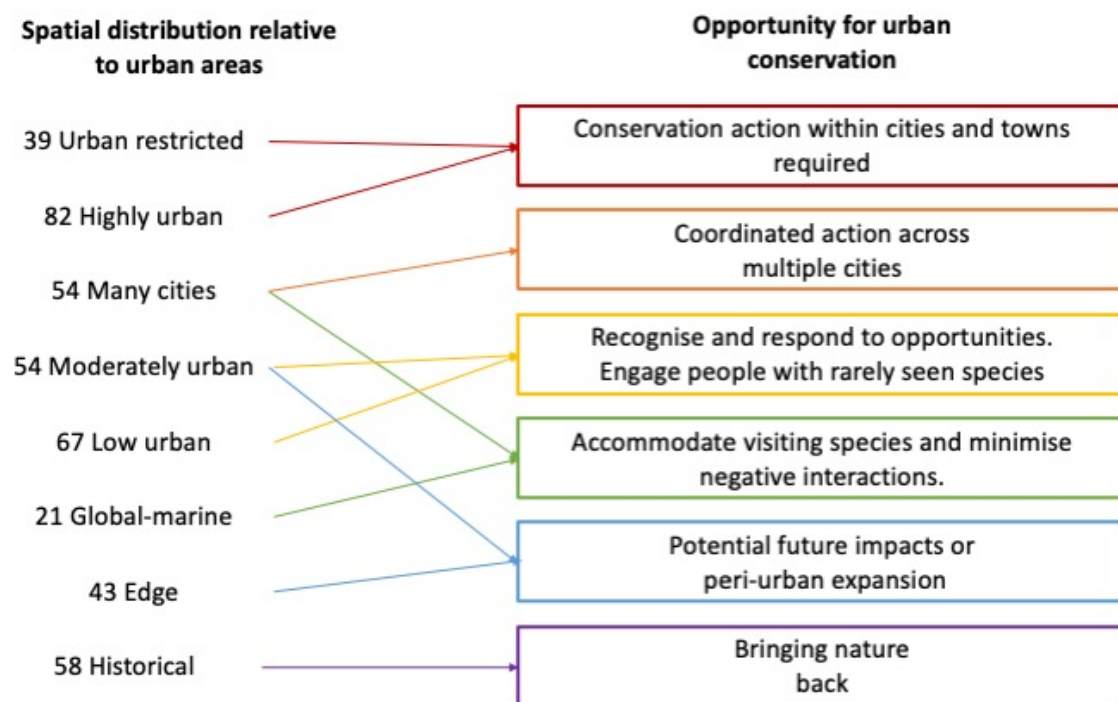


Figure 7. Overview of conservation approaches for threatened species in cities.

Conservation within cities and towns is necessary

The successful recovery of many species depends on our ability to implement effective conservation strategies within cities and towns. These species reside within urban environments and cities represent an important proportion of their range. Urban conservation actions must include the mitigation of threats, provision of resources, efforts to increase the number of individuals or populations, and protection from further incremental loss. We estimate that at least 121 of Australia's threatened species depend on conservation action within cities and towns for their long-term persistence and represent important targets for urban conservation.

Example species: The Sunshine diuris is an urban-restricted species within Melbourne. After suffering a massive range contraction due to habitat destruction for agricultural and urban development, the species now occupies just 1% of its former range. The threats to the species persistence in suburban Melbourne have included illegal collection, damage from visiting naturalists or enthusiasts, crushing or damage from rubbish dumping and vehicular access (both recreational and maintenance), altered fire regimes through arson and suppressed fire, and herbivory by common urban-dwelling species such as snails and slugs. Despite the precarious nature of the species location – an urban railway reserve – the species is an example of conservation success. It has been the subject of ongoing conservation action and recovery, both ex situ and in situ, and benefits from a large community support campaign.

Coordinated actions across multiple cities

Species that occur in multiple cities present an opportunity for coordinated action at regional or national scales. These species are not predominantly urban in nature and the management of threats elsewhere in their range will continue to be critical. However, actions can be implemented within cities across their range, in turn affecting a large portion of the species distribution. The species most likely to benefit from such actions are those with large ranges that interact with many cities, or those whose range occurs in areas of intense urban development, such as the east coast of NSW and south-east Queensland. This would typically involve dealing with a specific, urban-prevalent threats, for example reducing road fatalities for mammals such as bandicoots and koalas, or reducing window collisions for highly mobile honeyeaters or parrots. The potential benefits of multi-city campaigns include high community engagement in threatened species management and the capacity to further the evidence-base for urban conservation action by implementing and evaluating novel conservation actions across multiple locations at a large scale.

Accommodate visitors

Some animal species are not permanent residents in urban environments, but instead visit cities infrequently or seasonally. For these species, cities provide important feeding, resting or breeding grounds, but these opportunities may be overlooked due to their fleeting presence. The most important threats to these species when in urban environments are

collisions with infrastructure, disturbance from noise and light, predation or attack by feral or domestic animals, or the destruction of small feeding or nesting sites.

Recognise and respond to opportunities when they arise

For many species, urban conservation may not be a high priority relative to land-use or climate change, or threats operating in large parts of their range. For example, species we classed as having low or moderate urban occurrence were more typically threatened by agriculture and grazing than urbanisation. However, urban environments still have capacity to impact conservation outcomes for these species, particularly when:

- Cities house important populations of the species, either because they are of significant size, represent an important part of the species range, or are evolutionarily distinct.
- Cities present a critical breeding or foraging site
- The threats operating in the urban portion of the range, while small, have a significant impact on the species.
- Conservation actions are more likely to be successful in urban environments than non-urban areas.
- There are opportunities to engage people with the species, which they would not ordinarily encounter.
- There is local support for species based on high cultural values or community interest.

For example, species such as the matted flax lily and western ringtail possum do not have predominantly urban ranges, however there is significant community interest in their conservation. For these species, there are effective conservation strategies in place that mitigate urban threats while taking advantage of the opportunities that this community interest presents. The conservation potential for species with low or moderate urban ranges should therefore be assessed on a case-by-case basis, taking into account the local context.

Protect from potential future impacts of urban expansion

As urban areas expand, more species and populations will become urban-affected. We identified 43 threatened species whose only urban-occurrence was on the edge of a single Australian city or town. However, a further 37 species that were recorded 'in' cities also had edge populations. For species that currently have minimal urban occurrences or are on the edges of cities and towns, the priority should be to prevent further loss from future urban developments and limit the impact of off-site impacts (e.g. changes to hydrology, storm-water run-off). This may require strong legislative protection of sites or evidence-based approaches to minimising the impacts of development (e.g. Garrard *et al.* 2017, Soanes *et al.* 2019).

Bringing nature back

When species have become locally extinct from their urban ranges, there may be opportunities to reintroduce them to cities. Local governments and urban managers worldwide are considering options for restoring species "lost" to urban environments through approaches such as 'bringing nature back' (Mata *et al.* 2020) or 'wildlife restoration' (Watson and Watson, 2015). Australia's threatened species could be considered for reintroduction into cities in cases where either the initial cause of decline is no longer

present, the urban environment provides resources and suitable novel habitats that were previously not available, or when threats to the species can be mitigated through conservation action. In our investigation, 58 threatened species were only known from Australian cities through historic records. However, a further 138 species that have a current distribution within at least one city have become locally extinct from one or more other urban locations. For example, the green and golden bell frog is currently found in six cities but was previously known from six others, the eastern quoll is currently known from only a single city but was historically present in five others, and the basalt peppergrass is currently known from two cities while being locally extinct in two others. The fact that such species are able to maintain populations within other cities suggests that urban environments can support their persistence if the right conditions and conservation strategy are provided. Urban conservation presents an opportunity to reclaim parts of a species range that were previously lost.

Urban-specific threats and conservation actions

Urban environments bring their own sets of threats, challenges and opportunities to threatened species recovery. Understanding these can help tailor conservation approaches to better suit the urban environment, taking advantage of unique resources that are present and avoiding pitfalls. Here, we bring the urban context to the fore, drawing on our review of the recovery documents to present lists of urban-specific threats (Table 6) and urban-specific actions (Table 7) that should be considered in the recovery planning of urban-occurring threatened species. These represent threats and actions that are likely to be either a) unique to an urban environment, b) more prevalent within an urban environment, or c) have an urban mechanism that requires a management response that is unique to an urban environment.

The categories are deliberately broad, allowing them to be tailored based on species needs and context, even when information on the management of a given species in an urban setting is lacking. More detailed examples of common urban conservation actions can be found in the “National summary of local actions” (Threlfall *et al.* 2019) and “Expanded inventory of urban conservation actions” (Taylor *et al.* 2020), that summarise >300 existing projects for urban biodiversity across the country, including for threatened species and communities.

Table 6. Urban-specific threats to threatened species in cities

Threatening process	How it can occur in an urban environment
Small scale habitat destruction	Urban infill and development of informal green space Road widening and maintenance Draining or in-filling ponds
Change in abiotic conditions required for survival	Altered soil condition and hydrology due to urban infrastructure and impervious surfaces Heat island effect creating increased vulnerability to heat waves and heat stress
Disruption of ecological process	Changed fire regimes due to arson or suppressed fire Loss of key pollinators or symbionts Habitat fragmentation Disrupted recruitment
Collision with infrastructure	Collision with vehicles (e.g. roadkill, boat strike) Collision with buildings, windows or powerlines Weirs, culverts and concrete waterways
Sensory disturbance	Noise from vehicles and people Artificial light at night from urban infrastructure and buildings Presence of people in or near the habitat
Loss of key habitat elements	Removal of hollow bearing trees or limbs Removal of rocks, fallen logs and debris, leaf litter Either for human safety, cleaning up greenspace, or collection for residential gardens
Poisons and pollutants	Herbicides to control weeds and tidy up pathways Heavy metals and nutrients in storm water run-off poisons for pest control (e.g. rodenticides)
Hunting and removal	Persecution due to conflict or mistaken identity with pests Collection or harvest (e.g. attractive or rare species)
Crushing and damage	Rubbish dumping and trampling Vehicle access or mechanical damage from maintenance vehicles
Attack and herbivory	Attack by domestic cats and dogs, urban foxes, aggressive native birds Herbivory by snails, slugs, mice and rabbits
Competition and encroachment	Weed spread through ornamental and landscape plantings, garden escapees or dumping of garden waste Ornamental tree and shrub plantings in inappropriate locations shade out smaller native plants Competition with non-native pollinators or hollow nesting species; overabundant aggressive bird species; destruction of food resources.
Disease	Increased disease load in urban areas (e.g. toxoplasmosis, beak and feather disease) Diseases from feeding on urban rubbish, junk food.

Table 7. Urban-specific conservation actions for threatened species in cities

Type of action	Description and rationale	Examples
Unconventional locations	While land dedicated to conservation is scarce, other spaces and land-uses can provide resources for threatened species conservation	Green roofs or walls, Landscape and garden plantings, Roadsides, airports, cemeteries, schools and industrial land Restoring vacant lots or wasteland, converting concreted waterways to riparian habitats Protecting non-native or weedy vegetation that serves an important ecological role
Artificial replacements or interventions	Management actions specifically to replace a missing resource or process	Artificial nesting hollows or habitat structures Watering regimes Microclimate modifications through shade cloths etc. Wildlife crossing structures Indigenous burning practices and ecological burning Water-sensitive urban design
Physical modifications	Reducing sources of disturbance or mortality by making physical changes	Adding blinkers or shades to reduce spill over from artificial light at night Roadside fencing to reduce roadkill Modifications to reduce electrocution at powerlines Flags and markers to reduce collision with windows
Control of other species	Commensal or urban-prolific species can have direct negative effects (e.g. predation) or indirectly affect the success of management actions (e.g. occupy hollows)	Hand-weeding to remove competition pest control to remove rabbits Baiting or trapping
Regulation or enforcement	Restricting behaviours and actions that negatively impact species	Rules and policies, fines, prohibition Fencing and gates to restrict access Secure tenure to prevent development
Biodiversity-friendly management	Supporting urban biodiversity alongside the management of unconventional spaces	Greening and corridor initiatives Sympathetic management practices that pair species needs with land-use goals
Partnerships	Urban areas have a wide range of stakeholders and land managers. Relationships with stakeholders and land managers to protect species or enhance populations.	Road and utilities managers Local government and city councils Indigenous land management Knowledge transfer and awareness of sympathetic management regimes
Awareness and engagement	Harnessing people-power. An aware and engaged community can make huge contributions to conservation.	Signage, information campaigns and outreach Volunteering in conservation action and citizen science Stewardship through 'Friends of' groups Flagship species and crowd-funding
Design features	Tools to design or retrofit spaces to enable multi-use for people and nature	Biodiversity sensitive urban design Raised walkways to avoid trampling of sensitive areas Green building and public space guidelines
Providing alternative resources for people	Addressing the source of the conflict behaviour	Quoll-proof chicken coops Designated dog-friendly areas and walking or biking trails Alternative sources of wood/rocks for gardens

Conclusions and recommendations

Categorising opportunities for urban conservation of threatened species

- Many species and cities should be a high priority for conservation. The greatest needs likely arise for urban restricted species, those with a high proportion of their distributions in urban areas, species with important urban populations, or those species which occur in many cities.
- Recovery planning documents should acknowledge or flag these ‘urban important’ species, to alert decision-makers and practitioners to the need for urban conservation action.
- Even species that have minimal urban distributions can benefit from conservation actions in urban environments, whether it be the provision of temporary resources, protection of important populations, mitigation of threats which are prevalent in other parts of the range but are rare or easily managed in urban environments, or cases where the opportunities to engage with the community are high.
- Our assessments for each species are preliminary and will benefit from further ground-truthing and consultation with species and recovery team experts.
- We reiterate that while spatial information is an important starting point, it is not the only information needed to identify and prioritise conservation opportunities. Other factors such as the presence of important populations, detail on the species ecology, socio-economic factors, and the availability and effectiveness of conservation actions should all be considered in formal decision-making processes.

Incorporating urban factors in threatened species conservation

- We have highlighted a supplementary approach to threatened species conservation when urban environments make up part or all of the species distribution, based on extensive review of recovery documents and research into urban conservation.
- This approach recognises that:
 - Many threats may be more prevalent (e.g. noise or light pollution) or may occur through a different pathway in urban environments (e.g. attack by domestic pets, weeds from garden waste);
 - Urban environments present opportunities (e.g. novel resources, community stewardship); and
 - Management actions must address unique challenges (e.g. human-wildlife conflict, lack of secure tenure, multi-use spaces).
- Many urban factors threatening biodiversity are difficult to manage and understudied (e.g. noise pollution, artificial light at night, rubbish, disease). There remains a need for novel approaches to mitigate such threats and research into their effectiveness.
- Further ecological research needed to identify species capacity to persist in urban environments, identify new solutions to urban threats and challenges, and evaluate the cost-effectiveness of conservation actions. Such information would help inform future evidence-based prioritisation of conservation actions within urban environments and across a species range.

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Appendices

Appendix 1. Australian cities and towns considered in the analysis of urban-occurring threatened species

The analysis focused on 99 cities and towns across Australia, including the capital cities of Adelaide, Brisbane, Canberra–Queanbeyan, Darwin, Hobart, Perth, Sydney and Melbourne, as well as the following cities (presented in alphabetical order): Albany, Albury–Wodonga, Alice Springs, Armidale, Bacchus Marsh, Bairnsdale, Ballarat, Ballina, Batemans Bay, Bathurst, Bendigo, Bowral–Mittagong, Broken Hill, Broome, Bunbury, Bundaberg, Burnie–Wynyard, Busselton, Cairns, Central Coast, Cessnock, Coffs Harbour, Colac, Dalby, Devonport, Drysdale–Clifton Springs, Dubbo, Echuca–Moama, Ellenbrook, Emerald, Forster–Tuncurry, Geelong, Geraldton, Gladstone–Tannum Sands, Gold Coast–Tweed Heads, Goulburn, Grafton, Griffith, Gympie, Hervey Bay, Horsham, Karratha, Kempsey, Kurri Kurri–Weston, Launceston, Lismore, Lithgow, Mackay, Maryborough, Melton, Mildura–Wentworth, Moe–Newborough, Morisset–Cooranbong, Mount Gambier, Mount Isa, Murray Bridge, Muswellbrook, Nelson Bay–Corlette, Newcastle–Maitland, Nowra–Bomaderry, Ocean Grove–Point Lonsdale, Orange, Parkes, Port Augusta, Port Hedland, Port Lincoln, Port Macquarie, Port Pirie, Rockhampton, Sale, Shepparton–Mooroopna, Singleton, Sunshine Coast, Tamworth, Taree, Toowoomba, Torquay, Townsville, Traralgon–Morwell, Ulladulla, Ulverstone, Victor Harbor–Goolwa, Wagga Wagga, Wangaratta, Warragul–Drouin, Warrnambool, Warwick, Whyalla, Wollongong and Yeppoon.

The following table ranks the cities based on the total number of threatened species identified through our analysis. The tally of threatened species for each city includes those currently within urban boundaries (“in”), outside of cities but within 2km of the urban boundary (“edge”) and historical records from the city prior to the year 2000 (“historical”).

City	In	Edge	Historical	Total
Sydney	80	3	10	93
Melbourne	46	1	14	61
Central Coast	39	3	6	48
Gold Coast–Tweed Heads	39	5	4	48
Perth	35	3	6	44
Brisbane	30	1	11	42
Newcastle–Maitland	33	2	4	39
Hobart	29	1	8	38
Adelaide	22	5	10	37
Sunshine Coast	26	3	8	37
Wollongong	29	2	5	36
Coffs Harbour	20	2	10	32
Canberra–Queanbeyan	24	2	4	30
Victor Harbor–Goolwa	15	2	12	29
Ballina	12	0	8	20
Morisset–Cooranbong	16	0	4	20
Port Macquarie	16	1	3	20
Toowoomba	12	6	2	20

Nowra–Bomaderry	17	1	2	20
Cairns	12	3	4	19
Launceston	11	1	5	17
Lismore	9	1	6	16
Forster–Tuncurry	14	0	2	16
Busselton	9	3	3	15
Bundaberg	8	0	6	14
Albany	10	0	4	14
Ocean Grove–Point Lonsdale	12	0	2	14
Geelong	9	4	1	14
Ulladulla	14	0	0	14
Bairnsdale	6	2	5	13
Townsville	8	1	4	13
Bendigo	7	2	3	12
Burnie–Wynyard	9	0	3	12
Warrnambool	9	0	3	12
Darwin	9	1	2	12
Nelson Bay–Corlette	9	1	2	12
Albury–Wodonga	10	2	0	12
Alice Springs	3	3	4	10
Bacchus Marsh	5	1	4	10
Ulverstone	5	1	4	10
Rockhampton	6	0	4	10
Gladstone–Tannum Sands	6	1	3	10
Cessnock	8	1	1	10
Kurri Kurri–Weston	8	2	0	10
Grafton	3	0	6	9
Ballarat	4	1	4	9
Devonport	5	0	4	9
Port Lincoln	5	0	4	9
Bathurst	5	1	3	9
Dubbo	6	0	3	9
Melton	4	3	2	9
Batemans Bay	7	0	2	9
Hervey Bay	7	0	2	9
Echuca–Moama	2	1	5	8
Armidale	3	0	5	8
Dalby	4	0	4	8
Sale	4	1	3	8
Taree	3	3	2	8
Maryborough	5	1	2	8

Mackay	6	0	2	8
Murray Bridge	6	2	0	8
Tamworth	1	1	5	7
Griffith	2	1	4	7
Moe–Newborough	4	1	2	7
Kempsey	5	0	2	7
Bowral–Mittagong	4	2	1	7
Ellenbrook	4	2	1	7
Shepparton–Mooroopna	2	0	4	6
Traralgon–Morwell	3	0	3	6
Wagga Wagga	3	0	3	6
Lithgow	3	1	2	6
Mildura–Wentworth	4	0	2	6
Orange	4	0	2	6
Bunbury	5	0	1	6
Torquay	6	0	0	6
Horsham	2	0	3	5
Colac	2	1	2	5
Whyalla	4	0	1	5
Wangaratta	1	0	3	4
Parkes	2	0	2	4
Goulburn	2	1	1	4
Muswellbrook	2	1	1	4
Broome	4	0	0	4
Gympie	4	0	0	4
Yeppoon	4	0	0	4
Emerald	0	0	3	3
Mount Isa	2	0	1	3
Singleton	2	0	1	3
Warwick	2	0	1	3
Karratha	3	0	0	3
Warragul–Drouin	0	1	1	2
Broken Hill	1	0	1	2
Port Hedland	1	0	1	2
Port Pirie	1	0	1	2
Mount Gambier	1	1	0	2
Drysdale–Clifton Springs	2	0	0	2
Geraldton	2	0	0	2
Port Augusta	2	0	0	2

Appendix 2. Full species list.

The following tables include all 418 threatened species identified through our investigation. We present data on their EPBC-listing, degree of urban occurrence, and the number of cities in which they are present.

Urban restricted threatened species

Scientific name	Common name	EPBC listing	Cities present in
<i>Discocharopa vigens</i>	Charopid land snail	CE	Hobart
<i>Pseudemydura umbrina</i>	Western Swamp Tortoise	CE	Perth, Ellenbrook
<i>Acacia terminalis</i> subsp. <i>terminalis</i> MS	Sunshine Wattle	EN	Sydney
<i>Allocasuarina portuensis</i>	Nielsen Park She-oak	EN	Sydney
<i>Caladenia actensis</i>	Canberra Spider Orchid	CE	Canberra–Queanbeyan
<i>Caladenia amoena</i>	Charming Spider-orchid	EN	Melbourne
<i>Caladenia procera</i>	Carbunup King Spider Orchid	CE	Bussleton
<i>Caladenia robinsonii</i>	Frankston Spider-orchid	EN	Melbourne
<i>Caladenia saggicola</i>	Sagg Spider-orchid	CE	Hobart
<i>Caladenia</i> sp. <i>Kilsyth South</i> (G.S.Lorimer 1253)	Kilsyth South Spider-orchid	CE	Melbourne
<i>Caladenia thysanochila</i>	Fringed Spider-orchid	EN	Melbourne
<i>Calytrix breviseta</i> subsp. <i>breviseta</i>	Swamp Starflower	EN	Perth
<i>Conospermum undulatum</i>	Wavy-leaved Smokebush	VU	Perth
<i>Darwinia apiculata</i>	Scarp Darwinia	EN	Perth
<i>Diuris basaltica</i>	Small Golden Moths Orchid	EN	Melbourne, Bacchus Marsh
<i>Diuris fragrantissima</i>	Sunshine Diuris	EN	Melbourne
<i>Eucalyptus copulans</i>	Eucalyptus copulans	EN	Sydney
<i>Eucalyptus morrisbyi</i>	Morrisbys Gum	EN	Hobart
<i>Gossia gonoclada</i>	Angle-stemmed Myrtle	EN	Brisbane
<i>Grevillea caleyi</i>	Caley's Grevillea	EN	Sydney
<i>Haloragodendron lucasii</i>	Hal	EN	Sydney
<i>Hibbertia basaltica</i>	Basalt Guinea-flower	EN	Hobart
<i>Hibbertia puberula</i> subsp. <i>glabrescens</i>	Hibbertia puberula	CE	Sydney
<i>Keraudrenia exastia</i>	Fringed Keraudrenia	CE	Broome
<i>Lepidium ginninderrense</i>	Ginninderra Peppercross	VU	Canberra–Queanbeyan
<i>Lepidosperma rostratum</i>	Beaked Lepidosperma	EN	Perth
<i>Microtis angusii</i>	Angus's Onion Orchid	EN	Sydney
<i>Notelaea ipsviciensis</i>	Cooneana Olive	CE	Brisbane
<i>Pherosphaera fitzgeraldii</i>	Dwarf Mountain Pine	EN	Sydney
<i>Pimelea spicata</i>	Spiked Rice-flower	EN	Sydney, Wollongong

<i>Prasophyllum milfordense</i>	Milford Leek-orchid	CE	Hobart
<i>Prasophyllum perangustum</i>	Knocklofty Leek-orchid	CE	Hobart
<i>Prostanthera marifolia</i>	Seaforth Mintbush	CE	Sydney
<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	EN	Sydney
<i>Ptilotus pyramidatus</i>	Pyramid Mulla-mulla	CE	Perth
<i>Zieria baeuerlenii</i>	Bomaderry Zieria	EN	Nowra–Bomaderry
<i>Trithuria occidentalis</i>	Swan Hydatella	EN	Perth
<i>Acacia pubescens</i>	Downy Wattle	VU	Sydney, Central Coast
<i>Allocasuarina thalassoscopica</i>	Allocasuarina thalassoscopica	EN	Coffs Harbour, Sunshine Coast

High urban species

Scientific name	Common name	EPBC listing	No. cities in	No. cities edge	No. cities historical
<i>Tympanocryptis pinguicolla</i>	Grassland Earless Dragon	EN	2	0	0
<i>Antipodia chaostola leucophaea</i>	Tasmanian Chaostola Skipper	EN	1	0	0
<i>Thersites mitchellae</i>	Mitchell's Rainforest Snail	CE	1	0	0
<i>Semotrachia euzyga</i>	a land snail	EN	1	0	0
<i>Engaeus granulatus</i>	Central North Burrowing Crayfish	EN	1	0	0
<i>Engaeus yabbimunna</i>	Burnie Burrowing Crayfish	VU	1	0	0
<i>Ozothamnus reflexifolius</i>	Reflexed Everlasting	VU	1	0	0
<i>Prostanthera junonis</i>	Somersby Mintbush	EN	1	1	0
<i>Acacia gordonii</i>	Acacia gordonii	EN	1	0	0
<i>Prostanthera eurybioides</i>	Monarto Mintbush	EN	1	0	0
<i>Prostanthera densa</i>	Villous Mintbush	VU	2	0	0
<i>Caladenia concolor</i>	Crimson Spider-orchid	VU	1	0	0
<i>Myrsine richmondensis</i>	Purple-leaf Muttonwood	EN	1	0	0
<i>Epacris exserta</i>	South Esk Heath	EN	1	0	0
<i>Eucalyptus parramattensis subsp. decadens</i>	Earp's Gum	VU	3	1	0
<i>Triunia robusta</i>	Triunia robusta	EN	1	0	0
<i>Eucalyptus hallii</i>	Goodwood Gum	VU	1	0	0
<i>Verticordia plumosa var. vassensis</i>	Vasse Featherflower	EN	1	0	0
<i>Rutidosia heterogama</i>	Heath Wrinklewort	VU	5	0	0
<i>Caladenia rigida</i>	Stiff White Spider-orchid	EN	1	0	0
<i>Endiandra hayesii</i>	Rusty Rose Walnut	VU	1	0	1
<i>Syzygium moorei</i>	Rose Apple	VU	1	0	0
<i>Eucalyptus benthamii</i>	Camden White Gum	VU	1	0	0
<i>Persoonia acerosa</i>	Needle Geebung	VU	1	0	0
<i>Grevillea shiressii</i>	Grevillea shiressii	VU	2	0	0
<i>Eucalyptus langleyi</i>	Albatross Mallee	VU	1	0	0
<i>Zieria prostrata</i>	Headland Zieria	EN	1	0	0
<i>Planchonella eerwah</i>	Shiny-leaved Condoe	EN	1	0	0
<i>Macarthuria keigheryi</i>	Keighery's Macarthuria	EN	1	0	0
<i>Dodonaea rupicola</i>	Velvet Hopbush	VU	1	0	0
<i>Diplazium cordifolium</i>	Diplazium cordifolium	VU	1	0	0
<i>Randia moorei</i>	Spiny Gardenia	EN	1	1	0
<i>Fontainea venosa</i>	Bahr's Scrub Fontainea	VU	1	0	0
<i>Acacia aphylla</i>	Leafless Rock Wattle	VU	1	0	0
<i>Swainsona recta</i>	Small Purple-pea	EN	1	0	0

<i>Acacia anomala</i>	Grass Wattle	VU	1	0	0
<i>Zieria granulata</i>	Illawarra Zieria	EN	1	0	0
<i>Eucalyptus conglomerata</i>	Swamp Stringybark	EN	1	0	0
<i>Leptospermum deanei</i>	Deane's Tea-tree	VU	1	0	0
<i>Anthocercis gracilis</i>	Slender Tailflower	VU	1	0	0
<i>Diuris praecox</i>	Newcastle Doubletail	VU	2	0	1
<i>Prasophyllum wallum</i>	Wallum Leek-orchid	VU	1	0	0
<i>Notelaea lloydii</i>	Lloyd's Olive	VU	1	0	0
<i>Caladenia rosella</i>	Rosella Spider-orchid	EN	1	0	0
<i>Leucopogon exolasius</i>	Woronora Beard-heath	VU	1	0	0
<i>Microtis globula</i>	South-Coast Mignonette Orchid	VU	1	0	0
<i>Diuris purdiei</i>	Purdie's Donkey-orchid	EN	1	0	0
<i>Lasiopetalum joyceae</i>	Lasiopetalum joyceae	VU	1	0	0
<i>Graptophyllum reticulatum</i>	Veiny Graptophyllum	EN	1	0	0
<i>Caladenia sylvicola</i>	Forest Fingers	CE	1	0	0
<i>Persoonia hirsuta</i>	Hairy Persoonia	EN	1	0	0
<i>Tetraloche juncea</i>	Black-eyed Susan	VU	3	0	0
<i>Angophora inopina</i>	Charmhaven Apple	VU	3	0	0
<i>Caladenia huegelii</i>	King Spider-orchid	EN	2	0	2
<i>Genoplesium baueri</i>	Yellow Gnat-orchid	EN	2	0	0
<i>Melaleuca deanei</i>	Deane's Melaleuca	VU	1	0	0
<i>Persoonia bargoensis</i>	Bargo Geebung	VU	1	0	0
<i>Pimelea curviflora</i> var. <i>curviflora</i>	P. curviflora	VU	2	0	0
<i>Prasophyllum pruinosum</i>	Plum Leek-orchid	EN	1	0	0
<i>Spyridium coactilifolium</i>	Butterfly Spyridium	VU	1	0	0
<i>Allocasuarina glareicola</i>	Allocasuarina glareicola	EN	1	0	0
<i>Micromyrtus minutiflora</i>	Micromyrtus minutiflora	VU	1	0	0
<i>Persoonia mollis</i> subsp. <i>maxima</i>	Persoonia mollis	EN	1	0	0
<i>Rhizanthella slateri</i>	Eastern Underground Orchid	EN	1	0	0
<i>Plectranthus habrophyllus</i>	Plectranthus habrophyllus	EN	2	0	0
<i>Eucalyptus camfieldii</i>	Camfield's Stringybark	VU	2	0	0
<i>Pultenaea parviflora</i>	Pultenaea parviflora	VU	1	0	0
<i>Persoonia nutans</i>	Nodding Geebung	EN	1	0	0
<i>Darwinia biflora</i>	Darwinia biflora	VU	1	0	0
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	EN	3	0	0
<i>Euphrasia bowdeniae</i>	Euphrasia bowdeniae	VU	1	0	0
<i>Prostanthera askania</i>	Tranquillity Mintbush	EN	1	0	0
<i>Allocasuarina emuina</i>	Emu Mountain Sheoak	EN	1	0	0
<i>Genoplesium littorale</i>	Tuncurry Midge Orchid	CE	1	0	0
<i>Pterostylis vernalis</i>	Halbury Rustyhood	CE	1	0	0
<i>Thelymitra adorata</i>	Wyong Sun Orchid	CE	1	0	0

<i>Pultenaea glabra</i>	Smooth Bush-pea	VU	1	0	1
<i>Asterolasia elegans</i>	Asterolasia elegans	EN	1	0	0
<i>Pomaderris pilifera subsp. talpicutica</i>	Moleskin Dogwood	VU	1	0	0
<i>Ochrosia moorei</i>	Southern Ochrosia	EN	1	0	1
<i>Leionema lachnaeoides</i>	Leionema lachnaeoides	EN	1	0	0
<i>Daphnandra johnsonii</i>	Illawarra Socketwood	EN	1	0	0

Multi-city species

Scientific name	Common name	EPBC listing	No. cities in	No. cities edge	No. cities historical
<i>Litoria aurea</i>	Green and Golden Bell Frog	VU	6	1	6
<i>Sarcophilus harrisii</i>	Tasmanian Devil	EN	5	0	0
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	VU	8	0	2
<i>Dasyurus maculatus maculatus</i> (SE mainland population)	Spot-tailed Quoll	EN	14	0	3
<i>Perameles gunnii gunnii</i>	Eastern Barred Bandicoot_TAS	VU	5	0	0
<i>Polytelis swainsonii</i>	Superb Parrot	VU	8	0	0
<i>Rostratula australis</i>	Australian Painted Snipe	EN	17	3	15
<i>Calyptorhynchus latirostris</i>	Carnaby's Black-Cockatoo	EN	6	0	0
<i>Phascolarctos cinereus</i> (combined populations of Qld, NSW and the ACT)	Koala	VU	35	3	5
<i>Mixophyes iteratus</i>	Giant Barred Frog	EN	5	0	0
<i>Xeromys myoides</i>	Water Mouse	VU	6	0	0
<i>Calyptorhynchus baudinii</i>	Baudin's Black-Cockatoo	VU	6	0	0
<i>Prototroctes maraena</i>	Australian Grayling	VU	9	0	3
<i>Litoria raniformis</i>	Growling Grass Frog	VU	10	3	11
<i>Bidyanus bidyanus</i>	Silver Perch	CE	4	0	0
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN	31	0	13
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	VU	5	0	2
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	VU	43	0	0
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	17	2	4
<i>Grantiella picta</i>	Painted Honeyeater	VU	8	2	7
<i>Aquila audax fleayi</i>	Wedge-tailed Eagle	EN	3	1	0
<i>Delma impar</i>	Striped Legless Lizard	VU	3	1	0
<i>Isoodon obesulus obesulus</i>	Southern Brown Bandicoot	EN	3	1	5
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	VU	4	0	0
<i>Synemon plana</i>	Golden Sun Moth	CE	4	1	0
<i>Macquaria australasica</i>	Macquarie Perch	EN	3	0	3
<i>Erythrotriorchis radiatus</i>	Red Goshawk	VU	4	0	6
<i>Geophaps scripta scripta</i>	Squatter Pigeon	VU	4	0	1
<i>Turnix melanogaster</i>	Black-breasted Button-quail	VU	3	2	3
<i>Litoria olongburensis</i>	Wallum Sedge Frog	VU	3	0	1
<i>Galaxiella pusilla</i>	Eastern Dwarf Galaxias	VU	3	1	0
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	VU	4	0	1
<i>Maccullochella peelii</i>	Murray Cod	VU	3	0	2
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	4	0	3
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	CE	3	1	3
<i>Lathamus discolor</i>	Swift Parrot	EN	35	0	10

<i>Nannoperca obscura</i>	Yarra Pygmy Perch	VU	3	0	1
<i>Acronychia littoralis</i>	Scented Acronychia	EN	6	0	0
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	VU	7	0	1
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	VU	5	0	0
<i>Arthraxon hispidus</i>	Hairy-joint Grass	VU	5	1	0
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	VU	7	2	0
<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	VU	6	0	0
<i>Acacia bynoeana</i>	Bynoe's Wattle	VU	5	0	0
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass	VU	5	0	1
<i>Macadamia integrifolia</i>	Macadamia Nut	VU	3	0	0
<i>Allocasuarina defungens</i>	Dwarf Heath Casuarina	EN	3	0	0
<i>Phaius australis</i>	Lesser Swamp-orchid	EN	3	1	0
<i>Cryptocarya foetida</i>	Stinking Cryptocarya	VU	3	0	0
<i>Cynanchum elegans</i>	White-flowered Wax Plant	EN	3	0	2
<i>Drakaea elastica</i>	Glossy-leafed Hammer-orchid	EN	3	0	0
<i>Dianella amoena</i>	Matted Flax-lily	EN	4	2	0
<i>Thesium australe</i>	Toadflax	VU	3	1	2
<i>Persicaria elatior</i>	Knotweed	VU	3	0	1

Moderate urban species

Scientific name	Common name	EPBC listing	No. cities in	No. cities edge	No. cities historical
<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	VU	1	0	0
<i>Saccolaimus saccolaimus nudicluniatus</i>	Bare-rumped Sheathtail Bat	CE	2	0	0
<i>Aprasia pseudopulchella</i>	Flinders Ranges Worm-lizard	VU	1	0	0
<i>Litoria rheocola</i>	Common Mistfrog	EN	1	0	0
<i>Ceyx azureus diemenensis</i>	Tasmanian Azure Kingfisher	EN	2	0	0
<i>Pteropus conspicillatus</i>	Spectacled Flying-fox	VU	1	0	0
<i>Craterocephalus fluviatilis</i>	Murray Hardyhead	EN	2	0	0
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	VU	2	0	1
<i>Elusor macrurus</i>	Mary River Turtle	EN	1	0	0
<i>Delma torquata</i>	Collared Delma	VU	2	0	0
<i>Eulamprus leuraensis</i>	Blue Mountains Water Skink	EN	1	0	0
<i>Pardalotus quadragintus</i>	Forty-spotted Pardalote	EN	1	0	0
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black-Cockatoo	VU	1	0	0
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard	VU	2	1	0
<i>Allocasuarina simulans</i>	Nabiac Casuarina	VU	1	0	0
<i>Persoonia glaucescens</i>	Mittagong Geebung	VU	1	0	0
<i>Verticordia densiflora</i> var. <i>pedunculata</i>	Long-stalked Featherflower	EN	1	0	0
<i>Verticordia plumosa</i> var. <i>ananeotes</i>	Tufted Plumed Featherflower	EN	1	0	0
<i>Eucalyptus balanites</i>	Cadda Road Mallee	EN	1	0	0
<i>Caladenia macroclavia</i>	Large-club Spider-orchid	EN	1	0	0
<i>Acacia menzeli</i>	Menzel's Wattle	VU	1	0	0
<i>Cycas ophiolitica</i>	Cycas ophiolitica	EN	2	0	0
<i>Diuris drummondii</i>	Tall Donkey Orchid	VU	1	0	0
<i>Eucalyptus glaucina</i>	Slaty Red Gum	VU	1	1	0
<i>Marsdenia longiloba</i>	Clear Milkvine	VU	1	0	0
<i>Desmodium acanthocladum</i>	Thorny Pea	VU	1	0	0
<i>Acacia rhetinocarpa</i>	Neat Wattle	VU	1	0	0
<i>Caladenia behrii</i>	Pink-lipped Spider-orchid	EN	1	0	0
<i>Diospyros mabacea</i>	Red-fruited Ebony	EN	1	0	0
<i>Macadamia tetraphylla</i>	Rough-shelled Bush Nut	VU	2	0	1
<i>Pterostylis arenicola</i>	Sandhill Greenhood Orchid	VU	1	0	0
<i>Lepidium hyssopifolium</i>	Basalt Pepper-cress	EN	2	1	2
<i>Samadera bidwillii</i>	Quassia	VU	1	1	0
<i>Pimelea spinescens</i> subsp. <i>spinescens</i>	Spiny Rice-flower	CE	2	2	0

<i>Asperula asthenes</i>	Trailing Woodruff	VU	1	2	0
<i>Floydia praealta</i>	Ball Nut	VU	2	0	0
<i>Pterostylis bryophila</i>	Hindmarsh Valley Greenhood	CE	1	0	0
<i>Macadamia ternifolia</i>	Small-fruited Queensland Nut	VU	2	0	0
<i>Acacia attenuata</i>	Acacia attenuata	VU	2	0	1
<i>Gossia fragrantissima</i>	Sweet Myrtle	EN	2	0	0
<i>Thelymitra stellata</i>	Star Sun-orchid	EN	1	0	0
<i>Caladenia argocalla</i>	White-beauty Spider-orchid	EN	1	0	0
<i>Drakaea micrantha</i>	Dwarf Hammer-orchid	VU	2	0	0
<i>Hicksbeachia pinnatifolia</i>	Monkey Nut	VU	0	1	1
<i>Prostanthera cineolifera</i>	Singleton Mint Bush	VU	1	0	0
<i>Diploglottis campbellii</i>	Small-leaved Tamarind	EN	1	1	0
<i>Eleocharis keigheryi</i>	Keighery's Eleocharis	VU	1	0	1
<i>Rutidosis leptorrhynchoides</i>	Button Wrinklewort	EN	2	0	0
<i>Senecio macrocarpus</i>	Large-fruit Fireweed	VU	1	0	0
<i>Diuris micrantha</i>	Dwarf Bee-orchid	VU	1	0	0
<i>Callitris oblonga subsp. oblonga</i>	South Esk Pine	EN	1	0	0
<i>Selaginella andrewsii</i>	Tallebudgera spikemoss	VU	1	0	0
<i>Pomaderris brunnea</i>	Rufous Pomaderris	VU	1	0	0
<i>Corchorus cunninghamii</i>	Native Jute	EN	1	0	0

Low urban species

Scientific name	Common name	EPBC listing	No. cities in	No. cities edge	No. cities historical
<i>Epthianura crocea tunneyi</i>	Yellow Chat	EN	1	0	0
<i>Potorous longipes</i>	Long-footed Potoroo	EN	1	0	0
<i>Erythrura gouldiae</i>	Gouldian Finch	EN	2	0	0
<i>Macrotis lagotis</i>	Greater Bilby	VU	1	0	1
<i>Eulamprus tympanum marnieae</i>	Corangamite Water Skink	EN	1	0	0
<i>Polytelis anthopeplus monarchoides</i>	Regent Parrot	VU	1	0	0
<i>Egernia rugosa</i>	Yakka Skink	VU	1	0	0
<i>Bettongia penicillata ogilbyi</i>	Woylie	EN	1	0	0
<i>Astacopsis gouldi</i>	Giant Lobster	VU	1	0	2
<i>Acanthophis hawkei</i>	Plains Death Adder	VU	1	1	0
<i>Pedionomus torquatus</i>	Plains-wanderer	CE	1	0	7
<i>Casuaris casuaris johnsonii</i>	Southern Cassowary	EN	1	0	0
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	VU	2	0	3
<i>Maccullochella macquariensis</i>	Trout Cod	EN	1	0	0
<i>Neoceratodus forsteri</i>	Lungfish	VU	1	0	1
<i>Leipoa ocellata</i>	Malleefowl	VU	1	1	3
<i>Phyllodes imperialis smithersi</i>	Pink Underwing Moth	EN	1	0	0
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	VU	1	0	1
<i>Idiosoma nigrum</i>	Shield-backed Trapdoor Spider	VU	1	0	0
<i>Mixophyes balbus</i>	Stuttering Frog	VU	1	0	0
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	EN	1	1	1
<i>Polytelis alexandrae</i>	Princess Parrot	VU	1	0	0
<i>Litoria dayi</i>	Lace-eyed Tree Frog	EN	1	0	0
<i>Amytornis textilis myall</i>	Western Grasswren	VU	1	0	0
<i>Poephila cincta cincta</i>	Black-throated Finch	EN	1	0	0
<i>Dasyurus viverrinus</i>	Eastern Quoll	EN	1	0	5
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	VU	1	0	1
<i>Rhinolophus robertsi</i>	Large-eared Horseshoe Bat	EN	2	0	0
<i>Eleocharis retroflexa</i>	a sedge	VU	1	0	0
<i>Prasophyllum pallidum</i>	Pale Leek-orchid	VU	1	0	0
<i>Prasophyllum petilum</i>	Tarengo Leek Orchid	EN	1	0	0
<i>Acacia whibleyana</i>	Whibley Wattle	EN	1	0	0
<i>Acrophyllum australe</i>	Acrophyllum australe	VU	1	0	0
<i>Pultenaea aristata</i>	Pultenaea aristata	VU	1	0	0
<i>Allocasuarina robusta</i>	Mount Compass Oak-bush	EN	1	1	0
<i>Dodonaea procumbens</i>	Trailing Hop-bush	VU	1	0	0

<i>Haloragis exalata</i> subsp. <i>exalata</i>	Wingless Raspwort	VU	1	0	0
<i>Syzygium hodgkinsoniae</i>	Smooth-bark Rose Apple	VU	1	0	2
<i>Andersonia gracilis</i>	Slender Andersonia	EN	1	0	0
<i>Lepidium peregrinum</i>	Wandering Pepper-cress	EN	1	0	0
<i>Eucalyptus raveretiana</i>	Black Ironbox	VU	1	0	0
<i>Cycas megacarpa</i>	Cycas megacarpa	EN	1	0	0
<i>Caladenia anthracina</i>	Black-tipped Spider-orchid	CE	1	0	0
<i>Leucochrysum albicans</i> var. <i>tricolor</i>	Hoary Sunray	EN	2	0	0
<i>Olearia pannosa</i> subsp. <i>pannosa</i>	Silver Daisy-bush	VU	2	0	0
<i>Glycine latrobeana</i>	Clover Glycine	VU	2	2	1
<i>Omphalea celata</i>	Omphalea celata	VU	1	0	0
<i>Xerochrysum palustre</i>	Swamp Everlasting	VU	1	0	0
<i>Bosistoa transversa</i>	Three-leaved Bosistoa	VU	1	0	2
<i>Picris evae</i>	Hawkweed	VU	1	0	2
<i>Eucalyptus strzeleckii</i>	Strzelecki Gum	VU	1	1	0
<i>Dichanthium setosum</i>	bluegrass	VU	2	1	1
<i>Cupaniopsis shirleyana</i>	Wedge-leaf Tuckeroo	VU	1	0	0
<i>Senecio psilocarpus</i>	Swamp Fireweed	VU	1	0	0
<i>Caladenia caudata</i>	Tailed Spider-orchid	VU	1	0	2
<i>Caladenia audasii</i>	Mclvor Spider-orchid	EN	1	0	0
<i>Pterostylis cucullata</i>	Leafy Greenhood	VU	1	1	0
<i>Pterostylis wapstrarum</i>	Fleshy Greenhood	CE	1	0	0
<i>Euphrasia collina</i> subsp. <i>osbornii</i>	Osborn's Eyebright	EN	1	0	0
<i>Pterostylis ziegeleri</i>	Grassland Greenhood	VU	1	0	0
<i>Prasophyllum frenchii</i>	Maroon Leek-orchid	EN	1	0	0
<i>Eucalyptus paludicola</i>	Mount Compass Swamp Gum	EN	1	0	0
<i>Prasophyllum spicatum</i>	Dense Leek-orchid	VU	1	0	0
<i>Pomaderris vacciniifolia</i>	Round-leaf Pomaderris	CE	1	0	0
<i>Callistemon megalongensis</i>	Megalong Valley Bottlebrush	CE	1	0	0
<i>Commersonia prostrata</i>	Dwarf Kerrawang	EN	1	0	0
<i>Eucalyptus aggregata</i>	Black Gum	VU	2	0	0

Global-marine species

Scientific name	Common name	EPBC listing	No. cities in	No. cities edge	No. cities historical
<i>Arctocephalus tropicalis</i>	Subantarctic Fur-seal	VU	5	0	4
<i>Calidris ferruginea</i>	Curlew Sandpiper	CE	43	0	10
<i>Caretta caretta</i>	Loggerhead Turtle	EN	9	0	4
<i>Chelonia mydas</i>	Green Turtle	VU	16	0	6
<i>Dermochelys coriacea</i>	Leatherback Turtle	EN	1	0	5
<i>Diomedea epomophora (sensu stricto)</i>	Southern Royal Albatross	VU	3	0	1
<i>Diomedea exulans (sensu lato)</i>	Wandering Albatross	VU	9	0	6
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	VU	8	0	2
<i>Lepidochelys olivacea</i>	Olive Ridley Turtle	EN	4	0	2
<i>Macronectes giganteus</i>	Southern Giant Petrel	EN	9	0	5
<i>Macronectes halli</i>	Northern Giant Petrel	VU	13	0	1
<i>Mirounga leonina</i>	Southern Elephant Seal	VU	2	0	3
<i>Natator depressus</i>	Flatback Turtle	VU	4	0	1
<i>Neophoca cinerea</i>	Australian Sea-lion	VU	3	0	0
<i>Numenius madagascariensis</i>	Eastern Curlew	CE	34	0	1
<i>Phoebastria fusca</i>	Sooty Albatross	VU	2	0	3
<i>Sternula nereis nereis</i>	Australian Fairy Tern	VU	21	0	0
<i>Thalassarche bulleri</i>	Buller's Albatross	VU	3	0	0
<i>Thalassarche cauta cauta</i>	Shy Albatross	VU	3	0	3
<i>Thalassarche chrysostoma</i>	Grey-headed Albatross	EN	3	0	1
<i>Thalassarche melanophris</i>	Black-browed Albatross	VU	17	0	3

Edge species

Scientific name	Common name	EPBC listing	No. cities in	No. cities edge	No. cities historical
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	EN	0	1	0
<i>Engaeus orramakunna</i>	Mount Arthur Burrowing Crayfish	VU	0	1	0
<i>Hylacola pyrrhopygia parkeri</i>	Chestnut-rumped Heathwren	EN	0	1	0
<i>Litoria booroolongensis</i>	Booroolong Frog	EN	0	1	2
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog	VU	0	1	2
<i>Litoria nannotis</i>	Waterfall Frog	EN	0	1	0
<i>Petrogale lateralis MacDonnell Ranges race</i>	Warru	VU	0	1	0
<i>Sinumelon bednalli</i>	Bednall's Land Snail	EN	0	1	0
<i>Acacia caerulescens</i>	Limestone Blue Wattle	VU	0	1	0
<i>Astrotricha crassifolia</i>	Thick-leaf Star-hair	VU	0	1	0
<i>Baloskion longipes</i>	Dense Cord-rush	VU	0	1	0
<i>Boronia deanei</i>	Deane's Boronia	VU	0	1	0
<i>Bothriochloa bunyensis</i>	Satin-top Grass	VU	0	1	0
<i>Caladenia busselliana</i>	Bussell's Spider-orchid	EN	0	1	0
<i>Chamelaucium sp. S coastal plain (R.D.Royce 4872)</i>	Royce's Waxflower	VU	0	1	0
<i>Davidsonia johnsonii</i>	Smooth Davidsonia	EN	0	1	0
<i>Diuris flavescens</i>	Pale Yellow Doubletail	CE	0	1	0
<i>Endiandra floydii</i>	Floyd's Walnut	EN	0	1	0
<i>Epacris hamiltonii</i>	<i>Epacris hamiltonii</i>	EN	0	1	0
<i>Epacris virgata</i>	Pretty Heath	EN	0	1	0
<i>Eucalyptus argutifolia</i>	Yanchep Mallee	VU	0	1	0
<i>Eucalyptus paedoglauca</i>	Mt Stuart Ironbark	VU	0	1	0
<i>Euphrasia collina subsp. muelleri</i>	Purple Eyebright	EN	0	1	0
<i>Grevillea althoferorum</i>	Split-leaved grevillea	EN	0	1	0
<i>Grevillea curviloba subsp. incurva</i>	Narrow curved-leaf Grevillea	EN	0	1	0
<i>Grevillea quadricauda</i>	Four-tailed Grevillea	VU	0	1	0
<i>Kunzea rupestris</i>	Kunzea rupestris	VU	0	1	0
<i>Lepidium aschersonii</i>	Spiny Pepper-cress	VU	0	1	0
<i>Muehlenbeckia tuggeranong</i>	Tuggeranong Lignum	EN	0	1	0
<i>Petrophile latericola</i>	Laterite Petrophile	EN	0	1	0
<i>Phlegmariurus tetrastichoides</i>	Square Tassel Fern	VU	0	1	0
<i>Prasophyllum fuscum</i>	Tawny Leek-orchid	VU	0	1	1
<i>Samadera sp. Moonee Creek (J.King s.n. Nov. 1949)</i>	Samadera sp.	EN	0	1	0

<i>Sclerolaena napiformis</i>	Turnip Copperbur	EN	0	1	0
<i>Senecio behrianus</i>	Stiff Groundsel	EN	0	1	0
<i>Synaphea stenoloba</i>	Dwellingup Synaphea	EN	0	1	0
<i>Tecticornia flabelliformis</i>	Bead Glasswort	VU	0	1	0
<i>Triplarina nowraensis</i>	Nowra Heath-myrtle	EN	0	1	0
<i>Tylophora rupicola</i>	Tylophora rupicola	EN	0	1	0
<i>Tylophora woollsii</i>	Tylophora woollsii	EN	0	1	0
<i>Veronica derwentiana subsp. homalodonta</i>	Mount Lofty Speedwell	CE	0	1	1
<i>Zieria bifida</i>	<i>Zieria bifida</i>	EN	0	1	0
<i>Zieria collina</i>	<i>Zieria collina</i>	VU	0	1	0

Historically urban species

Scientific name	Common name	EPBC listing	Cities historically occurred in
<i>Acacia denticulosa</i>	Sandpaper Wattle	VU	Perth
<i>Acacia enterocarpa</i>	Jumping-jack Wattle	EN	Port Lincoln
<i>Acacia pinguifolia</i>	Flat-leaved wattle	EN	Victor Harbor–Goolwa
<i>Angophora robur</i>	Sandstone Rough-barked Apple	VU	Grafton
<i>Boronia gunnii</i>	Cataract Gorge Boronia	VU	Launceston
<i>Boronia umbellata</i>	Orara boronia	VU	Coffs Harbour
<i>Swainsona plagiotropis</i>	Red Swainson-pea	VU	Echuca–Moama
<i>Westringia crassifolia</i>	Whipstick Westringia	EN	Bendigo
<i>Pseudomys fumeus</i>	Smoky Mouse	EN	Canberra–Queanbeyan
<i>Calectasia cyanea</i>	Blue Tinsel Lily	CE	Perth
<i>Correa baeuerlenii</i>	Chef's cap correa	VU	Batemans Bay
<i>Dasyurus geoffroii</i>	Chuditch	VU	Perth
<i>Daviesia elongata</i> subsp. <i>elongata</i>	Long-leaved Daviesia	VU	Busselton
<i>Diuris lanceolata</i>	Snake Orchid	EN	Hobart
<i>Eleocharis papillosa</i>	Dwarf Desert Spike-rush	VU	Alice Springs
<i>Halobaena caerulea</i>	Blue Petrel	VU	Adelaide, Sydney, Central Coast, Ocean Grove–Point Lonsdale, Victor Harbor–Goolwa, Warrnambool, Wollongong
<i>Phascogale calura</i>	Red-tailed phascogale	VU	Alice Springs
<i>Phyllota humifusa</i>	Dwarf Phyllota	VU	Bowral–Mittagong
<i>Pterodroma mollis</i>	Soft-plumaged Petrel	VU	Adelaide, Perth
<i>Rhaponticum australe</i>	Austral Cornflower	VU	Toowoomba
<i>Acacia carneorum</i>	Needle Wattle	VU	Broken Hill
<i>Swainsona murrayana</i>	Slender Darling-pea	VU	Echuca–Moama
<i>Litoria nyakalensis</i>	Mountain Mistfrog,	CE	Cairns
<i>Prasophyllum apoxychilum</i>	Tapered Leek-orchid	EN	Hobart
<i>Denisonia maculata</i>	Ornamental Snake	VU	Emerald, Rockhampton
<i>Sophora fraseri</i>	Sophora fraseri	VU	Brisbane
<i>Dichanthium queenslandicum</i>	King Blue-grass	EN	Emerald
<i>Pseudomugil mellis</i>	Honey Blue-eye	VU	Sunshine Coast
<i>Furina dunmali</i>	Dunmall's Snake	VU	Gladstone–Tannum Sands, Rockhampton
<i>Zeuxine polygonoides</i>	Velvet Jewel Orchid	VU	Cairns
<i>Uvidicolus sphyrurus</i>	Border Thick-tailed Gecko	VU	Tamworth
<i>Litoria castanea</i>	Yellow-spotted Tree Frog	EN	Canberra–Queanbeyan, Armidale
<i>Ptilotus beckerianus</i>	Ironstone Mulla Mulla	VU	Port Lincoln
<i>Lachnagrostis adamsonii</i>	Adamson's Blown-grass	EN	Melbourne
<i>Thelymitra epipactoides</i>	Metallic Sun-orchid	EN	Melbourne
<i>Banksia brownii</i>	Brown's Banksia	EN	Albany
<i>Caladenia tessellata</i>	Thick-lipped Spider-orchid	VU	Sydney, Melbourne, Central Coast

<i>Homopholis belsonii</i>	Belson's Panic	VU	Dalby
<i>Tyto novaehollandiae castanops</i> (Tasmanian population)	Masked Owl (Tasmanian)	VU	Hobart
<i>Eucalyptus nicholii</i>	Narrow-leaved Peppermint	VU	Armidale
<i>Nannoperca oxleyana</i>	Oxleyan Pygmy Perch	EN	Sunshine Coast
<i>Dasyurus maculatus maculatus</i> (Tasmanian population)	Spotted-tailed Quoll (Tasmanian)	VU	Devonport, Launceston
<i>Banksia verticillata</i>	Granite Banksia	VU	Albany
<i>Caladenia harringtoniae</i>	Harrington's Spider-orchid	VU	Albany
<i>Clematis fawcettii</i>	Stream Clematis	VU	Lismore
<i>Brachionichthys hirsutus</i>	Spotted Handfish	EN	Hobart
<i>Grevillea flexuosa</i>	Zig Zag Grevillea	VU	Perth
<i>Deyeuxia appressa</i>	Deyeuxia appressa	EN	Sydney
<i>Androcalva procumbens</i>	Androcalva procumbens	VU	Dubbo
<i>Canarium acutifolium</i>	Canarium acutifolium	VU	Cairns
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Fig-Parrot	CE	Brisbane, Coffs Harbour, Gold Coast–Tweed Heads
<i>Elseya albagula</i>	Southern Snapping Turtle	CE	Bundaberg, Gladstone–Tannum Sands
<i>Liopholis slateri slateri</i>	Slater's Skink	EN	Alice Springs
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE Mainland)	VU	Gold Coast–Tweed Heads
<i>Pterodroma leucoptera leucoptera</i>	Gould's Petrel	EN	Sydney, Ballina, Central Coast, Coffs Harbour, Gold Coast–Tweed Heads
<i>Pterodroma neglecta neglecta</i>	Kermadec Petrel (western)	VU	Gold Coast–Tweed Heads
<i>Saiphos reticulatus</i>	Three-toed Snake-tooth Skink	VU	Grafton
<i>Caladenia versicolor</i>	Candy Spider-orchid	VU	Adelaide, Hobart, Burnie–Wynyard, Launceston

Appendix 3. Details on threat types identified within the recovery plans

Threat type	Details and examples
Urbanisation-development	References to urbanisation, development, residential or industrial construction.
Invasive species	Included weeds, invertebrates, and vertebrate species.
Altered fire regime	Changed or inappropriate fire regimes.
Loss or destruction of habitat	Through clearing of trees, infilling waterways
Trampling	By people, including bushwalkers, horses, bikes, military use of lands.
Competition-encroachment	From introduced or native species. E.g. encroachment of weeds, competition with hollow-dependent fauna.
Herbivory	Grazing by livestock, invertebrates, invasive herbivores or overabundant natives.
Roads-linear infrastructure	Roads, rail, power line development and maintenance.
Vandalism-tourism-access	Negative effects of human access, such as vandalism, rubbish dumping, arson, disturbance from tourism or recreation activities.
Disease	e.g. phytophthora, chytrid, water mould.
Hunting-culling-removal	Any reference to culling, hunting, fishing, persecution or removal of species.
Climate change	Climate change more broadly, altering habitat suitability or extreme weather events.
Agriculture-grazing	Agricultural land use; reference to grazing or cropping.
Soil degradation	e.g. compaction, salinity, fouling by livestock, changes to moisture or nutrient levels, landslide or erosion
Mechanical damage	e.g. due to farming equipment, forestry activity, mowing, boats mooring, slashing etc
Water-hydrological degradation	Silt and sedimentation; storm-water run off; altered hydrological flows or water table; pollutants.
Chemical inputs	Pollutants, herbicides, pesticides, fertilisers, oil spills, heavy metal pollution.
Low pollination-recruitment	Loss of symbionts; inefficient pollination by non-natives; low recruitment due to degradation of habitat.
Fragmentation	General reference to fragmentation, restricted movement, or the loss of corridors.
Mining-extraction	Resource extraction; quarries.
Unrestricted vehicles	Unrestricted vehicular access (aquatic and terrestrial); 4-wheel drives; boats; jet skis; trail bikes; military vehicles; dust from road traffic; boating wakes.
Unintentional mismanagement	Removal or destruction of habitats (novel or traditional) for conservation reasons (e.g. removal of weedy trees that species relies on).
General habitat degradation	General description of habitat degradation or use of the term.
Predation-attack	By invasive, native or domestic animals.
Loss-removal critical habitat elements	e.g. hollow bearing trees, rocks, firewood removal, river snags.
Forestry-logging	-
Infrastructure collision	Death due to infrastructure e.g. roadkill/vehicle strike, wind farms, electrocution, shark fences.
Dams-concreting waterways	-
Noise	-

Light	-
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Appendix 4. Details on action types identified within the recovery plans

Action type	Details and examples
Monitoring and research	Monitoring; ecological, social or genetic research; research to better understand threats and priorities, or evaluate the success of actions; surveys to improve knowledge of distribution.
Ex-situ approaches	Seed collection; captive breeding; hand pollination.
Weed management	Actions to prevent weed invasion; remove existing weeds; reduce grass biomass; ensure weeding does not negatively impact the species.
Raise public profile	Campaigns and community outreach; targeting specific groups, such as enthusiasts; flagship species or mascots.
Appropriate fire regimes	Manage fire; create appropriate fire management plans.
Actions to expand or increase population size	General statements to increase population size; Specific actions than general habitat management e.g. stimulating seed bank or regeneration; manual management of undergrowth to create microhabitat for recruitment.
Planning and policy instruments (e.g. recovery plans, offsets, conditions of approval)	Appropriate planning and policy; require development applications to include recovery actions; offsetting and biobanking; establish a task force; create or review recovery plans.
Prohibit human access	Manage the negative effects of human disturbance by controlling or prohibiting access.
Inter-agency knowledge transfer	Public or institutional manager training; intergovernmental and stakeholder cooperation and information exchange
Secure tenure	Land acquisition; private covenants.
Manage or restrict impacts of development or land-use	Manage or restrict develop and land use to minimise adverse effects; through policy, protection, guidelines, regulation; sympathetic grazing or management regimes; remedial works.
Community involvement in conservation	Friends and community groups involved in surveys and monitoring; encourage private landowners to participate in restoration.
Fence target areas	Fence regenerating areas, plants or populations.
Reduce impacts from other species (predation, trampling, grazing)	Reduce threat of predation, grazing or trampling; Manage invasive competitors and predators.
Manage human recreation	Reduce disturbance from human recreational activities.
Manage hydrological impacts	Manage changes to hydrological processes and water availability; replicate natural flows; use environmental watering to prevent habitats drying out; maintain important water sources.
Signage, markers and maps	Signage and maps to alert general public and land managers to presence of species (e.g. roadside marker schemes).
Reduce damaging inputs and pollutants	Reduce inputs of damaging pollutants, either through pesticides, poisons, herbicides, or run off of storm water, sewerage.
Identify priority populations	Identify populations and sites of high conservation priority for conservation management and protection.
Control or manage disease	Implement quarantine; control phytophthora; beak and feather disease.
Revegetate or enhance habitats	Works to enhance habitat through revegetation or restoration of key habitat elements; artificial habitat supplementation; protection of nesting sites.
Improve movement or dispersal	Maintain success of pollinators and dispersal vectors; translocation across barriers; create vegetation corridors; wildlife crossing structures and fishways; modification of structures that impede migration.
Manage human disturbance without prohibiting access	-

Reduce other human-caused mortality (e.g. vehicle strike, hunting, removal)	Reduce hunting, fishing, or other removal; reduce roadkill; reduce conflict or attack from domestic pets; relocate species to areas of lower conflict.
Manage the risks of cultivars and pet trade	Avoid planting cultivated plants; review domestic licensing; establish cultivated populations specifically for horticulture and provide guidelines.
Rehabilitate injured wildlife	-