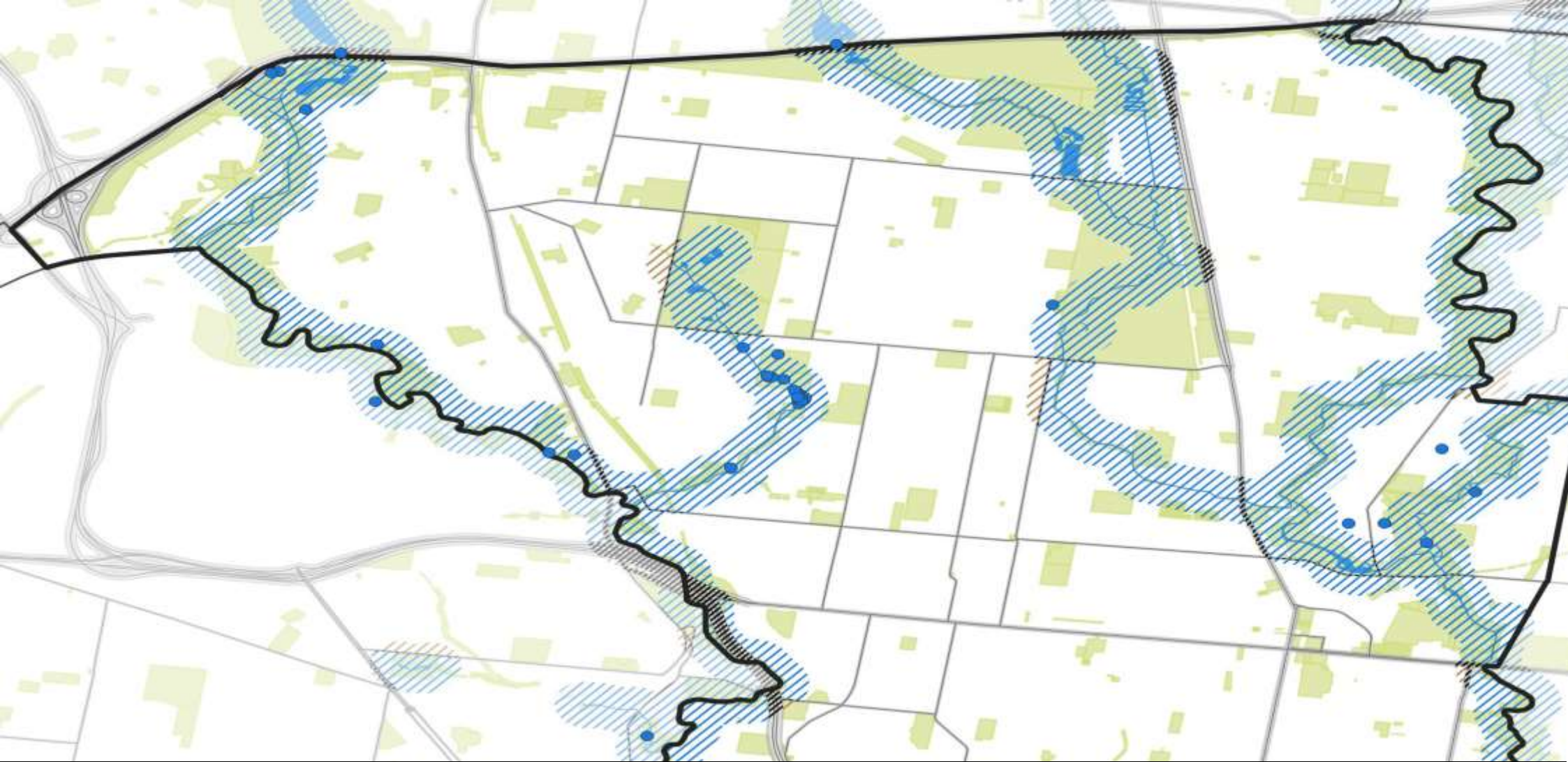




Wildlife habitat connectivity across the City of Merri-bek

Amy Hahs, Luis Mata, Estibaliz Palma and Julia Schiller



Cover photo: cropped from Eastern Banjo Frog (*Limnodynastes_dumerili*) by Matt from Melbourne, Australia, CC BY 2.0 <<https://creativecommons.org/licenses/by/2.0>>, via Wikimedia Commons

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Wildlife habitat connectivity across the City of Merri-bek

Report prepared for Merri-bek City Council

July 2024

by

Amy Hahs, Luis Mata, Estibaliz Palma, Julia Schiller

School of Agriculture, Food and Ecosystem Sciences,

The University of Melbourne

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1. Background

Merri-bek City Council is seeking to understand the biodiversity that has been recorded within their municipality, and important locations for wildlife connectivity. They engaged ecologists from the University of Melbourne to help fill these knowledge gaps.

1.1 What is the composition and distribution of species records in the municipality?

Biodiversity baseline from Atlas of Living Australia records and other datasets

We downloaded plant, fungi, and animal records from the Atlas of Living Australia for an area covering the City of Merri-bek and a 1 km buffer in the 7 adjacent LGAs (Brimbank, Darebin, Hume, Melbourne, Moonee Valley, Whittlesea and Yarra). We also included in the dataset additional records provided by Merri-bek City Council.

We removed records with no species level taxonomic information and standardised species names following the Atlas of Living Australia taxonomy. We used this dataset to produce a summary table with:

1. Information related to the species, such as the main taxonomic group – including amphibians, arachnids, birds, fungi, insects, mammals, other invertebrates, plants, and reptiles – and subgroup (e.g., main insect orders such as Diptera (Flies) and Lepidoptera (Moths and Butterflies)). The origin (native or introduced) and EPBC/FFG status for all species was also included, which were based on the definitions of origin documented in the Victorian Biodiversity Atlas and the Federal Department of Environment websites.

2. Information related to the number of records and their distribution in time (year of earliest record, most recent record, and earliest record post 1990) and space (proportion of records in Merri-bek versus the surrounding 1 km buffer).

The tables summarise over 100,500 records collected between 1990 and 2020 in the City of Merri-bek and a 1km outside buffer within its adjacent LGAs. In total, the records represent 1,685 species.

These tables were provided to Merri-bek City Council as Excel spreadsheets. Summaries of the number of species found exclusively in the City of Merri-bek, exclusively in the buffer area, and in both areas are given in Table 1.1-1.10.

Distribution of biodiversity based on Atlas of Living Australia records and other datasets

We mapped the distribution of records and the species richness for the main taxonomic groups using a 500 m x 500 m grid across the City of Merri-bek (Figures 1.1 - 1.11). Cells with a deeper shade indicate a higher number of species present.

With the exception of birds, insects and plants, there are large areas of the municipality where there are no data in terms of species records. These areas could be used as focal locations for more detailed biodiversity surveys by taxa experts, or through community science crowdsourced biological surveys (e.g., Biodiversity Blitz or City Nature Challenge).

In the areas of the municipality where there are biodiversity records, the locations with the highest species richness for most taxa correspond with known natural areas within the municipality, such as Merri Creek and Edgar's Creek corridors, Northern Golf Club, Jacana Wetlands, Fawkner Memorial Park and adjacent Melbourne Water Retarding Basin, and the Moonee Ponds Creek. While these locations are likely to support a higher diversity of species, it is possible that other areas within the municipality may support similar levels of diversity but have simply not been sampled with the same level of effort. The information obtained through additional surveys will help to fill out a more complete picture of biodiversity across the municipality.

Table 1.1 Summary of total species richness.

Main group	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Arachnids		9	9		16	16		12	12	37
Birds	1	20	21	5	30	35	20	148	168	224
Frogs		1	1		1	1		6	6	8
Fungi		30	30		12	12		7	7	49
Insects	3	176	179	3	159	162	4	93	97	438
Mammals	2	3	5	0	3	3	5	10	15	23
Other invertebrates		13	13		6	6		7	7	26
Plants	93	162	255	79	154	233	197	191	388	876
Reptiles		2	2		5	5	1	7	8	15
Totals	99	416	515	87	386	473	227	481	708	1,696

Table 1.2 Summary of species richness for Arachnids.

	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Main group										
Mites		1	1							1
Spiders		8	8		16	16		12	12	36
Totals		9	9		16	16		12	12	37

Table 1.3 Summary of species richness for Birds.

	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Main group										
Birds of prey							1	18	19	19
Bushbirds		7	7	3	4	7	4	11	15	29
Parrots	1	1	2		3	3	1	17	18	23
Seabirds		2	2		2	2		3	3	7
Songbirds		8	8	1	9	10	12	65	77	95
Waterbirds		2	2	1	12	13	2	34	36	51
Totals	1	20	21	5	30	35	20	147	167	224

Table 1.4 Summary of species richness for Frogs.

	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Main group										
Ground frogs								3	3	3
Tree frogs		1	1		1	1		2	2	4
Water frogs								1	1	1
Totals		1	1		1	1		6	6	8

Table 1.5 Summary of species richness for Fungi.

	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Main group										
Club fungi		21	21		11	11		7	7	39
Sac fungi		9	9		1	1				10
Totals		30	30		12	12		7	7	49

Table 1.6 Summary of species richness for Insects.

Main group	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Ants		5	5	1	5	6				11
Aphids								1	1	1
Bees		3	3		36	36	1	2	3	42
Beetles	1	82	83	1	17	18	1	17	18	119
Butterflies	1	2	3		6	6	1	9	10	19
Caddisfly		1	1		5	5				6
Cicadas					1	1		1	1	2
Cockroaches	1		1		3	3				4
Dragonflies and damselflies		2	2		7	7		4	4	13
Earwigs		1	1	1		1				2
Flies		7	7		10	10		4	4	21
Grasshoppers and crickets					2	2		3	3	5
Heteropteran bugs		5	5		4	4		5	5	14
Jumping plant lice		1	1		1	1				2
Lacewings		5	5		3	3				8
Leafhoppers and treehoppers		1	1		1	1				2

Mantises				1	1		2	2	3	
Moths	56	56		47	47		42	42	145	
Parasitoid wasps	3	3		2	2				5	
Planthoppers				3	3		1	1	4	
Sawflies	1	1		1	1		1	1	3	
Scale insects	1	1							1	
Stick insects				1	1				1	
Stinging wasps				3	3	1	1	2	5	
Totals	3	176	179	3	159	162	4	93	97	438

Table 1.7 Summary of species richness for Mammals.

Main group	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Bats		1	1		1	1		2	2	4
Carnivore mammals							2		2	2
Hares and rabbits	1		1		1	1	1		1	3
Hoofed mammals	1		1							1
Marsupials		2	2		1	1		5	5	8
Mice and rats							2	1	3	3
Platypus and echidnas								2	2	2
Totals	2	3	5		3	3	5	10	15	23

Table 1.8 Summary of species richness for Other Invertebrates.

Main group	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Centipedes					2	2		1	1	3
Crustaceans					2	2		3	3	5
Flatworms								1	1	1
Millipedes								1	1	1
Molluscs		13	13		2	2		1	1	16
Totals		13	13		6	6		7	7	26

Table 1.9 Summary of species richness for Plants.

Main group	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Clubmosses					3	3				3
Conifers		1	1		3	3	1		1	5
Eudicots	72	95	167	56	111	167	130	112	242	576
Ferns		8	8		3	3		1	1	12
Liverworts		4	4		1	1				5
Magnoliids				1	2	3				3
Monocots	21	38	59	22	23	45	66	75	141	245
Mosses		16	16		8	8		3	3	27
Totals	93	162	255	79	154	233	197	191	388	876

Table 1.10 Summary of species richness for Reptiles.

Main group	Only in Merri-bek			Only in buffer			Both in Merri-bek and buffer			Total
	Introduced	Native	Total	Introduced	Native	Total	Introduced	Native	Total	
Agamid lizards					2	2				2
Geckos								1	1	1
Skinks		1	1		2	2		4	4	7
Snakes		1	1					2	2	3
Turtles				1		1		1	1	2
Totals		2	2	1	4	5		8	8	15

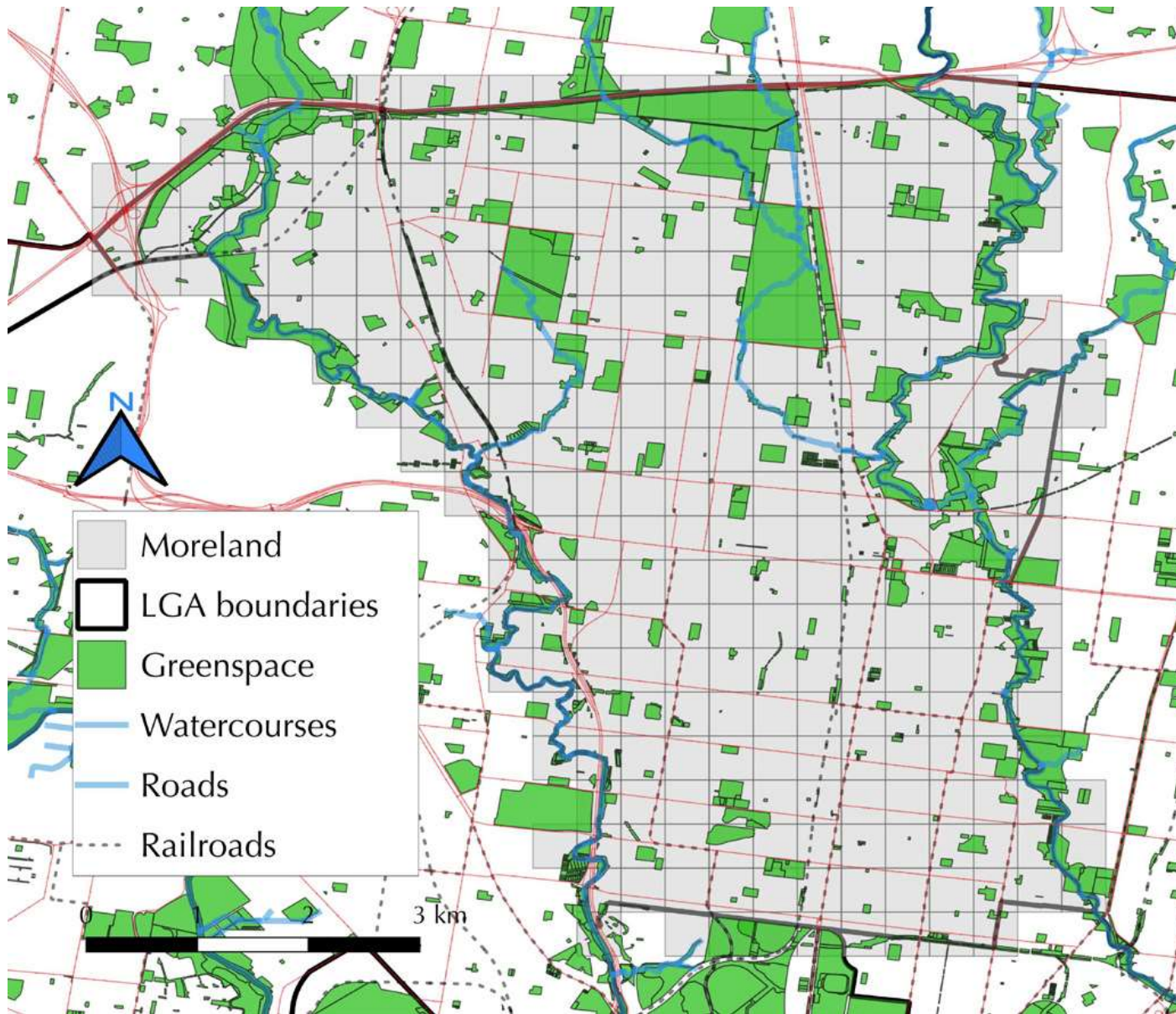


Figure 1.1 Legend map of the City of Merri-bek for grid-based biodiversity summaries. Each cell is 500x500 m.

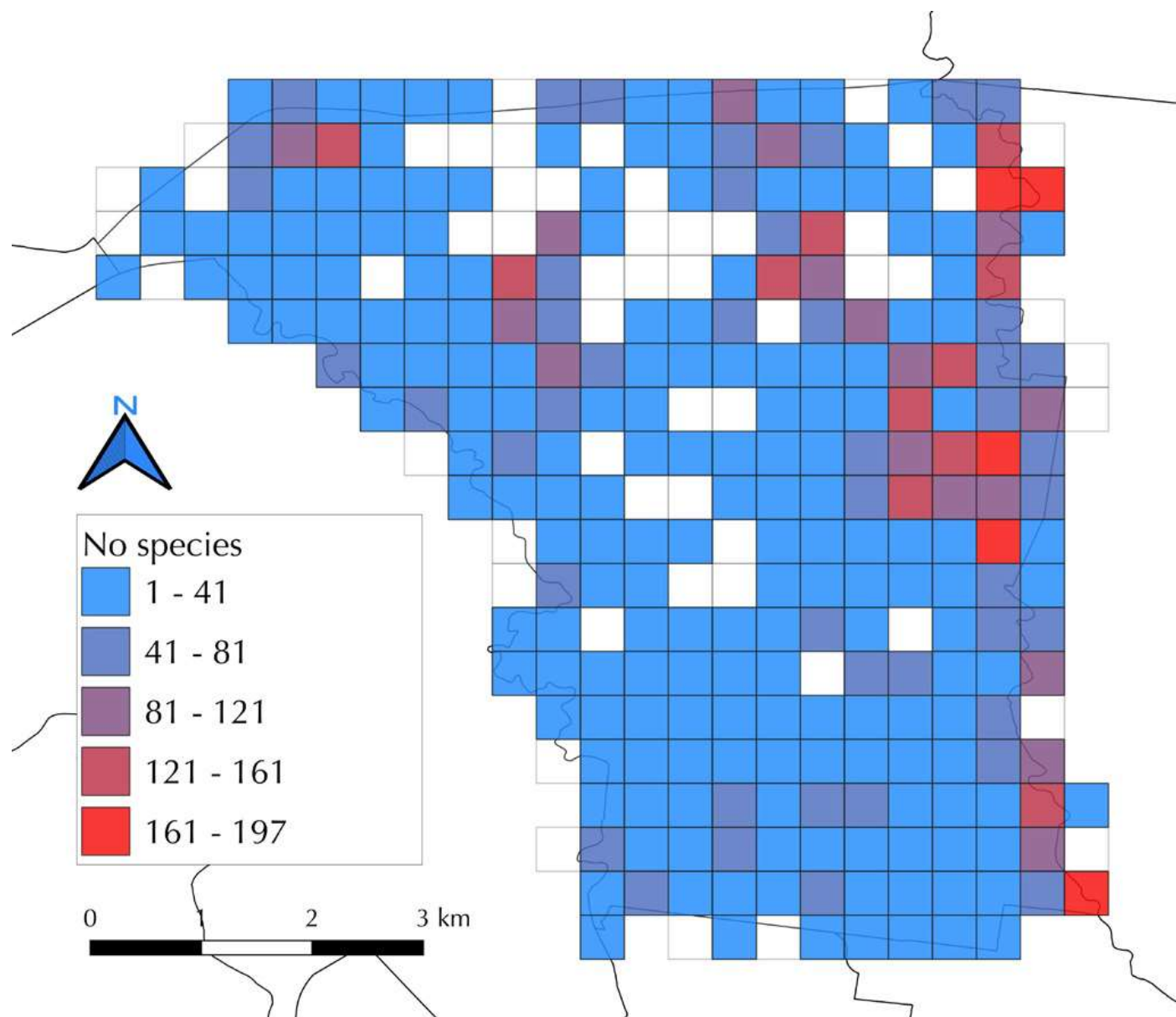


Figure 1.2 Total species richness by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

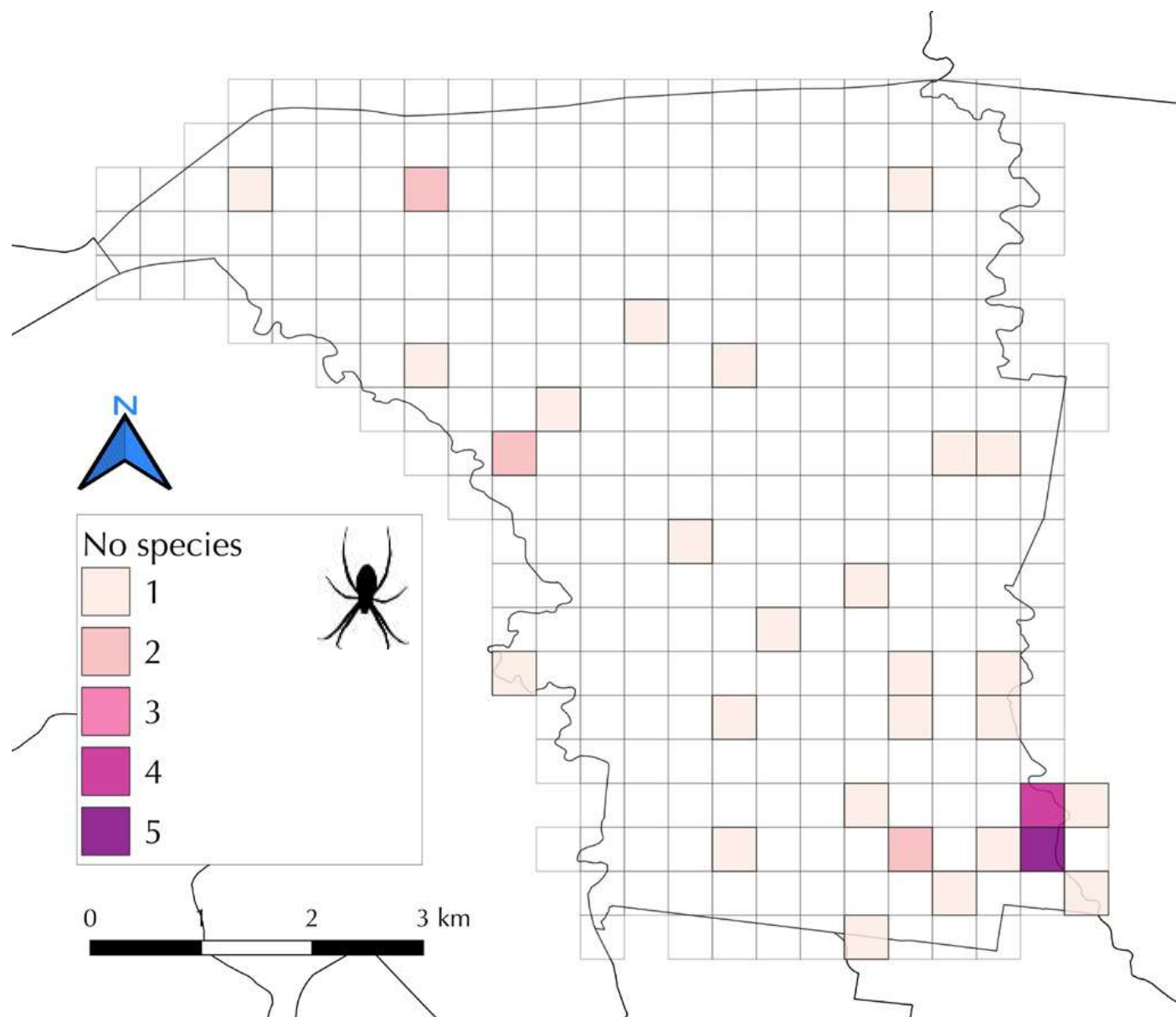


Figure 1.3 Species richness of Arachnids by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

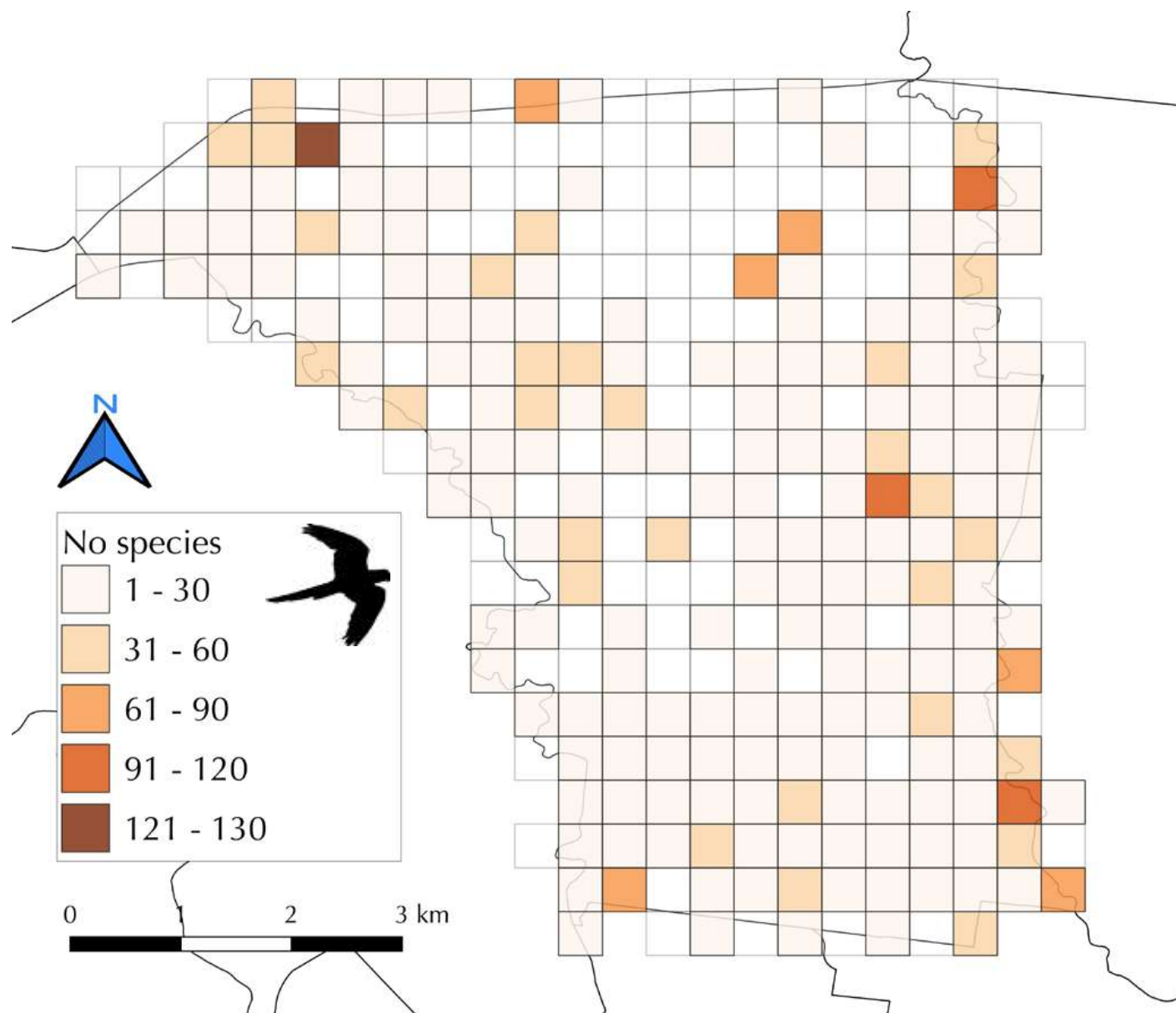


Figure 1.4 Species richness of Birds by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.



Figure 1.5 Species richness of Amphibians by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

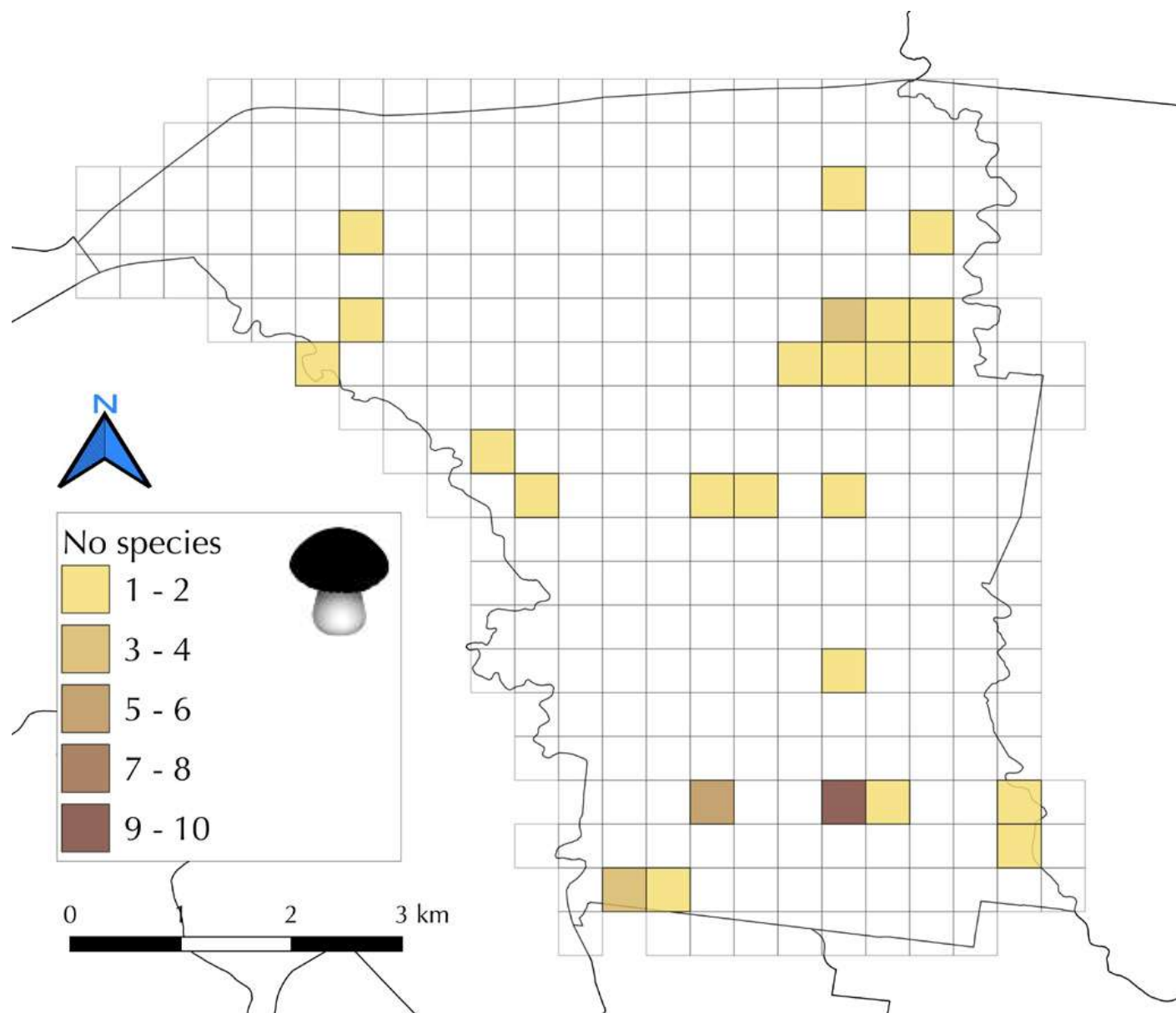


Figure 1.6 Species richness of Fungi by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

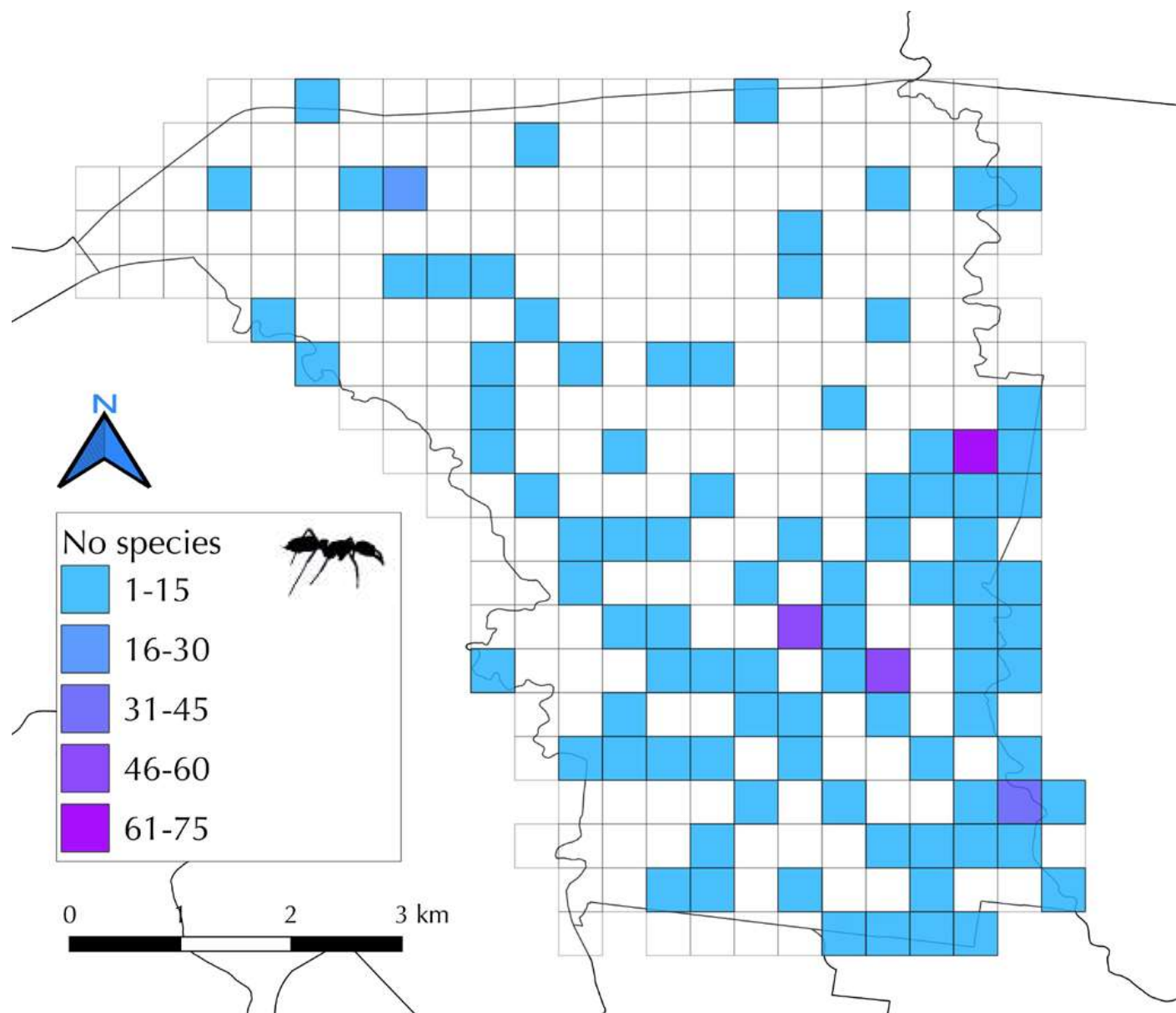


Figure 1.7 Species richness of Insects by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

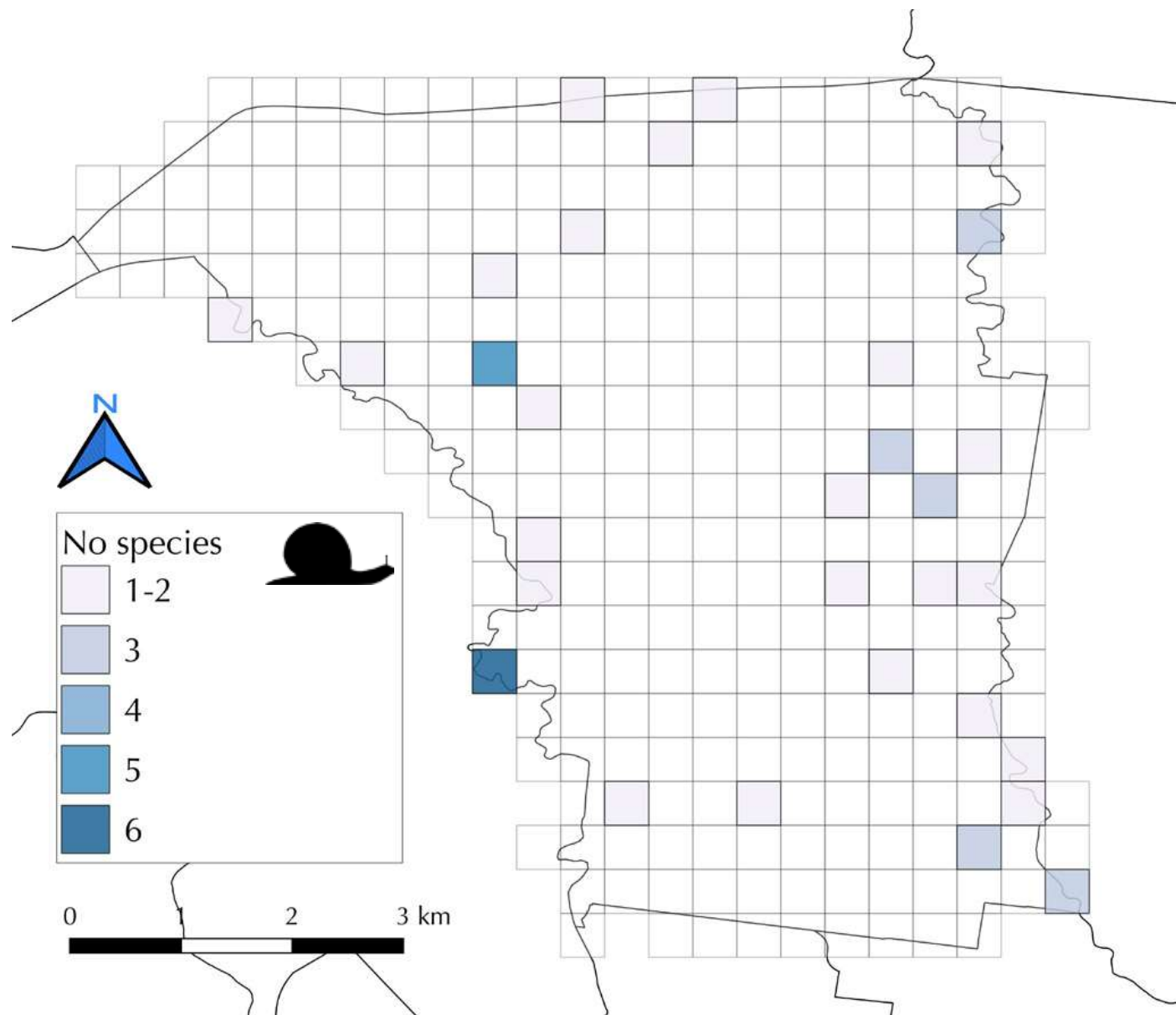


Figure 1.8 Species richness of Other Invertebrates by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

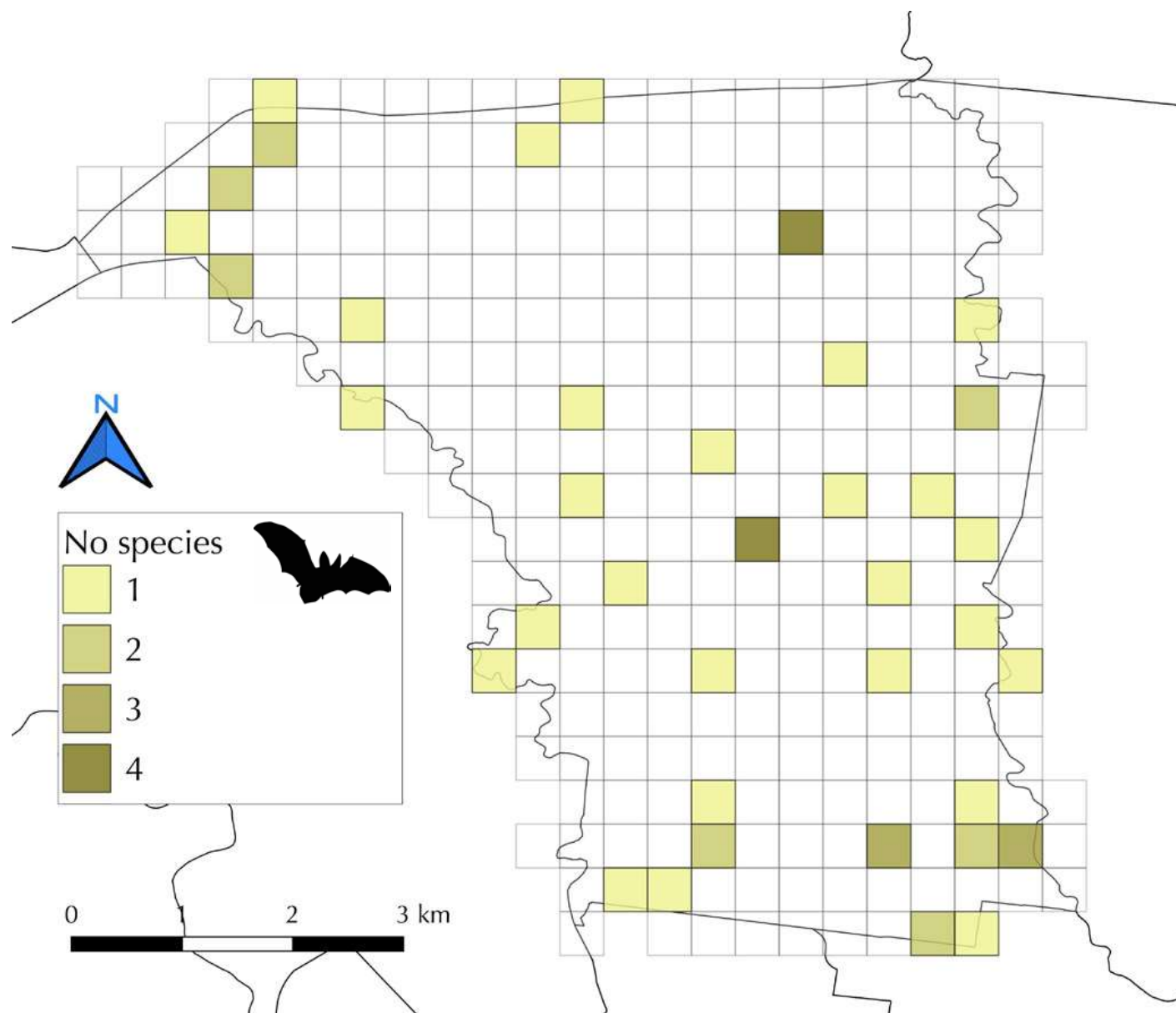


Figure 1.9 Species richness of Mammals by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

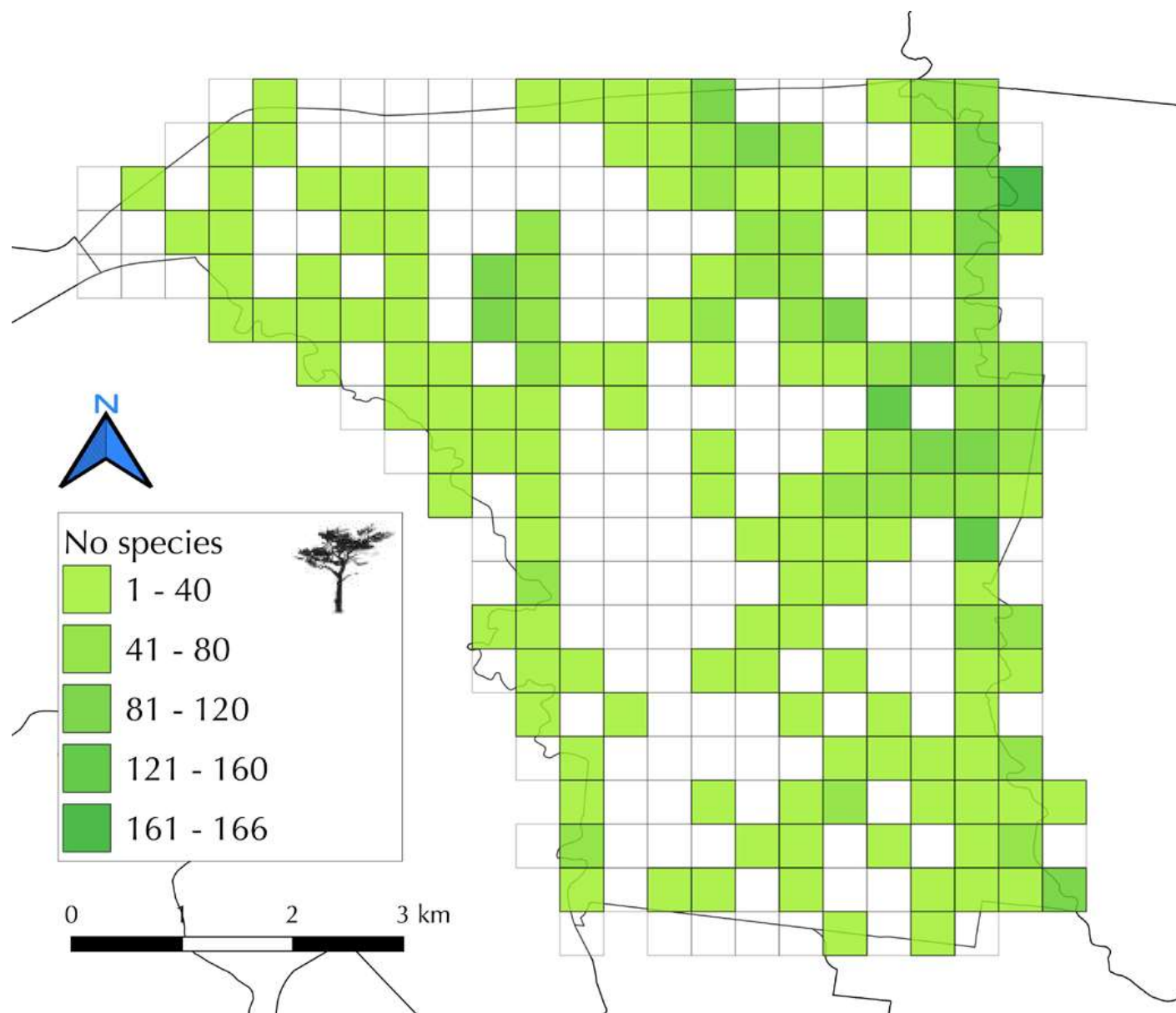


Figure 1.10 Species richness of Plants by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

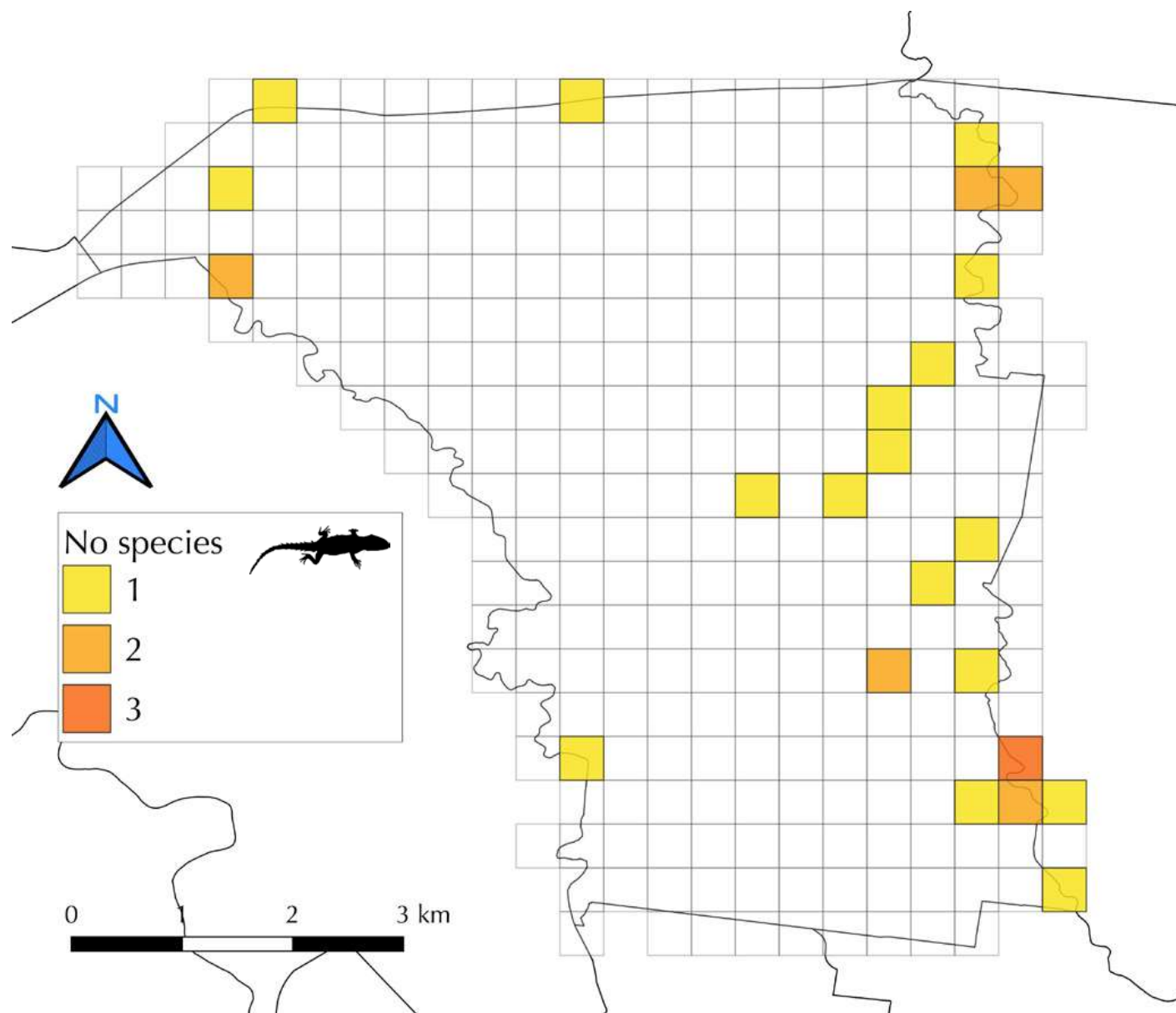


Figure 1.11 Species richness of Reptiles by cell. The City of Merri-bek has been divided into 500x500 m cells. Empty cells represent areas where no species have been recorded.

2. Habitat connectivity

2.1 Where are the important habitat connectivity opportunities for biodiversity?

In collaboration with the Merri-bek City Council project team, we identified a suite of 12 focal taxa to represent a (1) diverse array of taxonomic and functional groups of species within the municipality, and (2) range of different habitat requirements and movement capabilities. While habitat connectivity is also an important consideration for plants, for the purpose of this project the focus will be on mobile animal species.

In a multistep process, the 12 focal taxa were conceptualised to represent a balanced selection in terms of:

Habitat requirements (e.g., canopy, midstory, understory, riparian/wetland)

Dispersal distances

Dispersal heights (ground vs aerial) or modes (flying vs walking)

Taxonomic groups (e.g., amphibians, birds, insects, mammals, reptiles)

as well as:

Number of records in the municipality

Habitat requirements and dispersal information related to each species and the ability to represent this using existing spatial data sources

Stories and meanings relevant to Merri-bek City Council initiatives and local interest.

The twelve focal taxa are presented in Table 2.1. The selected taxa belong to many of the important species' groups and habitat characteristics present in Merri-bek. Collectively they represent a diversity of (1) movements (ground and aerial); (2) dispersal distances (0 m – 1500 m); (3) habitat needs (water, open areas, tree canopy, remnant vegetation, dark areas); and (4) the main animal groups present within Merri-bek, including one

amphibian, five birds, three insects, two mammals (one bat and one marsupials), and one reptile.

2.2 Habitat connectivity maps for individual focal groups

As the focal taxa were selected to deliberately represent a range of habitat requirements and dispersal characteristics, it is helpful to look at the individual connectivity maps to understand the different scales and opportunities for connectivity within Merri-bek. Here, we present the habitat connectivity maps for each of the focal taxa. In the next section, this information will be synthesised to provide an overall understanding of wildlife habitat connectivity, and where there are opportunities to strengthen connectivity for multiple species through targeted actions.

2.2.1 Superb fairy wren | *Malurus cyaneus*

The Superb fairy wren is a small insectivorous bird that relies on low shrubs and areas of denser vegetation cover. Their nests are constructed in low bushes and built from long grasses. The males have a very bright distinctive blue plumage which make them one of the more recognisable bird species in urban areas (Birdlife Australia 2023).

The map of habitat connectivity for the Superb fairy wren is shown in Figure 2.1. Greenspaces are highlighted in light green and those with remnant vegetation in dark green. Habitat for this species is represented by greenspaces with remnant vegetation. Fig. 2.1 assumes that greenspaces with remnant vegetation provide better quality habitat and support for Superb fairy wrens.

Actions that improve habitat connectivity for the superb fairy wren rely on habitat restoration, particularly on increasing the shrub and ground cover layers within greenspaces where remnant vegetation is absent. The arrows in Fig. 2.1 suggests locations in the City of Merri-bek for actions of habitat restoration. These largely seek to expand into the connected areas and fill in the gap between nearby connected areas.

The connectivity maps developed for the superb fairy wren can be extrapolated to other small insectivorous birds living in the City of Merri-bek, and other small insectivorous birds such as the Willie Wagtail (*Rhipidura leucophrys*), Brown Thornbill and (*Acanthiza pusilla*) White-browed Scrubwren (*Sericornis frontalis*) especially those nesting in remnant or shrubby vegetation.

2.2.2 Spotted pardalote | *Pardalotus punctatus*

The spotted pardalote is one of Australia's smallest birds. They build their nests in horizontal tunnels dug into the soil of creek banks, embankments, quarries, rabbit burrows, or potted plants in gardens. Spotted pardalotes forage in gum tree crowns, plucking psyllids and other invertebrates from leaves (Birdlife Australia 2023).

The map of habitat connectivity for the spotted pardalote is shown in Fig. 2.2. Dark green areas represent open space that coincides with records of *Eucalyptus*, a genus on which spotted pardalotes are known to forage.

Spotted pardalote individuals have been found to fly between 150 m and 1.3 km from their nesting sites to find food (Doerr et al. 2005). We defined the connectivity buffer for this species, presented using striped green in the map, as 150m around greenspace smaller than 1 ha, 500 m around those between 1 and 6 ha, and 1.3 km for greenspaces larger than 6 ha. The larger the area of the greenspace with *Eucalyptus* trees, the more likely it is that the pardalotes visit the site from further away.

Watercourses are shown in the map in dark blue.

Habitat connectivity for the spotted pardalote within the City of Merri-bek could be promoted by increasing the presence of *Eucalyptus* sp. trees on open greenspaces (for foraging), particularly those around watercourses, and restoring riparian habitats (for nesting spots).

Fig. 2.2 shows suggested locations for actions to improve habitat connectivity. Although these connectivity maps have been developed for the spotted pardalote, they are representative of the connectivity limitations and opportunities that exist for other small birds living in the City of Merri-bek, especially those using native tree canopies for foraging and feeding. Similar species include the Western gerygone (*Gerygone fusca*) and Mistletoebird (*Dicaeum hirundinaceum*).

2.2.3 Red-rumped parrot | *Psephotus haematonotus*

Red-rumped parrots forage on seeds and plant material in grassy open areas, and they nest in tree hollows (Birdlife Australia 2023).

The map of habitat connectivity for the red-rumped parrot is shown in Fig. 2.3. Greenspaces greater than 1

hectare in size that contain large grassy areas are considered suitable habitat for this species and shown in dark green. A buffer area of 500 m around these greenspaces is presented in pale green and represents the dispersal ability of the species (Kirk et al. 2018).

Increased habitat connectivity for red-rumped parrots requires habitat restoration, with an emphasis on the conservation of old trees inside and outside greenspaces.

In Fig. 2.3 we suggest areas in the City of Merri-bek where habitat restoration and the provision of additional natural or artificial tree hollows may benefit connectivity for the species.

The habitat connectivity maps developed for red-rumped parrots can be used to understand connectivity limitations that apply to other species that nest in larger tree canopy hollows, such as the Yellow-tailed black cockatoo (*Zanda funereal*) and Powerful owl (*Ninox strenua*).

2.2.4 Black-shouldered kite | *Elanus axillaris*

Black-shouldered kites are a medium sized raptor that predominantly feeds on small, mouse sized animals.

When feeding it hovers above open grassy areas before dropping down in its prey in one or two stages. (Birdlife Australia 2023).

Black-shouldered kites are found in open grassy areas, and nest close in a shallow untidy nest of sticks in the tree canopy (Birdlife Australia 2023).

The map of habitat connectivity for the black-shouldered kite is shown in Fig. 2.4. Greenspaces greater than 1 ha in size with open grassy cover are marked in dark green, with a buffer area of 500 m around them in pale green.

Habitat connectivity for the black-shouldered kite within the City of Merri-bek could be promoted by providing areas of taller grass and other habitat features that support small animals in larger open areas that support their hovering hunting style.

Fig. 2.4 shows suggested locations for actions to improve habitat connectivity. The habitat connectivity opportunities shown in these maps may apply to other birds that prey on small or medium bodied animals in open grassy areas, such as the Collared sparrowhawk (*Accipiter cirrocephalus*) and Brown Falcon (*Falco berigora*).

2.2.5 Tawny frogmouth | *Podargus strigoides*

Tawny frogmouths are nocturnal birds in more closely related to nightjars rather than owls. During the day, they perch on branches of rough-barked eucalypts camouflaged as sticks. During the night they remain perched as they watch for prey, before pouncing down on insects, worms, snails and occasionally small frogs (Australian Museum 2021).

Habitat connectivity was mapped using a 145 m buffer around green spaces with *Eucalyptus* sp., and the resulting map is shown in Fig. 2.5.

Opportunities to improve habitat for the tawny frogmouth include planting more rough-barked eucalypts along quieter streets and parklands, particularly in the northern half of the municipality where the light at night remains at relatively low levels. Locations to prioritise these actions are shown in Fig. 2.5. Additional species likely to benefit from these actions include other nocturnal birds and microbats.

2.2.6 Swamp wallaby | *Wallabia bicolor*

Swamp wallabies live in thick forest undergrowth or sandstone heath. They feed on a variety of plants,

including introduced and native shrubs, grasses, and ferns (Australian Museum 2021).

The habitat connectivity map for the swamp wallaby is shown in Fig. 2.6. Dark green shows areas of dense vegetation surrounded by a buffer of 300 m (Downes et al. 1997), representing the core suitable habitat for swamp wallabies and their average dispersal distance. We also present a wider buffer zone, of 1500 m around dense vegetation (Downes et al. 1997), which aims to identify islands of dense vegetation (i.e. corridor) that could provide opportunities for longer dispersal for the species. The paler orange tone in this buffer represents areas within Merri-bek that represent risks for wallabies to potentially become isolated due to the presence of major roads (in grey). These areas represent a mortality risk for the species.

Increased habitat connectivity for the swamp wallaby relies on actions that reduce the risk of collision with motor vehicles. These include the addition of below or above road crossing structures for wildlife and limited traffic volume or speed around areas of dense vegetation and greenspaces. Additional actions could include cues that discourage individuals from venturing into areas where they could become isolated and at

higher risk of injury. The arrows in Fig. 2.6 indicate suggested areas where actions could be prioritised.

Although these connectivity maps were developed for the swamp wallaby, they are representative of the connectivity limitations and opportunities that exist for other large marsupials living in the City of Merri-bek, such as the eastern grey kangaroo *Macropus giganteus*. They may also benefit medium-bodied terrestrial marsupials such as the short-beaked echidna *Tachyglossus aculeatus*.

2.2.7 Lesser long-eared bat | *Nyctophilus geoffroyi*

Lesser long-eared bats roost in hollows in old trees, buildings, and timber stacks, and prey on small insects at ground level or on leaves. Their colonies are comprised of up to 50 bats (Australian Museum 2021).

Their habitat is considered to be areas of open space containing remnant vegetation, and they are unlikely to move across landscapes that are brightly lit. Haddock and colleagues (2019) reported they are sensitive to higher levels of artificial light at night, foraging more actively in the dark interior and edges of bushland patches, rather than the more brightly lit edges where streetlights were present.

The map of habitat connectivity for the lesser long-eared bat is shown in Figure 2.7. Open space areas with remnant vegetation, suitable for nesting, are shown in dark green. They are surrounded by a pale green buffer of 600 m, which represents the average distance this species has been captured away from the nest (i.e. average flight distance; Gonsalves et al. 2013).

Within these buffers, grey areas represent locations with dark night light (i.e. average nighttime radiance below 9 nW/cm²/sr). These areas can be considered for habitat restoration actions such as planting additional tree and shrub species the lesser long-eared bats are known to feed near.

In areas outside of these dark corridors, habitat connectivity could be improved by reducing light levels down as far as possible through the use of wildlife friendly lighting initiatives. Examples of these initiatives include physical shielding of the streetlights to prevent upward spill, reduction of the light intensity (lux), or installation of timers that allow some lights to be dimmed or turned off during periods of little human activity (e.g., 1am – 4 am).

The other areas in the municipality with darker nighttime lights (grey areas) that occur outside of the

600 m buffer also have potential for habitat restoration, through actions such as increasing greenspace area or providing additional habitat, particularly when close to areas of open space with remnant vegetation.

Suggested locations for different habitat connectivity actions for lesser long-eared bat are shown in Figure 2.7. These maps of habitat connectivity are representative of the issues faced by other microbats, including the chocolate wattled bat *Chalinolobus morio* and the Gould's long-eared bat *Nyctophilus gouldi*.

2.2.8 Eastern blue-tongued lizard | *Tiliqua scincoides*

The Eastern (Common) blue-tongued lizards are amongst the largest members of the skink family, growing to almost 60 cm in length. They live in open country with lots of ground cover such as tussocky grasses or leaf litter, and shelter at night in amongst the leaf litter or under rocks and logs.

Eastern blue-tongued lizards feed on a wide variety of plants and animals (Australian Museum 2021). Major roads represent a barrier for the dispersal of this species (Koenig et al 2002).

The map of habitat connectivity for the eastern blue-tongued lizard is shown in Fig. 2.8. In dark green are greenspace areas with remnant vegetation, surrounded by a buffer zone of 1 km that represents the species' average dispersal distance (Kirk et al. 2018). Within this buffer zone, areas that can be accessed from patches of remnant vegetation are shown in dark green, while areas that are unavailable due to the presence of major roads (in grey) are shown in light orange. We classified these areas as isolated for the blue-tongued lizard, given that they would need to cross a major road in order to get access to them.

Greenspaces without remnant vegetation are presented in light green and watercourses in dark blue.

Connectivity for eastern blue-tongued lizards in the City of Merri-bek relies mostly on actions that reduce the risk of collision with motor vehicles when moving among different patches of suitable habitat. This can be achieved by building crossing structures that wildlife can use above or below the roads. Habitat restoration in greenspaces with no remnant vegetation, especially the increase of ground cover, for example with indigenous grasses, would be beneficial to facilitate the species movement across the City of Merri-bek.

We suggest locations where these actions would improve habitat connectivity in Fig. 2.8. The maps of habitat connectivity developed for eastern blue-tongued lizards can be used to understand issues faced by other lizards, skinks and snakes found in Merri-bek.

2.2.9 Eastern banjo frog/ Pobblebonk | *Limnodynastes dumerlii*

Pobblebonks, also known as the southern bullfrog or the eastern banjo frog, live in a wide range of habitats, including urban, heath, and sclerophyll forest areas close or around wetlands and waterbodies. They burrow in loamy soils and emerge to feed and breed after rains (Frogwatch SA 2021). They place their eggs in points of still water, where they hatch, and their tadpoles grow (State of Victoria 2017).

Pobblebonks are sensitive to roads and are less likely to occur at ponds with higher density of roads in the surrounding 500 m (Parris 2006). The map of habitat connectivity for the pobblebonk is shown in Fig. 2.9. Waterbodies and watercourses are shown in dark blue, surrounded by a blue buffer zone of 200 m that represents the average distance around aquatic habitats that are used by a similar sized frog (growling grass frog *Litoria raniformis*) (State of Victoria 2013).

Major roads are considered a disruptor for this species and therefore sections of the buffer that can only be accessed by crossing a major road (in grey) are considered unavailable and classified as isolated in the map. These isolated parts of otherwise suitable habitat are presented in light orange.

Additional drainage lines that connect isolated waterbodies to the larger stream network could significantly increase connectivity for this species. The improvement of riparian vegetation as well as vegetation in close-by greenspaces could also promote the dispersal of the species by providing suitable nesting habitat in areas along the creek that may currently be suboptimal.

Suggested locations for different habitat connectivity actions for pobblebonks are shown in Figure 2.9. The connectivity maps developed for the pobblebonk highlight connectivity opportunities and limitations for other native ground frogs living in the City of Merri-bek, such as the striped marsh frog (*Limnodynastes peronii*) and the spotted marsh frog (*Limnodynastes tasmaniensis*).

2.2.10 Blue skimmer dragonfly | *Orthetrum caledonicum*

Blue skimmer dragonflies live near freshwater habitats, as their juvenile stage is entirely aquatic. As adults, they feed on aquatic invertebrates and flying insects. Their habitat is waterbodies, particularly those with emergent reeds for sheltering in.

The map of habitat connectivity for the blue skimmer dragonfly is shown in Figure 2.10. Waterbodies in the City of Merri-bek are represented by dark blue. Waterbodies are surrounded by a buffer of 500 m, which represents their dispersal distances (Kirk et al. 2018). Areas within this buffer are considered unavailable to blue skimmer dragonflies, if they need to cross a major road to access them. We have classified these areas within the buffer as isolated habitat for the species and represented them in light orange in the map. Major roads were defined as anything that is Class Code 3 or lower in the VicMap Transport Roads dataset, as these are usually multi-laned and support traffic speeds above 60 km/h.

Opportunities to improve connectivity are shown in Figure 2.10. Improvements could take the form of increasing the availability of waterbodies throughout

the year by adding ponds and drainage lines, and adding plants that are known to be used for sheltering or as preferred food sources of their insect prey. These actions will also benefit other species that depend on freshwater habitats, such as frogs and turtles, or that feed on the emerging insects, such as microbats.

2.2.11 Blue-banded bee | *Amegilla asserta*

Blue-banded bees are solitary bee, building their nest in shallow burrows in clay soil or mudbricks (Aussie Bees 2021). Adult blue-banded bees in Greater Melbourne feed on a small range of indigenous plant species, including flax-lilies (genus *Dianella*), austral stork's-bill (*Pelargonium australe*), hop goodenia (*Goodenia ovata*), showy isotome (*Isotoma axillaris*), small crowea (*Crowea exalata*), bulbine lily (*Bulbine bulbosa*), and native bluebells (genus *Wahlenbergia*). They have also been recorded on a few plant species that are not indigenous to Victoria (e.g. species of *Eremophila*, *Westringia*, and *Pimelea*), as well as some plant species that have been introduced into Australia by the ornamental gardening industry (e.g. species of *Salvia*).

The map of habitat connectivity for blue-banded bees is shown in Fig. 2.11. Dark green areas represent open space that coincides with records of the indigenous

plant species listed above. The pale green buffers represent the mean dispersal distance of these bees (350 m; Kirk et al. 2018).

Habitat connectivity for blue-banded bees could be improved by increasing the amount and coverage of the indigenous species that the bees are known to forage on in public greenspaces across Merri-bek, as well as promoting the use of these plant species in private gardens by Merri-bek residents. In both cases, these actions would be concomitantly implemented with improvements of the bees nesting requirements.

Suggested locations within the City of Merri-bek public greenspaces to implement these actions are shown in Fig. 2.11. The connectivity maps developed for the blue-banded bees heavily rely on the specificity between these insect species and the indigenous species they are attracted to. Despite not being directly equivalent to habitat connectivity patterns for other pollinators, the same approach could be used to develop specific habitat connectivity maps for other insects with well-known host specificity.

2.2.12 Australian painted lady | *Vanessa kershawii*

Australian painted lady butterflies are regularly observed in urban landscapes of south-eastern Australia. Their habitat within the City of Merri-bek includes areas of open space that contain known food plants. Juveniles (caterpillars) feed on plants from the Asteraceae family, such as strawflower (*Xerochrysum bracteatum*), *Chrysocephalum* species, as well as introduced species such as capeweed (*Arctotheca calendula*).

The map of habitat connectivity for the Australian painted lady is shown in Figure 2.12. The dark green areas represent open space that coincide with Atlas of Living Australia records of the known juvenile host plants for this butterfly. The light green buffers indicate areas within 150 m of these green spaces. The minimum patch size can be relatively small, if there are several within the 150 m foraging range. Actions to increase connectivity for this species largely involve planting larger populations of known host plants and providing resources for both the adult and juvenile stages. Suggested locations for these actions are shown in Figure 2.12.

While the connectivity map developed for the Australian painted lady includes quite specific host plants, the connectivity maps may look quite different if developed for a different butterfly species. However, the relatively strong connectivity for this species, and potential for enhancement mean that further connectivity mapping would only be required if there was a species of interest with very specific needs, such as the Common Imperial Blue butterfly *Junonia evagoras* which has a close association with wattles and ants from the genus *Iridomyrmex* (Bradby 2016).

Table 2.2 Characteristics of the twelve focal taxa

Focal taxa	Scientific name	Movement	Dispersal distance	Habitat connectivity representation
Superb fairy wren	<i>Malurus cyaneus</i>	Arial	Short from shrub layers	500 m buffer around greenspaces with remnant vegetation
Spotted pardalote	<i>Pardalotus punctatus</i>	Arial	Medium from tree canopy	Buffer of varying size around patches with Eucalyptus tree canopy; 150 m for patches <1 Ha, 500 m for patches 1-6 Ha, and 1300 m for patches >6 Ha
Red-rumped parrot	<i>Psephotus haematonotus</i>	Arial	Medium from tree hollows	500 m buffer around grassy greenspaces adjacent to hollow forming tree species
Black-shouldered kite	<i>Elanus axillaris</i>	Arial	Large around open grassy areas	500 m buffer around grassy greenspaces larger than 1 hectare
Tawny frogmouth	<i>Podargus strigoides</i>	Arial	Small around rough barked eucalypt trees	145 m buffer around greenspaces with <i>Eucalyptus</i> species
Swamp wallaby	<i>Wallabia bicolor</i>	Ground	Large around dense vegetation	300 m buffer around areas of dense vegetation to identify core habitat, and 1500 m buffer to identify islands of dense vegetation forming a corridor
Lesser long-eared bat	<i>Nyctophilus geoffroyi</i>	Arial	Medium within darker nocturnal canopy areas	600 m buffer around open space patches with remnant vegetation, excluding areas with nocturnal light levels above 9 nW/cm ² /sr (ideally <1 Lumen, but unable to represent this with available data)

Focal taxa	Scientific name	Movement	Dispersal distance	Habitat connectivity representation
Eastern blue-tongued lizard	<i>Tiliqua scincoides</i>	Ground	Large around open areas with shrubs and grass	1000 m buffer around greenspace with remnant vegetation
Eastern banjo frog / Pobblebonk	<i>Limnodynastes dumerilii</i>	Ground	Medium around water	200 m buffer around watercourses and waterbodies
Blue skimmer dragonfly	<i>Orthetrum caledonicum</i>	Aerial	Medium around water	395 m buffer around waterbodies
Blue-banded bee	<i>Amegilla asserta</i>	Aerial	Medium around areas with specific indigenous plant species	350m buffer around open space patches with records of known host plants (<i>Dianella</i> spp., <i>Pelargonium australe</i> , <i>Goodenia ovata</i> , <i>Isotoma axillaris</i> , <i>Crowea exalata</i> , <i>Bulbine bulbosa</i> , and <i>Wahlenbergia</i> spp.)
Australian painted lady	<i>Vanessa kershawi</i>	Aerial	Limited around specific food plants	No buffer around site

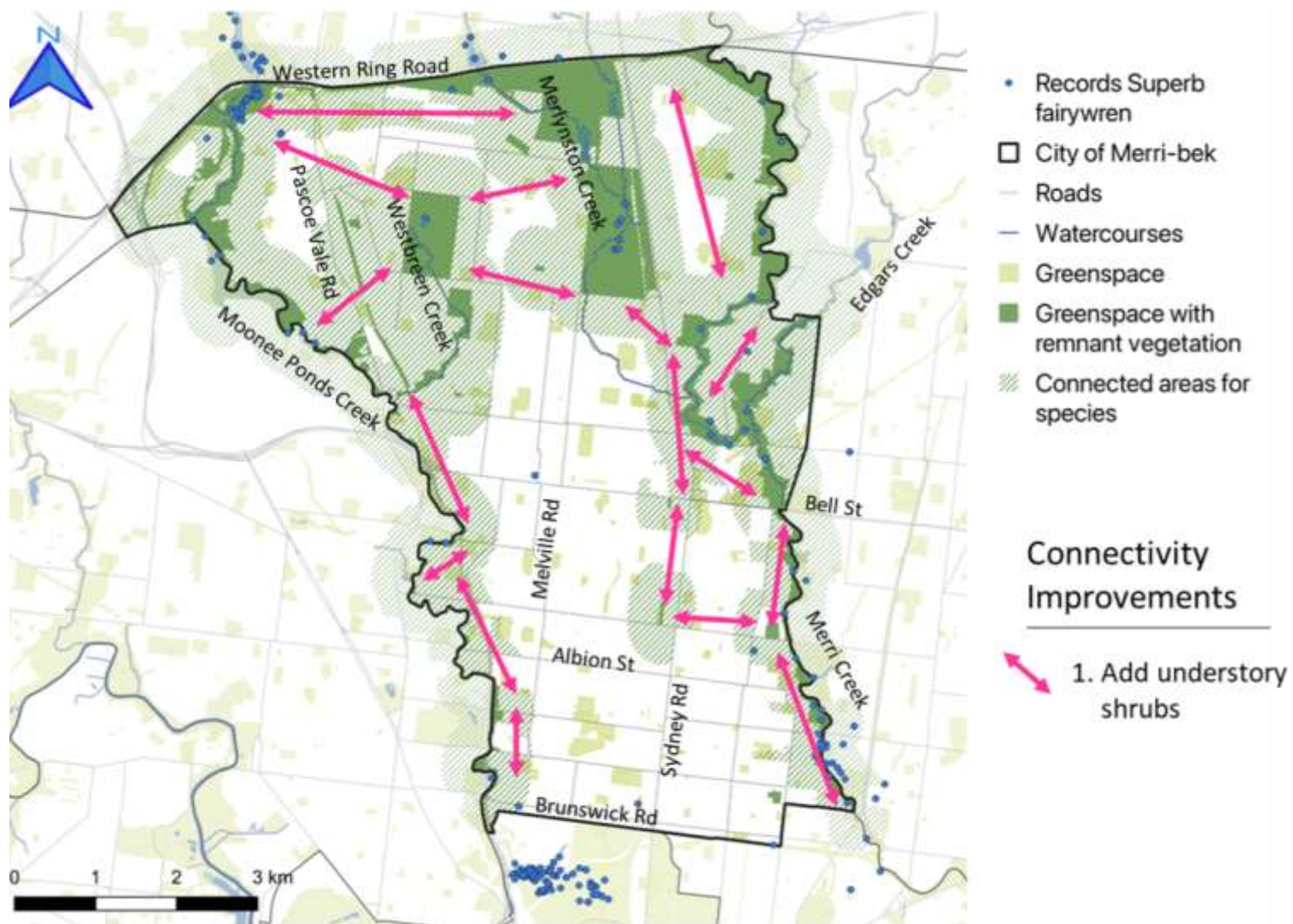


Figure 2.1 Map of habitat connectivity for the Superb fairywren (*Malurus cyaneus*). Currently connected areas result from a buffer area of 500 m around greenspaces with remnant vegetation.

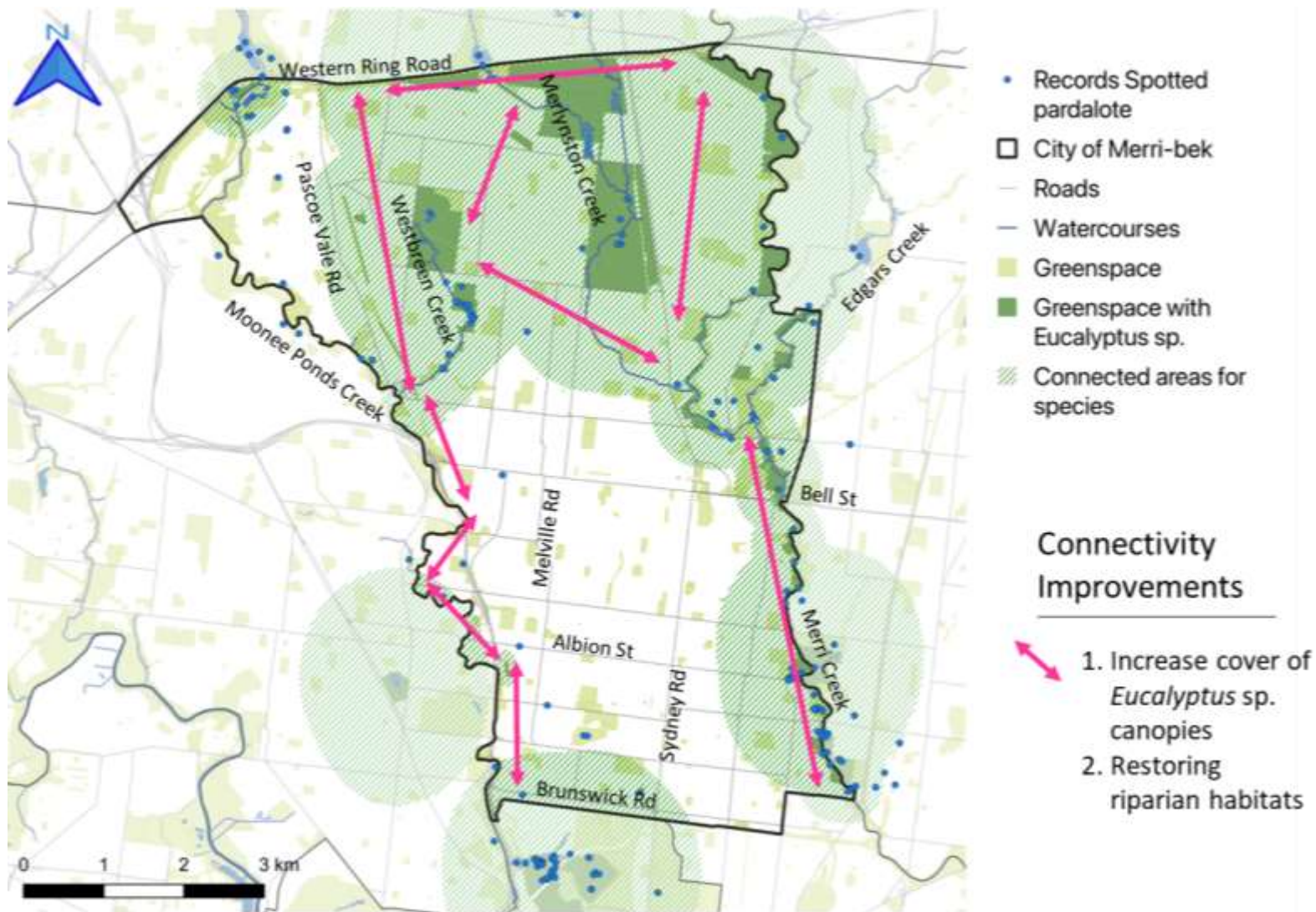


Figure 2.2 Map of habitat connectivity for the Spotted pardalote (*Pardalotus punctatus*). Currently connected areas result from a size-based buffer area around green spaces with Eucalyptus species.

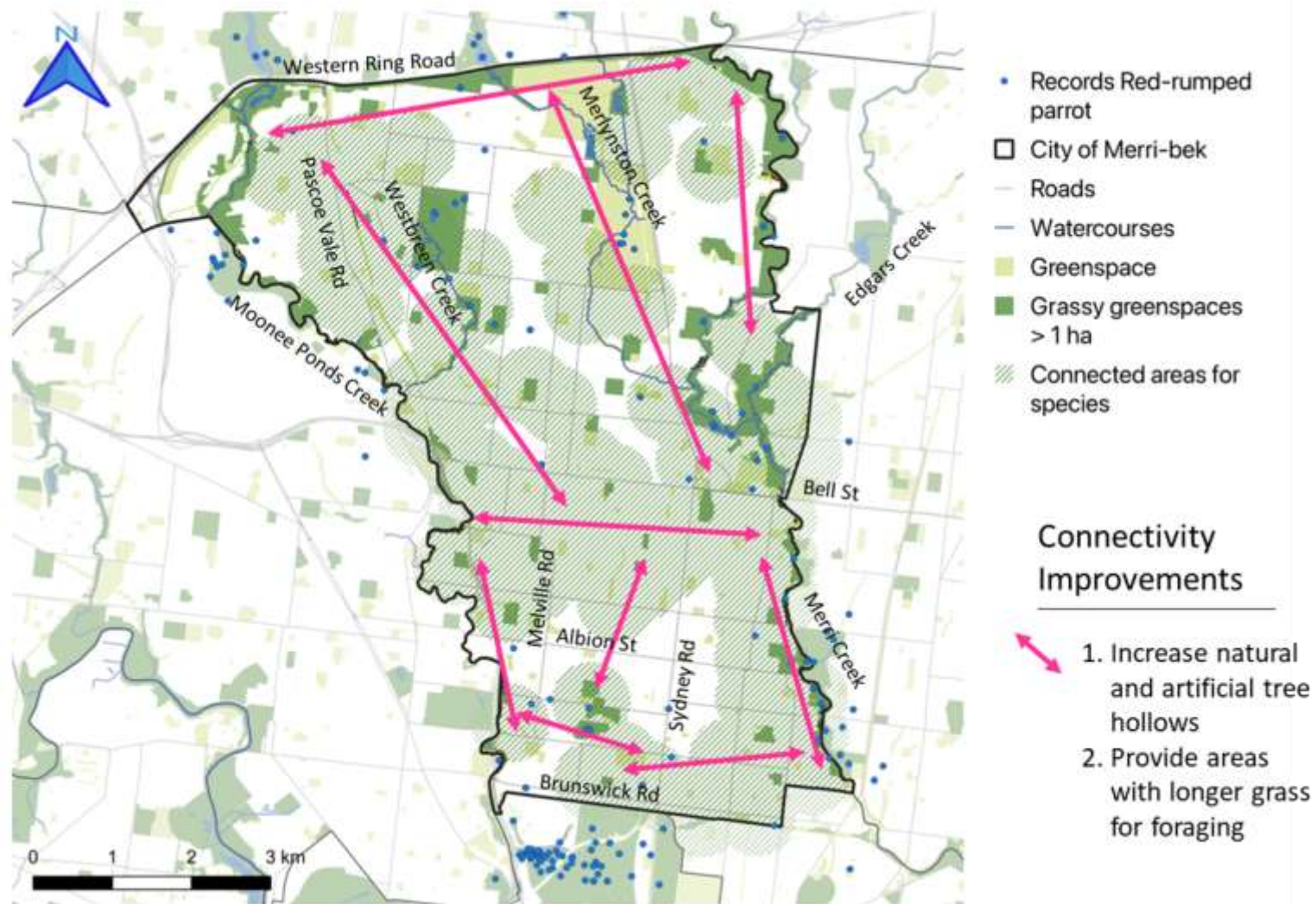


Figure 2.3 Map of habitat connectivity for the Red-rumped parrot (*Psephotus haematonotus*). Currently connected areas result from areas with high density of hollow forming tree species that are within a buffer area of 500 m to grassy green spaces > 1 ha .

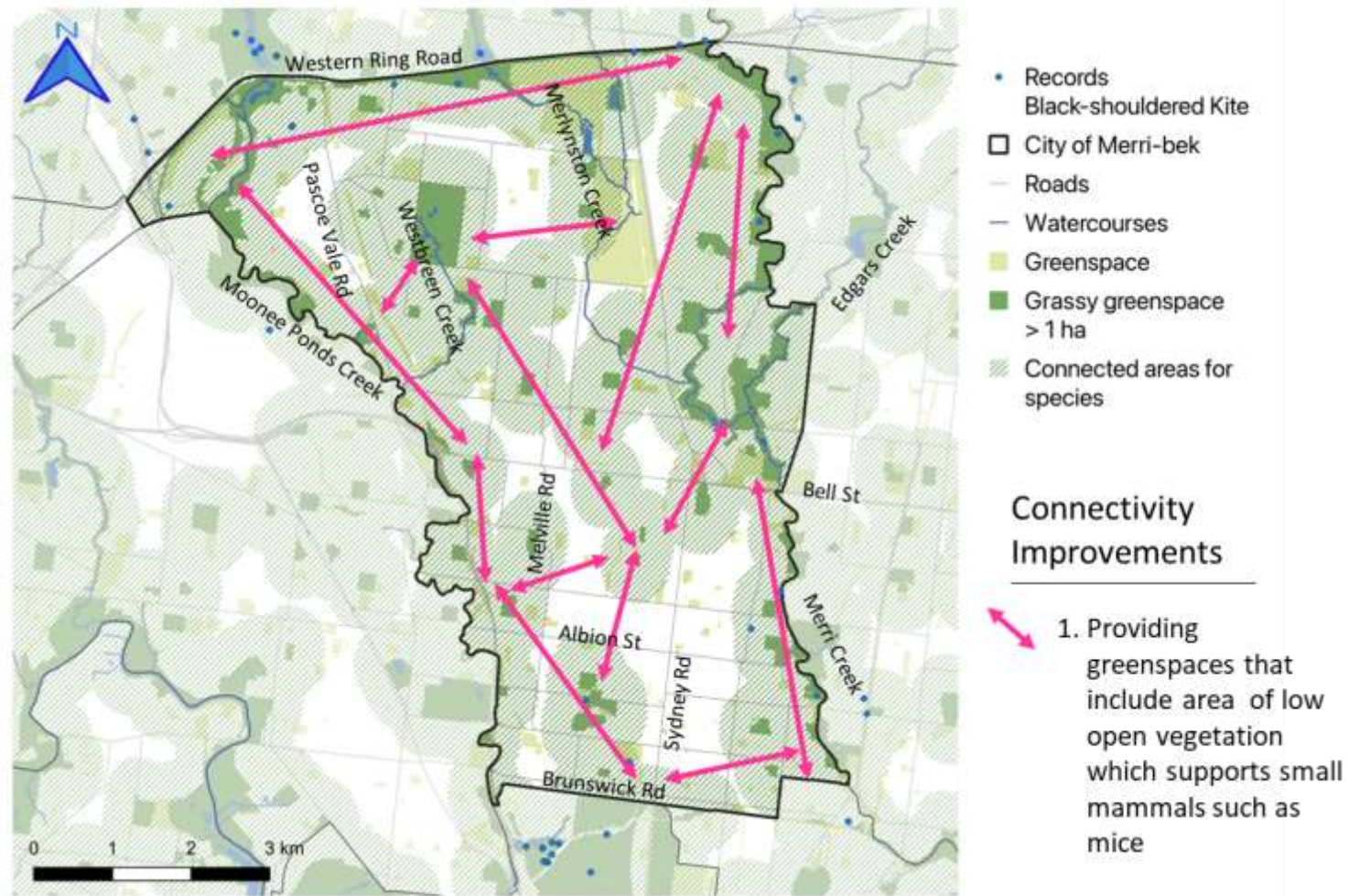


Figure 2.4 Map of habitat connectivity for the Black-shouldered kite (*Elanus axillaris*). Currently connected areas result from a buffer area of 500 m around grassy green spaces greater than one hectare.

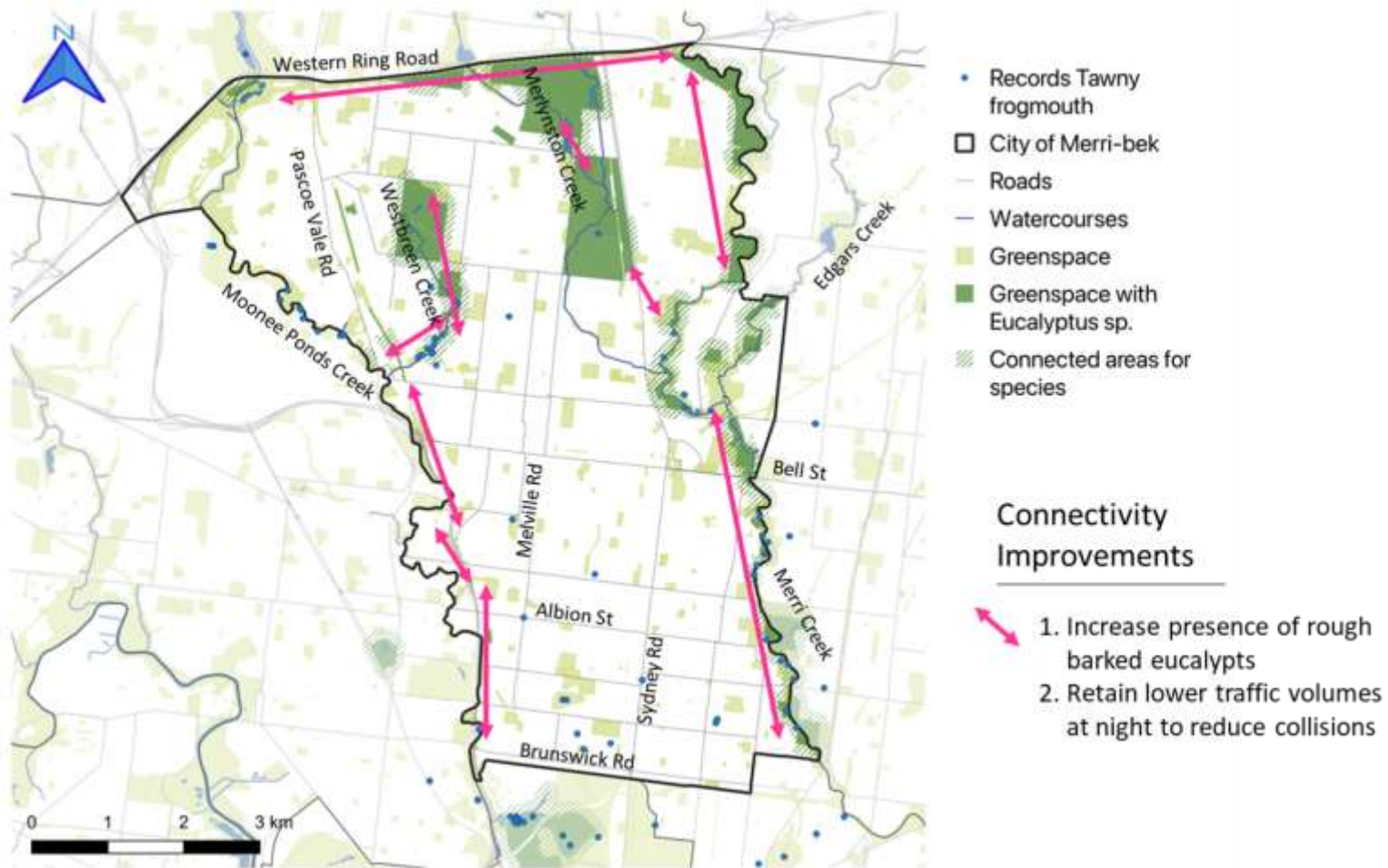


Figure 2.5 Map of habitat connectivity for the Tawny frogmouth (*Podargus strigoides*). Currently connected areas result from a buffer area of 145 m around green spaces with Eucalyptus species.

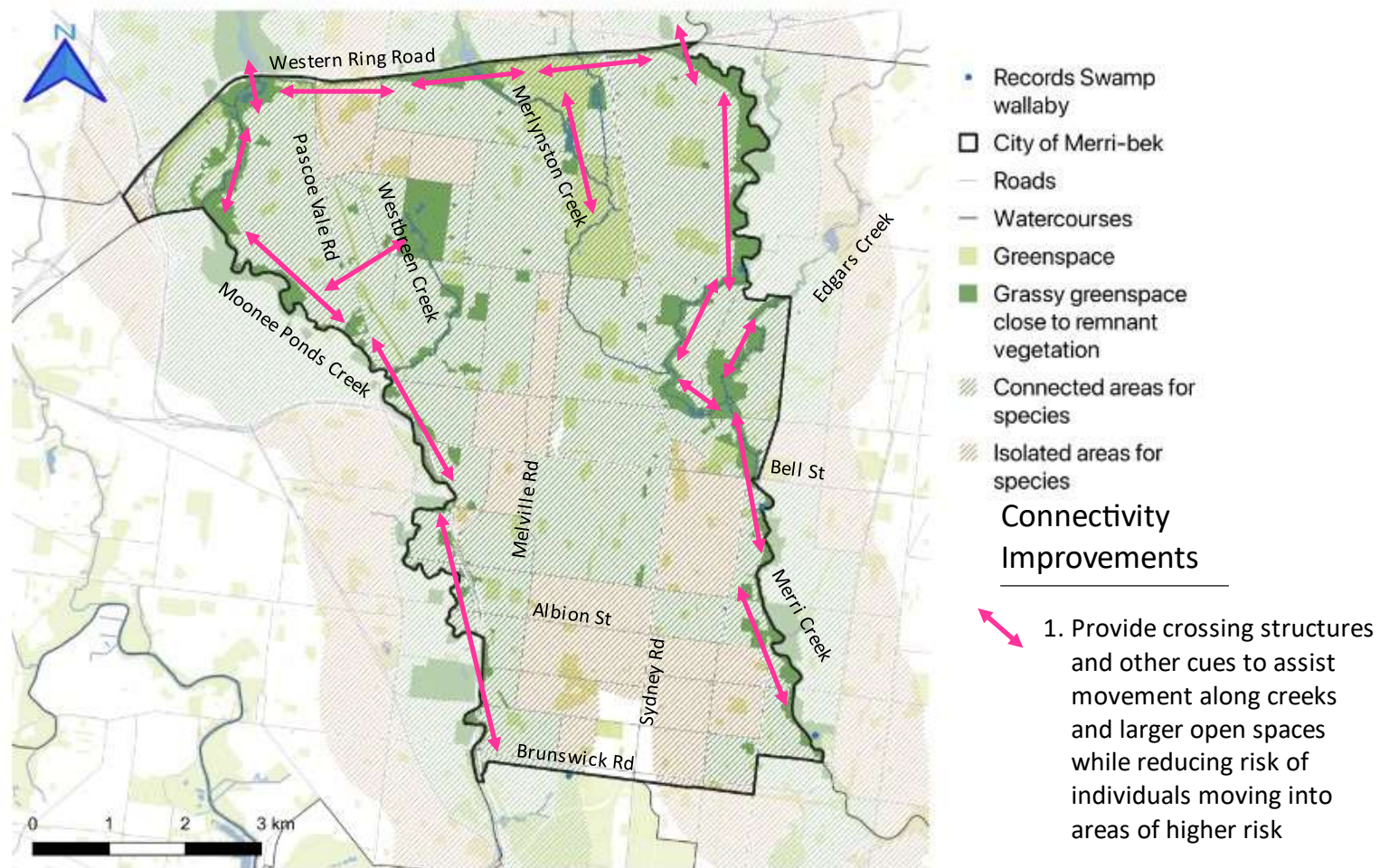


Figure 2.6 Map of habitat connectivity for the Swamp wallaby (*Wallabia bicolor*). Currently connected areas result from a buffer area of 1,500 m around grassy greenspaces close to remnant vegetation, while major roads result in isolated areas.

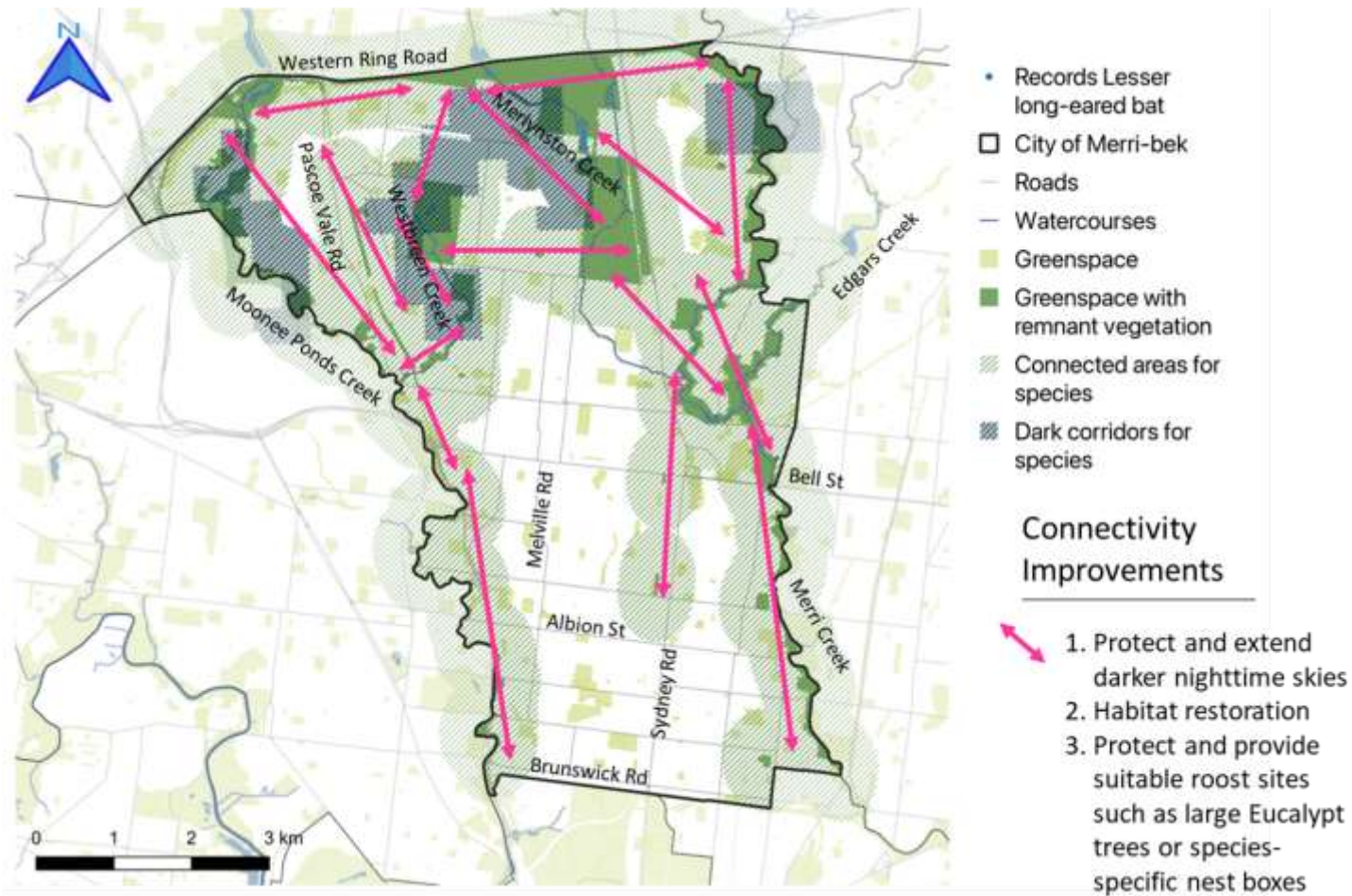


Figure 2.7 Map of habitat connectivity for the Lesser long-eared bat (*Nyctophilus geoffroyi*). Currently connected areas result from a buffer area of 600 m around green spaces with remnant vegetation, while important dark corridors are also indicated.

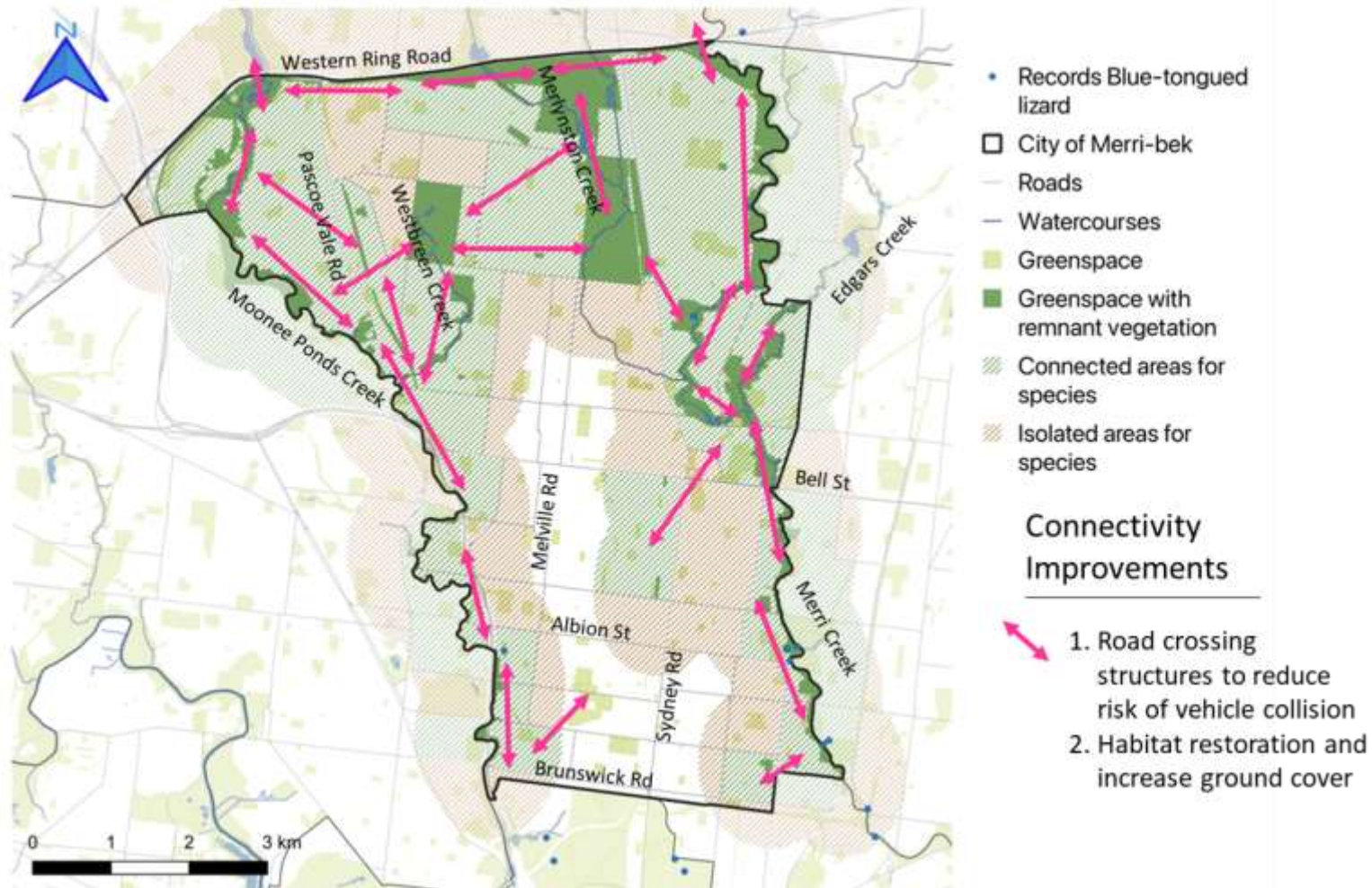


Figure 2.8 Map of habitat connectivity for the Eastern blue-tongued lizard (*Tiliqua scincoides*). Currently connected areas result from a buffer area of 1,000 m around green spaces with remnant vegetation, while major roads result in isolated areas.

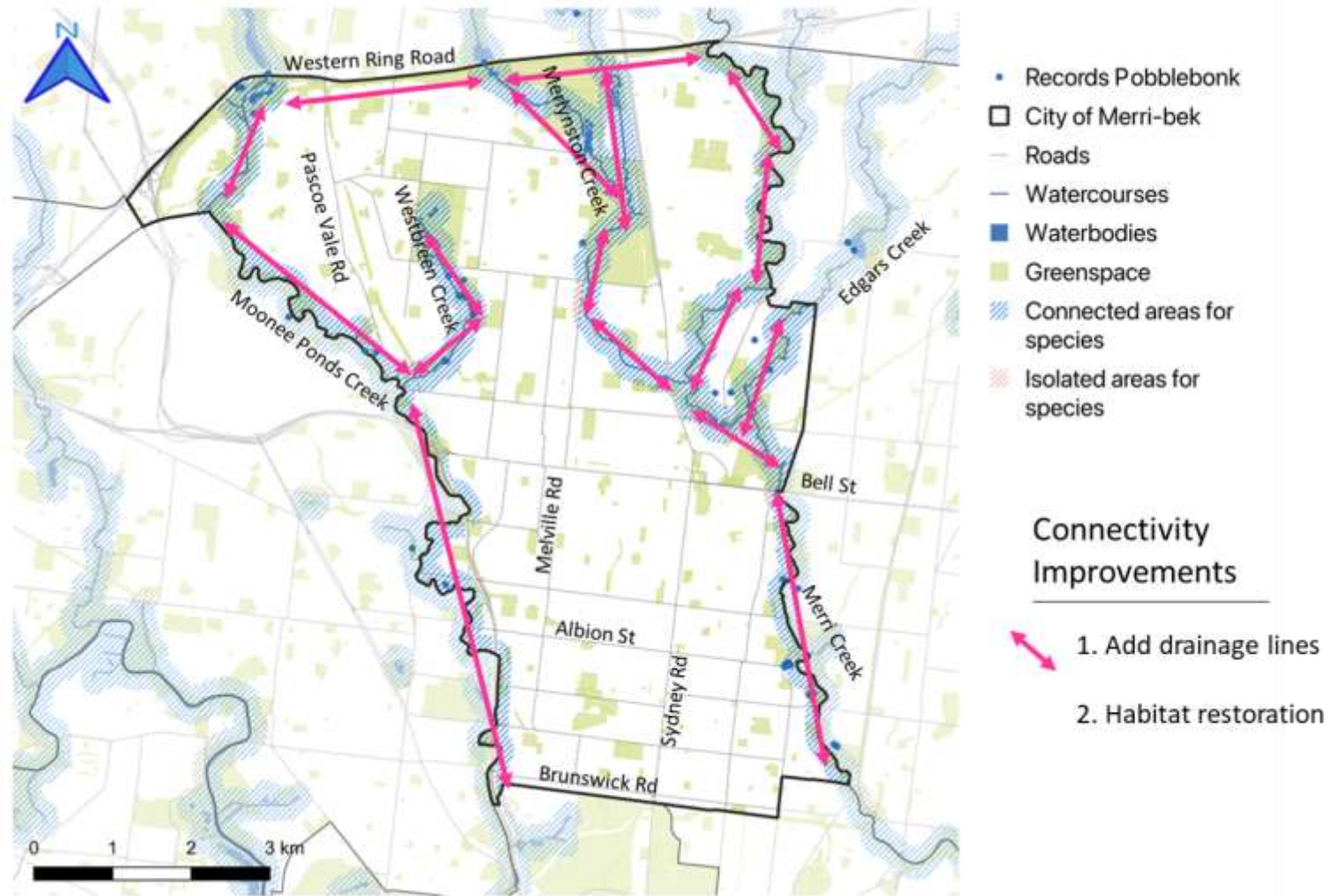


Figure 2.9 Map of habitat connectivity for the Pobblebonk (*Limnodynastes dumerilii*). Currently connected areas result from a buffer area of 200 m around waterbodies, while major roads result in isolated areas. NOTE: some sections of Merlyston Creek and Westgreen Creek are piped underground, and this is not captured in this analysis.

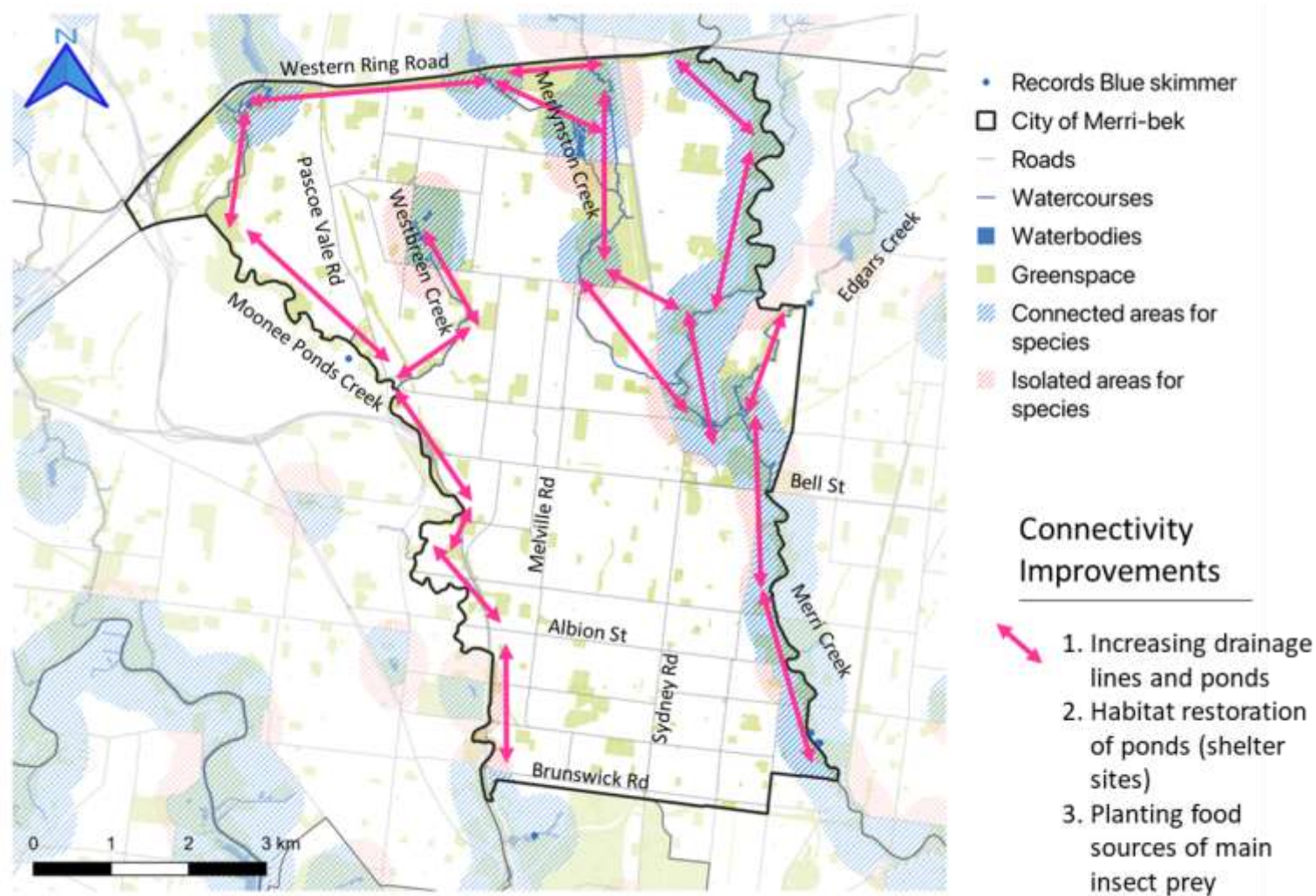


Figure 2.10 Map of habitat connectivity for the Blue skimmer dragonfly (*Orthetrum caledonicum*). Currently connected areas result from a buffer area of 500 m around waterbodies, while major roads result in isolated areas. NOTE: some sections of Merlyston Creek and Westbreen Creek are piped underground, and this is not captured in this analysis.

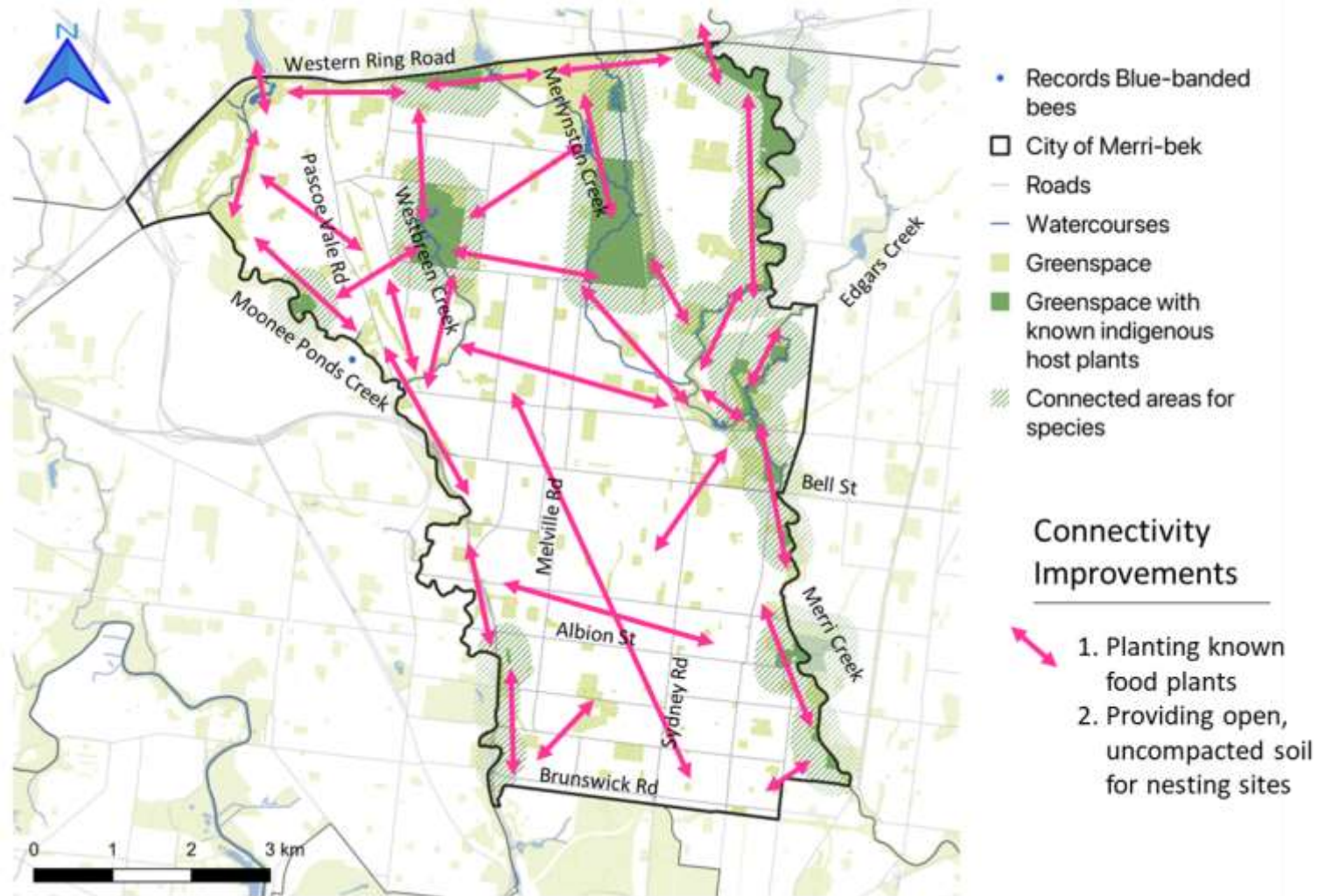


Figure 2.11 Map of habitat connectivity for the Blue-banded bees (*Amegilla asserta*). Currently connected areas result from a buffer area of 350 m around green spaces with known indigenous host plants.

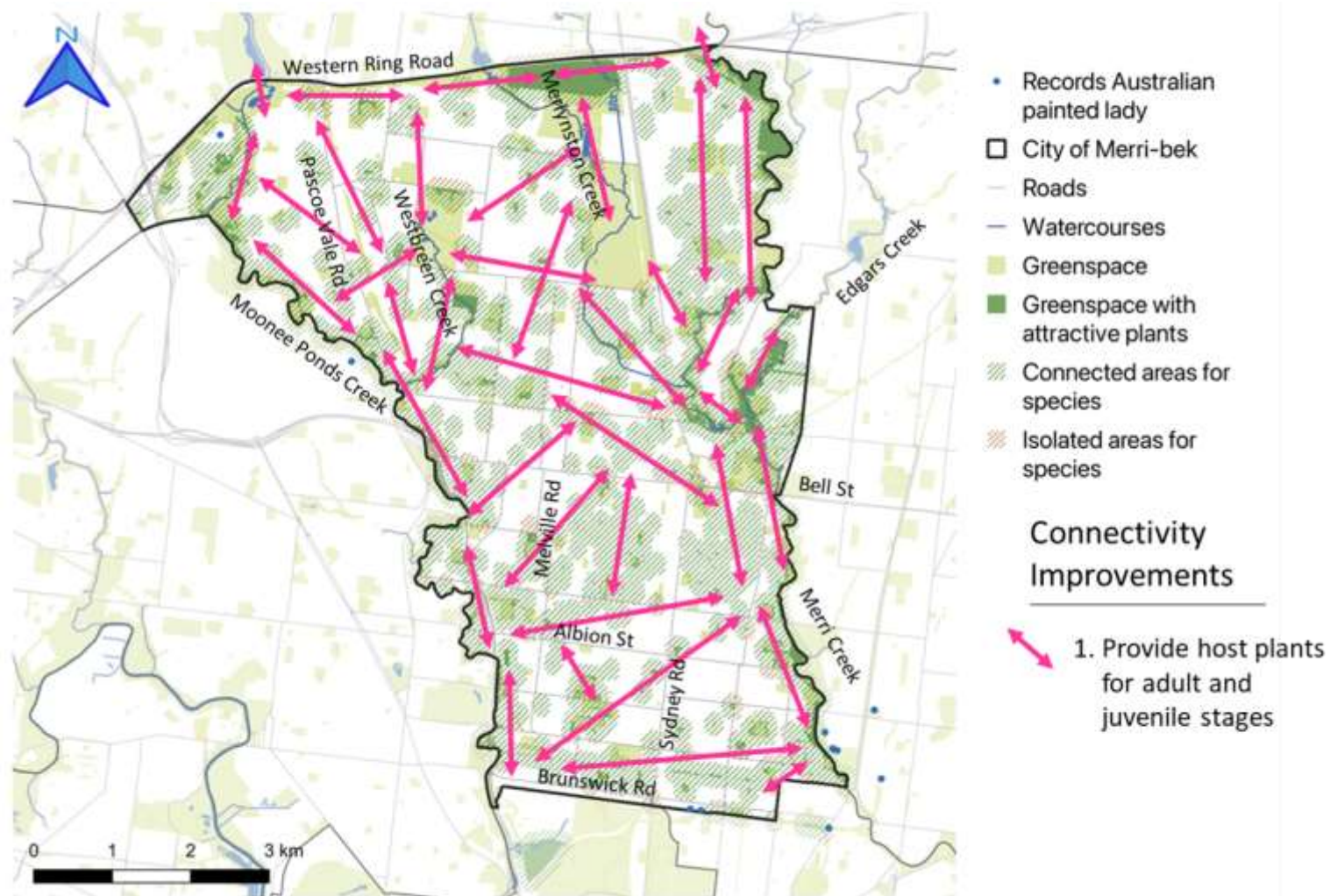


Figure 2.12 Map of habitat connectivity for the Australian painted lady (*Vanessa kershawi*). Currently connected areas result from a buffer area of 150 m around greenspaces with attractive plant species, while major roads result in isolated areas.

3. Synthesised wildlife habitat connectivity maps for the City of Merri-bek

While understanding the individual habitat connectivity requirements of different focal species can be important, it makes sense to look more closely for synergies amongst species as this will help to identify synergies where a small number of actions can deliver multiple benefits. We identified 15 locations within the City of Merri-bek that are key areas of connectivity (Figures 3.1 and 3.2). These corridors are either associated with known riparian corridors (Connections 1-6); known areas of connected greenspaces (Connections 7 and 9); or represent key opportunities to develop actions to help connect existing corridors - for example, Connection 10 would help connect Connection 5 (Westbreen Creek to Northern Golf Club) to Connection 9 (Fawkner Memorial Wedge)..

Management actions that can improve the benefits of each corridor are presented in Table 3.1, along with the functional groups (represented by the focal species) that are associated with those Connections and would benefit from such actions. Nine Connections have been identified as important for all 12 focal taxa (Connectors 1-9). They represent the Merri Creek (Connectors 1-2), Moonee Ponds Creek (Connectors 3-4), Northern boundary (Connectors 7-8), and areas of more extensive greenspace in the northern part of the municipality (Connectors 5,6 and 9). In each of these connectors, there are multiple interventions that would further enhance connectivity, including habitat enhancements, creation of additional ponds and drainage lines, as well as reducing the level of artificial light at night (Table 3.1).

Two additional connectors are important for 9 of the 10 terrestrial species (swamp wallabies would potentially be discouraged from using these areas for connectivity). These connectors help to create links between the riparian connectors on the west and east of the Municipality (Connectors 10-11). In these locations, the constructive interventions are to focus on habitat installation and enhancement, mitigating potential road effects, and ensuring nesting and roosting requirements have been met (Table 3.1).

The four remaining connectors (Connectors 11-15) offer benefits to a smaller number of focal species, most of which are strong fliers with specific nesting and feeding requirements (red-rumped parrot and black-shouldered kite); or insect pollinators which are mobile enough to navigate urban landscapes, but small enough that their individual resource requirements can be met in a relatively localised area (Table 3.1).

In examining these general connectors, several areas emerge as opportunities for strategically investing in additional habitat locations (Figure 3.3.). The smaller locations in the northern section would contribute to the terrestrial connections and darker skies identified as important for all 12 of the focal species (Connectors 6, 10-11). In contrast, the large, consolidated area in the southern section of the municipality coincides with the most densely built areas where greenspaces are relatively small and highly dispersed, which contributed to the much smaller number of focal species that could utilise this area (Connectors 11-15). Decisions on how to prioritise investments would need to consider the trade-offs between boosting relatively scarce resources and connectivity opportunities in the south, with opportunities to consolidate and strengthen connections in the northern section, potentially enabling stronger outcomes for more sensitive urban biodiversity.

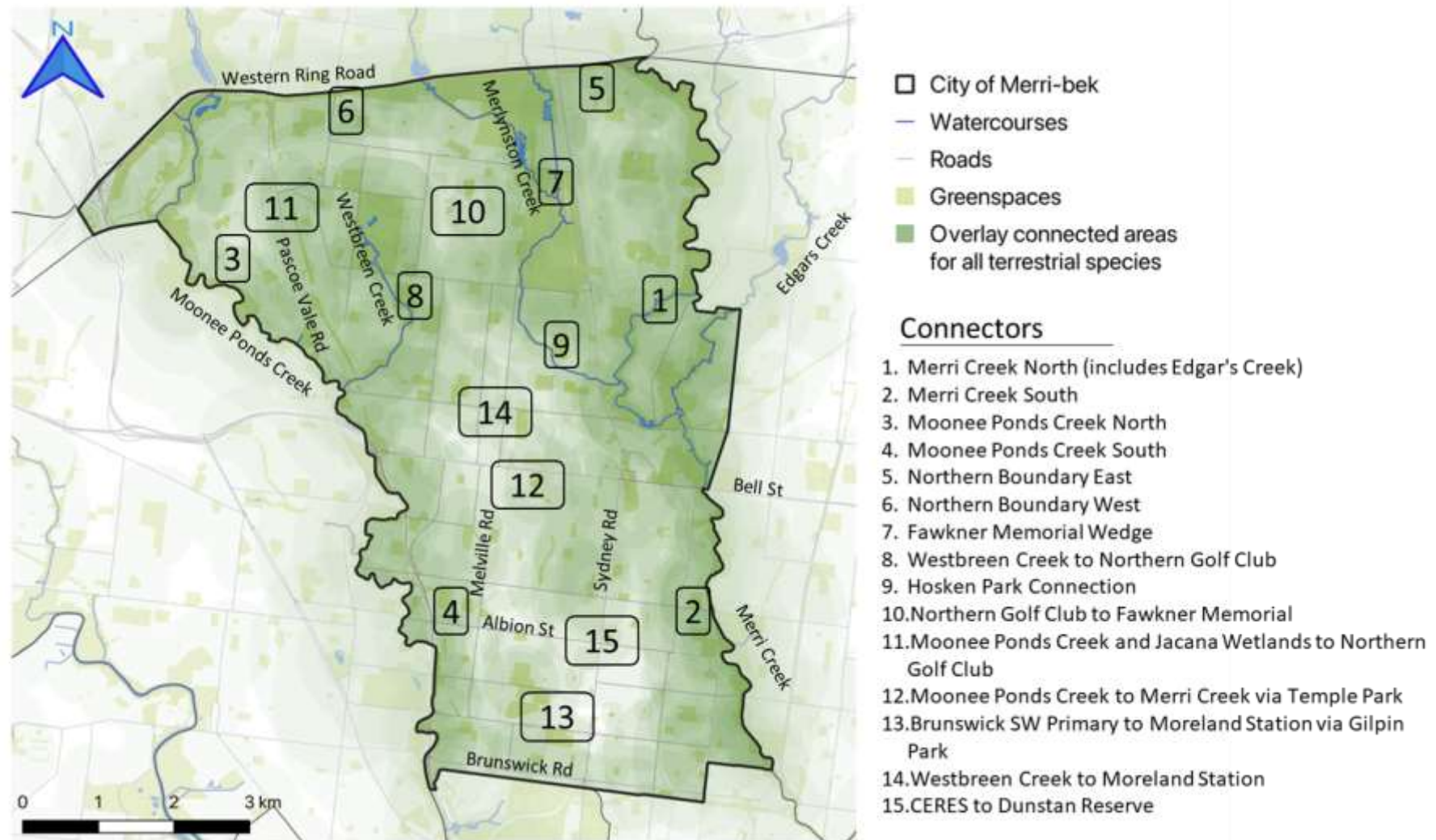


Figure 3.1 Map of the main corridors for habitat connectivity in the City of Merri-bek for the ten terrestrial species. See Table 3.1 for more information on each corridor. The darker an area, the more species can utilise it to move between suitable habitat

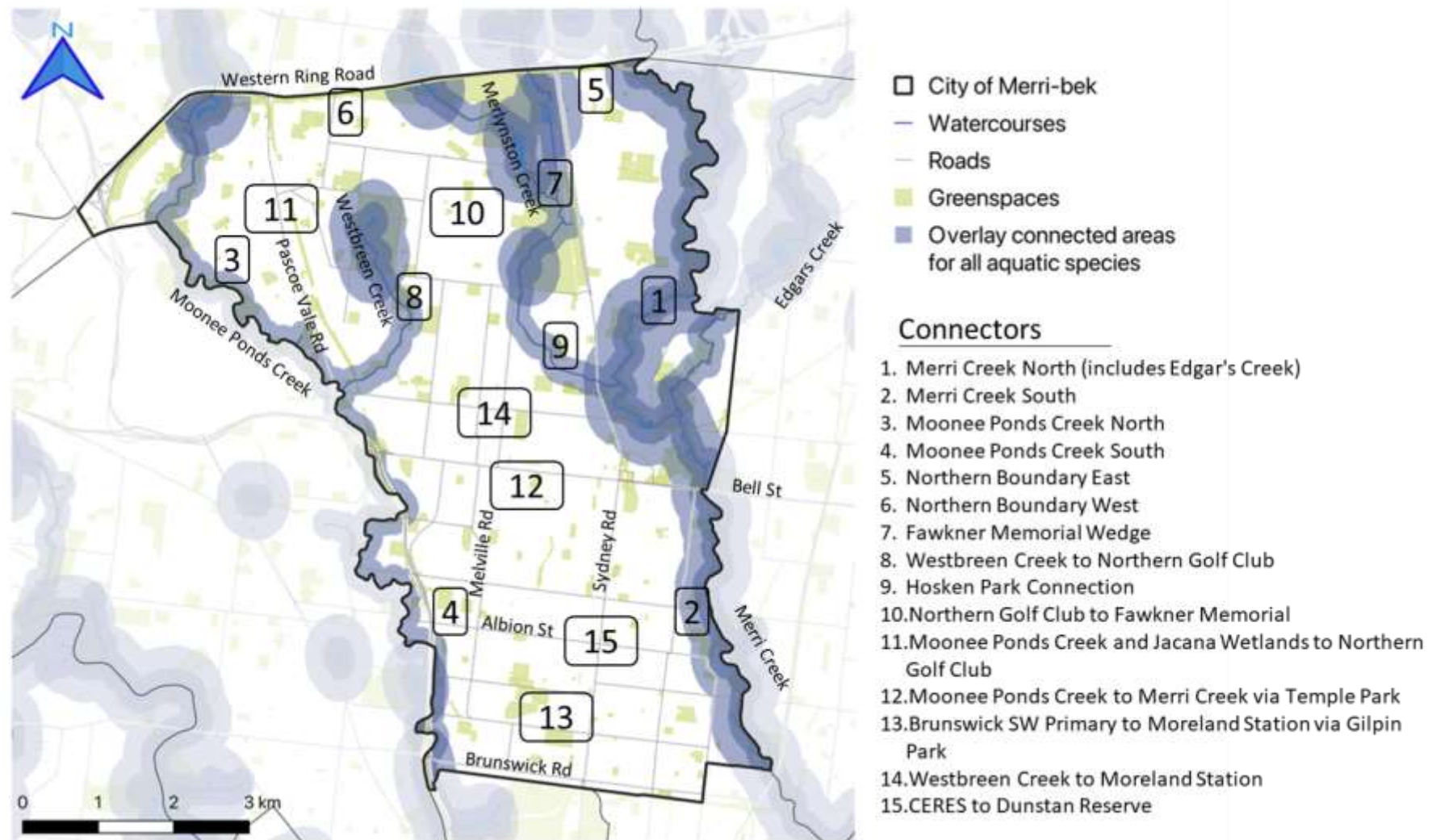


Figure 3.2 Map of the main corridors for habitat connectivity in the City of Merri-bek for the two aquatic species. See Table 3.1 for more information on each corridor. The darker an area, the more species can utilise it. NOTE: this map includes some sections of watercourses know to be underground, e.g. Merlyston Creek from Sussex St Hadfield to Renown St Coburg North; Westbreen Creek in Pascoe Vale from Rhodes Pde to Northumberland Rd and Zenith St to Moonee Ponds Creek.

Table 3.1 Main habitat connectivity corridors in City of Merri-bek

ID	Connection	System	Nighttime light	# Focal species	Focal species types	Interventions
1	Merri Creek North (includes Edgar's Creek)	Riparian	Bright	12	All focal species	Habitat enhancements, nesting and roosting resources, dark sky protection, increase ponds and drainage lines, road crossings for swamp wallaby and blue-tongued lizard
2	Merri Creek South	Riparian	Bright	12	All focal species	As above
3	Moonee Ponds Creek North	Riparian	Bright	12	All focal species	As above
4	Moonee Ponds Creek South	Riparian	Bright	12	All focal species	As above
5	Westbreen Creek to Northern Golf Club	Riparian	Dark	12	All focal species	As above
6	Hosken Park Connection	Riparian	Bright	12	All focal species	As above
7	Northern Boundary East	Terrestrial	Bright	12	All focal species	As above

ID	Connection	System	Nighttime light	# Focal species	Focal species types	Interventions
8	Northern Boundary West	Terrestrial	Bright	12	All focal species	As above
9	Fawkner Memorial Wedge	Terrestrial	Dark	12	All focal species	As above
10	Northern Golf Club to Fawkner Memorial	Terrestrial	Bright	9	All terrestrial species, except swamp wallaby	Habitat installation and enhancement in public and private realm, road effect mitigation measures at larger roads, provision of nesting/roosting resources
11	Moonee Ponds Creek and Jacana Wetlands to Northern Golf Club	Terrestrial	Dark	9	All terrestrial species, except swamp wallaby	As above
12	Moonee Ponds Creek to Merri Creek via Temple Park	Terrestrial	Bright	4	Insect pollinators (blue-banded bee and Australian painted lady) and strong fliers (red-rumped parrot and black-shouldered kite)	Provide areas of taller grass in greenspaces > 1ha to support foraging opportunities for red-rumped parrot and black-shouldered kite; increase availability of food plants and nesting sites for insect pollinators (adult and juvenile stages)

ID	Connection	System	Nighttime light	# Focal species	Focal species types	Interventions
13	Brunswick SW Primary to Moreland Station via Gilpin Park	Terrestrial	Bright	3	Insect pollinators (blue-banded bee and Australian painted lady), strong flier (black-shouldered kite)	As above
14	Westbreen Creek to Moreland Station	Terrestrial	Bright	2	Insect pollinators (blue-banded bee and Australian painted lady)	increase availability of food plants and nesting sites for insect pollinators (adult and juvenile stages)
15	CERES to Dunstan Reserve	Terrestrial	Bright	1	Strong flier (red- rumped parrot)	Increase resting/foraging opportunities, e.g. areas of taller grass in larger green spaces, to encourage movement

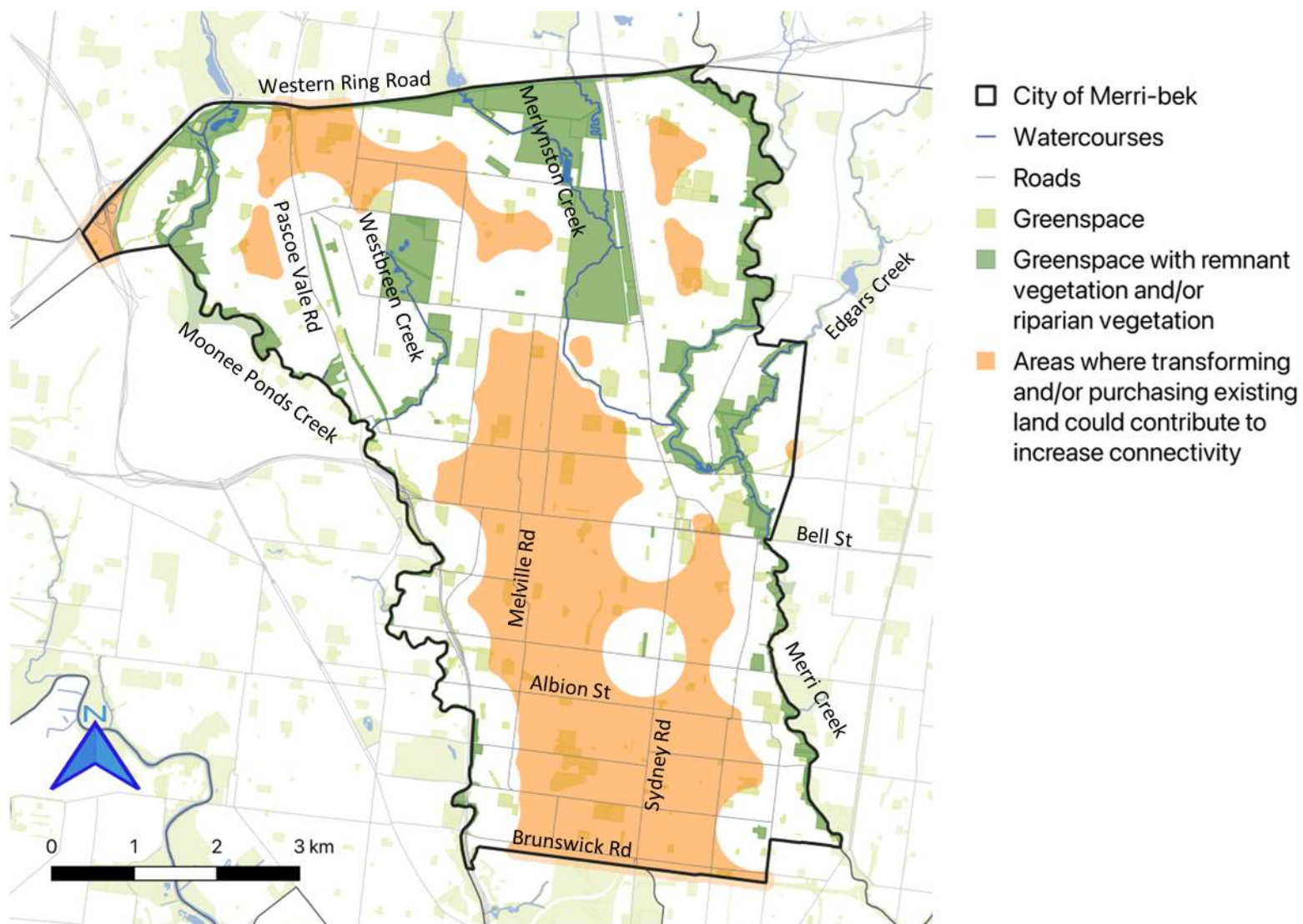


Figure 3.3 Areas within the City of Merri-bek where private property could be purchased and transformed to increase wildlife connectivity through the corridors presented in Table 3.1 and shown in Figures 3.1 and 3.2

4. Technical Considerations

This report maps habitat connectivity across a landscape, rather than modelling the likely movement of target species. Habitat connectivity mapping uses the spatial arrangement of features known to be similar to habitats where the focal species occur. It is not a guarantee that the focal taxa are already present at the site. It is simply a tool for mapping where suitable habitat for that species is already present in the landscape.

Any mapping exercise is only as detailed as the spatial data available to use as input. For this report, we were relying on data from the State of Victoria, which is

largely produced at the scale of the entire state. For examining general connectivity patterns across the entire municipality, this resolution of data is acceptable.

However, it is important to note that a finer scale investigation may reveal additional patches of potential habitat (e.g., waterbodies, small areas of remnant vegetation) or instances where the data do not reflect the current circumstances for other reasons (e.g., an area of vegetation has now been cleared). Therefore, it is worth interpreting these outcomes as a reliable first step to identify areas suitable for a more detailed investigation.

5. Summary

Merri-bek City Council is home to a wide diversity of plant and animal species, and supports a number of locations with key habitats for the 12 functional groups investigated in this report. The existing corridors are largely located along riparian areas, such as the Merri Creek, Edgar's Creek and Moonee Ponds Creek.

Protecting these existing corridors, managing potential urban impacts, such as artificial light at night, and adding additional habitat within the corridors to help increase connectivity will help to enhance the habitat value of these existing assets.

This study has also identified additional locations for actions to help increase connectivity, often through residential landscapes and terrestrial areas between different riparian corridors. These locations may

provide additional challenges for delivering increased connectivity, but the restoration actions and the actions required to reduce urban impacts are similar. Focusing on the functional groups that have been linked to these corridors will help to narrow the number of activities to target in those locations. Actions to support additional taxa can potentially be considered at a later stage.

This report was a desktop study that relied on existing spatial data. Collecting additional data at a finer scale within specific corridor locations will help provide a clearer picture of how to supplement existing habitats with additional areas. Capturing this information will also assist future studies by providing more detailed information that can allow for a more in-depth mapping and investigation in the future.

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Appendix 1

Details of methodological approach

1. Summarising biodiversity records – overview of methods

Summarise biodiversity records for the municipality and a 1 km buffer of the surrounding landscape. Produce maps illustrating the distribution of species richness in 500 m² grid cells across the municipality for major taxonomic groups. Use the information from the biodiversity records and mapping exercise to identify important taxonomical and functional groups within the municipality and to help inform the selection of 12 focal taxa to act as representatives for each group.

2. Connectivity mapping – overview of methods

Investigate available literature to identify information related to habitat requirements, dispersal distances, and

minimum patch sizes relevant to each focal taxon, and the aspects of the urban landscape known to influence the likelihood of observing that species.

Use the information from the literature to create spatial themes that represent potential connectivity of habitat for each focal taxon based on those conditions.

Use the information from the literature to create spatial themes that represent potential barriers or less suitable habitat for each focal taxon.

Intersect the potential habitat connectivity theme with the potential barriers/urban threats theme to create a map of the current connectivity conditions across the municipality.

Use the map of current connectivity conditions to identify opportunities for actions that will increase

connectivity across the municipality. Document these opportunities in both map form and with an accompanying table of recommended actions.

3. Connectivity mapping – specific methods related to habitat elements

Remnant vegetation - Native Vegetation - Modelled 2005 Ecological Vegetation Classes (with Bioregional Conservation Status) (NV2005_EVCBCS/EVCBCS). State of Victoria | Creative Commons Attribution 4.0 International licence.

Dense tree canopy - Tree Density 1:25,000 - Vicmap Vegetation (tree_density_dense). State of Victoria | Creative Commons Attribution 4.0 International licence.

Waterbodies - HY_WATER_AREA_POLYGON Water Area (polygon) 1:25,000 - Vicmap Hydro. State of Victoria | Creative Commons Attribution 4.0 International licence. Mitcham reservoir was removed from this layer.

Watercourses – Hy_watercourse Network 1:25,000 - Vicmap Hydro. State of Victoria | Creative Commons Attribution 4.0 International licence.

Open space – Melbourne metropolitan open space network (VPA_Draft_Open_Space_Data). Planning Victoria | Creative Commons Attribution 4.0 International licence.

Open space with remnant vegetation – Select by location all ‘open space’ features that intersect NV2005_EVCBCS. Saved as VPA_OS_EVCs.

Open space with Eucalyptus species present – Select by location all ‘open space’ features that intersect records where [Genus] = ‘Eucalyptus’. Saved as VPA_OS_Eucalyptus.

Open space with Acacia species present – Select by location all ‘open space’ features that intersect records where [Species] = ‘Acacia melanoxylon’ OR [Species] = ‘Acacia mearnsii’ or [Species] = ‘Acacia implexa’. Saves as VPA_OS_Acacias.

Open space with indigenous plant species in which adult blue-banded bees are known to forage – Select by location all ‘open space’ features that intersect records where [Species] = ‘Pelargonium australe’ OR [Species] = ‘Goodenia ovata’ OR [Species] = ‘Isotoma axillaris’ OR [Species] = ‘Crowea exalata’ OR [Species] = ‘Bulbine

bulbosa' OR [Genus] = 'Dianella' OR [Genus] = 'Wahlenbergia'. Saves as VPA_OS_Pollination.

Dense riparian vegetation – Select by location patches of 'dense tree' canopy that intersect the watercourses + 200 m buffer. Saves as Dense_Riparian_Veg.

Nighttime light levels – Version 1 Nighttime VIIRS Day/Night Band Composites with VIIRS Cloud Mask - Outlier Removed - Nighttime Lights layer (SVDNB_npp_20160101-20161231_00N060E_vcm-orm-ntl_v10_c201807311200.avg_rade9). Earth Observation Group, NOAA/NCEI.

4. Connectivity mapping – specific methods related to each focal taxon

Superb fairy wren | *Malurus cyaneus*

Habitat connectivity: 500 m buffer (Mulder 1995) around open space patches with remnant vegetation (VPA_OS_EVCs). Saved as VPA_OS_EVCs_500m.

Habitat disruptor: Medium to high density residential housing.

Spotted pardalote | *Pardalotus punctatus*

Habitat connectivity: Open space patches with Eucalypts (VPA_OS_Eucalyptus). 150 m around patches smaller than 1 ha, 1.3 km buffer around patches larger than 6 ha, 500 m buffer around patches 1-6 ha in size. Saved as VPA_OS_Eucalyptus_buffered_by_size.

Habitat disruptor: Unable to be represented by available spatial data.

Red-rumped parrot | *Psephotus haematonotus*

Habitat connectivity: Density of hollow bearing tree species per Merri-bek grid > 10 (Treehollows_grid). 500 m buffer around centroid of selected grid polygons intersect grassy open space patches greater than 1 ha. Saved as: con_parrot.

Habitat disruptor: Roads >15 m width (Kirk et al. 2019)

Black-shouldered Kite | *Elanus axillaris*

Habitat connectivity: 500 m buffer (Barnes 2005) around open grassy areas with scattered trees >1ha

Habitat disruptor: Unable to be represented by available spatial data.

Tawny frogmouth | *Podargus strigoides*

Habitat connectivity: 145 m buffer (Weaving 2015) around open space patches (VPA_OS_EVCs) with *Eucalyptus* sp. Saved as VPA_OS_Eucalyptus_145m.

Habitat disruptor: High density residential housing and roads >12km/km² within 500m buffer (Weaving 2015).

Swamp wallaby | *Wallabia bicolor*

Habitat connectivity: 300 m and 1500 m buffer around dense vegetation (tree_density_dense). Saved as tree_density_dense_300m and tree_density_dense_1500m.

Habitat disruptor: Major roads. Variable buffer for roads with Class Code > 4 based on information from the VicRoads Supplement to AGRD Part 3 - Geometric design (2016) and visual assessment of number of lanes for key roads within the municipality. Saved as roads_CClt4_Buffered.

Lesser long-eared bat | *Nyctophilus geoffroyi*

Habitat connectivity: 600 m buffer (Hosken 1996) around VPA_OS_EVCs. Saved as VPA_OS_EVCs_600m.

Habitat disruptor: Brightly lit areas – Band calculator to select all raster cells with radiance value > 9 in Version 1 Nighttime VIIRS Day/ Night Band Composites with VIIRS Cloud Mask - Outlier Removed - Nighttime Lights layer (SVDNB_npp_20160101-20161231_00N060E_vcm-orm-ntl_v10_c201807311200.avg_rade9). Earth Observation Group, NOAA/NCEI. Saved as 16VCmOrmNtl_gt9_polygons.

Eastern blue-tongued lizard | *Tiliqua scincoides*

Habitat connectivity: 1000 m buffer around greenspaces with remnant vegetation (VPA_OS_EVCs). Saved as VPA_OS_EVCs_1000m.

Habitat disruptor: Major roads. Variable buffer for roads with Class Code > 4 based on information from the VicRoads Supplement to AGRD Part 3 - Geometric design (2016) and visual assessment of number of lanes for key roads within LGA. Saved as roads_CClt4_Buffered.

Eastern banjo frog / Pobblebonk | *Limnodynastes dumerilii*

Habitat connectivity: 200 m buffer around watercourses and waterbodies. Saved as Hy_waterbodies_watercourse_200.

Habitat disruptor: Major roads. Buffered roads with Class Code > 4 based on information from the VicRoads Supplement to AGRD Part 3 - Geometric design (2016) and visual assessment of number of lanes for key roads within the municipality. Variable buffer using the information provided in Table A1. Saved as roads_CCIt4_Buffered.

Blue skimmer dragonfly | *Orthetrum caledonicum*

Habitat connectivity: 500 m buffer of vegetation around waterbodies (HY_Waterbodies).

Habitat disruptor: Roads >10 m width.

Blue-banded bee | *Amegilla asserta*

Habitat connectivity: 350 m buffer around areas of open space that contain the indigenous plant species on which the bees are known to forage (VPA_OS_Pollination). Saved as VPA_OS_Pollination_350m.

Habitat disruptor: Unable to be represented by available spatial data.

Australian painted lady | *Vanessa kershawi*

Habitat connectivity: VPA_OS_FoodPlants with 150 m buffer (Cant et al. 2005). Individuals rarely travel far from the host plants of Winged Everlasting (*Ammobium alatum*), Strawflower (*Xerochrysum bracteatum*), Yellow Buttons (*Chrysocephalum apiculatum*), Rice Flower (*Chrysocephalum semipapposum*), Everlastings (*Xerochrysum species*), Western Sunray (*Rhodanthe chlorocephalum*), and introduced Capeweed (*Arctotheca calendula*) and Scotch Thistle (*Onopordum acanthium*).

Habitat disruptor: Unable to be represented using available spatial data due to highly localised distributions.

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