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Manly Creek Riparian Corridor Biodiversity Study, Wandella Road, Manly Vale and Allambie Heights

Prepared for Northern Beaches Council
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Document control

Project number	Client	Project manager	LGA
4797	Northern Beaches Council	Matthew Stanton	Northern Beaches

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Executive summary

Project outline

The bushland surrounding the Mermaid Pool has long been treated as a council reserve extending the existing David Thomas Reserve. However, only portions of the area are formally zoned for conservation and/or recreation. Council has initiated a process to clarify the status of the lands and is seeking to improve the database of the ecological values at the site.

Niche Environment and Heritage completed a flora and fauna survey from February 2019 to June 2019 with the aim of describing the flora and fauna communities and habitat values of the site. Flora was investigated with a series of Rapid Data Point survey and more intensive standard Biodiversity Assessment Method (OEH 2017) plots, combined with targeted and wide ranging searches for additional flora species.

Vertebrate fauna were surveyed using several methods including ultrasonic call detection for bats, spotlighting for nocturnal fauna, plot based bird surveys for diurnal birds, nest boxes to target small cryptic vertebrates such as the Eastern Pygmy Possum (*Cercartetus nanus*) and game camera traps for a range of terrestrial fauna.

Summary of findings

The study area has a diverse vegetation, typical of sites with multiple physical environments and a range of disturbance histories. The vegetation communities on shallow sandstone based soils within the subject site are largely intact and only have minor weed incursions, while the alluvial creek flats have had a more dramatic disturbance history and provide conditions that suit some of the worst environmental weeds. The prevalence of weeds and the long history of planting non-local native species for bush regeneration purposes makes it impossible to describe the plant community type for much of the creek-side vegetation. The more elevated communities fall into three Plant Community Types (PCTs): Coastal Sandstone Gully Forest, Sydney North Exposed Sandstone Woodland and Coastal Sandstone Heath Mallee.

However, all the wooded environments are providing some resources for wildlife so while there were no threatened flora species detected, there were a number of threatened fauna species and other native fauna that are otherwise uncommon in a suburban setting.

Threatened fauna detected were the Southern Myotis (*Myotis macropus*), Eastern Bentwing-bat (*Miniopterus schreibersii*), Little Bentwing-bat (*Miniopterus australis*), Grey headed Flying Fox (*Pteropus poliocephalus*), Black Bittern (*Ixobrychus flavicollis*), Powerful Owl (*Ninox strenua*), White-throated Needletail (*Hirundapus caudacutus*), Little Lorikeet (*Glossopsitta pusilla*), Swift Parrot (*Lathamus discolor*), Heath Monitor (*Varanus rosenbergi*) and Red-crowned Toadlet (*Pseudophryne australis*).

Conclusion

The study area contains areas valuable for the conservation of biodiversity in the Northern Beaches region. The site helps to link the more substantial bushland areas to the west with smaller patches of habitat and open space towards the coastal beaches. The site is also one of the closest patches of wooded habitat to North Head (Sydney Harbour National Park) which contains an endangered population of the Long-nosed Bandicoot (*Perameles nasuta*). The area is important habitat in its own right for a number of threatened animals. The preservation of this site is important for the ongoing welfare of wildlife in the local area.

Glossary and list of abbreviations

Term or abbreviation	Definition
BC Act	NSW *Biodiversity Conservation Act 2016*
BioNet	NSW BioNet is the repository for biodiversity data products managed by the Office of Environment and Heritage (OEH)
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
Local population	The population of a particular threatened species that occurs in the locality
Locality	The area within 10 km of the study area
Local occurrence	Refers to the distribution of an ecological community within the study area and continuous with it
Matters of NES	Matters of national environmental significance
OEH	NSW Office of Environment and Heritage (Now DPIE)
PCT	Plant Community Type
TEC	Threatened ecological community as listed on the BC Act and/or EPBC Act. Collective term to describe vulnerable, endangered and critically endangered ecological communities
Threatened biodiversity	Threatened species, populations and ecological communities as listed on the BC and or EPBC Acts

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1. Introduction

1.1 Background and need for the project

Northern Beaches Council commissioned Niche Environment and Heritage (Niche) to undertake a biodiversity study of David Thomas Reserve and surrounding bushland located in the suburbs of Allambie Heights and Manly Vale (the site). This patch of bushland has a long rich history, containing the well-known Mermaid Pools, a nominated Aboriginal site, which is the subject of an ongoing community restoration project. The Manly Creek/Mermaid's Pool Restoration Plan was written in 2003 (Total Earth Care), and the pools were featured on Gardening Australia and other media in 2004.

The land is bounded by low-density residential development to the north and south and the vegetation at the site directly connects to Manly Dam (Manly Warringah War Memorial Park) to the west, and Millers reserve and Warringah Golf Club to the east, from there widening until the creek discharges into Manly Lagoon. The land is made up of nine (9) lots, a section of Wandella Road un-made road reserve and Manly Creek. See Figure 1 for the subject site and locality.

1.2 Purpose and objectives

The overall aim of this project is to design and conduct a comprehensive field study, report findings and provide an assessment of the biodiversity values of the site, including its value as a wildlife corridor.

The following objectives have been designed to meet this aim:

- Determine and map the NSW Plant Community Types (PCTs) at the site
- Undertake a comprehensive field survey including complete flora and fauna inventory, targeting threatened flora and fauna as well as small cryptic birds and introduced species, in accordance with relevant government guidelines and including the most up-to-date survey methods
- Record and map important habitat features and wildlife corridors, including known threatened species and small bird habitat
- Report on findings and provide general recommendations to improve biodiversity values in the future.

This assessment details the species and ecological communities observed or likely to occur on site, including those listed as threatened in NSW under the *Biodiversity Conservation Act 2016* (BC Act), *Fisheries Management Act 1994* (FM Act), or Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An assessment has been made on the habitat value and connectivity of the site to assess its value as a wildlife corridor.

1.3 The subject site and study area

The subject site (the site) occurs within the Northern Beaches Council local government area in NSW and consists of approximately 11 ha; of which 7.4 ha is vegetated and over 3 ha is managed grassed sports fields and associated amenities of David Thomas Reserve.

Manly Creek runs from west to east through the site. Manly Creek also divides Allambie Heights to the north and Manly Vale to the south. This bushland is connected to Manly Dam reserve to the west and provides a woody vegetation link to two golf courses to the east as well as a link to open space and patches of native vegetation along the nearby beaches and headlands.

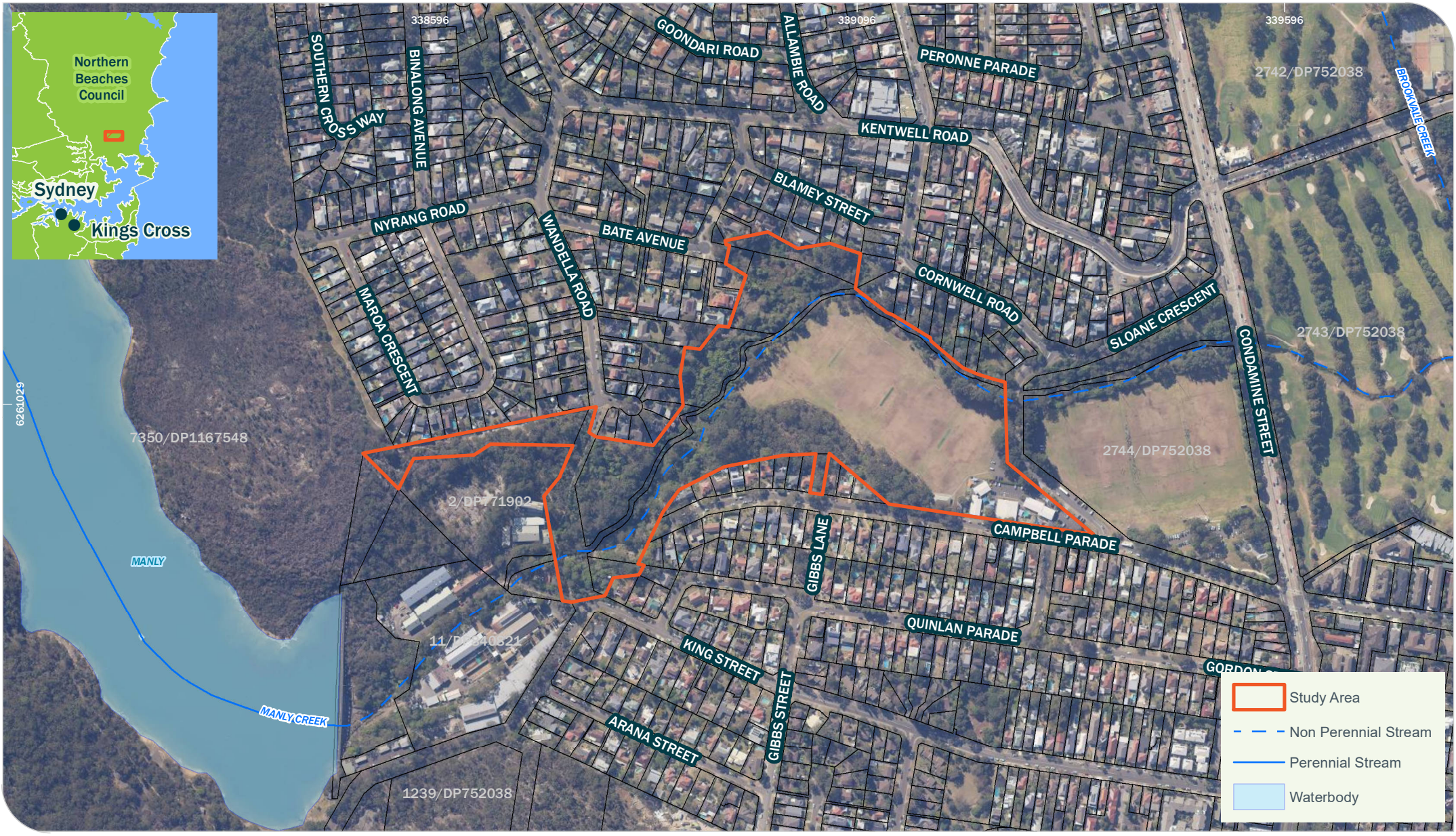
The study site includes the following lots: Lot 7369 DP 1165551 (1.053 ha), Lot 1490 DP 752038 (0.614 ha), Lot 2501 DP 752038 (0.819 ha), Lot 2705 DP 752038 (0.075 ha), Lot 7371 DP 1165577 (0.365 ha), Lot 2748

DP 752038 (6.453 ha), Lot 7370 DP 1165551 (0.153 ha), Lot 17 DP 27009 (0.0674 ha) and Lot 1 DP 771902 (0.71ha). Also included is the majority of the unmade road reserve connecting Wandella Road and King Street, Manly Vale and the creek reserve surrounding Manly Creek where it abuts these lots (Figure 1).

A summary of the major geophysical features of the subject site is presented in Table 1 below.

Table 1: Geophysical context of the subject site

Geographical feature	Description
Bioregion	Sydney Basin
Local Land Services region	Greater Sydney
Local government area	Northern Beaches Council
Watercourses	Manly creek runs from west to east through the subject site, through controlled release from Manly Dam to the west. Within the site, Manly Creek forms the notable Mermaid Pool and flows towards Manly Lagoon through a narrow strip of forest and other woody vegetation and past recreational open space (Figure 1). There is a minor tributary drain that flows past the end of Wandella Road before flowing over a small cliff and into the main creek.
Nearby conservation areas	Miller Reserve and Manly Reservoir. The subject area is one of the closest bush-land links to North Head, a significant portion of Sydney Harbour National Park and home to a threatened population of Long-nosed Bandicoot (Figure 3).



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Study Area
Manly Creek Riparian Corridor Biodiversity Study

Figure 1

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2. Methods

The following section outlines the methods used to collect and consolidate information on the biodiversity values present within the study site. This includes desktop based reviews, field survey and data analysis.

2.1 Background review

A background review was undertaken to capture historical biodiversity values of the site and provide field staff with greater context. Database searches for a 10 km radius around the study area were conducted in February 2019 to identify threatened biodiversity and migratory species with known or predicted occurrences in the locality. (We have reduced the search range to 5km for this study as it became clear that 10 km was excessive in this instance (Figure 2 & Figure 3)). The following databases were used for this purpose:

- BioNet, Atlas of NSW Wildlife (OEH 2019a)
- EPBC Act Protected Matters Report (DoEE 2019a)
- Threatened Species Profiles for threatened species, endangered populations and threatened ecological communities (TECs) listed under the BC Act (OEH 2019b)
- Species Profile and Threats Database (DoEE 2019b).

Key pieces of literature that were taken into account in the preparation of this report include:

- Warringah Council (2007) Local Habitat Corridors Strategy
- Warringah Council (2005) Vegetation History and Wildlife Corridors
- OEH Vegetation mapping for the location (2016).

2.2 Site inspection and survey methods

Flora survey

The flora field survey commenced on 14th February 2019 by Dr Cairo Forrest (Ecologist and BAM Accredited Assessor).

Thirteen Rapid Data Points (RDPs) were completed to capture species diversity across the study site. RDP's identify the dominant species and their ground cover percentage within view of a given point, which can be used to characterise the vegetation community present at that point.

In addition to the RDP's, an extensive site walk was undertaken to verify existing OEH vegetation mapping (2016) and identify significant weed stands within the subject site. Adjustments were made to existing vegetation mapping as identified on site and the spatial extent of weed stands were mapped.

Once the broad layout of the vegetation communities was established, two plots were undertaken in accordance with the Biodiversity Assessment Method (BAM) (OEH 2017b) to confirm PCTs. See Figure 4 for locations of RDPs and BAM plots.

Threatened flora searches were undertaken during the site survey by walking over as much of the site as possible in a random meander throughout the reserve. Certain habitats were targeted for more attention during the search. These were rock shelf and streamside environments which were not adequately covered during the plot based sampling.

Fauna survey

The fauna component of the survey had three aims:

1. To search for threatened and regionally significant fauna
2. To detect as many species using the study area as possible
3. To examine the functional role of the reserve as wildlife habitat and as a wildlife corridor for wildlife dispersing from more substantial bushland reserves to the north-west to the more diffuse forested habitat towards the east and the coastal fringe.

The following methods were undertaken:

Ultrasonic bat call detection

SongMeter ultrasonic bat detectors (SM2+Bat, Wildlife Acoustics, Massachusetts) were deployed to record and store microbat echolocation calls at five locations through the site. Two recording periods were run, one in late summer (15th to 21nd February 2019) and one in late Autumn (21st to 27th May 2019). Two sites had a detector for each of these periods and the fifth site, in a more public area, had a detector for just the night of the 21st May 2019. Each SongMeter was programmed to record continuously from sunset until half an hour before sunrise at 192 kHz giving a functional detection range up to 96 kHz. Ultrasonic bat detector locations are mapped in Figure 5.

Calls were processing from the full spectrum recordings into zero-crossings format in Kaleidoscope 5 software (Wildlife Acoustics 2019). The resulting zero crossings files were assessed in ANALOOKW software, to species level by comparison with our own species reference recordings and recordings contained in '*Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats'*. (Pennay *et al.* 2004). Bat calls of three pulses or more that could not be attributed to a species were attributed to a species group and were still counted to assess bat activity levels over-all.

The two detectors set in February were also set to record half an hour of the dawn chorus for bird calls (22 kHz recording frequency) and an hour of low frequency audio around sunset for frog calls (at 11 kHz).

Automated game cameras

Terrestrial fauna were targeted using game cameras positioned at twelve points through the site. Camera position was limited to places presumed to be less frequented by people. This was to protect the privacy of members of the public and to minimise issues with camera theft or vandalism. Despite efforts to avoid interference, two cameras were stolen, leaving results from ten remaining cameras. Cameras were set on substantial trees, stumps or rocks at <50 cm height from the ground and angled down a little so as to capture good images of small animals and less false triggering from the sky. A white flash camera (ScoutGuard SG860C) was chosen to produce colour photos which aid in identification of many small mammals. These are triggered by thermal variation in the camera line of sight. Game cameras can also be useful for capturing records of cryptic ground bird and diurnal reptile species. Cameras were set on the 15th February without baits and a fish oil lure was added for six cameras on the 10th March. A second lure of honey scent was added to the 10 remaining cameras on 21st May and a sardine bait was also set for six of the cameras. Cameras were retrieved on the 6th June 2019. Thus cameras were both baited and unbaited at varying times of the study. There were a total of 1100 camera trap nights retrieved. Camera locations are mapped in Figure 5.

Spotlighting and call playback

Arboreal mammals, nocturnal birds and other nocturnal wildlife such as frogs and nocturnal active reptiles were surveyed by spotlight and call playback survey methods. Spotlighting was carried out by at least two observers using LED spotlights capable of outputting up to 2600 lumens (but usually much less) in a variety of beam patterns. Spotlighting was carried out moving on foot at around 1 km per hour. Spotlight dates were 26th March and 21st May 2019 for around 4 hours on each occasion. All habitats of the site were covered by spotlighting with the exception of an inaccessible weed infested patch in the north of the site and an area covered in vines along the base of a cliff adjacent to Manly Creek.

Call playback for large forest Owls was performed in May using a listen/play calls/listen method for each species based on the method of Kavanagh and Bamkin (1995). Calls for Barking Owl and Masked Owl were played as these two species seemed most likely to be present of species that were unknown for the site.

Attention was paid to waterbodies both for frogs and other aquatic fauna. Rock shelves and overhangs were checked for animal activity.

Nest Boxes

As there appeared to be a shortage of hollow trees, providing nest boxes of a suitable size to accommodate Eastern Pygmy Possums was considered one of the most appropriate methods for detecting this threatened species (Bladon *et al.* 2002). Seven boxes, five made from refurbished natural hollow logs and two made from 90 mm PVC stormwater pipe and fittings with timber additions were installed throughout the site. Boxes had a single circular 25 mm entrance hole. Each box was mounted to a tree around 1 to 1.5 m from the ground. A small amount of bark was crushed and left in the bottom of the box to provide insulation material. Five natural boxes were set in February and the two plastic boxes were set at the end of March. Each box was set near a potential Eastern Pygmy Possum food source to improve the chances of animals discovering the box (Plate 1). Boxes were checked once each month of the study and were left in situ for further checks in the future. On checking boxes, the observer was looking for either the inhabitants of the box or evidence of additional bedding or other signs of use of the box (scats, hair, wear marks). Box locations are mapped in Figure 5.

PVC nest box for Eastern Pygmy Possum affixed to a Eucalyptus flowering at the time.

Natural timber log nest box for Eastern Pygmy Possum affixed to a Banksia which flowered during the study

Plate 1: Nest boxes designed for Eastern Pygmy Possum

Bird Census

Birds were surveyed at five points evenly spaced through the reserve a minimum of 160 m apart or screened from each other by topographic features (mapped in Figure 5). This was to allow independence for each survey point in case the sites will be used for population monitoring into the future. Four counts were completed on each survey point, each done in the morning immediately following sunrise.

At each bird point, the first 10 minutes were spent quietly standing at the centre point listening and watching for birds. During this period the distances that individual birds approached the point were recorded in distance categories so as bird density estimates could be calculated from the data (after successive years of counting). The second ten minutes was spent actively searching for birds around an area up to 2 ha (as the terrain and tenure allowed). This nested method allows for a measure of species detectability. Due to the constrained nature of the site, birds were still counted if they were detected within neighbouring properties. Survey dates were 16th February, 10th March, 21st May and 6th June.

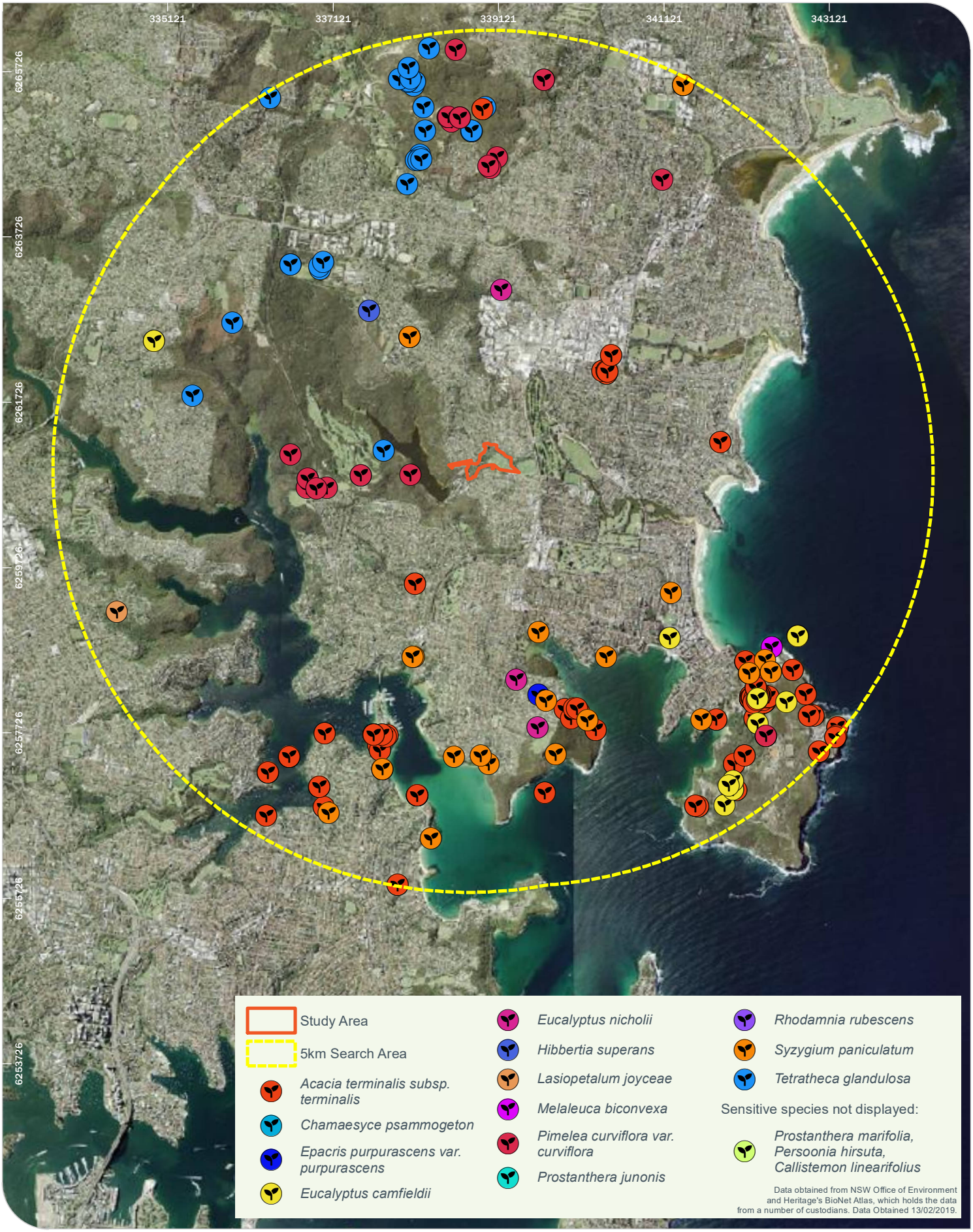
All study survey points are mapped in Figure 5.

2.3 Threatened flora and fauna likelihood of occurrence

A list of subject threatened flora and fauna within the locality (5 km radius) was determined from database searches (Appendix 1, Figure 2, and Figure 3). The species list obtained from desktop searches formed the basis of deciding which survey methodology to be undertaken for the biodiversity study. The likelihood of occurrence was assessed based on proximity of existing records and the presence of suitable habitat or threats combined with knowledge of each species habitat requirements.

2.4 Limitations

Numerous threatened flora and fauna species are cryptic or difficult to detect. For instance, some cryptic flora species are more easily detected at certain times of the year, such as during flowering events (e.g. terrestrial orchids). Some fauna can only be detected during certain seasons (e.g. migration patterns or intra-torpor periods). Because this study has not extended through any part of spring, there are bound to be species missed that only inhabit this area or become detectable in that season. This particularly applies to birds which are often most vocal during spring breeding season.



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Threatened flora records in the surrounding area

Manly Creek Riparian Corridor Biodiversity Study

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Figure 2

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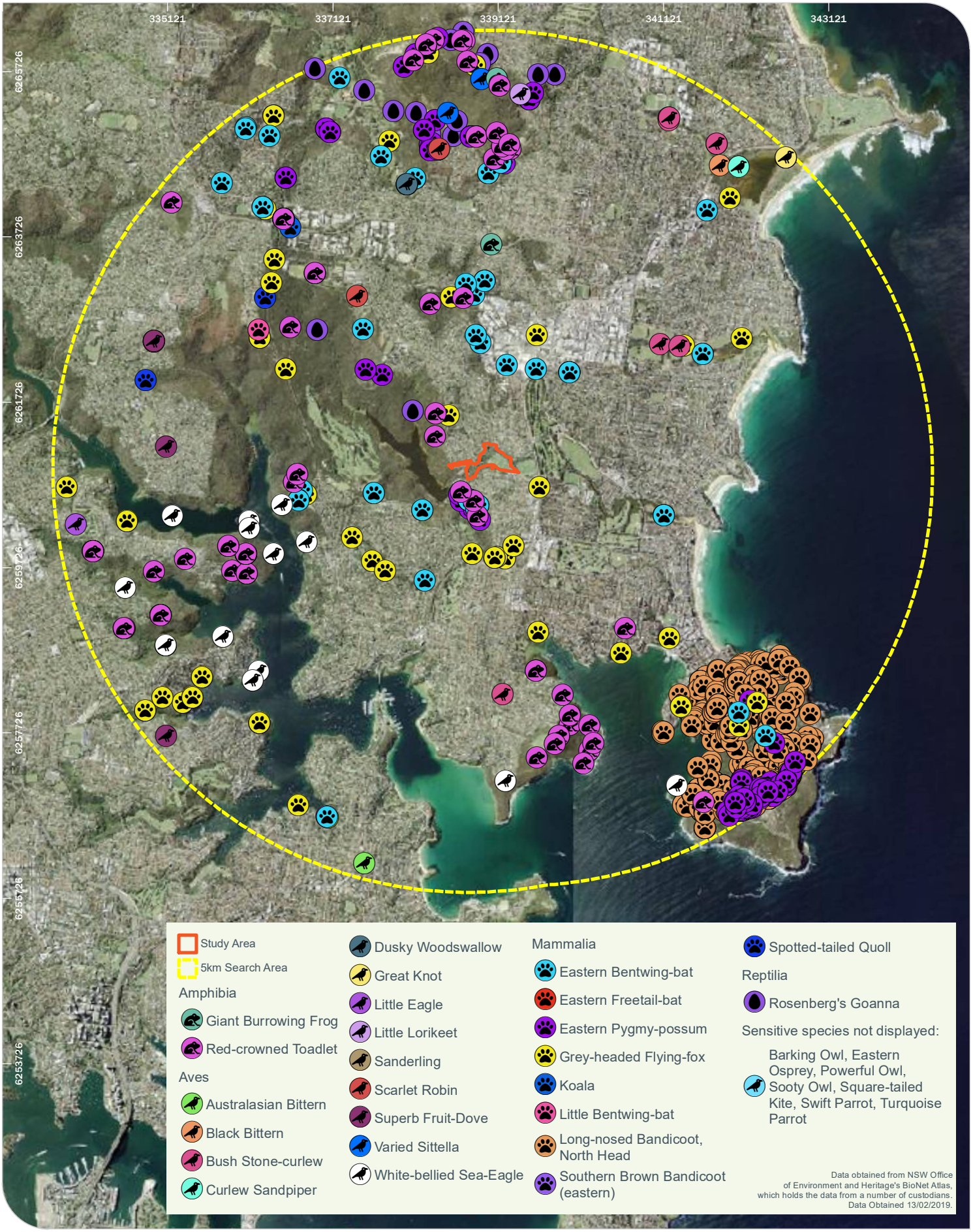

Study Area

5km Search Area

Amphibia

- Giant Burrowing Frog
- Red-crowned Toadlet

Aves

- Australasian Bittern
- Black Bittern
- Bush Stone-curlew
- Curlew Sandpiper
- Dusky Woodswallow
- Great Knot
- Little Eagle
- Little Lorikeet
- Sanderling
- Scarlet Robin
- Superb Fruit-Dove
- Varied Sittella
- White-bellied Sea-Eagle

Mammalia

- Eastern Bentwing-bat
- Eastern Freetail-bat
- Eastern Pygmy-possum
- Grey-headed Flying-fox
- Koala
- Little Bentwing-bat
- Long-nosed Bandicoot, North Head
- Southern Brown Bandicoot (eastern)
- Spotted-tailed Quoll

Reptilia

- Rosenberg's Goanna

Sensitive species not displayed:

- Barking Owl, Eastern Osprey, Powerful Owl, Sooty Owl, Square-tailed Kite, Swift Parrot, Turquoise Parrot

Data obtained from NSW Office of Environment and Heritage's BioNet Atlas, which holds the data from a number of custodians. Data Obtained 13/02/2019.

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Threatened fauna records in the surrounding area

Manly Creek Riparian Corridor Biodiversity Study

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Figure 3

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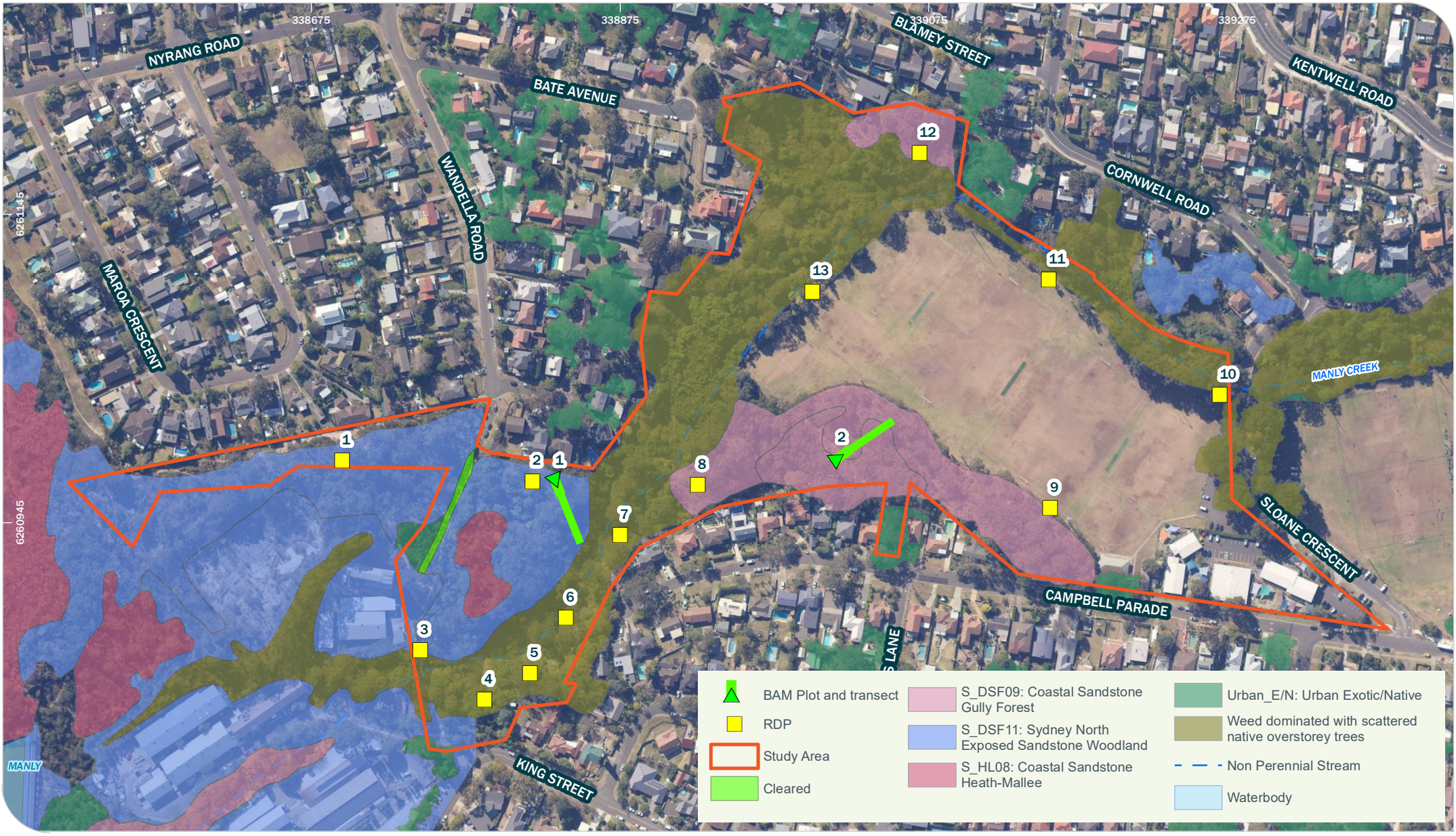

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Flora study Rapid Data Points and BAM floristic plot locations
Manly Creek Riparian Corridor Biodiversity Study

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Figure 4

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Fauna study points for birds survey (B_), game cameras (C_), pygmy possum nest boxes (P_) and ultrasonic bat call detector sites (U_)

Manly Creek Riparian Corridor Biodiversity Study

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Figure 5

3. Results

3.1 Flora

A total of 243 flora species or types were detected within the site during this study. A little over half of these were detected at the Rapid Data Points and BAM vegetation plots, and the remainder were detected during other survey activities. The flora data is presented below in terms of the approximate percentage of cover that each species contributes to that area. Species without cover values were those only detected away from vegetation points or plots. Australian native flora species made up the majority of flora diversity with 169 species recognised (Table 2). Exotic species numbered 74 (Table 3). However, many of the Australian native flora species probably did not occur in the area prior to British colonisation and might be better considered as exotics. For example, the Fishbone Fern (*Nephrolepis cordifolia*) is widespread in Coastal NSW but probably was confined to the North Coast before 1788. Two RDPs did not record any exotic species. Exotic species made up a substantial portion of the flora species at some of the RDPs, with point 11 having no native species cover even though these plots were not targeted at the most weed infested areas.

Much of the vegetation along Manly Creek has clearly been planted. In some cases 'grow tubes' can still be seen in place around the tree trunks. In contrast, much of the vegetation in the higher elevation portions of the study area appeared to have stemmed from natural revegetation and natural recruitment from the seed bank was observed in a portion that had recently experienced a hazard reduction burn.

Table 2: Australian native flora detected at Rapid Data Points, floristic plots and opportunistically through the study area. Values are approximate percentages of cover for that species on that plot. Species without values were only detected opportunistically.

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Aizoaceae															
Tetragonia tetragonioides	New Zealand Spinach														
Alismataceae															
Alisma plantago-aquatica	Water plantain					0.3									
Amaranthaceae															
Alternanthera denticulata	Lesser Joyweed														
Apiaceae															
Actinotus helianthi	Flannel Flower														
Actinotus minor	Lesser Flannel Flower														
Centella asiatica	Indian Pennywort								0.2			0.2			
Hydrocotyle ranunculoides	Floating pennywort									0.1					
Platysace lanceolata	Shrubby Platysace														
Platysace linearifolia	Carrot Tops														0.1
Xanthosia pilosa	Woolly Xanthosia														0.1
Araceae															
Alocasia brisbanensis	Cunjevoi						0.5								
Araucariaceae															
Araucaria cunninghamii	Hoop pine						1								

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Arecaceae															
Archontophoenix cunninghamiana	Bangalow Palm														
Livistona australis	Cabbage Palm														
Asteraceae															
Ozothamnus diosmifolius	White Dogwood														
Sigesbeckia orientalis	Eastern St Paul's-wort														0.1
Bignoniaceae															
Pandorea pandorana	Wonga Vine	0.2													
Casuarinaceae															
Allocasuarina distyla	Scrub she-oak									0.5					
Allocasuarina littoralis	Black She-oak	5	0.1			2				0.3					
Casuarina cunninghamia	River Oak								40						
Casuarina glauca	Swamp She-oak					2					80				
Commelinaceae															
Commelina cyanea	Native Wandering Jew	0.3	0.5		0.5	5	0.5	0.2							0.2
Cunoniaceae															
Bauera rubioides	Dog Rose														
Callicoma serratifolia				5					25			15			
Ceratopetalum apetalum	Coachwood		0.5		0.1										
Cyperaceae															
Caustis flexuosa	Curly Wig		0.3												
Caustis pentandra	Thick Twist Rush														
Cyathochaeta diandra	Sedge														
Gahnia clarkei	Tall Saw-sedge						0.2								
Lepidosperma laterale	Variable Sword-sedge														0.1
Lepidosperma viscidum	Sedge														
Schoenus brevifolius	Bog-rush														
Schoenus imberbis	Bog-rush	0.1								0.1					0.3
Davalliaceae															
Nephrolepis cordifolia	Fishbone Fern		1					20						0.1	
Dennstaedtiaceae															
Pteridium esculentum	Bracken fern	10	5	0.3	45	2	80	50	80			20	5	70	10
Dicksoniaceae															
Calochlaena dubia	Rainbow Fern														
Dilleniaceae															
Hibbertia linearis	Guinea Flower														

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Elaeocarpaceae															
Elaeocarpus reticulatus	Blueberry Ash						0.5	0.3						25	
Ericaceae															
Epacris longiflora	Fuchsia Heath														
Epacris microphylla	Coral heath	0.2													
Leucopogon ericoides	Pink Beard-heath														
Leucopogon microphyllus	Beard-heath														
Styphelia longifolia	Five-corners														
Woollsia pungens	Woollsia														
Euphorbiaceae															
Homalanthus populifolius	Bleeding heart							0.1							
Micrantheum ericoides	Small shrub														
Fabaceae (Faboideae)															
Bossiaea scolopendria	Pea														
Dillwynia retorta	Pea														0.3
Hardenbergia violacea	False Sarsaparilla														
Kennedia rubicunda	Dusky Coral Pea														
Pultenaea daphnoides	Large-leaf Bush-pea														
Pultenaea ferruginea	A Bush-pea	0.2													
Pultenaea tuberculata	A Bush-pea														
Fabaceae (Mimosoideae)															
Acacia linifolia	White Wattle								0.4			0.4	0.5		0.2
Acacia longifolia	Sydney Golden Wattle	1	0.3	0.2	0.1										0.5
Acacia myrtifolia	Red-stemmed Wattle			0.3						0.3					
Acacia suaveolens	Sweet Wattle														
Acacia terminalis	Sunshine Wattle												5		
Acacia ulicifolia	Prickly Moses														
Gleicheniaceae															
Gleichenia dicarpa	Pouched Coral Fern		10	5	20	2		0.5			0.3			5	
Sticherus flabellatus	Umbrella Fern			0.1											
Goodeniaceae															
Dampiera stricta	Blue Dampiera														
Goodenia stelligera	Spiked Goodenia														
Scaevola sp.	Fan Flower														
Hydrocharitaceae															
Hydrilla verticillata	Hydrilla					40									
Vallisneria australis	Ribbon Weed														

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Lauraceae															
Cassytha glabella	Slender Devil's Twine		0.2	0.2											
Cassytha pubescens	Downy Devil's Twine														
Lomandraceae															
Lomandra glauca	Pale Mat-rush														
Lomandra longifolia	Spiny-headed Mat-rush		10		0.3									10	25
Lomandra obliqua	Alternating Mat-rush														
Luzuriagaceae															
Eustrephus latifolius	Wombat Berry	0.2													
Malvaceae															
Brachychiton acerifolius	Illawarra Flame Tree				0.1										
Lasiopetalum ferrugineum	Rusty Petals														
Meliaceae															
Melia azedarach	White Cedar														
Moraceae															
Ficus coronata	Creek Sandpaper Fig						0.3		0.5	0.3		0.5	5		0.1
Ficus rubiginosa	Port Jackson Fig														
Myrtaceae															
Angophora bakeri	Narrow-leaved Apple														
Angophora costata	Sydney Red Gum		10				2	20		25					20
Angophora crassifolia	Hard-leaf Angophora														
Angophora hispida	Dwarf Apple														
Callistemon citrinus	Crimson Bottlebrush			0.1	0.2	0.2					0.2				0.2
Callistemon sp.	Hard-leaf Bottle Brush?														
Callistemon linearis	Narrow-leaved Bottlebrush														
Callistemon salignus	Willow Bottlebrush C.														
Callistemon viminalis	Weeping Bottlebrush C.														
Corymbia gummifera	Red Bloodwood	15	25												15
Corymbia maculata	Spotted gum		5												
Eucalyptus botryoides	Bangalay														
Eucalyptus haemastoma	Scribbly Gum														
Eucalyptus paniculata	Grey Ironbark														
Eucalyptus piperita	Sydney Peppermint	20	20	35											
Eucalyptus punctata	Grey Gum														15
Eucalyptus racemosa	Narrow-leaf Scribbly Gum	20													
Eucalyptus resinifera	Red Mahogany											10			
Eucalyptus robusta	Swamp Mahogany						15						10		

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Eucalyptus saligna	Sydney Blue Gum					5			50	10				15	
Eucalyptus sieberi	Silvertop Ash														
Eucalyptus umbra	Broad-leaf White Mahogany														
Kunzea ambigua	Tick Bush		0.3							5	0.2			0.3	0.3
Leptospermum grandifolium	Woolly Teatree														
Leptospermum laevigatum	Coast Teatree														
Leptospermum polygalifolium	Tea-tree				0.3										
Leptospermum trinervium	Slender Tea-tree														
Melaleuca armillaris	Bracelet Honey-myrtle														
Melaleuca hypericifolia	Hillock bush														
Melaleuca linariifolia	Snow in Summer														
Melaleuca nodosa	Paperbark														
Melaleuca quinquenervia	Broad-leaved Paperbark									0.3			5		
Melaleuca styphelioides	Prickly-leaved Paperbark								10	0.2		1			
Syncarpia glomulifera	Turpentine														
Orchidaceae															
Acianthus pusillus	Gnat Orchid														
Cryptostylis subulata	Large Tongue Orchid														
Pterostylis acuminata	Sharp Greenhood														
Philydraceae															
Philydrum lanuginosum	Frogsmouth														
Phormiaceae															
Dianella caerulea	Blue Flax-lily														
Dianella revoluta	Blueberry Lily	1	0.2			0.1								0.2	
Phyllanthaceae															
Breynia oblongifolia	Coffee Bush		0.1		0.2		1							0.3	0.3
Glochidion ferdinandi	Cheese Tree		5	10	30	1	0.3	25	10		0.3	10	5	5	0.2
Pittosporaceae															
Billardiera scandens	Hairy Apple Berry														
Hymenosporum flavum	Native Frangipani														0.3
Pittosporum undulatum	Sweet Pittosporum	1	0.5	30	75		10	30	0.3		5	0.3	5	10	
Poaceae															
Cenchrus brownii	Fine-bristled Burrgrass	0.5													
Chloris truncata	Rhodes Grass			2											
Cynodon dactylon	Common Couch														
Entolasia stricta	Wiry Panic														
Imperata cylindrica	Blady Grass	10	10	70	30		20			60				5	0.5

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Microlaena stipoides	Weeping Grass				20										
Oplismenus aemulus	Basket grass				5			20							
Phragmites australis	Common Reed														
Polygonaceae															
Persicaria decipiens	Slender Knotweed					0.3									
Persicaria lapathifolia	Pale Knotweed		0.2			0.2	0.2			0.1					
Persicaria orientalis	Knotweed					0.5				0.3					
Proteaceae															
Banksia ericifolia	Heath-leaved Banksia														
Banksia integrifolia	Coastal Banksia												5		
Banksia marginata	Silver Banksia														
Banksia serrata	Old Man Banksia	0.3													0.3
Banksia spinulosa	Hairpin Banksia													2	
Grevillea buxifolia	Grey Spider Flower														
Grevillea linearifolia	Linear-leaf Grevillea	0.3								70					5
Grevillea mucronulata	Green spider flower	0.1													
Grevillea robusta	Silky Oak														
Grevillea sericea?	Pink Spider Flower?														
Grevillea speciosa	Red Spider Flower														
Hakea dactyloides	Finger Hakea	0.3	0.5		0.2										
Hakea sericea	Needlebush														
Hakea teretifolia	Needlebush														
Lambertia formosa	Mountain Devil														
Lomatia myricoides	River Lomatia						2		0.3			0.3			
Persoonia lanceolata	Lance Leaf Geebung														
Persoonia levis	Broad-leaved Geebung														
Persoonia pinifolia	Pine-leaved Geebung														
Petrophile pulchella	Conesticks														
Restionaceae															
Empodisma minus	Wire Rush	0.2													
Lepyrodia scariosa	Rush														
Rhamnaceae															
Alphitonia excelsa	Red Ash														
Rosaceae															
Rubus parvifolius	Native Raspberry														
Rutaceae															
Boronia ledifolia	Sydney Boronia														

Family/Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	12	13	B1	B2
Correa alba	White Correa														
Crowea saligna	Willow-leaved crowea														0.1
Sapindaceae															
Dodonaea triquetra	Large-leaf Hop-bush														
Smilacaceae															
Smilax glyciphylla	Sweet Sarsparilla														
Thymelaeaceae															
Pimelea linifolia	Slender Rice Flower														
Typhaceae															
Typha orientalis	Broad-leaved Cumbungi					0.3									
Ulmaceae															
Trema tomentosa	Native Peach				0.2										
Violaceae															
Hybanthus vernonii	Erect Violet														
Viola hederacea	Native Violet		0.5												
Vitaceae															
Cissus antarctica	Water Vine		80				50								
Cissus hypoglauca	Giant Water Vine														
Xanthorrhoeaceae															
Xanthorrhoea media	Grass Tree	0.3		2											0.3
Xanthorrhoea resinosa	Grass Tree														

Table 3: Exotic flora detected on Rapid Data Points, floristic plots and opportunistically through the study area. Values are approximate percentages of cover for that species on that plot. Species without values were only detected opportunistically.

Family/Scientific Name	Common Name	2	4	5	6	7	8	9	10	11	12	13	B1	B2
Acanthaceae														
Hygrophila costata	Hygrophila			0.5										
Hygrophila polysperma	Indian Swampweed			0.3										
Alismataceae														
Sagittaria sp.	Arrowhead													
Anthericaceae														
Chlorophytum comosum	Spider Plant													
Apiaceae														
Foeniculum vulgare	Fennel								0.3	0.1				
Hydrocotyle bonariensis	Pennywort													
Apocynaceae														
Araujia sericifera	Moth Vine													
Araceae														

Family/Scientific Name	Common Name	2	4	5	6	7	8	9	10	11	12	13	B1	B2
Colocasia sp.	Elephant ears								0.5					
Monstera deliciosa	Fruit Salad Plant				0.5									
Arecaceae														
Phoenix sp.	Date Palm	0.2										0.2		
Syagrus romanzoffiana	Cocos Palm													
Asparagaceae														
Asparagus aethiopicus	Asparagus Fern	0.2												
Asteraceae														
Ageratina adenophora	Crofton Weed	0.1			0.3									
Bidens pilosa	Farmer's friend			10					5	20			0.1	
Chrysanthemoides monilifera	Boneseed													
Conyza bonariensis	Flaxleaf Fleabane								0.5					
Conzya bonariensis	Tall fleabane				0.1									
Hypochaeris radicata	Catsear													
Senecio madagascariensis	Fireweed													
Sonchus sp.	Sowthistle													
Taraxacum officinale	Dandilion							0.1						
Basellaceae														
Anredera cordifolia	Madeira Vine													
Bignoniaceae														
Jacaranda mimosifolia	Jacaranda	0.5												
Cannaceae														
Canna indica	Arrowroot													
Caprifoliaceae														
Lonicera japonica	Japanese Honeysuckle													
Commelinaceae														
Tradescantia fluminensis	Wandering Jew	0.1	30		1		20		40		20	20		
Convolvulaceae														
Ipomoea cairica	Coastal morning glory				0.5							30		
Ipomoea indica	Morning glory								30					
Ipomoea purpurea	Morning glory				0.5									
Crassulaceae														
Bryophyllum delagoense	Mother of millions													0.1
Cyperaceae														
Cyperus esculentus	Yellow Nutgrass				0.1									0.1
Euphorbiaceae														
Ricinus communis	Castor Oil Plant													
Fabaceae (Caesalpinioideae)														
Senna pendula	Senna	0.3			0.5					0.5				
Fabaceae (Faboideae)														
Erythrina crista-galli	Cockspur Coral Tree				0.3				0.3					
Erythrina x sykesii	Coral tree								80	60				
Haloragaceae														

Family/Scientific Name	Common Name	2	4	5	6	7	8	9	10	11	12	13	B1	B2
Myriophyllum aquaticum	Parrot Feather Watermilfoil													
Hydrocharitaceae														
Egeria densa	Dense Waterweed													
Elodea canadensis	Elodea													
Lamiaceae														
Glechoma hederacea	Creeping Charlie												0.2	
Lauraceae														
Cinnamomum camphora	Camphor laurel					50								
Malaceae														
Cotoneaster sp.	Cotoneaster													
Malvaceae														
Modiola caroliniana	Red-flowered Mallow													
Sida rhombifolia	Paddy's Lucerne			0.5										
Moraceae														
Morus nigra	Mulberry tree					20								
Musaceae														
Musa sp.	Banana trees				0.3									
Myrtaceae														
*Agonis flexuosa**	Willow Myrtle													
Nymphaeaceae														
Nymphaea mexicana	Yellow Waterlily			80										
Ochnaceae														
Ochna serrulata	Mickey Mouse Plant	0.1											0.1	
Oleaceae														
Ligustrum lucidum	Large-leaved Privet				50		0.2		10		0.2			
Ligustrum sinense	Small-leaved Privet					10	0.2		0.3	30	0.2			
Olea europaea	African Olive													
Onagraceae														
Ludwigia peruviana	Water Primrose			0.1					50	0.5				
Oxalidaceae														
Oxalis corniculata	Creeping Oxalis													
Pinaceae														
Pinus sp.	Pine													
Plantaginaceae														
Plantago lanceolata	Lamb's Tongues													
Poaceae														
Andropogon virginicus	Whisky Grass													
Arundo donax	Giant Reed			0.3		0.3								
Bouteloua sp.	Blue Buffalo Grass	0.3		40										
Cenchrus clandestinus	Kikuyu grass									60				
Cortaderia selloana	Pampas Grass													
Ehrharta erecta	Panic Veldtgrass								30					
Paspalum dilatatum	Paspalum	0.2		35						0.2				

Family/Scientific Name	Common Name	2	4	5	6	7	8	9	10	11	12	13	B1	B2
Phyllostachys sp.	Rhizomatous bamboo						80							
Stenotaphrum secundatum	Buffalo Grass							1						
Polygonaceae														
Acetosa sagittata	Rambling Dock	0.2	0.5		0.5				0.3					
Primulaceae														
Lysimachia arvensis	Scarlet Pimpernel													
Rosaceae														
Rubus fruticosus	Blackberry													
Sapindaceae														
Cardiospermum grandiflorum	Balloon Vine								30	80				
Koelreuteria elegans	Chinese Rain Tree			20										
Solanaceae														
Cestrum parqui	Green cestrum								0.3					
Solanum mauritianum	Wild Tobacco Bush								0.1					
Solanum nigrum	Black-berry Nightshade													
Urticaceae														
Parietaria judaica	Asthma Weed			0.2										
Verbenaceae														
Lantana camara	Lantana				1				0.3			25		

3.2 Plant Community Types

A review of the SMCMA Version 3 mapping study (OEH 2016) identified three (3) NSW PCTs within the site. See Figure 8 for mapped areas. These mapped PCTs were:

1. PCT 1250 Sydney Peppermint - Smooth-barked Apple - Red Bloodwood shrubby open forest on slopes of moist sandstone gullies, eastern Sydney Basin Bioregion, Coastal Sandstone Gully Forest (DSF09) (OEH 2016), the largest patch being immediately south of the playing field and a smaller patch north within Lot 7371 DP 1165577;

2. PCT 1783 Red Bloodwood - Scribbly Gum / Old-man Banksia open forest on sandstone ridges of northern Sydney and the Central Coast, Sydney North Exposed Sandstone Woodland (DSF11) (OEH 2016), mapped within Lot 7369 DP 1165551, Lot 1 DP 771902 and the land between these lots, and;

3. PCT 1824 Mallee - Banksia - Tea-tree - Hakea heath-woodland of the coastal sandstone plateaus of the Sydney basin, Coastal Sandstone Heath-Mallee (HL08) (OEH 2016), smaller patch mapped within Lot 7369 DP 1165551.

Broadly, the plant communities matched those already mapped as PCTs for the site, at least to the landscape scale intended in the mapping (OEH, 2016). Vegetation boundaries are often up to 20 m misaligned. There are some minor inconsistencies with the PCT descriptions regarding elevation.

The areas mapped as exotic are quite variable in the constituent species with some areas being dominated by Australian native plants often clearly planted as part of previous bush regeneration or landscaping attempts. These areas are difficult to identify to a standard PCT.

Some of the areas mapped as weed communities were exclusively composed of exotic species and in a couple of areas were monocultures of bamboo or lantana. A large (0.5 ha) patch in the north of the site was composed of more diverse weeds but was still approximately 80% Lantana (*Lantana camara*) cover.

3.3 Fauna

3.3.1 Terrestrial and arboreal mammals

All terrestrial and arboreal mammal species detected during the study were represented on the game camera data (Table 4). Three mammal species were detected on 80% of the recovered cameras. These were the Long-nosed Bandicoot (*Perameles nasuta*), Swamp Wallaby (*Wallabia bicolor*) and the exotic Fox (*Vulpes vulpes*). All three species are clearly widespread with numerous individuals represented in the photographs.

Foxes were seen carrying prey items on three occasions, two of which were probably parts of the same Common Brushtail Possum (*Trichosurus vulpecula*) and the third may also have been part of a Common Brushtail Possum. Cat images were limited to one camera (C31) which photographed three individual cats, one with a collar.

The next most widespread was the exotic Black Rat (*Rattus rattus*), mostly confined to dense or weedy sites but also in rocky locations. The new-endemic rodent, the Bush Rat (*Rattus fuscipes*) was possibly detected on one site, the highest elevation camera at site C25 (Figure 5).

Plate 2: Long-nosed Bandicoot

Plate 3: Swamp Wallaby

Plate 4: A Fox at camera 27 carrying first the front half of a Common Brushtail Possum and then 45 minutes later the back half (of presumably the same possum).

Table 4: Fauna detected on ten game cameras deployed in the study area.

Species	20	21	22	23	24	25	27	28	30	31
Australian Brush-turkey (*Alectura lathami*)	X	X	X			X	X	X	X	X
Australian Magpie (*Cracticus tibicen*)						X	X			
Bar-shouldered Dove (*Geopelia humeralis*)						X	X			
Black Bittern (*Ixobrychus flavicollis*)			X							
Black Rat (*Rattus rattus*)	X		X	X		X		X	X	
Bush Rat (*Rattus fuscipes*)						X				
Cat (*Felis catus*)										X
Common Brushtail Possum (*Trichosurus vulpecula*)			X			X	X			X
Common Ringtail Possum (*Pseudocheirus peregrinus*)	X		X						X	X
Dog (*Canis lupus familiaris*)			X		X					
Eastern Blue-tongue Skink (*Tiliqua scincoidies*)	X						X			
Eastern Water Dragon (*Intellagama lesueurii*)	X		X			X				
Eastern Whipbird (*Psophodes olivaceus*)	X		X					X		
Eastern Yellow Robin (*Eopsaltria australis*)			X							
Fox (*Vulpes vulpes*)	X	X			X	X	X	X	X	X
Heath Monitor (*Varanus rosenbergi*)						X				
Long-nosed Bandicoot (*Perameles nasuta*)	X	X	X			X	X	X	X	X
Rabbit (*Oryctolagus cuniculus*)						X	X		X	
Red-bellied Black Snake (*Pseudechis porphyriacus*)	X		X							
Short-beaked Echidna (*Tachyglossus aculeatus*)						X				
Superb Fairy Wren (*Malurus cyaneus*)							X			
Swamp Wallaby (*Wallabia bicolor*)	X	X			X	X	X	X	X	X
White-browed Scrub Wren (*Sericornis frontalis*)	X		X	X				X		

Game camera numbers are plotted on Figure 5.

The two arboreal marsupials detected appeared to be common to abundant. Common Ringtail Possums were spot-lit 27 times and Common Brushtail Possums were spot-lit 12 times. Both were detected on four cameras each.

The Short-beaked Echidna (*Tachyglossus aculeatus*) was detected on only one camera, however, scats from this species were seen throughout the site. There were a number of birds and reptiles detected by cameras and discussed below.

3.3.2 Bats

Ultrasonic calls of six bat species were detected during the 21 nights of bat detecting undertaken during this study (Table 5). The total bat passes detected was moderately low at a mean of 25.2/detector night during February and 4.2 for May. The most consistently active bat species were the Eastern Bentwing-bat (*Miniopterus schreibersii*) followed by the Gould's Wattled-bat (*Chalinolobus gouldii*). Half the species detected were threatened species being the two Bentwing-bats and the Myotis. Examples of the zero crossing ultrasonic analysis are presented for the threatened species in Plate 5.

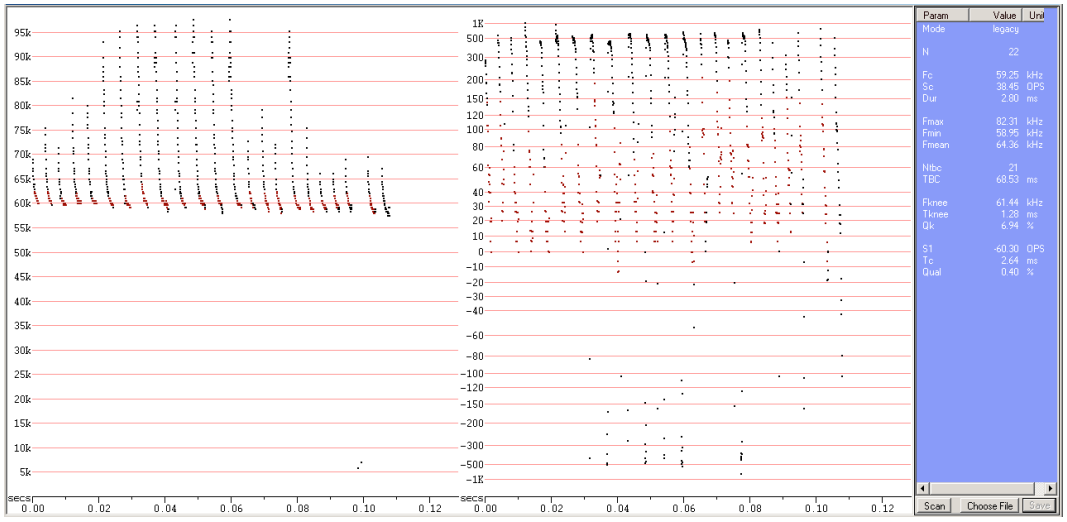
Table 5: Bat species detection nights by ultrasonic call and total bat passes at five sites within the site.

Species	(U1) Manly Creek (Feb)	(U2) Mermaid Pool (Feb)	(U3) Above Mermaid Pool (May)	(U4) Burnt Area (May)	(U5) Lower Manly Creek (May)*
Eastern Bentwing-bat (*Miniopterus schreibersii)* Vul.	4	5	1	3	1
Eastern Freetail-bat (*Mormopterus ridei)*	1	1			1
Gould's Wattled Bat (*Chalinolobus gouldii)*	4	5	1	2	
Little Bentwing-bat (*Miniopterus australis)* Vul.	2		4	1	
Little Forest Bat (*Vespadelus vulturnus)*		1			
Southern Myotis (*Myotis macropus*) Vul.	2				
Total Bat Passes	53	199	26	15	5

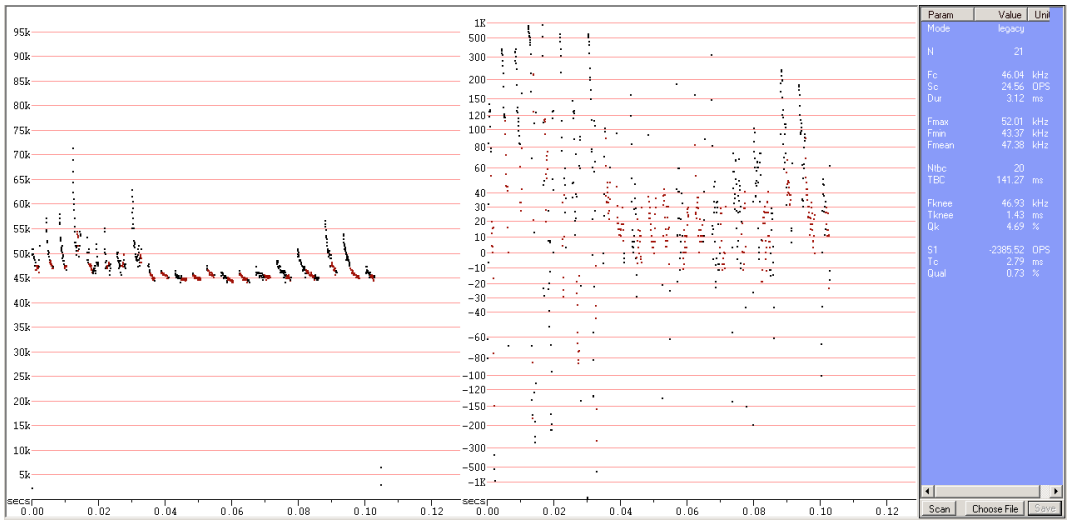
*Values represent the number of nights that detections were made out of five possible nights except U5, where only a single night was conducted.

Grey-headed Flying-fox (*Pteropus poliocephalus*) was detected on each night of spotlighting, feeding in Sydney Blue Gums (*Eucalyptus saligna*) in February and Swamp Mahogany (*Eucalyptus robusta*) and Heath-leaved Banksia (*Banksia ericifolia*) in May. However, there was no sign of them camping on the site.

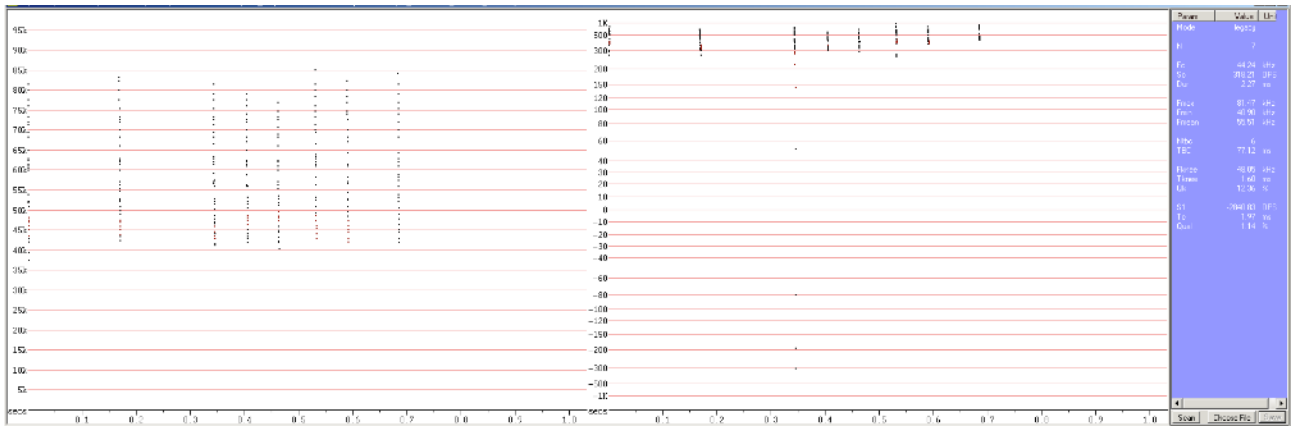
One flying-fox was also seen in the talons of a Powerful Owl (*Ninox strenua*) (Plate 6).



Search phase call by Little Bentwing-bat (*Miniopterus australis*)



Search phase call by Eastern Bentwing-bat (*Miniopterus schreibersii*)



Search phase call by Southern Myotis (*Myotis macropus*)

Plate 5: AnalookW zero crossings display of calls by the three threatened bat species detected at the study area.

3.3.3 Nocturnal birds

Records for a number of nocturnal birds were obtained during spotlighting. The Tawny Frogmouth (*Podargus strigoidies*) was regularly encountered through a variety of habitats. Australian Owlet-nightjar (*Aegotheles cristatus*) was heard just once during the surveys.

The Powerful Owl (*Ninox strenua*) was encountered in the middle of the site during the March sample period. A male with a distinctive aberration of its right iris was seen holding a freshly caught and killed Grey-headed Flying-fox. A second Powerful Owl was calling from nearby. At dusk that evening a couple of Powerful Owl calls had been heard although the exact location of the calling owl could not be ascertained. The male appears to be the same individual that has been photographed in the Manly Dam reserve area towards North Balgowlah and is thought to be a member of a breeding pair in that area. There was no detection of the Powerful Owl later in Autumn-2019 at the start of the breeding season.

Playback of Barking Owl and Masked Owl calls did not elicit any responses.

Plate 6: Powerful owl holding the remains of a partly eaten Grey-headed Flying-fox. Note the damaged or deformed right eye.

3.3.4 Diurnal birds

A total of 60 bird species were detected on the formal bird census, however 34 species was the maximum number of species recorded on any one site, with the riparian forest site having only 27 (Table 6). The data shows bird site differentiation.

Each census added more species to the species list. Figure 6 shows the mean increase in bird species added for each additional census. The additional species added were in part due to seasonality and part due to the general mobility of birds. If census were to continue, it could be expected from the slope (predicted by the formula included on the chart), for the number of species to continue increasing.

Table 6: Abundance and species richness of birds at each of five bird census sites in the study area.

Bird Site	Mean count of birds per census site count	Number of species
1: Exposed woodland (recently burnt)	31	34
2: Exposed woodland/Mermaid Pool	37.5	33
3: Riparian tall forest	33.5	27
4: Sandstone gully forest (north facing)	36.25	30
5: Sandstone gully forest (south facing)	29.5	34
All	33.55	60

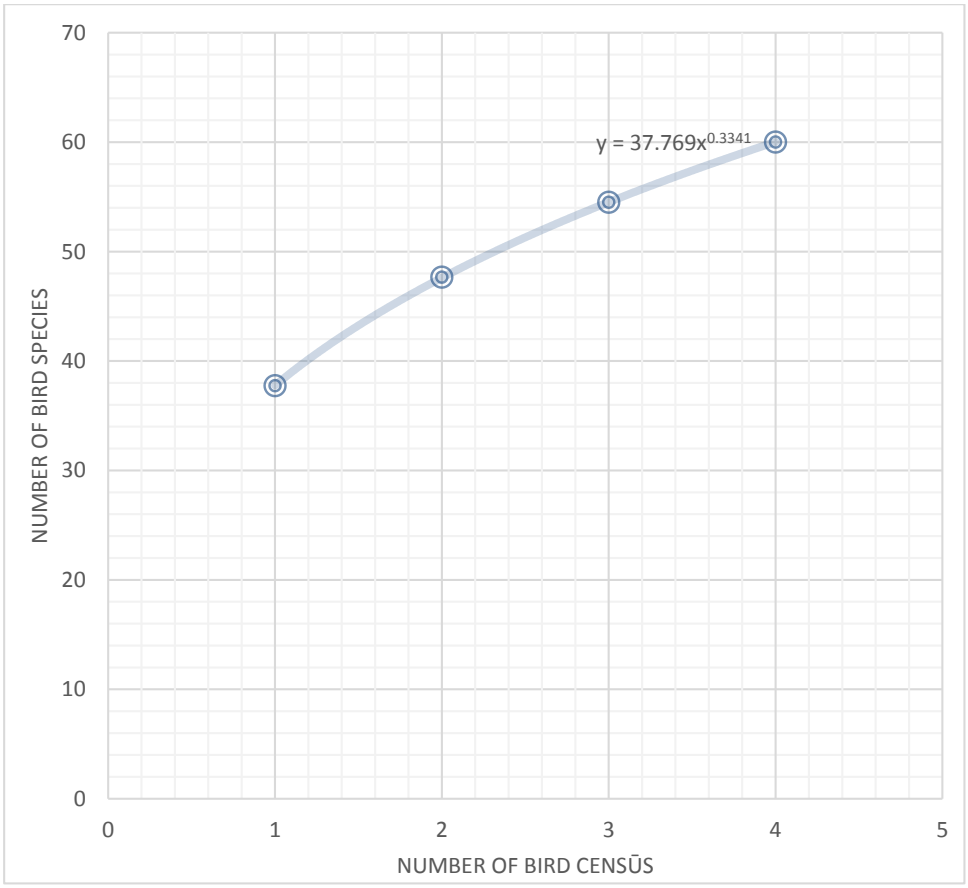


Figure 6: Species cumulative curve for bird census at Manly Vale

Table 7 gives the full list of bird species detected on bird counts and the season in which they were counted. The numbers indicate the number of birds counted within the five 2 ha plots for each month. A

number of species were detected in only a single month. The two most abundant species were the Noisy Miner (*Manorina melanocephala*) and the Rainbow Lorikeet (*Trichoglossus haematodus*), both species well adapted to suburbia. There were two species of threatened bird detected on bird counts being the vulnerable (BC Act) Little Lorikeet (*Glossopsitta pusilla*) and the critically endangered (EPBC Act) Swift Parrot (*Lathamus discolor*), a winter migrant from Tasmania. Both species are nectar and lerp feeders in Eucalyptus trees.

Table 7: Birds detected during bird surveys presented as number counted within five 2 ha/20 min counts per month.

Scientific Name	Common Name	Februar y	March	May	June
Acanthiza nana	Yellow Thornbill			2	
Acanthiza pusilla	Brown Thornbill		2	6	3
Acanthorhynchus tenuirostris	Eastern Spinebill	1		3	3
Accipiter novaehollandiae	Grey Goshawk				1
Alectura lathami	Australian Brush-turkey	2	2	1	4
Alisterus scapularis	Australian King-Parrot	1	2		
Anthochaera carunculata	Red Wattlebird	1	2	5	6
Anthochaera chrysoptera	Little Wattlebird	3	1	11	5
Cacatua galerita	Sulphur-crested Cockatoo	6	9	2	1
Cacatua sanguinea	Little Corella	2	9		2
Colluricincla harmonica	Grey Shrike-thrush	1	3		
Coracina novaehollandiae	Black-faced Cuckoo-shrike		1	1	1
Coracina papuensis	White-bellied Cuckoo-shrike		2		
Corvus coronoides	Australian Raven	3	2	9	3
Cracticus tibicen	Australian Magpie	3	4	4	3
Cracticus torquatus	Grey Butcherbird	14	8	6	10
Dacelo novaeguineae	Laughing Kookaburra	3	2	1	3
Dicaeum hirundinaceum	Mistletoebird			1	
Egretta novaehollandiae	White-faced Heron				1
Entomyzon cyanotis	Blue-faced Honeyeater	1			
Eopsaltria australis	Eastern Yellow Robin	2	1		
Eudynamys orientalis	Eastern Koel	1			
Geopelia humeralis	Bar-shouldered Dove			1	
Glossopsitta concinna	Musk Lorikeet	2	8	6	2
Glossopsitta pusilla	Little Lorikeet		2		
Hirundo neoxena	Welcome Swallow			2	
Lathamus discolor	Swift Parrot				2
Lichenostomus chrysops	Yellow-faced Honeyeater	1	5	3	1
Malurus cyaneus	Superb Fairy-wren				2

Scientific Name	Common Name	Februar y	March	May	June
Malurus lamberti	Variegated Fairy-wren		5	10	4
Manorina melanocephala	Noisy Miner	33	21	29	15
Meliphaga lewinii	Lewin's Honeyeater	4	5	7	6
Melithreptus brevirostris	Brown-headed Honeyeater		2		
Melithreptus lunatus	White-naped Honeyeater		2		
Myiagra rubecula	Leaden Flycatcher		1		
Myzomela sanguinolenta	Scarlet Honeyeater			1	
Neochmia temporalis	Red-browed Finch			2	4
Ocyphaps lophotes	Crested Pigeon	3	1	1	1
Oriolus sagittatus	Olive-backed Oriole	1	1	1	1
Pachycephala pectoralis	Golden Whistler			4	2
Pachycephala rufiventris	Rufous Whistler		1		
Pardalotus punctatus	Spotted Pardalote	2	4	7	6
Phylidonyris novaehollandiae	New Holland Honeyeater	1	7	4	4
Platycercus elegans	Crimson Rosella	1		2	
Platycercus eximius	Eastern Rosella				1
Psophodes olivaceus	Eastern Whipbird	5	8	6	2
Ptilonorhynchus violaceus	Satin Bowerbird	1	3		
Pycnonotus jocosus	Red-whiskered Bulbul	3	1	1	5
Rhipidura albiscapa	Grey Fantail				1
Rhipidura leucophrys	Willie Wagtail	1		1	1
Rhipidura rufifrons	Rufous Fantail	1			
Scythrops novaehollandiae	Channel-billed Cuckoo	1			
Sericornis frontalis	White-browed Scrubwren	5	6	10	8
Sphecotheres vieilloti	Australasian Figbird		2	6	9
Strepera graculina	Pied Currawong	2	1	4	5
Streptopelia chinensis	Spotted Dove	1	1	2	1
Sturnus tristis	Common Myna	1			1
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet				2
Trichoglossus haematodus	Rainbow Lorikeet	14	9	20	20
Zosterops lateralis	Silvereye	4	18	29	13
Total birds counted in 2 ha counts		131	164	211	165
Number of species for Census		36	38	37	40

Another bird of note detected during the surveys was the Black Bittern (*Ixobrychus flavicollis*) detected on camera 22 (Table 4) and listed as vulnerable in NSW under the BC Act. The record came about a week after the site was inundated by a larger release of water from Manly Dam. The conditions were overcast.

Some migratory species were detected during the formal bird census. The White-throated Needletail (*Hirundapus caudacutus*) was detected in large numbers on the first day of this study (before the start of the bird census). While they were not seen to land, it is possible that they roost in trees in the area from time to time during their summer visits.

Plate 7: Black Bittern photo taken by a game camera.

3.3.5 Reptiles

Fourteen reptile species were detected throughout the site on the game cameras (Table 4), during bird counts and other diurnal activities, during spotlighting and in pygmy possum nest boxes.

The most commonly recorded species was the Eastern Water Dragon (*Intellagama lesueurii*).

Eastern Snake-necked Turtle (*Chelodina longicollis*) was observed in the Mermaid Pool.

Golden-crowned Snake (*Cacophis squamulosus*) was detected during spotlighting in May.

Red-bellied Black Snake (*Pseudechis porphyriacus*) was detected on two game cameras both above and below the Mermaid Pool.

Broad-tailed Gecko (*Phyllurus platurus*) was mostly detected at the western end of the site but also on the rock faces around the Mermaid Pool.

Cream-striped Fence-skink (*Cryptoblepharus virgatus*) was found in a nest box and commonly seen on tree trunks throughout the lower elevation areas.

Copper-tailed Skink (*Ctenotus taeniolatus*) was seen at bird point 1.

Dark-flecked Garden Sunskink (*Lampropholis delicata*) was the most abundant skink on the study site being encountered at all bird sites. The Pale-flecked Garden Sunskink (*Lampropholis guichenoti*) was also present

but somewhat less common as was the Weasel Skink (*Saproscincus mustelinus*) which was only seen near bird point 5, a south facing slope.

Eastern Water-skink (*Eulamprus quoyii*) was seen around the Mermaid Pool and near the bridge on Sloane Crescent.

Eastern Blue-tongue (*Tiliqua scincoides*) was detected with a couple of the cameras at sites above the Mermaid Pool.

Lace Monitor (*Varanus varius*) was only seen in a large nest box set above the Mermaid Pool. Heath Monitor (*Varanus rosenbergi*) was detected on the western most camera. This is a threatened species in NSW. They rely on live termite mounds to sustain their breeding activity. Live termite mounds were not observed at a high density in the study area.

Plate 8: Eastern Water Dragon is common through most environments at the site

Plate 9: Golden Crown Snake is a nocturnal species that often goes un-noticed

Plate 10: Broad-tailed Gecko is textured like the sandstone it lives upon.

Plate 11: Heath Monitor was detected in the recently burnt part of the study area.

Frogs

Five frog species were detected during the survey. Few frog species were detected in or near Manly Creek. The only species detected near the creek were the two most common frogs in the Sydney urban environment, Striped Marsh Frog (*Limnodynastes peronii*) and the Common Eastern Froglet (*Crinia signifera*).

The Bleating Tree Frog (*Litoria dentata*) and Peron's Tree Frog (*Litoria peronii*) were heard away from the creek in local back yards.

The threatened species Red-crowned Toadlet (*Pseudophryne australis*) was heard calling from just down slope of the foot track extending from the end of Wandella Road (Figure 7). The vegetation is moderately dense with lots of litter and the frogs were not calling vigorously enough when heard in May to allow them to be found. The call can be confused with closely related species, however, on balance of probabilities it was the Red-crowned Toadlet calling.

All threatened fauna species are mapped on Figure 7.

3.3.6 Fish

Fish were not specifically targeted in this study, however, the following species were noted.

Longfin Eel (*Anguilla reinhardtii*) was detected above, in and below the Mermaid Pool. Possibly Short-finned Eel (*Anguilla australis*) was also present. These two species are common in almost all coastal streams of this region.

Cox's Gudgeon (*Gobiomorphus coxii*) and its close relative the Striped Gudgeon (*Gobiomorphus australis*) were both present in Manly Creek below the Mermaid Pool. One or both species was also present in the Mermaid Pool. A Galaxias, most likely to be Common Jollytail (*Galaxias maculatus*) was seen in Manly Creek below the Mermaid Pool. The identification is based on the apparent body shape, mouth position and relative positions of the dorsal and anal fins. However, confirmation of species will require capture of specimens. All of the above species are native to the area. Two additional native fish species have been previously observed in this catchment: Dwarf Flathead Gudgeon (*Philypnodon macrostomus*) and the Climbing Galaxias (*Galaxias brevipinnis*) (Lo 1996).

Two exotic species were observed. Mosquito Fish (*Gambusia holbrooki*) was observed in large numbers in the Mermaid Pool and lesser numbers downstream. A single large European Carp (*Cyprinus carpio*) was

observed in the Mermaid Pool. Lo (1996) observed that other exotic species have been stocked above the dam over time.

3.3.7 Invertebrates

Invertebrates were not specifically targeted in this study, however, one interesting decapod was noted in Manly Creek above the Mermaid Pool. It was the Riffle Shrimp (*Australatya striolata*), a specialist filter feeder from streams in Eastern Australia. There are no other records in the Northern Beaches (ALA, 2019).

Plate 12: Riffle Shrimp in the small pools above the falls into the Mermaid Pool, Manly Creek.

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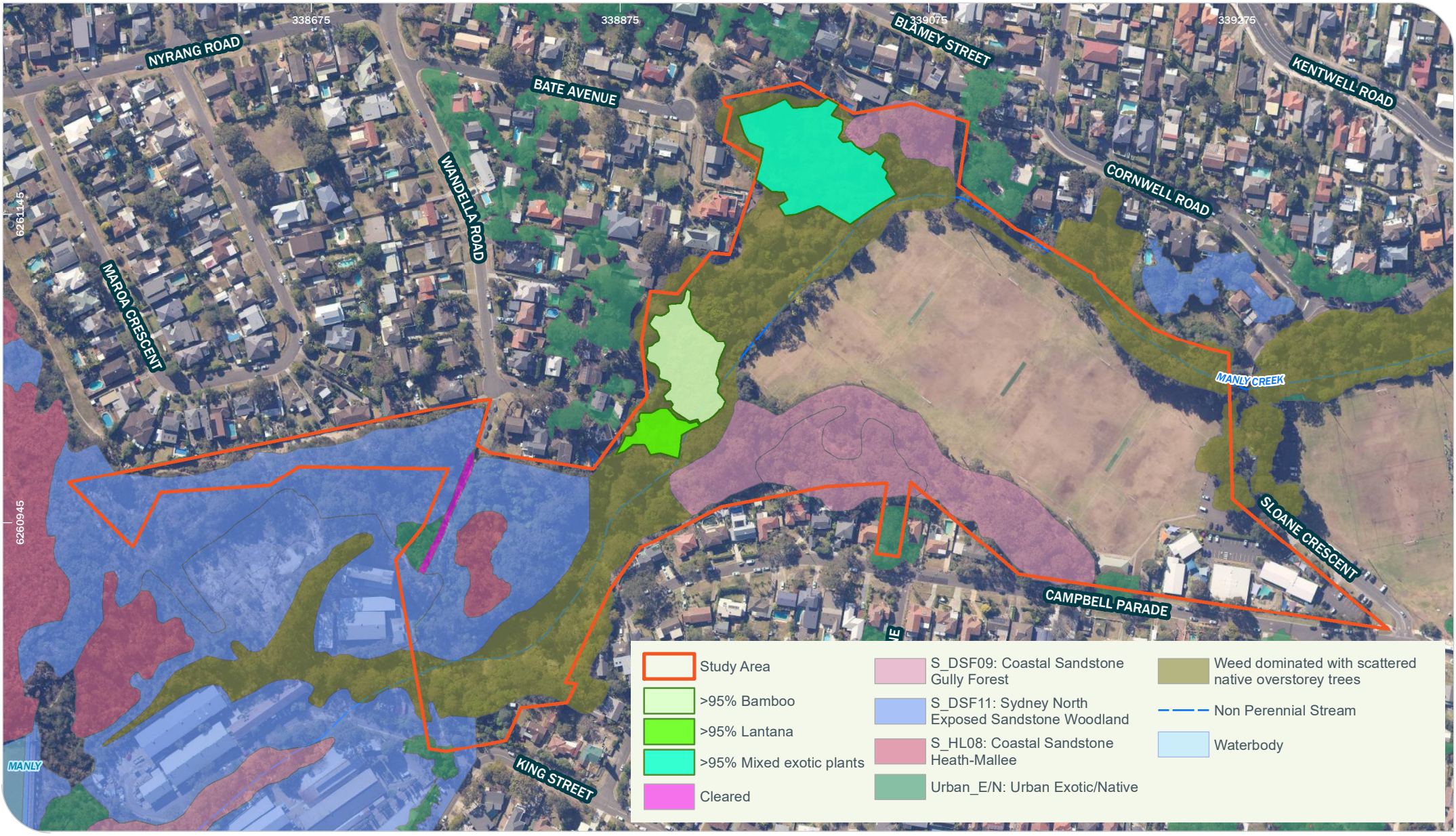
GDA 1994 MGA Zone 56

Map of threatened fauna records from this study

Manly Creek Riparian Corridor Biodiversity Study

Niche PM: Matthew Stanton
Niche Proj. #: 4797
Client: Northern Beaches Council

Figure 7



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Ground-truthed plant community mapping and weed infestations

Manly Creek Riparian Corridor Biodiversity Study

Niche PM: Matthew Stanton
Niche Proj. #: 4797
Client: Northern Beaches Council

Figure 8

4. Discussion

4.1 Matching the flora to the mapped Plant Community Types

The flora of the site consists of a mix of native and exotic species, some of which have been planted but most of which are either native constituents of local vegetation communities, or else have invaded the area via run off from the surrounding catchment, or via avian deposition.

Whilst a mix of native and exotic species can be observed across the entirety of the reserve, certain well defined sections of the reserve have been more or less invaded by exotic weed species. Certain sections of the reserve, such as the western-most border and vegetation along the mid southern border of the reserve (bordering Campbell Parade), represent native vegetation communities in a very good condition, whilst vegetation along the creek line is dominated by both overstorey and understorey weed species.

The vegetation community structure of the study site can be divided into three NSW BioNet recognised native vegetation communities: Coastal Sandstone Gully Forest, Sydney North Exposed Sandstone Woodland and Coastal Sandstone Heath-Mallee, with the remainder of the reserve being best described as 'weed dominated with scattered native overstorey trees', or else a 'Weed monoculture' (area of >95% weed coverage).

The vegetation within the site was assigned to one of the above vegetation community / structural types by comparing the flora species composition observed on the ground (i.e, dominant overstorey, midstorey and understorey species) with the NSW BioNet Plant Community Type (PCT) description of the species composition / structure described in 'The Native Vegetation of the Sydney Metropolitan Area, Volume 2: Vegetation Community Profiles, Version 3.0' (OEH, 2016), for each community type. Where the community structure changed significantly, the border of that community was drawn and a new community mapped.

The BioNet descriptions of the vegetation communities and the specific diagnostic species used to align the vegetation observed at the site to these communities, as seen in Figure 8, are detailed below:

4.1.1 Coastal Sandstone Gully Forest (NSW Plant Community Type: 1250: Sydney Peppermint-Smooth-barked Apple-Red Bloodwood Shrubby Open Forest)

The Office of Environment and Heritage's description of this vegetation community, found within 'The Native Vegetation of the Sydney Metropolitan Area, Volume 2: Vegetation Community Profiles' document (OEH, 2013) was used as a baseline description of the Coastal Sandstone Gully Forest community species structure:

"Coastal Sandstone Gully Forest is widely distributed along the eastern extent of the Sydney sandstone plateaus. It occupies sheltered aspects on infertile Hawkesbury sandstone in areas that receive more than 1000 millimetres of mean annual rainfall. Sydney peppermint (*Eucalyptus piperita*) and smooth-barked apple (*Angophora costata*) form a moderately tall open forest. These are rocky environments and the understorey is a diverse mix of heath and shrub species such as banksias, tea-trees and wattles. The taller NSW Christmas bush (*Ceratopetalum gummiferum*) is also commonly encountered and is conspicuous in early summer when it flowers profusely *(sic).* South of Sydney the spectacular large red flower and luxuriant green leaves of the Gymea lily (*Doryanthes excelsa*) immediately catches the eye. They are found scattered across the forest floor amongst patches of ferns, grasses, sedges and rock outcrops. The Gymea lily however is uncommonly recorded in northern Sydney though it becomes more frequent again in this community north of the Hawkesbury River. The community is found at elevations up to 500 metres above sea level".

During the site visit the following species that are indicative of the Coastal Sandstone Gully Forest community were observed at the southern and northern borders of the mid-section of the study area (Figure 8):

Dominant overstorey trees: *Angophora costata* (Sydney Red Gum), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus punctata* (Grey Gum) and *Eucalyptus piperita* (Sydney Peppermint).

Midstorey / smaller trees: *Ceratopetalum gummiferum* (Christmas Bush), *Hakea dactyloides* (Finger Hakea) and *Hakea teretifolia* (Needlebush).

Shrub species: *Acacia terminalis* (Sunshine Wattle)**,** *Banksia ericifolia subsp. ericifolia* (Heath-leaved Banksia)**,** *Lambertia formosa* (Mountain Devil) and *Grevillea linearifolia* (Linear-leaf Grevillea)

Understorey species: *Platysace linearifolia* (Carrot Tops)**,** *Caustis flexuosa* (Curly Sedge)**,** *Lepidosperma laterale* (Variable Sword-sedge), *Lomandra longifolia* (Spiny Headed Mat Rush) and *Pteridium esculentum* (Bracken Fern).

This community was in good condition with relatively few exotic weed species within the mapped area and would be considered to be a good example of a remnant native community of its type. The patch of this vegetation on the south facing slope (north side of study area) is being actively weeded and has a recovering understorey but will require ongoing attention.

4.1.2 Sydney North Exposed Sandstone Woodland (NSW Plant Community Type: 1783: Red Bloodwood-Scribbly Gum Heathy Woodland on Sandstone Plateaux, Sydney Basin)

The NSW BioNet description of this vegetation community, found within 'The Native Vegetation of the Sydney Metropolitan Area, Volume 2: Vegetation Community Profiles' document (OEH, 2013) was used as a baseline description of the Sydney North Exposed Sandstone Woodland community species structure:

"This exposed heathy woodland is widespread across the Hawkesbury sandstone plateau of northern Sydney and the hinterland of the Central Coast. The eucalypt canopy is typically low in height with a structure that varies between an open woodland and an open forest. In long unburnt sites the dry shrub layer is thick and impenetrable, whereas elsewhere it is less dense. The ground layer comprises sedges and grasses. The canopy consistently includes red bloodwood (*Corymbia gummifera*) and scribbly gums (*Eucalyptus haemastoma* or *Eucalyptus racemosa*) with old-man banksia (*Banksia serrata*) present in the lower canopy. Other eucalypts include smooth-barked apple (Angophora costata) and broad-leaved white mahogany (*Eucalyptus umbra*) with yellow bloodwood (*Corymbia eximia*) occurring in the Cowan catchment in Ku-ring-gai Chase NP. The shrub layer comprises a diverse range of sclerophyllous plants such as banksias, tea-tree, wattle, geebungs and peas. It occurs on free-draining sandy soils in exposed locations such as crests, ridges and exposed gully slopes. Soil development is generally poor. This is coastal woodland occurring within areas that receive more than 900 millimetres of mean annual rainfall. It is restricted to elevations between 200 and 500 metres above sea level".

During the site visit the following species that are indicative of the Sydney North Exposed Sandstone Woodland community were observed at the western border of the reserve (Figure 8):

Dominant overstorey trees: *Corymbia gummifera* (Red Bloodwood) and *Eucalyptus racemosa* (Narrow-leaved Scribbly Gum).

Shrub species: *Allocasuarina distyla* (Scrub she-oak*), Banksia ericifolia* (Heath-leaved Banksia) and *Boronia ledifolia* (Sydney Boronia).

Understorey species: *Cyathochaeta diandra* (Sheath rush), *Entolasia stricta* (Wiry Panic*), Xanthosia pilosa* (Woolly Xanthosia), *Epacris microphylla* (Coral heath), *Leucopogon ericoides* (Pink Beard-heathand), *Lomandra glauca* (Pale Mat-rush) and *Lomandra obliqua* (Alternating Mat-rush).

This community was in good condition with almost no exotic weed species within the mapped area and would be considered to be a very good example of a remnant native community of its type. Despite the site being lower than the stated elevation for this community, the species composition makes it a better fit than alternative PCTs.

4.1.3 Coastal Sandstone Heath-Mallee (NSW Plant Community Type: 882: Hairpin Banksia-Slender Tea-tree Heath on Coastal Sandstone Plateaux, Sydney Basin)

The Office of Environment and Heritage's description of this vegetation community, found within 'The Native Vegetation of the Sydney Metropolitan Area, Volume 2: Vegetation Community Profiles' document (OEH, 2013) was used as a baseline description of the Coastal Sandstone Heath-Mallee community species structure:

"Coastal Sandstone Heath-Mallee is widespread across the coastal Hawkesbury sandstone plateaus of the Sydney region. It is variable in structure, ranging from a treeless heath to a low open woodland with mallees. It is common on exposed skeletal soils along narrow ridges and exposed slopes of both the Woronora and Hornsby plateaus. The heath is dominated by heath-leaved banksia (*Banksia ericifolia subsp. ericifolia*) and is joined by a highly diverse combination other banksias, tea-trees, hakeas, wattles, grevilleas and geebungs. Scrub she-oak (*Allocasuarina distyla*) may also be prominent. The heath is low-growing on rocky sites and exceeds several metres in height in long unburnt areas with slightly deeper soil. The upper stratum may include low mallees and mallee-form eucalypts including the Port Jackson mallee (Eucalyptus obstans) and yellow-topped mallee ash (*Eucalyptus luehmanniana*) as well as red bloodwood (*Corymbia gummifera*) and dwarf apple (*Angophora hispida*). There is a variable cover of sedges and other monocots in the ground layer. This community is associated with the wetter zones of the sandstone plateau where mean annual rainfall exceeds 1100 millimetres per annum. It ranges in elevation between 50 and 250 metres above sea level. In the study area it covers extensive areas of Royal, Ku-ring-gai Chase and Garigal national parks. Elsewhere it is found between the Central Coast and Jervis Bay (Tozer et al. 2010)".

During the site visit the following species that are indicative of the Coastal Sandstone Heath-Mallee community were observed in an isolated 15 metre by 60 metre patch, just east of the Wandella Road/King Road footpath and coincidentally largely under power-lines (Figure 8):

Dominant overstorey trees: *Corymbia gummifera* (Red Bloodwood), *Eucalyptus haemastoma* (Scribbly Gum) and *Banksia serrata* (Old man banksia).

Midstorey / smaller trees: *Leptospermum trinervium* (Slender Tea-tree), *Kunzea ambigua* (Tick Bush)

Shrub species: *Banksia ericifolia subsp. ericifolia* (Heath-leaved Banksia)**,** *Lambertia formosa* (Mountain Devil), *Boronia ledifolia* (Sydney boronia*), Leptospermum trinervium* (Slender Tea-tree), *Leucopogon microphyllus* and *Acacia suaveolens*.

Understorey species: *Cyathochaeta diandra*, *Xanthorrhoea media* (Grass Tree), *Lomandra glauca* (Pale Mat-rush), *Lomandra obliqua* (Alternating Mat-rush) and *Schoenus imberbis* (Bog-rush).

This community was in good condition with relatively few exotic weed species within the mapped area and would be considered to be a good example of a remnant native community of its type. However, it is being modified by tree and shrub pruning under the power-lines.

4.1.4 Weed dominated with scattered native overstorey trees

A large strip of the reserve that follows and borders Manly Creek, from the south western border of the reserve up and along the northern border, running east to the north-eastern border of the reserve (Figure 8), is dominated by exotic weed species in all stratum (overstorey, mid-storey and ground cover). The dominant exotic species within this zone are:

Overstorey species: *Erythrina crista-galli* (Coral Tree), and *Ligustrum lucidum* (Large-leaved Privet).

Midstorey / shrub species: *Ligustrum sinense* (Small-leaved Privet) and *Ludwigia peruvian* (Water Primrose).

Ground cover species: *Tradescantia fluminensis* (Wandering Jew), *Ageratina adenophora* (Crofton Weed), *Sida rhombifolia* (Paddy's Lucerne) and *Bidens pilosa* (Farmer's friend).

Native overstorey species can also be found sparsely scattered throughout this zone, some of the more noticable species include: *Glochidion ferdinandi* (Cheese Tree), *Melaleuca quinquenervia* (Broad-leaved Paperbark), *Melaleuca styphelioides* (Prickly-leaved Paperbark), *Eucalyptus resinifera* (Red Mahogany), *Eucalyptus robusta* (Swamp Mahogany), *Eucalyptus saligna* (Sydney Blue Gum), *Eucalyptus sieberi* (Silvertop Ash), *Eucalyptus umbra* (Broad-leaved White Mahogany), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus botryoides* (Bangalay), *Callistemon citrinus* (Crimson Bottlebrush) *Casuarina cunninghamia* (River Oak) and *Casuarina glauca* (Swamp She-oak).

Mapping this community as weeds and exotics may be overly pessimistic but it does not align strongly with any natural PCT because of the mix of planted species.

Plate 13: A typical patch of forest mapped as weeds and exotics. Despite the weeds, a large number of native plants (many planted) are surviving.

4.1.5 Weed monoculture

A ¼ ha patch of Rhizomatous Bamboo (*Phyllostachys sp.* probably *P. aurea*) is located in the centre of the reserve along the north-west side of Manly Creek. It is growing as a monoculture and trees within the patch have been killed, even those of other weed species such as Large-leaved Privet. It appears that there have been efforts to minimise its spread to the north where there is active weed management being undertaken and to the south-west where a break has been cut between the bamboo and an adjacent monoculture patch of Lantana (approximately 0.1 ha area). The Bamboo does not seem to have been able to cross the creek and it grows up to a low cliff line on the north-west side which is roughly the boundary with private property.

While the bamboo is smothering all other plant life, it is not impenetrable to wildlife and Swamp Wallabies were found sheltering in the patch during the day. It may provide shelter to other species, however, it offers little other amenity and keeping it in check or completely removing it should be a priority of management if restoration of the native bushland is the management goal.

Plate 14: Bamboo patch (*Phyllostachys sp*.)

Plate 15: 1/2 ha patch of continuous weeds, mostly lantana with assorted other exotics. Natives appearing at the edges were water vines and Bracken

A similar sized patch of mixed weed species consisting of Lantana, Tobacco Bush and three types of Morning Glory is located towards the north-western border of the study area and has an exotic coverage of >95% (Figure 8).

No threatened flora species (listed under the BC Act or EPBC Act) were located during the field surveys although some species present have been listed in ROTAP listings of the past. Given the disturbance history and weed infested condition of much of the reserve, it is unlikely that sensitive species persist within the area unless they have been planted during past improvement plantings.

4.1.6 The aquatic environment

One of the most obvious weed infestations at the Mermaid Pool is the choking mass of exotic yellow water lilies covering much of the pool. Other weeds include an invasive milfoil and pond weeds (*Egeria* and *Elodea*). Emergent weeds of *Sagittaria* and *Hygrophila* block the creek channel and probably change its flow

pattern. However, there were some native water plants present such as ribbon grass (*Vallisneria australis*) and stonewort (an algae). Where the creek is well shaded the creek is suddenly open and fish can be seen.

The exotic water plants almost all thrive in nutrient rich sediments. There is potential to use the plants to remove the excess nutrients by removing the plants periodically and composting them off-site.

4.2 Habitats for threatened species

The seven ha of wooded vegetation on the site gives a wide range of vegetation cover and food resources for wildlife. The floristic diversity is wide enough that fauna in some groups can live their entire life cycle within the site. For example, there were nectar producing plants flowering on every visit, which would enable nectar feeders to access nectar year round without migration. Floristic diversity could similarly be aiding folivores such as the possums and Swamp Wallaby. Having a consistent food source for the possums and flying-foxes is almost certainly why their numbers are sufficient that the Powerful Owl can use the area for foraging. However, the Powerful Owl cannot currently complete its lifecycle at the site because nesting amenities are not present. There are no trees with hollows large enough for a Powerful Owl nest site. Hollows of any size are very rare. This is due to all the trees on site, even some extremely large ones, being less than 75 years old. Observing the series of air photos taken in 1943 and available on SixMaps (NSW DFI) shows that there were no large trees on the site at that time. Some areas were completely cleared while other rocky ground was more sparsely vegetated and any large trees had been removed for some other purpose. The reason for the state of the native vegetation is not obvious from the photographs but possibly fire may have had a role. Hollows in trees can take centuries to form. Even trees such as *Angophora costata* have not had time to form anything but the smallest hollows in that period and many of today's trees may not have started to grow until the 1970s.

The presence of complex sandstone shelves would provide shelter sites for a range of reptiles and potentially small mammals, however, the results for small mammals for this study were disappointing, even for relatively common species. Further investigation of threatened bat roost sites around the Mermaid Pool may be warranted.

4.3 The site as a corridor for wildlife movement

4.3.1 Terrestrial fauna

The population of Long-nosed Bandicoot at North Head is scheduled as threatened because the population is not connected by any wildlife corridor. David Thomas Reserve is about the closest Long-nosed Bandicoot population to North Head so if the two populations are ever going to have unassisted genetic exchange, this is the place it is most likely to happen. To disperse the 4 km between the two patches, a bandicoot would have to utilise small patches of cover on golf courses and scattered through suburban yards. Odd records of bandicoots through Manly suggest that it is not impossible.

The study site provides plentiful cover for terrestrial fauna in ground litter and herb cover, abundant shrubs and a strong tree cover. These features would benefit a wide range of species, protecting them from predation even though in many areas the cover is afforded by exotic flora. However, the eastern end of the site has a number of roads which could act as a significant barrier to dispersal, particularly Condamine Street.

4.3.2 Arboreal fauna

The two abundant native arboreal mammal species detected during this study could move through the entire length of the reserve with minimal need to come to the ground. Touching tree crowns are a feature

of much of the forest with some exceptions around the south eastern side of the Mermaid pool and in the western portion connecting to Manly Dam Reserve.

4.3.3 Aerial fauna

During this study, the Swift Parrot was recorded flying down Manly Creek. The creek corridor of trees should not be underestimated as a better dispersal medium than open country or suburbia. The resource provision of the trees and the shelter provided means that migratory birds could face fewer challenges to their mobility. Bats may also find cover along the flyway although it also provides cover for ambush predators like the Powerful Owl.

The challenge for managers of the site is to avoid making the area a sink for wildlife. The corridor is a very narrow one and it is patrolled by two of the most destructive exotic predators, the Cat and the Fox. Other wildlife traps could include collision hazards (large glass windows and fences on surrounding dwellings) and road impacts (Sloane Cresent lies across a natural pathway).

5. Conclusion

The site provides a flora and fauna refuge, with a large proportion of the refuge maintained only through the efforts of bush care workers reducing areas of weed infestation. The total of 169 native flora species is possibly somewhat inflated because any plant native to Eastern Australia was recorded as a native species. Regardless of the local status of the flora, they generally perform the same function as locally endemic plants that would have occurred prior to development in the area and resultant disturbances. However, there are three patches of vegetation totalling nearly one hectare that have no floristic value for bushland regeneration (Figure 8). Containing the spread of these patches should be a priority for management.

Management of the large variety of weeds is likely to be difficult as, for example, clearing one weed may open the site for another. The use of fire in the relatively intact patches of native vegetation appears to have been effective at maintaining the resilience of the native vegetation. Some persistent weeds such as Mother-of-millions will still require additional attention.

Much of the native wildlife appears to be unaffected by the prevalence of weeds at the site. Brush-turkeys (*Alectura lathami*) readily rake exotic leaf litter for nest mounds and the browsing mammals are able to forage on many weeds. The Powerful Owl is benefitted by the resulting abundance of prey animals. The cover provided by some of the weed stands along the creek is likely to enable birds such as the Black Bittern to persist and utilise the habitat here.

The installed nest boxes scattered through the forest areas of the site are almost certainly providing a missing habitat component for hollow dwelling wildlife, although there is still a distinct absence of many hollow dwelling birds and mammals. The nest box effort will need to be maintained for some time into the future until the large trees are old enough to start forming hollows.

The site retains ecological value and, as a result, the surrounding suburbs will maintain a level of native flora and fauna diversity and the associated environmental benefits. Any reduction in size of the wooded area will compromise the value of the bushland as habitat and a wildlife corridor.

6. Recommendations

Bush regeneration has been ongoing at the site for some decades and if possible the program needs to be expanded to eradicate some of the most problematic weeds and control the spread of others. The methods of hand removing weeds is appropriate in most areas of the site, however, weed removal by machine might be appropriate for the three areas of heavy weed infestation identified in this study. Removal and treating of topsoil in those areas could help by removing higher nitrogen in the soil that benefits many weeds and will remove the weed seed bank. Planting with the desired native species would be required immediately after treatment.

Feral predators are active throughout the site. The Northern Beaches area has had effective fox baiting programs in the past. The site offers a good opportunity to control foxes in the area. As a narrow corridor, it is likely that most foxes dispersing through the site will pass close to certain spots which could be utilised for a baiting or trapping program. While cats do not appear to be occupying the whole reserve, they are using it for hunting at least in some areas. Local residents need to be educated about the risks their pets can pose to the wildlife in the reserve.

Rabbits also occur in a number of parts of the site. It is unclear what damage they are currently doing to the vegetation, however, their presence is unlikely to be promoting the restoration of the native vegetation. In the longer term, their removal is likely to be beneficial.

Any feral animal control measures should be monitored for effectiveness and for ongoing targeting of effort. The autonomous game camera methods used in this study are the ideal method for monitoring.

The small nest boxes deployed during this study might be usefully left deployed, both for an ongoing search for small mammals and for a simple addition of denning habitat to the site. Larger nest boxes suitable for possums and larger birds are already well deployed on site. Additional boxes for smaller animals might be useful in creating habitat for Eastern Pygmy Possum, Feathertail Glider and Brown Antechinus which were not yet detected on the site.

Further investigation of threatened bat roost sites around the Mermaid Pool may be warranted. Spring surveys for birds would undoubtedly expand the species list for the reserve. Similarly, flora surveys through the spring and summer months may reveal additional cryptic plant species.

7. References

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Appendix 1 Threatened species records from BioNet (pre survey)

Data from the BioNet BioNet Atlas website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Licensed Report of all Valid Records of Threatened (listed on TSC Act 1995) ,Commonwealth listed ,CAMBA listed ,JAMBA listed or ROKAMBA listed Entities in selected area [North: -33.73 West: 151.21 East: 151.31 South: -33.83] returned a total of 3,789 records of 100 species.

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Class	Family	Scientific Name	Common Name	NSW status	Comm. status	Records
Amphibia	Myobatrachidae	*Heleioporus australiacus*	Giant Burrowing Frog	V,P	V	3
Amphibia	Myobatrachidae	*Pseudophryne australis*	Red-crowned Toadlet	V,P		81
Amphibia	Hylidae	*Litoria aurea*	Green and Golden Bell Frog	E1,P	V	1
Reptilia	Varanidae	*Varanus rosenbergi*	Rosenberg's Goanna	V,P		29
Aves	Columbidae	*Ptilinopus magnificus*	Wompoo Fruit-Dove	V,P		1
Aves	Columbidae	*Ptilinopus superbus*	Superb Fruit-Dove	V,P		4
Aves	Apodidae	*Apus pacificus*	Fork-tailed Swift	P	M	1
Aves	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	P	V,M	9
Aves	Ardeidae	*Botaurus poiciloptilus*	Australasian Bittern	E1,P	E	1
Aves	Ardeidae	*Ixobrychus flavicollis*	Black Bittern	V,P		2
Aves	Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	P	C	3
Aves	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V,P	C	29
Aves	Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V,P		2
Aves	Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V,P,3		1
Aves	Accipitridae	*Pandion cristatus*	Eastern Osprey	V,P,3		3
Aves	Burhinidae	*Burhinus grallarius*	Bush Stone-curlew	E1,P		8
Aves	Burhinidae	*Esacus magnirostris*	Beach Stone-curlew	E4A,P		2
Aves	Charadriidae	*Pluvialis squatarola*	Grey Plover	P	M	2
Aves	Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	P	M	1
Aves	Cacatuidae	*^^Calyptorhynchus lathami*	Glossy Black-Cockatoo	V,P,2		15
Aves	Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V,P		1
Aves	Psittacidae	*Lathamus discolor*	Swift Parrot	E1,P,3	CE	6
Aves	Psittacidae	*Neophema pulchella*	Turquoise Parrot	V,P,3		1
Aves	Strigidae	*Ninox connivens*	Barking Owl	V,P,3		4
Aves	Strigidae	*Ninox strenua*	Powerful Owl	V,P,3		238
Aves	Tytonidae	*Tyto novaehollandiae*	Masked Owl	V,P,3		1
Aves	Tytonidae	*Tyto tenebricosa*	Sooty Owl	V,P,3		1
Aves	Meliphagidae	*Anthochaera phrygia*	Regent Honeyeater	E4A,P	CE	3
Aves	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V,P		2
Aves	Artamidae	*Artamus cyanopterus*	Dusky Woodswallow	V,P		5
Aves	Petroicidae	*Petroica boodang*	Scarlet Robin	V,P		2
Mammalia	Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V,P	E	5
Mammalia	Peramelidae	*Isoodon obesulus obesulus*	Southern Brown Bandicoot	E1,P	E	2

Class	Family	Scientific Name	Common Name	NSW status	Comm. status	Records
Mammalia	Peramelidae	*Perameles nasuta*	Long-nosed Bandicoot, NUR	E2,P		2068
Mammalia	Phascolarctidae	*Phascolarctos cinereus*	Koala	V,P	V	5
Mammalia	Burramyidae	*Cercartetus nanus*	Eastern Pygmy-possum	V,P		349
Mammalia	Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V,P	V	147
Mammalia	Molossidae	*Mormopterus norfolkensis*	Eastern Freetail-bat	V,P		1
Mammalia	Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	V,P		5
Mammalia	Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V,P		57
Mammalia	Vespertilionidae	*Myotis macropus*	Southern Myotis	V,P		3
Mammalia	Muridae	*Pseudomys novaehollandiae*	New Holland Mouse	P	V	1
Flora	Asteraceae	*Senecio spathulatus*	Coast Groundsel	E1		1
Flora	Dilleniaceae	*Hibbertia puberula*		E1		1
Flora	Dilleniaceae	*Hibbertia superans*		E1		1
Flora	Elaeocarpaceae	*Tetratheca glandulosa*		V		48
Flora	Ericaceae	*Epacris purpurascens var. purpurascens*		V		2
Flora	Euphorbiaceae	*Chamaesyce psammogeton*	Sand Spurge	E1		3
Flora	Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	E1	V	14
Flora	Fabaceae (Mimosoideae)	*Acacia terminalis subsp. terminalis*	Sunshine Wattle	E1	E	193
Flora	Lamiaceae	*Prostanthera junonis*	Somersby Mintbush	E1	E	3
Flora	Lamiaceae	*Prostanthera marifolia*	Seaforth Mintbush	E4A,3	CE	168
Flora	Malvaceae	*Lasiopetalum joyceae*		V	V	1
Flora	Myrtaceae	*Callistemon linearifolius*	Netted Bottle Brush	V,3		4
Flora	Myrtaceae	*Eucalyptus camfieldii*	Camfield's Stringybark	V	V	22
Flora	Myrtaceae	*Eucalyptus nicholii*	Narrow-leaved Black Peppermint	V	V	4
Flora	Myrtaceae	*Melaleuca biconvexa*	Biconvex Paperbark	V	V	1
Flora	Myrtaceae	*Rhodamnia rubescens*	Scrub Turpentine	E4A		1
Flora	Myrtaceae	*Syzygium paniculatum*	Magenta Lilly Pilly	E1	V	26
Flora	Orchidaceae	*^^Caladenia tessellata*	Thick Lip Spider Orchid	E1,P,2	V	5
Flora	Orchidaceae	*^^Genoplesium baueri*	Bauer's Midge Orchid	E1,P,2	E	1
Flora	Orchidaceae	*^^Microtis angusii*	Angus's Onion Orchid	E1,P,2	E	1
Flora	Orchidaceae	*^^Sarcochilus hartmannii*	Hartman's Sarcochilus	V,P,2	V	1
Flora	Proteaceae	*Grevillea caleyi*	Caley's Grevillea	E4A,3	CE	25
Flora	Proteaceae	*Persoonia hirsuta*	Hairy Geebung	E1,P,3	E	26
Flora	Thymelaeaceae	*Pimelea curviflora var. curviflora*		V	V	27

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