City of Bayswater Native Bee Surveys

November – February 2020/21

Report prepared for City of Bayswater by Dr Kit Prendergast, native bee ecologist

Summary

Bushland remnants are important habitats for native bee biodiversity, yet the assemblages have yet to be characterised in many urban bushland remnants in the southwest Western Australian biodiversity hotspot. Within the City of Bayswater three bushland remnants – Arbor Park, Baigup Wetlands, and Lightning Swamp – were surveyed by native bee ecologist Dr Kit Prendergast, to conduct baseline surveys in order to understand the species composition, how this varied between the sites and months, and floral hosts of native bees. Each site was surveyed for one hour on the same day once a month from November – February 2020/21 using targeted sweepnetting. A total of 153 specimens belonging to 41 species were recorded across all surveys. Comparing sites, 65 specimens belonging to 23 species were collected from Arbor Park, 42 specimens belonging to 21 species, and 46 specimens belonging to 15 species from Baigup Wetlands. The higher numbers of bees at Arbour Park was due to high numbers of *Corymbia calophylla* and *Jacksonia furcellata* – both keystone forage species for many native bees. There was high turnover between months and phenological patterns were not concordant between sites. A major finding was the high dissimilarity between sites: each site had a unique taxonomic composition, with numerous species only occurring at one site. Only a limited number of flora were visited, emphasising the specialised niches of native bees and the importance of planting large patches of preferred host flora to support native bees in this region. It is strongly recommended that with the discovery of large patches of *Goodenia filiformis,* a host for EPBC listed threatened native bees, at Lightning Swamp, targeted surveys be conducted. These surveys established that these bushland remnants in City of Bayswater each host a unique, diverse assemblage of native bees, the diversity of which cannot be captured at a single site or in a single month. Ongoing monitoring is highly recommended given the high interannual variation in bee assemblages, to assess how the populations are responding to environmental and management changes.

Introduction

Native bees are a precious component of biodiversity, and many play important roles in the structure and functioning of ecosystems (Potts et al., 2016). Their diverse ecologies (Michener, 2007), in terms of nesting substrate requirements, specialisation or generalisation on pollen resources, preferences or reliance on particular flowering plants, body size, and phenologies, means that they are bioindicators of ecosystems, and the composition of bee assemblages can provide insights into ecosystem functioning and responses to environmental change. With over 1600 species, and many more to be discovered and described (Australian Government Department of the Environment and Energy, 2021), Australian native bees represent a major component of biodiversity. Despite this, there is little known about the native bee assemblages in many parts of Australia.

Whilst the surveying, monitoring, and taxonomic descriptions of species is severely underfunded and under-researched, there are global concerns about the plight of pollinators (Potts et al., 2016). Given their roles as pollinators, it is surprising that until recently there has been little attention regarding understanding the ecologies, distributions, trends and vulnerabilities of native bees on the Swan Coastal Plain, which is part of an internationally recognised biodiversity hotspot, renowned for a high diversity of flowering plants, many endemic, but also recognised as having had over 80% of the original vegetation cleared (Lambers, 2019; Laurie, 2015; Myers et al., 2000). A main cause of land-clearing in this region, especially today, is for urban expansion (Lambers, 2019). Recent research has underscored the important of bushland remnants in this region for the conservation of native bees (Prendergast et al., in prep; (Prendergast & Ollerton, 2021b). Surveys of bushland remnants have revealed that despite being surrounded by threatening processes and factors that negatively impact native bees such as roads, impervious surfaces, loss of trees, and replacement of native vegetation with exotic flora, bushland remnants still host a large number of native bee species (Prendergast, 2020a, 2021d; Prendergast, 2020b). What these surveys to date have also revealed however is how distinctive each bushland remnant is, often with a unique composition, and species that have yet to be scientifically described. Within increasing pressures on remnant vegetation, it is vital that remaining bushland remnants are surveyed to understand their species composition and potentially identify rare or new species.

In addition, there is a positive movement to plant and restore native vegetation around the suburbs of cities, including Western Australia. Yet such initiative are seldom evidence-based, and do not take into consideration the flora that are preferred by native bees. As such, targeted surveys to discover

the flowering plants preferred by native bees throughout the activity season is vital so that restoration and revegetation initiatives can be more than token gestures.

To this end, City of Bayswater employed native bee ecologist, Dr Kit Prendergast, to undertake native bee surveys at three bushland remnants, with the goals of a) determining the native bee species assemblages in these bushland remnants and how they vary between the sites and over the season; and b) understand the plant host associations of these native bee assemblages.

Methods

Native bees were collected by a native bee expert, Dr Kit Prendergast, using targeted sweepnetting (Fig. 1). This method is the most effective at collecting the greatest abundance and diversity of native bees in this region (Prendergast et al., 2020), and allows identification of floral hosts (Prendergast & Hogendoorn, 2021). Using a single, experienced surveyor prevented inter-observer bias. Surveys were conducted monthly during the main native bee activity season (the warmer months in the southern Hemisphere) (Prendergast, pers. obs.) to be able to capture the phenology of native bees. Surveys occurred October – December 2020, and Jan – Feb 2021.

Fig. 1. Dr Kit Prendergast using targeted sweepnetting to collect native bees (above), and the collected specimens (below).

Three bushland remnants were surveyed within the City of Bayswater: Abor Park, Baigup Wetlands, and Lightning Swamp (Fig. 2). Each of the three sites were surveyed for an hour each on the same day, with the order randomised. Surveys were conducted on warm days (>20°C), under conditions of low to no cloud cover. During each survey K. Prendergast walked slowly around the site, stopping to observe patches (approx. >0.25m^2) for at least a minute before moving on if no activity was observed.

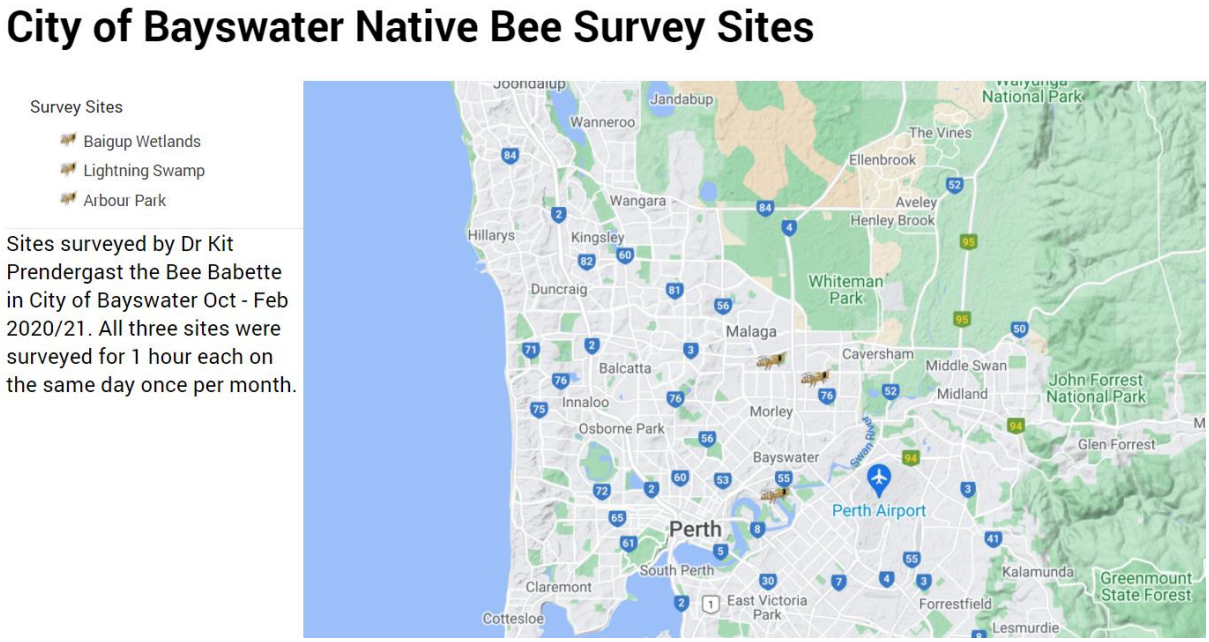

Fig. 2. Native bee survey sites within City of Bayswater

Species were pinned and labelled with location, GPS location, date of collection, collector, host plant, and given a unique identifier number. Species were identified by K.S. Prendergast using published descriptions, keys to genera (where available) (e.g. see references in (Houston, 2018)), and with reference to a previous collection of native bees collected on the Swan Coastal Plain (Prendergast, 2019, 2020a), which in turn were cross-checked with the WA Museum Entomology collection. When a species could not be keyed out or did not match any published descriptions, it was assigned a unique morphospecies ID.

In addition to comparing species occurrences and their relative abundances, taxonomic composition for each site was calculated using categories in (Prendergast & Ollerton, 2021a; Prendergast & Ollerton, 2021c).

Results and Discussion

Native bee community

Across all surveys a total of 153 bees were recorded belonging to 41 species (Table 1). 42 specimens belonging to 21 species were collected from Lightning Swamp (Table 2), 46 specimens belonging to 15 species from Baigup Wetlands (Table 3), and 65 specimens belonging to 23 species from Arbor Park (Table 4). The most abundant species was *Megachile (Eutricharaea) chrysopyga* (22 specimens). Fourteen species (34.1%) were singletons.

Despite the three sites being in the same geographic area (Fig. 2), there was high turnover between the sites and each had a unique assemblage. Only three species (*Megachile (Eutricharaea) cf. macularis, Megachile (Eutricharaea) cf. obtusa* and *Megachile (Eutricharaea) chrysopyga*) occurred at all three sites. Twelve species (28.6% of all species) occurred at two sites, and remarkably 27 species, representing the vast majority (64.3%), occurred at only one site. Twelve species occurred exclusively at Arbor Park, 11 species occurred exclusively at Lightning Swamp, and four species were collected only from Baigup Wetlands (Table 5).

Table 1. Native bee species and their abundances collected across three sites within the City of Bayswater by Dr Kit Prendergast Nov – Feb 2020/21

Species	Abundance
Euryglossina (Euryglossina) argocephala	3
Euryglossina (Euryglossina) hypochroma	6
Euryglossina (Euryglossina) kellyi	1
Euryglossina (Euryglossina) lynettae	2
Euryglossina (Euryglossina) micheneri	1
Euryglossina (Euryglossina) perpusilla	1
Euryglossina (Euryglossina) philoxantha	6
Euryglossina (Euryglossina) pseudoatomaria	1
Euryglossina (Microdontura) mellea	4
Pachyprosopis (Pachyprosopula) purnongensis	5
Hylaeus (Euprosopoides) ruficeps kalamundae	6
Hylaeus (Prosopisteron) aralis	10
Hylaeus (Prosopisteron) breviscapatus	3
Hylaeus (Prosopisteron) latifacies	5
Hylaeus (Prosopisteron) vittatifrons	1
Hylaeus sp._LightningSwampBeaufortia	1
Hyleoides zonalis	1
Leioproctus (Leioproctus) plumosus	1
Leioproctus sp._LightningSwampLechnaultiaLeioproctus	2
Homalictus (Homalictus) cf. houstoni	2
Lasioglossum (Chilalictus) castor	2
Lasioglossum (Parasphecodes) hiltacum	1
Lipotriches (Austronomia) flavoviridis species-group	6
Lipotriches (Austronomia) moerens	2
Megachile "houstoni"	7
Megachile (Austrochile) remotula	1
Megachile (Eutricharaea) cf. macularis	4
Megachile (Eutricharaea) cf. phenacopa	1
Megachile (Eutricharaea) cf. serricauda	2
Megachile (Eutricharaea) chrysopyga	22
Megachile (Eutricharaea) cf. obtusa	6
Megachile (Eutricharaea) simplex	4
Megachile (Hackeriapis) apicata	4
Megachile (Hackeriapis) canifrons	1
Megachile (Hackeriapis) tosticauda species-group	5
Megachile aurifrons	1
Megachile callura	3
Megachile leeuwinensis	3
Megachile sp.Bayswater1	1
Megachile speluncarum	13
Rozenapis ignita	2

Table 2. Native bees collected by month at Arbor Park. N = abundance, R = species richness

Month	Family	Genus	Species	female n	male n	total	Total N	Total R
Oct	Colletidae	*Euryglossina*	*Euryglossina (Euryglossina) hypochroma*		6	6	9	4
		Hylaeus	*Hylaeus (Prosopisteron) breviscapatus*	1		1		
		Leioproctus	*Leioproctus (Leioproctus) plumosus*		1	1		
	Megachilidae	*Megachile*	*Megachile (Eutricharaea) chrysopyga*	1		1		
Nov	Megachilidae	*Megachile*	*Megachile (Eutricharaea) chrysopyga*	1	1	2	6	5
			Megachile (Eutricharaea) cf. serricauda	1		1		
			Megachile (Eutricharaea) cf. macularis	1		1		
			Megachile (Eutricharaea) obtusa		1	1		
		Rozenapis	*Rozenapis ignita*	1		1		
Dec	Megachilidae	*Megachile*	*Megachile (Eutricharaea) cf. obtusa*	1		1	10	4
			Megachile (Eutricharaea) cf. simplex	1		1		
			Megachile (Eutricharaea) chrysopyga	5		5		
			Megachile speluncarum	3		3		
Jan	Colletidae	*Euryglossina*	*Euryglossina (Euryglossina) argocephala*	2		2	24	8
			Euryglossina (Euryglossina) pseudoatomaria	1		1		
			Euryglossina (Euryglossina) philoxantha	5	1	6		
		Pachyprosopis	*Pachyprosopis (Pachyprosopula) purnongensis*	3	2	5		
		Hylaeus	*Hylaeus (Prosopisteron) aralis*	4	1	5		
			Hylaeus (Prosopisteron) breviscapatus	2		2		
	Halictidae	*Homalictus*	*Homalictus (Homalictus) cf. houstoni*	2		2		
		Lasioglossum	*Lasioglossum (Parasphecodes) hiltacum*	1		1		
Feb	Colletidae	*Euryglossina*	*Euryglossina (Euryglossina) micheneri*	1		1	16	6
			Euryglossina (Euryglossina) lynettae	2		2		
		Hylaeus	*Hylaeus (Euprosopoides) ruficeps kalamundae*	1	1	2		
			Hylaeus (Prosopisteron) aralis	4	1	5		
			Hylaeus (Prosopisteron) latifacies	2	3	5		
	Megachilidae	*Megachile*	*Megachile (Hackeriapis) tosticauda*	1		1		

Table 3. Native bees collected by month at Baigup Wetlands. N = abundance, R = species richness

Month	Family	Genus	Species	female n	male n	total	Total N	Total R
Oct	Halictidae	*Lasioglossum*	*Lasioglossum (Chilalictus) castor*	1		1	6	4
	Megachilidae	*Megachile*	*Megachile (Eutricharaea) chrysopyga*	2	1	3		
			Megachile (Hackeriapis) canifrons		1	1		
			Megachile speluncarum		1	1		
Nov	Megachilidae	*Megachile*	*Megachile (Eutricharaea) cf. phenacopa*		1	1	9	6
			Megachile (Eutricharaea) obtusa		1	1		
			Megachile (Hackeriapis) apicata	1		1		
			Megachile (Eutricharaea) chrysopyga	1		1		
			Megachile "houstoni"	1	1	2		
			Megachile (Hackeriapis) tosticauda species-group		3	3		
Dec	Megachilidae	*Megachile*	*Megachile speluncarum*	6	1	7	14	4
			Megachile (Hackeriapis) tosticauda species-group		1	1		
			Megachile (Hackeriapis) apicata	2		2		
			Megachile (Eutricharaea) chrysopyga	2	2	4		
Jan	Colletidae	*Hyleoides*	*Hyleoides zonalis*		1	1	8	3
	Megachilidae	*Megachile*	*Megachile (Eutricharaea) chrysopyga*	3	2	5		
			Megachile speluncarum	1	1	2		
Feb	Colletidae	*Euryglossina*	*Euryglossina (Microdontura) mellea*	2		2	9	6
			Euryglossina (Euryglossina) perpusilla	1		1		
	Megachilidae	*Megachile*	*Megachile (Eutricharaea) simplex*	2	1	3		
			Megachile (Eutricharaea) serricauda	1		1		
			Megachile (Eutricharaea) obtusa		1	1		
			Megachile (Eutricharaea) macularis		1	1		

Table 4. Native bees collected by month at Lightning Swamp. N = abundance, R = species richness

Month	Family	Genus	Species	female n	male n	total	Total N	Total R
Oct	Colletidae	*Hylaeus*	*Hylaeus sp._LightningSwampBeaufortia*	1		1	9	4
	Halictidae	*Lipotriches*	*Lipotriches (Austronomia) flavovirids species-group*	5		5		
			Lipotriches (Austronomia) moerens	2		2		
	Megachilidae	*Megachile*	*Megachile (Austrochile) remotula*		1	1		
Nov	Megachilidae	*Megachile*	*Megachile (Eutricharaea) cf. macularis*	1	1	2	7	6
			Megachile leeuwinensis	1		1		
			Megachile aurifrons	1		1		
			Megachile (Eutricharaea) obtusa		1	1		
			Megachile (Eutricharaea) chrysopyga	1		1		
			Megachile sp.Bayswater1	1		1		
Dec	Megachilidae	*Megachile*	*Megachile "houstoni"*	3	2	5	18	7
			Megachile callura	2	1	3		
			Megachile leeuwinensis	1	1	2		
		Rozenapis	*Rozenapis ignita*		1	1		
	Colletidae	*Euryglossina*	*Euryglossina (Microdontura) mellea*		2	2		
		Hylaeus	*Hylaeus (Prosopisteron) vittatifrons*	1		1		
			Hylaeus (Euprosopoides) ruficeps kalamundae	2	2	4		
Jan	Colletidae	*Leioproctus*	*Leioproctus sp._LightningSwampLechnaultiaLeioproctus*	2		2	5	4
	Halictidae	*Lipotriches*	*Lipotriches (Austronomia) flavovirids species-group*	1		1		
		Lasioglossum	*Lasioglossum (Chilalictus) castor*		1	1		
	Megachilidae	*Megachile*	*Megachile (Eutricharaea) obtusa*		1	1		
Feb	Colletidae	*Euryglossina*	*Euryglossina (Euryglossina) kellyi*	1		1	3	3
			Euryglossina (Euryglossina) argocephala	1		1		
	Megachilidae	*Megachile*	*Megachile (Hackeriapis) apicata*	1		1		

Table 5. Native bee species unique to each City of Bayswater bushland remnant

Arbor Park	**Baigup Wetland**	**Lightning Swamp**
Euryglossina (Euryglossina) micheneri	*Euryglossina (Euryglossina) perpusilla*	*Euryglossina (Euryglossina) kellyi*
Euryglossina (Euryglossina) pseudoatomaria	*Hyleoides zonalis*	*Hylaeus (Prosopisteron) vittatifrons*
Lasioglossum (Parasphecodes) hiltacum	*Megachile (Eutricharaea) cf. phenacopa*	*Hylaeus sp._LightningSwampBeaufortia*
Leioproctus (Leioproctus) plumosus	*Megachile (Hackeriapis) canifrons*	*Megachile (Austrochile) remotula*
Euryglossina (Euryglossina) lynettae		*Megachile aurifrons*
Homalictus (Homalictus) cf. houstoni		*Megachile sp.Bayswater1*
Hylaeus (Prosopisteron) breviscapatus		*Lipotriches (Austronomia) moerens*
Pachyprosopis (Pachyprosopula) purnongensis		*Leioproctus sp._LightningSwampLechnaultiaLeioproctus*
Hylaeus (Prosopisteron) latifacies		*Megachile callura*
Euryglossina (Euryglossina) hypochroma		*Megachile leeuwinensis*
Euryglossina (Euryglossina) philoxantha		*Lipotriches (Austronomia) flavoviridis species-group*
Hylaeus (Prosopisteron) aralis		

Three species were recorded that had not been collected previously by K. S. Prendergast and could not be identified with confidence and may represent undescribed, or even undiscovered species: *Hylaeus sp._LightningSwampBeaufortia*, *Leioproctus sp._LightningSwampLechnaultiaLeioproctus, Megachile sp.Bayswater1.* All were collected at Lightning Swamp.
In addition, a number of species were collected which had not been collected by K. S. Prendergast during her surveys of fourteen sites over ten months spanning two years in the Perth metropolitan region, nor at two other bushland remnants in the Perth region (Herdsman Lake and Lake Claremont) (Prendergast, 2020a, 2021d; Prendergast, 2020b).

There was considerable variation in abundance and species richness between months, and this also varied according to site (Fig. 3a, b). At Arbour Park, the greatest abundance and diversity occurred in January 2021 (24 specimens belonging to 8 species); the fewest bees were recorded in Nov 2020 (6 specimens), and fewest species in Oct and Dec (4 species). Overall, the most abundant species was *Hylaeus (Prosopisteron) aralis* (10 specimens in total).
Peak abundance at Baigup Wetlands occurred in December 2020 (14 specimens), whereas peak species richness occurred in Nov 2020 and Feb 2021 (10 species). The most abundant species was *Megachile (Eutricharaea) chrysopyga*, with thirteen specimens collected in total.
The greatest abundance and species richness of bees at Lightning Swamp was recorded in December 2020 (18 specimens belonging to 7 species), and lowest abundance and species richness was recorded in February 2021 (3 specimens representing 3 species). The most abundant species was *Lipotriches (Austronomia) flavoviridis species-group,* with six specimens collected.

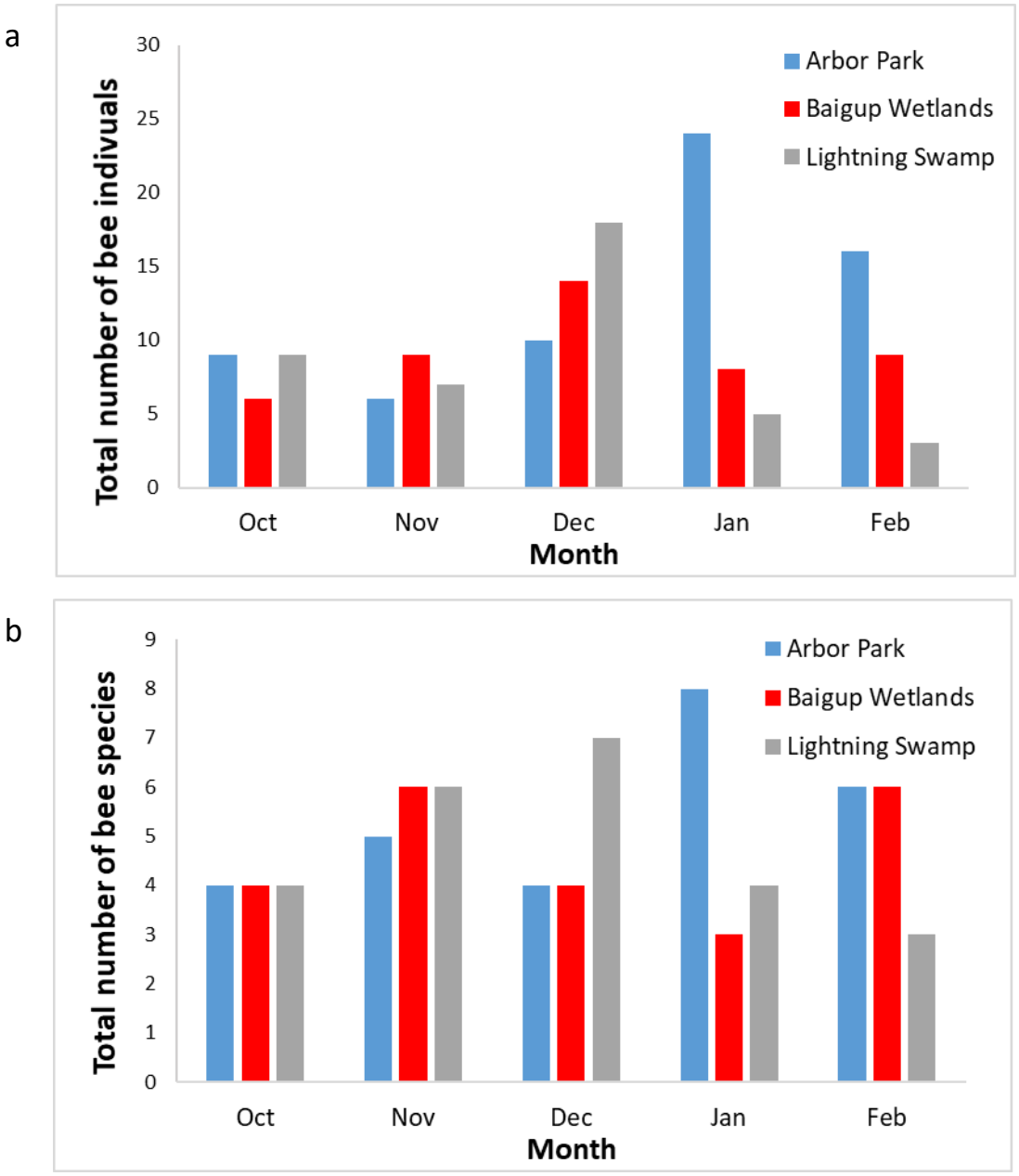

Fig. 3. Phenological patterns of native bees in a) abundance and b) species richness across survey months at Arbor Park, Baigup Wetlands and Lightning Swamp.

Species composition

Despite previous surveys in this region finding *Amegilla* to be highly abundant, no *Amegilla* were collected; however, a number were seen but unable to be collected at Lightning Swamp. Also absent were *Trichocolletes,* which are early-season specialists on Fabaceae. Conducting surveys in September may have resulted in collecting these species. *Meroglossa,* which is represented by a single species *M. rubricata*, were also absent; their absence is less able to be explained, but they are rarely seen foraging (Prendergast, 2017). Installing bee hotels may results in recording this taxon (Prendergast, 2017). What was highly unusual were the lack of Allodapini (largely represented by *Exoneura*), since these are generalists, and during surveys conducted over the same period in nature reserves in the Jarrah forest they were one of the dominant taxa (Prendergast, 2021a, b, c). Their absence may be due to how, being social (Houston, 2018), they require larger amounts of quality resources to sustain their small colonies, or how, being stem-nesters (Houston, 2018), there was insufficient hollow, pithy stems in this region.

Overall, all ground-nesting genera (*Amegilla, Homalictus, Lasioglossum, Lipotriches, Leioproctus, Trichocolletes*) were rare or absent. This finding mirrors previous surveys in the urbanised region of southwest WA (Prendergast et al., under review), and mirrors many other urbanise regions where it appears the high proportions of impervious surfaces restrict nesting opportunities, causing ground-nesting taxa to be relatively under-represented, despite comprising more species globally (Prendergast et al., under review). Similar to previous studies (Prendergast et al., under review)(Prendergast, 2021d; Prendergast, 2020b), above-ground cavity-nesting Megachilids dominated (52.3% of individuals, 41.5% of species), and were over-represented compared with their Australian representation (10.2%: 169 described species out of 1654 described species (AFD, 2021)). Small colletids (Euryglossinae and Hylaeinae) were next most represented taxa.

Taxonomic composition also varied greatly in both relative abundance and species diversity between the three Bayswater sites (Fig. 4). Only four of the seven taxonomic categories were present at Baigup, and megachilids heavily dominated (89% of individuals). Megachilids made up only 27.7% of species at Arbor Park, with the small colletids Euryglossinae and Hylaeinae making up 35.4% and 30.8%. Lightning Swamp was the only site with *Lipotriches*, which comprised almost one fifth of all individuals; Megachilids comprised 50% of individuals. Patterns in the relative representation of taxa in species richness were similar to that regarding abundance (Fig. 4).

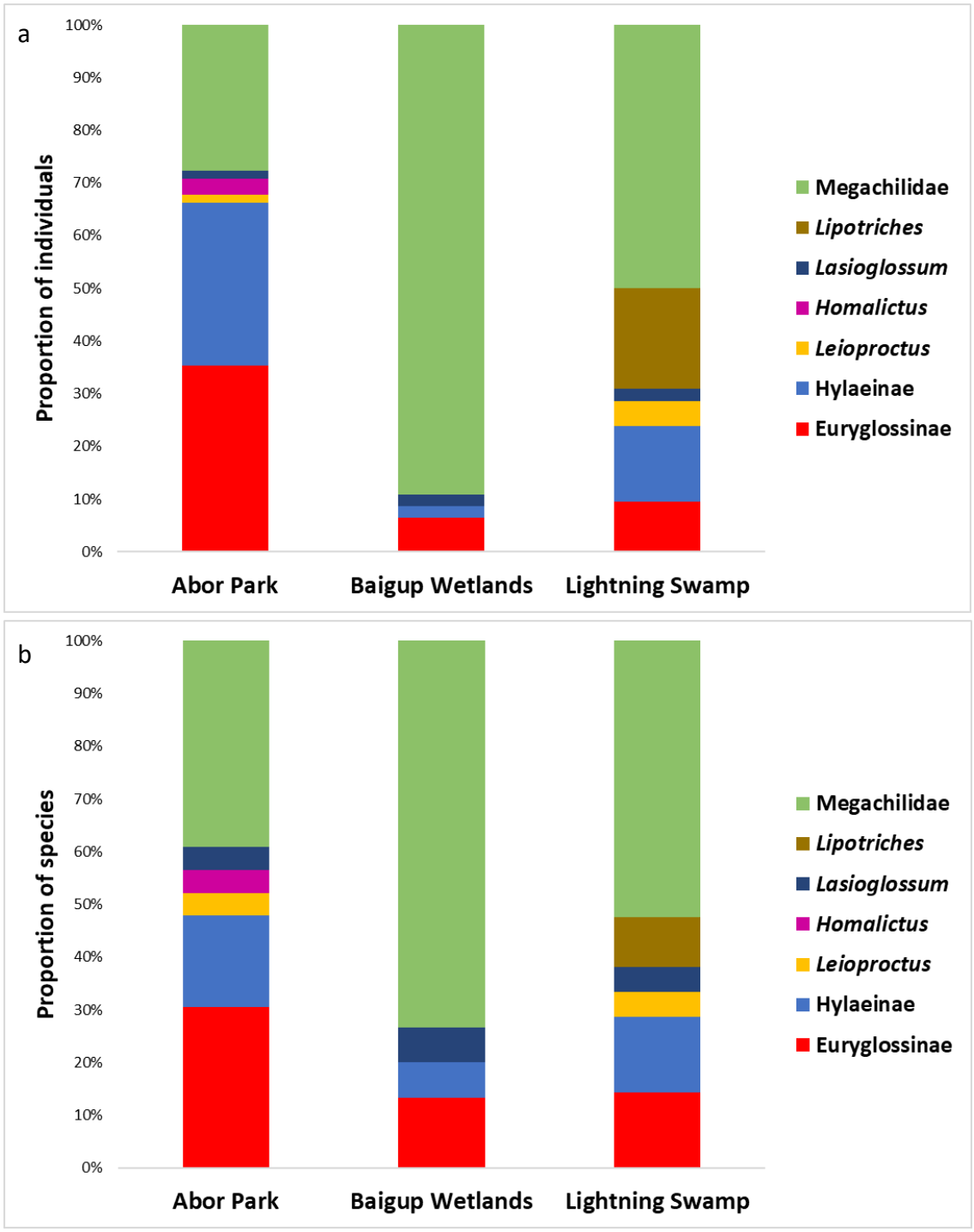

Fig. 4. Taxonomic composition of native bees in a) abundance and b) species richness at Arbor Park, Baigup Wetlands and Lightning Swamp.

Host flower preferences

Very few plant species were visited, which is both a reflection of the few species of plants available during some surveys (e.g. at Arbour Park there is generally low plant species richness); however, this had no bearing on how many species were collected, with single 'keystone' species being able to host a diversity of native bees. Instead, this is more of a reflection of the specialised nature of the foraging preferences of many native bees in this region (see also (Prendergast & Ollerton, 2021c)).

At Arbor Park, in all months native bees were collected from just a single plant species, except October where they were collected from two plant species (Appendix 1). Despite this Arbour Park had the greatest number of native bees collected overall. This is attributed to the large numbers of 'keystone' plant species: *Corymbia calophylla* (in the park), which is a keystone resource for specialised small colletids (Euryglossinae and Hylaeinae, as well as being visited by generalists), and a street *Eucalyptus marginata,* which attracts a similar assemblage, and the numerous *Jacksonia furcellata,* which are keystone resources for specialist Megachilidae.
In October a plant species not part of the park per se but on a verge adjacent to the park – a horticultural pink variety of *Callistemon* - attracted the majority of native bees and native bee species. Including more of these trees would be advisable, or encouraging residents in the area to retain or plant these as garden or street trees. Across all months only four plants were visited.

At Baigup Wetlands, number of plants foraged on per survey ranged from one to four, and across all surveys nine plant species were visited (Appendix 2). Overall *Jacksonia sternbergiana* attracted the greatest number of individuals, and *Hemiandra pungens, Jacksonia sternbergiana, Jacksonia sericea* and *Lotus sp.* attracted the greatest number of species.
Interestingly, an introduced weed (*Lotus* sp.) attracted the majority of native bees in February, warranting caution about removing this 'weed'. The majority of bees at Baigup wetland were collected at the very start of the Baigup Wetland trail (off Swan View Terrance), where there are managed plantings of key flora for native bees such as *Jacksonia, Pimelea, Eucalyptus, Calothamnus* and *Hemiandra.* Apart from the *Melaleucas,* much 'wetland' vegetation is not attractive to native bees. This section therefore should be prioritised for preservation.

At Lightning Swamp, native bees foraged on two to five plant species, with a total of twelve species visited across the entire season (Appendix 3). *Jacksonia furcellata* was visited by the greatest number of species, and *Jacksonia furcellata* and *Goodenia filiformis* received the greatest number of

visits. *Goodenia filiformis* is particularly of interest: a large patch of *Goodenia filiformis* was found in the east of the reserve. *Goodenia filiformis* is the host of two of the very few species that have had their conservation status assessed and are listed on the EPBC Act Federal Government Threatened Species List (Department of the Environment, 2018b). *Neopasiphae simplicior* is currently only known a single location within the bushland of the Forrestdale Lake Nature Reserve adjacent to Forrestdale Lake and the Armadale Golf Course (Department of the Environment, 2018a, b), with a previous population known from Cannington (Perth's southern suburbs) of which recent surveys failed to relocate it (Prendergast, 2019). Surveys at another previously recorded location (Kooljerrinup Nature Reserve (Atlas of Living Australia, 2021) failed to find this bee (Prendergast, 2021e). *Leioproctus (Andrenopsis) douglasiellus* is also listed as Critically Endangered (Department of the Environment, 2018a; Threatened Species Scientific Committee, 2013). It is thought to occur only in three locations within the Perth metropolitan area ranging from Cannington to Forrestdale (DEC, 2009), however the Cannington site appears to no longer host the bee (Prendergast, 2019). With a large population of the host plant and occurring within the range of these two critically endangered species, there is the potential for Lightning Swamp to host this species. Given only one short survey was conducted here monthly, it is strongly recommended that K.S. Prendergast conduct intensive targeted surveys for these two native bee species at this location during the flowering period of the host (late September to January).

Future Research

The taxonomy of native bees is in dire need of revisions, with many undescribed species, and even for those that are described, there are no keys for entire clades, and descriptions written over a century ago are inadequate. Research and investment into native bee taxonomy is an urgent priority (Taxonomy Australia, 2020). Due to the limited taxonomic work on native bees, numerous species could not be identified to species, and some may represent synonyms.

There is no key to most genera, and the entire Allodapini clade lack a key.

Females of *M. serricauda* and *M. obtusa* are virtually indistinguishable and their distributions are sympatric hence these identifications are tentative; additionally there are undescribed cryptic sympatric species (BOLD:ACC9593; BOLD:AAQ0516; BOLD:ABW2483). Likewise with *M. simplex* (very similar to undescribed species: BOLD:ACC9626; BOLD:AAQ0516). DNA barcoding is the only way to verify with certainty. In addition, a key for the *Eutricharaea* subgenus is forthcoming (Judy King, pers. comm., 2021), and hence any identifications at present may be subject to revisions. Additionally,

there were a number of species that have yet to be described, or could not be keyed out with confidence.

Due to these shortcomings in the current state of native bee taxonomy in Australia, including samples of the species collected here in the AUSBS BOLD database project is highly recommended (Hogendoorn et al., 2014). Including the specimens that were undescribed will also be of high value to the taxonomic and native bee community.

It is highly recommended that long-term monitoring be conducted. This is a major knowledge gap and hurdle to successful native bee conservation. Already it is very evident that phenology plays a major role in determining which species are active when, and each species is active for only a short time period. It is also evident that the flower host associations also changed from month to month. In light of this, under current climate change projections blooming may occur earlier, with unknown consequences for Australian native bees (research in the northern hemisphere has found mixed responses (Cane, 2021; Gérard et al., 2020; Miller-Struttmann et al., 2015)). Climate change and increases in drought are also predicted to adversely impact flowering resources (Descamps et al., 2021), with the scant research in Australia revealing this can have devastating impacts on native bees (Santos et al., 2020). Consequently monitoring of bee assemblages, and management of vegetation to try and ameliorate these issues should be a priority.

Further ongoing surveys are essential to determine how the patterns recorded here persist over the years. Increased planting of the key flora the native bees were found foraging on is recommended to ensure there is an abundance of resources. Surveys of other bushland remnants within the City will also expand knowledge of the native bee fauna in this region.

There is virtually no ongoing monitoring schemes for native bees across Australia, and therefore the conservation status of the majority of native bees cannot be assessed with confidence. It is advised that regularly monitoring every year or two years is needed to determine levels of natural variation, and determine if species are exhibiting shifts in phenology, and detect ongoing trends in their demography. Such data will enable proactive actions to assist in ensuring that population declines do not go under the radar.

Appendices

Appendix 1. Arbor Park plant-bee network

Appendix 2. Baigup Wetlands plant-bee network

Appendix 3. Lightning Swamp plant-bee network

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