5 OTHER SURVEY RESULTS

5.1 SCAT COLLECTION

A total of 61 “carnivore” type scats were collected during the project. Of these 55 were suitable for analysis. 48 of these scats were identified as fox scats and the contents analyzed by an expert in this field. The remaining scats were identified as dog (wild), echidna and skink. Looking at fox scats only- invertebrates, birds and grass were the most common diet items (Figure 25). Up to 4 diet items were identified in each of the scats (Figure 26).

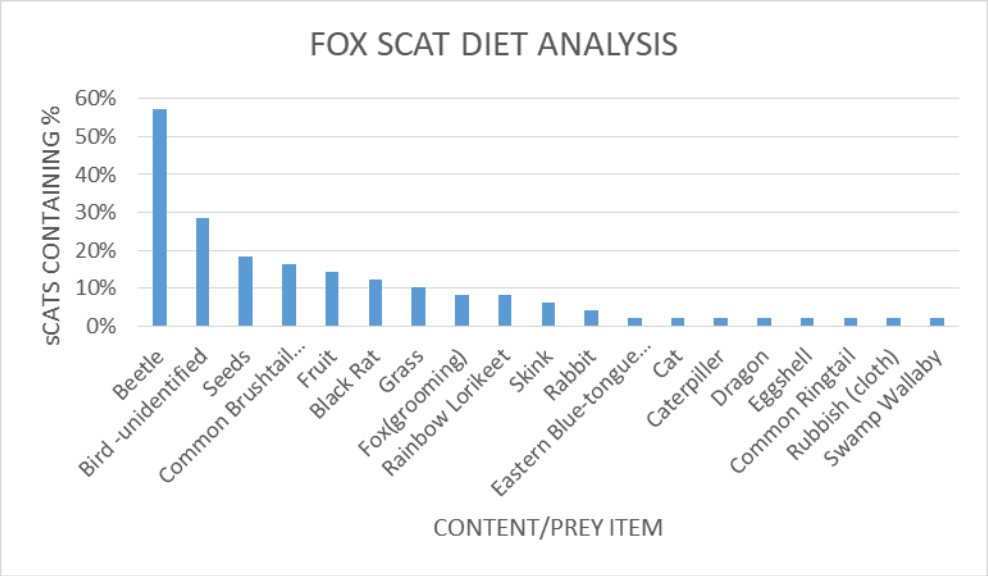

Figure 25 Proportion of scats containing discrete diet items as listed

This varies considerably when looking at primary prey items only. For example beetles occur in 60% of scats (Figure 25) but only 8% of scats (Figure 27) have beetle as the primary prey item. The typical proportion of beetle in a scat is illustrated in Figure 26.

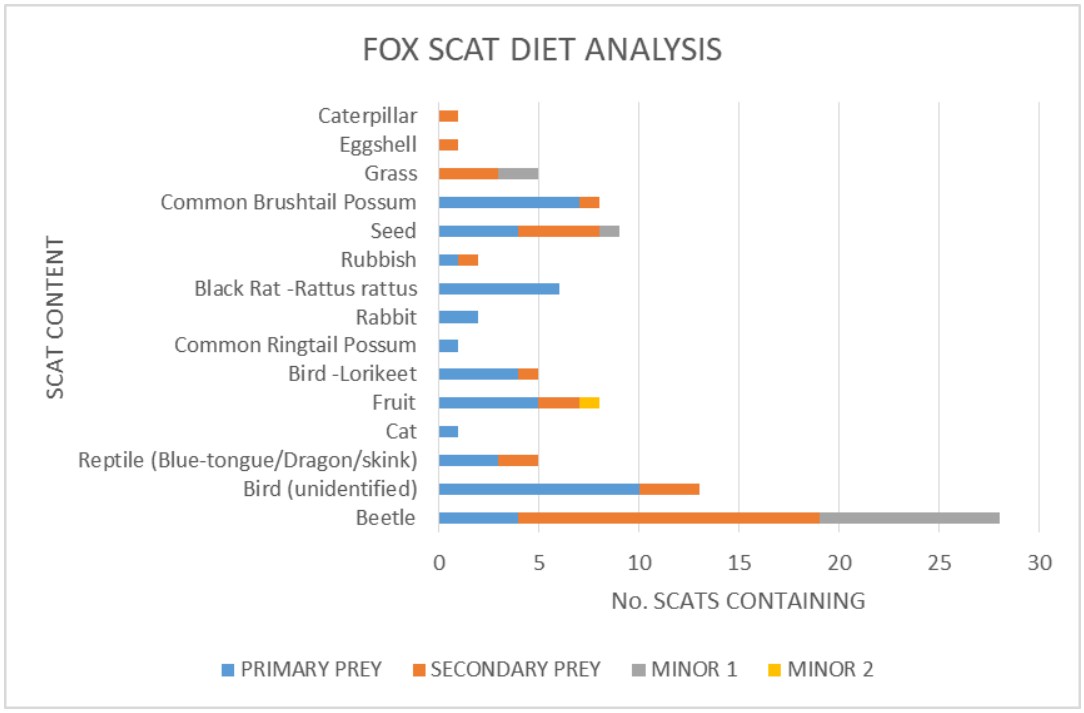

Figure 26 Indicative prevalence of each item in the scat where “Ptimary prey” has the highest content and Minor 2 the lowest.

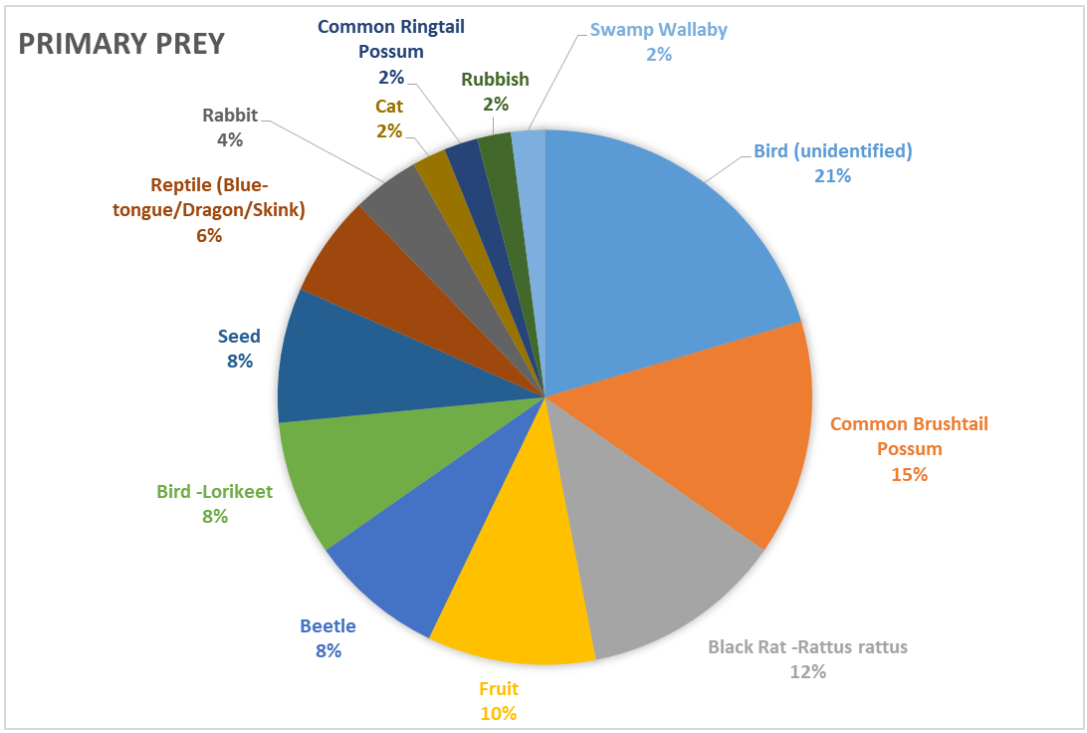

Figure 27 Proportion of scats containing a given prey item as the primary item consumed

Figure 28 Example of fox scats collected during the project. Foxes use faeces, along with urine and anal scent, as a way of displaying the extent of their territory and thus scats are often highly visible on tracks, elevated on fallen logs and grasses.

Evidence of fox predation was common within the corridors. It is common for foxes to carry the prey away from the kill location, often to a den. Carcasses are often buried/cached for later consumption.

Figure 29 Some of the prey items left near natal dens observed during the survey(clockwise from top) Rabbit, Tawny Frogmouth, Eastern Long-necked Turtle eggs, Common Brushtail Possum, Grey-headed Flying-fox and Pied Currawong.

Figure 30 Scats from species excluding fox

SCAT SPECIES	CONTENTS 1	CONTENTS 2	CONTENTS 3
Echidna			
Wild Dog(probable)	Rabbit, Grass, bird	Beetle, seeds	Beetle, seeds
Skink	Seeds	Beetle	

Figure 31 Wild dog scat

5.2 HAIRTUBE ANALYSIS

131 samples of fur obtained from hairtubes baited with peanut butter, honey and rolled oats were analysed to determine genus/ species. Results are illustrated in Figure 32.

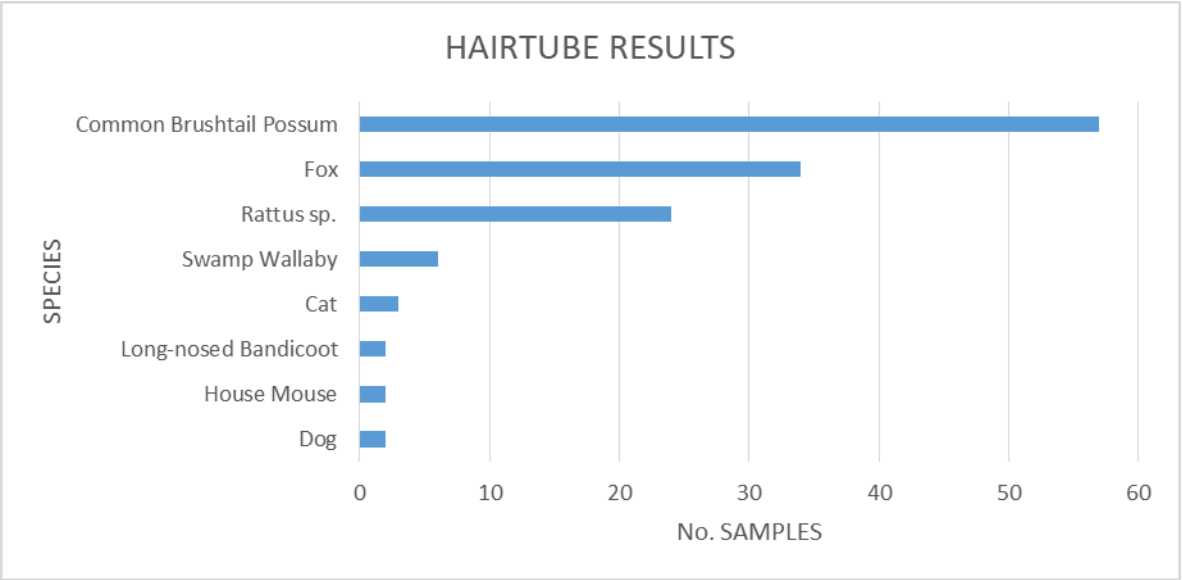

Figure 32 Hairtube hair analysis results

This remote method is very useful and can be used in conjunction with other techniques. For example, hairtubes were the first techniques to detect Swamp Wallabies in Galaringi Reserve and subsequent targeted scat searches for this species provided concurring results.

5.3 PELLET ANALYSIS

21 owl pellets were collected during the survey period. All but one was from owls at the Quarry Branch corridor. Many of the known owl roost sites are over water and pellets cast by these birds, unfortunately, end up in the water.

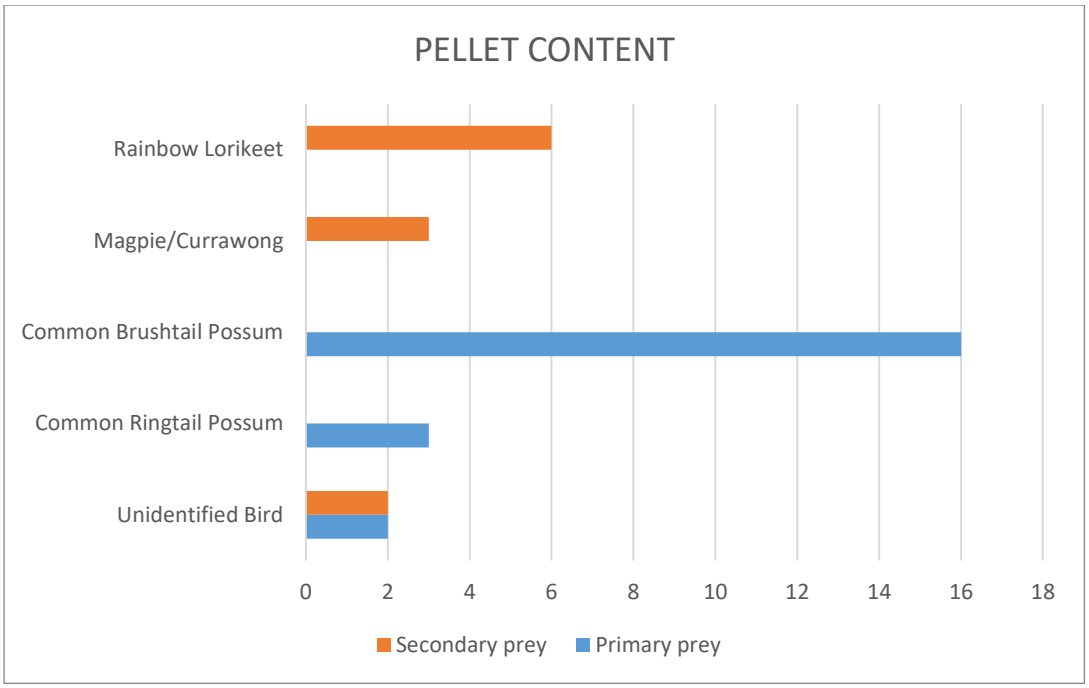

Figure 33 Powerful Owl pellet contents

The majority of these pellets were collected in late spring when owlets were still present with adults. This may have influenced prey choices.

5.4 GROUND TRAPPING

No animals were caught during trapping.

6 FURTHER DISCUSSION

The City of Parramatta has undertaken a variety of actions to improve the quantity and quality of habitat in the LGA over many years. Management actions such as a program of integrated pest animal control, weed management, community engagement/education and habitat improvement works (eg nest box installation) have been undertaken, are ongoing and are embedded in Council policy and adopted reserve Plans of Management.

This section provides additional information to assist in the decision-making process to manage fauna in reserves, at the reserve-urban interface and across the LGA.

6.1 SUMMARY DATA FROM SURVEYS

6.1.1 Overall species richness

The following highlights were recorded from recent fauna surveys in bushland reserves around Parramatta LGA during 2016-17:

- 97 species of birds, including 88 species of native birds and 9 introduced species
- 7 species of amphibians, all native
- 16 species of reptiles, all native
- 29 species of mammals, including 15 species of microbats, 7 introduced species and 7 other native species

These were not uniformly distributed throughout the LGA (Table 11). The greatest overall diversity was recorded in the Hunts Creek Corridor, with 105 species. Diversity in other reserves ranged from 83 species in Upper Toongabbie Creek Corridor to 27 species in Devlins Creek Corridor and in Edna Hunt Sanctuary.

Greater diversity of avian fauna was reported from Hunts Creek Corridor, with 65 species, closely followed by Upper Toongabbie Creek Corridor with 60 species. Avian diversity in other reserves ranged from 14 species to 45 species.

More species of amphibians were reported from Hunts Creek Corridor, where all 7 species were recorded.

More species of reptiles were reported from Hunts Creek Corridor, with 14 species of the total 16 species present.

More species of microbats were recorded from Lower Toongabbie Creek Corridor, with 10 species of the total 14 species present. Half of the reserves surveyed had 8 or more species of microbats present.

More species of mammals were recorded from Terrys Creek Corridor, with 19 species of the total 29 species present. More introduced mammals were reported from Upper Toongabbie Creek Corridor, with 4 species of the total 7 introduced species present.

Targeted searches for invertebrate threatened species recorded one species in the 14 bushland reserves surveyed, and was reported from Hunts Creek Corridor and Quarry Branch Corridor.

In general, species richness was greatest in the largest reserves. One apparent anomaly was the Terrys Creek Corridor, which recorded high species diversity overall and high diversity of reptiles, amphibians and mammals. The Terrys Creek Corridor lies across the boundary between City of Parramatta and City of Ryde LGAs, and is actually much larger than the 21.51 hectares on the Parramatta side of the creek.

Table 11 Summary of species richness for faunal groups from 14 bushland reserve corridors in Parramatta LGA

RESERVE NAME	DARLING MILLS	HUNTS CREEK	DEVLINS CREEK	TERRYS CREEK	QUARRY BRANCH	VINEYARD CREEK	UPPER PONDS CREEK	LOWER PONDS-SUBIACO	UPPER TOONGABBIE	LOWER TOONGABBIE	BALUDARRI	ERMINGTON BAY	EDNA HUNT	HAINES AVE
RESERVE AREA (ha)	57.36	105.9	16.42	21.51	36.09	22.8	35.2	27.84	63.45	28.66	1.646	27.29	7.213	4.73
PERIMETER (km)	19.5	21.61	8.5	6.65	10.72	6.28	8.05	15.35	20.06	14.83	0.82	1.8	1.813	1.8
EDGE:CORE RATIO	2.94	4.90	1.93	3.23	3.37	3.63	4.37	1.81	3.16	1.93	2.01	15.16	3.98	2.63
NATIVE BIRDS	41	61	14	39	38	26	35	23	54	40	20	32	15	14
INTRODUCED BIRDS	1	4	0	1	2	1	3	3	6	5	4	4	1	0
TOTAL BIRDS	42	65	14	40	40	27	38	26	60	45	24	36	16	14
AMPHIBIANS	5	7	3	4	6	5	4	4	3	1	0	2	1	4
REPTILES	7	14	2	10	8	8	3	4	8	1	5	2	2	5
MICROBATS	9	9	5	9	9	8	3	8	5	10	5	7	5	4
OTHER NATIVE MAMMALS	5	6	2	7	3	4	5	3	3	0	3	3	2	4
INTRODUCED MAMMALS	2	3	1	3	3	2	3	3	4	2	2	3	1	2
TOTAL MAMMALS	16	18	8	19	15	14	11	14	12	12	10	13	8	10
INVERTEBRATES	0	1	0	0	1	0	0	0	0	0	0	0	0	0
TOTAL SPECIES RECORDED	**70**	**105**	**27**	**73**	**70**	**54**	**56**	**48**	**83**	**59**	**39**	**53**	**27**	**33**

6.1.2 Avian fauna species richness

For most of the bushland reserve corridors, less than 10% of the avian fauna recorded is introduced, with the exception of Lower Toongabbie Creek, Lower Ponds - Subiaco Creek, Baludarri Wetlands, and Ermington Bay (Figure 34).

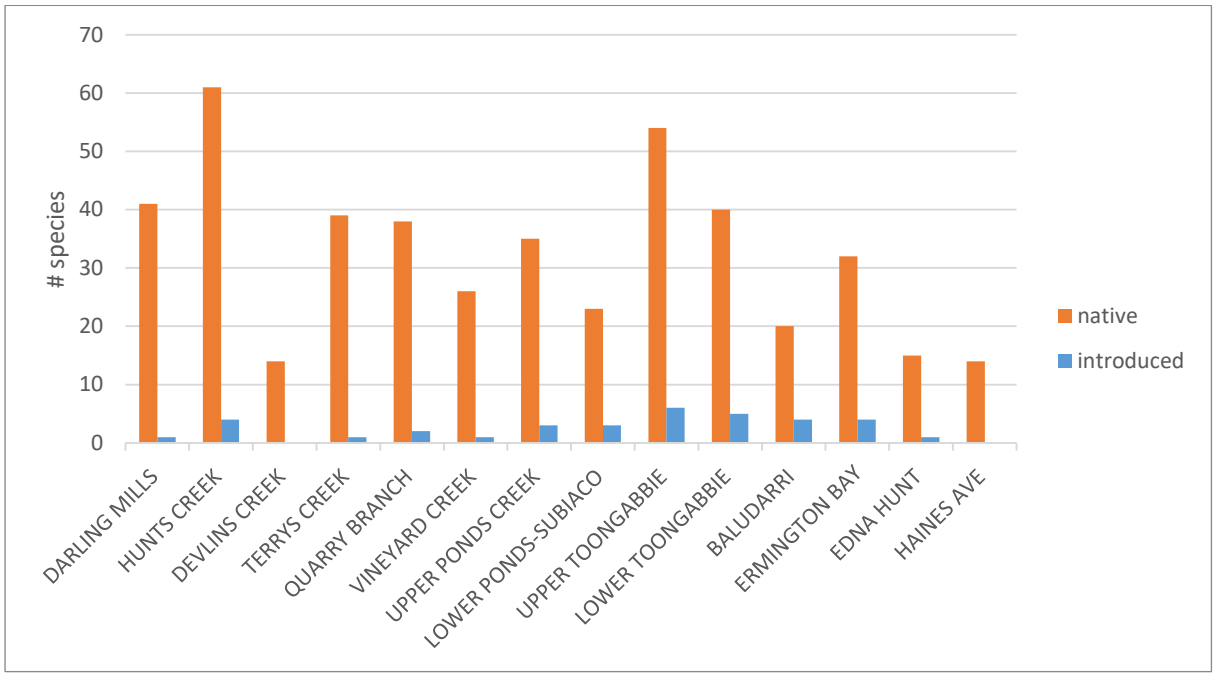

Figure 34 Native and introduced avian species abundance at bushland reserves in Parramatta LGA

6.2 Avian species abundances

We calculated likelihood of sighting a species in a particular reserve on any given day, based on the number of times it was recorded per number of survey days in the reserve. This was estimated as:

- 1 observation only = rare
- 1-10% chance of sighting = uncommon
- 11-20% chance of sighting = moderately common
- 21-59% chance of sighting = common
- >60% chance of sighting = abundant

For most of the reserves, at least half of the avian species present are common or abundant. Hunts Creek Corridor, Upper Ponds Creek Corridor, Upper Toongabbie Creek Corridor and Baludarri Wetlands are also home to a high proportion of uncommon and rare species (Figure 35). Abundant species are more likely to be seen on any given visit, but do not dominate the avian fauna in any of the reserve corridors.

Reserves with a higher proportion of uncommon and rare species potentially provide some sort of niche habitat opportunity that may not be available more generally in the LGA.

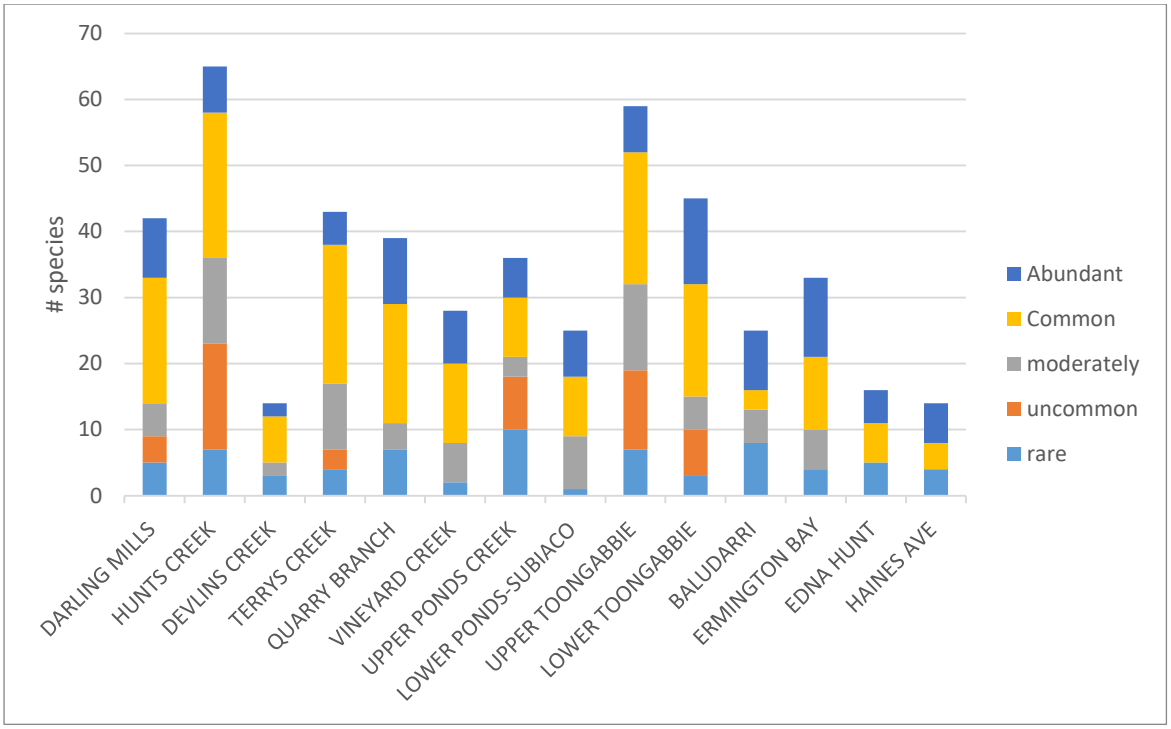

Figure 35 Relative abundance of each avian species in bushland reserves in Parramatta LGA, based on likelihood of sightings

A total of 17 species of native birds were only recorded in one reserve, and several of these were only recorded on a single occasion. This included 6 species only recorded in Hunts Creek Corridor. These included a threatened species, a migratory species, a small raptor and two water birds recorded on Lake Parramatta. Another 5 species were only recorded in Ermington Bay, all of which are aquatic species.

6.3 WHAT NATIVE BIRDS LIVE WHERE?

6.3.1 Darling Mills Creek Corridor

Avian species were allocated to a series of categories for a range of life history characteristics. Avian fauna in the reserves of Darling Mills Creek Corridor is dominated by small, sedentary and insectivorous species that feed/live in the mid-storey and forest canopy. Ground dwelling species were also common. Large birds and nomadic birds were present in low species numbers. Extensive areas of forest with dense understorey exist in this reserve, providing good habitat for small birds.

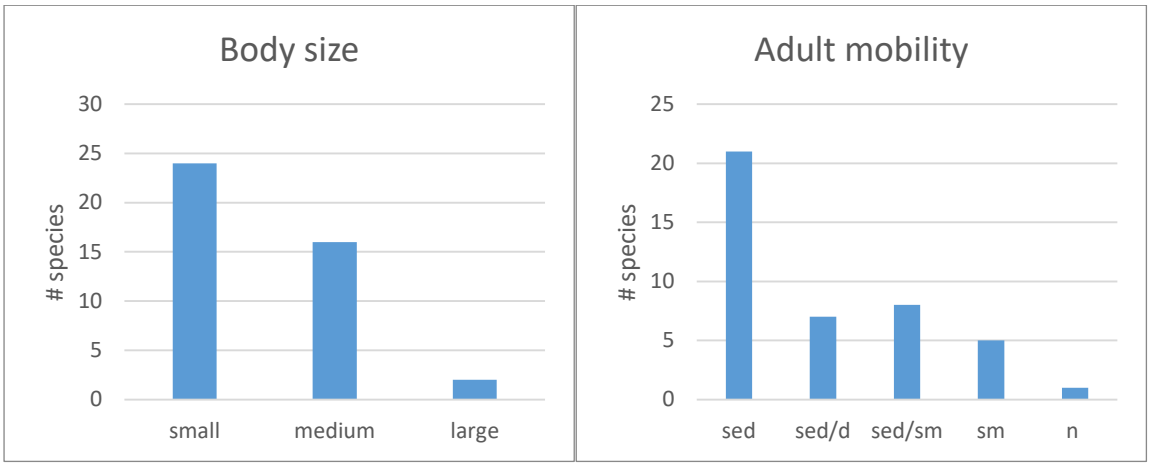

Figure 36 (left) Body size, and (right) adult mobility patterns for avian species present in Darling Mills Creek Corridor

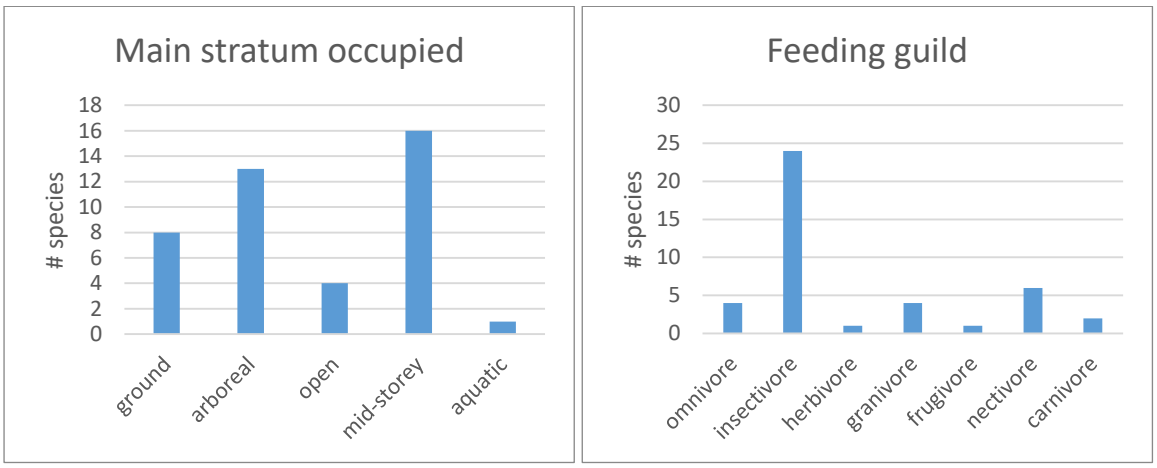

Figure 37 (left) Main stratum occupied, and (right) feeding guilds for avian species present in Darling Mills Creek Corridor

6.3.2 Hunts Creek Corridor (including Lake Parramatta)

Avian fauna in Hunts Creek Corridor and Lake Parramatta was dominated by medium sized birds, sedentary species and insectivores. There were also numerous small bird species, and birds were generally found in the mid-storey shrub layer and the canopy. Unlike many other sites, there was a high proportion of aquatic species in this corridor, making use of the ample freshwater habitat in Lake Parramatta.

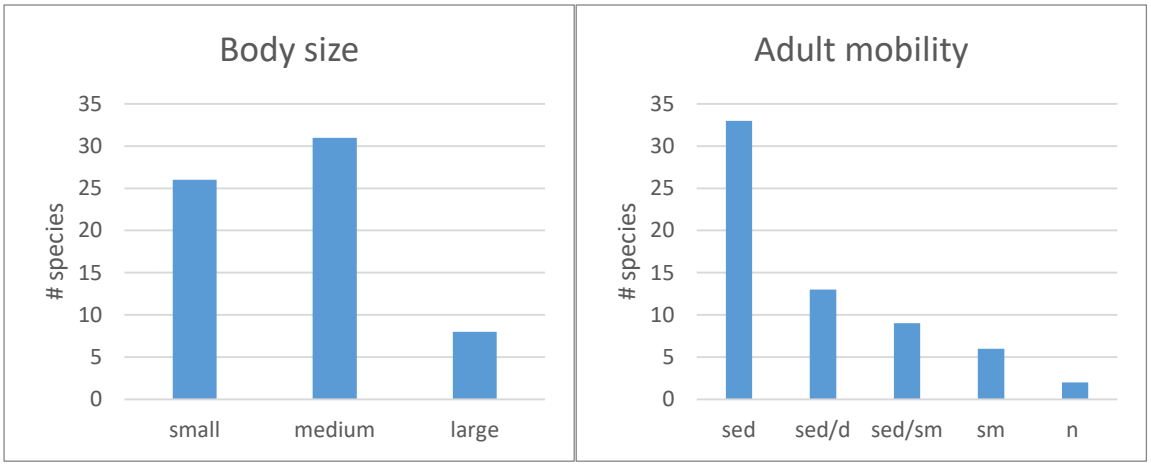

Figure 38 (left) Body size, and (right) adult mobility patterns for avian species present in Hunts Creek Corridor

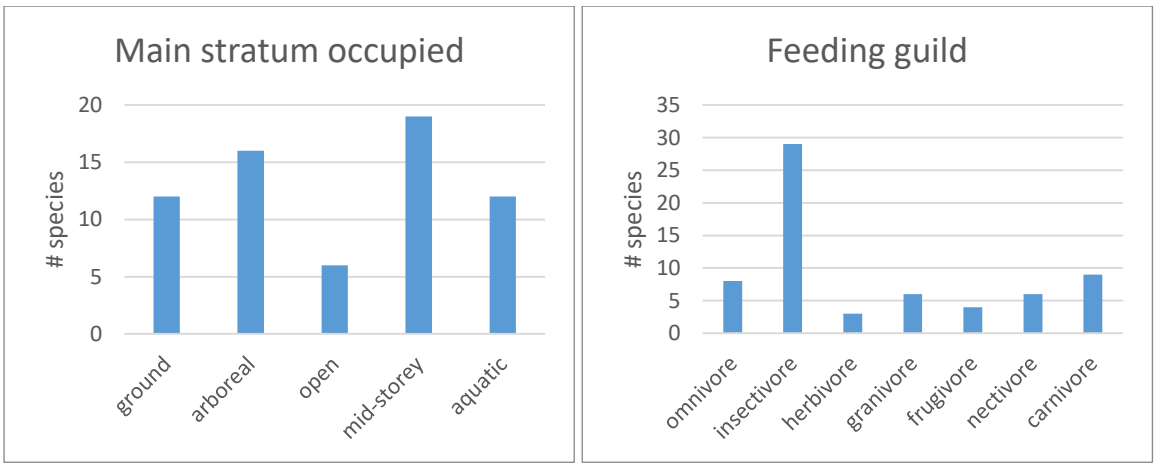

Figure 39 (left) Main stratum occupied, and (right) feeding guilds for avian species present in Hunts Creek Corridor

6.3.3 Devlins Creek Corridor

Reserves in Parramatta's section of the Devlins Creek Corridor have been disconnected from the rest of the corridor following the construction and ongoing works on the M2, a fact that is reflected in the diversity and abundance of avian species present. Medium sized birds dominated this reserve group, and all birds were predominantly sedentary. Ground dwellers/foragers and open area specialists were more common, and most of the species present were insectivores or omnivores. This broadly generalist avifauna is more common in areas with an ongoing disturbance history. Carnivores are proportionally well represented in this reserve corridor.

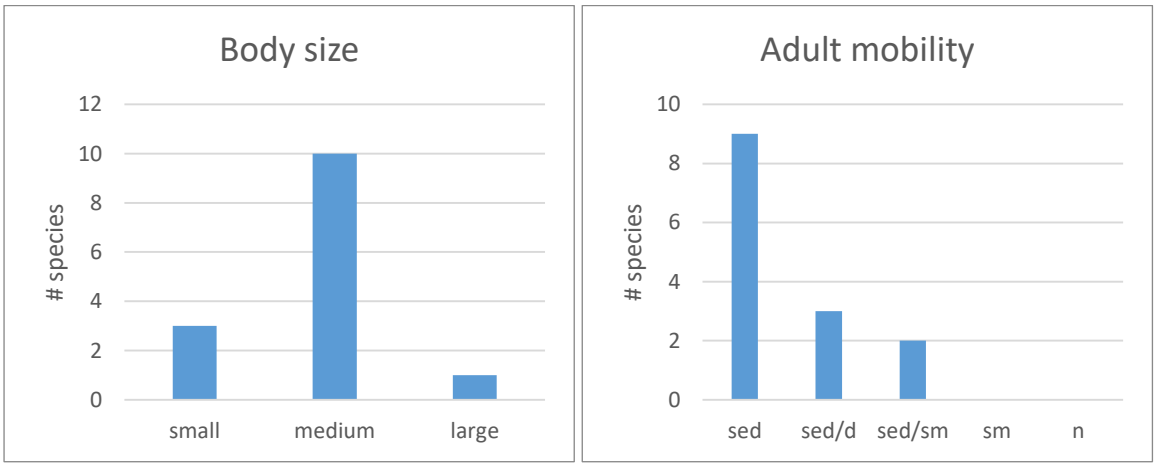

Figure 40 (left) Body size, and (right) adult mobility patterns for avian species present in Devlins Creek Corridor

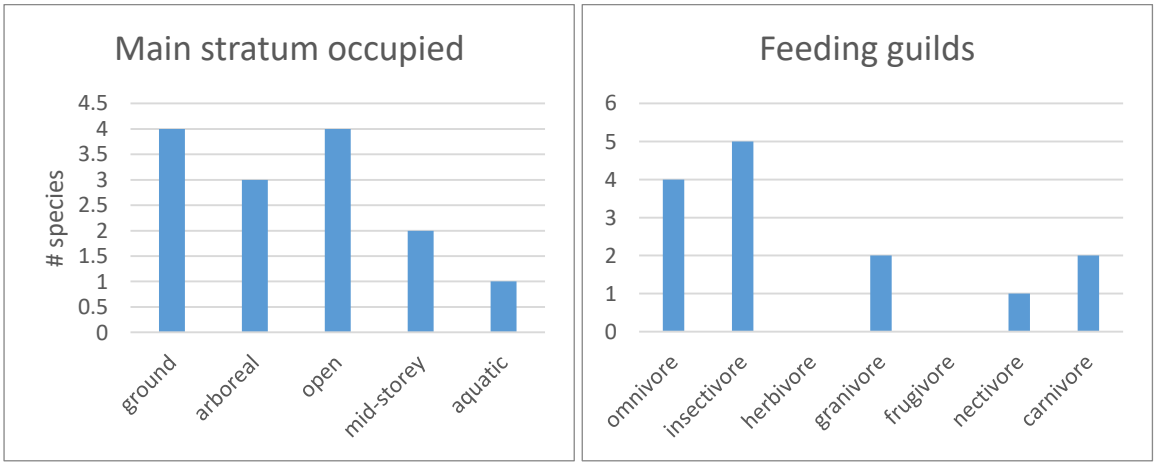

Figure 41 (left) Main stratum occupied, and (right) feeding guilds for avian species present in Devlins Creek Corridor

6.3.4 Terrys Creek Corridor

Avifauna in Terrys Creek Corridor is dominated by small and medium sized birds. The corridor is shared by Parramatta and Ryde LGAs, and includes a series of reserves with high to moderate urban influences. Most species are sedentary, and typically occupy the mid-storey shrub layer and canopy. However, there is a notable proportion of species that are seasonally migratory in this reserve. Again, insectivores dominate, providing an important service to the adjoining urban areas.

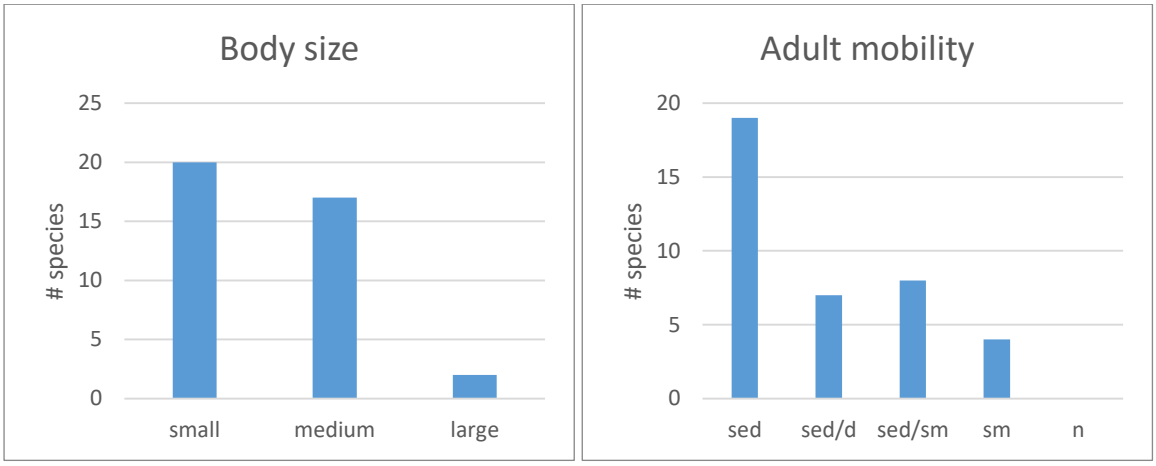

Figure 42 (left) Body size, and (right) adult mobility patterns for avian species present in Terrys Creek Corridor

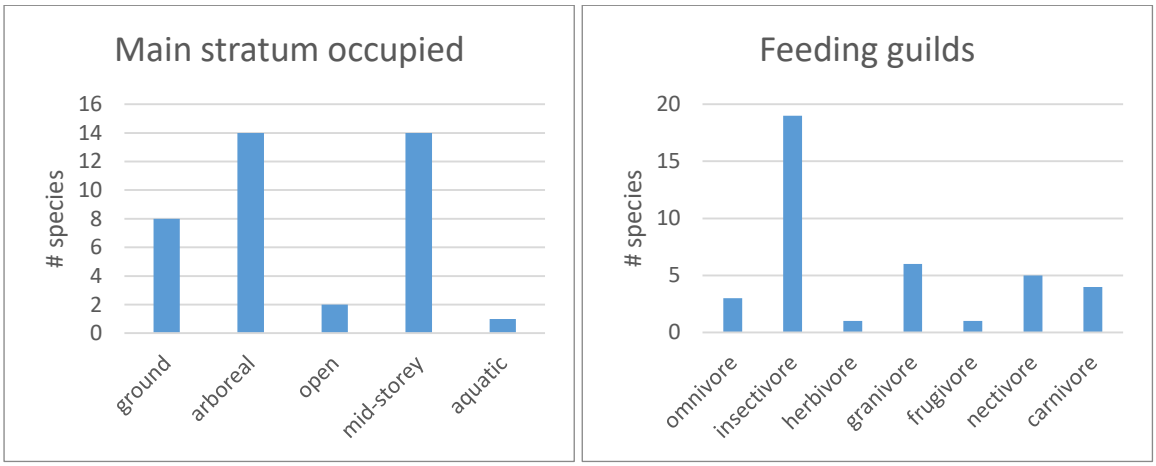

Figure 43 Main stratum occupied, and (right) feeding guilds for avian species present in Terrys Creek Corridor

6.3.5 Quarry Branch Corridor

Quarry Branch Corridor is a comparatively narrow strip of bushland within a stable residential catchment. Avifauna is dominated by small and medium species, most of which are sedentary. Most of the species present live in the mid-storey shrub layer and the canopy, and are predominantly insectivores.

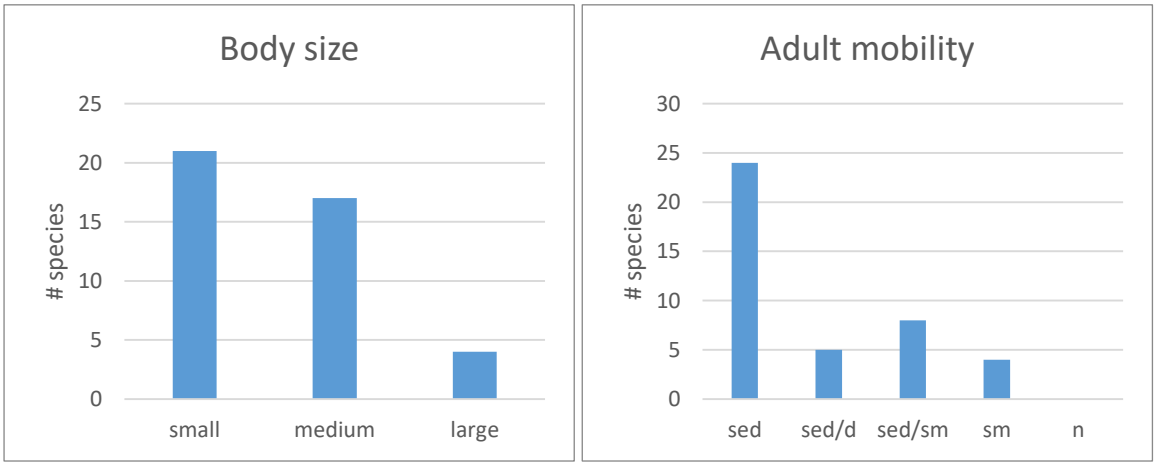

Figure 44 (left) Body size, and (right) adult mobility patterns for avian species present in Quarry Branch Corridor

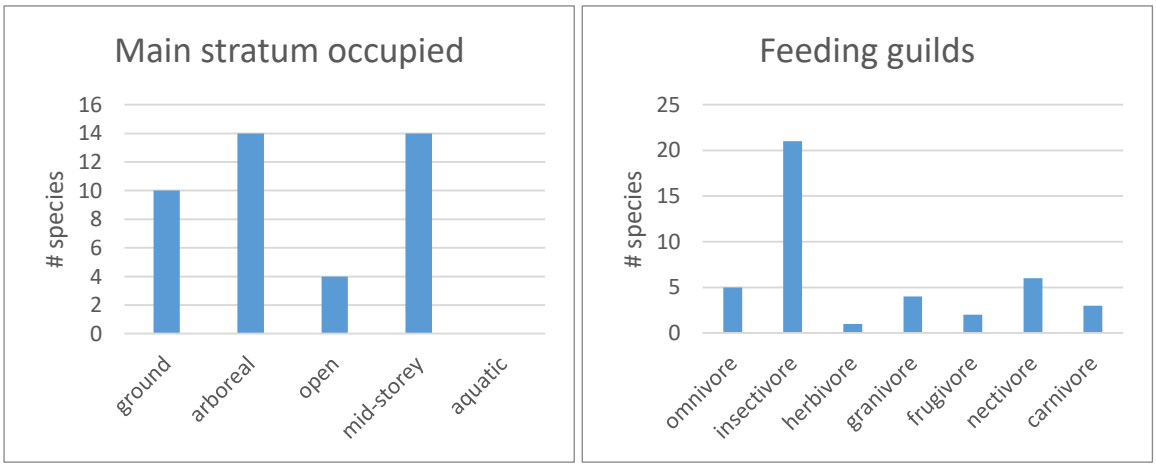

Figure 45 Main stratum occupied, and (right) feeding guilds for avian species present in Quarry Branch Corridor

6.3.6 Vineyard Creek Corridor

Like Quarry Branch, the Vineyard Creek Corridor is a comparatively narrow strip of bushland within a stable residential catchment. Avifauna is dominated by medium and small species, most of which are sedentary. There are some seasonally migratory species present. The species present are fairly well distributed through the available habitat areas, reflecting the level of urbanisation, and are predominantly insectivores.

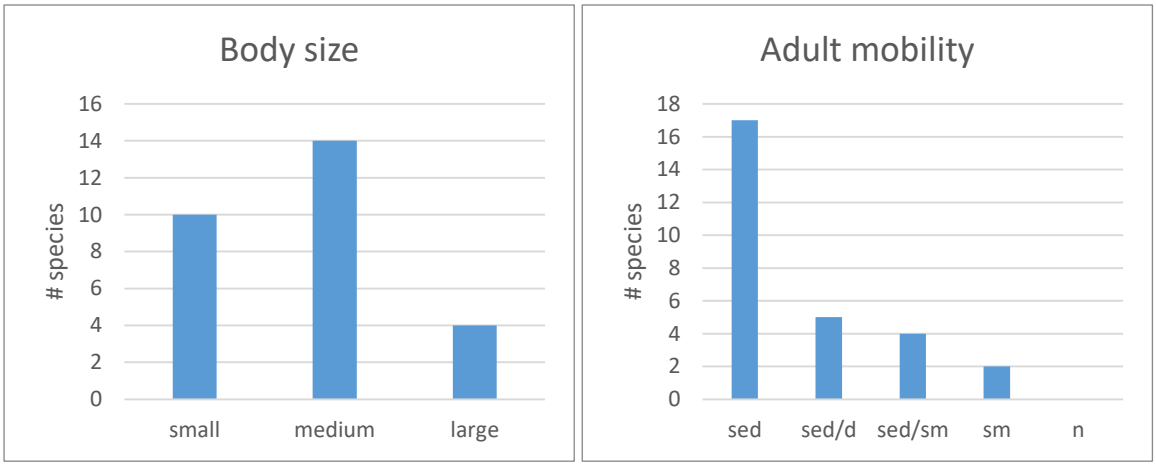

Figure 46 (left) Body size, and (right) adult mobility patterns for avian species present in Vineyard Creek Corridor

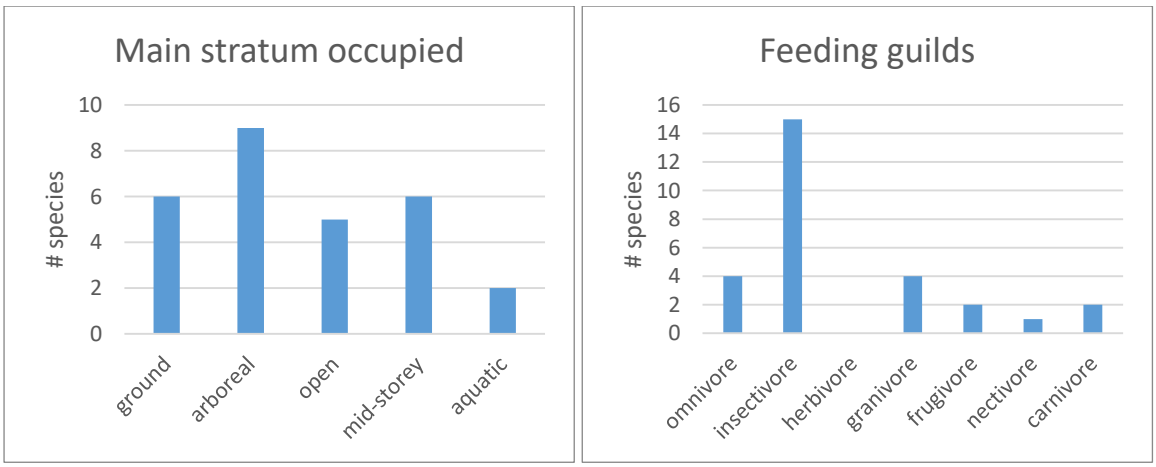

Figure 47 Main stratum occupied, and (right) feeding guilds for avian species present in Vineyard Creek Corridor

6.3.7 Upper Ponds Creek Corridor

Upper Ponds Creek Corridor has a large bushland reserve at the top of the catchment which is connected via a series of narrow reserves lining the path of the creek through a stable residential area. The suite of avian species present is dominated by small and medium sized species, most of which are sedentary, but also with a noteworthy number that are dispersive or seasonally migratory, allowing them to move to other areas during stress events. These tend to be generalist species, and will occupy open areas and ground space, along with mid-storey shrubs and canopy. Despite this, insectivores dominate the avifauna present.

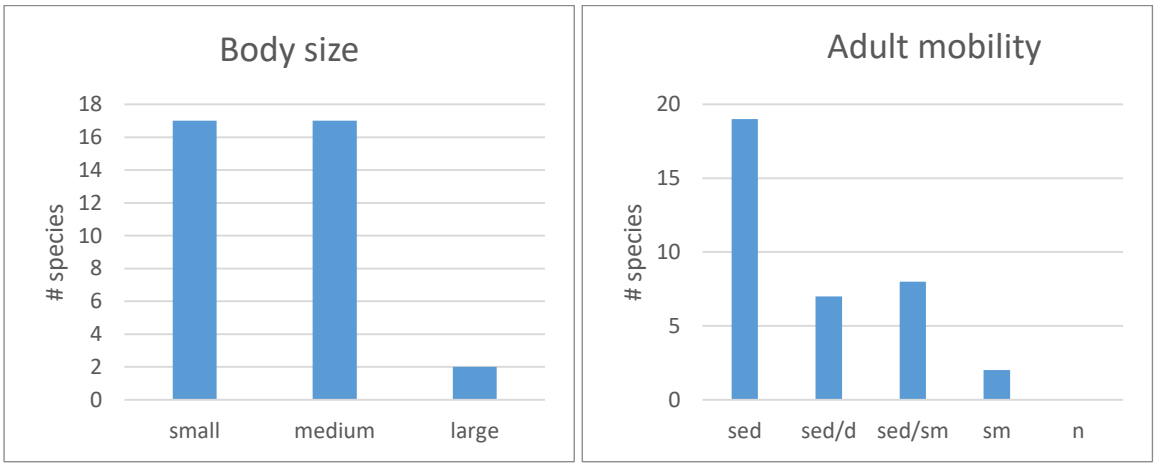

Figure 48 (left) Body size, and (right) adult mobility patterns for avian species present in Upper Ponds Creek Corridor

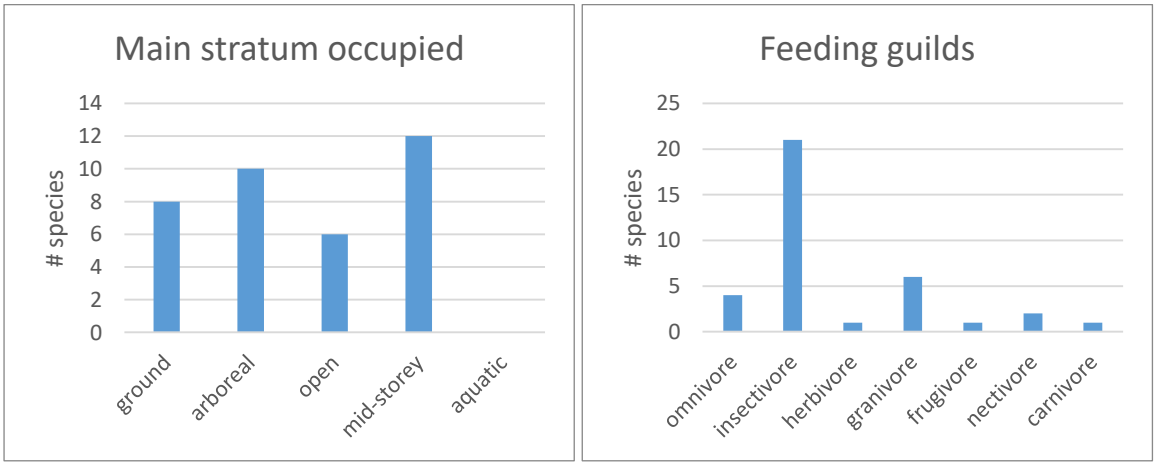

Figure 49 Main stratum occupied, and (right) feeding guilds for avian species present in Upper Ponds Creek Corridor

6.3.8 Lower Ponds – Subiaco Creek Corridor

Lower Ponds – Subiaco Creek Corridor is similar to many other bushland reserve corridors in Parramatta LGA, with a series of narrow reserves along a highly urbanised drainage line. This is reflected in the avifauna present, with medium sized species dominant, and all species sedentary or locally dispersive or migratory. Species that use open ground dominated, and were predominantly insectivores and granivores. The more vulnerable small bird species were largely absent, most probably because of the lack of suitable refuges, and larger species also absent due to the limited resources available for them.

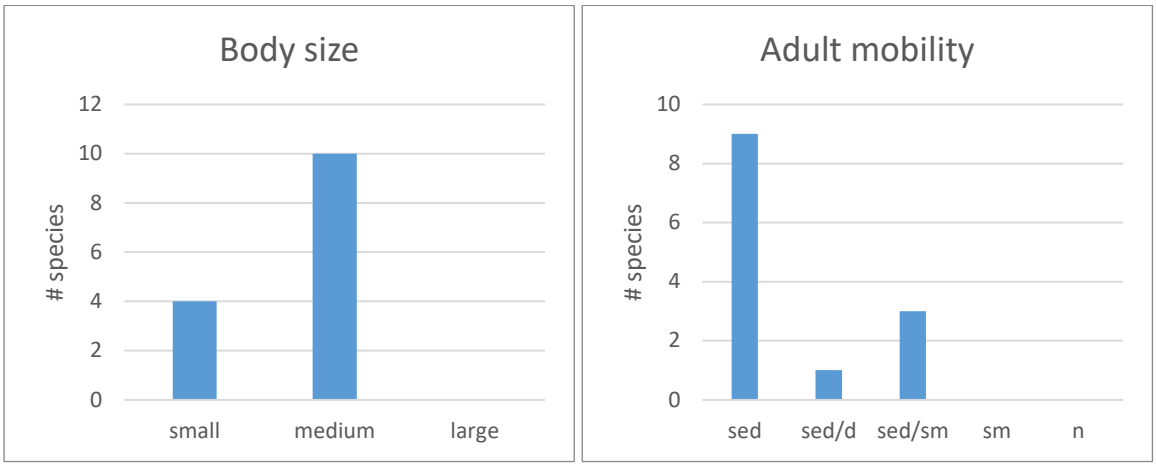

Figure 50 (left) Body size, and (right) adult mobility patterns for avian species present in Lower Ponds – Subiaco Creek Corridor

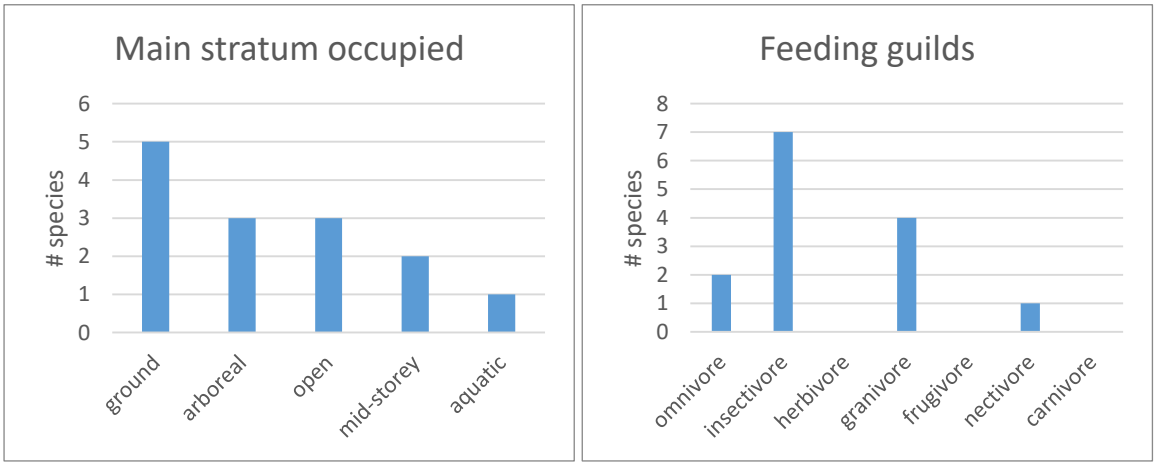

Figure 51 Main stratum occupied, and (right) feeding guilds for avian species present in Lower Ponds – Subiaco Creek Corridor

6.3.9 Upper Toongabbie Creek Corridor

Unlike Upper Ponds Creek, the Upper Toongabbie Creek Corridor lacks the large bushland reserve at the top of the catchment. The avifauna present is dominated by medium sized species, and these are predominantly sedentary, although some nomadic or seasonally migratory species were present. Many of the avian species are generalists, occupying ground, mid-storey and canopy areas in roughly equal proportions. Like other sites, insectivores were the most common feeding guild present, with granivores also notable.

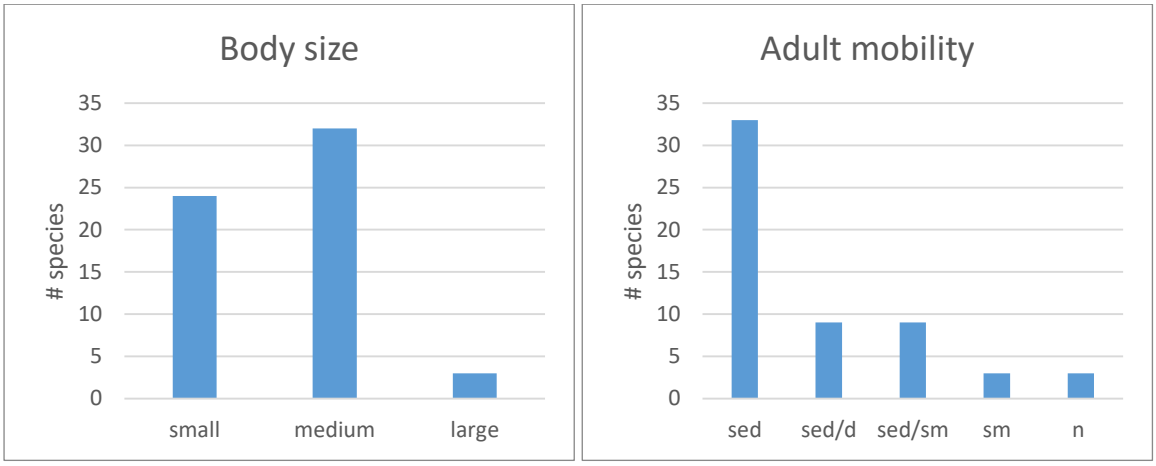

Figure 52 (left) Body size, and (right) adult mobility patterns for avian species present in Upper Toongabbie Creek Corridor

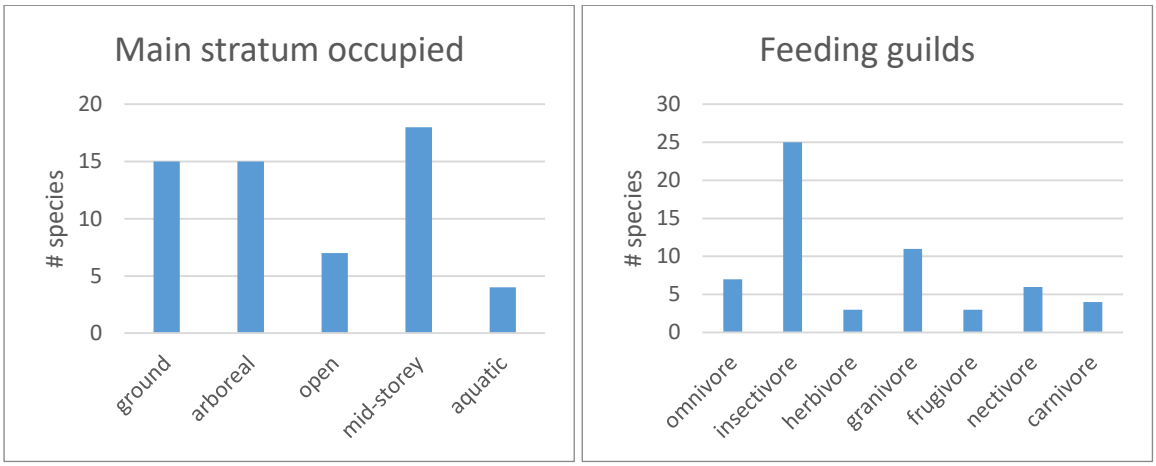

Figure 53 Main stratum occupied, and (right) feeding guilds for avian species present in Upper Toongabbie Creek Corridor

6.3.10 Lower Toongabbie Creek Corridor

Unlike Upper Toongabbie Creek, the Lower Toongabbie Creek Corridor has several larger bushland reserves in the catchment. The effects of urbanisation are still evident with the avifauna dominated by medium sized species, and these are predominantly sedentary, although some dispersive or seasonally migratory species were also present. Many of the avian species are generalists, occupying ground, mid-storey and canopy areas in roughly equal proportions. Like other sites, insectivores were the most common feeding guild present, with granivores also notably present.

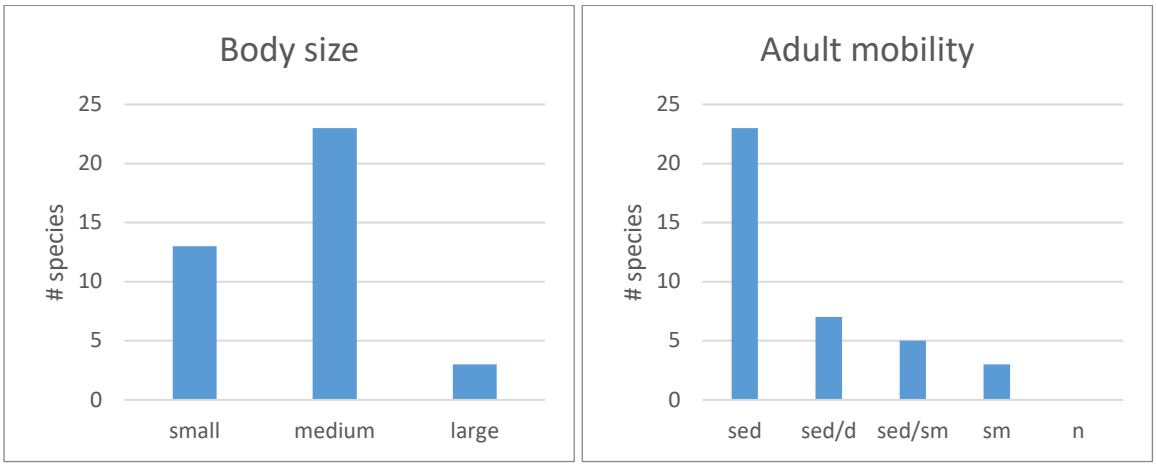

Figure 54 (left) Body size, and (right) adult mobility patterns for avian species present in Lower Toongabbie Creek Corridor

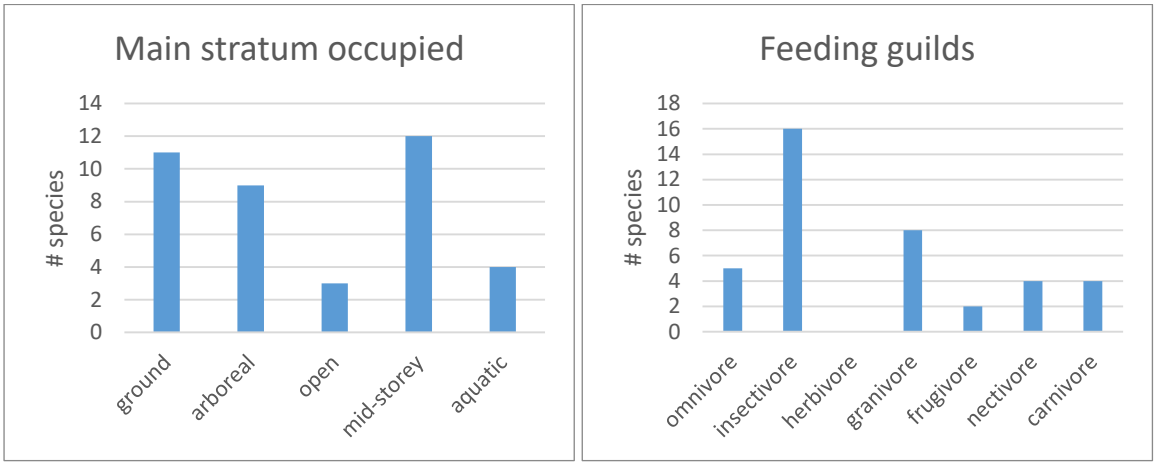

Figure 55 Main stratum occupied, and (right) feeding guilds for avian species present in Lower Toongabbie Creek Corridor

6.3.11 Baludarri Wetland

Baludarri Wetland comprises a small reserve on the edge of Parramatta River. The reserve includes areas of freshwater and moderately saline wetland and saltmarsh. Avifauna is dominated by medium sized birds and to a lesser degree by small species. Most species are sedentary, but there is a notable presence of seasonally migratory species. Despite the presence of wetland habitats, most species are canopy and mid-storey specialists. Insectivores are common, but not as dominant as in other reserve corridors.

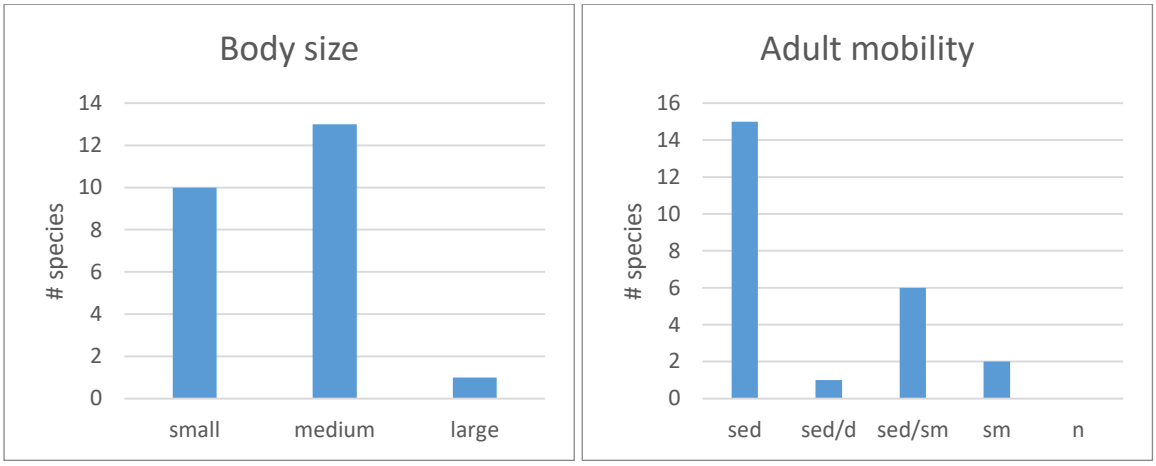

Figure 56 (left) Body size, and (right) adult mobility patterns for avian species present in Baludarri Wetland

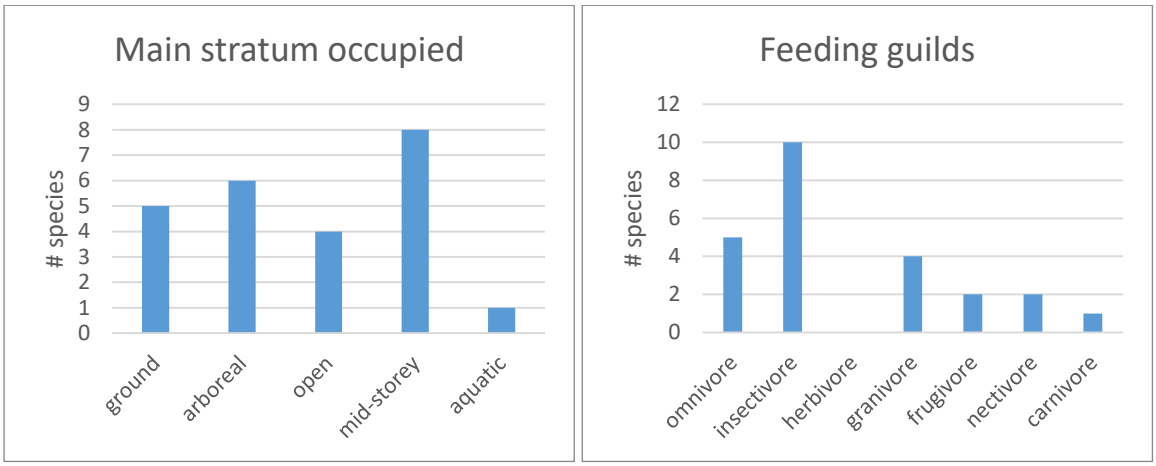

Figure 57 Main stratum occupied, and (right) feeding guilds for avian species present in Baludarri Wetland

6.3.12 Ermington Bay

Ermington Bay includes a largely open reserve bordered by mangroves, and mudflats stretching to a small shallow island. The avifauna is dominated by medium sized species, and a proportionally greater number of large species. Sedentary species are most common but seasonally migratory species are also well represented. Many of the species present are aquatic, while ground foragers and arboreal species are also among the most common. Most of the species present are insectivores, although other feeding guilds are also fairly well represented.

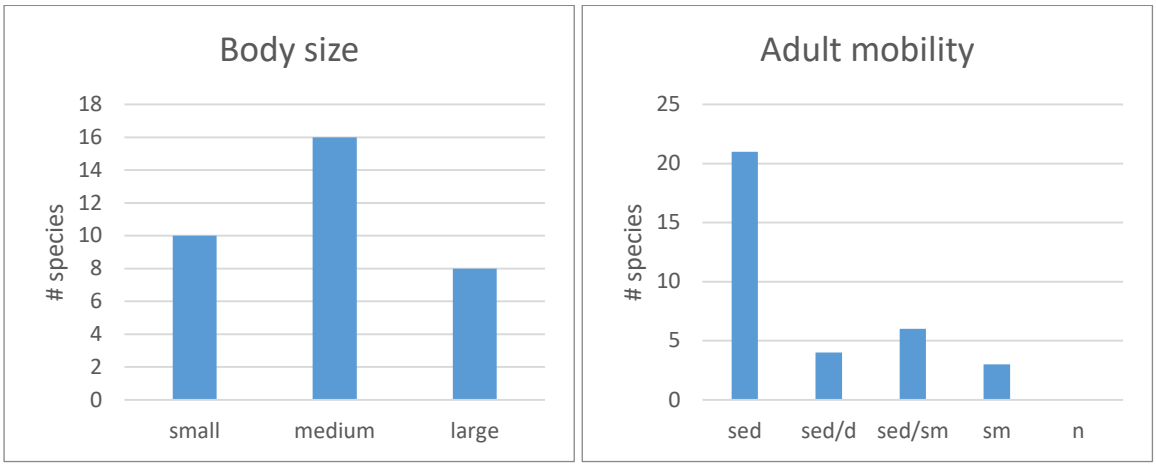

Figure 58 (left) Body size, and (right) adult mobility patterns for avian species present in Ermington Bay

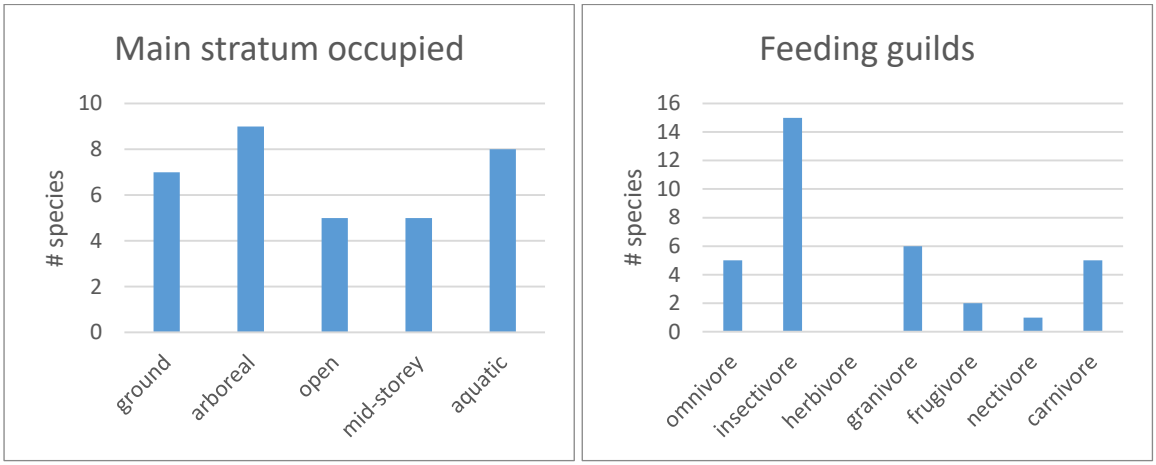

Figure 59 Main stratum occupied, and (right) feeding guilds for avian species present in Ermington Bay

6.3.13 Edna Hunt Sanctuary

Edna Hunt Sanctuary is a comparatively small and isolated reserve with remnant bushland surrounded by well established residential housing. This is reflected by the dominance of medium sized species, most of which are sedentary, with some moderately dispersive and nomadic species. Arboreal species are dominant, and are best able to avoid predation by domestic pets such as cats. Insectivores and granivores are dominant, but other feeding guilds are also well represented.

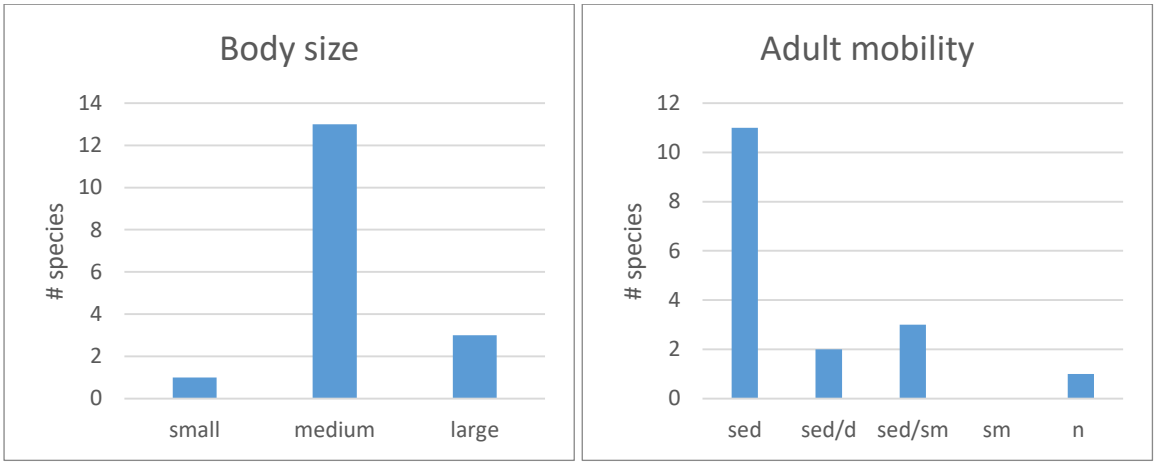

Figure 60 (left) Body size, and (right) adult mobility patterns for avian species present in Edna Hunt Sanctuary

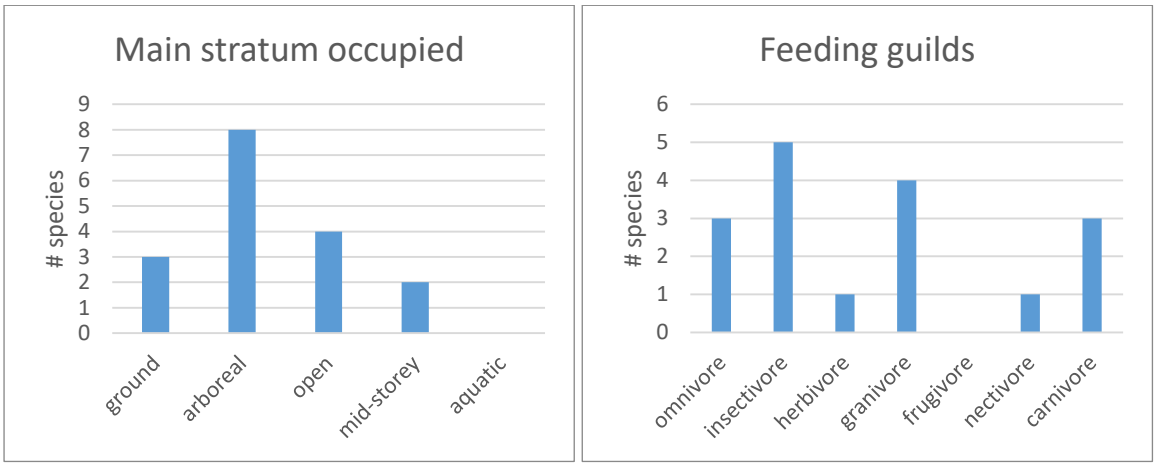

Figure 61 Main stratum occupied, and (right) feeding guilds for avian species present in Edna Hunt Sanctuary

6.3.14 Haines Reserve Corridor

Haines Reserve is split across two LGAs, with a small section in Parramatta, isolated by the M2 road corridor from the larger part of the reserve in The Hills Shire. The result is a small and highly impacted remnant of bushland dominated by medium sized and sedentary species. Large birds were absent, reflecting the lack of feeding resources for this group. Arboreal and open space dwellers were common. Insectivores were most common but most feeding guilds were represented in this reserve.

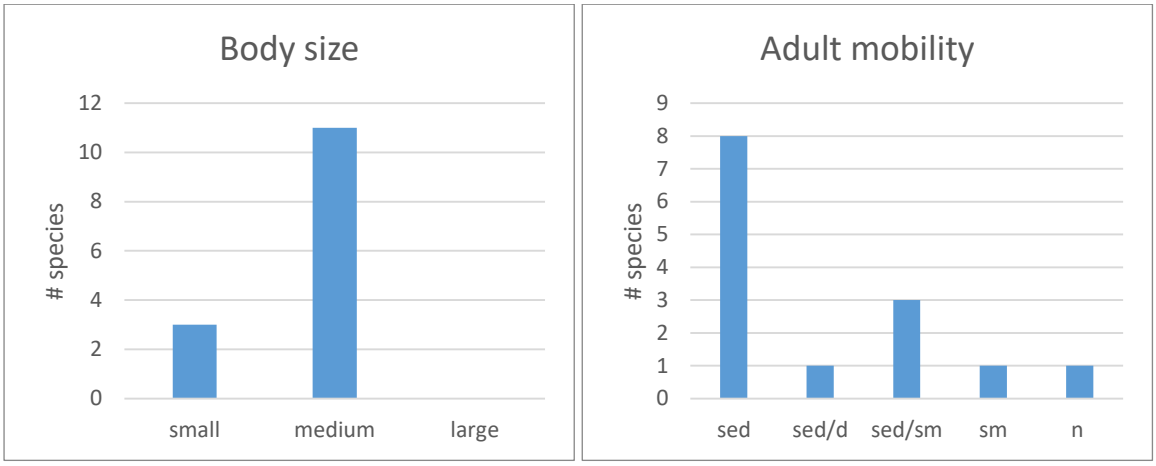

Figure 62 (left) Body size, and (right) adult mobility patterns for avian species present in Haines Reserve Corridor

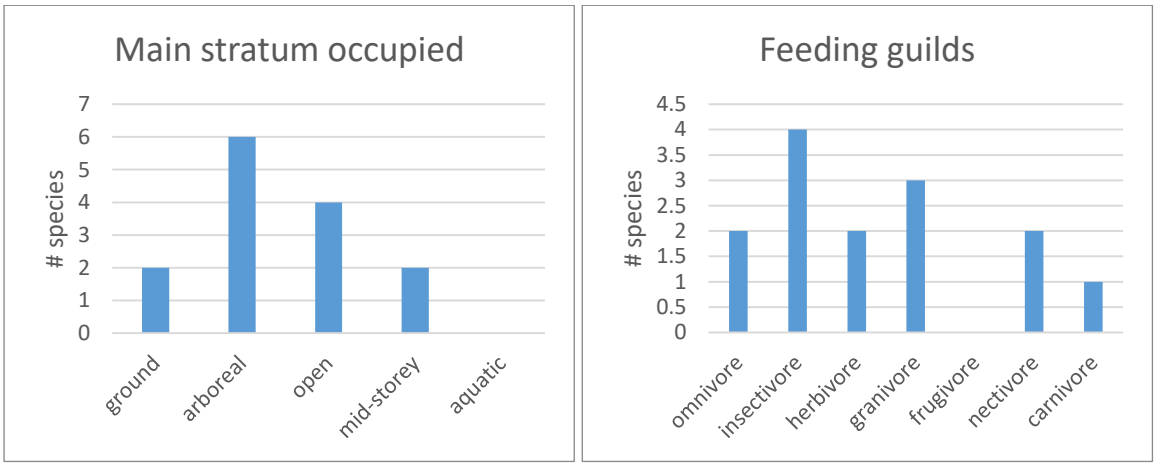

Figure 63 Main stratum occupied, and (right) feeding guilds for avian species present in Haines Reserve Corridor

6.4 SOME OVERALL TRENDS

6.4.1 Birds

There are strong trends of similarities in suites of avifauna present in each of the reserves/corridors surveyed (Table 12).

Table 12 Summary of the dominant characteristics for suites of avian fauna in each of the reserve corridors.

RESERVE/CREEK CORRIDOR	DOMINANT BODY SIZE	DOMINANT ADULT/LIFE MOBILITY	DOMINANT STRATUM OCCUPIED	DOMINANT FEEDING GUILD
Darling Mills Creek Corridor	Small	Sedentary	Mid-storey	Insectivore
Hunts Creek Corridor	1) Medium 2) Small	Sedentary	Mid-storey	Insectivore
Devlins Creek Corridor	Medium	Sedentary	1) Ground 2) Open	1) Insectivore 2) Omnivore
Terrys Creek Corridor	1) Small 2) Medium	1) Sedentary 2) Seasonal migratory	1) Arboreal 2) Mid-storey	Insectivore
Quarry Branch Creek Corridor	1) Small 2) Medium	1) Sedentary 2) Seasonal migratory	1) Arboreal 2) Mid-storey	Insectivore
Vineyard Creek Corridor	1) Small 2) Medium	Sedentary	Arboreal	Insectivore
Upper Ponds Creek Corridor	1) Small 2) Medium	Sedentary	1) Arboreal 2) Mid-storey	Insectivore
Lower Ponds – Subiaco Creek Corridor	Medium	Sedentary	Ground	1) Insectivore 2) Granivore
Upper Toongabbie Creek Corridor	1) Medium 2) Small	Sedentary	1) Mid-storey 2) Ground 3) Arboreal	1) Insectivore 2) Granivore
Lower Toongabbie Creek Corridor	Medium	Sedentary	1) Mid-storey 2) Ground 3) Arboreal	1) Insectivore 2) Granivore
Baludarri Wetland	1) Medium 2) Small	Sedentary	1) Mid-storey 2) Ground 3) Arboreal	1) Insectivore 2) Omnivore
Ermington Bay	Medium	Sedentary	1) Arboreal 2) Aquatic 3) Ground	Insectivore
Edna Hunt Sanctuary	Medium	Sedentary	Arboreal	1) Insectivore 2) Granivore 3) Omnivore
Haines Reserve Corridor	Medium	1) Sedentary 2) Seasonal migratory	Arboreal	1) Insectivore 2) Granivore

More than half of the reserves are dominated by medium sized species. Most of the avian species present are sedentary, with a few important exceptions. Some of the seasonally migratory species and their habitats are protected under state or federal legislation and/or international agreements. With few exceptions, the dominant stratum occupied by the bird species recorded in this study are the mid-storey shrub layer and the (arboreal) canopy. Ermington Bay provides important habitat for a range of aquatic species. Insectivores dominate the avifauna throughout, providing a valuable ecosystem service for local

residents. In some reserves, granivores and omnivores are also common, and tend to represent gregarious ground foraging species and common medium sized generalists.

Woodland birds actually live in a range of forests and woodlands. Small woodland birds are threatened by larger and more aggressive birds. Noisy miners and similar introduced birds, such as the Common or Indian Myna, Common Starling, and European Blackbird, chase other birds and exclude them from woodlands. As well, introduced Starlings and Indian Mynas compete with native birds for nest hollows. Degraded woodlands have few shrubs, regenerating trees or piles of dead wood. They have less cover for sheltering small birds from aggressive birds while they are feeding, or hiding nests from predators and cuckoos. Reserves where these habitat resources are abundant are important for their conservation.

6.4.2 How similar are avifauna groups across the reserves?

The strong trends of commonality among reserves/corridors noted in the previous section suggest that many of the reserve groups have similar suites of avian species present. These were compared using standardised abundance for each species (Figure 64). As a baseline, there was 40% similarity in avifauna across the reserves. Two clear groups emerged with 60% similarity, and a third set of reserves really had little similarity with any other reserves beyond about 50%. Therefore, while there is considerable similarity in avifauna present in each reserve, many of them also provide important habitat opportunities for poorly represented species. Species present in multiple reserves are more likely to have locally and even regionally sustainable populations, provided they have opportunities for connectivity between the reserves.

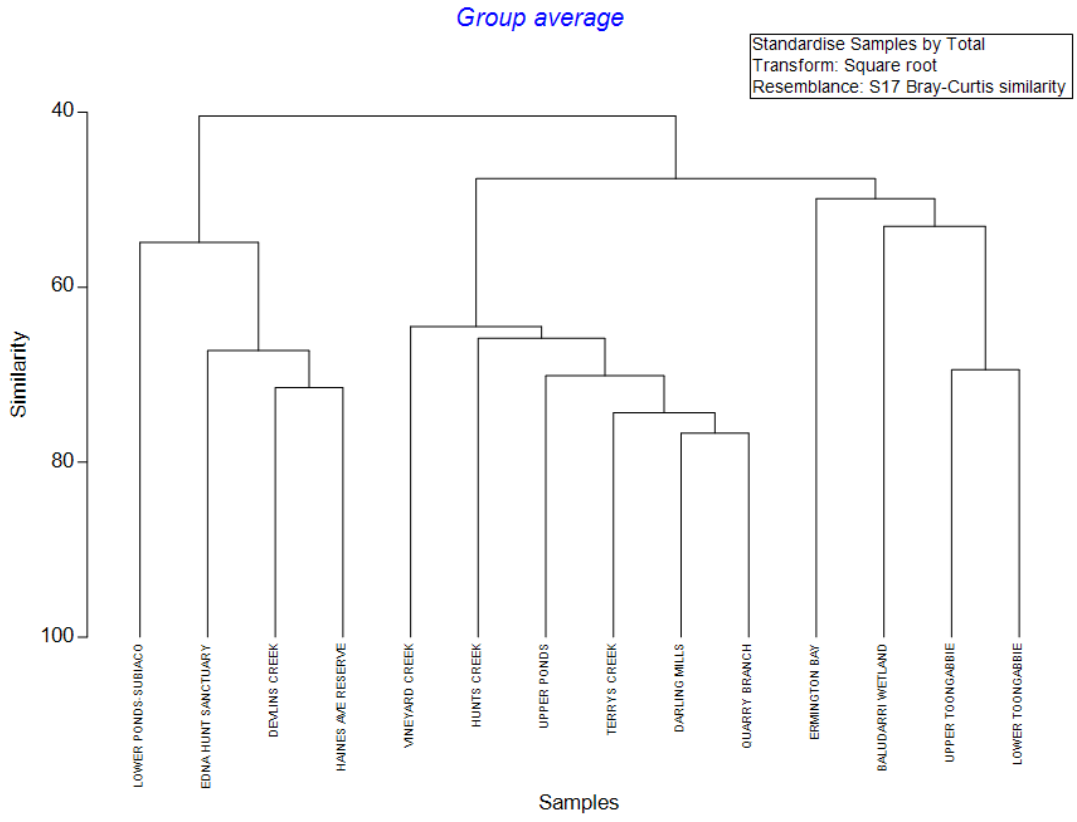

Figure 64 Dendrogram representation of Bray-Curtis similarities for suites of avian species recorded at each reserve

Reserve size has been strongly indicated as being important for biodiversity – larger reserves tend to support a more diverse suite of species. As well, reserves with more intact vegetation can also support a more diverse suite of species. Reserves were categorised as large: >50 hectares, medium 10-50 hectares, and small <10 hectares. Devlins Creek Corridor consists of two separate reserves, both of which are less than 10 ha, and so it was included in the small reserve category.

Multi-Dimensional Scaling, or MDS ordination can be used to provide a clear visual representation of the similarity between native avifauna at a given reserve group and all other reserve groups. These can be compared based on species richness (Figure 65) or abundance of animals (Figure 66).

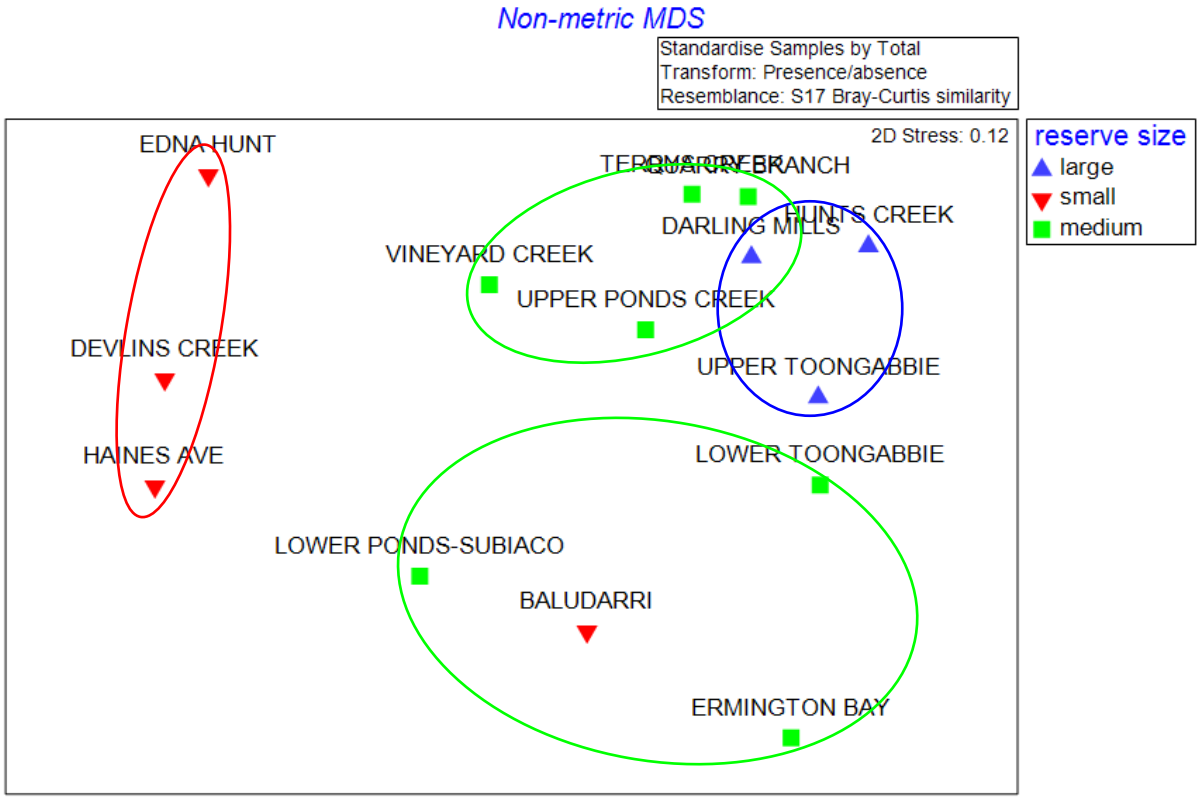

Figure 65 Multi-dimensional scaling plots of Bray-Curtis similarities for avian species richness in bushland reserves

Large reserves supported reasonably similar extensive suites of avifauna, shown by the loose cluster of blue triangles in Figure 65. Medium sized reserves split into two groups, roughly separated by the condition of bushland. A more tightly clustered group of reserves, shown by green squares, includes medium sized reserves with better quality bushland, while the lower catchment reserves are very loosely grouped. As more species are lost due firstly to decreasing reserve size, and then to decreasing bushland quality, the remaining suites of species present become more dissimilar. Species that persist in these reserves are often utilising specific resources, such as the mud flats at Ermington Bay. Small reserves generally formed a loose cluster, suggesting the suites of avifauna present are approaching the limited set of medium sized generalists that exhibit gregarious or aggressive behaviours to ensure their safety and access to food and habitat resources.

The previous analysis used species richness as presence-absence data. Looking more closely at the available data, the analysis was repeated using abundance data for native avian species (Figure 66). There was some difference in survey effort for each of the reserves/corridors, however, this was at least in part a reflection of the difference in reserve sizes. To adjust for this, the abundance data was first normalised, and then square-root transformed. This reduces the potential dominance of under-represented species, without compromising the role of the more common species. All of the trends reported from the previous analysis were more pronounced when abundance data was included with species richness.

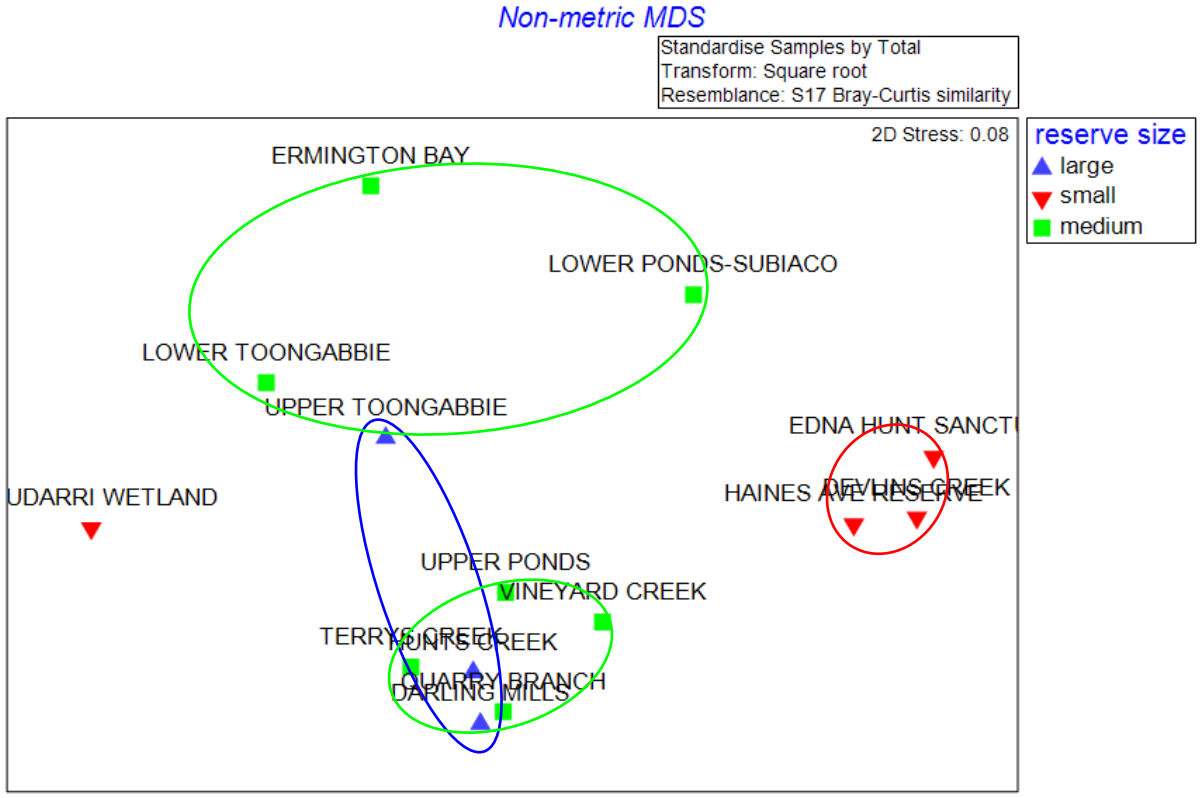

Figure 66 Multi-dimensional scaling plots of Bray-Curtis similarities for avian species abundance in bushland reserves

While this highlights the role of large reserves in conservation of avian biodiversity, it also demonstrates the role of medium sized and small reserves, as each of these contribute to the overall habitat resources available for avifauna in Parramatta LGA.

6.4.3 All other vertebrates

Avifauna dominated the biodiversity in bushland reserves around Parramatta LGA, with 97 species recorded. Other vertebrate species recorded totalled 51 species, and also form a significant component of the biodiversity of the LGA. Multi-dimensional scaling was used to perform a similar analysis for other vertebrate fauna, focusing on presence-absence data because of the way some of these faunal groups are sampled. For example, microbats were recorded using echolocation calls for identification. These provide a useful indication of microbat activity levels, but do not give a good representation of actual numbers of animals present. In a similar manner, frog calls can under or over represent the actual population because only the males can be heard calling.

More of the full range of vertebrate fauna was recorded in each of the large reserve groups, resulting in a tightly clustered set of reserves (Figure 67; blue triangles). Again, as the reserves got smaller, and the quality of bushland was reduced, more species were lost from this full suite of species, and the medium sized reserves were less tightly clustered (green squares) and some became quite separated from the rest. And finally for the small reserves (red triangles) the trend continued until the remaining vertebrate fauna comprised a more generalised set of species, many of which are introduced or even feral pest animals.

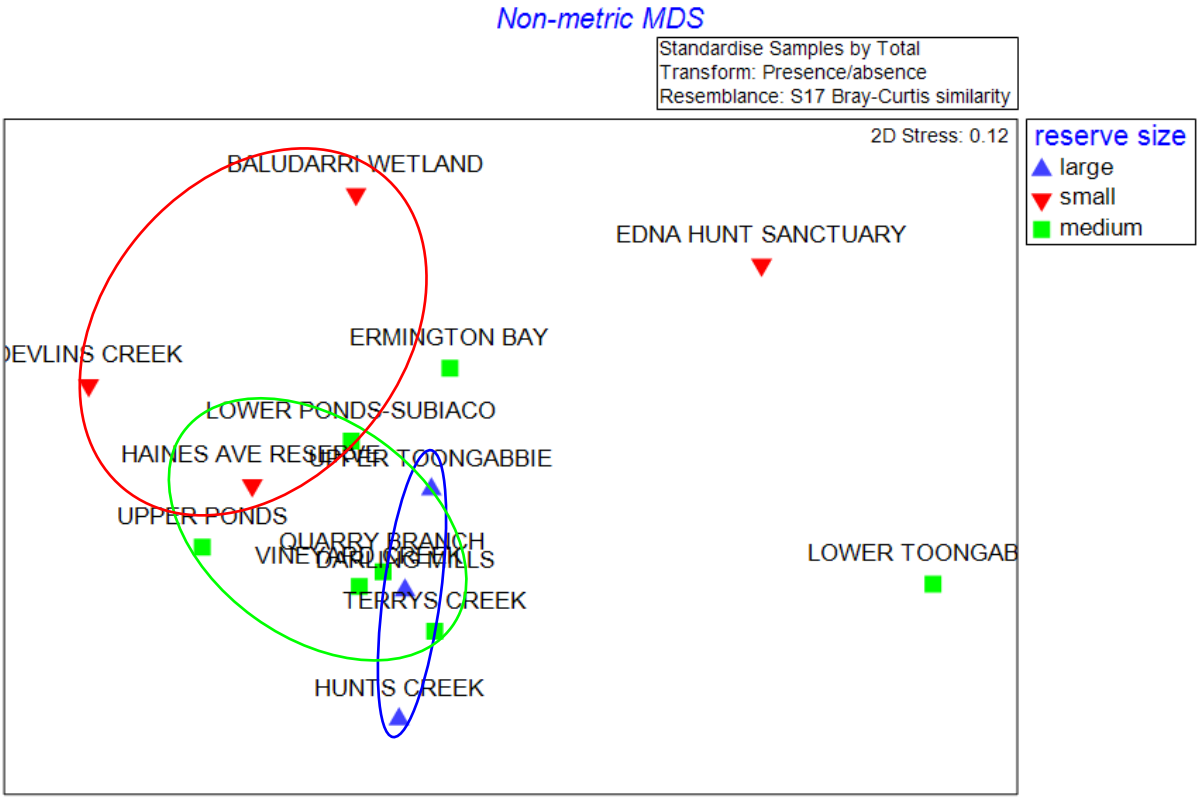

Figure 67 Multi-dimensional scaling plots of Bray-Curtis similarities for other vertebrate species richness in bushland reserves

6.5 THREATENED AND MIGRATORY SPECIES

Threatened species can be protected under the NSW Threatened Species Conservation Act 1995 and/or the federal Environmental Protection and Biodiversity Conservation Act 2000. Migratory species include birds and other animals protected under international agreements such as JAMBA, CAMBA, and RoKAMBA. One thing these species all have in common is the legislative obligation to protect the animals and their habitat using a "maintain or improve" approach.

Threatened species recorded included 3 birds, 6 species of microbats, one other mammal and one invertebrate (Table 14). An additional 4 species are listed under migratory bird agreements, and one threatened bird is also listed under a migratory bird agreement (Table 13). From this it is clear that the threatened fauna of Parramatta LGA is dominated by microbats, a group of fauna that are often misunderstood or simply not well known.

Table 13 Threatened and migratory bird species recorded in bushland reserves in Parramatta LGA during 2016-17 surveys

SPECIES	SCIENTIFIC NAME	NSW TSC STATUS	EPBC STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Powerful Owl	*Ninox strenua*	V			**Y**		**YX**	**Y**	**YX**							**Y**		5
Varied Sittella	*Daphoenositta chrysoptera*	V			**Y**													1
Black-faced Monarch	*Monarcha melanopsis*		M	**Y**	**Y**		**YXO**	**Y**				**Y**			**Y**			6
Great Egret	*Ardea modesta*		M		**Y**								**Y**		**Y**			3
Rufous Fantail	*Rhipidura rufifrons*		M	**Y**	**Y**		**YX**	**Y**	**YO**	**Y**			**Y**					7
White-bellied Sea-eagle	*Haliaeetus leucogaster*	V	M		**X**										**Y**			2
White-throated Needletail	*Hirundapus caudacutus*		M		**X**		**X**					**Y**						3

Table 14 Threatened mammal and invertbrate species recorded in bushland reserves in Parramatta LGA during 2016-17 surveys

SPECIES	SCIENTIFIC NAME	NSW TSC STATUS	EPBC STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V		Y							Y		Y					3
East-coast Free-tailed Bat	*Mormopterus norfolkensis*	V		Y			Y	Y										3
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*	V					Y	Y						Y	Y		Y	5
Large-footed Myotis	*Myotis macropus*	V		Y	Y		Y	Y	Y		Y	Y	Y		Y			9
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V						Y			Y	Y						3
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	V		Y	Y	Y		Y	Y	Y			Y			Y		8
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	13
Dural Land Snail	*Pommerhelix duralensis*	E	E		Y			Y										2

6.6 COMPARISON WITH PREVIOUS SURVEYS

Fourteen bushland corridors or reserves were surveyed in the current study. A number of these were recently included in Parramatta LGA following changes of boundaries, while a number of other reserves were lost from the LGA. Of the 14 reserves, 10 were surveyed wholly or in part during a comprehensive survey of fauna reserves completed in 2011-12. Six of these 10 reserves were also surveyed in a pilot survey of selected bushland reserves conducted in 2010-11. The earlier studies had a lesser survey effort than the current study, which involved concentrated surveys focussing on key bushland reserve corridors for the LGA. Increases in survey effort included more extensive microbat detection and use of trail cameras, and this has resulted in some key increases in species richness for microbats and other mammals. Another key factor affecting the observed changes in species richness for reserves include extending Lake Parramatta Reserve to include new (to the LGA) reserves in Hunts Creek Corridor, linking a series of reserves through a core bushland corridor with Lake Parramatta. The result is the largest contiguous bushland reserve in the LGA at 105 hectares, and this doesn't include significant areas of adjoining bushland in private ownership.

The following figures show changes in species richness recorded over the three surveys in areas common to the three surveys only. Data includes all species – exotic and native.

For avian fauna, there was a fairly consistent increase in species richness recorded in the current study (Figure 68), with the exceptions of Quarry Branch and Lower Ponds – Subiaco Creeks. For Upper Toongabbie Creek and Hunts Creek corridors there was an increase in the number of reserves from those included in the 2010-11 survey, and this may have contributed to the marked increase in species richness reported for these sites. Another clear trend is the tendency for a lower species richness for most reserves reported from the 2011-12 survey. This may be an artefact of a weather event, or simply a reflection of the main aim of that project – to conduct snapshot surveys to underpin management of biodiversity in all of Parramatta's reserves.

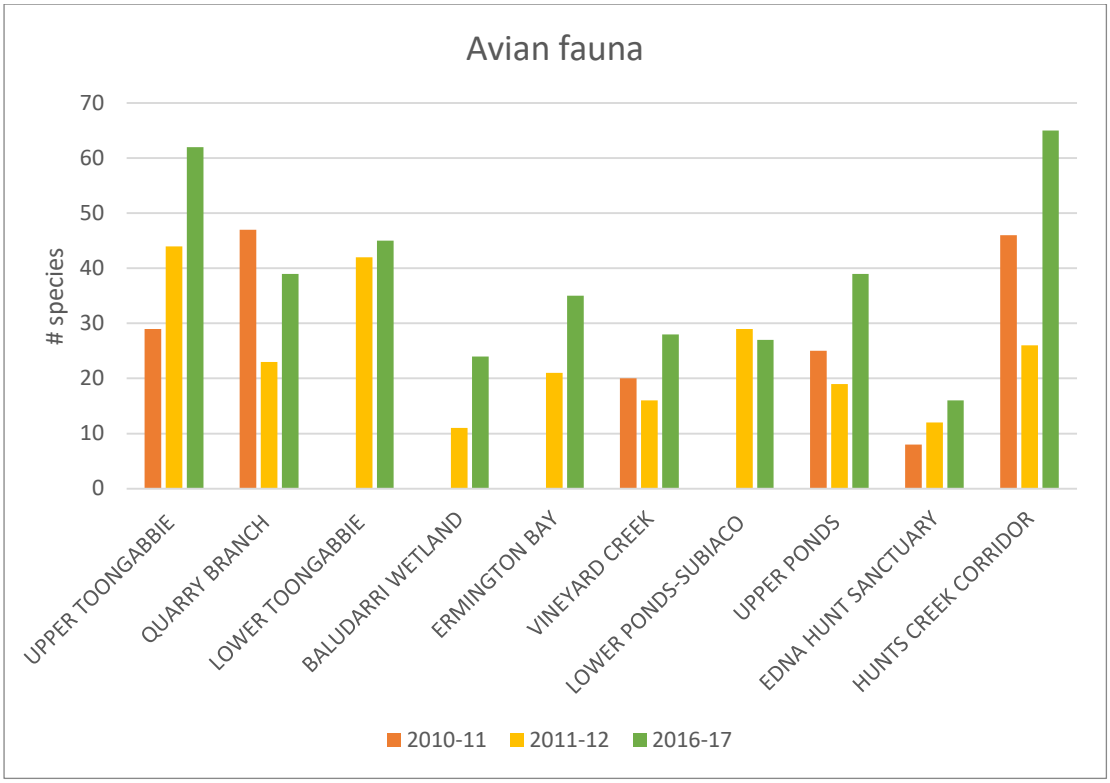

Figure 68 Comparison of species richness for avian fauna with previous studies

Greatest species richness recorded in the current study was in the Upper Toongabbie Creek and Hunts Creek corridors. Hunts Creek includes Lake Parramatta, an area identified in previous studies as a fauna hotspot for the LGA. Upper Toongabbie Creek has been noted in previous studies to support a diverse suite of avifauna, although this is surprising given the poor condition of much of the bushland, and the absence of large areas of core bushland habitat. This may simply be a result of the geology – Upper Toongabbie Creek has shale derived soils, unlike the rest of the LGA which is on sandstone. Shale soils are very fertile, and support the Cumberland Plain suite of vegetation communities. This vegetation provides better nutrition simply because it grows on more fertile soils, and so it can support a diverse suite of avifauna. Of particular note for this reserve corridor was the presence of a diverse suite of honeyeaters compared to that recorded elsewhere.

Trends in weather conditions during the current study would also be expected to have an influence of species richness. The survey commenced during spring and was projected to be finalised in March. The summer survey period included extended periods of very hot and dry weather, becoming almost tropical in late summer/early autumn with very hot weather and heavy rainfall events, with record rainfalls occurring in March. Overall, this was not typical weather for the area.

Some similar trends were noted for mammal fauna in the three studies (Figure 69). Overall, there was a much greater species richness reported from the current study – again this is most likely to be an artefact of the increased survey effort for microbat detection and camera trapping. For many of the reserves, there were at least 8 or 9 species of microbats recorded, so that this fauna group comprised the bulk of the mammal species recorded. This has contributed to the marked increase in mammal species richness observed in many of the smaller reserves, particularly those close to the Parramatta River. Mammal species richness was greatest in the Hunts Creek corridor, with more species present other than the microbat fauna. Many of the remnant mammal species in the area tend to be 'shy' and will hide in the dense understorey vegetation available in the core bushland of this reserve.

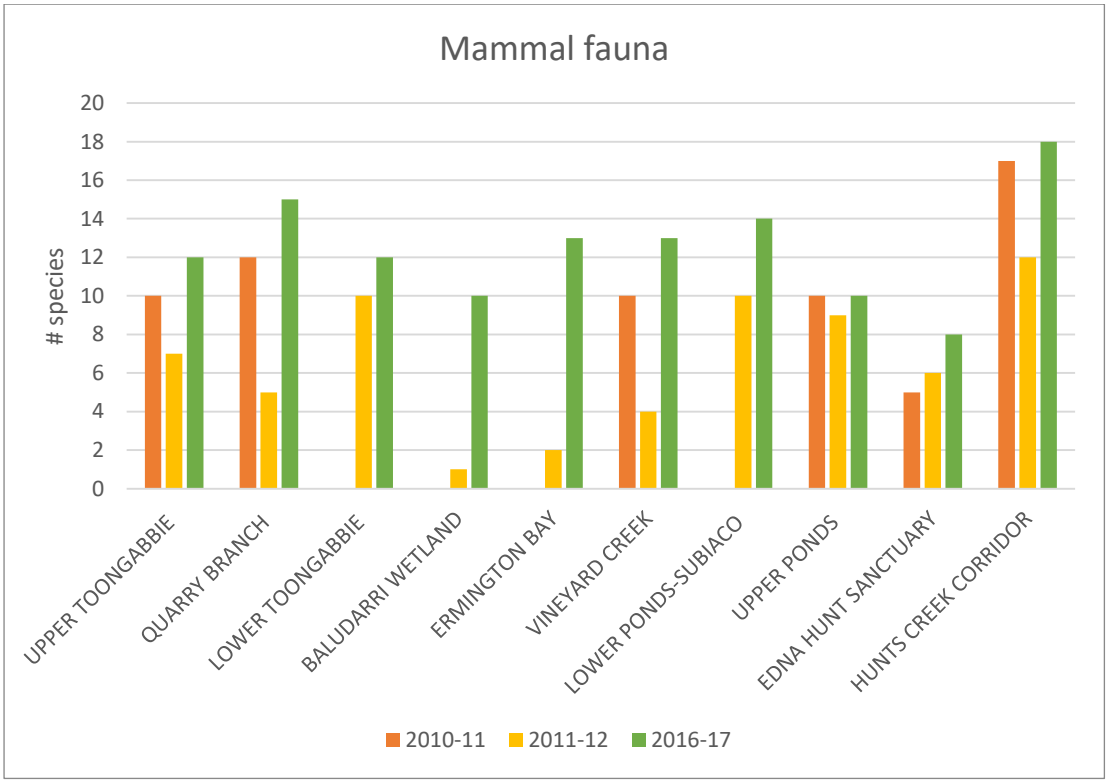

Figure 69 Comparison of species richness for mammal fauna with previous studies

Herpetofauna species richness had the same trend of increased species richness from the current study (Figure 70). In many cases, however, the increase was only fairly small compared with at least one of the previous surveys. For this faunal group, the most likely explanation is the increase in survey effort. Greatest diversity was noted from Hunts Creek, Quarry Branch and Vineyard Creek corridors. Quarry Branch and Vineyard Creek corridors incorporate some of the larger reserves in the LGA – other than the new reserves. As a result they have larger areas of core bushland habitat, and this is reflected in the greater diversity of both herpetofauna and mammal fauna from these reserves.

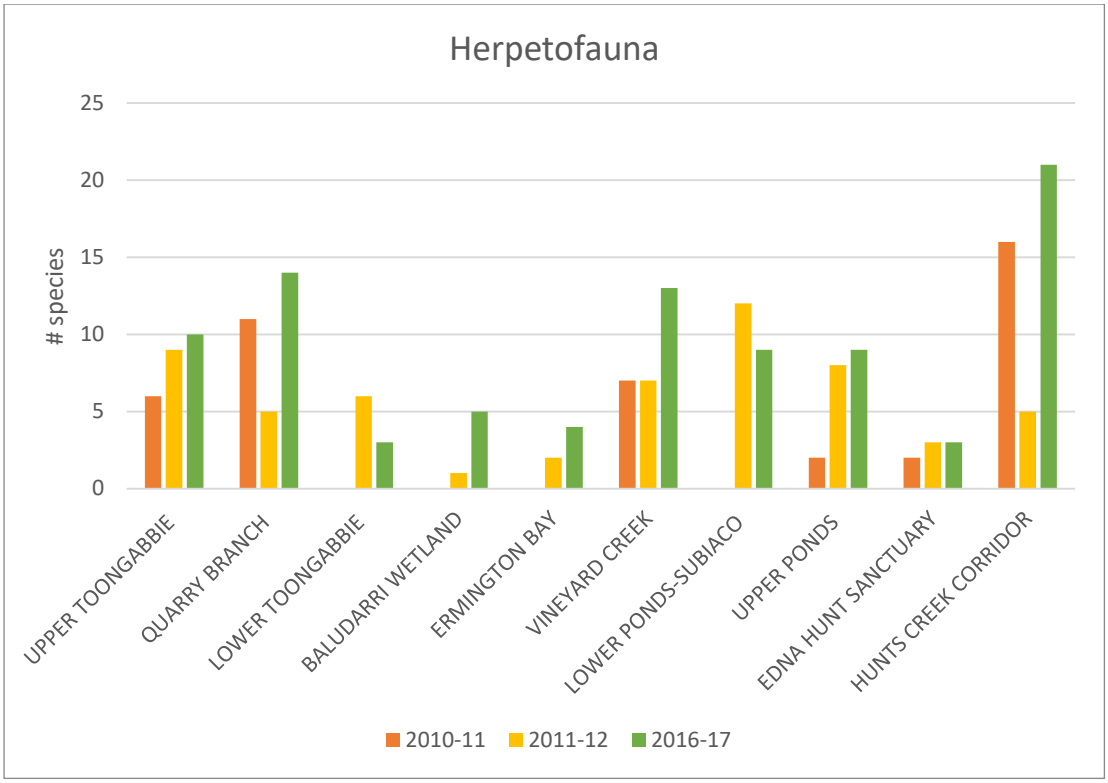

Figure 70 Comparison of species richness for herpetofauna with previous studies

A number of the new reserve areas now incorporated into the LGA provide additional large areas of core bushland habitat, in particular Hunts Creek additional reserves and the Darling Mills Creek corridor, but also the bushland reserves on the western side of Terry's Creek. Information about species richness in previous studies for these reserves was not available during this study.

6.7 MICROBATS OF PARRAMATTA BUSHLAND

As noted in previous sections, microbats comprise a significant proportion of the threatened species recorded in Parramatta LGA. As well, they are the dominant faunal group represented in the mammal fauna recorded for most of the reserves surveyed. As a faunal group, they tend to be poorly known, and often misunderstood. The following sections aim to address some of this shortfall in knowledge.

6.7.1 Identification using echolocation calls

Microbat call identification is a specialised process. Calls were forwarded to Marg Turton for analysis. Calls that are considered not clear enough for ID are not identified - this includes very short calls that consist of just a few pulses. Identifications are usually classes as "confident", "probable" or "possible". For this study, "possible" identifications were eliminated, and the few "probable" identifications were treated as "confident" since, in most cases, the same species was recorded elsewhere in the reserve or in another reserve nearby. *Nyctophilus* species, the Long-eared Bats, are not able to be differentiated by echolocation calls, and were reported as a species complex. A similar situation exists for the *Vespadelus* species, known as Forest Bats, which may sometimes be differentiated based on call characteristics, and other times calls deemed to be probable are grouped into another species complex.

Given the high number of calls recorded at each site, and often on each night, analysis was limited to identification of species present. In reality, the number of calls does not represent the number of bats present as a single bat may make numerous passes in front of the detector. The number of calls may give an indication of the level of microbat activity in the area – more calls can indicate the location is used more frequently by microbats. Call identification to this level can become very expensive, and may not add significantly to the overall project.

6.7.2 RESULTS OF SURVEYS

A total of 14 species of microbats were identified during the current study. Of these, 6 species are listed as Vulnerable under the NSW Threatened Species Conservation Act 1995. One genus of microbats cannot be identified to species using echolocation calls, and has been assumed to be a single species. An additional group of calls were also identified to genus, but two species of this genus were identified and it has been assumed that these calls belong to one of these species, rather than represent an additional species.

Table 15 Microbat species recorded, conservation status, and number of reserves where species were present

SPECIES NAME	COMMON NAME	TSC Act	# RESERVES
Austronomus australis	White-striped Free-tailed Bat		10
Chalinolobus gouldii	Gould's Wattled Bat		14
Chalinolobus morio	Chocolate Wattled Bat		3
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	3
Miniopterus orianae oceanensis	Eastern Bentwing Bat	V	5
Mormopterus norfolkensis	East-coast Free-tailed Bat	V	3
Mormopterus ridei	Ride's Free-tailed Bat		10
Myotis macropus	Large-footed Myotis	V	9
Nyctophilus species complex	Long-eared Bats		13
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	V	9
Scoteanax rueppellii	Greater Broad-nosed Bat	V	2
Scotorepens orion	Eastern Broad-nosed Bat		5
Vespadelus darlingtoni	Large Forest Bat		1
Vespadelus species complex	Forest Bats		5
Vespadelus vulturnus	Little Forest Bat		1

Gould's Wattled Bat (*Chalinolobus gouldii*) was the most commonly reported microbat species, and was recorded at all the 14 reserve groups surveyed. The *Nyctophilus* species were recorded at 13 reserves, and the White-striped Free-tailed Bat and Ride's Free-tailed Bat were each recorded at 10 reserve corridors. Two of the threatened species, the Large-footed Myotis and the Yellow-bellied Sheath-tailed Bat, were each recorded in 9 reserve corridors. For more information on these species see the profile descriptions elsewhere in this report.

Table 16 Distribution of microbat species within bushland reserve corridors (part 1)

SPECIES NAME	COMMON NAME	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR
Austronomus australis	White-striped Free-tailed Bat	y	y	y	y	y	y	
Chalinolobus gouldii	Gould's Wattled Bat	y	y	y	y	y	y	y
Chalinolobus morio	Chocolate Wattled Bat		y	p			y	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	y						
Miniopterus orianae oceanensis	Eastern Bentwing Bat				y	y		
Mormopterus norfolkensis	East-coast Free-tailed Bat	y			y	y		
Mormopterus ridei	Ride's Free-tailed Bat	y	y		y	y	y	
Myotis macropus	Large-footed Myotis	y	y		y	y	y	
Nyctophilus sp	a Long-eared Bat	y	y	y	y	y	y	y
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	y	y	y		y	y	y
Scoteanax rueppellii	Greater Broad-nosed Bat					y		
Scotorepens orion	Eastern Broad-nosed Bat	y	y		p		p	
Vespadelus darlingtoni	Large Forest Bat							
Vespadelus sp	a Forest Bat	y	y		p			
Vespadelus vulturnus	Little Forest Bat							
	TOTAL SPECIES	**10**	**9**	**5**	**9**	**9**	**8**	**3**

Nyctophilus species cannot be identified to species based on echolocation calls (Pennay et al, 2004). Four *Nyctophilus* species have been recognised in NSW, of which three have been reported from the Sydney Basin (NSW Wildlife Atlas, OEH, 2017). These are *N. corbeni* (Corben's Long-eared Bat), a threatened species, and the more common *N. geoffroyi* (Lesser Long-eared Bat) and *N. gouldi* (Gould's Long-eared Bat). Both *N. geoffroyi* and *N. gouldi* have been reported in the vicinity of the City of Parramatta LGA, with identification confirmed by trapping, making either of these the most likely species present.

Vespadelus species can also be difficult to identify to species from echolocation calls alone (Pennay et al, 2004). *Vespadelus darlingtoni* calls can have overlapping frequencies with *V. vulturnus* and a third species, *V. regulus*. As well, there is potential for confusion with *Miniopterus schreibersii oceanensis* in the Sydney Basin. By referring call analysis to a specialist, we have avoided this as much as possible.

Table 17 Distribution of microbat species within bushland reserve corridors (part 2)

SPECIES NAME	COMMON NAME	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE
Austronomus australis	White-striped Free-tailed Bat		y	y	y	y		
Chalinolobus gouldii	Gould's Wattled Bat	y	y	y	y	y	y	y
Chalinolobus morio	Chocolate Wattled Bat	y						p
Falsistrellus tasmaniensis	Eastern False Pipistrelle	y		y				
Miniopterus orianae oceanensis	Eastern Bentwing Bat				y	y		y
Mormopterus norfolkensis	East-coast Free-tailed Bat							
Mormopterus ridei	Ride's Free-tailed Bat	y	y	y	y	y	y	
Myotis macropus	Large-footed Myotis	y	y	y		y		
Nyctophilus sp	a Long-eared Bat	y	y	y		y	y	y
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat		y	y			y	
Scoteanax rueppellii	Greater Broad-nosed Bat	p	y					
Scotorepens orion	Eastern Broad-nosed Bat		y	y			y	
Vespadelus darlingtoni	Large Forest Bat		y					
Vespadelus sp	a Forest Bat	y			y	y		
Vespadelus vulturnus	Little Forest Bat			y				
	TOTAL SPECIES	**8**	**9**	**9**	**5**	**7**	**5**	**4**

In general, the larger bushland corridors had more species of microbat present . However, 8 or more species were recorded at more than half of the 14 reserve corridors, with the most species recorded in the Darling Mills Creek Corridor. Threatened microbat species were recorded in at least one reserve within each bushland corridor.

Did you know? A single microbat can catch 1,200 mosquitos and small insects in just 1 hour! (http://www.bats.org.au/about-bats/microbats.php)

7 DISCUSSION

Management of vegetation, control of weeds, along with control of feral animals, are important and ongoing issues for bushland management and for fauna management. These are the subject of extensive literature, and have been discussed in detail for each reserve in previous reports (see Applied Ecology 2011, 2012 and others). Feral animal control must be done on a holistic basis, in conjunction with adjoining council areas, and is currently the subject of a regional management plan being developed by the Greater Sydney Local Land Services. Impacts of elevated nutrients and poor water quality are also well studied, and management of water quality has become a key target for the Parramatta River Catchment Group, with the 'Our Living River' initiative to make the Parramatta River swimmable again by 2025.

Information about the main impacts for each of the threatened and regionally significant species has been provided with the species profile. The following sections of this Discussion aim to supplement this with a more in depth look at the current issues for management of key faunal groups in urban areas, and Parramatta LGA in particular. Information on management of Swamp Wallabies was prepared for a separate report written concurrently, and as a result of this study. Parts of this report have been included here.

7.1 FIRE IMPACTS AND MANAGEMENT

Fire-dependent ecosystems are defined as those in which species have evolved in the presence of fire. In fire-prone regions such as Australia, the frequency and intensity of wildfire may affect different components of the biota in different ways. In such ecosystems, large fires are a key influence on the creation and maintenance of landscape heterogeneity. Landscape heterogeneity is influenced by multiple components of the fire regime, although this is moderated by environmental variation, particularly topography (Roman-Cuesta et al. 2009). Fire intensity will vary within a fire boundary so that some patches of vegetation remain unburnt, some are burnt at low severity (understorey only is burnt), and others experience high severity fire (both understory and canopy are consumed). In forested landscapes, these patterns are modified by topography. Gullies and drainage lines are less likely to be severely burnt than slopes due to less flammable vegetation, protection from wind and higher moisture levels (Bradstock et al. 2010, Leonard et al. 2014, Berry et al. 2015a).

Ecological fire management in Australia is often built on an assumption that meeting the needs of plant species will automatically meet the needs of animal species. However, the scarcity of ecological data on the needs of fauna in relation to fire undermines the confidence managers should place in current popular frameworks for planning ecological burning. Such frameworks are built almost entirely around the goal of maintaining plant community diversity (Clarke, 2008). Most anthropogenic fire in Australia, however, is for the purpose of management of fuel levels. A key issue in addressing the potentially competing demands of fuel reduction and biodiversity conservation is the length of time over which

successional processes operate, compared with the short time-period over which changes in fuels or biota have often been documented (Haslem et al, 2011).

Fire impacts for fauna fall into two broad categories: surviving the actual fire, and surviving in the post fire landscape. Possible outcomes from encounters with fire include mortality, emigration, and survival within the burn site. Different faunal groups will tend to favour one or two of these, with the main response usually dictated by the degree of mobility for the animal. Survival post fire in a burnt landscape brings new challenges. Changes in the availability of vital resources for food and shelter may make an area uninhabitable for a period of time. Post fire recovery generally follows a successional pattern with a concurrent recovery in habitat resources, although the timeframe for this recovery is still poorly understood (Haslem et al, 2011). For some habitat resources, such as availability of hollows, recovery to a pre-fire level can take decades or even centuries.

7.1.1 Impacts on vegetation and habitat

Structurally complex forests and woodlands are important to provide a diverse array of habitats for a range of fauna. Frequent fire can simplify forest structure, particularly destroying tree hollows, log volume and vegetation complexity. These effects, however, are more pronounced on ridges and less pronounced in gullies. Trees in gullies are less likely to collapse following fire scarring, and extensively decomposing logs in gullies are largely unaffected by fire (Collins et al, 2012b). Crown fire will destroy hollows in stags (standing dead trees), but will contribute to the formation of hollows in trees with a healthy crown (Collins et al, 2012a).

While gullies are important refuges from fires for plants and animals, they are occasionally burnt, especially in catastrophic or ‘megafires’. In their unburnt state, gullies have significantly greater structural complexity than forest slopes. Both gullies and slopes recovered from severe fires along similar trajectories for the first few years (Bassett et al, 2017). More than two years after the fire, however, heterogeneity in structural complexity becomes more evident for gullies and slopes, both at site and landscape scale. Mechanisms that drive this include spatial variation in fire severity as well as differential responses by plant species to fire.

Despite the resultant creation of hollows following fire, hollow availability has been found to be greatest at sites burnt at very low frequency. Time since fire is the most important factor for maintaining the abundance of critical faunal habitat attributes (Croft et al, 2016). Tree and log hollows and fallen timber volume are markedly more abundant in long-unburnt vegetation. Time since fire (since the most recent fire) and inter-fire interval (frequency of fires) are also important factors for maintaining fauna habitat, although they affect this in different ways (Haslem et al, 2012). As time since fire increases, so does the probability of live and dead stems containing hollows. Live stems rarely begin to develop hollows less than 40 years post fire, while in dead stems this generally takes at least 50-60 years. Inter-fire interval has a greater influence on hollows in dead stems. Longer inter-fire intervals generally results in an increased density of dead hollow bearing stems. Longer inter-fire intervals also allows plant species to move from allocation of resources for regrowth to reproduction, with the resultant increase in fauna resources (Knox & Morrison, 2005).

In stark contrast to commonly held beliefs, fuel loads in open forests and woodlands unburnt for 100 or more years are low to moderate, with fire hazard levels that are remarkably similar to those in recently burnt sites, so the net planned result of hazard reduction is never really achieved. Rather, long-unburnt vegetation should be identified as a threatened asset in fire planning and management and should be protected and actively promoted (Croft et al, 2016).

7.1.2 Impacts for animals

The fauna of much of Australia has co-evolved with fire and has developed many mechanisms to survive fire and exploit fire. This has led to a belief that many fauna species are adapted to live with fire and the impact will always be beneficial (Clarke 2008). However, their habitats are becoming increasingly fragmented, resulting in reduced extent and quality. Fire regimes have also changed following European settlement. The successional stages of vegetation and the fire regime are important determinants of vegetation structure and composition and therefore composition of fauna species. In the absence of specific fauna information, wildlife managers often use the floristic response to fire as a surrogate for the response of fauna species, because vegetation structure and composition are important determinants of the value of a particular habitat to a given species of fauna (Hope 2012).

Landscape heterogeneity following large fires influences the distribution of animal species in several ways. There may be a direct effect through mortality of species during, or shortly after, a major fire. Indirect effects of fire on species distributions result from spatial variation in the fire regime. This leads to variation in the composition and structure of vegetation, which determines the availability of resources (shelter, refuge, foraging substrates) for species (Nimmo et al. 2014). Unburnt, or less severely burnt, vegetation may act as a refuge for fauna within large fires and have a strong influence on post-fire patterns of occurrence in the burnt landscape (Lindenmayer et al, 2013; Robinson et al. 2013).

If these refuges do serve as a source for recolonization and faunal recovery, then the occurrence of species in burnt sites is likely to be influenced by the proximity and amount of unburnt vegetation. In contrast, if post-fire recovery is driven primarily by in situ survival rather than dispersal and recolonization (Banks et al. 2011a), then context effects are less likely. The reality seems to be that many species use a combination of survival techniques, including avoidance and emigration, depending both on degree of mobility and the severity of the fire. Most faunal groups, however, have dominant survival strategies for the fire event, and in the post fire recovery period.

Arboreal mammals

Eucalypt forests in south-eastern Australia are among the most fire-prone forests in the world (Adams and Attiwill 2011), and arboreal mammals are particularly vulnerable to wildfire (Lindenmayer et al, 2013). Within the mosaic of burn intensities associated with large scale wildfire, fire severity is the strongest influence on abundance of arboreal mammals, even years after the fire (Chia et al, 2015). Reduced abundance immediately after

wildfire can occur as a result of injury or mortality, whereas animals often survive low intensity burns (Garvey et al, 2010), or escape to unburnt areas (Banks et al, 2011b).

In severely burnt areas, the occurrence of arboreal mammals, such as gliders and possums, is influenced by landscape context: abundance tends to increase with increasing amount of unburnt and understorey-only burnt forest within a 1 km radius (Chia et al, 2015). Loss of habitat such as tree hollows, reduced availability of food resources, and increased exposure to predation all have effects that are exacerbated with increasing intensity of fire. Recolonisation will occur from nearby areas over time as the burnt areas begin to recover.

In Parramatta's urban bushland, all of the reserves include a drainage line, and usually in a steep or moderately steep sided gully. This landscape should be viewed as an important refuge from fire for arboreal mammals. The abundance of arboreal mammals in forested gullies is typically higher than other parts of the forest, especially after wildfire (Berry et al, 2015b). The topographic location of gullies, their high moisture content and fire resistant vegetation reduce exposure to high severity fires, allowing them to maintain structural complexity, including trees with hollows (Collins et al. 2012).

Microbats

Fire impacts for microbats appear to be remarkably minor. Several studies have reported that bat activity in burnt areas is equivalent or higher than in unburnt areas (Boyles & Aubrey, 2006; Buchalski et al, 2013; Lacki et al, 2009). This is often attributed to the increase in prey availability or at least prey accessibility (Loeb & Wardrop, 2008). Another key factor is the change in vegetation structure, with reduced vegetation "clutter" following burning of the canopy and/or shrub layers. This allows for greater microbat activity, especially among the less manoeuvrable, faster flying "clutter intolerant" species (Inkster-Draper et al, 2013).

There is often a shift in microbat community composition, with an increase in the less manoeuvrable, faster flying species, and a decrease in activity for the highly manoeuvrable "clutter tolerant" species that are adapted to hunting within the canopy. These species are often smaller, and/or slower flyers, and more susceptible to predation in open spaces. Most of the smaller and more manoeuvrable species are forest bats, and these species may also be affected by loss of roosting habitat, such as small hollows, loose bark, cracks in tree trunks, which are commonly destroyed by bushfire.

Macropods

Swamp wallabies tend to be more common in larger inner urban bushland reserves, while kangaroos are more likely to be encountered in the much larger reserves found in the outer urban areas around Sydney. Kangaroos and wallabies have adapted for surviving bushfires, mostly through avoidance of fire fronts (Homan, 2012). For most macropods, frequent low-intensity prescribed burns simplify habitat complexity and can influence the abundance of populations through the effects on vegetation cover (Garvey et al, 2010). This begins with a sudden loss of vegetation, followed by a flush of new green growth that provides good pickings for macropods, at which point heavy grazing or browsing can have a marked effect on the rate of vegetation recovery following fire.

Survival of fire events by medium to large mammals is strongly affected by the intensity of the fire, the mobility of the species and their ability to find suitable refuge (Garvey et al, 2010). Swamp wallabies frequently take advantage of landscape refuges where fire is excluded or the impacts of fire are much less than other parts of the landscape, including creek lines and deep gullies. Animals with a high degree of mobility will frequently double back through the fire front and take refuge in areas already burnt, a behaviour documented in swamp wallabies (Newsome et al, 1975), tammar wallabies and woylies (Christensen, 1980). This behaviour is common among macropods, but may have an impact on post fire survival, whereas fire avoidance in a landscape refuge uses less energy and has less risks.

After fire, tammar wallabies, woylies, quokkas and brush wallabies increase their use of burnt area edges, where they benefit from new growth post fire, and from nearby refuges in the adjoining unburnt areas (Christensen 1980). There is, however, a strong tendency for animals to return to their post fire distribution as soon as the area can provide the required resources (Garvey et al, 2010). For macropods in Parramatta bushland reserves, the main portion of each reserve is the kind of habitat that would act as refugial habitat in a larger forested landscape. Burning these reserves amounts to burning key landscape refuge areas, and doing this is a manner where crossing the fire front and doubling back to previously burnt areas is either impractical or results in an increased exposure to predators. For swamp wallabies, while they are adapted to surviving bushfires, the availability of fire refuges is strictly limited in their urban bushland reserves, and they would be best suited if fire was excluded, or limited to very small, low intensity, mosaic burns.

Small mammals

Refuges have three main functions in relation to fire. They enhance immediate survival during a fire event, facilitate the persistence of individuals and populations after fire, and assist in the re-establishment of populations in the longer term. Refuges may be of natural or anthropogenic origin, and can be created through deterministic or stochastic processes. Specific attributes that determine refuge value include within-patch characteristics including vegetation structure and composition, patch scale attributes relating to size and shape, and landscape context and spatial arrangement in relation to fire patterns and land use (Robinson et al, 2013).

Within-patch refuges are of particular importance for smaller vertebrates, including small mammals, mainly because of their reduced levels of mobility. These can include rock crevices, decomposing logs, underground hollows, wet areas and open water, areas of dense vegetation and areas of non-combustible vegetation. These typically occur in or contribute to unburnt patches within the fire boundary (Robinson et al, 2014).

Fire and herbivory can interact synergistically to affect forest understorey vegetation, especially post fire. In areas with higher levels of herbivory the rate of recovery for palatable plants is much slower. A higher rate of herbivory by large mammals, such as macropods, tends to discourage smaller mammals, such as *Antechinus* sp, that rely on a level of cover from vegetation (Foster et al, 2016). Rabbits are also more active in burnt areas, and can contribute to slower rates of vegetation recovery post fire.

Many smaller vertebrates also maintain a fairly stable core home range post fire. Bandicoots have been observed in similar areas before and after fire, but with a shift to non combustible refuge sites for nesting after fire (Hope, 2012). Differences in site fidelity, habitat use and intraspecific competition between species are likely factors influencing responses to refugia. For example, agile antechinus abundance will increase in gullies immediately post-fire, consistent with a shift of individuals from burnt parts of the landscape (Swan et al, 2016). In contrast, fire has little effect on bush rat abundance in gullies, evidencing their use of passive refugia.

Fire severity is often the most significant impact associated with fire regimes for small mammals, but it affects different species in different ways (Chia et al, 2015). The way unburnt patches function as faunal refugia and the subsequent influence they have on post-fire population dynamics depends on the life history attributes of individual species. Small mammal species closely associated with direct measures of habitat structure are those most strongly influenced by fire regimes (Kelly et al, 2017).

Woodland birds

Two main factors contribute to persistence of avian species in forests. For frugivores, insectivores and canopy feeders the time since the last fire is a strong determinant of species richness, while environmental heterogeneity in the surrounding landscape contributes to increased species richness in long unburnt landscapes (>10 years since fire; Burgess & Maron, 2015).

Woodland patches with greater than 20 years time since fire typically harbour 20-40% more avian species than more recently burnt areas. Bird abundance is also greater in long unburnt areas, with up to 50% more individuals present, and generally at least 20% less individuals in sites with less than 3 years time since fire (Robinson et al, 2014). Overall, unburnt and ground-burnt patches of short time-since-fire provided habitat for more species and have different assemblages to that of severely burnt sites. Under similar conditions of fire severity and fire history, gullies maintain greater species richness and abundance than slopes, along with a distinct bird assemblage (Robinson et al, 2016).

This highlights the need to retain patches of unburnt vegetation within the fire boundary for prescribed burns, even for more mobile species such as larger and smaller woodland birds. Overall, bird diversity within a patch can increase following an appropriately patchy prescribed fire. In a recent before-after control-impact study in the Otway Ranges, Victoria, Sitters et al (2015) found that for prescribed burns where around half of the site remains unburnt, and these are well dispersed throughout the site, there was no apparent difference between bird diversity before and after the burn. This highlights the importance of formally incorporating patchiness into prescribed burning for the ecologically sensitive management of contemporary urban landscapes.

Woodland birds include larger species such as the Sooty Owl and Powerful Owl, both of which are highly territorial and predominantly sedentary, and typically rare in the landscape. The Sooty Owl is closely associated with old growth forests, while the Powerful Owl has become adapted to life in urban bushland remnants (Bilney, 2009). Both species are

affected by fire in similar ways, although how owls respond to fire is largely unknown. Main impacts are loss of nesting and roosting hollows, loss of food resources because of impacts on small mammals, and potential mortality during the fire. Too frequent fire also has secondary impacts from simplification of habitat and subsequent loss of abundance for small mammals.

Reptiles and frogs

Like most other faunal groups, many reptiles are most likely to persist in areas that have a lower percentage of surrounding area burnt in bushfires. This trend was noted for habitat generalist snake species and habitat specialists (McDonald et al, 2012), and indicates that the availability of refuges to survive the fire is more important for this group of animals. Small vertebrates that utilise more open habitats, such as the small skink *Lampropholis delicata*, tend to be more active in burnt areas. Many snakes are also more active, probably because their prey is more exposed (Foster et al, 2016).

Unlike mammals, reptiles do not show predictable responses to fire (Lindenmayer et al, 2008). Nor can the responses of individual species be readily predicted from life history attributes. A possible explanation for this might be the rapidity of post-fire recovery of many components of native vegetation cover that were found to be important for reptiles. Most reptile species responses to fire are much more strongly linked to vegetation type than fire variables. Practical management of fire in Parramatta's bushland reserves should involve setting objectives to meet conservation goals for individual species of reptiles.

Many studies have shown that frogs are resilient to fire, based on high post-fire count data (Keyser et al. 2004; Greenburg & Waldrop 2008; Engbrecht & Lannoo 2012; Hossack et al, 2013). Explanations for this resilience include the concurrent resilience of food items (e.g. freshwater invertebrates) (Dunham et al. 2007), behavioural adjustments (Engbrecht & Lannoo 2012) and increased immigration of individuals from nearby source populations (Greenburg & Waldrop 2008).

It is currently unclear how increasing fire frequency may impact the long-term persistence of frog populations (Potvin et al, 2016). Large and severe fires have significant impacts on genetic diversity, including increased levels of inbreeding and declines in effective population size, so that amphibian populations in fire-prone environments may be increasingly vulnerable to extinction, particularly where rates of immigration are low. Priorities for planning controlled burns in reserves with important amphibian populations include careful consideration of the timing of controlled burns, along with maintaining habitat connectivity.

7.1.3 Recommendations for management of reserves

Urban reserves constitute very small remnants of the forest and woodland ecosystems that used to cover the whole of the Sydney Basin. The fire regimes that existed in this previous time helped to shape the flora and fauna that lived there. This in no way implies that any species of flora or fauna needs fire to live or reproduce, but does mean that most species have developed a response to fire that facilitates their short and long term survival. Today,

however, the fires that most reserves experience are not the same as the fires that shaped the ecosystem millennia ago. Most burns are anthropogenic in origin, and mainly prescribed burns for hazard reduction, or arson. Naturally ignited fires are comparatively few and far between, and historically would have been contained, or at least constrained, by the landscape itself.

Gullies, wet vegetation and otherwise non-combustible vegetation, are among the landscape features that constrain the spread of fire. In the past, they provided important refuge areas for wildlife from a range of faunal groups. Today, however, these fire refuges are often all that remain of the original landscape, and are now being subject to the burns that once were excluded. The result of this is that we now target fauna refuge areas for hazard reduction burns, and in doing so, risk the destruction of the remaining sources for recolonization post fire.

Wildfire is a landscape forming event but is not a desirable event in modern landscapes. Burns for hazard reduction rarely achieve this over anything but very short term, and the observed fuel loads are comparable to unburnt areas within 2 years. Regular repeated burning destroys the whole ecosystem, including habitat features, flora and fauna refuges, sources for recolonization, and ultimately creates a homogenous landscape that will only support generalist species. To prevent this, the following management recommendations are provided:

- Whole of reserve burns are to be avoided at all cost
- Mosaic burns should burn less than half of any reserve, and there should be good dispersal of burnt and unburnt areas, ideally with a range of fire intensities for the burnt areas
- Native fauna species need to be able to move through the landscape to emigrate, access refuge areas, or remain in in-situ refuges, if they are to survive a fire
- Some species are not able to avoid fire, such as the Dural Land Snail, and some areas should be dedicated as 'fire excluded' for this species
- A more holistic approach to fire management be adopted by council and any relevant fire authorities, such as NPWS, RFS, NSW Fire & Rescue

7.2 Microbats in urban areas

Microbats comprise a major component of remnant mammalian fauna in urban areas. Urbanisation can negatively affect bat communities through noise, artificial lighting, collisions with cars and predation from domestic animals (Gehrt and Chelsvig 2004). Overseas studies on the effects of urbanisation on bats in Europe and North America identified the high ecological value of habitat remnants, and this is generally true for Australia (Basham et al. 2011; Threlfall et al. 2011).

Microbat assemblages along the urban gradient appear to be structured by a complex interaction between the extent of habitat available (site area), the degree of urban development, past land use practices, particularly logging, as well as the availability of

important habitat features (i.e. hollow-bearing trees and tree species diversity). The absence of a clear trend for the effects of urbanisation on microbats is potentially the result of a tendency to retain large forested parks (bushland) within larger cities. These may offset the habitat loss caused by urbanisation, and effectively mitigate any negative impacts to bats at the regional scale.

Jung & Threlfall (2016) reviewed studies on microbats in urban environments from Europe, North America and Australia. Most of these studies report relatively high bat activity and species richness in areas with remaining vegetation such as older residential areas, riverine habitats or parklands. Certain bat species appear to thrive in these urban environments, and success has been linked to species-specific traits (Duchamp and Swihart 2008). In particular, bat species with high wing loadings and aspect ratios, so presumed to forage in open areas (Norberg and Rayner 1987), which also roost primarily in human structures appeared to adjust to urban environments, provided that there is sufficient tree cover (Dixon 2012).

It is typically members of the Molossidae, which are known to forage in the open spaces above the tree canopy that seem to tolerate and potentially profit from highly urbanised areas (Jung and Kalko, 2011). In addition, many buildings in cities provide potential roost sites that resemble natural crevices and are known to be readily occupied by molossid bats (Scales and Wilkins, 2007).

Some studies report a reduced richness and greater dominance of a few species in highly urbanised areas (Jung and Kalko 2011), but in other cases there is greater species richness in urban parks and residential areas (Hourigan et al. 2010; Threlfall et al. 2012). In general, though, there tends to be a positive relationship with native remnant vegetation. This provides the roost sites and forage availability that are the two essential components that ensure the persistence of microbat species in urban environments. The availability of these resources can be affected by past and present land-use practices, such as logging and urban development, and particularly by current trend of medium density housing following complete clearing of the subdivision area. Other considerations for microbats include competition for roost sites, especially tree hollows (Threlfall et al. 2013).

7.2.1 Habitat partitioning in Parramatta LGA

Microbat echolocation calls fall within a spectrum of frequencies. Lower frequency calls travel further but are not always able to locate very small insects and other items. Higher frequency calls do not travel as far, but are very good for locating small insects close by. Combining this with flight speed and manoeuvrability means that some microbats are better suited to foraging in open sky while others are well adapted to foraging in or around the canopy and shrub layers. Some of the observed foraging niche selection is also influenced by potential exposure to predation. Key life history characteristics for microbats in Parramatta LGA are summarised in Table 18.

Table 18 Key life history characteristics for microbats in Parramatta LGA (see below for data sources)

SPECIES NAME	COMMON NAME	ECHOLOCATION FREQUENCY	FLIGHT PATTERNS	FORAGING NICHE**	SENSITIVE TO URBANISATION*	RESERVES PRESENT
Austronomus australis	White-striped Free-tailed Bat	low	fast, low manoeuvrability	Open	tolerant	10
Chalinolobus gouldii	Gould's Wattled Bat	low	fast, high manoeuvrability	Edge	tolerant	13
Chalinolobus morio	Chocolate Wattled Bat	high	fast, moderate manoeuvrability	Edge	moderately sensitive	5
Falsistrellus tasmaniensis	Eastern False Pipistrelle	low	fast, high manoeuvrability	Edge	very sensitive	3
Miniopterus orianae oceanensis	Eastern Bentwing Bat	medium	fast, moderate manoeuvrability	Edge	tolerant	4
Mormopterus norfolkensis	East-coast Free-tailed Bat	low	fast, low manoeuvrability	Open	moderately sensitive	3
Mormopterus ridei	Ride's Free-tailed Bat	low	medium, moderate manoeuvrability	Open	tolerant	11
Myotis macropus	Large-footed Myotis	linear	medium, moderate manoeuvrability	Clutter	very sensitive	9
Nyctophilus sp	a Long-eared Bat	linear	slow, high manoeuvrability	Clutter	moderately sensitive	12
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	low	fast, low manoeuvrability	Open	unknown	9
Scoteanax rueppellii	Greater Broad-nosed Bat	low	medium, moderate manoeuvrability	Edge	moderately sensitive	3
Scotorepens orion	Eastern Broad-nosed Bat	low	not known	Edge	moderately sensitive	7
Vespadelus darlingtoni	Large Forest Bat	medium	fast, moderate manoeuvrability	Clutter	unknown	1
Vespadelus sp	a Forest Bat	unknown	fast, high manoeuvrability	Clutter	moderately sensitive	6
Vespadelus vulturnus	Little Forest Bat	high	fast, high manoeuvrability	Clutter	moderately sensitive	1

Foraging spaces are defined following Milne et al (2004) and Adams et al (2009) as: 1) open-space; 2) edge-space; and 3) clutter (known gleaning species). Overall sensitivity to urbanisation is described in Threlfall et al (2013). Echolocation ranges are based on Reinhold et al (2001) and Pennay et al (2004) with characteristic call frequency ranges: low <38 kHz; medium 38-48 kHz; high >48 kHz; or linear (vertically linear calls).

In general, microbats with greater sensitivity to urbanisation were recorded at fewer reserves in the current study, moderately sensitive species showed a broad range of distribution frequencies, and tolerant species were recorded at most of the reserves (Figure 71). There were several obvious exceptions to this expected pattern.

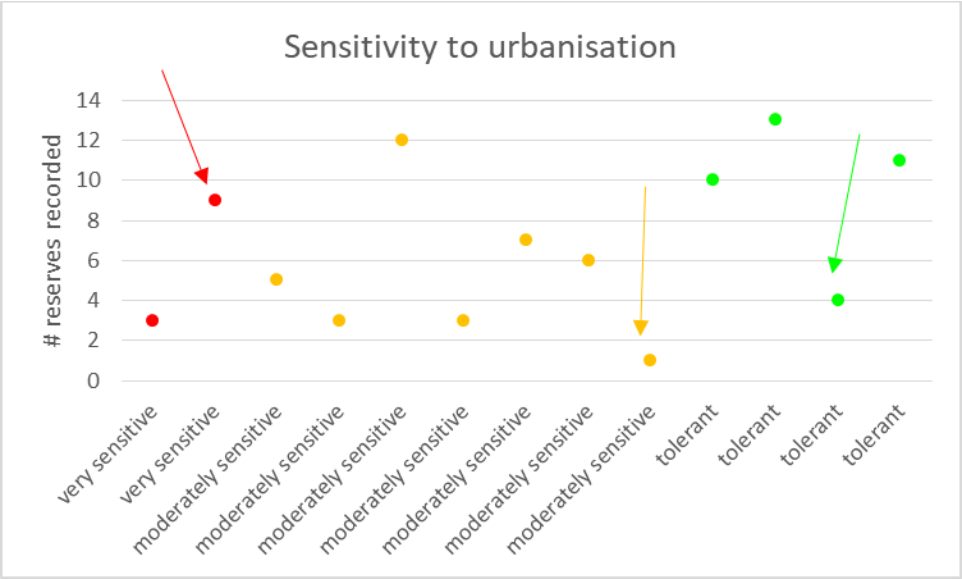

Figure 71 Sensitivity to urbanisation for species recorded at reserves in Parramatta LGA (arrows indicate outlier species)

Myotis macropus, a threatened species, is classed as a very sensitive species but was recorded at 9 of the 14 reserves surveyed. This species forages over and in open water, trawling and catching surface insects, and large macroinvertebrates and even small fish under the surface of the water. Its relatively high presence in the LGA could easily be attributed to the presence of large bodies of open water. *Vespadelus vulturnus*, the Little Forest Bat, is classed as a moderately sensitive species but was identified at one reserve only. A further six species of *Vespadelus* were not identified to species, and there is a high probability that at least half of these are *V. vulturnus*. Of the tolerant taxa recorded in this study, *Miniopteris orianae oceanensis*, a threatened species, was recorded at 4 of the 14 reserves. This may be an indication of increasing pressures on this species in other parts of its life history range. This species regularly undertakes long seasonal migrations – up to 300km at a time – to one cave for overwintering, and then females migrate a further 200-300km to a maternity cave in one of two or three locations in NSW.

We then used Multi-dimensional Scaling of Bray-Curtis similarities to compare suites of microbat species distribution across reserves of different sizes in Parramatta LGA, and found there were no clear trends in microbat species richness. Most microbats are highly mobile species, and can forage up to 5km from their roost sites. As well, they may alternate between

several roost sites in different parts of their range. They have been described as the most persistent group of native fauna following the ongoing impacts of urbanisation – their mobility, combined with their capacity to roost almost opportunistically as long as there are suitable locations, have contributed to the persistence of these species.

Within the microbats there are notable differences in feeding behaviours, speed and manoeuvrability in flight, all of which contribute to the development of preferred niches for individual species. Like other animals, microbats need water for drinking, and will access this in rivers, creeks, ponds, dams, pools and wetlands – anywhere with suitable open water. Concentrations of insects, especially flying insects, tends to be higher on or around water, thus bats are able to access most of their required intakes in these areas.

Distribution of microbat species was contrasted with distance to a river – Parramatta River or Lane Cove River. The following distance to the river categories were used for reserves: very short = on the edge of the river, short = <1.5km, moderate = 1.5-2.5km, long = >3km. Suites of species closest to the river showed the greatest similarity (Figure 72), and each group was most similar to the group next closest to the river. Many of the more densely forested reserves were a moderate distance from the river, and these provided good foraging and roosting habitat.

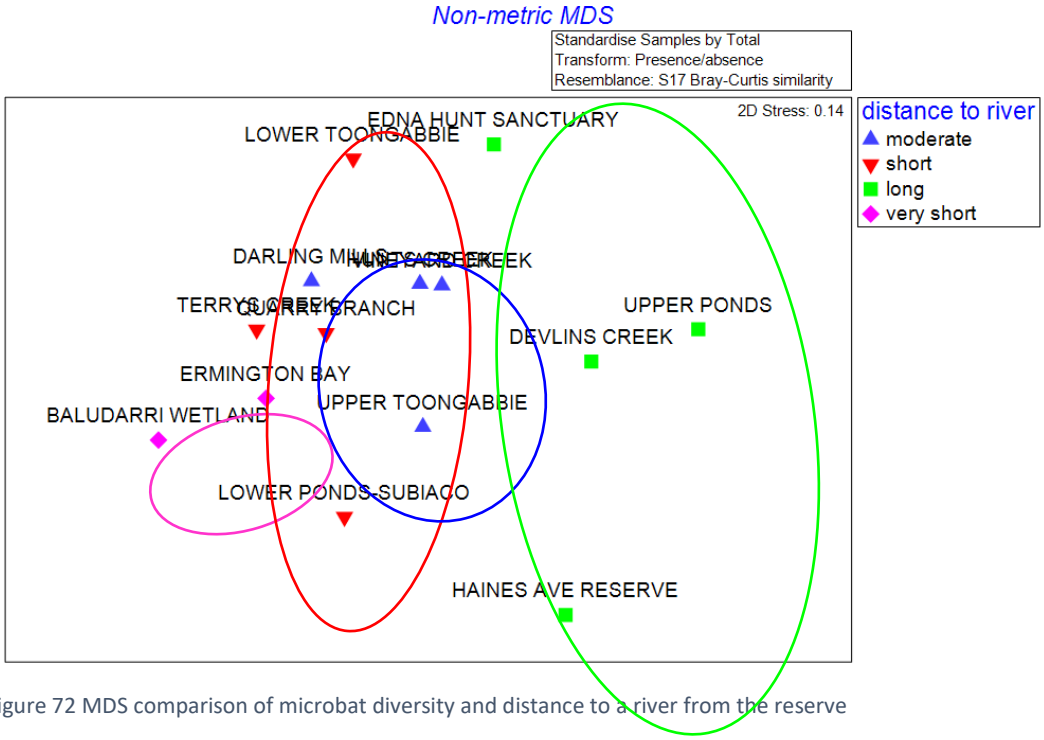

Figure 72 MDS comparison of microbat diversity and distance to a river from the reserve

In reality, all the reserves are within 5km of a river, and thus none of them would be excluded on the basis of excessive distance. For reserves a long way from a river there would be other factors contributing to the observed differences in microbat species present. Many of the microbats recorded in the current study are listed as threatened species in NSW, so reserves that can support different suites of species are as important as reserves that support larger numbers of species. Other factors that have a direct or indirect influence on the ongoing success of microbats in urban areas are discussed in the following sections of this report.

7.2.2 Availability of food resources

Wilson et al (2012) explored the effects of urbanisation on insect abundance in Melbourne, and found that there was a decrease in abundance of nocturnal insects with increasing urbanisation. This was also linked to diversity and abundance of microbat species, with more bats from more species present in areas with greater nocturnal insect abundance. Within the urban matrix, there was greater insect abundance in riparian areas, bushland remnants and residential areas than in golf courses, industrial areas and urban parks.

Nocturnal insect biomass can be up to an order of magnitude greater within Sydney's urban landscapes for both backyards and bushland areas on more fertile soils, such as shale influenced soils, compared to nutrient poor sandstone based soils (Threlfall et al, 2012a). Consequently, the feeding activity of bats tends to be much greater in bushland and riparian areas on more fertile soils. Most of the variation in insect biomass and microbat foraging activity is due to a combination of the following three factors. In general, higher ambient temperature, lower housing density and a greater percentage of fertile shale geologies in the landscape all contributed to increased microbat activity. Variation in insect biomass was not directly linked to microbat foraging activity as there was reduced feeding activity in highly urbanised areas due to avoidance of these areas by some species. The Upper Toongabbie Creek Corridor is located on shale soils, but has a higher housing density, so the net outcome for microbat populations was a moderately high, but not very high, species diversity.

7.2.3 Habitat preferences

Many microbat studies imply that protecting and establishing tree networks may improve the resilience of some bat populations to urbanisation (Hale et al. 2012). Population- and assemblage-level responses along gradients of urbanisation reveal that foraging activity of bats generally seems to be higher in rural and forested areas than in urban areas

Trees are important for bats because they provide focal points for navigation and foraging (Law, Chidel & Turner 2000; Lumsden & Bennett 2005) Tree density has also been related to microbat activity, with both species richness and activity peaking at intermediate tree densities (Hanspach et al, 2012). Areas with low tree cover tend to be dominated by larger, fast flying species, while areas with high tree cover tend to be dominated by smaller, highly manoeuvrable species, a pattern that has been consistently reported from studies around the world.

Presence of hollow bearing trees is a major determinant in microbat diversity and abundance. Nearly 60% of all microbat species in Australia are dependent on tree hollows for roosting habitat and/or maternity habitat. Research indicates that hollow-bearing trees are in decline across all forest types within Australia, and particularly in urban areas. In urban landscapes, the persistence of hollow-dependent bats arguably depends upon the protection of roosting habitat, the hollow bearing trees.

In a recent survey on the Gold Coast across a gradient of increasing urban development, Treby and Castley (2016) found that there were similar levels of species richness in urban and rural areas, but that the suite of species present was quite different. Less than half of the species recorded from rural areas were also present in the urban areas. Key differences were attributed

to the presence of hollow bearing trees, which a number of bat species are almost completely dependent on. Species richness was greatest in peri-urban areas, midway along the urbanisation gradient, an observation that was attributed to the presence of important habitat requirements and the absence of excluding impacts.

McConville et al (2013) found that habitat type based on vegetation community best explained activity of two sympatric and morphologically similar species. They both were more active in floodplain areas, with most foraging activity recorded in the freshwater wetland habitat type. The key difference was the response to urban areas: the threatened *Mormopterus norfolkensis* avoided urban areas, in contrast with *Mormopterus* species 2 which occurred frequently in urban bushland.

Threlfall et al (2012) assessed the use of hollows by an urban sensitive species, Gould's Long-eared Bat (*Nyctophilus gouldi*), and found that the species tended to use hollows in trees in one large suburban bushland reserve (around 40ha), despite the abundance of hollows in available trees in smaller patches outside the reserve. *N. gouldi* displayed a clear preference for trees with a greater amount of understory and canopy cover, and only roosted where the extent of forest cover in the local landscape was greatest. Maternity roosts also were predominately located in gullies, and closer to creek lines. As well, birds were observed occupying bat roosts on days following bat occupancy, while bats roosted in trees where there were fewer hollow-using birds than randomly available trees. Thus abundant, urban-adapted, hollow nesting birds may render hollows a limiting resource to hollow-users such as bats in urban landscapes.

Variation in microbat assemblages on the urban-peri urban-rural gradient have been attributed to site area, with some species, such as *Miniopteris orianae ocenaensis*, only being recorded in larger and more intact areas (Treby & Castley, 2016). This agreed with another recent study that found that site area has a significant impact on many species (Beninde et al, 2015). Despite this, *M. orianae oceanensis* is believed to be relatively tolerant to urbanised landscapes, mainly because it will utilise man-made structures for roosting sites, including stormwater drains, tunnels and culverts, and buildings. *Chalinobolus gouldii* appears very tolerant to the effects of urbanisation with a widespread distribution throughout larger and smaller urban areas (Threlfall et al 2012a). It is a hollow-using species that favours large flyways and low level of forest clutter i.e. an open understorey (Lloyd et al. 2006) and therefore is highly adaptable to foraging in cities, making them one of the most common city microbats in Australia (Richards et al. 2012). *Austronomus australis* has been found to make extensive use of the urban matrix where it has been recorded more frequently foraging above cleared and grassy flood-plains (Threlfall et al 2012a). By comparison, clutter tolerant species such as *Vespadelus vulturnus* and *V. darlingtoni* belong to a group of microbats that are most vulnerable to the effects of habitat fragmentation and urbanisation (Threlfall et al. 2012a).

7.2.4 Predatory and competitive birds

The following bird species recorded in this study are considered potential predators of bats (adapted from Luck et al, 2013): laughing kookaburra *(Dacelo novaeguineae*), grey butcherbird (*C. torquatus*), pied currawong (*Strepera graculina*) and Australian raven (*Corvus coronoides*).

The following hollow-nesting bird species were considered potential competitors of bats: little corella (*Cacatua sanguinea*), long-billed corella (*C. tenuirostris*), galah (*Eolophus roseicapillus*), sulphur-crested cockatoo (*C. galerita*), rainbow lorikeet (*Trichoglossus haematodus*), musk lorikeet (*Glossopsitta concinna*), little lorikeet Australian king parrot (*Alisterus scapularis*), crimson rosella (*Platycercus elegans*), eastern rosella (*P. eximius*), red-rumped parrot (*P. haematonotus*), common starling (*Sturnus vulgaris*) and common myna (*S. tristis*).

7.2.5 MAIN URBANISATION IMPACTS FOR MICROBATS

Despite their comparative ability to persist and thrive with increasing levels of urbanisation, microbats are still detrimentally affected by a number of environmental factors. These are discussed in the following sections.

Artificial lighting

Under moonlight, for mammals, there may be fewer but more successful prey encounters. Some species show a noticeable response to artificial light in the wild, while others show no response at all (Beier, 2006). Fast flying bats exploit insect attraction to city lighting and road lighting. Slow flying gleaner and flutter detector bats avoid street lighting (Rydell, 2006). In some areas this has led to competitive exclusion of species when two species both hunt the same prey but one species hunts in the lit zone and the other avoids the lit zone but the prey is attracted to the lit zone.

Artificial lighting has an effect on both microbats and their prey species. Artificial lighting attracts and repels animals in taxon-specific ways and affects physiological processes. Being nocturnal, bats are likely to be strongly affected by artificial lighting. Many species of bats are insectivorous, and insects are also strongly influenced by lighting (Rowse et al, 2016).

Impacts on bats and their prey depend on the light spectra produced by street lights; ultraviolet (UV) wavelengths attract more insects and consequently insectivorous bats (Rowse et al, 2016). Bat responses to lighting are species-specific and reflect differences in flight morphology and performance; fast-flying aerial hawking species frequently feed around street lights, whereas relatively slow flying bats that forage in more confined spaces are often light-averse. Increasing light levels have a negative influence on microbat species that are tolerant of 'clutter' in the environment, such as *Myotis* species, regardless of the type of artificial lighting.

Relationships between bat species and artificial illumination may be very complex and reflect differences in, for example, the type of light source (e.g. mercury vapour vs. sodium vapour lights), bat ecology and landscape context. While certain light sources attract insects and subsequently foraging bats, artificial illumination can disrupt bat foraging behaviour and flight paths. Lighting technologies are changing rapidly, with the use of light-emitting diode (LED) lamps increasing. Rapid changes in street lighting offer the potential to explore mitigation

methods such as part-night lighting (PNL), dimming, directed lighting, and motion-sensitive lighting that may have more beneficial consequences for light-averse bat species.

Insectivorous bats that hunt in open spaces above the canopy (open-space foragers) or along vegetation edges such as forest edges, tree lines or hedgerows (edge foragers) are the most tolerant of artificial lighting (Jung and Threlfall 2016). When foraging at street lights, open-space foragers typically fly above the lamps, diving into the light cone to catch insects (Jung and Kalko 2010). Edge foragers tend to be more manoeuvrable than open-space foragers (Kalko et al. 2008), and some conduct circuits inside the light cone when hunting insects at street lights (Jung and Kalko 2010). Though a relatively high proportion of aerial insectivorous bats may forage in suburban habitats, bat activity and the number of bat species decrease significantly in highly urbanised areas. This is probably because roosts and insect habitats are both lacking, and those insects which are present might not aggregate at street lamps because the pervasive artificial lighting in city centres causes a dilution effect, rendering the lights less attractive for bats (Jung & Kalko 2011; Jung & Threlfall 2016).

For forest dwelling bats, their morphology only allows slow flight speeds, which might render them more vulnerable to predators when flying in a sphere of light away from protective vegetation cover (Rydell et al. 1996). Most forest-dwelling bat species emerge from their roosts relatively late in the evening, presumably to minimise predation risk from diurnal birds of prey (Jones and Rydell 1994) and so may be 'hard-wired' to be light-averse. Furthermore, slow-hawking bats use echolocation calls that are adapted for short-range prey detection among clutter (Norberg and Rayner 1987), and so these may not be suitable for orientation in semi-open habitats where most street lights are positioned. For example, the chocolate wattled bat *Chalinolobus morio* avoided parks when lights were switched on (Scanlon and Petit 2008). In contrast, eastern horseshoe bats Rhinolophus megaphyllus were repeatedly observed traversing 200 m of open grassland to forage extensively around artificial lights (Pavey, 1999).

Extinction risk is highest in bat species with low aspect ratios (Jones et al. 2003; Safi and Kerth 2004), which are the species that show aversion to artificial lighting. Thus, species that may suffer most from light pollution are likely to be already threatened taxa.

Effects of noise for microbats

Ambient noise influences the availability and use of acoustic information in animals in many ways. For example, *Myotis* species are part of an especially vulnerable group of gleaning bats that rely on listening for prey rustling sounds to find food. This strategy of 'passive listening' is adopted by bat species specialized to glean arthropods from vegetation or the ground where prey echoes are masked by overlapping, strong background echoes. For such 'passive listening' bats, it is conceivable that environmental noise interferes with the detection of prey. As these bats use echolocation for spatial orientation, the reception of relevant echoes could potentially be impaired by noise as well (Gillam and McCracken, 2007).

In an assessment of feeding behaviours for the greater mouse-eared bat (*Myotis myotis*), Schaub et al (2008) found a clear effect of the type of noise on the allocation of foraging effort and on the distribution of prey capture events. The degree to which the background noise

deterred bats from the compartment increased from traffic noise to vegetation movement noise to broadband computer generated noise. Vegetation noise, set 12dB below the traffic noise amplitude, had a larger repellent effect; presumably because of its acoustic similarity with prey sounds. As bats roost in noisy places, it appears likely that a specific noise-impairment on perception of prey sounds (Goerlitz et al., 2008), on echolocation (Gillam and McCracken, 2007), or both, and possibly specific characteristics of the noise, are reasons for avoidance of noisy places.

Microbats and fire

Fire in bushland is most commonly a result of anthropogenic ignition, either accidentally or as deliberate burns for landscape management (Abbott & Burrows, 2003). This has led to considerable debate over whether current fire regimes are beneficial for many species of flora and fauna (Green & Sanecki, 2006), leading to numerous studies investigating the responses of various animals and plants to disturbance by fire. Despite this there have been very few studies of the effects of fire on microbats, notwithstanding the fact they comprise a significant proportion of Australian mammal fauna (Simmons & Wetterer, 2010). Milne et al (2005) found that there were only limited influences from fire on microbat species assemblages in a study relating fire frequency and time since last fire in savannas in the Northern Territory.

Several overseas studies found some beneficial effects for microbats, where prescribed fires in pine and oak forests in North America increased habitat suitability through the creation of additional roost sites (Boyles & Aubrey, 2006; Lacki et al, 2009). Severity of fire was found to have a limited effect on microbat diversity and abundance following the 2002 McNally fire in the Sierra Nevada region of California, USA (Buchalski et al, 2013). Bat activity in burned areas was either equivalent or higher than in unburned stands. Evidence of differentiation between fire severities was observed with some Myotis species having higher levels of activity in stands of high-severity burn. Larger-bodied bats, typically adapted to more open habitat, showed no response to fire. Extent of high-severity fire damage in the landscape had no effect on activity of bats in unburned sites. This suggested that there was no landscape effect of fire on foraging site selection, and highlights the idea that stand-scale conditions drive bat activity.

None of these studies investigated the immediate effects of fire on microbat activity and community structure. Inkster-Draper et al (2013) used paired before-after burn comparisons to assess impacts on microbat assemblages for a series of prescribed burns in a national park near Townsville. They found an overall increase in microbat activity in the burnt areas, most of which was attributed to five of the fourteen species present. Two other species showed a distinct reduction in activity for the burnt areas. Most of these trends were attributed to the change in vegetation structure following fire, in particular the reduction in “clutter”. Loeb and Wardrop (2008) attributed this type of trend to an increase in prey availability, although it is more likely to be an increase in prey accessibility.

Inkster-Draper et al (2013) found that changes to the bat community structure following the fire were most consistent with expectations based on the relationships between body and wing morphology, and flying behaviour and habitat, suggesting that the physical structure of the environment provides a significant influence on bat community assemblage. Thus the reduction

in vegetation clutter made the habitat more favourable for less manoeuvrable, faster flying species, and less favourable for highly manoeuvrable species that are adapted to hunting within the canopy. These species are often smaller, and/or slower flyers, and more susceptible to predation in open spaces.

None of these studies recognise the loss of individual animals as a result of fire, although most prescribed burns occur during the day when microbats are asleep in their tree hollow or tree bark roosts. For well managed burns the height of flames are kept at or below 2m, but the reality is that many of these burns are not well managed, and can even be the start of serious wildfire events. Unlike prescribed burns, wildfire will ignite canopy vegetation as well as groundlayer and shrub layers, and will ignite loose bark, burn through hollow trees, and create extremely high temperatures within tree trunks that can be seen post fire through trunk scarring and splitting.

7.2.6 Summary of potential impacts for microbats

Main potential impacts identified for microbats from literature and the current study include:

- Reduced clutter through simplification of vegetation, eg following too frequent fire
- Increasing density of urbanisation
- Loss of hollow bearing trees and other roost sites
- Disruption to flyways, especially for regionally migratory species
- Artificial lighting
- Exposure to predation
- Lack of understanding, eg vilification as 'disease-ridden vermin'

Recommendations for mitigating these impacts are provided in the management section of this report.

7.3 THREATS FOR SWAMP WALLABIES IN URBAN AREAS

Key threats to Swamp Wallabies within the LGA are likely to predation by fox and potentially dogs. Other threats are inadvertent off target poisoning with Pindone and to a lesser degree the inherent dangers of crossing roads within the urban matrix. Dispersal to and from reserves such as Lake Parramatta/Hunts Creek and Galaringi Reserve by necessity involve crossing roads. Dogs and foxes (and reserve users) have the ability to startle and flush wallabies onto local roads.

Local resident Joanne Finlay said the wallaby looked "scared witless". Photo: Joanne Finlay

Figure 73 A terrified Swamp Wallaby likely flushed from Lane Cove National Park in Chatswood (SMH 2015).

Ongoing suppression of the fox population is likely to be necessary for Swamp Wallabies to persist in the LGA. One fox scat collected in Quarry Branch Corridor during recent surveys contained the remains of Swamp Wallaby. Coates (2008) found that after suppression of a fox population in a reserve near Melbourne there was an increase in both activity and range of Swamp Wallabies indicating that fox predation may act to limit both the total size of populations and types of vegetation occupied.

Management of vegetation, including prescribed burns, needs to consider whether core swamp wallaby shelter and browsing sites are negatively impacted. Foster et al. (2010) illustrated that browsing by Swamp Wallabies following fire created an understorey dominated by an unpalatable, fire-resistant fern species (bracken, *Pteridium esculentum*) and concluded that "The ability of bracken to suppress the establishment of other plants means that, once established, this fern-dominated understorey may be difficult to reverse. Our results demonstrate the key role of fire–browsing interactions in forest vegetation dynamics and highlight the importance of integrating large herbivore management with fire planning in forest ecosystems".

Pindone poisoning of rabbits is a direct threat to non-target species including Swamp Wallabies. Baits used with Pindone including oats and carrots are very attractive to Swamp Wallabies. Kangaroos "appear highly sensitive" to pindone and Swamp Wallaby deaths are documented in NSW (National Registration Authority for Agricultural and Veterinary Chemicals, 2002). Both The Hills Shire and City of Ryde Councils have used Pindone as part of rabbit baiting programs in Pembroke Park (Terrys Creek Corridor) and, prior to LGA boundary adjustments, in Excelsior Reserve (Darling Mills Corridor).

7.3.1 Future projects for Swamp Wallaby management

Figure 74 Scats collected during recent surveys. The wetter, single pellets (top right & bottom right) were the most commonly found pellets along tracks, with multiple pellet droppings more common “off-track” in sheltered areas (photos Applied Ecology 2016). Chewed plant matter can be clearly seen in swamp wallaby scats

Figure 75 like most herbivore scats, swamp wallaby scats can be broken up in the hand into a combination of rough and fine plant fibres (Photo: AE 2017)

7.3.2 Vegetation Management for Swamp Wallabies

A brief examination of the vegetation where Swamp Wallaby records were found showed that they were most commonly recorded in Coastal Enriched Sandstone Dry Forest (CESDF, Table 19). Swamp Wallabies were not targeted during the recent series of fauna surveys across Parramatta LGA, and once their presence was noted in a reserve they were only recorded incidentally, for example, by remote camera. However, this does provide a starting point for vegetation management to promote effective conservation of the species in the LGA. More than half (57%) the records were from CESDF, and many others were from locations in different vegetation communities but close to CESDF.

Table 19 Vegetation communities where Swamp Wallabies were recorded (* = EEC)

VEGETATION COMMUNITY	NUMBER OF RECORDS IN RESERVE CORRIDORS				
	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	TOTAL
CESDF	7	3	7		17
STIF*	2		1		3
CSSF*		1			1
CESMF		1	1		2
BGHF*			1	3	4
CSGF			3		3
TOTAL	9	4	13	3	

Using the vegetation communities where Swamp Wallaby activity was recorded, it is possible to begin to build an understanding of what parts of the reserve are utilized by the species. Osowa (1990) compiled a list of 32 flora species found in the stomach contents of roadkill Swamp Wallabies in southeastern Queensland. Of these, half the species were weeds or only found north of Newcastle, leaving 16 species that might be found in Parramatta LGA. Cross referencing species lists for the vegetation communities in Table 2 (see 'Vegetation Community Profiles' from 'Native Vegetation of the Sydney Metropolitan Area', OEH, 2013) with those from Osowa (1990; see Table 1) produced a list of potential food species that would be appropriate for each of the vegetation communities vegetation communities utilised (Table 2).

Table 20 Flora species for food resources for Swamp Wallabies. Species in large font are from Osowa (1990). Species with √√ are considered diagnostic for the community; species with √ are frequently present but not diagnostic.

FOOD RESOURCE SPECIES	**CESDF**	**CSGF**	**BGHF**	**STIF**	**CESMF**	**CSSF**
Acacia ulicifolia	√√	√√		√	√	√
Bossiaea heterophylla		√√				
Bossiaea obcordata	√√					√√
Cyperus spp.			√			
Desmodium rhytidophyllum			√			
Desmodium varians			√√	√√		
Dillwynia floribunda						
Dillwynia retorta	√	√√				√
Dillwynia revoluta	√					
Elaeocarpus reticulatus	√√	√√	√√	√	√√	√
Epacris pulchella		√√				√√
Glycine clandestina	√		√√	√√	√	√√
Glycine microphylla			√√	√√		√
Glycine tabacina			√√	√√		
Hibbertia aspera	√		√√	√√		√
Hibbertia dentata	√		√√	√	√	
Hibbertia salicifolia						
Leucopogon ericoides	√	√√				
Leucopogon juniperinus	√√		√√	√√	√	√√

Leucopogon lanceolatus		√			√√	√
Micrantheum ericoides	√√	√√				√√
Microlaena stipoides var stipoides	√√		√√	√√	√√	√√
Monotoca scoparia		√√				√
Poranthera microphylla			√	√√	√	
Pratia purpurescens	√√		√√	√√	√	√√
Pteridium esculentum	√√	√√	√√		√√	√√
Ricinocarpos pinifolius		√√				
Themeda australis	√√		√	√√		√√
Woollsia pungens		√√				
Zieria pilosa	√√	√			√√	
Zieria smithii	√√		√	√√	√√	

The original 16 species has been supplemented with other potential food species to provide flora species suitable for revegetation planting in each community. These are intended as a guide only, and would be better informed by a more targeted Swamp Wallaby survey and more comprehensive dietary analysis based on scats collected from key bushland reserves in Parramatta LGA. It is worth noting that three of the vegetation communities showing a level of use by Swamp Wallabies are listed as Endangered Ecological Communities and care should be taken to ensure the ongoing integrity of these communities.

For the communities listed in Tables 2 and 3, most are tall open forests. The following brief community descriptions outline understoreys ranging from dense or moderately dense, to highly variable, open or even sparse.

Coastal Enriched Sandstone Dry Forest is a tall open eucalypt forest with an moderately dense understorey of dry sclerophyll shrubs with ferns and forbs amongst the ground cover. Coastal Enriched Sandstone Moist Forest is a tall open eucalypt forest also with a distinctive dense mesic shrub and small tree layer. Coastal Sandstone Gully Forest is a moderately tall open forest with a dense understorey that is a diverse mix of heath and shrub species such as banksias, tea-trees and wattles.

Blue Gum High Forest is a tall wet sclerophyll forest found on fertile shale soils with a ground layer that is variable in both composition and cover. It may be ferny, grassy or herbaceous depending on topographic situation and disturbance history. At some sites vines and climbers are prolific. In contrast, Sydney Turpentine-Ironbark Forest is a tall open forest with an open midstrata of mesic and sclerophyllous shrubs and small trees with a grassy ground cover. Different again, Coastal Shale-Sandstone Forest is often a tall open eucalypt forest with a sparse layer of dry sclerophyllous shrubs and a grassy ground cover.

The communities with more dense understorey layers provide more holistic resources for Swamp Wallabies.

8 SUMMARY OF RECOMMENDED MANAGEMENT ACTIONS

8.1 MANAGEMENT OF FAUNA SPECIES/GROUPS

Specific management actions for fauna species and/or faunal groups have been provided throughout this report. These are summarised here to facilitate the development of management plans for the protection of Parramatta's fauna biodiversity.

Avian fauna

Large ground dwelling birds (includes Brush Turkeys and Lyrebirds)

- Encourage residents to keep cats inside at night and wear bells during the day
- Encourage residents to walk their dogs somewhere else, and keep them inside the yard

Hollow dependent birds (and other species)

- Retain standing stags and dead limbs on trees. If necessary, fence around the tree to prevent limb drop in areas where there is risk of injury
- Retain old growth trees on development sites adjoining reserves
- If hollow bearing trees are being removed, harvest hollow bearing branches before felling the tree; relocated hollows in younger trees in areas of forest regeneration
- If stags are being removed, consider relocating to a reserve as a standing stag
- Consider hollow augmentation in younger mature trees in areas where there are little or no natural hollows. Monitor and share the results, and monitor successes of other hollow augmentation projects, eg. Swift Parrot in Tasmania, Superb Parrot in Central Tablelands of NSW

Small woodland birds (includes Varied Sittellas)

- Use staged removal of weedy shrubs
- Combine with revegetation planting to re-establish a comprehensive shrub layer for small birds; ensure that supplementary planting includes a range of food resource species that are appropriate to that vegetation community
- Establish cat and dog free areas – parks for biodiversity – in areas with moderately high populations of small birds, and especially in newly acquired reserves
- Exclude fire or limit to strictly monitored patchy burns, with less than half of the area burnt at any given time, and that there is a suitable inter-fire interval and time since fire

Water birds (includes EP&BC listed migratory species)

- Use signage to discourage dogs off leash in wetlands/shore birds with high avian use
- Consider fencing in areas where breeding events are concentrated
- Monitor water quality and manage to reduce poor water events

Nocturnal birds (includes nightjars, owls, and tawny frogmouths)

- Establish cat and dog free areas – parks for biodiversity – in areas with ground dwelling or nesting birds such as nightjars

- Exclude fire from areas with ground nesting bird species, at least during their breeding seasons
- Consider establishing noise constraint areas around reserves with known breeding sites for nocturnal birds, eg construction noise restrictions
- Ensure that large shrubby weed control along creeklines is conducted in a staged manner to prevent over disturbance to existing roost sites for Powerful Owls
- Exclude fire from known roosting sites
- Actively promote ethical birding, particularly by photographers
- Do not dessiminate information regarding roost and breeding site locations for owl species

Amphibians

- Monitor and manage water quality in creeks to reduce impacts on frogs
- Retain a range of vegetation around waterways to ensure a more diverse range of frog habitats
- Establish cat and dog free areas – parks for biodiversity – in areas with higher frog diversity
- Exclude fire from areas around drainage lines to prevent inbreeding depression and loss of genetic diversity

Reptiles

- Establish cat and dog free areas – parks for biodiversity – in areas with higher reptile diversity
- Limit fire to patch burns, ensuring that no more than 50% of the area is burnt at any one time, and that there is a suitable inter-fire interval and time since fire
- Close and brush mat small side trails to prevent cyclists in reserves with higher reptile diversity, such as Lake Parramatta
- Investigate strategies to reduce carp in waterways to improve habitat for Eastern Long-necked Turtles

Possums and gliders

- Maintain hollow bearing trees, supplement with nest boxes and translocated hollows
- Limit fire to cool autumn burns with flame height less than 2m
- Exclude fire from smaller reserves, especially in areas with newer urban development where there is limited opportunity for animals to escape using temporary emigration

Flying foxes

- Maintain food resources for this species in the LGA
- Include food plants in revegetation planting species selections
- Promote a positive attitude in the community to flying foxes, and give a realistic understanding of their role in the transmission of Hendra virus to horses

Swamp Wallabies

- Do not use feral animal control methods that might affect swamp wallabies, such as pindone
- Ensure that shrubby weed control is conducted in a staged manner to prevent over disturbance to existing refuge sites
- Limit fire to patch burns, ensuring that no more than 50% of the area is burnt at any one time, and that there is a suitable inter-fire interval and time since fire
- Establish cat and dog free areas – parks for biodiversity – in areas with populations of swamp wallabies, and especially in newly acquired reserves

Microbats

- Maintain street trees, especially larger and older trees, to provide navigation, foraging opportunities and refuge from predation
- Prevent removal of hollow bearing trees, supplement available hollows with harvested limbs
- Ensure that old structures such as buildings, culverts, bridges, etc are adequately surveyed for microbats before removal
- Ensure that all new outdoor lighting is shielded with full cutoff covers; where possible use timers to turn lights off when they are not required, or use motion sensors
- Encourage staged replacement of existing lighting with full cutoff covers and timers or motion sensors as part of maintenance activities
- Maintain or improve vegetated corridors from bushland reserves to Parramatta River and Lane Cove River
- Promote a positive attitude in the community to microbats, and give a realistic understanding of the potential for the transmission of Australian Bat Lyssavirus

Dural Land Snail

- Install signage about the species in key reserve areas
- Install raised footpath/cycleway in key habitat areas of reserves, especially on high use tracks such as Hunts Creek Reserve walking trail
- Ensure ample leaf litter is retained to provide food and shelter
- Exclude fire from reserve areas that are known habitat for the species
- Conduct surveys during suitable conditions to gain further understanding of the distribution of the species in Parramatta LGA
- Engage with private landholders and land managers in areas with known populations, and establish joint conservation management plans, eg Kings School and other landholders along Hunts Creek
- Encourage bushcare volunteers to learn to identify the species, and structure works so that if the Dural Land Snail is found they can avoid trampling it or disturbing habitat

8.2 MANAGEMENT OF RESERVES/CORRIDORS

This section provides key management actions for promotion of native fauna biodiversity in Parramatta's bushland reserves. These are individually tailored for each reserve/corridor, and aim to address the main issues identified for significant fauna and/or significant impacting factors.

General recommendations

- Maintain/improve connectivity between reserves and corridors to ensure genetic diversity is maintained, and that animals have adequate access to refuge areas during fire and other perturbations
- Exclude dogs and cats from bushland reserves
- Manage fire to ensure the ongoing persistence of sensitive species
- Use signage to restrict reserve use to established tracks and inform of key reserve wildlife assets

Devlins Creek Corridor, Haines Reserve

- Ensure good water quality for high frog diversity reserve
- Develop mechanisms to re-establish connectivity with bushland on the other side of the M2 by improving habitat around the overpass
- Expand bushland corridor where possible, engage local residents to encourage planting of feeding and refuge plants appropriate for the vegetation community
- Educate residents about feeding Rainbow Lorikeets
- Ongoing fox management

Darling Mills Creek Corridor

- Improve water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained
- Monitor for the presence of cryptic species such as the Dural Land Snail
- Manage fire to ensure the ongoing persistence of the existing diverse fauna
- Engage bush regeneration contractors who can provide ropework weed control for steep sides in parts of this corridor
- Locate and establish opportunities to increase connectivity with Hunts Creek Corridor and Lake Parramatta
- Ongoing fox management

Hunts Creek Corridor (includes Lake Parramatta)

- Ensure good water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained

- Monitor for the presence of cryptic species such as the Dural Land Snail
- Manage fire to ensure the ongoing persistence of sensitive species such as the DLS, as well as the existing diverse fauna
- Liaise with local landholders to manage DLS and other significant species, especially Kings School
- Encourage Kings School involvement in managing their land for fauna, eg by removing barbed wire from fences along bushland boundaries
- Target bushland in private ownership for acquisition
- Close and brush mat/direct seed/revegetate small tracks and encourage mountain bikers to stay on the main tracks only (Hunts Creek reserves)
- Locate and establish opportunities to increase connectivity with Darling Mills Creek Corridor
- Ongoing fox management

Quarry Branch Corridor, Vineyard Creek Corridor

- Expand bushland corridor where possible, engage local residents to encourage planting of feeding and refuge plants appropriate for the vegetation community
- Maintain and improve connectivity between reserves and corridors to ensure genetic diversity is maintained, and that animals have adequate access to refuge areas during fire and other perturbations
- Ensure good water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained
- Manage fire to ensure the ongoing persistence of sensitive species
- Ongoing fox management

Upper Toongabbie Creek Corridor, Lower Toongabbie Creek Corridor

- Ensure good water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained
- Manage fire to ensure the ongoing persistence of sensitive species
- Expand existing bushland corridor by planting into grassed areas; plant shrub species to provide food resources for small birds, especially honeyeaters while not creating Noisy Miner habitat
- Ongoing fox management

Lower Ponds – Subiaco Creek Corridor

- Expand bushland corridor through planting where possible, engage local residents to encourage planting of feeding and refuge plants appropriate for the vegetation community
- Maintain and improve connectivity between reserves and corridors

- Ensure good water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained
- Ongoing fox management

Upper Ponds Creek Corridor

- Expand bushland corridor through planting where possible, engage local residents to encourage planting of feeding and refuge plants appropriate for the vegetation community
- Maintain and improve connectivity between reserves and corridors
- Ensure good water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained
- Manage fire to ensure the ongoing persistence of sensitive species
- Install supplementary hollows from harvested limbs to create additional habitat for sugar gliders
- Ongoing fox management

Edna Hunt Sanctuary

- Supplementary planting of shrub layer species to provide additional resources for small birds
- Educate local residents on the importance of cat curfews
- Engage local residents to encourage planting of feeding and refuge plants appropriate for the vegetation community
- Manage fire to ensure the ongoing persistence of sensitive species
- Install supplementary hollows from harvested limbs to create additional habitat
- Ongoing fox management

Terrys Creek Corridor

- Liaise with City of Ryde to manage the whole corridor more holistically
- Ensure good water quality to promote healthy populations of native fauna
- Use staged weed control with supplementary planting as required to ensure a good shrub layer is retained, manage this to maintain Powerful Owl habitat for breeding pairs
- Manage fire to ensure the ongoing persistence of sensitive species
- Maintain and improve connectivity between reserves and corridors
- Ongoing fox management

Ermington Bay, Baludarri Wetland

- Expand bushland corridor through planting where possible, engage local residents to encourage planting of feeding and refuge plants appropriate for the vegetation community
- Signage to discourage dog walkers from allowing dogs off leash on the mud flats during waders residence period
- Ongoing fox management

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APPENDICES

Terrys Creek Owl

Photo: Jenny Stiles

10 APPENDIX A PROJECT SPECIES LIST

SPECIES	SCIENTIFIC NAME	STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
AVES (97 SPECIES)																	
Australasian Darter	*Anhinga novaehollandiae*			Y										Y			2
Australasian Figbird	*Sphecotheres vieilloti*												Y	Y			2
Australasian Grebe	*Tachybaptus novaehollandiae*			Y													1
Australian Brush-turkey	*Alectura lathami*		Y	Y	Y	Y		Y	Y						Y		7
Australian King-Parrot	*Alisterus scapularis*		Y	Y	Y	Y	Y	Y	Y		Y			Y	Y	Y	11
Australian Magpie	*Cracticus tibicen*		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	13
Australian Pelican	*Pelecanus conspicillatus*													Y			1
Australian Raven	*Corvus coronoides*		Y	Y		Y		Y	Y	Y	Y	Y		Y	Y		10
Australian White Ibis	*Threskiornis molucca*									Y		Y		Y			3
Australian Wood Duck	*Chenonetta jubata*			Y						Y	Y	Y					4
Bell Miner	*Manorina melanophrys*		Y								Y	Y					3
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		Y	Y		Y	Y		Y		Y	Y					7
Black-faced Monarch	*Monarcha melanopsis*	*Bonn*	Y	Y		Y	Y				Y			Y			6
Brown Falcon	*Falco berigora*										Y						1
Brown Gerygone	*Gerygone mouki*		Y	Y		Y	Y	Y	Y		Y						7
Brown Goshawk	*Accipiter fasciatus*			Y													1
Brown Thornbill	*Acanthiza pusilla*		Y	Y		Y	Y	Y	Y								6
Channel-billed Cuckoo	*Scythrops novaehollandiae*			Y													1
Chestnut Teal	*Anas castanea*			Y													1
Crested Pigeon	*Ocyphaps lophotes*									Y	Y	Y		Y			4
Crested Tern	*Thalasseus bergii*													Y			1
Crimson Rosella	*Platycercus elegans*		Y	Y		Y	Y		Y							Y	6
Dollar Bird	*Eurystomus orientalis*		Y	Y		Y	Y		Y		Y	Y			Y		8
Dusky Moorhen	*Gallinula tenebrosa*			Y	Y			Y			Y	Y					5
Eastern Koel	*Eudynamys orientalis*		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			11
Eastern Rosella	*Platycercus eximius*			Y			Y		Y	Y	Y	Y			Y	Y	8
Eastern Spinebill	*Acanthorhynchus tenuirostris*		Y	Y		Y	Y		Y		Y						6
Eastern Whipbird	*Psophodes olivaceus*		Y	Y		Y	Y	Y	Y	Y	Y	Y			Y		10
Eastern Yellow Robin	*Eopsaltria australis*		Y	Y	Y	Y	Y	Y	Y		Y	Y					9
Eurasian Coot	*Fulica atra*			Y													1
Galah	*Eolophus roseicapillus*							Y			Y			Y			3
Golden Whistler	*Pachycephala pectoralis*		Y	Y		Y	Y	Y	Y		Y			Y			8
Great Egret	*Ardea alba*	***Jamba, Camba***		Y								Y		Y			3
Grey Butcherbird	*Cracticus torquatus*			Y	Y					Y	Y	Y			Y		6
Grey Fantail	*Rhipidura albiscapa*		Y	Y		Y	Y		Y		Y			Y			7

SPECIES	SCIENTIFIC NAME	STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Laughing Kookaburra	*Dacelo novaeguineae*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	13
Leaden Flycatcher	*Myiagra rubecula*						Y		Y		Y						3
Lewins Honeyeater	*Meliphaga lewinii*		Y	Y		Y	Y				Y						5
Little Black Cormorant	*Phalacrocorax sulcirostris*			Y							Y	Y					3
Little Corella	*Cacatua sanguinea*		Y				Y			Y	Y						4
Little Pied Cormorant	*Microcarbo melanoleucos*			Y			Y										2
Little Wattlebird	*Anthochaera chrysoptera*					Y					Y	Y					3
Long-billed Corella	*Cacatua tenuirostris*					Y	Y			Y							3
Magpie-lark	*Grallina cyanoleuca*				Y			Y	Y	Y	Y	Y	Y	Y		Y	9
Masked Lapwing	*Vanellus miles*									Y							1
Mistletoebird	*Dicaeum hirundinaceum*			Y							Y						2
Musk Lorikeet	*Glossopsitta concinna*										Y				Y	Y	3
New Holland Honeyeater	*Phylidonyris novaehollandiae*		Y	Y			Y				Y	Y	Y				6
Noisy Friarbird	*Philemon corniculatus*											Y					1
Noisy Miner	*Manorina melanocephala*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
Olive-backed Oriole	*Oriolus sagittatus*			Y							Y	Y	Y				4
Pacific Baza	*Aviceda subcristata*								Y								1
Pacific Black Duck	*Anas superciliosa*		Y	Y						Y	Y	Y					5
Pied Currawong	*Strepera graculina*		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	13
Powerful Owl	*Ninox strenua*	NSW-V		Y		Y	Y	Y							Y		5
Rainbow Lorikeet	*Trichoglossus haematodus*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
Red Wattlebird	*Anthochaera carunculata*		Y	Y		Y	Y		Y		Y	Y	Y	Y			9
Red-browed Finch	*Neochmia temporalis*		Y	Y		Y	Y	Y	Y		Y	Y	Y	Y			10
Red-rumped Parrot	*Psephotus haematonotus*										Y	Y					2
Royal Spoonbill	*Platalea regia*													Y			1
Rufous Fantail	*Rhipidura rufifrons*	Bonn	Y	Y		Y	Y	Y	Y			Y					7
Sacred Kingfisher	*Todiramphus sanctus*		Y	Y		Y					Y			Y			5
Satin Bowerbird	*Ptilonorhynchus violaceus*			Y		Y		Y			Y	Y					5
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*										Y						1
Scarlet Honeyeater	*Myzomela sanguinolenta*		Y	Y		Y	Y										4
Silver Gull	*Chroicocephalus novaehollandiae*													Y			1
Silvereye	*Zosterops lateralis*		Y	Y			Y		Y		Y	Y	Y	Y			8
Southern Boobook	*Ninox novaeseelandiae*		Y	Y		Y	Y							Y			5
Spotted Pardalote	*Pardalotus punctatus*		Y	Y		Y	Y	Y	Y		Y	Y	Y				9
Striated Thornbill	*Acanthiza lineata*		Y														1
Sulphur-crested Cockatoo	*Cacatua galerita*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	13
Superb Fairy-wren	*Malurus cyaneus*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	13
Tawny Frogmouth	*Podargus strigoides*		Y	Y		Y	Y		Y	Y	Y	Y		Y			9

SPECIES	SCIENTIFIC NAME	STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Varied sitella	*Daphoenositta chrysoptera*	NSW-V		Y													1
Variegated Fairy-wren	*Malurus lamberti*			Y		Y											2
Welcome Swallow	*Hirundo neoxena*			Y					Y	Y	Y	Y		Y			6
White-bellied Sea-eagle	*Haliaeetus leucogaster*	NSW-V												Y			1
White-browed Scrubwren	*Sericornis frontalis*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	13
White-cheeked Honeyeater	*Phylidonyris niger*		Y	Y													2
White-faced Heron	*Egretta novaehollandiae*			Y				Y					Y	Y			4
White-headed Stilt	*Himantopus himantopus*													Y			1
White-plumed Honeyeater	*Lichenostomus penicillatus*										Y	Y					2
White-throated Needletail	*Hirundapus caudacutus*	*Jamba, Camba, Rokamba*									Y						1
White-throated Nightjar	*Eurostopodus mystacalis*			Y													1
White-throated Treecreeper	*Cormobates leucophaea*			Y		Y											2
Willie Wagtail	*Rhipidura leucophrys*						Y		Y		Y	Y	Y				5
Yellow Thornbill	*Acanthiza nana*		Y	Y					Y		Y	Y					5
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*		Y	Y		Y	Y				Y		Y			Y	7
INTRODUCED AVES																	
Common Myna	*Sturnus tristis*			Y					Y	Y	Y	Y	Y	Y			7
Common Starling	*Sturnus vulgaris*											Y					1
Domestic Duck	*Anas platyrhynchos domesticus*			Y													1
European Blackbird	*Turdus merula*										Y	Y		Y			3
House Sparrow	*Passer domesticus*										Y						1
Nutmeg Mannikin	*Lonchura punctulata*												Y				1
Red-whiskered Bulbul	*Pycnonotus jocosus*		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		12
Rock Dove	*Columba livia*									Y	Y			Y			3
Spotted Turtle-Dove	*Streptopelia chinensis*			Y			Y		Y		Y	Y	Y				6
AMPHIBIANS (7 SPECIES)																	
Brown-striped Frog	*Limnodynastes peronii*		Y	Y	Y	Y	Y	Y	Y	Y	Y					Y	10
Bibron's Toadlet	*Pseudophryne bibronii*		Y	Y			Y										3
Common Eastern Froglet	*Crinia signifera*		Y	Y	Y	Y	Y	Y	Y	Y	Y			Y		Y	11
Eastern Dwarf Tree Frog	*Litoria fallax*			Y			Y	Y	Y								4
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*		Y	Y	Y	Y	Y	Y		Y						Y	8
Peron's Tree Frog	*Litoria peronii*		Y	Y		Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	12
Red-crowned Toadlet	*Pseudophryne australis*	NSW-V		Y													1
REPTILES (16 SPECIES)																	

SPECIES	SCIENTIFIC NAME	STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Dark-flecked Garden Sunskink	*Lampropholis delicata*		Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	12
Broad-tailed gecko	*Phyllurus platurus*		Y	Y		Y	Y	Y								Y	6
Burton's Legless-lizard	*Lialis burtonis*			Y													1
Copper-tailed skink	*Ctenotus taeniolatus*			Y													1
Eastern Blue-tongue Lizard	*Tiliqua scincoides*												Y				1
Eastern Long-necked Turtle	*Chelodina longicollis*			Y		Y		Y		Y	Y						5
Eastern Water Dragon	*Intellagama lesueurii*		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y			Y	11
Eastern Water-skink	*Eulamprus quoyii*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*		Y	Y		Y	Y	Y			Y						6
Jacky dragon	*Amphibolurus muricatus*			Y													1
Lace Monitor	*Varanus varius*			Y		Y											2
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*		Y	Y		Y	Y	Y			Y						6
Red-bellied Black Snake	*Pseudechis porphyriacus*					Y	Y				Y		Y				4
Stone Gecko	*Diplodactylus vittatus*			Y													1
Three-toed Skink	*Saiphos equalis*			Y													1
Weasel Skink	*Saproscincus mustelinus*		Y	Y		Y	Y	Y			Y					Y	7
MAMMALS (28 SPECIES)																	
Common Brushtail Possum	*Trichosurus vulpecula*		Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	12
Common Ringtail Possum	*Pseudocheirus peregrinus*		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	12
Grey-headed Flying-fox	*Pteropus poliocephalus*	NSW-V, FED-V	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	13
Long-nosed Bandicoot	*Perameles nasuta*					Y											1
Short-beaked echidna	*Tachyglossus aculeatus*		Y	Y		Y										Y	4
Sugar Glider	*Petaurus breviceps*			Y		Y		Y	Y								4
Swamp Wallaby	*Wallabia bicolor*		Y	Y		Y			Y								4
MICROBATS																	0
White-striped Free-tailed Bat	*Austronomus australis*		Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y		11
Gould's Wattled Bat	*Chalinolobus gouldii*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	13
Chocolate Wattled Bat	*Chalinolobus morio*			Y	Y			Y		Y						Y	5
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	NSW-V	Y							Y		Y					3
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*	NSW-V				Y	Y						Y	Y		Y	5
East-coast Free-tailed Bat	*Mormopterus norfolkensis*	NSW-V	Y			Y	Y										3
Ride's Free-tailed Bat	*Mormopterus ridei*		Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y		11
Large-footed Myotis	*Myotis macropus*	NSW-V	Y	Y		Y	Y	Y		Y		Y		Y			8
a Long-eared Bat	*Nyctophilus sp*		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	13

SPECIES	SCIENTIFIC NAME	STATUS	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	NSW-V	Y	Y	Y		Y	Y	Y			Y			Y		8
Greater Broad-nosed Bat	*Scoteanax rueppellii*	NSW-V					Y			Y	Y						3
Eastern Broad-nosed Bat	*Scotorepens orion*			Y		Y		Y				Y			Y		5
Large Forest Bat	*Vespadelus darlingtoni*											Y					1
a Forest Bat	*Vespadelus sp*		Y	Y		Y				Y			Y	Y			6
Little Forest Bat	*Vespadelus vulturnus*											Y					1
INTRODUCED MAMMALS																	
Black Rat	*Rattus rattus*		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	12
Cat (ID from hairtubes)	*Felis catus*									Y	Y				Y		3
Cat (from cams)	*Felis catus*		Y											Y		Y	3
Dog (ID from hairtubes)	*Canis lupus familiaris*						Y		Y								2
Dog (wild - ID from scats)	*Canis lupus familiaris*			Y							Y						2
House Mouse	*Mus musculus*											Y					1
Rabbit	*Oryctolagus cuniculus*					Y								Y			2
Red Fox	*Vulpes vulpes*		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	12
INVERTEBRATES																	
Dural Land Snail	*Pommehelix duralensis*	NSW-E, FED-E		Y			Y										2

11 APPENDIX B Combined Records -AE survey, Volunteers, Ebird and NSW Wildlife Atlas for period October 2016- April 2017

Y APPLIED ECOLOGY SURVEY

X Ebird

O COUNCIL/ BUSHCARE NETWORK

+ NSW WILDLIFE ATLAS (BIONET)

SPECIES	SCIENTIFIC NAME	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
AVES (105 SPECIES)																
Australasian Darter	*Anhinga novaehollandiae*		YXO										Y			2
Australasian Figbird	*Sphecotheres vieilloti*						O			X		Y	Y			4
Australasian Grebe	*Tachybaptus novaehollandiae*		YX													1
Australian Brush-turkey	*Alectura lathami*	Y	Y	YO	YXO		YXO	Y						Y		7
Australian King-Parrot	*Alisterus scapularis*	Y	YX	YO	YXO	Y	YO	YO		YX			Y	Y	Y	11
Australian Magpie	*Cracticus tibicen*	Y	YX	YO	YX		YO	YX	Y	YX	Y	Y	Y	Y	Y	13
Australian Pelican	*Pelecanus conspicillatus*												Y			1
Australian Raven	*Corvus coronoides*	Y	YX	O	YXO		YXO	YX	Y	Y	Y		Y	Y		11
Australian White Ibis	*Threskiornis molucca*			O					Y	X	Y		Y			5
Australian Wood Duck	*Chenonetta jubata*		YX		O				Y	YX	Y					5
Bell Miner	*Manorina melanophrys*	Y								Y	Y					3
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Y	YX		YX	Y		YX		YX	Y					7
Black-faced Monarch	*Monarcha melanopsis*	Y	Y		YXO	Y				Y			Y			6
Brown Cuckoo-dove	*Macropygia amboinensis*				O											1
Brown Falcon	*Falco berigora*									Y						1
Brown Gerygone	*Gerygone mouki*	Y	Y		YXO	Y	Y	YX		Y						7
Brown Goshawk	*Accipiter fasciatus*		Y						Y	Y						3
Brown Thornbill	*Acanthiza pusilla*	Y	YX		YXO	Y	Y	Y								6
Channel-billed Cuckoo	*Scythrops novaehollandiae*		YX	O	XO		O	X		X						6
Chestnut Teal	*Anas castanea*		Y													1
Common Myna	*Sturnus tristis*		Y				O	YX	Y	YX+	Y	Y	Y			8
Common Starling	*Sturnus vulgaris*										Y					1
Crested Pigeon	*Ocyphaps lophotes*		X	O	XO				Y	YX	Y		Y			7
Crested Tern	*Thalasseus bergii*												Y			1
Crimson Rosella	*Platycercus elegans*	Y	YX	O	YXO	Y	O	Y							Y	8
Dollar Bird	*Eurystomus orientalis*	Y	Y		YX	Y		Y	O	YX	Y			Y		9
Domestic Duck	*Anas platyrhynchos domesticus*		Y													1
Dusky Moorhen	*Gallinula tenebrosa*		YX	Y			YO			Y	Y					5

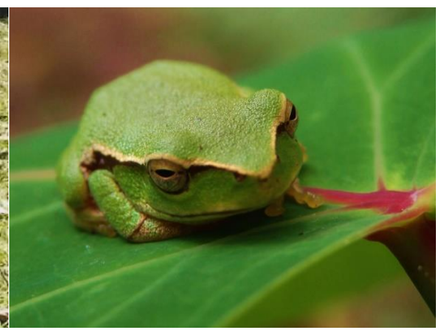
SPECIES	SCIENTIFIC NAME	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Eastern Koel	*Eudynamys orientalis*	Y	YX	O	YXO	Y	YO	YX	Y	YX	Y	Y	Y			12
Eastern Rosella	*Platycercus eximius*		Y			Y		YO	Y	Y	Y			Y	Y	8
Eastern Spinebill	*Acanthorhynchus tenuirostris*	Y	Y		YXO	Y		Y		Y						6
Eastern Whipbird	*Psophodes olivaceus*	Y	YX	O	YXO	Y	YO	YX	Y	Y	Y			Y		11
Eastern Yellow Robin	*Eopsaltria australis*	Y	YX	Y	YXO	Y	YX	Y		Y	Y					9
Eurasian Coot	*Fulica atra*		Y													1
European Blackbird	*Turdus merula*									Y	Y		Y			3
Forest Kingfisher*	*Todiramphus macleayii*		O													1
Galah	*Eolophus roseicapillus*		X	O	X		YO			YX			Y			6
Golden Whistler	*Pachycephala pectoralis*	Y	Y		YX	Y	YO	YX		Y			Y			8
Great Egret	*Ardea alba*		Y								Y		Y			3
Grey Butcherbird	*Cracticus torquatus*		YX	YO	XO		XO	X	Y	YX	Y			Y		9
Grey Fantail	*Rhipidura albiscapa*	Y	Y		YX	Y		Y		Y			Y			7
Grey Goshawk	*Accipiter novaehollandiae*				X											1
Grey Shrike-thrush	*Colluricincla harmonica*		X													1
House Sparrow	*Passer domesticus*									Y						1
Intermediate Egret	*Ardea intermedia*		O													1
Laughing Kookaburra	*Dacelo novaeguineae*	Y	YXO	YO	YXO	Y	YO	YX	Y	Y	Y	Y		Y	Y	13
Leaden Flycatcher	*Myiagra rubecula*				X	Y		Y		Y						4
Lewins Honeyeater	*Meliphaga lewinii*	Y	YXO		YX	Y				Y						5
Little Black Cormorant	*Phalacrocorax sulcirostris*		YX							Y	Y					3
Little Corella	*Cacatua sanguinea*	Y	X	O	O	Y			Y	YX						7
Little Pied Cormorant	*Microcarbo melanoleucos*		YX			Y										2
Little Wattlebird	*Anthochaera chrysoptera*		X		YXO					Y	Y					4
Long-billed Corella	*Cacatua tenuirostris*				YX				Y							2
Magpie-lark	*Grallina cyanoleuca*		O	Y			YO	Y	Y	YX	Y	Y	Y		Y	10
Masked Lapwing	*Vanellus miles*			O					Y							2
Mistletoebird	*Dicaeum hirundinaceum*		Y							Y						2
Musk Lorikeet	*Glossopsitta concinna*				X					YX				Y	Y	4
New Holland Honeyeater	*Phylidonyris novaehollandiae*	Y	Y		X	Y				Y	Y	Y				7
Noisy Friarbird	*Philemon corniculatus*				X						Y					2
Noisy Miner	*Manorina melanocephala*	Y	YX	Y	YXO	Y	YXO	YXO	Y	YX	Y	Y	Y	Y	Y	14
Nutmeg Mannikin	*Lonchura punctulata*											Y				1
Olive-backed Oriole	*Oriolus sagittatus*		YXO		XO					Y	Y	Y				5
Pacific Baza	*Aviceda subcristata*				X			Y								2
Pacific Black Duck	*Anas superciliosa*	Y	YXO	O	X				Y	Y	Y					7
Pied Currawong	*Strepera graculina*	Y	YX	YO	YX	Y	YO	YX	Y	YX		Y	Y	Y	Y	13
Powerful Owl	*Ninox strenua*		Y		YX	Y	YX							Y		5
Rainbow Lorikeet	*Trichoglossus haematodus*	Y	YX	YO	YXO	Y	YO	YXO	Y	YX	Y	Y	Y	Y	Y	14

SPECIES	SCIENTIFIC NAME	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Red Wattlebird	*Anthochaera carunculata*	Y	Y		YX	Y	O	YX		Y	Y	Y	Y			10
Red-browed Finch	*Neochmia temporalis*	Y	Y		YX	Y	Y	Y		Y	Y	Y	Y			10
Red-rumped Parrot	*Psephotus haematonotus*									Y	Y					2
Red-whiskered Bulbul	*Pycnonotus jocosus*	Y	Y		YX	Y	Y	YX	Y	Y	Y	Y	Y	Y		12
Restless Flycatcher	*Myiagra inquieta*		O													1
Rock Dove	*Columba livia*			O	O				Y	YX			Y			5
Royal Spoonbill	*Platalea regia*												Y			1
Rufous Fantail	*Rhipidura rufifrons*	Y	Y		YX	Y	YO	Y			Y					7
Sacred Kingfisher	*Todiramphus sanctus*	Y	YX		YX					Y			Y			5
Satin Bowerbird	*Ptilonorhynchus violaceus*		Y		YX		YO	X		Y	Y					6
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*									Y						1
Scarlet Honeyeater	*Myzomela sanguinolenta*	Y	YXO		Y	Y										4
Silver Gull	*Chroicocephalus novaehollandiae*												Y			1
Silvereye	*Zosterops lateralis*	Y	Y		X	Y		YX		Y	Y	Y	Y			9
Southern Boobook	*Ninox novaeseelandiae*	Y	YX	O	YX	Y	O									6
Spotted Pardalote	*Pardalotus punctatus*	Y	YXO		YX	Y	Y	YX		Y	Y	Y				9
Spotted Turtle-Dove	*Streptopelia chinensis*		YX			Y		Y		YX	Y	Y				6
Striated Thornbill	*Acanthiza lineata*	Y			X											2
Sulphur-crested Cockatoo	*Cacatua galerita*	Y	YXO	YO	YXO	Y	YO	YX	Y	YX	Y	Y		Y	Y	13
Superb Fairy-wren	*Malurus cyaneus*	Y	YXO	Y	YXO	Y	YO	YX	Y	YX	Y	Y	Y		Y	13
Tawny Frogmouth	*Podargus strigoides*	Y	Y	O	YX	Y		YXO	Y	Y	Y		Y			10
Varied sitella	*Daphoenositta chrysoptera*		Y													1
Variegated Fairy-wren	*Malurus lamberti*		YX		YX					+						3
Welcome Swallow	*Hirundo neoxena*		YO					Y	Y	YX	Y		Y			6
White-bellied Sea-eagle	*Haliaeetus leucogaster*		X										Y			2
White-browed Scrubwren	*Sericornis frontalis*	Y	Y	YO	YXO	Y	YXO	YX	Y	Y	Y	Y	Y		Y	13
White-cheeked Honeyeater	*Phylidonyris niger*	Y	Y		X											3
White-faced Heron	*Egretta novaehollandiae*		YXO				Y					Y	Y			4
White-headed Stilt	*Himantopus himantopus*												Y			1
White-plumed Honeyeater	*Lichenostomus penicillatus*									Y	Y					2
White-throated Needletail	*Hirundapus caudacutus*		X		X					Y						3
White-throated Nightjar	*Eurostopodus mystacalis*		Y													1
White-throated Treecreeper	*Cormobates leucophaea*		Y		YXO											2
Willie Wagtail	*Rhipidura leucophrys*					Y		Y		YX	Y	Y				5
Yellow Thornbill	*Acanthiza nana*	Y	Y					Y		Y	Y					5
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*	Y	YX		YX	Y				Y		Y			Y	7
Yellow-tailed Black Cockatoo				O												1

SPECIES	SCIENTIFIC NAME	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
* Unusual sighting - vagrant.																
AMPHIBIANS (8 SPECIES)																
Brown-striped Frog	*Limnodynastes peronii*	Y	Y	YO	Y	Y	Y	Y	Y	Y					Y	10
Bibron's Toadlet	*Pseudophryne bibronii*	Y	Y			Y										3
Bleating Tree Frog	*Litoria dentata*						O									1
Common Eastern Froglet	*Crinia signifera*	Y	Y	Y	Y	Y	YO	Y	Y	Y			Y		Y	11
Eastern Dwarf Tree Frog	*Litoria fallax*		Y			Y	YO	Y								4
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*	Y	Y	YO	Y	Y	Y	Y	Y						Y	9
Peron's Tree Frog	*Litoria peronii*	Y	Y	O	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	13
Red-crowned Toadlet	*Pseudophryne australis*	O	Y													2
REPTILES (16 SPECIES)																
Dark-flecked Garden Sunskink	*Lampropholis delicata*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14
Broad-tailed gecko	*Phyllurus platurus*	Y	Y		Y	Y	Y								Y	6
Burton's Legless-lizard	*Lialis burtonis*		Y													1
Common (Green) Tree Snake	Dendrelaphis punctulata	O														1
Copper-tailed skink	*Ctenotus taeniolatus*		Y													1
Eastern Blue-tongue Lizard	*Tiliqua scincoides*			O								Y				2
Eastern Long-necked Turtle	*Chelodina longicollis*		Y		Y		Y	Y	Y	Y						6
Eastern Water Dragon	*Intellagama lesueurii*	Y	YO	YO	Y	Y	Y	YO	Y	Y		Y			Y	11
Eastern Water-skink	*Eulamprus quoyii*	Y	Y	YO	Y	Y	YO	Y	Y	Y	Y	Y	Y	Y	Y	14
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*	Y	Y		Y	Y	Y			Y						6
Jacky dragon	*Amphibolurus muricatus*		Y						Y							2
Lace Monitor	*Varanus varius*		YO		YO											2
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*	Y	Y		Y	Y	Y			Y						6
Red-bellied Black Snake	*Pseudechis porphyriacus*		O		Y	Y				Y+		Y				5
Stone Gecko	*Diplodactylus vittatus*		Y													1
Three-toed Skink	*Saiphos equalis*		Y													1
Weasel Skink	*Saproscincus mustelinus*	Y	Y		Y	Y	Y			Y					Y	7
MAMMALS (28 SPECIES)																
Common Brushtail Possum	*Trichosurus vulpecula*	Y	Y	O	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	13
Black Rat	*Rattus rattus*	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	12
Common Ringtail Possum	*Pseudocheirus peregrinus*	Y	Y	YO	Y	Y	Y	Y	Y	Y		Y	Y		Y	12
a Forest Bat	*Vespadelus sp*	Y	Y		Y				Y			Y	Y			6
a Long-eared Bat	*Nyctophilus sp*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	13
Cat (ID from hairtubes)	*Felis catus*								Y	Y				Y		3
Cat (ID from cam)		Y											Y		Y	3

SPECIES	SCIENTIFIC NAME	DARLING MILLS CREEK CORRIDOR	HUNTS CREEK CORRIDOR	DEVLINS CREEK CORRIDOR	TERRYS CREEK CORRIDOR	QUARRY BRANCH CREEK CORRIDOR	VINEYARD CREEK CORRIDOR	UPPER PONDS CREEK CORRIDOR	LOWER PONDS-SUBIACO CREEKS CORRIDOR	UPPER TOONGABBIE CREEK CORRIDOR	LOWER TOONGABBIE CREEK CORRIDOR	BALUDARRI WETLAND	ERMINGTON BAY	EDNA HUNT SANCTUARY	HAINES AVE RESERVE	# RESERVES SIGHTED
Chocolate Wattled Bat	*Chalinolobus morio*		Y	Y			Y		Y						Y	5
Dog (ID from hairtubes)	*Canis lupus familiaris*					Y		Y								2
Dog (wild - ID from scats)	*Canis lupus familiaris*		Y							Y						2
East-coast Free-tailed Bat	*Mormopterus norfolkensis*	Y			Y	Y										3
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*				Y	Y						Y	Y		Y	5
Eastern Broad-nosed Bat	*Scotorepens orion*		Y		Y		Y				Y			Y		5
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	Y							Y		Y					3
Gould's Wattled Bat	*Chalinolobus gouldii*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	13
Greater Broad-nosed Bat	*Scoteanax rueppellii*					Y			Y	Y						3
Grey-headed Flying-fox	*Pteropus poliocephalus*	Y	Y	YO	Y	Y	YO	YO	Y	Y		Y	Y	Y	Y	13
House Mouse	*Mus musculus*										Y					1
Large Forest Bat	*Vespadelus darlingtoni*										Y					1
Large-footed Myotis	*Myotis macropus*	Y	Y		Y	Y	Y		Y		Y		Y			8
Little Forest Bat	*Vespadelus vulturnus*										Y					1
Long-nosed Bandicoot	*Perameles nasuta*				Y											1
Rabbit	*Oryctolagus cuniculus*				Y								Y			2
Red Fox	*Vulpes vulpes*	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	12
Ride's Free-tailed Bat	*Mormopterus ridei*	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y		11
Short-beaked echidna	*Tachyglossus aculeatus*	Y	Y		YO										Y	4
Sugar Glider	*Petaurus breviceps*		Y	O	Y		Y	Y								5
Swamp Wallaby	*Wallabia bicolor*	Y	Y		YO			Y								4
White-striped Free-tailed Bat	*Austronomus australis*	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y		11
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	Y	Y	Y		Y	Y	Y			Y			Y		8
INVERTEBRATES																
Dural Land Snail	*Pommehelix duralensis*		Y			Y										2

A Pacific Baza (above) is occasionally spotted in Hunts Creek Sanctuary (photo: Steve Paterson)



A Common (Green) Tree Snake was spotted by volunteers near the Randal Crescent Bushcare site at Darling Mills Corridor Northmea (photo:Leah Marshall)

An Echidna (centre left) spotted at Parramatta Park near Westmead gatehouse (Photo: Wayne de Belin).

A Green Stream Frog (Left) are regularly spotted in Hunts Creek Sanctuary (photo: Steve Paterson).

A male Swamp Wallaby is a semi-regular visiror to back yards along Terrys Creek (Photo: "Friends of Terrys Creek" member- Virginia)

12 APPENDIX C THE BUSHLAND CORRIDORS

1.1 DEVLINS CREEK

The Devlins Creek corridor is located in the suburb of Beecroft near the M2 motorway and is best accessed via Plympton Road in the south or Allerton Road in the north. It consists of two disjunct areas within the LGA but is joined by a continuous bushland corridor in the abutting Shire of Hornsby LGA, albeit bisected by the M2 motorway.

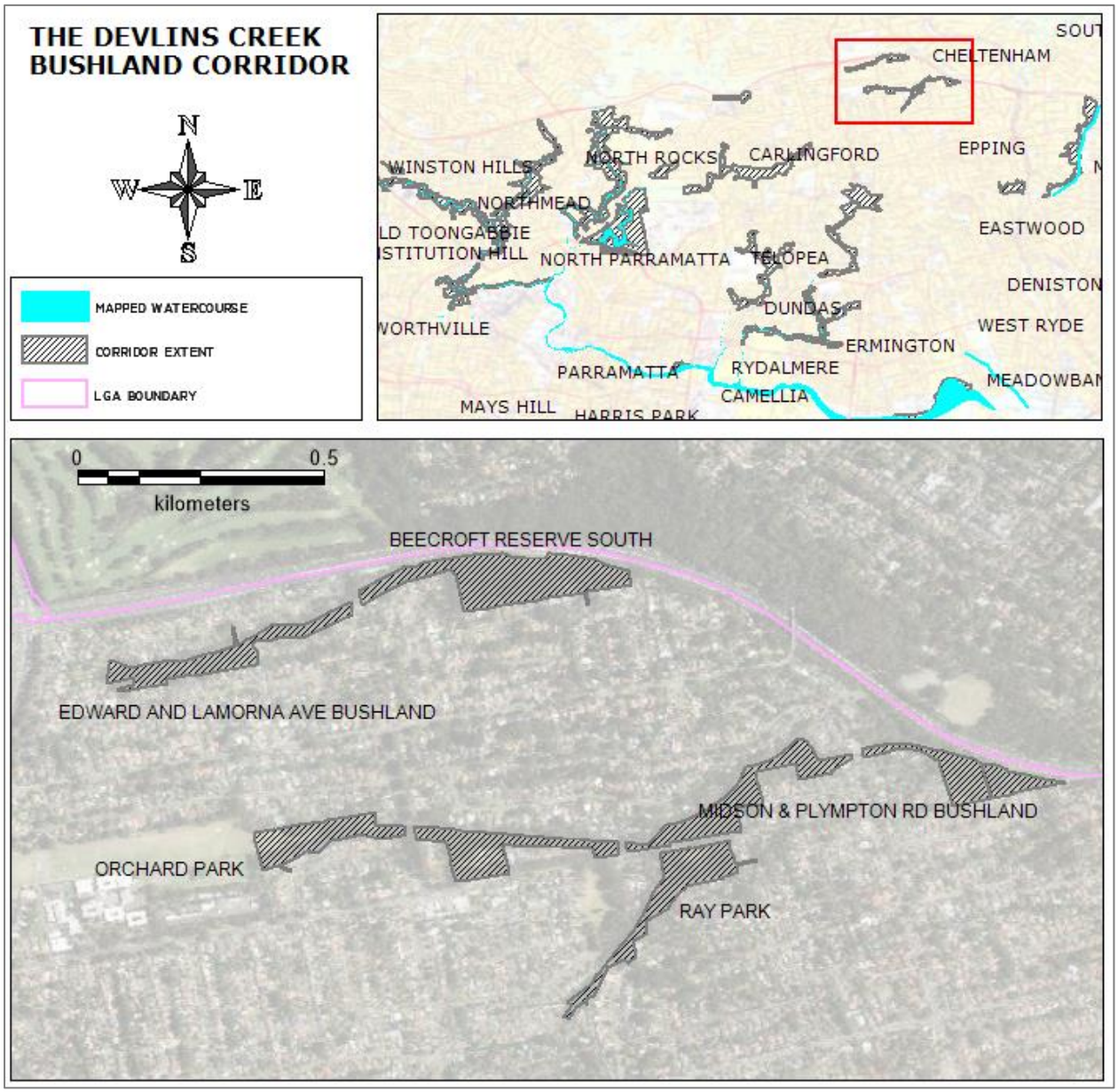


Figure 76 Devlins Creek Bushland Corridor locality overview

The corridor is 16.42 hectares in area with approximately 8.5 kilometres of edge and contains five named reserves. There is a significant underpass at the M2 at Beecroft Reserve South which would allow some movement of fauna. Despite noise and vibration at this location several frog species persist in the creek at this location. The eastern portion of the corridor cannot be accessed via track/trail from the Beecroft Reserve South along the M2.

Four vegetation communities occur within the corridor, two of which are listed as critically endangered under the Federal EPBC Act - Sydney Turpentine-ironbark Forest and Blue Gum High Forest in the Sydney Basin Bioregion.

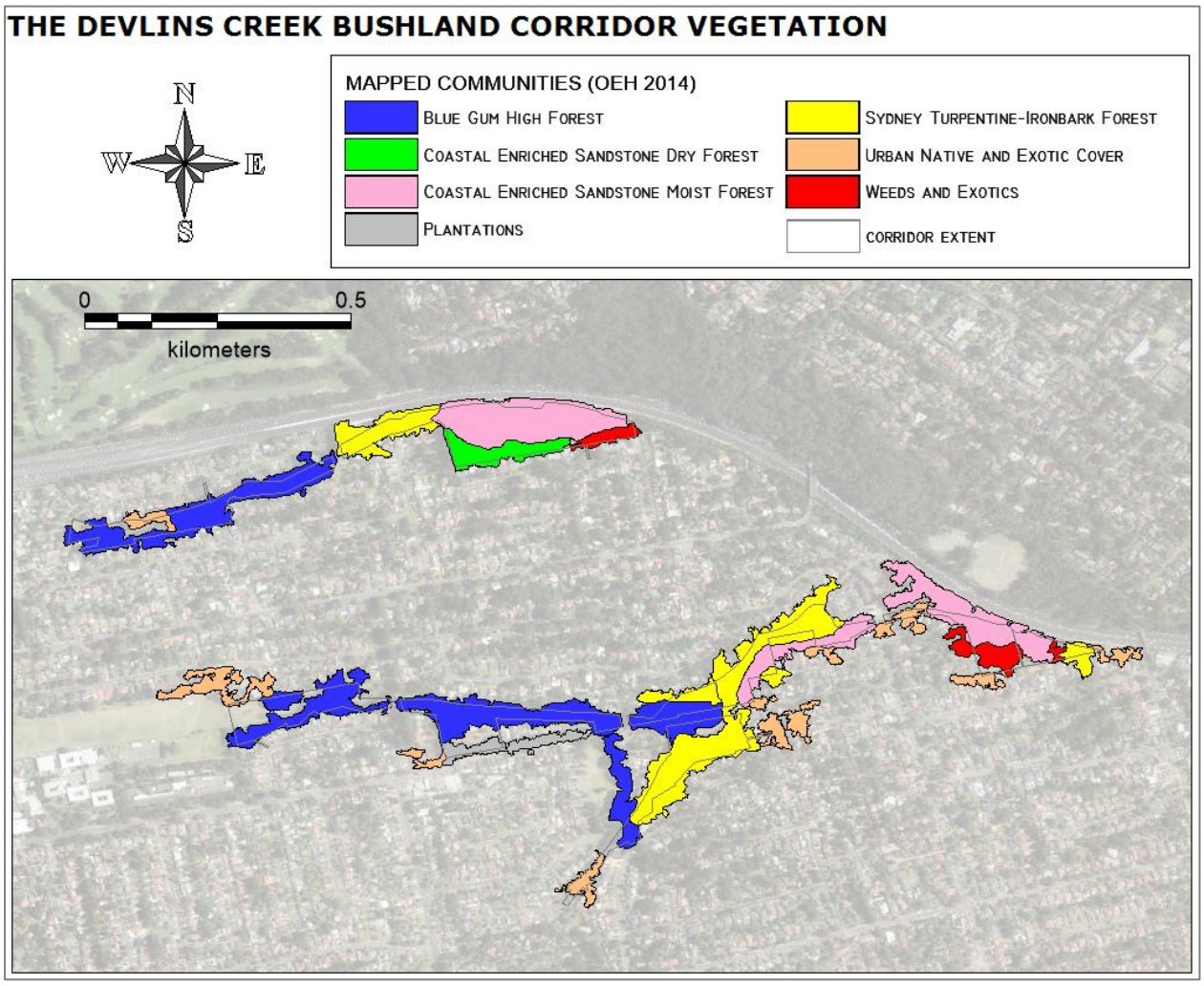


Figure 77 Mapped vegetation communities of Devlins Creek Bushland Corridor

Figure 78 Coastal Enriched Sandstone Moist Forest at Beecroft Reserve South (M2 motorway in background)

Figure 79 Devlins Creek at Ray Park after rain

Figure 80 Sydney Turpentine-ironbark forest at Ray park (left) and Midson & Plympton Rd Bushland (right)

Figure 81 Walking tracks at Ray park (left) and Midson & Plympton Rd Bushland (right)

Figure 82 Weed issues along the M2 at Midson & Plympton Rd Bushland

KEY ASSETS: Stunning examples of mature trees from STIF & BGHF communities, excellent walking tracks, active bushcare, well maintained nest boxes and "bee motels", numerous interpretive signs appropriate for the high usage by walkers of various capabilities that utilize the reserves.

Table 21 Species richness summary

CLASS	SPECIES COUNT
BIRDS	14
MAMMALS	8
REPTILES	2
AMPHIBIANS	3

KEY CONSTRAINTS: Corridor is narrow, long edged and primarily riparian, disjunct with significant weed issues where access is difficult, traffic noise from the M2 is significant in places, bird species dominated by Noisy Miners and Rainbow Lorikeets, a large flock of Sulphur-crested cockatoos roosts in the Beecroft Reserve South.

Table 22 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey		✓	
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation		✓	
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 23 Devlins Creek Species List

BIRDS	
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Dusky Moorhen	*Gallinula tenebrosa*
Eastern Yellow Robin	*Eopsaltria australis*
Grey Butcherbird	*Cracticus torquatus*
Laughing Kookaburra	*Dacelo novaeguineae*
Magpie-lark	*Grallina cyanoleuca*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
White-browed Scrubwren	*Sericornis frontalis*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
REPTILES	
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
MAMMALS	
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*

1.2 HAINES AVENUE RESERVE

Haines Avenue Reserve is located between Haines Avenue and the M2 motorway in the suburb of Carlingford. It extends in a narrow band along the M2 to the west, north of the Royal Institute for Deaf and Blind Children. A tributary of Blue Gum Creek runs through the reserve and links the reserve to a large bushland corridor to the north of the M2 in the Hills Shire via a large culvert under the M2 that provides access to walkers to safely traverse from one side of the M2 to the other. **The reserve is 4.73 hectares in area with 1.8 kilometres of edge and contains one named reserve.**

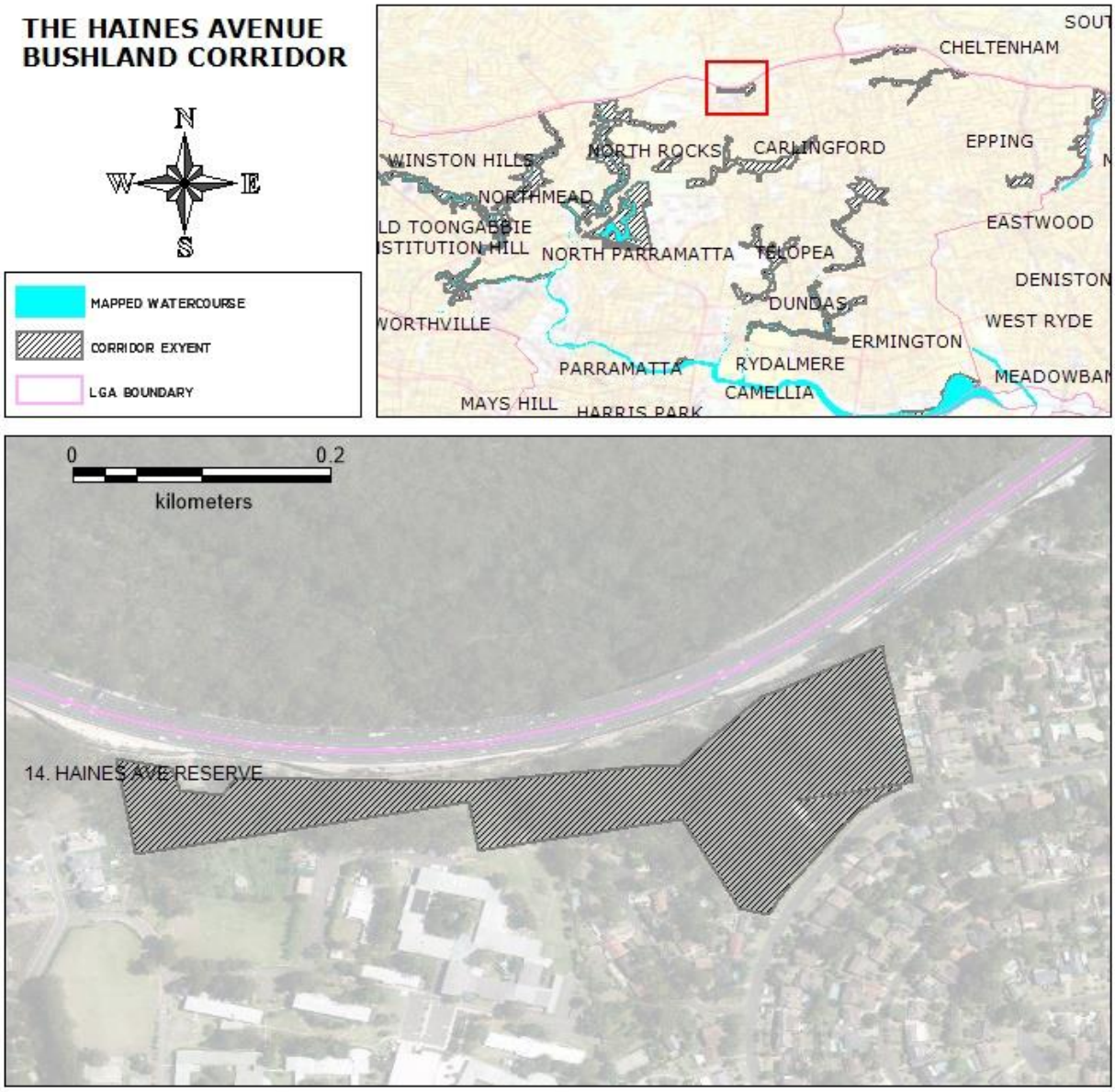


Figure 83 Haines Avenue Bushland Corridor locality overview

The corridor contains two mapped vegetation communities, however this mapping could be refined particularly in the vicinity of the watercourse.

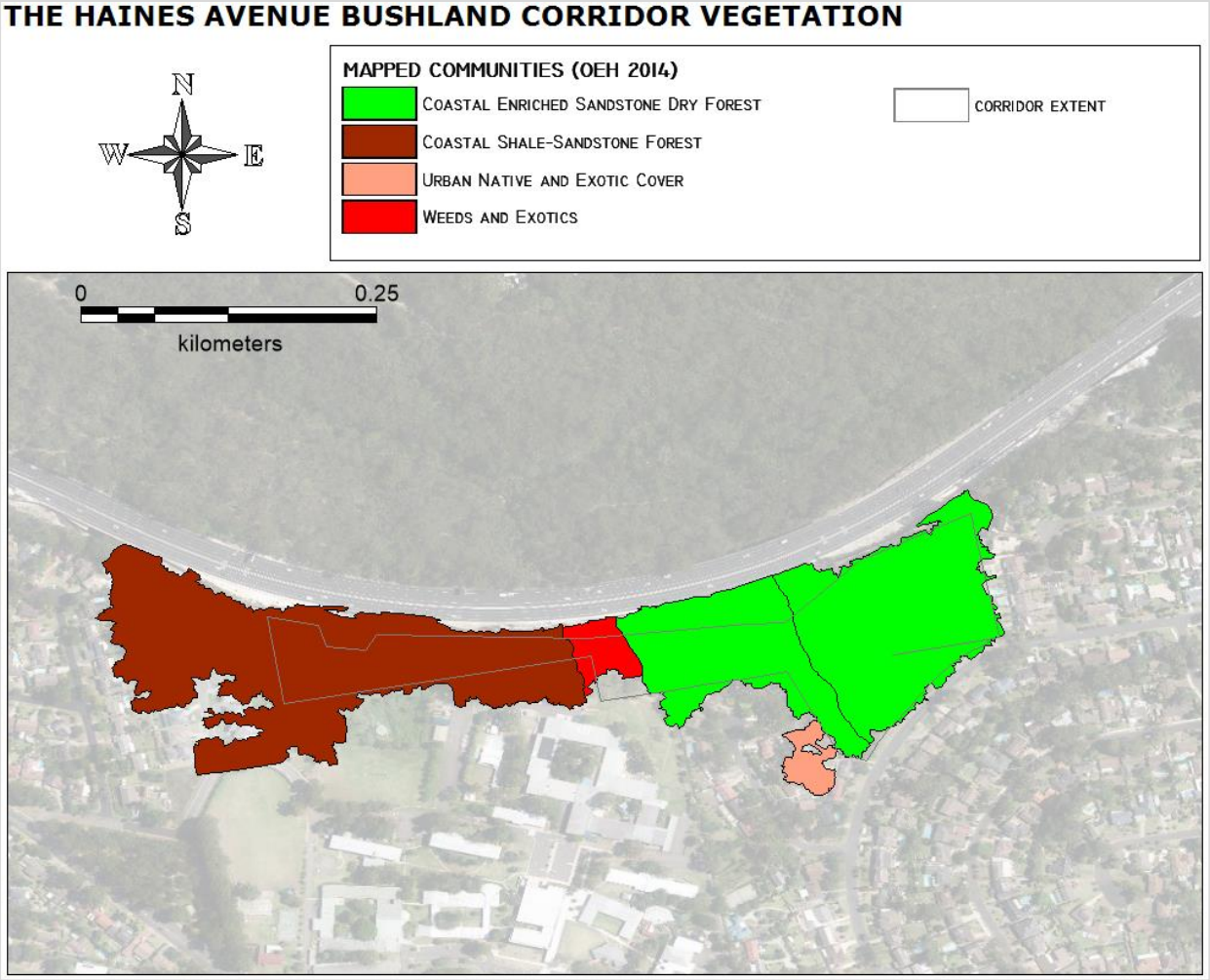


Figure 84 Mapped vegetation communities of Haines Avenue Bushland Corridor

Figure 85 Coastal Enriched Sandstone Dry forest at the eastern, elevated portion of the reserve

Figure 86 Tall, moist forest dominates the gully surrounding the creekline

KEY ASSETS: Some connectivity. Good mix of dry and wet/moist forest types in small area. Walkers are restricted to a single trail in the east with informal trails in the western portion of the reserve. Abundant nest boxes of various sizes in reasonable to good condition. A storm water detention pond on the edge of the reserve provides good off stream habitat for a variety of frog species.

Table 24 Species richness summary

CLASS	SPECIES COUNT
BIRDS	14
MAMMALS	10
REPTILES	5
AMPHIBIANS	4

KEY CONSTRAINTS: Corridor is narrow, long edged and degraded in areas, somewhat disjunct between the west and east portion, traffic noise from the M2 is significant in places, bird species dominated by Sulphur-crested Cockatoos, Noisy Miners and Rainbow Lorikeets. A large flock of Sulphur-crested Cockatoos roosts in the reserve at night.

Table 25 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey		✓	
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation	✓		
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails		✓	
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 26 Haines Avenue Species list

BIRDS	
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Crimson Rosella	*Platycercus elegans*
Eastern Rosella	*Platycercus eximius*
Laughing Kookaburra	*Dacelo novaeguineae*
Magpie-lark	*Grallina cyanoleuca*
Musk Lorikeet	*Glossopsitta concinna*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
White-browed Scrubwren	*Sericornis frontalis*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Broad-tailed gecko	*Phyllurus platurus*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Short-beaked echidna	*Tachyglossus aculeatus*
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*
a Long-eared Bat	*Nyctophilus sp*
Black Rat	*Rattus rattus*
Red Fox	*Vulpes vulpes*

1.3 DARLING MILLS BUSHLAND CORRIDOR

This large corridor is located between Windsor Road to the west and North Rocks Road to the east. The M2 motorway forms its northern boundary at the limit of the LGA and it extends southward to the Cumberland Hwy. The corridor is essentially a U- shaped ravine – a long, narrow and small valley with steep sides - the product of streamcutting erosion. Darling Mills Creek runs through the corridor and joins the corridor to large areas of bushland in the Hills Shire north of the M2 motorway via a large underpass. Rifle Range Creek flows westward into Darling Mills Creek forming a confluence below Ventura Road. A large damn wall is centrally located within the corridor. It is a significant waterway within the LGA as it meets Hunts Creek downstream of Lake Parramatta, before reaching its confluence with the Toongabbie Creek to form the Parramatta River.

The corridor is 57.36 hectares in area and has approximately 19.5 kilometres of edge. Although large the corridor is essentially covered by one named reserve, “Excelsior Reserve”, with three smaller named reserves on the periphery.

Figure 87 The Darling Mills dam

Figure 88 Darling Mills Creek upstraem of confluence with Rifle Range Creek

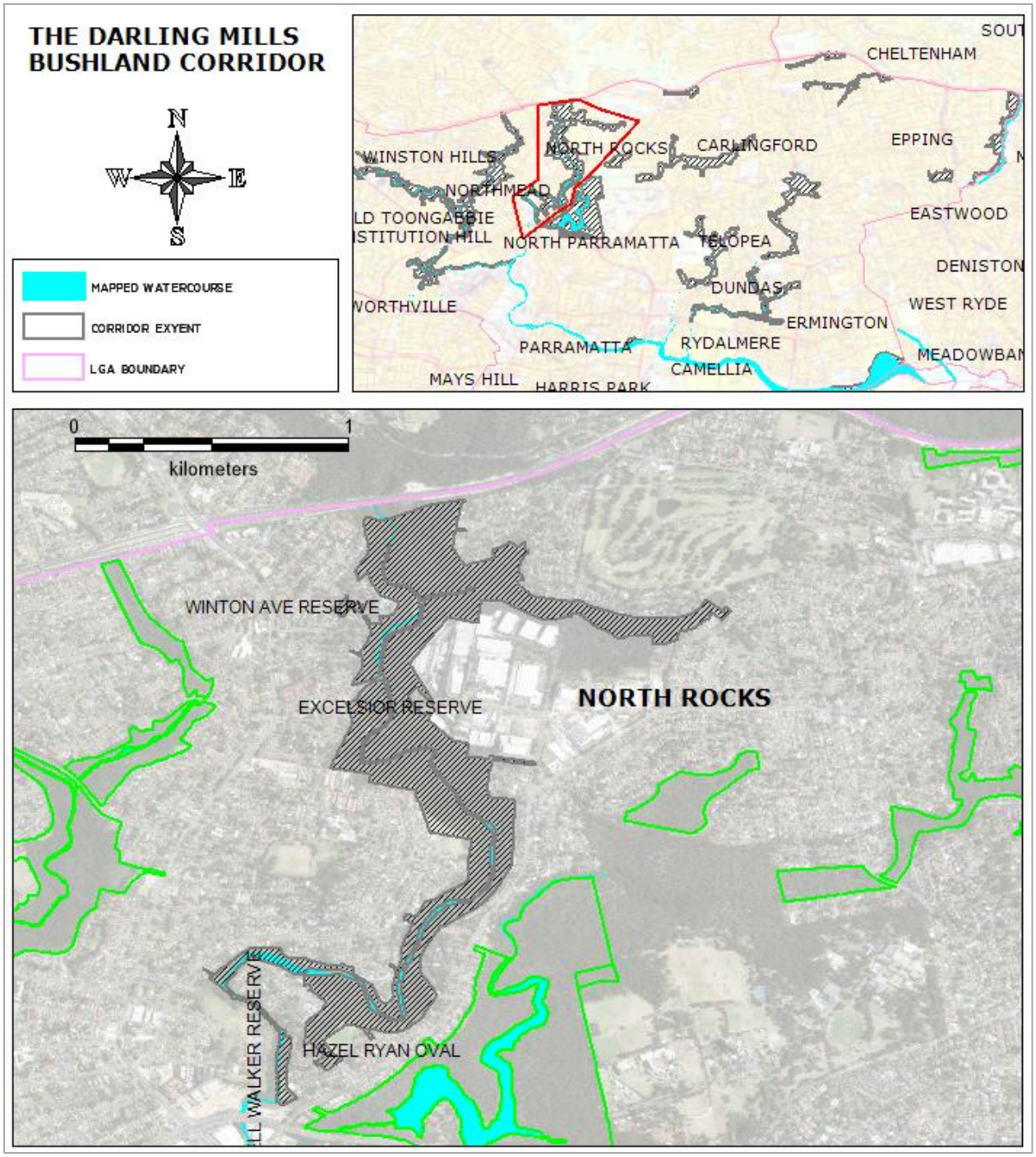


Figure 89 Darling Mills Bushland Corridor locality overview

The corridor contains five mapped vegetation communities one of which is critically endangered at a State and Federal level – Sydney Turpentine-ironbark Forest.

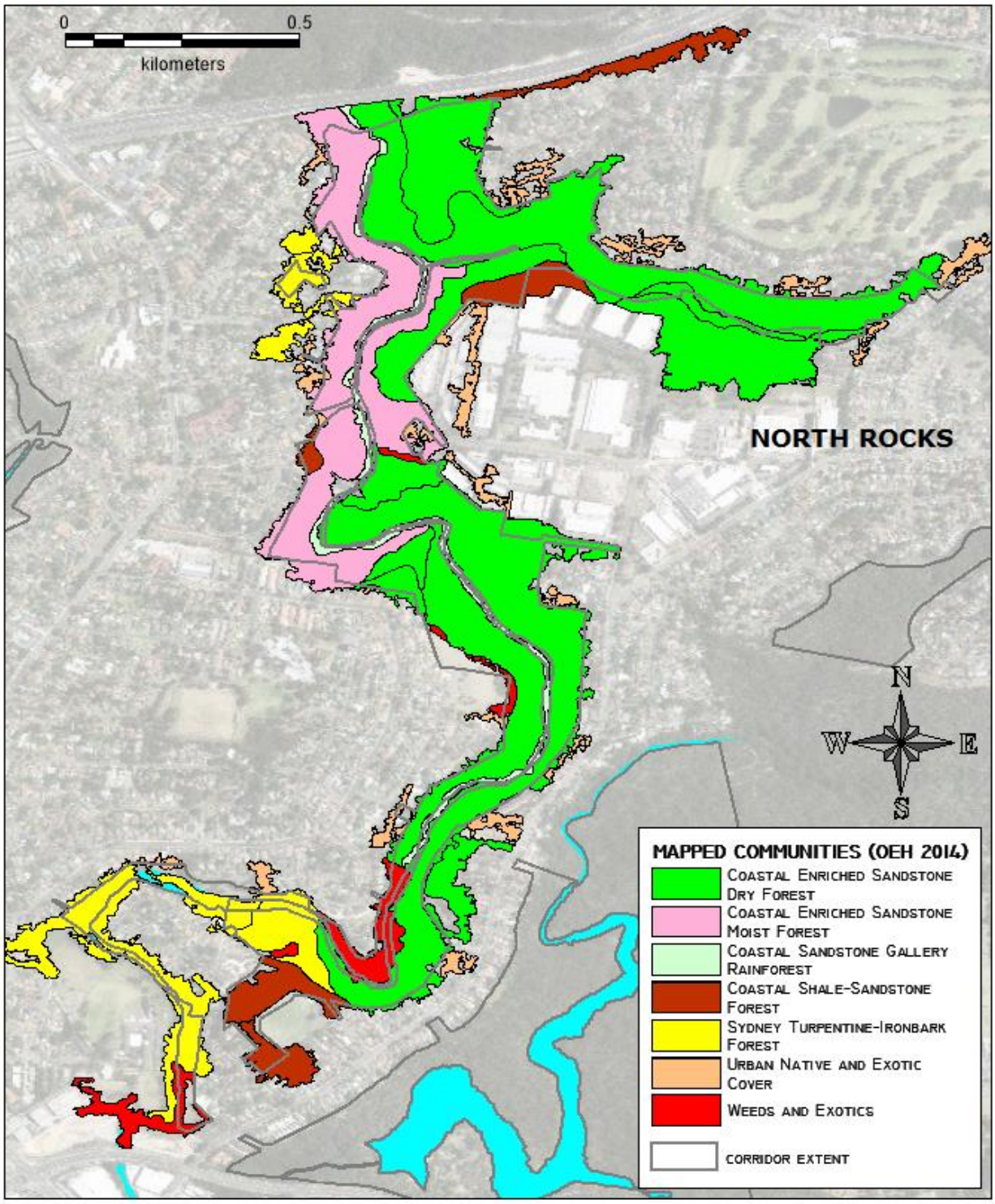


Figure 90 Mapped vegetation communities of Darling Mills Bushland Corridor

Figure 91 Coastal Enriched Sandstone Dry Forest below Sophia Crescent North Rocks

Figure 92 A wide trail follows the western edge of Darling Mills Creek (left) between the dam wall and the M2 (and beyond). Current road works have closed the trail (right) at the M2 limiting usage by the public during the survey period.

Figure 93 Coastal Sandstone Gallery Rainforest occurs along the creek line

KEY ASSETS: Some connectivity. Good mix of dry and wet/moist forest types over a large area. Access for most walkers is quite poor and there are not many informal trails within the corridor considering its size. Steep topography in many places makes access difficult. Good bird watching sites off Pye Avenue, Ventura Road and Sophie Crescent Northmead/North Rocks.

Table 27 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	42
MAMMALS	17
REPTILES	7
AMPHIBIANS	5

KEY CONSTRAINTS: Significant weed issues in parts of the reserve particularly in the riparian zone of Darling Mills Creek. Observed sewer overflows in Rifle Range Creek = poor water quality at times. Corridor is narrow in the southern section, generally steep to very steep in the north and central sections making weed control difficult and expensive, traffic noise from the M2 is significant along the northern edge where some of the best habitat exists. Bell Miner colony below Pye Avenue entrance.

Table 28 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey	✓		
Infrequent fire regime (more than 10 years between fires)	✓*		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits		✓	
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation	✓		
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)			✓
Rubbish dumping evident			✓

**The fire interval in the north east portion of the reserve may be less than 10 years*

Table 29 Darling Mills Species list

BIRDS	
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Bell Miner	*Manorina melanophrys*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Black-faced Monarch	*Monarcha melanopsis*
Brown Gerygone	*Gerygone mouki*
Brown Thornbill	*Acanthiza pusilla*
Crimson Rosella	*Platycercus elegans*
Dollar Bird	*Eurystomus orientalis*
Eastern Koel	*Eudynamys orientalis*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Golden Whistler	*Pachycephala pectoralis*
Grey Fantail	*Rhipidura albiscapa*
Laughing Kookaburra	*Dacelo novaeguineae*
Lewins Honeyeater	*Meliphaga lewinii*
Little Corella	*Cacatua sanguinea*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Miner	*Manorina melanocephala*
Pacific Black Duck	*Anas superciliosa*
Pied Currawong	*Strepera graculina*

Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Rufous Fantail	*Rhipidura rufifrons*
Sacred Kingfisher	*Todiramphus sanctus*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Silvereye	*Zosterops lateralis*
Southern Boobook	*Ninox novaeseelandiae*
Spotted Pardalote	*Pardalotus punctatus*
Striated Thornbill	*Acanthiza lineata*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
White-browed Scrubwren	*Sericornis frontalis*
White-cheeked Honeyeater	*Phylidonyris niger*
Yellow Thornbill	*Acanthiza nana*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
Red-whiskered Bulbul	*Pycnonotus jocosus*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Bibron's Toadlet	*Pseudophryne bibronii*
Common Eastern Froglet	*Crinia signifera*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Broad-tailed gecko	*Phyllurus platurus*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Short-beaked echidna	*Tachyglossus aculeatus*
Swamp Wallaby	*Wallabia bicolor*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
East-coast Free-tailed Bat	*Mormopterus norfolkensis*
Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
a Forest Bat	*Vespadelus sp*
Black Rat	*Rattus rattus*
Red Fox	*Vulpes vulpes*
Cat	*Felis catus*

1.4 HUNTS CREEK CORRIDOR (INCLUDES LAKE PARRAMATTA RESERVE)

The largest bushland corridor within the LGA consists of lands that abut Hunts Creek. The corridor begins in the east at Jenkins Road in Carlingford and winds in a south- west direction to the junction of North Rocks road and the Cumberland HWY at North Parramatta. Large areas of bushland within the corridor are managed by others but are currently managed for conservation creating a continuous corridor of bushland from Carlingford to North Parramatta. The area managed by Council totals 105.9 hectares in area and has approximately 21.61 kilometres of edge.

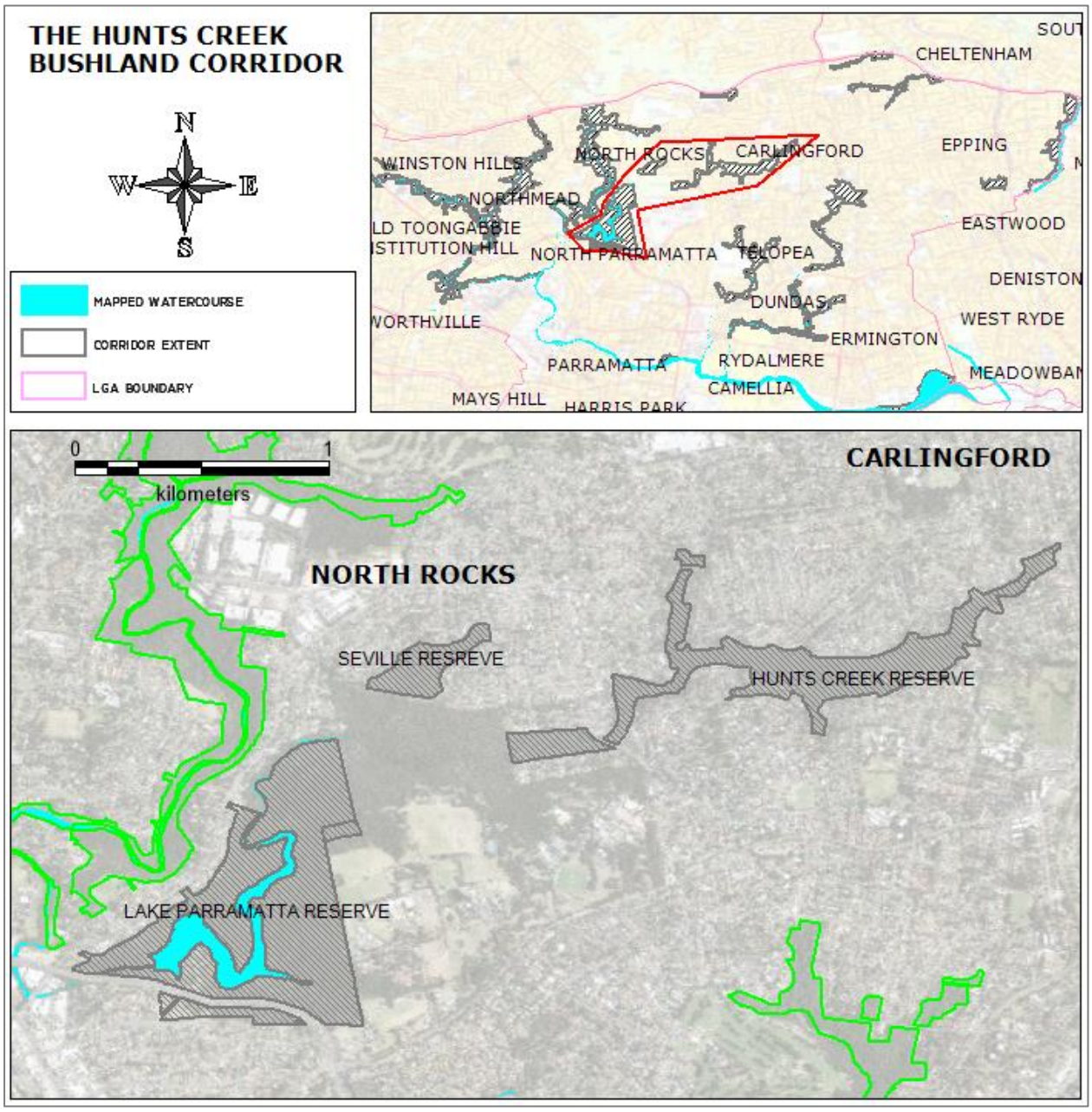


Figure 94 Hunts Creek Bushland Corridor locality overview

The corridor contains five mapped vegetation communities one of which is critically endangered at a State and Federal level – Sydney Turpentine-ironbark Forest.

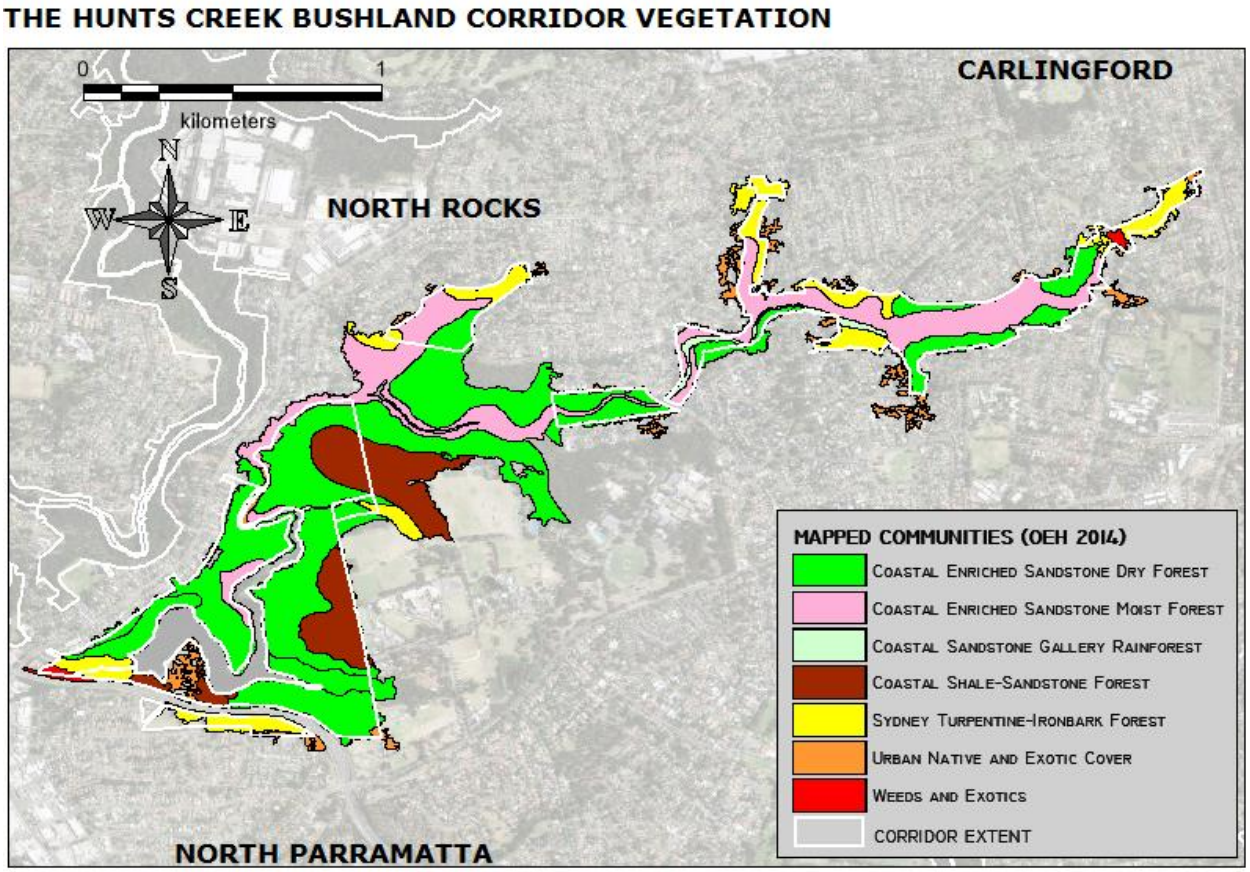


Figure 95 Mapped vegetation communities of Hunts Creek Bushland Corridor

Figure 96 STIF community at Sevilles Reserve (left) and Coastal Enriched Sandstone Dry Forest at Hunts Creek Reserve (right)

Figure 97 Hunts Creek north of Lake Parramatta at Lake Parramatta Reserve

Figure 98 Coastal Enriched Sandstone Dry Forest (left) and Coastal Enriched Sandstone Moist Forest (right) at Lake Parramatta Reserve

KEY ASSETS: Size, reserve shape- particularly from Lake Parramatta Reserve though to Sevilles Reserve. Close proximity to Darling Mills Reserve allows relatively easy movement of volant species between the reserves. Mix of dry and wet/moist forest type across varied topography. Good water quality. Abundant nest boxes of various sizes in reasonable to good condition, abundant natural hollows. Large areas of predominantly weed free bush in Lake Parramatta Reserve. Consolidation and closure of tracks appears successful in Lake Parramatta (and should be implemented in Hunts Creek Reserve). Multiple walks/spots provide excellent bird watching opportunities.

Table 30 Species richness summary

CLASS	SPECIES COUNT
BIRDS	65
MAMMALS	18
REPTILES	14
AMPHIBIANS	7
INVERTEBRATES	1

KEY CONSTRAINTS: Lacks true connectivity. Corridor is very narrow north of Sevilles Reserve, long edged and degraded in areas. High recreation use – can disturb wildlife. Bike riding on smaller, narrow tracks is a threat to reptiles – particularly in Lake Parramatta Reserve. The Kings School has fenced it's property with 6 foot chainmesh and barbed wire fencing. This fence is breached in several locations, however, it still acts as a major barrier to fauna movements .The barbed wire is a direct threat to Sugar Gliders and other arboreal mammals.

Figure 99 3 strands of barbed wire atop a 6 foot chain mesh fence that extends almost across the entire corridor.

Hunts Creek has a rich bird fauna despite being dominated by two aggressive natives - Noisy Miners and Rainbow Lorikeets. A large flock of Sulphur-crested Cockatoos also roosts in Hunts Creek Reserve.

Table 31 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey	✓		
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation	✓		
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails	✓		
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 32 Hunts Creek Corridor Species List

BIRDS	
Australasian Darter	*Anhinga novaehollandiae*
Australasian Grebe	*Tachybaptus novaehollandiae*
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Australian Wood Duck	*Chenonetta jubata*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Black-faced Monarch	*Monarcha melanopsis*
Brown Gerygone	*Gerygone mouki*
Brown Goshawk	*Accipiter fasciatus*
Brown Thornbill	*Acanthiza pusilla*
Channel-billed Cuckoo	*Scythrops novaehollandiae*
Chestnut Teal	*Anas castanea*
Crimson Rosella	*Platycercus elegans*

Dollar Bird	*Eurystomus orientalis*
Dusky Moorhen	*Gallinula tenebrosa*
Great Egret	*Ardea alba*
Eastern Koel	*Eudynamys orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Eurasian Coot	*Fulica atra*
Golden Whistler	*Pachycephala pectoralis*
Grey Butcherbird	*Cracticus torquatus*
Grey Fantail	*Rhipidura albiscapa*
Laughing Kookaburra	*Dacelo novaeguineae*
Lewins Honeyeater	*Meliphaga lewinii*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Pied Cormorant	*Microcarbo melanoleucos*
Mistletoebird	*Dicaeum hirundinaceum*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Miner	*Manorina melanocephala*
Olive-backed Oriole	*Oriolus sagittatus*
Pacific Black Duck	*Anas superciliosa*
Pied Currawong	*Strepera graculina*
Powerful Owl	*Ninox strenua*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Rufous Fantail	*Rhipidura rufifrons*
Sacred Kingfisher	*Todiramphus sanctus*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Silvereye	*Zosterops lateralis*
Southern Boobook	*Ninox novaeseelandiae*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Varied sitella	*Daphoenositta chrysoptera*
Variegated Fairy-wren	*Malurus lamberti*
Welcome Swallow	*Hirundo neoxena*
White-browed Scrubwren	*Sericornis frontalis*
White-cheeked Honeyeater	*Phylidonyris niger*
White-faced Heron	*Egretta novaehollandiae*
White-throated Nightjar	*Eurostopodus mystacalis*
White-throated Treecreeper	*Cormobates leucophaea*
Yellow Thornbill	*Acanthiza nana*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
Common Myna	*Sturnus tristis*
Domestic Duck	*Anas platyrhynchos domesticus*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Spotted Turtle-Dove	*Streptopelia chinensis*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Bibron's Toadlet	*Pseudophryne bibronii*
Common Eastern Froglet	*Crinia signifera*
Eastern Dwarf Tree Frog	*Litoria fallax*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*

Peron's Tree Frog	*Litoria peronii*
Red-crowned Toadlet	*Pseudophryne australis*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Broad-tailed gecko	*Phyllurus platurus*
Burton's Legless-lizard	*Lialis burtonis*
Copper-tailed skink	*Ctenotus taeniolatus*
Eastern Long-necked Turtle	*Chelodina longicollis*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*
Jacky dragon	*Amphibolurus muricatus*
Lace Monitor	*Varanus varius*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Stone Gecko	*Diplodactylus vittatus*
Three-toed Skink	*Saiphos equalis*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Short-beaked echidna	*Tachyglossus aculeatus*
Sugar Glider	*Petaurus breviceps*
Swamp Wallaby	*Wallabia bicolor*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Eastern Broad-nosed Bat	*Scotorepens orion*
a Forest Bat	*Vespadelus sp*
Black Rat	*Rattus rattus*
Dog (wild - ID from scats)	*Canis lupus familiaris*
Red Fox	*Vulpes vulpes*

1.5 THE QUARRY BRANCH BUSHLAND CORRIDOR

The Quarry Branch Bushland Reserve Corridor follows Quarry Branch Creek to Moxham Road in the south from the M2 Motorway in the north. It ends before the confluence of Quarry Branch Creek and Toongabbie Creek but is part of three named corridors that form a long narrow but contiguous vegetated corridor that is the largest in the LGA. **The Quarry Branch corridor is 36.09 hectares in area and has 10.72 kilometres of edge.** It contains 3 named reserves.

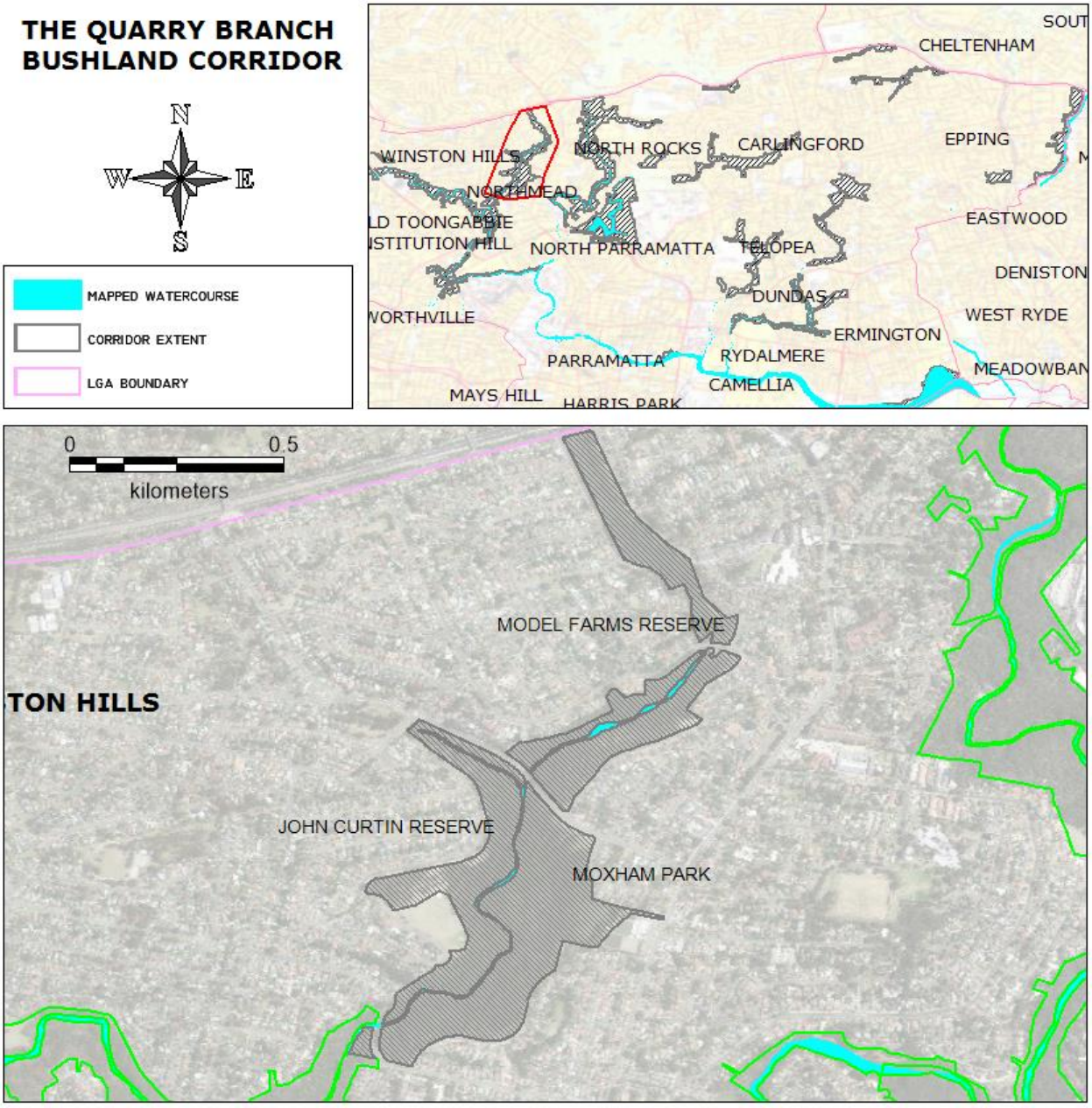


Figure 100 Quarry Branch Bushland Corridor locality overview

The corridor contains six mapped vegetation communities two of which are critically endangered at a State and Federal level – Sydney Turpentine-ironbark Forest and Cumberland Shale Plains Woodland.

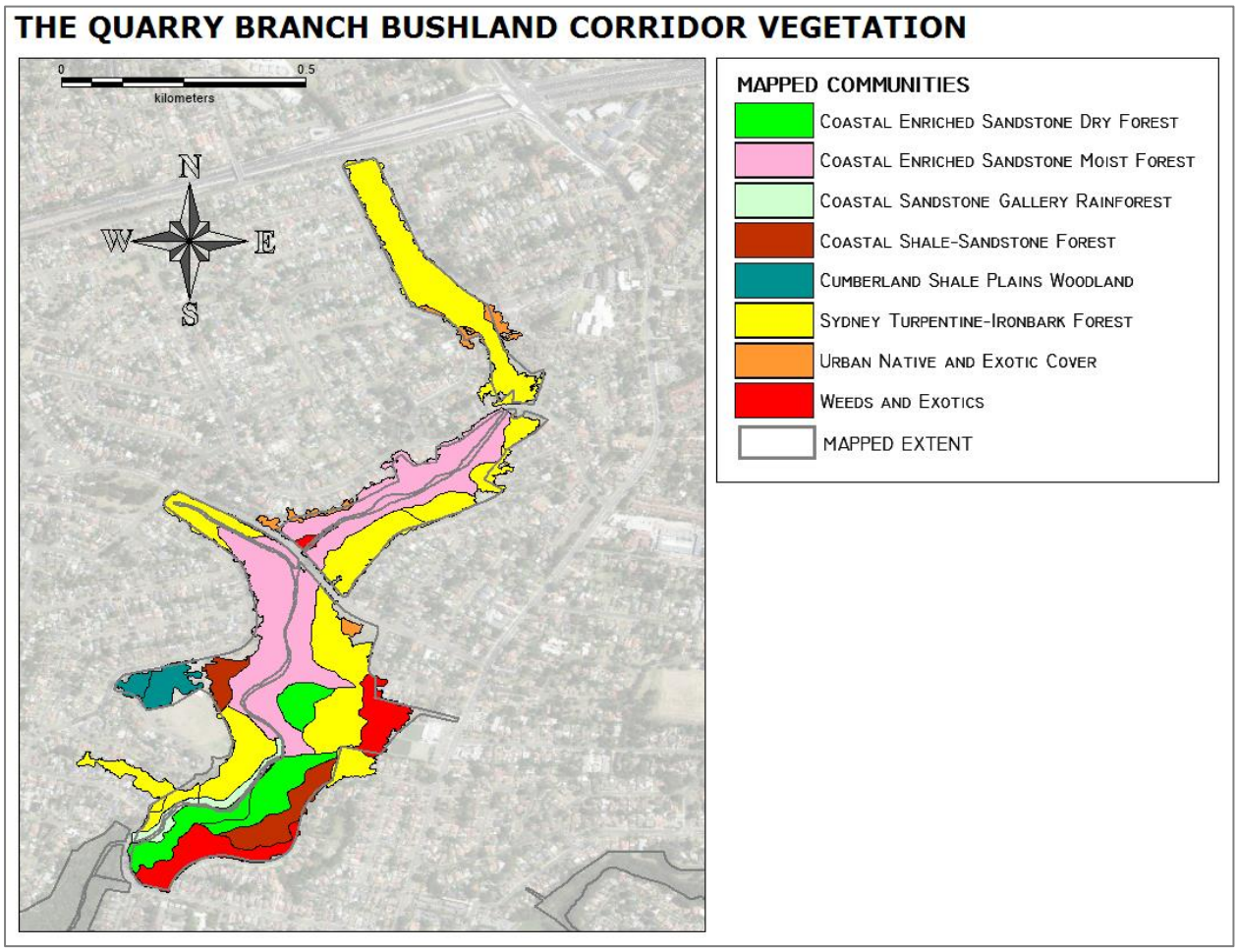


Figure 101 Mapped vegetation communities of Quarry Branch Bushland Corridor

KEY ASSETS: Mix of dry and wet/moist forest type across varied topography. Appears to have good water quality. Abundant nest boxes of various sizes in reasonable to good condition, abundant natural hollows. Good areas of predominantly weed free bush. Consolidation and attempted closure of informal tracks appears to have mixed results. Noisy miners are not a major issue, despite being present, compared to other reserves of similar width.

Table 33 Species richness summary

CLASS	SPECIES COUNT
BIRDS	40
MAMMALS	15
REPTILES	8
AMPHIBIANS	6
INVERTEBRATES	1

KEY CONSTRAINTS: Lacks connectivity. Weed issues in places (however active bushcare/bush regen works is evident)particularly along edges. Large Rainbow Lorikeet population and other parrots generally. Appears to have a resilient and active fox population (multiple sightings/abundant scats).

Table 34 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey	✓		
Infrequent fire regime (more than 10 years between fires)		?	
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits			✓

Aspect	Present	Minor or patchy	Absent/no
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation		✓	
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails	✓		
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 35 Attempts to close some tracks appears to be challenging

Figure 102 Just a few of the parrots that breed in the corridor- Rainbow Lorikeet (left), Crimson Rosella (centre) and Long-billed Corella (right)

Table 36 Quarry Branch Species List

BIRDS	
Australian King-Parrot	*Alisterus scapularis*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Black-faced Monarch	*Monarcha melanopsis*
Brown Gerygone	*Gerygone mouki*
Brown Thornbill	*Acanthiza pusilla*
Crimson Rosella	*Platycercus elegans*

Dollar Bird	*Eurystomus orientalis*
Eastern Koel	*Eudynamys orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Golden Whistler	*Pachycephala pectoralis*
Grey Fantail	*Rhipidura albiscapa*
Laughing Kookaburra	*Dacelo novaeguineae*
Leaden Flycatcher	*Myiagra rubecula*
Lewins Honeyeater	*Meliphaga lewinii*
Little Corella	*Cacatua sanguinea*
Little Pied Cormorant	*Microcarbo melanoleucos*
Long-billed Corella	*Cacatua tenuirostris*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Powerful Owl	*Ninox strenua*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Rufous Fantail	*Rhipidura rufifrons*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Silvereye	*Zosterops lateralis*
Southern Boobook	*Ninox novaeseelandiae*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
White-browed Scrubwren	*Sericornis frontalis*
Willie Wagtail	*Rhipidura leucophrys*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Spotted Turtle-Dove	*Streptopelia chinensis*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Bibron's Toadlet	*Pseudophryne bibronii*
Common Eastern Froglet	*Crinia signifera*
Eastern Dwarf Tree Frog	*Litoria fallax*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Broad-tailed gecko	*Phyllurus platurus*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Red-bellied Black Snake	*Pseudechis porphyriacus*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*
East-coast Free-tailed Bat	*Mormopterus norfolkensis*

Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Black Rat	*Rattus rattus*
Dog (ID from hairtubes)	*Canis lupus familiaris*
Red Fox	*Vulpes vulpes*
INVERTEBRATES	
Dural Land Snail	*Pommehelix duralensis*

1.6 UPPER TOONGABBIE CREEK CORRIDOR

The Upper Toongabbie Creek Corridor extends south and west from Moxham Road in Northmead to the western edge of the LGA near McCoy Street Seven Hills. It takes in the most southern reaches of Quarry Branch Creek, the confluence with Toongabbie Creek and all of the upper reaches of Toongabbie Creek up to the headwaters known as Blacktown Creek. **The corridor is 63.45 hectares in area and has 20.06 km of edge.** It contains 11 named reserves.

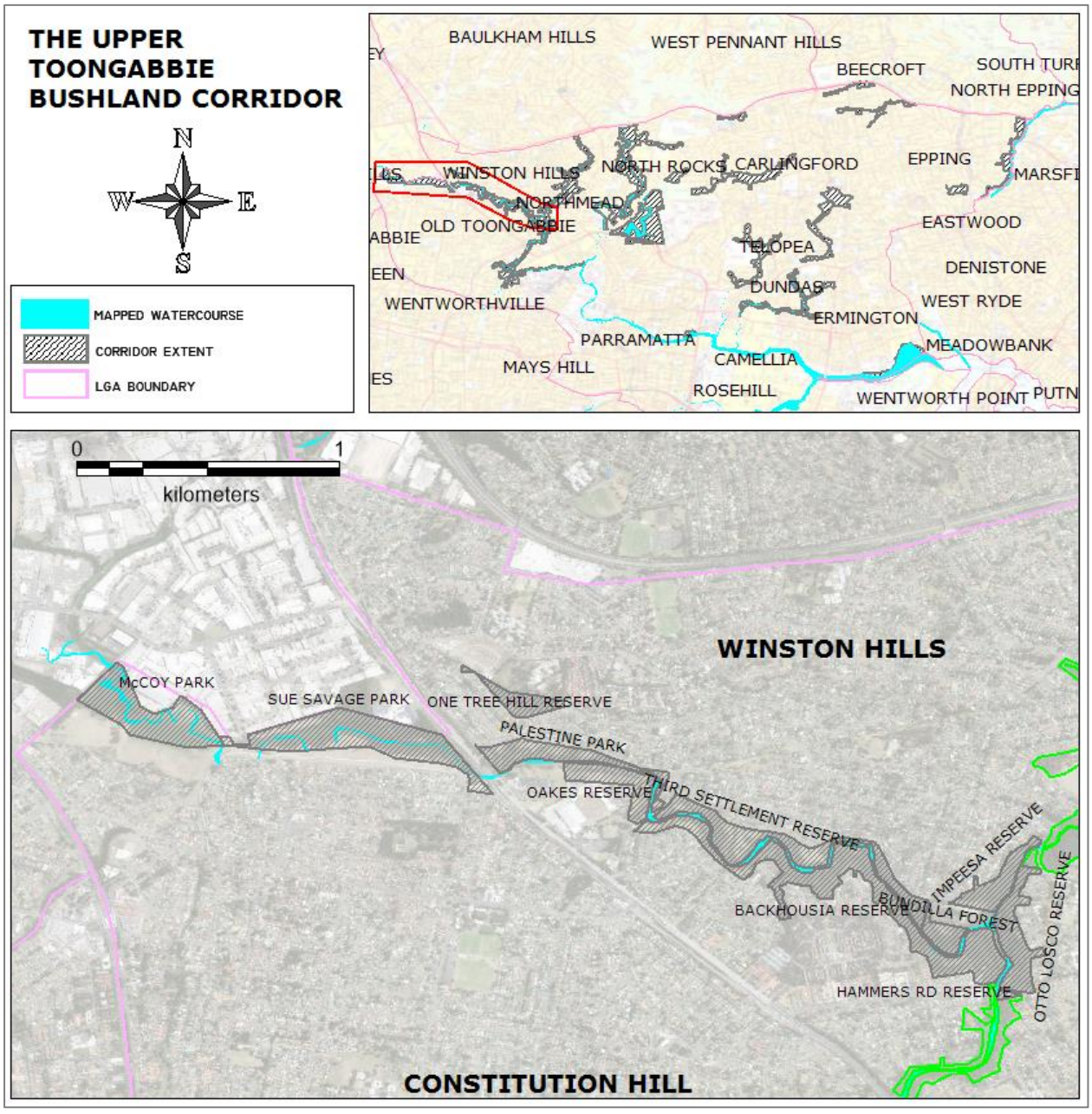


Figure 103 Upper Toogabbie Creek Corridor locality overview

The corridor contains four mapped native vegetation communities, two of which are critically endangered at a State and Federal level – Sydney Turpentine-ironbark Forest and Cumberland Shale Plains Woodland.

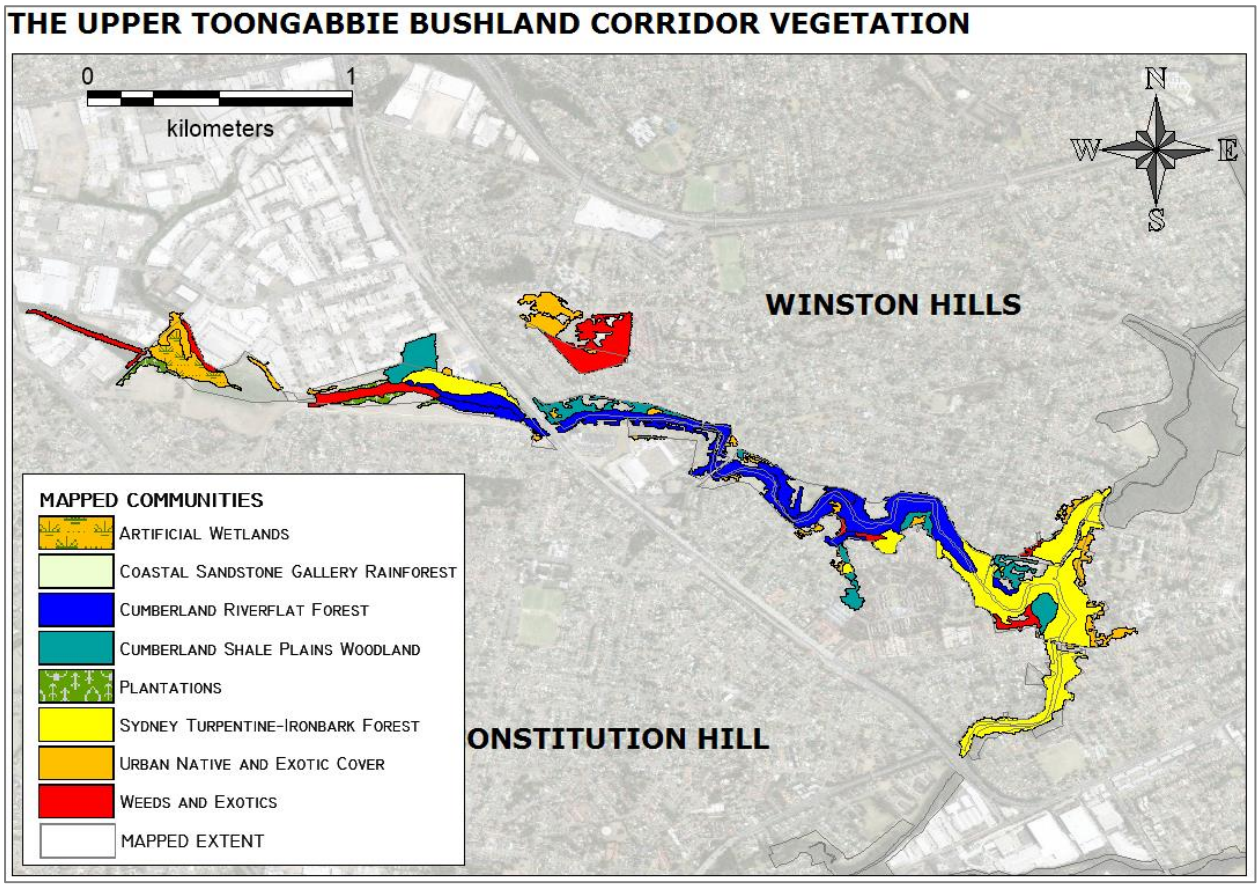


Figure 104 Mapped vegetation communities of Upper Toongabbie Creek Corridor

Figure 105 Toongabbie Creek at Sue Savage Park (left) and at Third Settlement Reserve (right)

Figure 106 Turbid stormwater enters Toongabbie Creek at Sue Savage Park after rainfall

Figure 107 Weed issues along Toongabbie Creek at Backhousia Reserve

KEY ASSETS: Along with Lower Toongabbie Creek, the only corridor with significant area of Cumberland Plain Woodland resulting in a slightly different suite of bird species to elsewhere in the LGA. Despite the "weediness" of the corridor the excellent trails (the Pemulwuy Loop & Settlers walk) provide a great experience for birdwatchers and other recreational users. Abundant nest boxes of various sizes in reasonable

to good condition, abundant natural hollows. Noisy miners are not a major issue, despite being present & active, compared to other reserves of similar width.

Table 37 Species richness summary

CLASS	SPECIES COUNT
BIRDS	60
MAMMALS	12
REPTILES	8
AMPHIBIANS	3

KEY CONSTRAINTS: Narrow and long corridor, abundant weeds in certain locations. Removal of weeds leaves an absent or very sparse understorey and midstorey in some areas. Two Bell miner colonies. Appears to have a resilient and active fox population (multiple sightings/abundant scats).

Table 38 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident		✓	
Complex and well developed mid-storey		✓	
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare		✓	
Evidence of rabbits		✓	
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity		✓	
Leaf litter present on >50% of ground		✓	
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation		✓	
Fallen timber and logs are left on the ground		✓	
Multiple tracks, informal trails	✓		
Low abundance of weeds (most remnants contain some weeds)			✓
Rubbish dumping evident		✓	

Figure 108 Large carp are very common in Toongabbie Creek

Table 39 Upper Toongabbie Corridor Species List

BIRDS	
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Australian Wood Duck	*Chenonetta jubata*
Bell Miner	*Manorina melanophrys*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Black-faced Monarch	*Monarcha melanopsis*
Brown Falcon	*Falco berigora*
Brown Gerygone	*Gerygone mouki*
Crested Pigeon	*Ocyphaps lophotes*
Dollar Bird	*Eurystomus orientalis*
Dusky Moorhen	*Gallinula tenebrosa*
Eastern Koel	*Eudynamys orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Galah	*Eolophus roseicapillus*
Golden Whistler	*Pachycephala pectoralis*
Grey Butcherbird	*Cracticus torquatus*
Grey Fantail	*Rhipidura albiscapa*
Laughing Kookaburra	*Dacelo novaeguineae*
Leaden Flycatcher	*Myiagra rubecula*
Lewins Honeyeater	*Meliphaga lewinii*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Corella	*Cacatua sanguinea*
Little Wattlebird	*Anthochaera chrysoptera*
Magpie-lark	*Grallina cyanoleuca*
Mistletoebird	*Dicaeum hirundinaceum*
Musk Lorikeet	*Glossopsitta concinna*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Miner	*Manorina melanocephala*
Olive-backed Oriole	*Oriolus sagittatus*
Pacific Black Duck	*Anas superciliosa*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Red-rumped Parrot	*Psephotus haematonotus*
Sacred Kingfisher	*Todiramphus sanctus*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*
Silvereye	*Zosterops lateralis*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Welcome Swallow	*Hirundo neoxena*
White-browed Scrubwren	*Sericornis frontalis*
White-plumed Honeyeater	*Lichenostomus penicillatus*
White-throated Needletail	*Hirundapus caudacutus*
Willie Wagtail	*Rhipidura leucophrys*
Yellow Thornbill	*Acanthiza nana*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
Common Myna	*Sturnus tristis*

European Blackbird	*Turdus merula*
House Sparrow	*Passer domesticus*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Rock Dove	*Columba livia*
Spotted Turtle-Dove	*Streptopelia chinensis*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Eastern Long-necked Turtle	*Chelodina longicollis*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Red-bellied Black Snake	*Pseudechis porphyriacus*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Ride's Free-tailed Bat	*Mormopterus ridei*
a Long-eared Bat	*Nyctophilus sp*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
Black Rat	*Rattus rattus*
Cat (ID from hairtubes)	*Felis catus*
Dog (wild - ID from scats)	*Canis lupus familiaris*
Red Fox	*Vulpes vulpes*

1.7 THE LOWER TOONGABBIE BUSHLAND CORRIDOR VEGETATION

The corridor begins south of Hammers Road and extends downstream along Toongabbie Creek. The creek flows eastward after the confluence with Coopers Creek at Wentworthville north of Westmead Hospital where it joins Darling Mills Creek to form the Parramatta River in North Parramatta. **The corridor is to 28.66 hectares in area with 14.83 kilometres of edge.** It contains 8 named reserves.

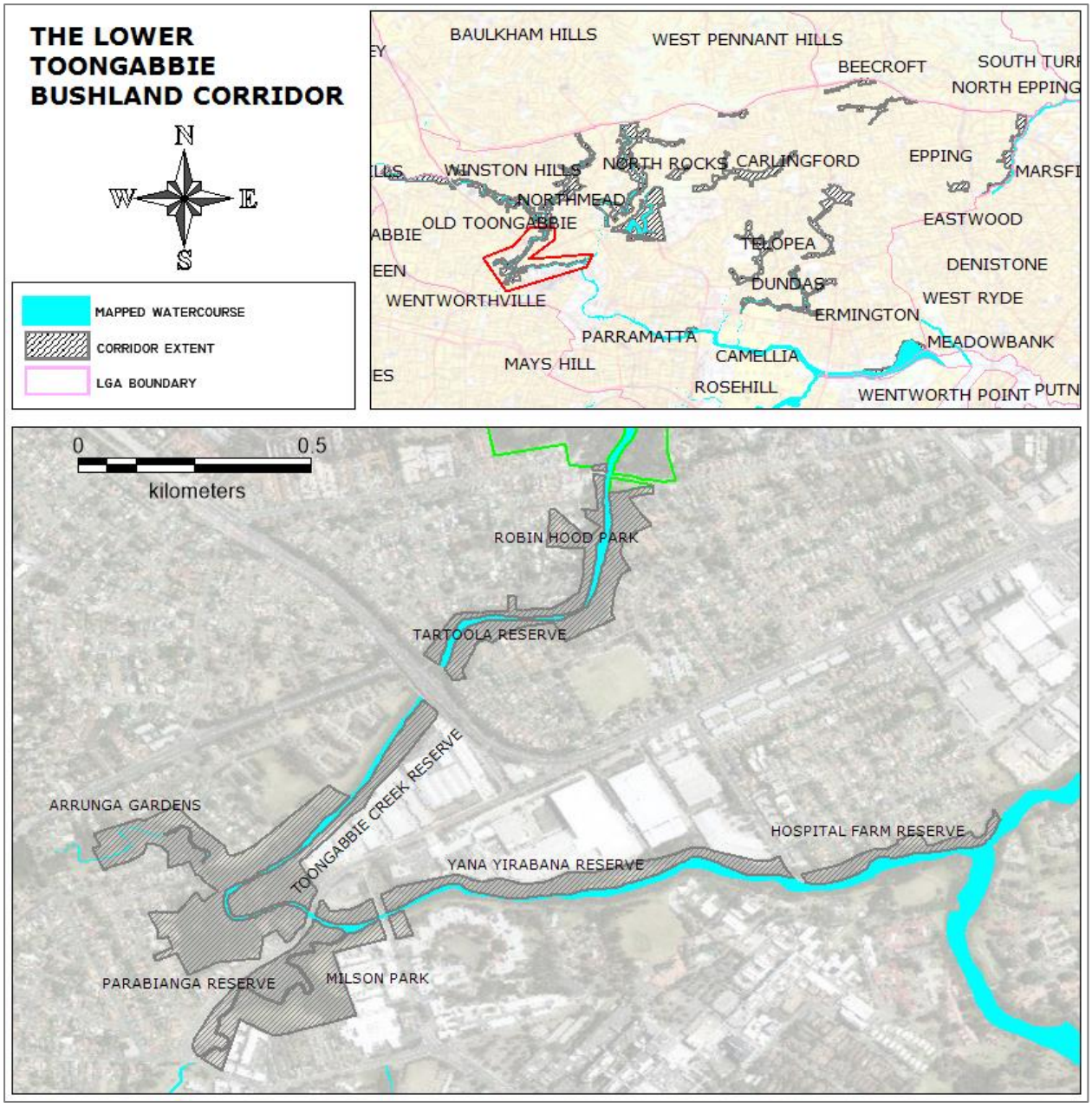


Figure 109 Lower Toogabbie Creek Corridor locality overview

The corridor contains three mapped native vegetation communities, all of which are critically endangered at a State and Federal level.

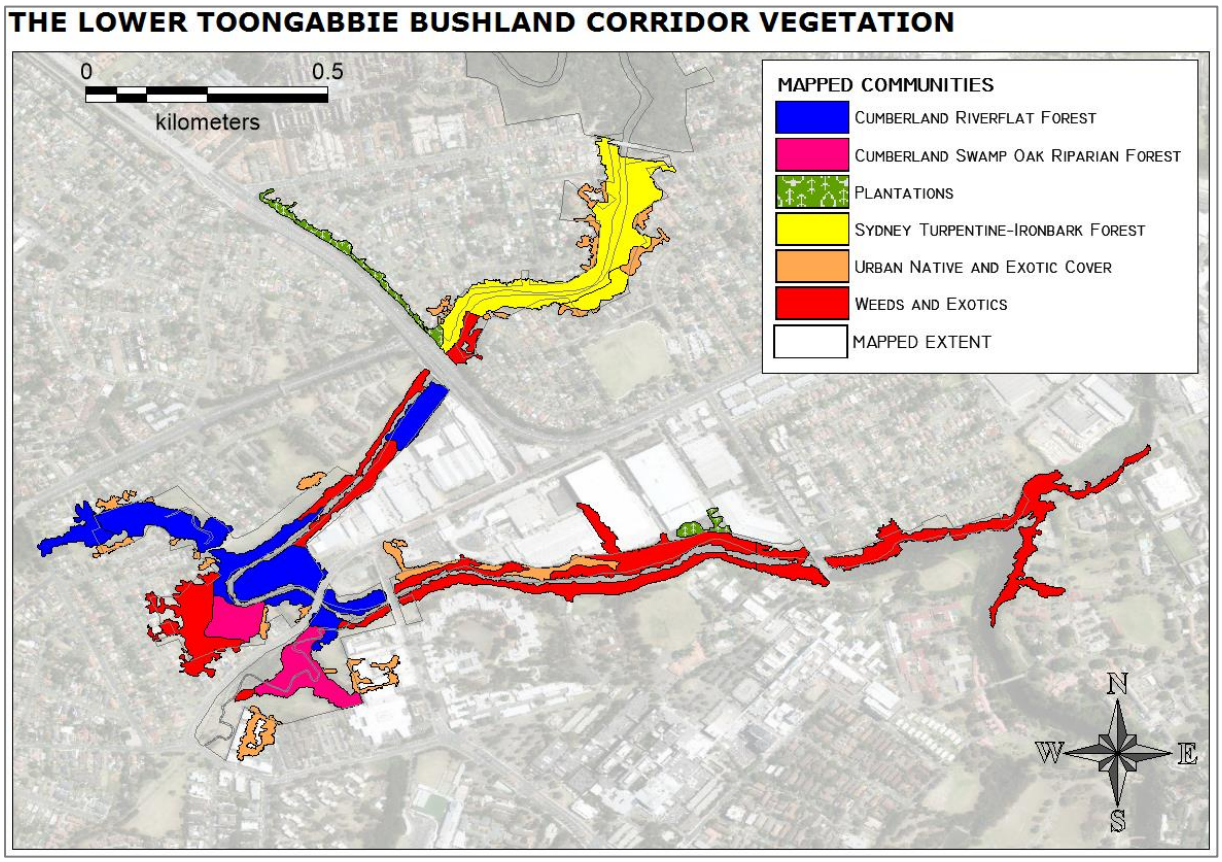


Figure 110 Mapped vegetation communities of Lower Toongabbie Creek Corridor

Figure 111 Looking east from Parabianga Reserve to Toongabbie Creek Reserve - tree death, abundant weeds evident

Figure 112 Looking north east from Parabianga Reserve upstream to Arrunga Gardens .

KEY ASSETS: Along with Upper Toongabbie Creek, the only corridor with significant areas of Cumberland Plain Woodland resulting in a slightly different suite of bird species to elsewhere in the LGA. Woodland at Parabianga Reserve provides the top birding site in the corridor. Abundant nest boxes of various sizes in reasonable to good condition, abundant natural hollows. Noisy miners are not a major issue, despite being present & active, compared to other reserves of similar width.

Table 40 Species richness summary

CLASS	SPECIES COUNT
BIRDS	45
MAMMALS	12
REPTILES	1
AMPHIBIANS	1

KEY CONSTRAINTS: Narrow and long corridor, abundant weeds in certain locations. Discontinuous canopy. Water often turbid, abundant gross pollutants. One small Bell miner colony.

Table 41 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident		✓	
Complex and well developed mid-storey		✓	
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare		✓	
Evidence of rabbits		✓	
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity		✓	
Leaf litter present on >50% of ground		✓	
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation		✓	
Fallen timber and logs are left on the ground		✓	
Multiple tracks, informal trails	✓		
Low abundance of weeds (most remnants contain some weeds)			✓
Rubbish dumping evident		✓	

Table 42 Lower Toongabbie Corridor Species List

BIRDS	
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Australian White Ibis	*Threskiornis molucca*
Australian Wood Duck	*Chenonetta jubata*
Bell Miner	*Manorina melanophrys*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Crested Pigeon	*Ocyphaps lophotes*
Dollar Bird	*Eurystomus orientalis*
Dusky Moorhen	*Gallinula tenebrosa*
Great Egret	*Ardea alba*
Eastern Koel	*Eudynamys orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Grey Butcherbird	*Cracticus torquatus*
Laughing Kookaburra	*Dacelo novaeguineae*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Wattlebird	*Anthochaera chrysoptera*
Magpie-lark	*Grallina cyanoleuca*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Friarbird	*Philemon corniculatus*
Noisy Miner	*Manorina melanocephala*
Olive-backed Oriole	*Oriolus sagittatus*
Pacific Black Duck	*Anas superciliosa*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Red-rumped Parrot	*Psephotus haematonotus*
Rufous Fantail	*Rhipidura rufifrons*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Silvereye	*Zosterops lateralis*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Welcome Swallow	*Hirundo neoxena*
White-browed Scrubwren	*Sericornis frontalis*
White-plumed Honeyeater	*Lichenostomus penicillatus*
Willie Wagtail	*Rhipidura leucophrys*
Yellow Thornbill	*Acanthiza nana*
Common Myna	*Sturnus tristis*
Common Starling	*Sturnus vulgaris*
European Blackbird	*Turdus merula*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Spotted Turtle-Dove	*Streptopelia chinensis*
AMPHIBIANS	
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
REPTILES	
Eastern Water-skink	*Eulamprus quoyii*
MAMMALS	
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Ride's Free-tailed Bat	*Mormopterus ridei*

Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Eastern Broad-nosed Bat	*Scotorepens orion*
Large Forest Bat	*Vespadelus darlingtoni*
Little Forest Bat	*Vespadelus vulturnus*
House Mouse	*Mus musculus*
Red Fox	*Vulpes vulpes*

1.8 VINEYARD CREEK BUSHLAND CORRIDOR

The Vineyard Creek Bushland Corridor is located in the suburbs of Telopea and Oatlands and extends northward from Kissing Point Road to Wesley Street. The Oatlands Golf Course abuts the western boundary and draws water for irrigation from a large dam on a tributary of Vineyard Creek below York Street. **The corridor is 22.8 hectares in area and has 6.28 kilometres of edge**. It contains 3 named reserves.

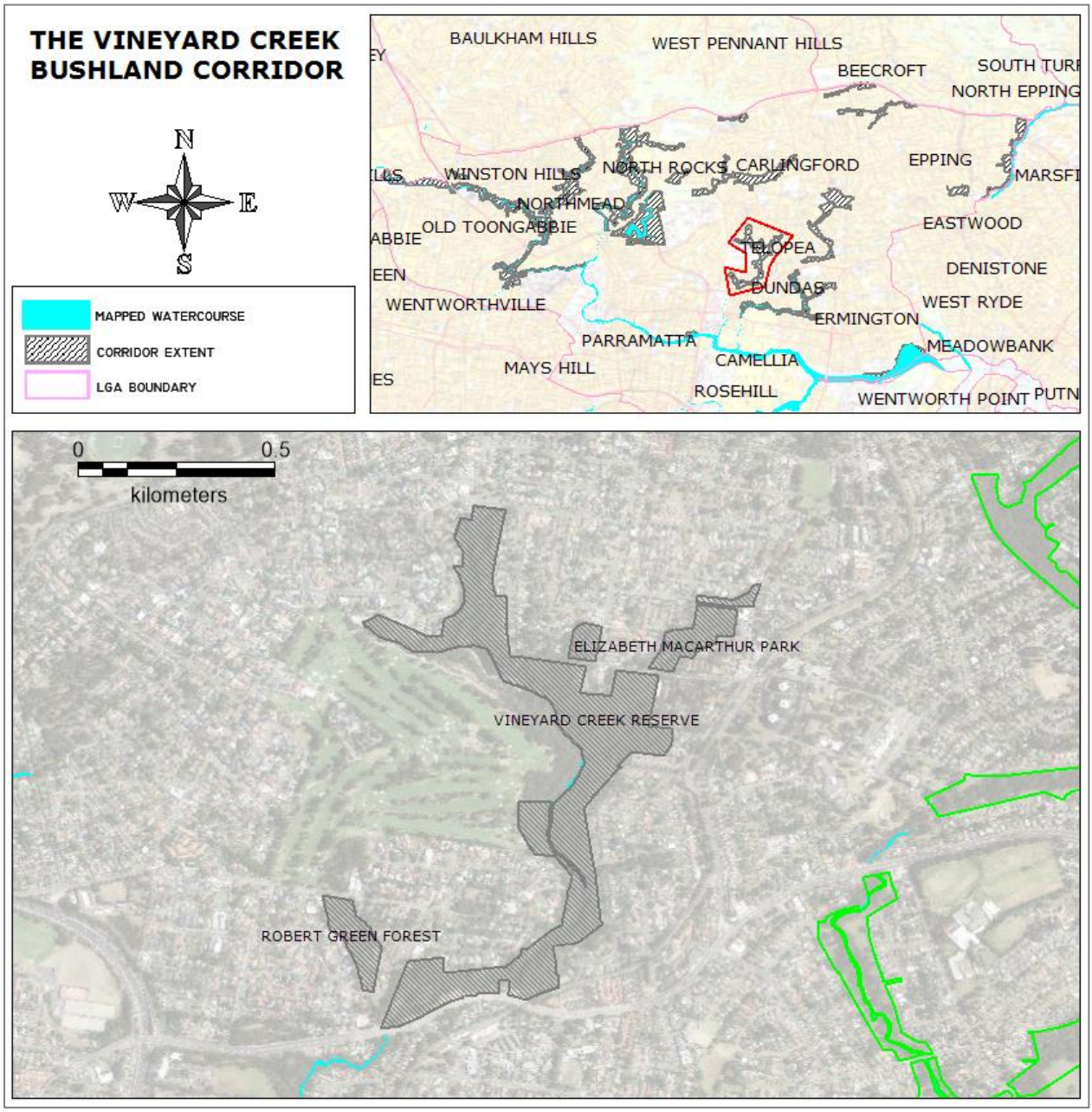


Figure 113 Vineyard Creek Corridor locality overview

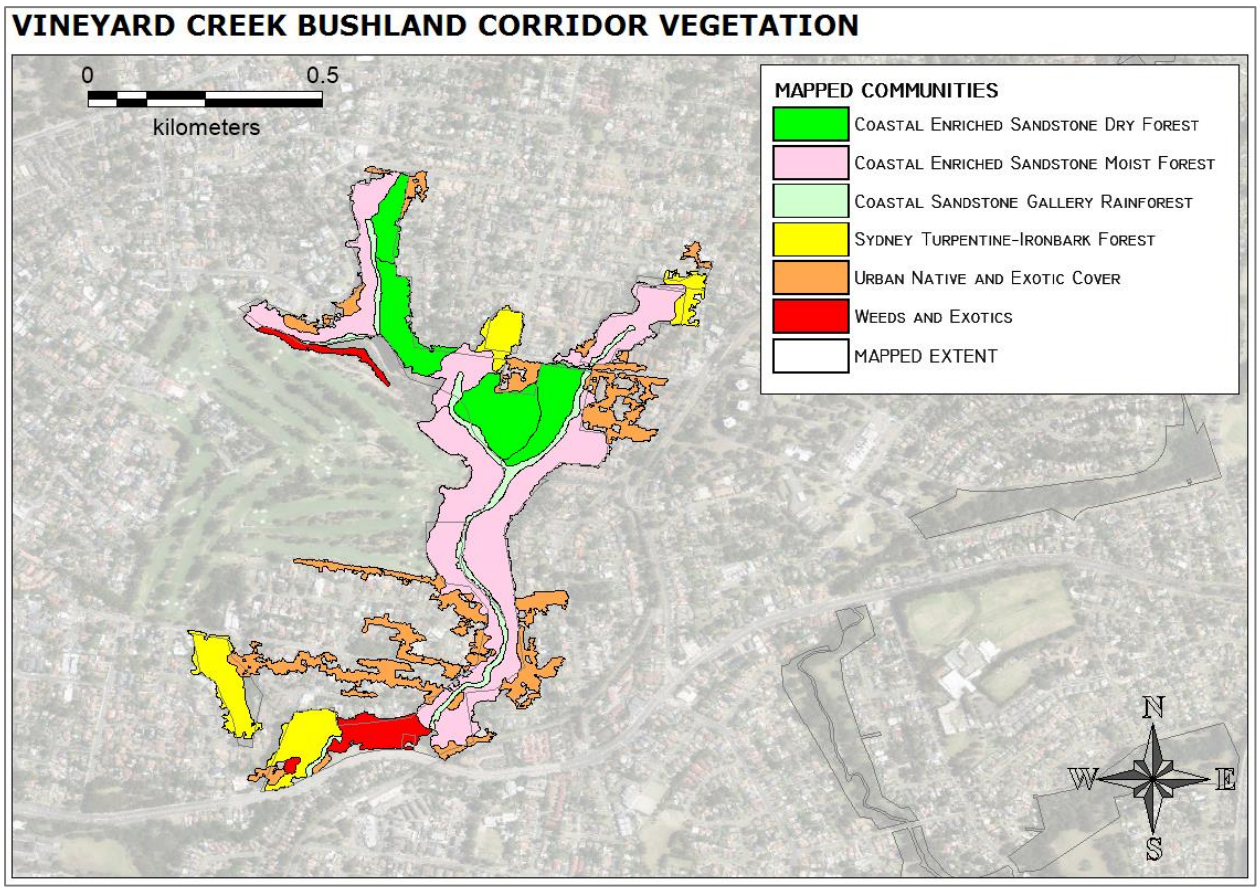


Figure 114 Mapped vegetation communities of Vineyard Creek Bushland Corridor

The corridor contains four mapped native vegetation communities one of which is critically endangered at a State and Federal level – Sydney Turpentine-ironbark Forest.

Figure 115 The riparian corridor dominates the reserve and is popular with walkers

KEY ASSETS: Well maintained trails and creek crossings. Mix of dry and moist forest with walking trails primarily in the riparian zones. Deep shady riparian zone provides excellent cover for resident Powerful Owls. Active bushcare/ bush regen works evident – some areas of very good bush.

Table 43 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	27
MAMMALS	14
REPTILES	8
AMPHIBIANS	5

KEY CONSTRAINTS: No connectivity. Permanent water available at the dam but a paucity of water fowl using this location – poor water quality may be an issue. Very narrow in the south portion and creekline becomes increasingly weedy.

Table 44 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey	✓		
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation	✓		
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)			✓
Rubbish dumping evident			✓

Table 45 Vineyard Creek Species List

BIRDS	
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Brown Gerygone	*Gerygone mouki*
Brown Thornbill	*Acanthiza pusilla*
Dusky Moorhen	*Gallinula tenebrosa*
Eastern Koel	*Eudynamys orientalis*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Galah	*Eolophus roseicapillus*
Golden Whistler	*Pachycephala pectoralis*
Laughing Kookaburra	*Dacelo novaeguineae*
Magpie-lark	*Grallina cyanoleuca*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Powerful Owl	*Ninox strenua*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red-browed Finch	*Neochmia temporalis*
Rufous Fantail	*Rhipidura rufifrons*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*

Superb Fairy-wren	*Malurus cyaneus*
White-browed Scrubwren	*Sericornis frontalis*
White-faced Heron	*Egretta novaehollandiae*
Red-whiskered Bulbul	*Pycnonotus jocosus*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Eastern Dwarf Tree Frog	*Litoria fallax*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Broad-tailed gecko	*Phyllurus platurus*
Eastern Long-necked Turtle	*Chelodina longicollis*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Sugar Glider	*Petaurus breviceps*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Eastern Broad-nosed Bat	*Scotorepens orion*
Black Rat	*Rattus rattus*
Red Fox	*Vulpes vulpes*

1.9 LOWER PONDS CORRIDOR

The Lower Ponds Corridor includes the southern reaches of Ponds Creek, below Kissing Point Road, to its confluence with Subiaco Creek in Rydalmere and Subiaco Creek north of Victoria Road to Kirby Street in the east. **The corridor is 27.84 hectares in area and has 15.35 kilometres of edge.** It contains 5 named reserves.

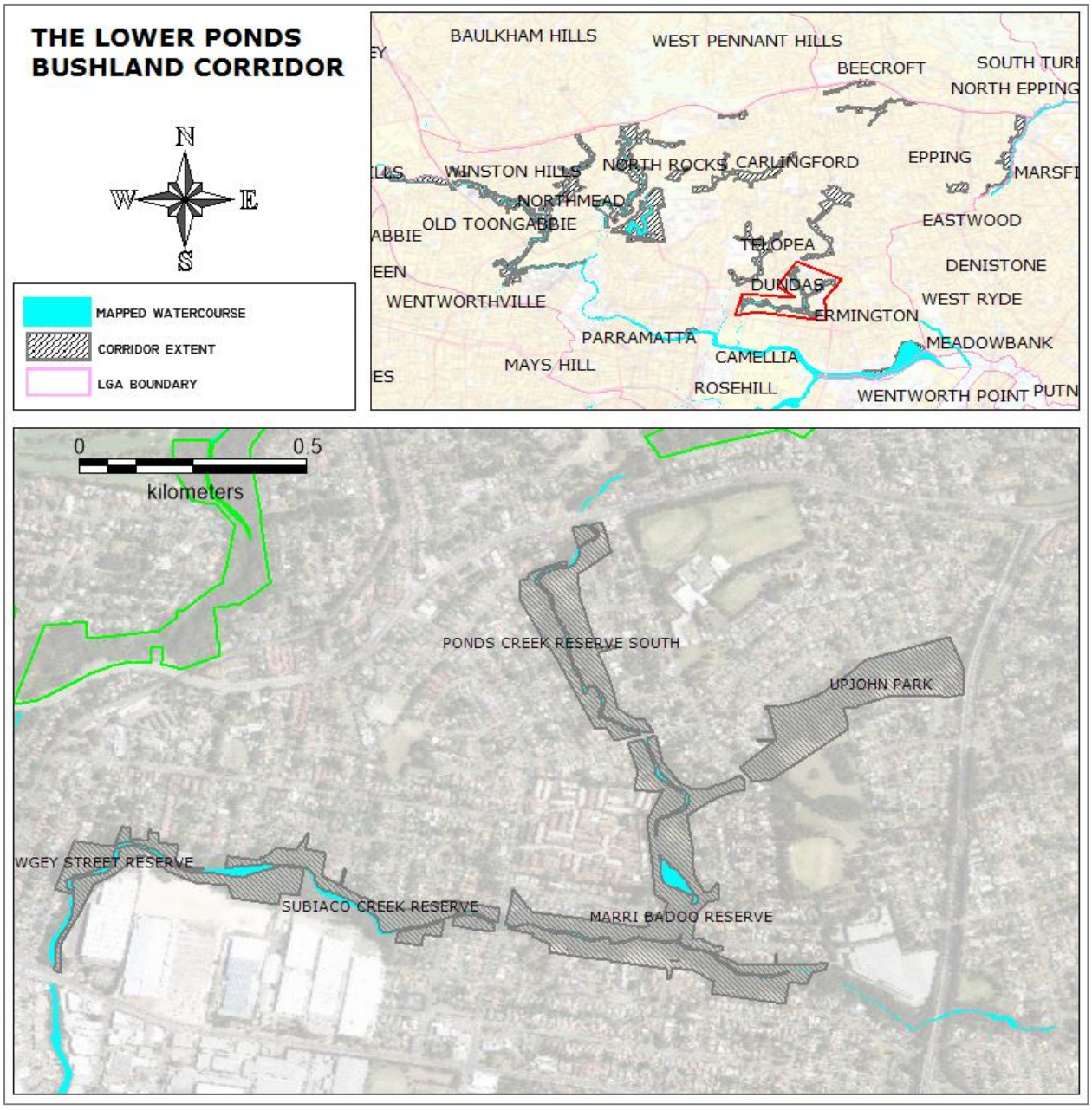


Figure 116 Lower Ponds Creek Corridor locality overview

The corridor contains two mapped native vegetation communities both of which are critically endangered at a State and Federal level.

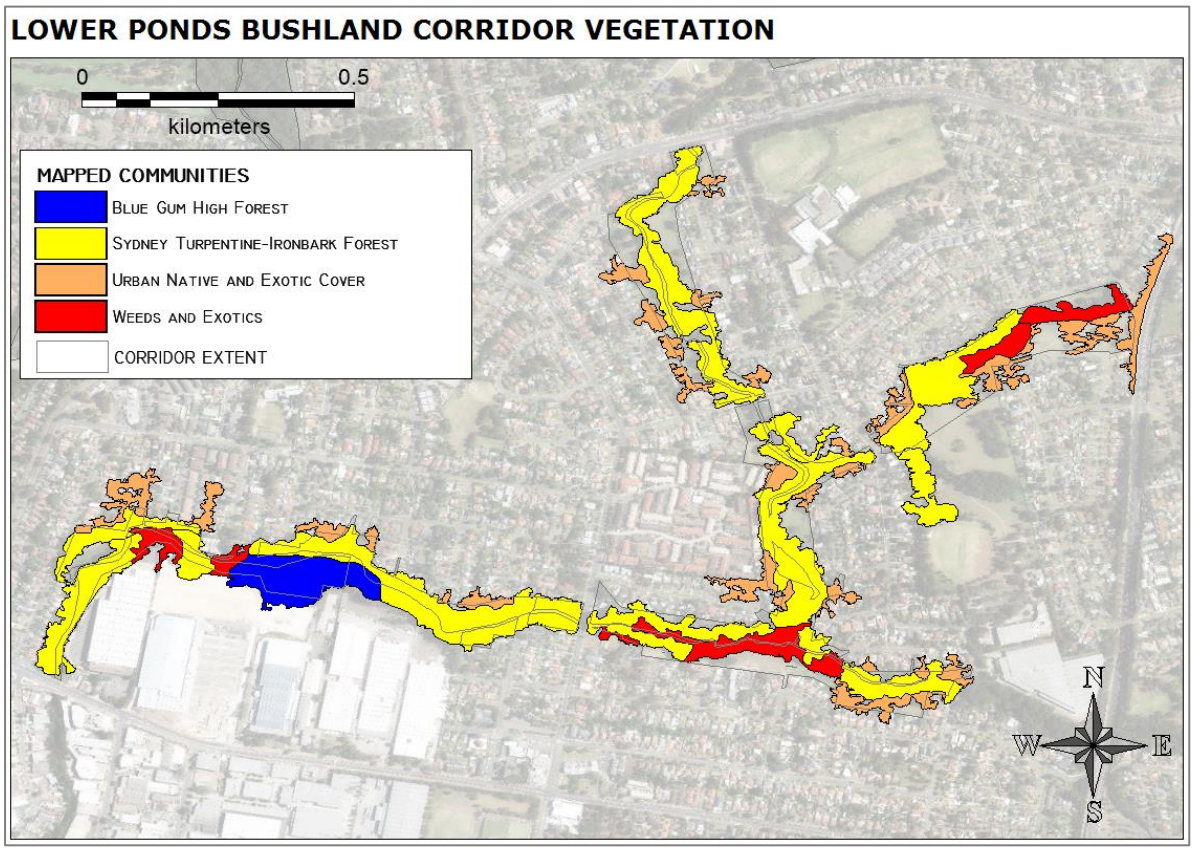


Figure 117 Mapped vegetation communities of Lower Ponds Creek Corridor

Figure 118STIF remnant with significant weed issues at Marri Badoo Reserve

KEY ASSETS: The Ponds walk is a popular walk along a well maintained trail with abundant signage. The large, mature trees (EEC) in parts of the corridor are the standout assets of this corridor. Abundant native bees can be found along Subiaco Creek.

Table 46 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	26
MAMMALS	4
REPTILES	4
AMPHIBIANS	14

KEY CONSTRAINTS: Very weedy. No connectivity. Narrow.

Table 47 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident		✓	
Complex and well developed mid-storey			✓
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare		✓	
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground		✓	
Cryptogams, cracks and rocks present			✓
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation			✓
Fallen timber and logs are left on the ground		✓	
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)			✓
Rubbish dumping evident			✓

Figure 119 (above) Aggregation of male Nomia bees – observed multiple times in Marri Badoo Reserve.
Figure 120 (above right) Blue-banded Bee in Marri Badoo Reserve – common at this location
Figure 121 (below right) Teddy-bear Bee in Marri Badoo Reserve– common at this location
(Photos: Applied Ecology 2016-17)

Table 48 Lower Ponds Species List

BIRDS	
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Australian White Ibis	*Threskiornis molucca*
Australian Wood Duck	*Chenonetta jubata*
Crested Pigeon	*Ocyphaps lophotes*
Eastern Koel	*Eudynamys orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Whipbird	*Psophodes olivaceus*
Grey Butcherbird	*Cracticus torquatus*
Laughing Kookaburra	*Dacelo novaeguineae*
Little Corella	*Cacatua sanguinea*
Long-billed Corella	*Cacatua tenuirostris*
Magpie-lark	*Grallina cyanoleuca*
Masked Lapwing	*Vanellus miles*
Noisy Miner	*Manorina melanocephala*
Pacific Black Duck	*Anas superciliosa*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Welcome Swallow	*Hirundo neoxena*
White-browed Scrubwren	*Sericornis frontalis*
Common Myna	*Sturnus tristis*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Rock Dove	*Columba livia*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Eastern Long-necked Turtle	*Chelodina longicollis*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*
Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Greater Broad-nosed Bat	*Scoteanax rueppellii*
a Forest Bat	*Vespadelus sp*
Black Rat	*Rattus rattus*
Cat (ID from hairtubes)	*Felis catus*
Red Fox	*Vulpes vulpes*

1.10 UPPER PONDS BUSHLAND CORRIDOR

The Upper Ponds Bushland Corridor begins at Kissing Point Road in Telopea and follows the Ponds Creek northward through the suburb of Carlingford to Pennant Hills Road in the north. **The corridor is 35.20 hectares in area with 8.05 kilometres of edge.** It contains 5 named reserves.

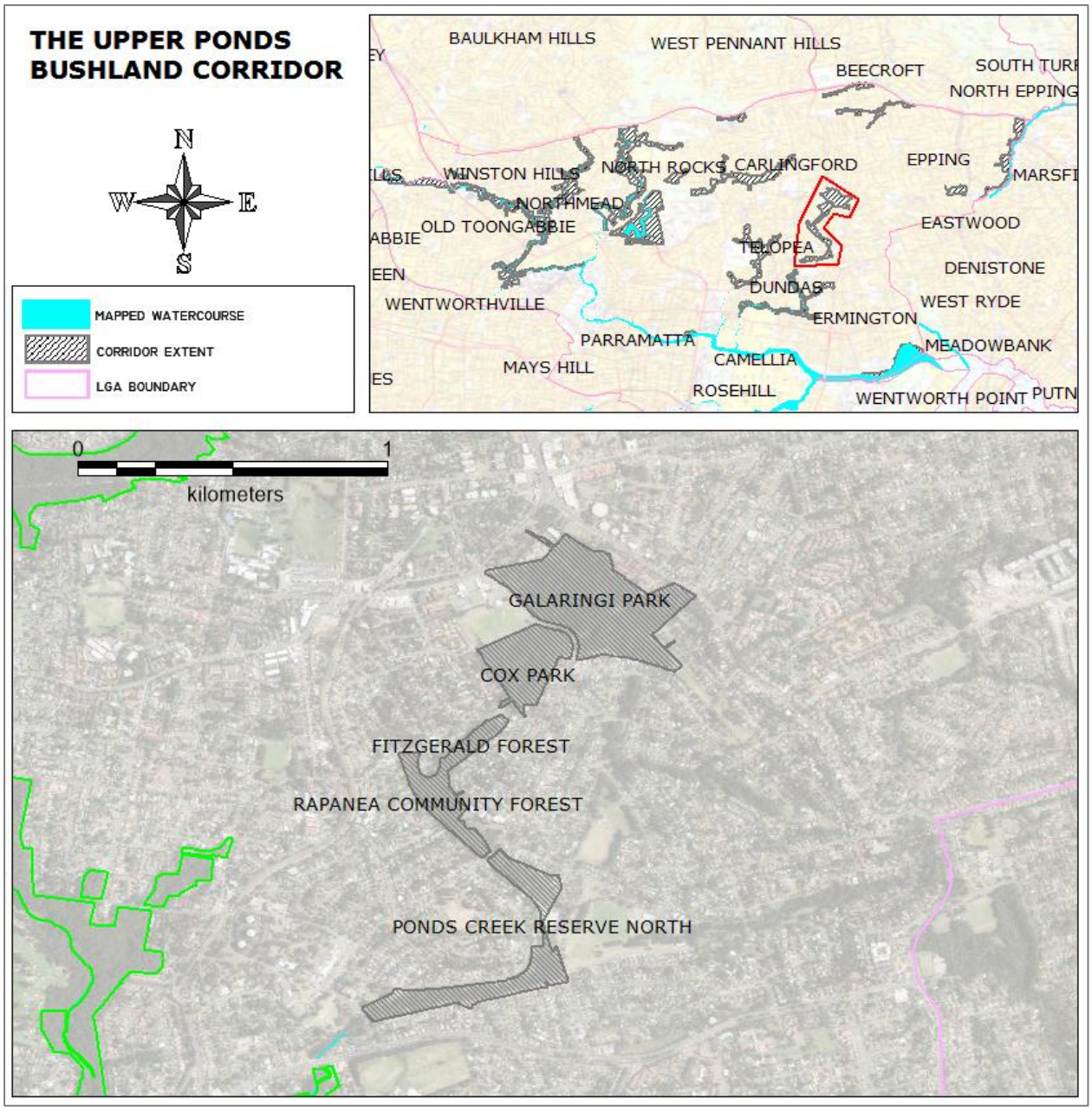


Figure 122 Upper Ponds Bushland Corridor locality overview

The corridor contains two mapped native vegetation communities both of which are critically endangered at a State and Federal level. Community boundaries through Galaringi Reserve are not particularly accurate.

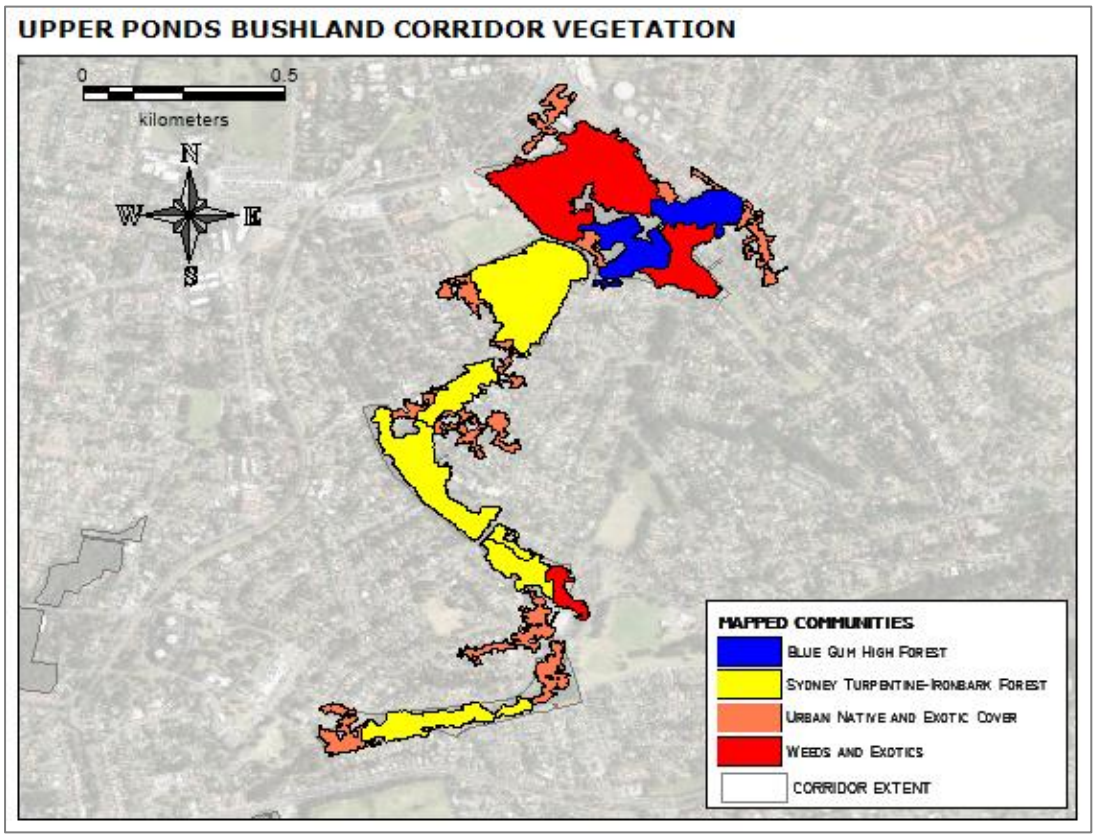


Figure 123 Mapped vegetation communities of Upper Ponds Bushland Corridor

Figure 124 Galaringi Reserve from Evans Road

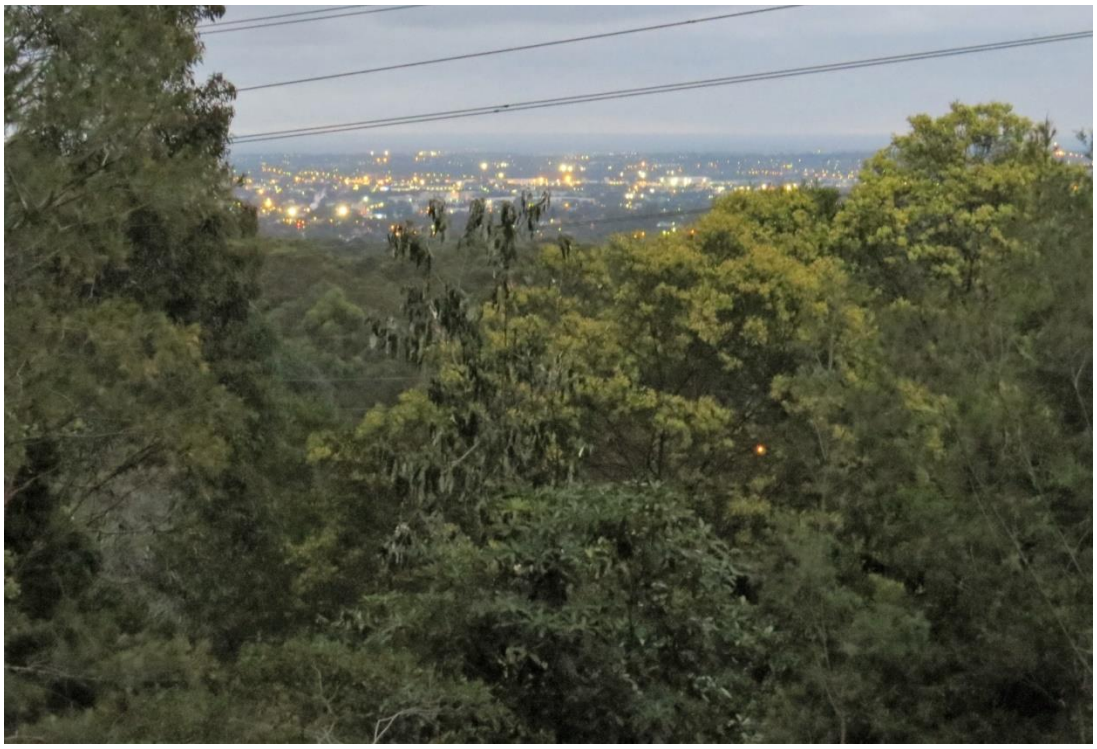


Figure 125 Looking across the bushland of Galaring Reserve and Cox Park from the elevated position of Pennant Hills Road

Figure 126 STIF - Cox Park.

KEY ASSETS: Permanent water at the "ponds" in the creek headwaters in Galaringi Reserve. Large stands of Acacia decurrens attract a very good variety of birds in Galaringi Reserve and appear to be a valuable resource for resident Sugar Gliders. Very good examples of STIF and BGHF with some simply stunning trees.

Table 49 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	38
MAMMALS	11
REPTILES	3
AMPHIBIANS	4

KEY CONSTRAINTS: Very weedy in places. Limited connectivity. Narrow in the south. High usage area.

Table 50 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey		✓	
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits		✓	
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present		✓	
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation			✓
Fallen timber and logs are left on the ground		✓	
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)			✓
Rubbish dumping evident			✓

Table 51 Upper Ponds Species List

BIRDS	
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Brown Gerygone	*Gerygone mouki*
Brown Thornbill	*Acanthiza pusilla*
Crimson Rosella	*Platycercus elegans*
Dollar Bird	*Eurystomus orientalis*
Eastern Koel	*Eudynamys orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Golden Whistler	*Pachycephala pectoralis*
Grey Fantail	*Rhipidura albiscapa*
Laughing Kookaburra	*Dacelo novaeguineae*
Leaden Flycatcher	*Myiagra rubecula*
Magpie-lark	*Grallina cyanoleuca*
Noisy Miner	*Manorina melanocephala*
Pacific Baza	*Aviceda subcristata*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Rufous Fantail	*Rhipidura rufifrons*
Silvereye	*Zosterops lateralis*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Welcome Swallow	*Hirundo neoxena*
White-browed Scrubwren	*Sericornis frontalis*
Willie Wagtail	*Rhipidura leucophrys*

Yellow Thornbill	*Acanthiza nana*
Common Myna	*Sturnus tristis*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Spotted Turtle-Dove	*Streptopelia chinensis*
Brown-striped Frog	*Limnodynastes peronii*
AMPHIBIANS	
Common Eastern Froglet	*Crinia signifera*
Eastern Dwarf Tree Frog	*Litoria fallax*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Sugar Glider	*Petaurus breviceps*
Swamp Wallaby	*Wallabia bicolor*
Gould's Wattled Bat	*Chalinolobus gouldii*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Black Rat	*Rattus rattus*
Dog (ID from hairtubes)	*Canis lupus familiaris*
Red Fox	*Vulpes vulpes*

1.11 EDNA HUNT SANCTUARY

Edna Hunt Sanctuary is located in the suburb of Epping. It abuts the rail corridor to the east and is surrounded by well established suburban dwellings on all other sides. The reserve is 7.213 hectares in area with 1.813 kilometres of edge.

Figure 127 Edna Hunt Sanctuary locality overview

The reserve contains one mapped native vegetation community which is critically endangered at the State and Federal level.

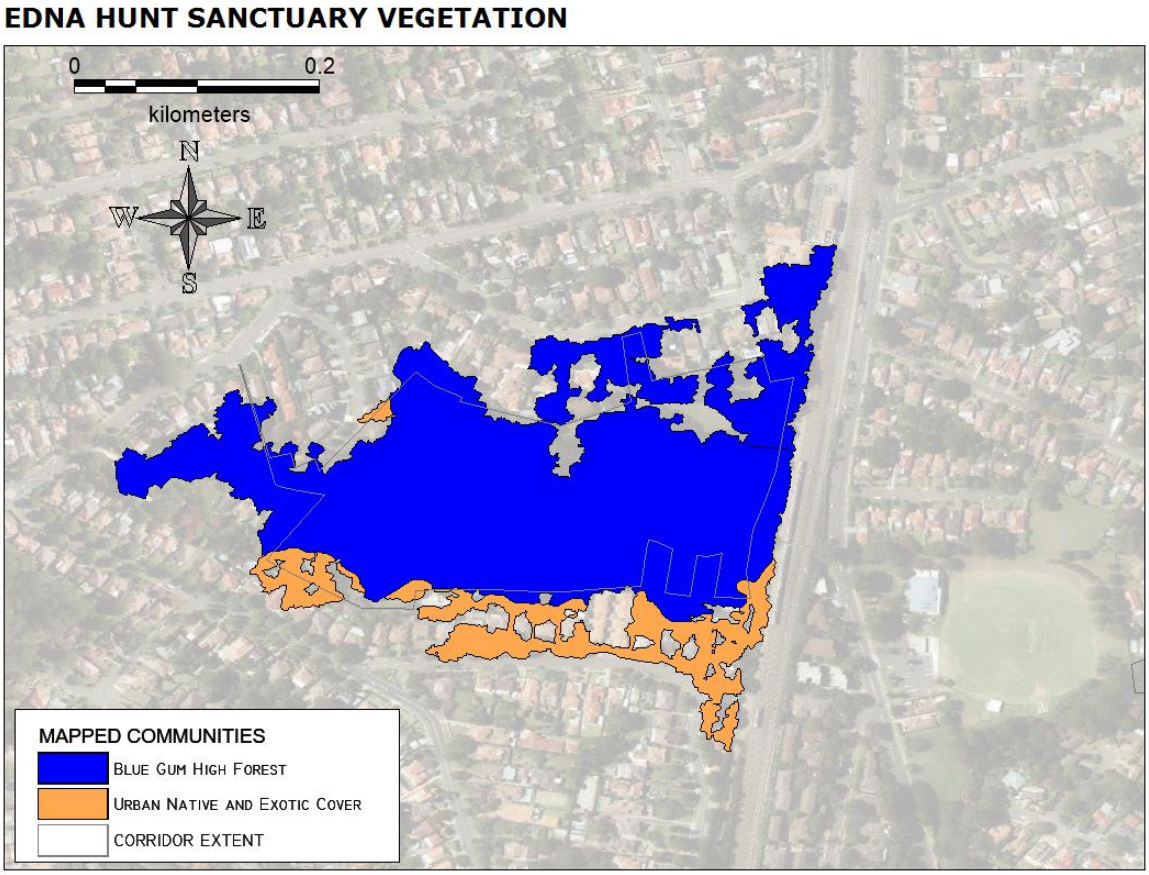


Figure 128 Mapped vegetation communities of Edna Hunt Sanctuary

Figure 129 The reserve is a combination of cleared and mown open space and remnant BGHF bisected by an ephemeral creek.

KEY ASSETS: The large, mature Blue Gums are the standout assets of this reserve. Active bushcare with potential and scope to improve understorey/midstorey and provide resources for smaller birds. Position in the urban landscape indicates it should be of considerable value to fauna as a stepping stone habitat.

Table 52 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	16
MAMMALS	8
REPTILES	2
AMPHIBIANS	1

KEY CONSTRAINTS: Small size. Lacks true connectivity. Lacks complexity in the understorey. Abundant and aggressive noisy miners in the reserve. Large flocks of Sulphur-crested Cockatoos roost in the reserve.

Table 53 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident		✓	
Complex and well developed mid-storey			✓
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground		✓	
Cryptogams, cracks and rocks present			✓
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation			✓
Fallen timber and logs are left on the ground		✓	
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 54 Edna Hunt Sanctuary Species List

BIRDS	
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Dollar Bird	*Eurystomus orientalis*
Eastern Rosella	*Platycercus eximius*
Eastern Whipbird	*Psophodes olivaceus*
Grey Butcherbird	*Cracticus torquatus*
Laughing Kookaburra	*Dacelo novaeguineae*
Musk Lorikeet	*Glossopsitta concinna*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Powerful Owl	*Ninox strenua*
Rainbow Lorikeet	*Trichoglossus haematodus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Red-whiskered Bulbul	*Pycnonotus jocosus*
AMPHIBIANS	
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Eastern Water-skink	*Eulamprus quoyii*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Grey-headed Flying-fox	*Pteropus poliocephalus*
White-striped Free-tailed Bat	*Austronomus australis*
Ride's Free-tailed Bat	*Mormopterus ridei*
a Long-eared Bat	*Nyctophilus sp*
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Eastern Broad-nosed Bat	*Scotorepens orion*
Cat (ID from hairtubes)	*Felis catus*

1.12 TERRYS CREEK BUSHLAND CORRIDOR

The Terrys Creek Bushland Corridor consists of reserves on the western side of Terrys Creek (which forms the eastern boundary of the LGA). The corridor is wholly within the suburb of Epping bound by the M2 motorway in the north and Albuera Road in the south. **The corridor is 21.51 hectares in area and has 6.65 kilometres of edge**- half of which is the centre line of the creek. A similar area is managed by the City of Ryde and the corridor, in reality, consists of over 40ha of continuous bushland south of the M2. The corridor contains of 5 named reserves.

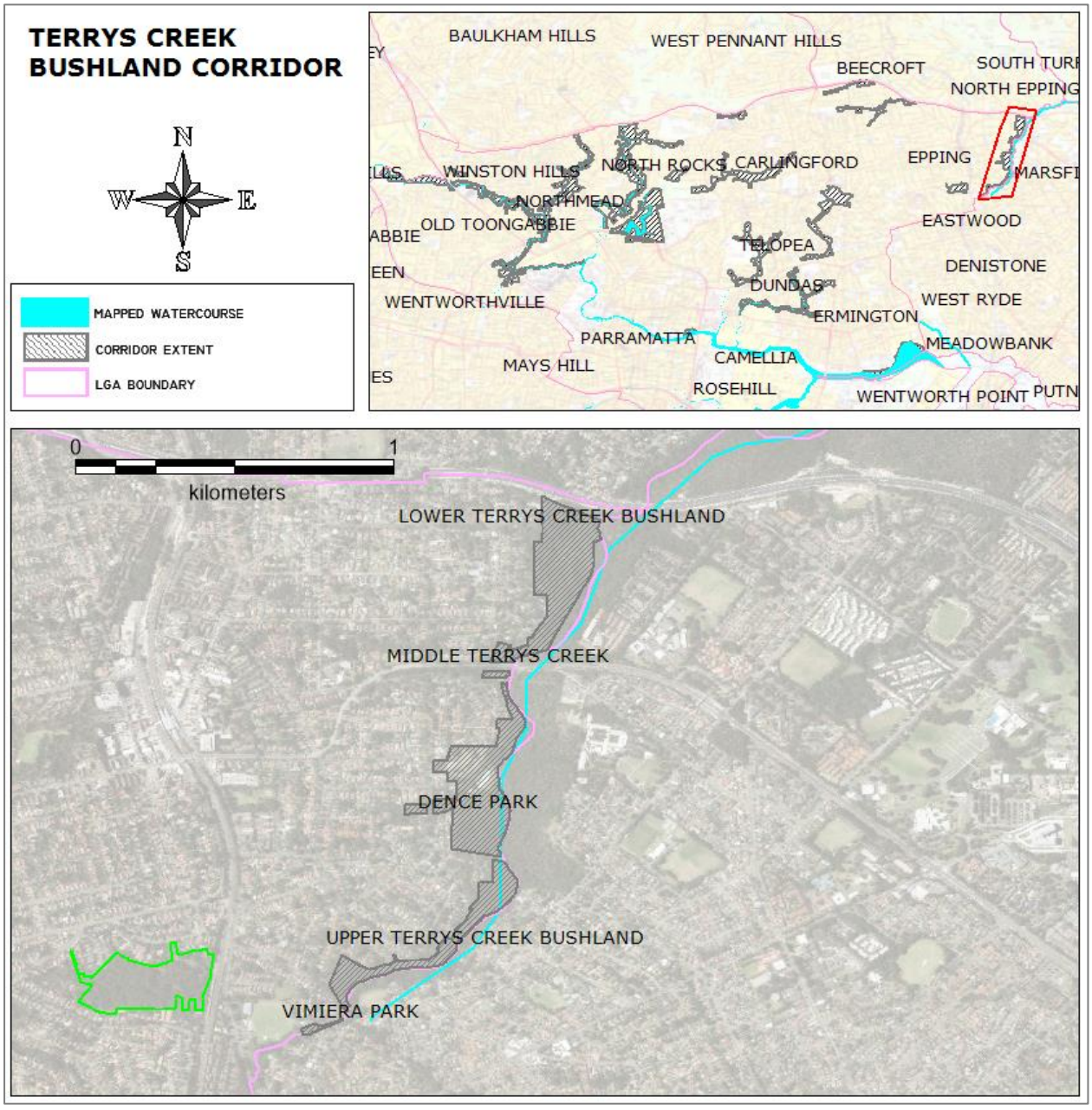


Figure 130 Terrys Creek Bushland Corridor locality overview

The corridor contains six mapped native vegetation communities two of which are critically endangered at a State and Federal level.

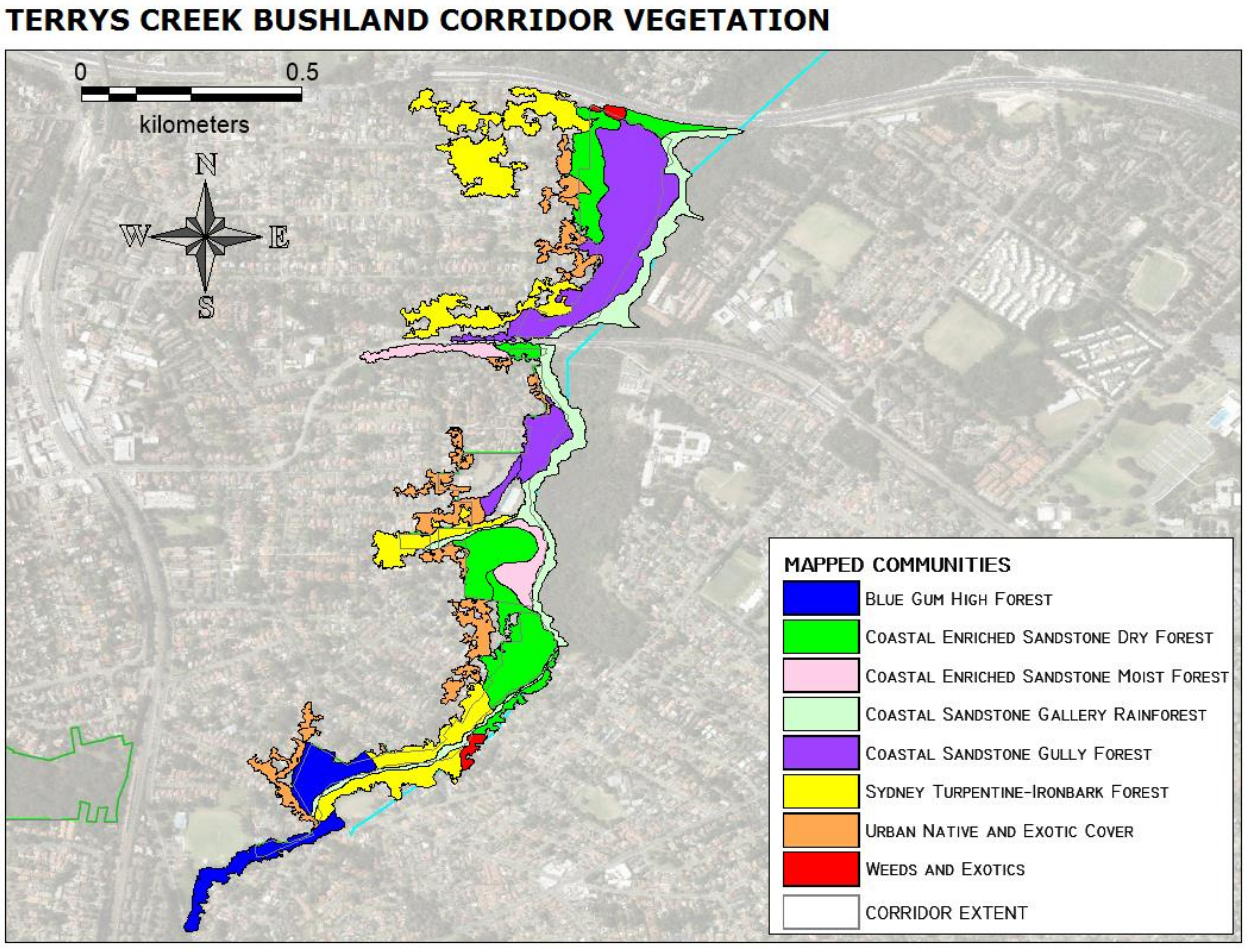


Figure 131 Mapped vegetation communities of Terrys Creek Bushland Corridor

Figure 132 Lucknow Reserve from Somerset Street with M2 visible to the left.

Figure 133 BGHF - Vimera Reserve

Figure 134 (left) Terrys Creek at Lucknow Reserve and exposed sandstone along the Terrys Creek walk.

KEY ASSETS: Connectivity through to the Lane Cove National Park via an underpass at the M2. Majority of corridor is good bush with active bushcare and residents working to improve degraded areas. Complex, diverse understorey and midstorey in gully and dry forest areas. Deeply shaded creekline provides roosting sites for the three pairs of powerful owls within the corridor.

Table 55 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	40
MAMMALS	19
REPTILES	10
AMPHIBIANS	4

KEY CONSTRAINTS: Poor water quality due to sewer overflows – odours and abundant gross pollutants evident. Ongoing weed control required to control weeds, particularly bamboo in southern reaches.

Table 56 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident	✓		
Complex and well developed mid-storey	✓		
Infrequent fire regime (more than 10 years between fires)	✓		

Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare	✓		
>2 large hollows >50mm diameter per hectare	✓		
Evidence of rabbits	✓		
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground	✓		
Cryptogams, cracks and rocks present	✓		
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation	✓		
Fallen timber and logs are left on the ground	✓		
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 57 Terrys Creek Species List

BIRDS	
Australian Brush-turkey	*Alectura lathami*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Raven	*Corvus coronoides*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Black-faced Monarch	*Monarcha melanopsis*
Brown Gerygone	*Gerygone mouki*
Brown Thornbill	*Acanthiza pusilla*
Crimson Rosella	*Platycercus elegans*
Dollar Bird	*Eurystomus orientalis*
Eastern Koel	*Eudynamys orientalis*
Eastern Spinebill	*Acanthorhynchus tenuirostris*
Eastern Whipbird	*Psophodes olivaceus*
Eastern Yellow Robin	*Eopsaltria australis*
Golden Whistler	*Pachycephala pectoralis*
Grey Fantail	*Rhipidura albiscapa*
Laughing Kookaburra	*Dacelo novaeguineae*
Lewins Honeyeater	*Meliphaga lewinii*
Little Wattlebird	*Anthochaera chrysoptera*
Long-billed Corella	*Cacatua tenuirostris*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Powerful Owl	*Ninox strenua*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Rufous Fantail	*Rhipidura rufifrons*
Sacred Kingfisher	*Todiramphus sanctus*
Satin Bowerbird	*Ptilonorhynchus violaceus*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Southern Boobook	*Ninox novaeseelandiae*
Spotted Pardalote	*Pardalotus punctatus*

Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Variegated Fairy-wren	*Malurus lamberti*
White-browed Scrubwren	*Sericornis frontalis*
White-throated Treecreeper	*Cormobates leucophaea*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
Red-whiskered Bulbul	*Pycnonotus jocosus*
AMPHIBIANS	
Brown-striped Frog	*Limnodynastes peronii*
Common Eastern Froglet	*Crinia signifera*
Green Stream (Leaf-green) Tree Frog	*Litoria phyllochroa*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Broad-tailed gecko	*Phyllurus platurus*
Eastern Long-necked Turtle	*Chelodina longicollis*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Elegant Snake-eyed Skink	*Cryptoblepharus pulcher*
Lace Monitor	*Varanus varius*
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*
Red-bellied Black Snake	*Pseudechis porphyriacus*
Weasel Skink	*Saproscincus mustelinus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
Long-nosed Bandicoot	*Perameles nasuta*
Short-beaked echidna	*Tachyglossus aculeatus*
Sugar Glider	*Petaurus breviceps*
Swamp Wallaby	*Wallabia bicolor*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*
East-coast Free-tailed Bat	*Mormopterus norfolkensis*
Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
Eastern Broad-nosed Bat	*Scotorepens orion*
a Forest Bat	*Vespadelus sp*
Black Rat	*Rattus rattus*
Rabbit	*Oryctolagus cuniculus*
Red Fox	*Vulpes vulpes*

1.13 ERMINGTON BAY

Ermington Bay is located on the Parramatta River in the suburbs of Ermington and Melrose Park. It extends from Wharf Road in the east to Broad Oaks Street in the west. **The reserve is 27.29 hectares in area** most of which is the tidal mudflats with approximately 1.8 kilometres of terrestrial edge. The bay is bounded by two named reserves.

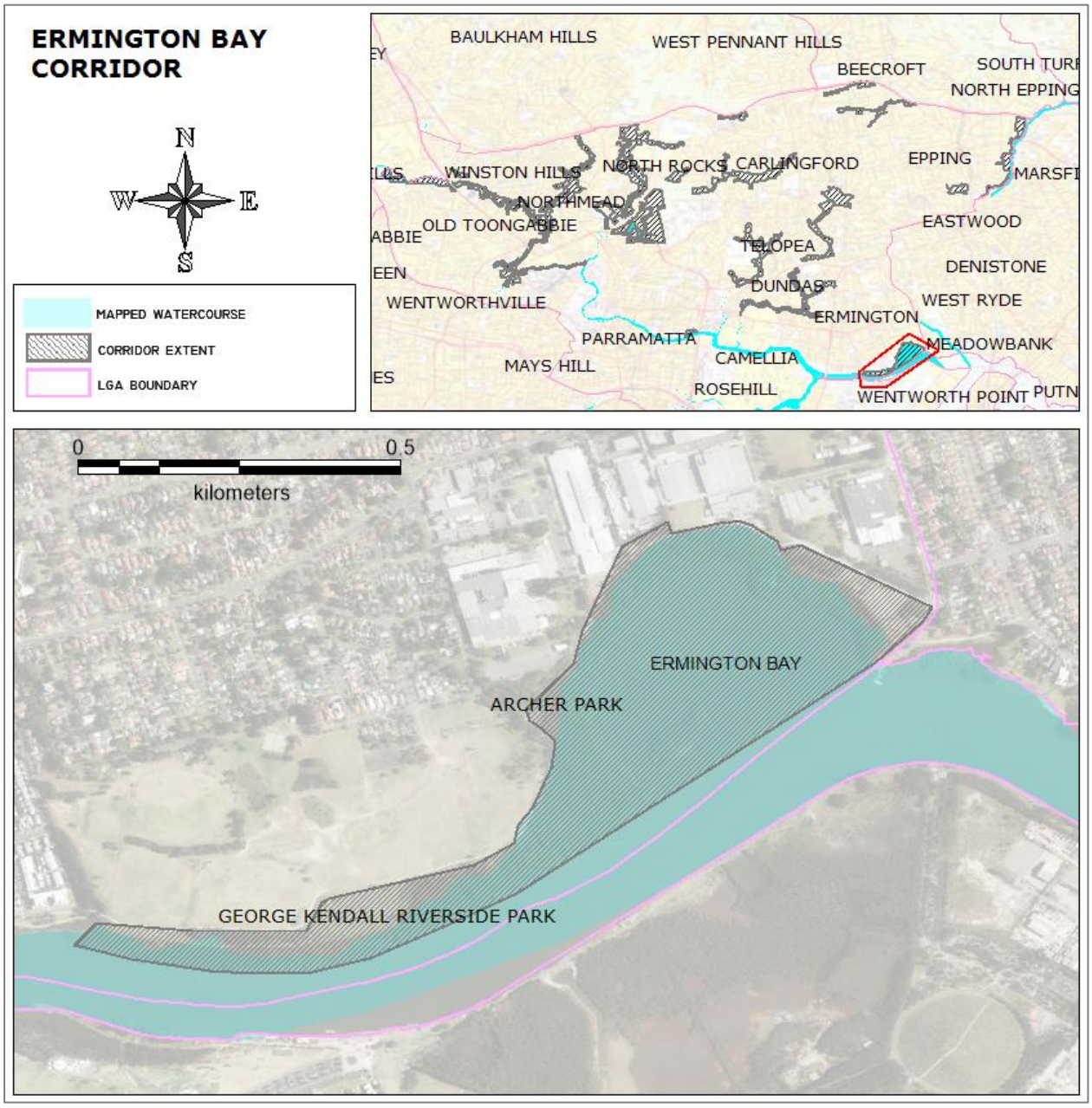


Figure 135 Ermington Bay locality overview

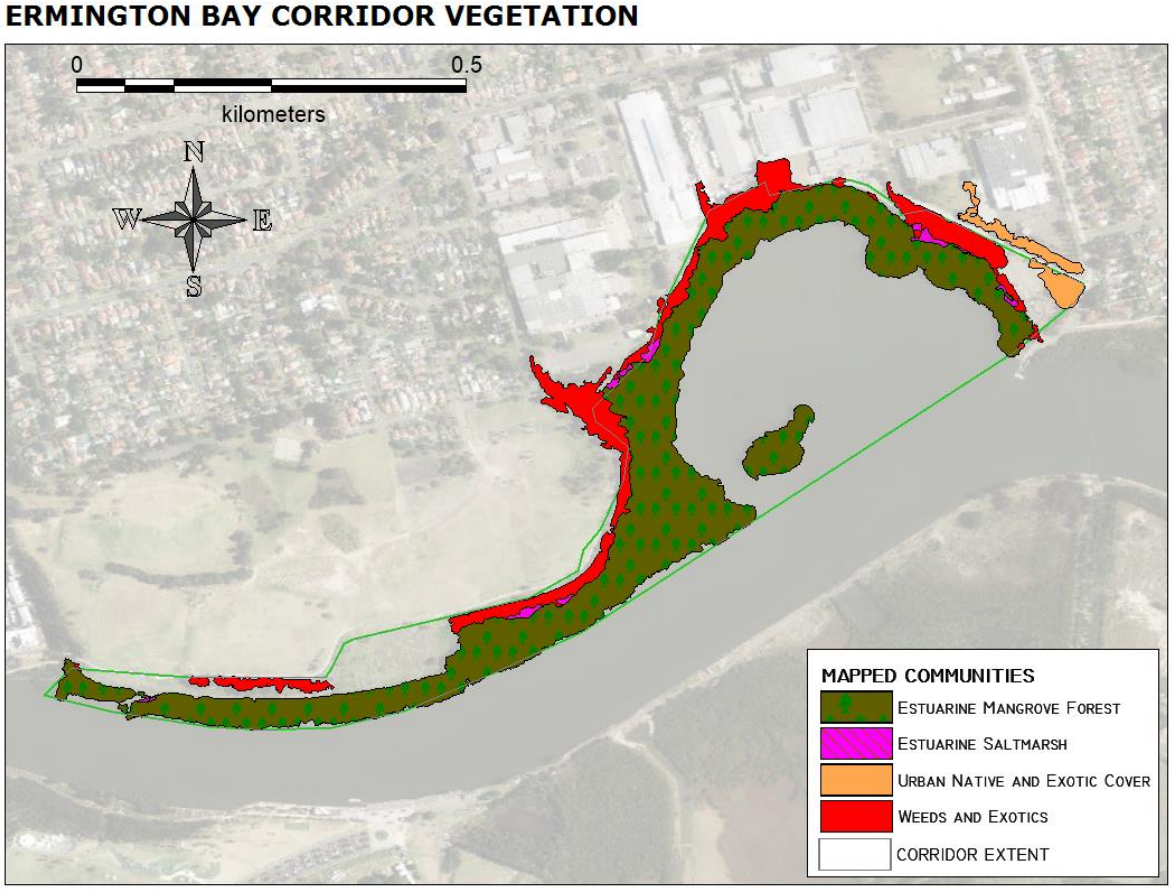


Figure 136 Mapped vegetation communities of Ermington Bay

The Bay has two mapped native vegetation communities one of which, Coastal Saltmarsh, is a listed endangered ecological community at State and Federal level.

Figure 137 Coastal saltmarsh to the left and Estuarine magroves to the right in Archers Park, Ermington Bay.

Figure 138 View across the mudflats at low tide from the viewing platform on the raised boardwalk.

KEY ASSETS: Popular and busy shared path and raised boardwalk follows the land side of the mangroves with off shoot to a viewing platform for birders to twitch across the mudflats. Active bushcare is improving the width and diversity of the bushland buffer through George Kendall Reserve.

Table 58 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	36
MAMMALS	13
REPTILES	2
AMPHIBIANS	2

KEY CONSTRAINTS: Very limited vegetated buffer between the mean high water mark and commercial properties and /or open space to the north of the river. Historic practice of infilling has changed natural topography and soils.

Table 59 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident		✓	
Complex and well developed mid-storey			✓
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare		✓	
>2 large hollows >50mm diameter per hectare			✓
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground		✓	
Cryptogams, cracks and rocks present			✓
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation			✓
Fallen timber and logs are left on the ground		✓	

Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Figure 139 Informative signage at the viewing platform to assist with bird ID.

Table 60 Ermington Bay Species List

BIRDS	
Australasian Darter	*Anhinga novaehollandiae*
Australasian Figbird	*Sphecotheres vieilloti*
Australian King-Parrot	*Alisterus scapularis*
Australian Magpie	*Cracticus tibicen*
Australian Pelican	*Pelecanus conspicillatus*
Australian Raven	*Corvus coronoides*
Australian White Ibis	*Threskiornis molucca*
Black-faced Monarch	*Monarcha melanopsis*
Crested Pigeon	*Ocyphaps lophotes*
Crested Tern	*Thalasseus bergii*
Great Egret	*Ardea alba*
Eastern Koel	*Eudynamys orientalis*
Galah	*Eolophus roseicapillus*
Golden Whistler	*Pachycephala pectoralis*
Grey Fantail	*Rhipidura albiscapa*
Magpie-lark	*Grallina cyanoleuca*
Noisy Miner	*Manorina melanocephala*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Royal Spoonbill	*Platalea regia*

Sacred Kingfisher	*Todiramphus sanctus*
Silver Gull	*Chroicocephalus novaehollandiae*
Silvereye	*Zosterops lateralis*
Southern Boobook	*Ninox novaeseelandiae*
Superb Fairy-wren	*Malurus cyaneus*
Tawny Frogmouth	*Podargus strigoides*
Welcome Swallow	*Hirundo neoxena*
White-bellied Sea-eagle	*Haliaeetus leucogaster*
White-browed Scrubwren	*Sericornis frontalis*
White-faced Heron	*Egretta novaehollandiae*
Common Myna	*Sturnus tristis*
European Blackbird	*Turdus merula*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Rock Dove	*Columba livia*
White-headed Stilt	*Himantopus himantopus*
AMPHIBIANS	
Common Eastern Froglet	*Crinia signifera*
Peron's Tree Frog	*Litoria peronii*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*
Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*
Ride's Free-tailed Bat	*Mormopterus ridei*
Large-footed Myotis	*Myotis macropus*
a Long-eared Bat	*Nyctophilus sp*
a Forest Bat	*Vespadelus sp*
Black Rat	*Rattus rattus*
Rabbit	*Oryctolagus cuniculus*
Red Fox	*Vulpes vulpes*

1.14 BALUDARRI WETLAND

Baludarri wetland reserve is located on the Parramatta River in the suburb of Parramatta. It is best accessed via Broughton Street. The reserve is 1.646 hectares in area with 0.82 kilometres of edge.

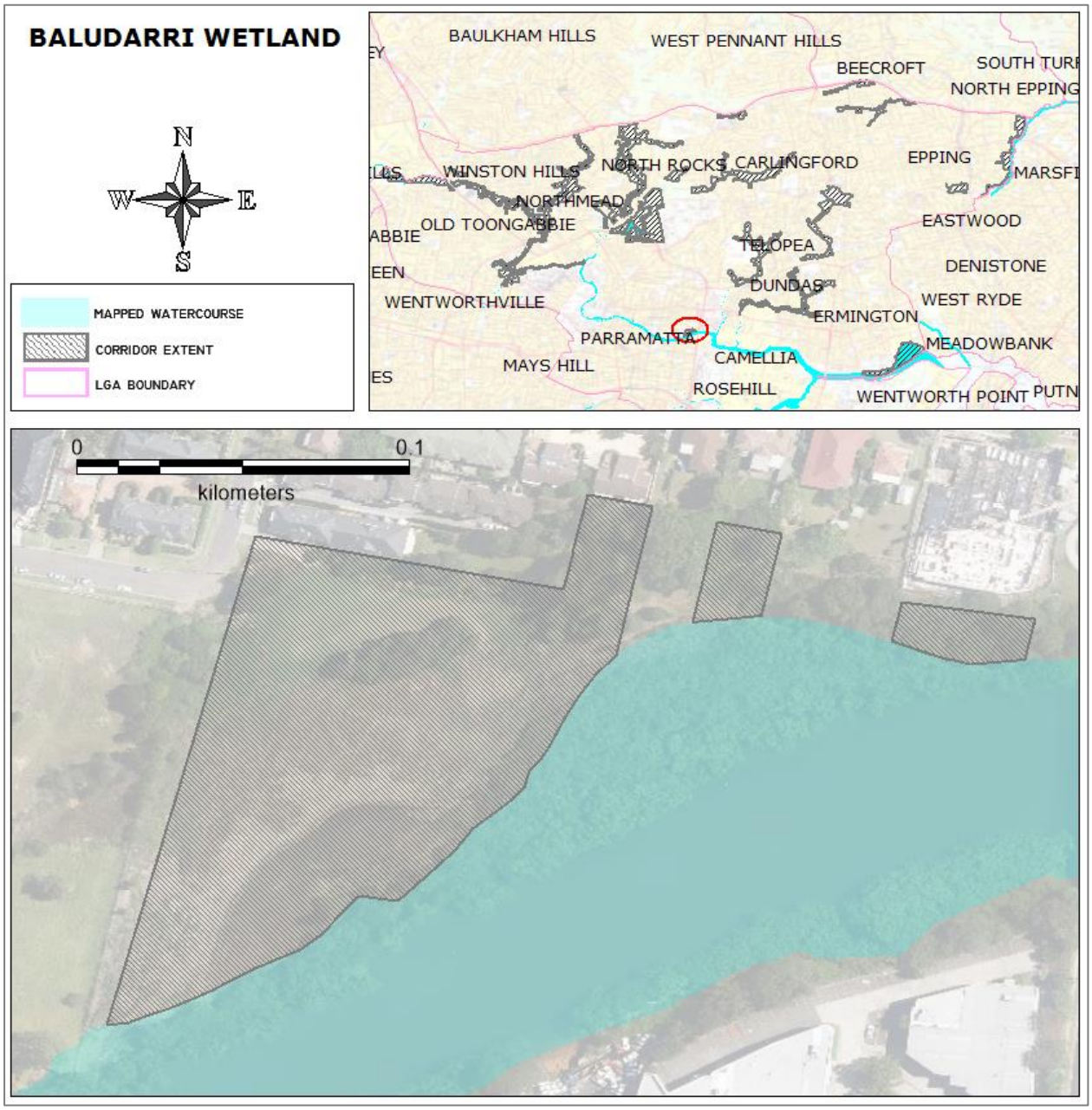


Figure 140 Baludarri Wetland Reserve locality overview

The reserve has two mapped native vegetation communities one of which, Coastal Saltmarsh, is a listed endangered ecological community at State and Federal level.

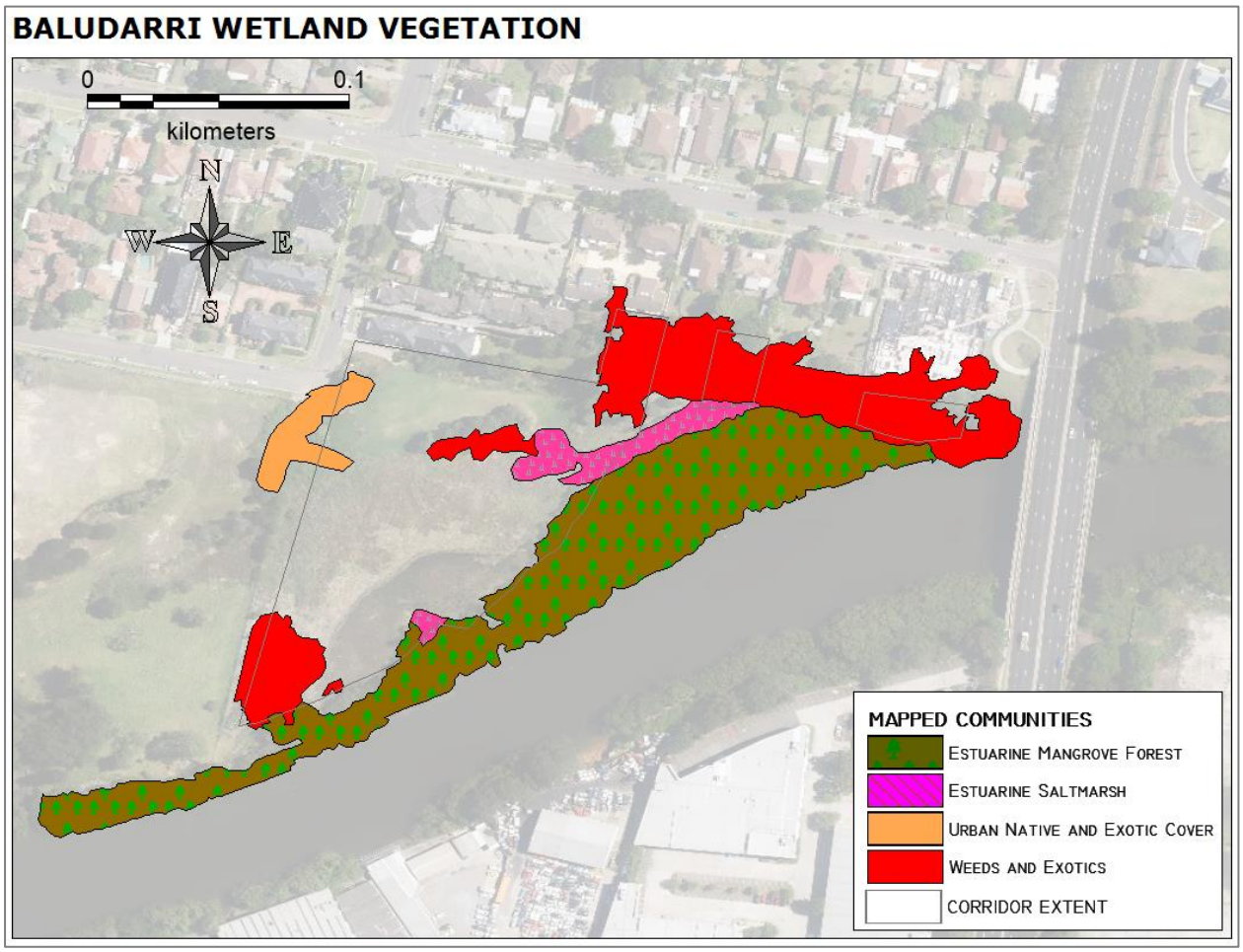


Figure 141 Mapped vegetation communities of Baludarri Wetland

Figure 142 The shared path and boardwalk provide excellent vantage points for observing birds in the wetland

Figure 143 Estuarine saltmarsh - dominated in this location by Juncus kraussii (left) and Samolus repens (right)

Figure 144 High rise development borders the reserve reducing its value to migratory birds as habitat.

KEY ASSETS: Popular and busy shared path and raised boardwalk wraps around the edge of the reserve clearly delineating a “no go” zone between hardened areas and natural areas. Quite beautiful areas of coastal saltmarsh that are largely protected from trampling.

Table 61 Fauna richness summary

CLASS	SPECIES COUNT
BIRDS	24
MAMMALS	
REPTILES	
AMPHIBIANS	

KEY CONSTRAINTS Small size and large size of new development on reserve boundaries. Noise and vibration from construction on both sides of the river. Gross pollutants at high water mark. Historic practice of infilling has changed natural topography and soils.

Table 62 Habitat features summary

Aspect	Present	Minor or patchy	Absent/no
Tree and shrub recruitment evident		✓	
Complex and well developed mid-storey			✓
Infrequent fire regime (more than 10 years between fires)	✓		
Healthy mature trees (no dieback)	✓		
>5 small hollows < 50mm diameter per hectare		✓	
>2 large hollows >50mm diameter per hectare			✓
Evidence of rabbits			✓
Evidence of foxes/cats	✓		
Evidence of firewood collection			✓
Obvious signs of erosion or salinity			✓
Leaf litter present on >50% of ground		✓	
Cryptogams, cracks and rocks present			✓
Less than 20% trees with mistletoe (some mistletoe is healthy)	✓		
Connected to or in close proximity to other remnant vegetation			✓
Fallen timber and logs are left on the ground		✓	
Multiple tracks, informal trails			✓
Low abundance of weeds (most remnants contain some weeds)		✓	
Rubbish dumping evident			✓

Table 63 Baludarri Wetland Species List

BIRDS	
Australasian Figbird	*Sphecotheres vieilloti*
Australian Magpie	*Cracticus tibicen*
Eastern Koel	*Eudynamys orientalis*
Laughing Kookaburra	*Dacelo novaeguineae*
Magpie-lark	*Grallina cyanoleuca*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Noisy Miner	*Manorina melanocephala*
Olive-backed Oriole	*Oriolus sagittatus*
Pied Currawong	*Strepera graculina*
Rainbow Lorikeet	*Trichoglossus haematodus*
Red Wattlebird	*Anthochaera carunculata*
Red-browed Finch	*Neochmia temporalis*
Silvereye	*Zosterops lateralis*
Spotted Pardalote	*Pardalotus punctatus*
Sulphur-crested Cockatoo	*Cacatua galerita*
Superb Fairy-wren	*Malurus cyaneus*
White-browed Scrubwren	*Sericornis frontalis*
White-faced Heron	*Egretta novaehollandiae*
Willie Wagtail	*Rhipidura leucophrys*
Yellow-faced Honeyeater	*Lichenostomus chrysops chrysops*
Common Myna	*Sturnus tristis*
Nutmeg Mannikin	*Lonchura punctulata*
Red-whiskered Bulbul	*Pycnonotus jocosus*
Spotted Turtle-Dove	*Streptopelia chinensis*
REPTILES	
Dark-flecked Garden Sunskink	*Lampropholis delicata*
Eastern Blue-tongue Lizard	*Tiliqua scincoides*
Eastern Water Dragon	*Intellagama lesueurii*
Eastern Water-skink	*Eulamprus quoyii*
Red-bellied Black Snake	*Pseudechis porphyriacus*
MAMMALS	
Common Brushtail Possum	*Trichosurus vulpecula*

Common Ringtail Possum	*Pseudocheirus peregrinus*
Grey-headed Flying-fox	*Pteropus poliocephalus*
White-striped Free-tailed Bat	*Austronomus australis*
Gould's Wattled Bat	*Chalinolobus gouldii*
Eastern Bentwing Bat	*Miniopterus orianae oceanensis*
Ride's Free-tailed Bat	*Mormopterus ridei*
a Forest Bat	*Vespadelus sp*
Black Rat	*Rattus rattus*
Red Fox	*Vulpes vulpes*

13 APPENDIX D WEATHER CONDITIONS DURING THE STUDY

The study was hampered by poor weather conditions over summer. Sydney experienced its hottest summer on record and high temperatures coupled with low rainfall altered the suite of species that may have potentially been detected. Low soil moisture reduced the chance of finding frogs and reptiles on or near the soil surface or under refugia. Under more benign conditions the soil surface under deep leaf litter, woody debris and rocks stays moist and cool providing refugia for reptiles and frogs during summer. Species would have moved to deeper crevices, deeper hollows, burrows etc seeking cool conditions. The number of birds sighted dwindled during this period, for example, the normally abundant and sedentary Spotted Pardalote was regularly seen in the first 6-8 weeks of the survey and then appeared to move from the LGA. It was not heard again until April.

The dry period was followed by the wettest March in 33 years with well over twice the mean monthly rainfall. This made surveying conditions challenging for most species but did provide good conditions for surveying for the Dural Land Snail.

The tables below summarise the daily readings into a monthly total that can be compared to the summary statistics for all years of records.

Table 64 Rainfall - Weather station Parramatta North (Masons Drive) (BoM)

RAINFALL							
2016	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1st	0	0	1	0	0.4	20	0.4
2nd	0	0	0	1.4	3.4	15	0
3rd	0	0	0	0.4	0	4	12.6
4th	0	0	0	3	0.2	32.4	6.2
5th	0	0	1.6	1.6	0	13	4
6th	0	0	4	7	0	1	0
7th	0	0	4.2	24.2	3	0.4	0
8th	0	0	0	0	57	2.2	0
9th	0	3	0	0	8.4	6.2	0
10th	0	10.4	0	0.6	0	0.4	10
11th	0.6	0	0	0	0	0	0
12th	0	9.4	0	0	0	0	0
13th	0	0	0	0	0	0	1.4
14th	0	0	0	0.2	0	6.2	0
15th	0	0.6	6	0	0	56	0
16th	0	0	34	0	0	8	0
17th	0	0	16.6	0	0	21	0
18th	3.8	0	0.4	0	11.4	39	0
19th	0	0	0.4	0	2.4	17	0
20th	0	0	0	0.2	5.4	1	0.6
21st	0	0	1.2	3.2	0	0	0
22nd	9.8	0	0	0	0	16	0
23rd	0.2	0	0	0	0	23	0
24th	0	5.8	0	0	0	10.2	0
25th	0	0	7.8	3.2	5	0	0
26th	0	0	0	0	29.6	0	1.2
27th	0	0	0	0	14.4	0	0.4
28th	2	0	0	0	2.2	0	0
29th	1.4	0	0	0		0	0
30th	0	0	0	0		0	0
31st	1.4		0	0		32	
Highest daily	9.8	10.4	34	24.2	57	56	12.6
Monthly Total	19.2	29.2	77.2	45	142.8	324	36.8
SUMMARY ALL YEARS	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Mean	66.7	85.5	73.6	104.5	121.6	110.9	92.5
Median	47.2	69.2	65.2	90.9	106.1	90.2	57.2
Highest daily	106.5	104	91.4	100	190.4	168.1	140.1
Date of highest daily	25th 1987	14th 1986	9th 1970	29th 1978	3rd 1990	6th 1967	30th 1988

TEMPERATURE							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1st	21	24	33	27.8	23.8	26.2	25.3
2nd	27	27	37	25.7	27	27	21.2
3rd	24.6	29	26.7	25.7	26.3	24.5	20
4th	23.2	31	30.2	25.5	33.6	22.4	21.8
5th	23.2	25.6	34.5	24.5	41.6	23.8	22.2
6th	27	26	25	26.7	35	25	23.5
7th	30.2	34	25.2	27	25	23.5	24
8th	23.3	27.8	34.3	32.8	26.3	23	25
9th	24.2	22.4	28	34	35	23.3	27.5
10th	33.5	27.8	24.8	36.3	44.5	25.7	18.6
11th	20.6	24.8	28	40.8	42.5	26.2	23.6
12th	22.8	35.2	30.3	29.2	33	30.5	21.2
13th	18	29.8	39	43	27.8	29.5	22.5
14th	21.6	24.8		36.6	24.6	23.2	25.2
15th	26.6	22.8	18.8	27.7	27	25.7	24.2
16th	30	24.6	26.2	31	35.7	26.7	26.2
17th	21.3	26	34.2	40.3	37	22.2	25
18th	25	36.2	22	39.2	28.3	24.3	25
19th	23.7	24	24.5	22.7	27	28	23.8
20th	21.8	27	36.8	30.5		29.2	24
21st	28.8	33	27	26.6	26.6	29.7	24.6
22nd	18.2	36.5	24.5	27.6	29	31	24.7
23rd	19.2	33	25.9	36	31.8	23	26.3
24th	20.7	23	30.4	37	27.3	24.2	25
25th	28	28.2	29.3	23.5	21.1	24	26
26th	29.7	23.5	33.6	25.5	25.2	28.5	23.8
27th	23	24	29	27	26.5	29.3	19.7
28th	19.3	30	34	36.7	26.4	24.2	21
29th	26.2	25.2	38.8	30.5		34.5	23.2
30th	28	27.2	35.2	43		26.2	22.8
31st	23.3		29.3	42		23	
Highest daily	33.5	36.5	39	43	44.5	34.5	27.5
Lowest daily	18	22.4	18.8	22.7	21.1	22.2	18.6
Monthly mean	24.3	27.8	29.9	31.7	30.2	26	23.6
SUMMARY ALL YEARS	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Mean	24	25.5	27.5	28.5	27.9	26.3	23.8
Highest monthly mean	28.9	28.6	31.3	31.7	31.7	29.5	26
Lowest monthly mean	20.7	22.9	22.9	25.1	24.9	23.9	21.3
Highest daily	40.1	42.7	43.9	45.5	44.5	40.5	37
Date of highest daily	21st 1988	25th 1982	21st 1994	18th 2013	10th 2017	9th 1983	4th 1986
Lowest daily	13.1	15.1	15.2	17.3	17.5	16.2	15.5
Date of lowest daily	3rd 1967	5th 1996	10th 2002	13th 1972	7th 1973	1st 1987	22nd 1985

Table 65- Temperature -Weather station Parramatta North (Masons Drive) (BoM)

14 APPENDIX E STUDY TEAM

PROJECT MANAGER **ANNE CAREY**

Anne has over 25 years industry experience and has extensive report writing, project management, contracts management and field experience with an excellent understanding of ecology and aquatic and terrestrial flora and fauna. Anne's passion for Australian fauna began at an early age and her first job was as a zoo keeper at the Australian Reptile Park. More recently Anne worked as an Environmental Manager for an alliance of private companies delivering infrastructure projects for Sydney Water; as an aquatic systems officer in local government; as a field ecologist, undertaking research, field trials, fauna and flora assessments and vegetation mapping for various companies and agencies including NSW National Parks and Wildlife Service. Anne holds a Bachelor of Science (Conservation Biology) from Macquarie University, and a Master of Wildlife Management degree (research interest: metapopulation dynamics in fragmented environments) and is currently undertaking further post graduate studies in GIS.

For this project Anne completed the mapping, report writing and field work lead.

Dr MEREDITH BRAINWOOD

Meredith holds a Master of Science (Hons) in Integrated Catchment Management and a Doctorate in Eco-hydromorphology, and has over 18 years experience in government, commercial and educational sectors of the environmental industry. Meredith specialises in the design and implementation of ecological restoration projects, mapping of ecosystem components and liaison with government, non-government, and private sector organisations. Meredith has a position as Adjunct Research Fellow with University of Western Sydney (Hawkesbury), studying aquatic population ecology and land use management impacts on aquatic communities. She has ongoing involvement in research areas including instream bioremediation processes, effective reuse of wastewater, sustainable resource utilisation and improving ecosystem resilience against the effects of climate change. Meredith emphasises the importance of practicality in environmental design solutions, and has supported this by also studying at TAFE to gain practical qualifications in Conservation Earthworks, Certificate II in Bushland Restoration and Certificate IV in Workplace Training and Assessment.

For this project Meredith completed the statistical analysis and wrote the microbat section of the report.