

City Of Melbourne



# University and Lincoln Squares Biodiversity Assessment



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# 1 Introduction

University Square in Carlton is one of the oldest parks in the City of Melbourne (CoM), with plantings and park design interventions dating back to the 1850s, 1880s and the early 20<sup>th</sup> century (CoM, 2016). The park is largely comprised of aging English Elms (*Ulmus procera*) and lawn, with many trees nearing senescence.

The context of the park has also changed, with the University of Melbourne now owning all the buildings surrounding the park. Locally, the human population of Carlton is also changing, with a 60% increase expected over the next decade. Furthermore, Carlton has Melbourne's youngest median age of 25 years, has one of the largest student populations, and more than 56% of residents born overseas. With a large proportion of Carlton residents now living in multi-storey apartments, there is a demonstrated need to provide more publicly accessible open space.

The City of Melbourne is proposing to refurbish and revitalise University Square by implementing the University Square Master Plan with its ten actions:

## MASTER PLAN ACTIONS



By implementing the University Square Master Plan, public open space gains will include:

- Adding 8379 m<sup>2</sup> of new public open space, representing a 48% increase from current levels;
- Creating 4300 m<sup>2</sup> of new garden beds;
- Adding 2009 m<sup>2</sup> of new lawn, representing a 30% increase on current levels; and
- Planting 253 new trees, a 47% increase on current numbers.

The City of Melbourne also has a strong commitment to increasing biodiversity within the municipality and connecting people to nature (CoM 2017). As part of this commitment, CoM is evaluating the extent to which management interventions increase biodiversity levels. To this end, EcoAerial was engaged by the City of Melbourne to undertake an ecological investigation incorporating a desktop review and on-site surveys to quantify the biodiversity within the park before redevelopment.

## 1.1 Aims/ Objectives

The key objectives of the impact assessment were:

1. Quantify the “baseline” species richness and abundance of bats, birds and possums within University Square, Lincoln Square and surrounding streets prior to the commencement of proposed master plan works.
2. Identify mitigation options and strategies for the City of Melbourne to consider when removing potential habitat from the site, during construction works and after construction is complete.

## 1.2 Study sites

Surveys for birds, bats and possums were undertaken at University Square, Lincoln Square and along Pelham Street connecting the two parks (Figure 1). In addition, bird surveys were also undertaken at a small area of park within The University of Melbourne campus.

University Square is 1.8 ha in size and Lincoln Square is 1.7 ha in size, with University Square dominated by ageing Elm trees and lawn, while Lincoln Square is more diverse with a range of tree species and some understorey plantings. Tree species at Lincoln Square include Moreton Bay Figs (*Ficus macrophylla*), Oaks (*Quercus canariensis*), Lemon Scented Gum (*Corymbia citriodora*), Golden Elm (*Ulmus glabra* ‘Lutescens’), Hoop Pine) *Araucaria cunninghamii*) and Willow leaf Peppermint (*Eucalyptus nicholii*), to name a few.

The bird survey control site the University of Melbourne was similar to Lincoln Square in that there was a diversity of tree species both exotic and native, including Plane trees (*Platanus x acerifolia*), Spotted Gum (*Corymbia maculata*) and open lawn area.



25 0 25 50 75 100 m



Map Projection: Transverse Mercator  
GDA 94 Zone 55



### Legend

 Study Areas

**Figure 1: Univeristy and Lincoln Square**

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## 2 Methods

The biodiversity assessment involved a 2-stage approach; a desktop review sourcing state ecological data within a 1km buffer and, a 1km buffer for Matters of National Environmental Significance (MNES) and, on-site investigations.

### **Terminology**

Common and scientific names of vertebrate fauna follow the Victorian Biodiversity Atlas (DELWP 2016).

### **2.1 Desktop Review**

Existing information on the fauna of the area was reviewed, including:

- Victorian Biodiversity Atlas administered by the Department of Environment, Land, Water and Planning (DELWP)
- The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool
- Accessing results of formal and informal surveys of University Square and other similar parks from our wide network of colleagues.

### **2.2 Site Surveys**

#### **2.2.1 Microbats**

There are two primary methods for surveying microbats, namely trapping and call detection. Both methods have their limitations and biases, particularly when implemented in urban parks.

Trapping is conducted by placing harp traps within the flight path or 'flyways' of bats; however trapping success is often limited by a lack of obvious flyways, especially in open-style parks such as University Square. In contrast, trapping can be very successful in forest situations when traps are placed on tracks, where bats are intercepted as they fly along the cleared roadway.

Both University Square and Lincoln Square have large areas of open area and neither have any flyways conducive to effective bat trapping. Consequently, the primary survey approach adopted was the use of bat detectors. These are small electronic devices that detect and record the ultrasonic calls of bats, allowing identification of species from their species-specific call traits. Active and passive call detection techniques were deployed to maximise both the number and quality of calls and thereby the completeness and accuracy of the survey.

Active call detection surveys involved deploying a Anabat Walkbout (Titley®) bat detector and walking of transects for 2-hours on six non-consecutive nights (refer to Figure 2). Active detection surveys were conducted on warm evenings without rain and low wind to increase detection rates. Visual flying fox counts were also undertaken at the same time as the active surveys.

Passive call detection surveys are conducted by deploying bat detectors in-situ for an extended period of time and programming them to turn on before dusk and turn off just after dawn. Six stations were established at both University Square and Lincoln Square (Figure 2),

and deployed Anabat Express (Titley®) bat detectors for two weeks at each station, equating to 84 detector nights at each park. To avoid theft, detectors were camouflaged by placing them inside possum nest boxes and installed at a height of approximately 5 – 5m up trees.

### **2.2.2 Bat Call Analysis**

Bat analysis involved the use of Analoow sound analysis software (Titley®) with a filter to discard non-bat calls. Bat calls were then visually analysed and identified to a species level. Bat call analysis can only provide a measure of activity and cannot be used to enumerate the number of bats present.

Bat call analysis follows the Australasian Bat Society guidelines (ABS 2003). Calls were identified by Rob Gration, a recognised expert in bat call identification.

### **2.2.3 Arboreal Mammals**

Possums within University and Lincoln Squares and along Pelham Street were surveyed by spotlighting with a hand-held 350 lumen torch by one observer (RvdR). Each park was traversed in a systematic manner, by starting in one corner and following each row of trees and carefully scanning the trunk, main branches and outer branches of each tree as well as the ground beneath each tree. When a possum was detected, the location of each sighting was recorded with a GPS, with an accuracy of <5m. The starting point of each transect (i.e. University Square or Lincoln Square) was varied from night to night to minimise the risk of introducing a systematic bias. Spotlighting commenced approximately one hour after sunset, and each transect lasted for approximately 1 hour and 15 minutes.

### **2.2.4 Bird Surveys**

Birds were surveyed using standard Birdlife Australia techniques; 20 minute 2ha area count (Loyn 1986) on five non-consecutive mornings. The south lawn at the University of Melbourne was included as a control site (refer to Figure 3).

### **2.2.5 Hollow-bearing Tree Assessments**

A broad-scale survey to identify trees with hollows at University Square, Lincoln Square and surrounding streets was undertaken on the 5<sup>th</sup> of April 2017. All trees within each park and adjacent streets were inspected from the ground with binoculars and were recorded as hollow-bearing if a hole greater than 3 cm in diameter was observed.

A detailed assessment of the number and size of hollows within each tree at University Square was undertaken on the 12<sup>th</sup> April 2017. Each tree was carefully searched from the ground from all directions with binoculars and the number and entrance size of all hollows seen was estimated and recorded. When it could be confirmed that entrance holes did not lead to usable hollows, these were not recorded as hollows. When such holes occurred higher in the canopy or were obscured from view for other reasons, they were recorded as hollows. It was possible, therefore, that some hollows may not be usable.

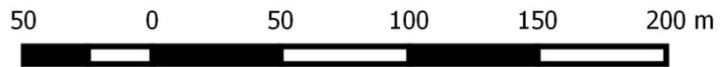
For both surveys (broad-scale survey and detailed assessment at University Square), the minimum size of a usable hollow was 3 cm diameter, and a usable hollow for the Common Brushtail Possum was defined as a minimum of 7 cm diameter. The species and diameter at

breast height of all trees was taken from the tree database maintained by the City of Melbourne.

### ***2.2.6 Animal Ethics Approvals & Research Permit***

Surveys were conducted under the following regulatory approvals

- AEC Approval No: 04.16
- DELWP Research Permit No: 10007972



Map Projection: Transverse Mercator  
GDA 94 Zone 55

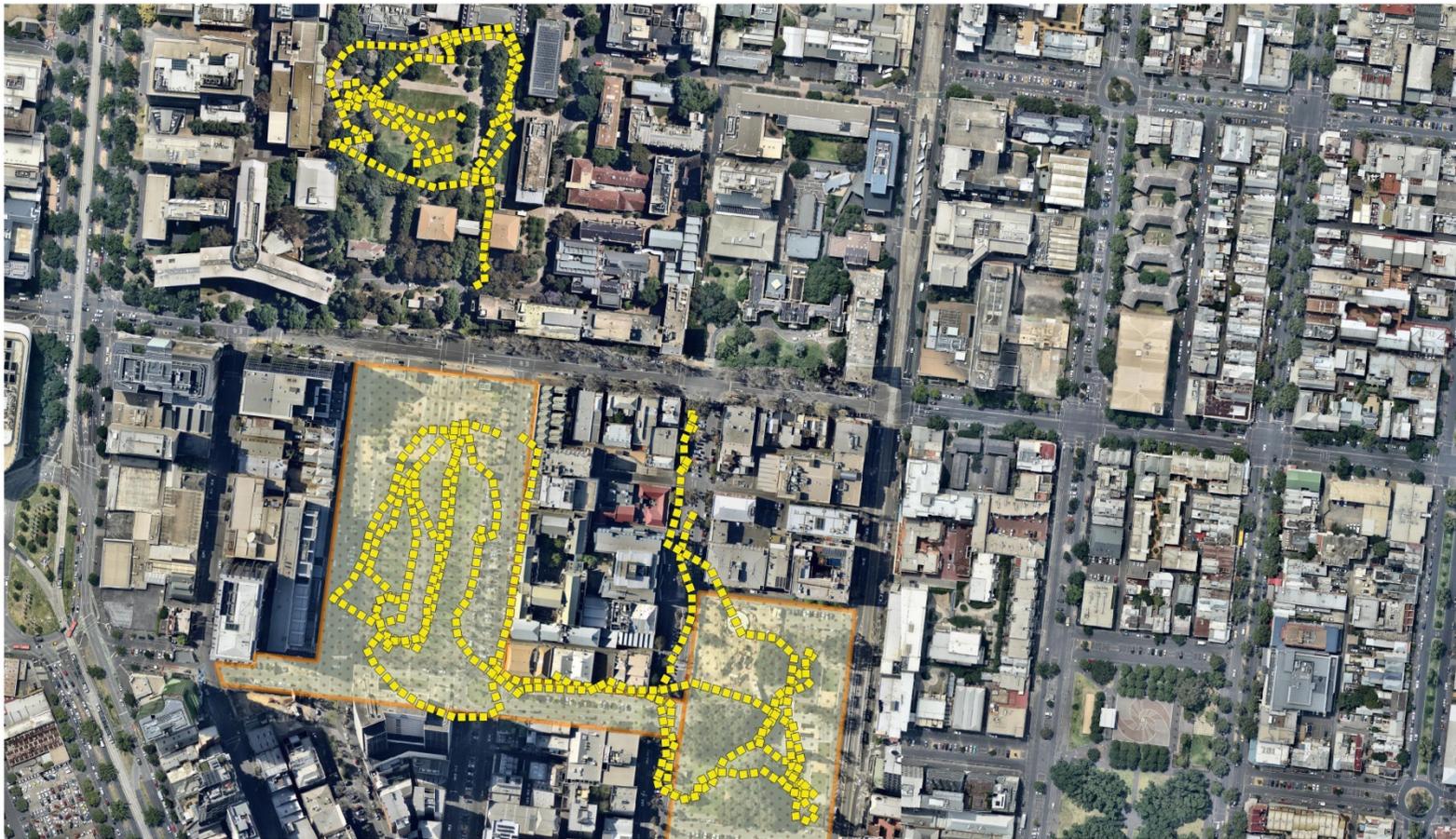


**Legend**

-  Study Areas
-  Bat Detectors
-  Active Bat Detector Transects

**Figure 2: Bat Detector Surveys**

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Date: 17/04/17  
Version No: 1



**Legend**

-  Study Areas
-  Bird Surveys

**Figure 3: Bird Surveys**

Map Projection: Transverse Mercator  
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Version No: 1

## 3 Results

### 3.1 Database review

#### 3.1.1 Environment Protection and Biodiversity Conservation Act 1999; Protected Matters Search Tool

Matters of National Environmental Significance (MNES) within a 1km buffer of the parks were analysed on the 13 April 2017 using the Department of Environment and Energy (DoEE) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (Appendix B). This tool lists those species, species habitat and vegetation communities that may occur, or are likely to occur within the 1km buffered area. MNES identified as potentially occurring included:

- 21 threatened species:
  - 15 fauna
  - 6 flora
- 4 threatened ecological communities:
  - Grassy Eucalypt Woodland of the Victorian Volcanic Plain - Critically Endangered
  - Natural Temperate Grassland of the Victorian Volcanic Plain - Critically Endangered
  - Natural Damp Grassland of the Victorian Coastal Plain - Critically Endangered
  - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

#### 3.1.2 Victorian Biodiversity Atlas

DELWP's Victorian Biodiversity Atlas was reviewed to obtain records of fauna within a 1km buffer of the study areas (accessed 8/04/2017). The review included species listed under the EPBC Act and *Flora and Fauna Guarantee Act 1988* (FFG Act). No threatened species have been recorded within 1km of the study area. A total of 25 bird species have been recorded within or adjacent to the study area (refer to Appendix B).

With the exception of the Grey-headed Flying-fox *Pteropus poliocephalus*, MNES and FFG Act listed species are considered highly unlikely to occur due to the highly urbanised extent of the study area.

## 3.2 Field surveys

### 3.2.1 Active bat survey

Two species of bat were detected during the active surveys. The EPBC listed Grey-headed Flying-fox was observed on one occasion at University Square and on six occasions at Lincoln Square. Gould's Wattled Bat *Chalinolobus gouldii* was recorded at both University and Lincoln Square on four of the six survey nights. The White-striped Freetail-bat *Tadarida australis* was detected on one occasion at University Square and two occasions at Lincoln Square (Table 1 & 2).

Table 1: Active Bat Survey Results

Date	Species	University Square	Lincoln Square
5/12/2016	Grey-headed Flying-fox	4	>40
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	White-striped Freetail-Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12/12/2016	Grey-headed Flying-fox	0	>30
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	White-striped Freetail-Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
22/12/2017	Grey-headed Flying-fox	0	>45
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	White-striped Freetail-Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9/01/2017	Grey-headed Flying-fox	0	>125
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	White-striped Freetail-Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
24/01/2017	Grey-headed Flying-fox	0	>100
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	White-striped Freetail-Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

9/01/2017	Grey-headed Flying-fox	0	>20
	Gould's Wattled Bat	☑	☑
	White-striped Freetail-Bat	☒	☑

☑ = Recorded, ☒ = Not recorded

### 3.2.2 Passive bat surveys

A total of four species of microbat were recorded during the passive bat surveys, namely Gould's Wattled Bat, White-striped Freetail-bat, Southern Freetail-bat and Yellow-bellied Sheathtail-bat. All four species were recorded at Lincoln Square, only Gould's Wattled bat was recorded at University Square (refer to Tables 2 & 3). Details of the call images of bats identified are provided in Appendix C.

Table 2: University Square

Study site	University Square				
Species	Week 1 5/12/2107	Week 2 13/12/2016	Week 3 21/12/2016	Week 4 28/12/2016	Total
Number of files	171	701	516	525	1913
Identified to species level	171	701	516	525	1913
Calls positively identified	100.00%	100.00%	100.00%	100.00%	100.00%
Gould's Wattled Bat	171	701	516	525	1913
<i>Chalinolobus gouldi</i>					

Table 3: Lincoln Square

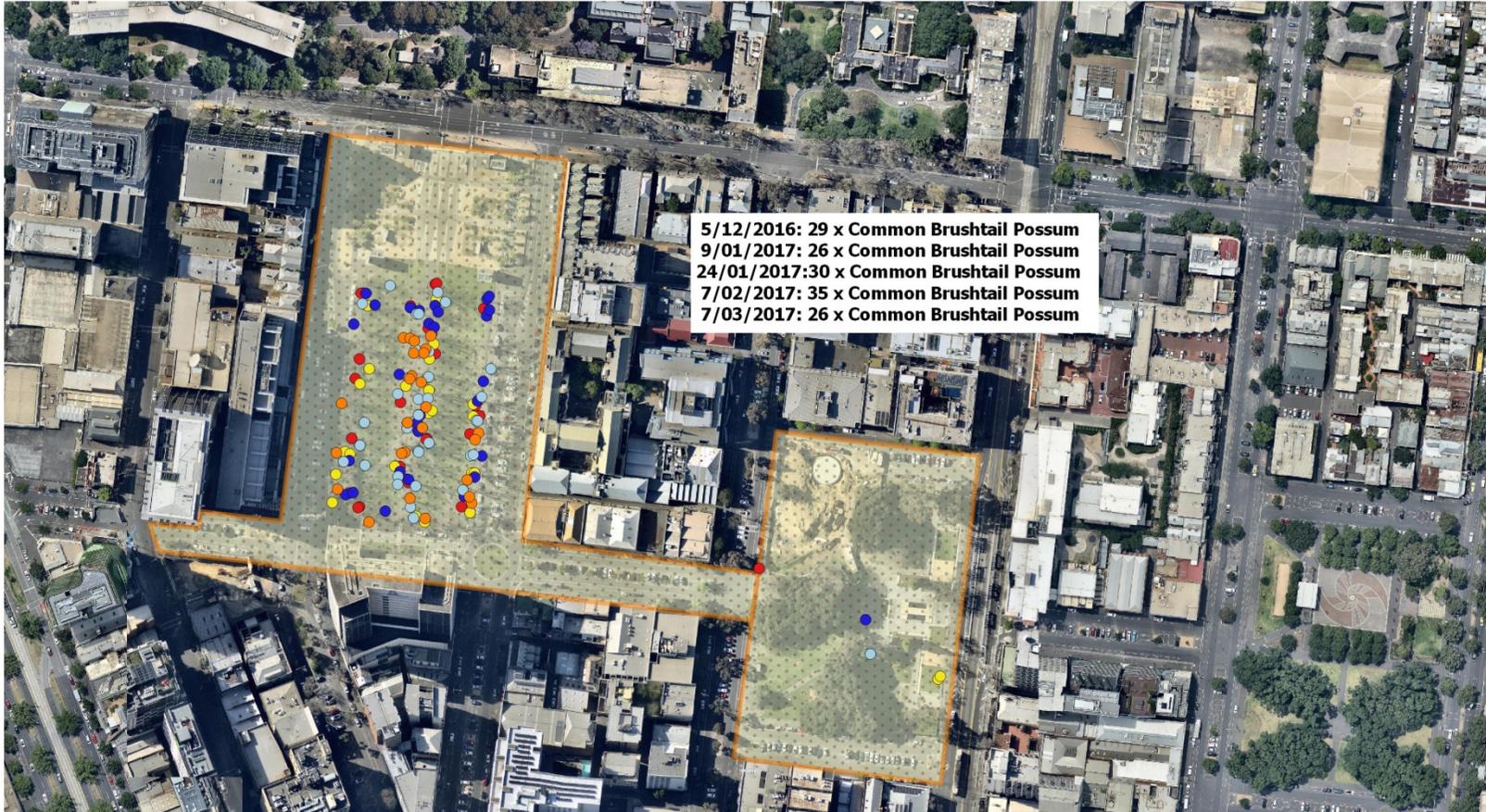
Study site	Lincoln Square				
Species	Week 1 9/01/2017	Week 2 16/01/2017	Week 3 23/01/2017	Week 4 2/02/2017	Total
Number of files	134	159	956	787	2036
Identified to species level	134	159	956	787	2036

<b>Calls positively identified</b>	<b>100.00%</b>	<b>100.00%</b>	<b>100.00%</b>	<b>100.00%</b>	<b>100.00%</b>
<b>Yellow-bellied Sheathtail Bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
<i>Saccolaimus flaviventris</i>					
<b>White-striped Freetail Bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>
<i>Tadarida australis</i>					
<b>Southern Freetail bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>10</b>	<b>10</b>
<i>Mormopterus planiceps</i>					
<b>Gould's Wattled Bat</b>	<b>134</b>	<b>159</b>	<b>956</b>	<b>773</b>	<b>2022</b>
<i>Chalinolobus gouldi</i>					

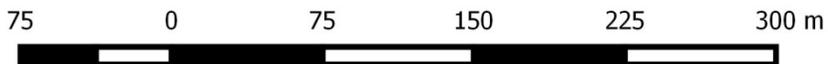
### 3.2.3 Possums

All possums detected during spotlighting were Common Brushtail Possums (*Trichosurus vulpecula*). A total of 146 possums were detected over the five nights of spotlighting, with an average of one per night at Lincoln Square (range: 0 – 2) and an average of 28.2 per night at University Square (range: 24 – 35). Possums were not detected in any of the relatively young plantings in the area of University Square above the underground car park. Possums at University Square were distributed approximately evenly along the rows of Elm trees, with a slightly lower density in the Elms adjacent to Barry Street. The majority of possums were detected within the Elm trees or on the ground immediately below the Elm trees, with only a small number detected on the ground moving between trees.

The average density of possums within University Square is 15.7 per ha and 0.6 per ha at Lincoln Square. If the area above the University Square car park is excluded, the average density of possums at University Square increases to 26.1 per ha (assuming the area of University Square with Elms is approximately 1.08 ha). No possums were detected along Pelham Street between University and Lincoln Squares.



5/12/2016: 29 x Common Brushtail Possum  
 9/01/2017: 26 x Common Brushtail Possum  
 24/01/2017: 30 x Common Brushtail Possum  
 7/02/2017: 35 x Common Brushtail Possum  
 7/03/2017: 26 x Common Brushtail Possum



Map Projection: Transverse Mercator  
 GDA 94 Zone 55



**Legend**

-  Study Areas
-  Possums 5/12/2016
-  Possums 9/01/2017
-  Possums 24/01/2017
-  Possums 7/02/2017
-  Possums 7/03/2017

**Figure 4: Possum Survey Results**

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 Date: 17/04/17  
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### **3.2.4 Birds**

A total of 22 species of birds were recorded across the 3 study sites; 18 at Melbourne University (Control Site), 10 at University Square and 17 at Lincoln Square (refer to Figure 5). This included 17 native birds, and 5 introduced birds. No MNES or FFG Act listed species were recorded in the study area. A breakdown of the species recorded during each survey period is provided in Appendix C.

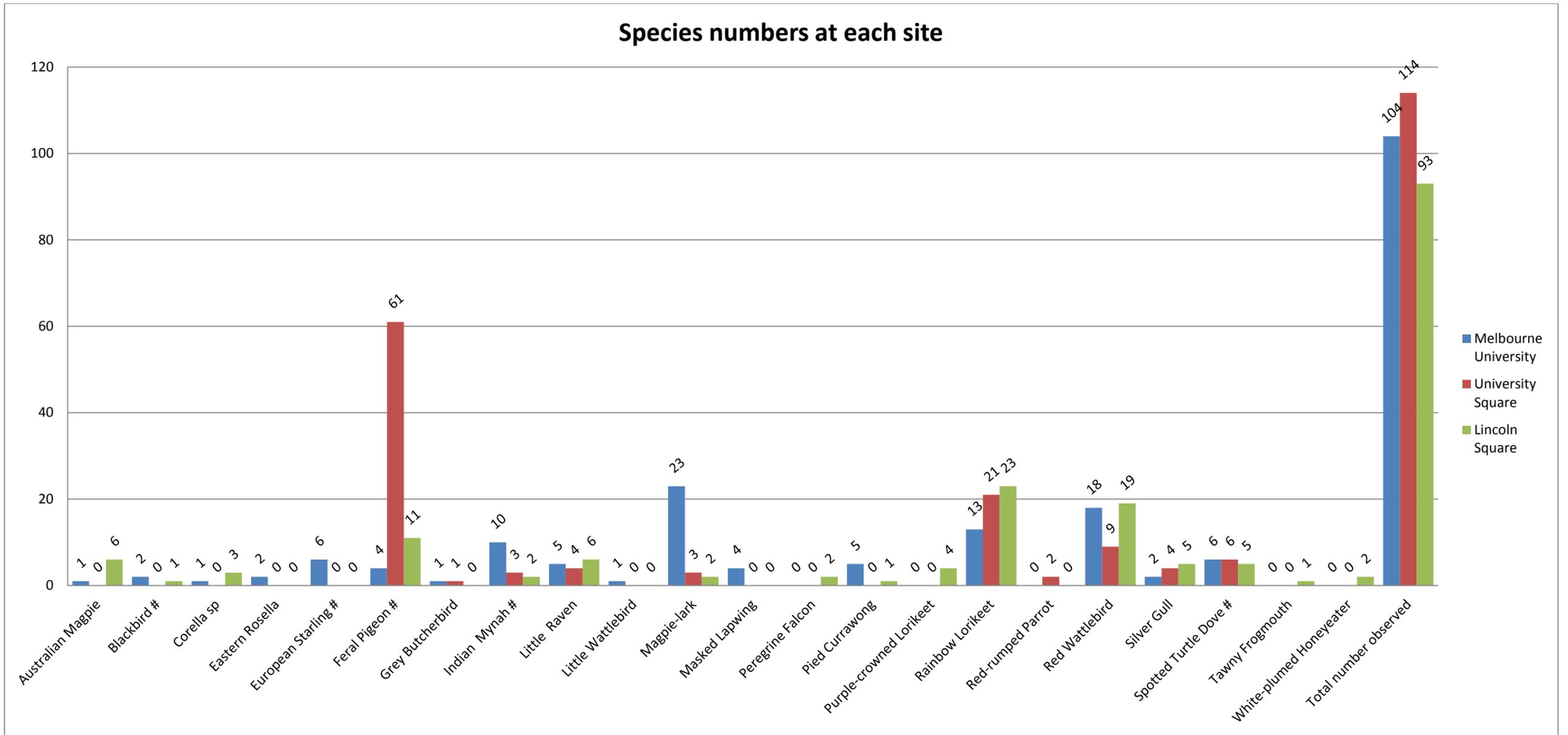


Figure 5: Breakdown of species and numbers across the 3 survey sites.

### 3.2.5 Tree hollows

The majority (47 out of 53) of elm trees at University Square had hollows, compared to seven of 38 trees at Lincoln Square. The six elms that did not contain hollows were among the eight elms planted more recently at the northern end of the park. None of the trees along Leicester, Barry, Grattan or Pelham Streets immediately adjacent to University Square had hollows, however three Elms along Grattan to the west of Barry Street and four elms along Barry Street to the south of Pelham Street contained hollows. At Lincoln Square, seven of 38 trees contained hollows, comprised of three elms, three Moreton Bay Figs, and the Sugar Gum.

A total of 255 hollows with an opening >3 cm in diameter were recorded in 47 Elm trees at University Square. Of these 255 hollows, 183 were estimated to be of a suitable size for use by the common brushtail possum (i.e. entrance size > 7 cm). These totals equate to an average of 5.4 hollows per tree, and 3.9 hollows per tree suitable for use by possums. The majority of trees had 2 – 7 hollows per tree (Fig. 6), with the maximum number of hollows observed in a tree of 10 (n = 5 trees). Only three trees had seven or more hollows suitable for use by possums, with moist trees supporting 2 – 6 hollows that possums could use (Fig. 6)

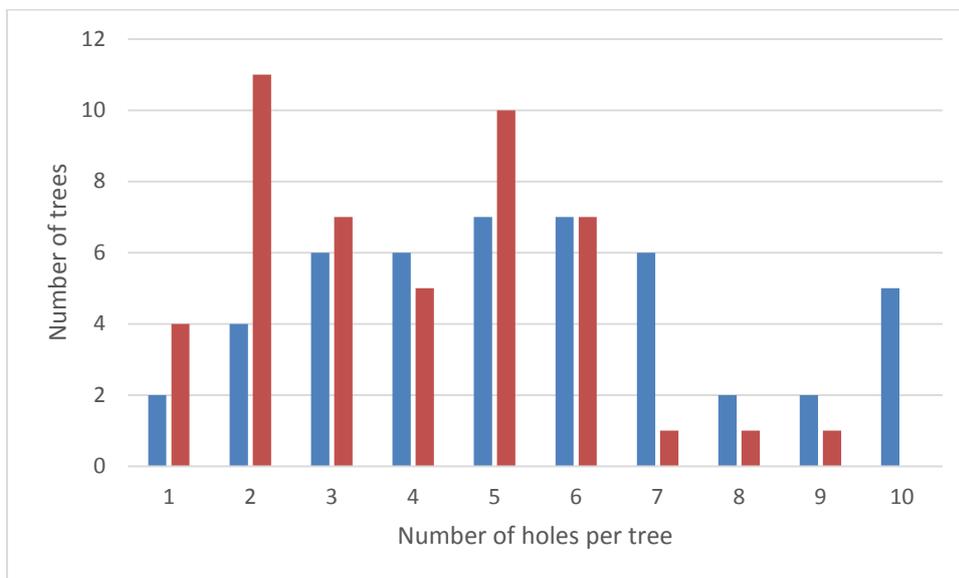


Figure 6. Frequency distribution of the number of all holes (blue columns) and number of holes suitable for use by the Common Brushtail Possum (red columns) per tree at University Square, Carlton.

Many of the elm trees that were planted at University Square in the 1880s show signs of historical pollarding and heavy pruning, resulting in many trees with large holes and hollowed-out trunks. This has resulted in numerous large cavities suitable for use by possums.

## 4 Discussion

### 4.1 Fauna

#### 4.1.1 Bats

A total of 5 species of bats were recorded over the duration of the survey; the implications of the results and a brief description of each species and their conservation status is provided below.

##### **University Square**

Three species of bats were recorded at University Square during the active bat surveys. Four Grey-headed flying-foxes were observed once; Gould's Wattle Bat was recorded on two occasions and White-striped Freetail-bat on one occasion.

Unlike the active surveys that provide a snapshot in time, the deployment of passive detectors records bat activity over a variety of environmental conditions that are likely to be conducive to bat activity. Notwithstanding this, only Gould's Wattle Bat was recorded over the 4-week survey period at University Square.

These results are not surprising due to the monoculture of Elm trees that provide little in the way of the varied insect prey required to support a variety of microbats and, there is no foraging habitat for flying foxes that fruit and pollen bearing trees provide.

##### **Lincoln Square**

Three species of bats were recorded at Lincoln Square during the active bat surveys. Grey-headed flying-foxes were observed on each survey occasion. The number of flying-foxes varied from approximately 30, to numbers in excess of 125. These numbers coincided with the maturing of fruit on the stand of Moreton Bay Fig trees (*Ficus macrophylla*). Gould's Wattle Bat and White-striped Freetail-bat were recorded on four and two occasions respectively.

The deployment of passive detectors recorded a total of four microbats; Yellow-bellied Sheath-tail-bat, Southern Freetail Bat, Gould's Wattle Bat and White-striped Freetail-bat. There was a 6% greater call activity at Lincoln Square when compared to University Square.

Of particular significance, is the recording of the FFG Act listed Yellow-bellied Sheath-tail-bat and Southern Freetail Bat, neither of which was recorded at University Square. Their presence can be attributed to the greater tree diversity at Lincoln Square, in particular native species that supports a variety of insects prey.

**It is likely that microbats are utilising tree hollows at both University Square and Lincoln Square. Due to the high density of possums at University Square, there is likely to be a high level of competition for tree hollows. There is also the likelihood that possums will predate on roosting bats.**

In terms of the removal of Elm trees and the potential impacts on microbats, the tree removal strategy in Section 4.2 equally applies to bats. The Australasian Bat Society (Caryl 2012; Wilson 2012) has also developed a series of fact sheets for managing urban trees, topics relevant to the study area are provided in Appendix D.

## Species descriptions

### *Grey-headed Flying-fox*

The Grey-headed Flying-fox is one of the larger flying foxes (megabat) with a weight up to 1kg and wingspan of up to 1.5m. Unlike microbats, flying foxes do not use echolocation to navigate or forage instead using their sight and smell to navigate and forage. They are distributed along the coast of eastern Australia, including Queensland, New South Wales and Victoria. A camp has also recently been established in Adelaide.

Grey-headed Flying-fox camps can comprise many thousands of individuals and are typically near water. They will travel up to 50 km each night to feed on fruit, pollen and nectar, eucalypts being the primary source of pollen (Churchill 2008). The nearest camp to the study site is 4.5km away at Yarra Bend.

**Conservation Status:** Vulnerable, EPBC Act; Listed, FFG Act

### *Yellow-bellied Sheath-tail-bat*

The Yellow-bellied Sheath-tail-bat is one of the larger microbats weighing up to 44 grams. They are distributed through northern Australia, central Australia into NSW and Victoria. They occupy all types of habitats including wet and dry forest, open woodland and grasslands. They're a fast flying bat foraging above the canopy feeding on beetles, wasps and flying ants.

They roost in large hollow bearing trees and are considered a vagrant in southern Victoria typically only recorded between January to April (Churchill 2008).

**Conservation Status:** Listed FFG Act

### *Gould's Wattled Bat*

Gould's Wattled Bat is one of Australia's most common bats and is distributed across most of Australia with the exception of Cape York. They weigh up to 13 grams and forage on moths, beetles, cockroaches and cicadas feeding above the tree canopy and in the gaps of vegetation. Gould's Wattled Bat is found in dense and open forest, tall shrubland, mallee and urban areas.

They roost in a range of sites including tree spouts, bird's nests and the ceilings or basements of buildings (Churchill 2008).

**Conservation Status:** Secure, locally common

### *Southern Freetail Bat*

Southern Freetail Bats occur in southern Victoria and South Australia. They are a medium-sized bat weighing up to 13 grams. They are known to roost in tree hollows, roofs of houses and under power pole caps. Colonies of up to 150 have been reported. They choose narrow entrances and cavities for their roosts.

Southern Freetail Bats eat beetles, ants and moths. They forage in the gaps between trees and the outer edge of remnant vegetation and above the forest canopy (Churchill 2008).

**Conservation Status:** Secure, locally uncommon

### *White-striped Freetail-bat*

The White-striped Freetail-bat is a large fast-flying bat (61km/h) similar in size to the Yellow-bellied Sheath-tail-bat. They forage high above the canopy and in the urban areas along streets. They are widely distributed across Australia with the exception of the far north, roosting individually or in groups of up to 25 in trees. They are found in a wide range of habitats including urban areas, open and closed forests and agricultural landscapes (Churchill 2008).

**Conservation Status:** Secure, locally common

### 4.1.2 Possums

**The population density of Common Brushtail Possums at University Square is amongst the highest in Melbourne, at 26.1 individuals per ha.**

In the wild, brushtail possums are one of the most widespread species of mammal in Victoria, and are only absent from treeless areas in the Mallee and the wet forests in Gippsland and the High Country. They are usually quite solitary and individuals have territories up to 5 to 7 ha, with densities in the wild typically less than one individual per ha (Menkhorst 1995).

Interestingly, the very high density of possums at University Square appears to be a relatively recent development. The CoM commissioned infra-red surveys of possums in numerous parks within the municipality in December 1999 and January 2000 and two possums were recorded in University Square and four were recorded from Lincoln Square (Peter C Harrison PTY LTD 2001). It is unclear why the population at University Square has increased to such an extent in the past 17 years. It is possible that some of the hollows formed in the past 17 years, but it is unlikely that most formed in the past 17 years. The population density at Lincoln Square appears to have decreased slightly, from four individuals to the average of one that we detected. In comparison, studies in the suburbs of Launceston Tasmania recorded 1.4 possums per ha (Statham and Statham, 1997) and an average of 8.1 possums per ha in the Fitzroy gardens, Melbourne (Pietsch 1994).

### 4.1.3 Birds

As was the case for the bats surveys, there was a two-fold greater diversity of bird species at Lincoln Square and the control site (Melbourne University) than University Square. Once again this can be attributed to the greater tree diversity at Lincoln Square and the control site.

A total of 18 and 17 species were recorded at Melbourne University and Lincoln Square respectively. With the exception of Peregrine Falcon and Tawny Frogmouth, bird diversity was limited to common urbanised species (e.g. natives included the Australian Magpie, Rainbow Lorikeets and non-native species, feral pigeons and Indian Myah).

**Although there was greater numbers of birds recorded at University Square, this can be attributed to the high numbers of pigeons present. Overall the introduced Feral Pigeon was the most common species recorded followed by Magpie-lark and Rainbow Lorikeet.**

Peregrine Falcons were observed foraging over Lincoln Square and are likely to be roosting on nearby buildings and use the wider area for sourcing prey, including other bird species. The Tawny Frogmouth was also observed in Lincoln Square and likely to use the area for both foraging (insects) and roosting. The removal of Elm trees in University Square is unlikely to have an impact on these two species. Lorikeets are likely to use tree hollows however as was the case with the microbats, they would be competing with common brushtail possum. They are also at risk of predation of eggs and chicks by the possums. The tree removal strategy in Section 4.2 equally applies to birds.

## **4.2 Tree hollows and tree removal strategy**

Tree hollows are a critical resource for a large proportion of Australia's vertebrates, including the birds, bats and possums detected in this project. Some estimates suggest that over 300 species rely on tree hollows for diurnal and nocturnal shelter sites, for raising young, for feeding, and thermoregulation (Gibbons & Lindenmayer 2002). The loss of tree hollows without replacement is a threat to many obligate hollow-users, and this process in timber production forests is listed as a 'threatening process' under the Victorian Flora and Fauna Guarantee Act (1988). Hollow-bearing trees are equally important for wildlife in urban areas and are similarly under threat (Le Roux et al. 2014), primarily due to the removal of large and dead trees and limbs due to safety risk and competition for space.

A major challenge in maintaining an ongoing supply of hollows is the long-time period it takes for hollows to develop naturally. Many studies have shown that hollows only form in trees that are many decades or centuries old. While artificial nest boxes have been used extensively as replacements to natural hollows for the past 20 to 30 years, they are prone to decay and collapse and require ongoing maintenance. More recently, moves to create hollows in standing trees using chainsaws has been promoted and is increasingly widely adopted, however their suitability for a wide variety of hollow-using fauna has yet to be demonstrated and their longevity has not yet been shown.

The proposed redevelopment of University Square will result in the removal of many of the large and hollow-bearing trees at the park. As discussed (Section 4.1.2), the unnaturally high density of possums in the park is primarily due to the abundance of suitable hollows, an abundance of artificially-supplied food, and the breakdown of natural territoriality of possums. The removal of trees with hollows will result in a reduction in the number of denning opportunities for possums, which will, over time, cause a reduction in the density of possums. For the purposes of planning, it should be assumed that all trees to be removed have hollows that are likely to be occupied by possums. It should be noted, however, that based on the number of possums observed in the park (average of 28) and the number of hollow-bearing trees (47), this equates to approximately one possum per 1.7 trees, or 0.6 possums per tree.

Other species of wildlife are also likely to use the hollows in the trees at University Square. During tree hollow surveys, we observed Rainbow Lorikeets within a tree hollow in tree 1040866. We were unable to confirm if it was actively nesting, or just investigating. While bat roosts were not detected in any of the University square trees, it is likely that bats will roost within those trees.

**There are two primary issues to consider in relation to tree removals and the loss of hollows. The first is that many species of native wildlife rely on tree hollows, and the second is that it can take many decades, or even centuries, for these hollows to form naturally.**

If most hollow-bearing trees are removed from University Square, it will take many years before this resource becomes available again. Biodiversity levels within the redeveloped University Square will remain below its potential, despite the increase in the size of the park and the massive increase in understorey and mid-storey plantings and the benefit of increased species diversity.

**As one goal of the University Square Master Plan is to also increase its biodiversity, it is recommend that more trees with hollows are retained around the park or artificial hollows be incorporated into the redevelopment.**

The second issue with the removal of trees with hollows is related to the welfare of animals that are displaced as hollows are removed. The loss of hollows within forests occurs naturally and ranges in severity from occasional tree or limb fall to large-scale declines due to wildfire or other disturbances such as wind. Most species can cope with the occasional loss of hollows because they often use multiple hollows over time, with some even swapping hollows every few days. As a result, many mobile species of wildlife are aware of the location of alternative hollows and can move into them if the need arises.

#### **4.2.1 *Tree and biodiversity management principles***

The following principles are recommended to minimise stress to the possums at University Square.

##### ***Principle 1: Retain as many trees with hollows as possible, while still allowing for the implementation of the University Square Master Plan***

Given that the implementation of the University Square Master Plan will be staggered due to the occupation of the northern end of the Square and Barry Street for works to construct the station for the Melbourne Metro Project, there is an opportunity to retain several trees in the central avenue as a haven for possums while other trees are removed to allow redevelopment works.

**Hollow surveys show that there are sufficient hollows within the central avenue to accommodate all the possums within University Square.**

##### ***Principle 2: Remove only the minimum number of trees required to undertake the next stage of redevelopment works***

Trees in different areas of University Square should be retained in the landscape for as long as possible and only removed when required in order to complete the next stage of works or when urgent safety concerns dictate immediate removal.

A delayed removal will allow possums to re-settle in different areas of the park gradually, reducing the stress to possums caused by clearing large numbers of trees simultaneously. In practice, the staggered removal can be achieved by banding and canopy-exclusion pruning one or two trees per fortnight and then felling a larger number of trees when convenient. In effect, one or two trees will become 'unavailable' per fortnight due to pruning and banding, with the actual rate depending on the timing of works.

Canopy exclusion pruning should occur before trunk-banding, preventing possums from moving from tree to tree via the canopy. Spotlighting evidence shows that most possums at University Square are frequently on the ground, feeding on the grass and human-supplied food, as well as moving between trees via the ground. Thus, canopy exclusion pruning will not cause additional stress or behaviour modification.

Banding around the trunks of the trees should be placed low enough to allow possums to leave the tree easily but be prevented from re-entering. This will ensure possums are not stranded in the tree after banding.

### ***Principle 3: Ensure hollows in trees are unoccupied at the time of tree removal***

Trees should be clear of possums prior to felling. This should be determined by inspecting all hollows of trees immediately prior to tree removal.

In addition, weekly spotlighting at night for 3 – 4 weeks prior to felling will also ascertain if the banding and pruning was successful – if the tree is consistently free of possums during spotlighting then there are unlikely to be any in the hollows at the time of removal.

It is also recommended that an experienced wildlife spotter-catcher is on-site during tree removals, just in case wildlife remains undetected in the hollows of the tree being removed.

### ***Principle 4: Monitor the distribution and abundance of possums at University Square prior to and during tree removals***

Undertake regular monitoring of the size and distribution of the possum population at University Square, Lincoln Square and adjacent streets before, during and after tree removal by spotlighting in order to provide council with real-time responses of the possum to tree clearing. This weekly spotlighting will also provide evidence of the effectiveness of the pruning and banding, as well as the overall approach to tree removal in urban parks on possums.

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## 6 Appendices

### Appendix A – Protected Matters Search Tool

### Appendix B – Victorian Biodiversity Atlas

#### Victorian Biodiversity Atlas Records

Common Name	Scientific Name
<b>Fauna</b>	
Australian Magpie	<i>Cracticus tibicen</i>
Australian White Ibis	<i>Threskiornis molucca</i>
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>
Common Blackbird	<i>Turdus merula</i>
Common Myna, Indian Myna	<i>Sturnus tristis</i>
Common Starling	<i>Sturnus vulgaris</i>
Eastern Rosella	<i>Platycercus eximius</i>
Galah	<i>Eolophus roseicapillus</i>
Grey Butcherbird	<i>Cracticus torquatus</i>
Grey Fantail	<i>Rhipidura albiscapa</i>
House Sparrow	<i>Passer domesticus</i>
Little Raven	<i>Corvus mellori</i>
Magpie-lark	<i>Grallina cyanoleuca</i>
Masked Lapwing, Plover	<i>Vanellus miles</i>
Pied Currawong	<i>Strepera graculina</i>
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
Red Wattlebird	<i>Anthochaera carunculata</i>
Red-rumped Parrot	<i>Psephotus haematonotus</i>
Rock Dove, Feral Pigeon	<i>Columba livia</i>
Silver Gull	<i>Chroicocephalus novaehollandiae</i>
Spotted Dove	<i>Streptopelia chinensis</i>
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>
Welcome Swallow	<i>Hirundo neoxena</i>
White-plumed Honeyeater	<i>Ptilotula penicillata</i>
Willie Wagtail	<i>Rhipidura leucophrys</i>

## Appendix C – Field Results

### Active Bat Surveys

Date	Species	University Square	Lincoln Square
5/12/2016	Grey-headed Flying-fox	4	>40
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12/12/2016	Grey-headed Flying-fox	0	>30
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
22/12/2017	Grey-headed Flying-fox	0	>45
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9/01/2017	Grey-headed Flying-fox	0	>125
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
24/01/2017	Grey-headed Flying-fox	0	>100
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9/01/2017	Grey-headed Flying-fox	0	>20
	Gould's Wattled Bat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

= Recorded,  = Not recorded

### Passive Bat Surveys

#### University Square

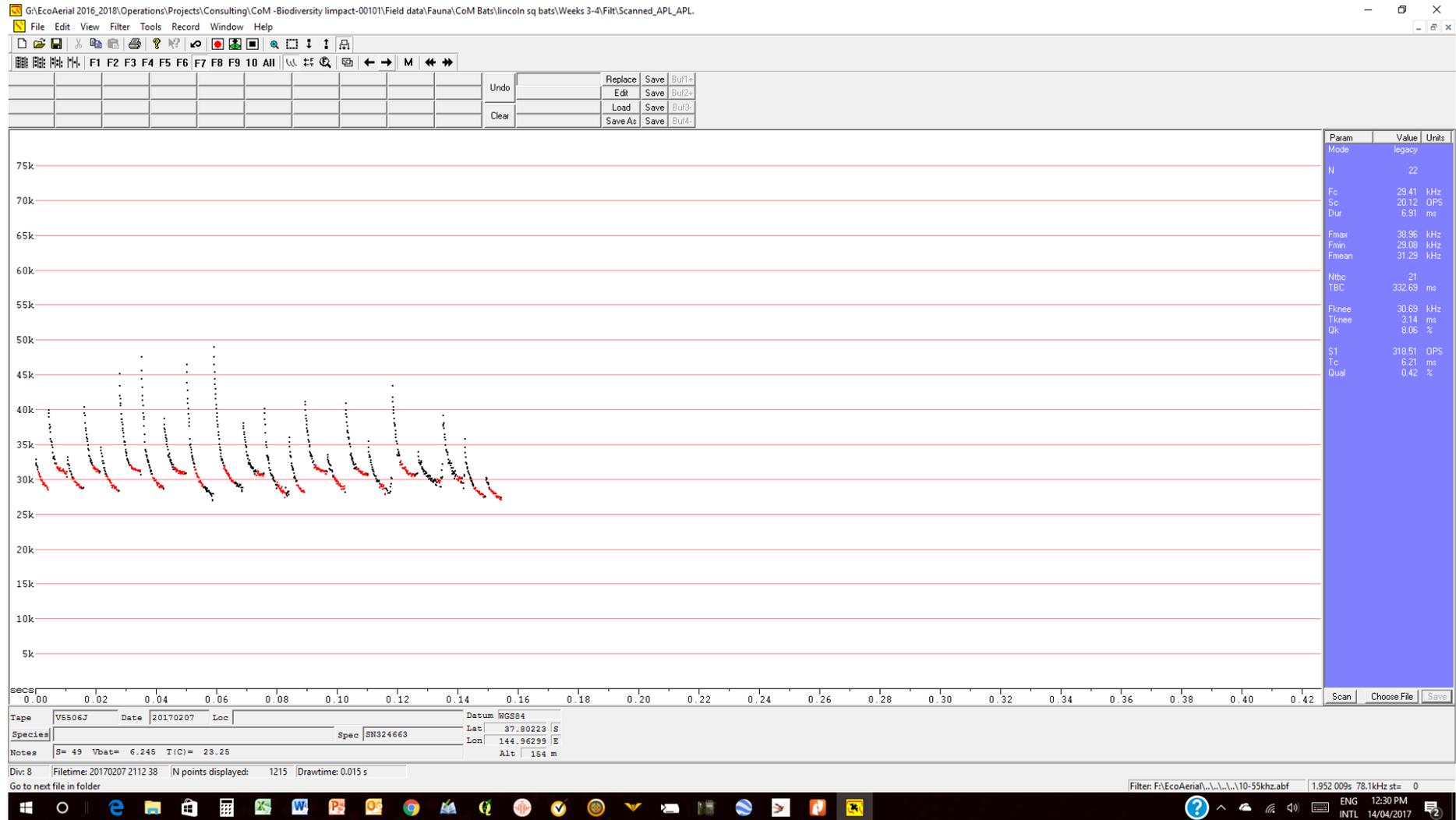
Study site	University Square				
Species	Week 1 5/12/2017	Week 2 13/12/2016	Week 3 21/12/2016	Week 4 28/12/2016	Total
Number of files	171	701	516	525	1913
Identified to species level	171	701	516	525	1913
Calls positively identified	100.00%	100.00%	100.00%	100.00%	100.00%
Gould's Wattled Bat	171	701	516	525	1913
<i>Chalinolobus gouldi</i>					
Identified to call complex	0	0	0	0	0
Percentage	0.00%	0.00%	0.00%	0.00%	0.00%
Mormopterus spp.	0	0	0	0	0
<i>Mormopterus sp2 &amp; sp4</i>					
Gould's Wattled Bat / Mormopterus sp.	0	0	0	0	0
<i>Chalinolobus gouldi</i> / <i>Mormopterus sp2 &amp; sp4</i>					
Long-eared Bat	0	0	0	0	0
<i>Nyctophilus sp.</i>					

<b>Forest Bat sp.</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Vespadelus darlingtoni</i> / <i>V. Regulus</i> / <i>V. vulturnus</i>					

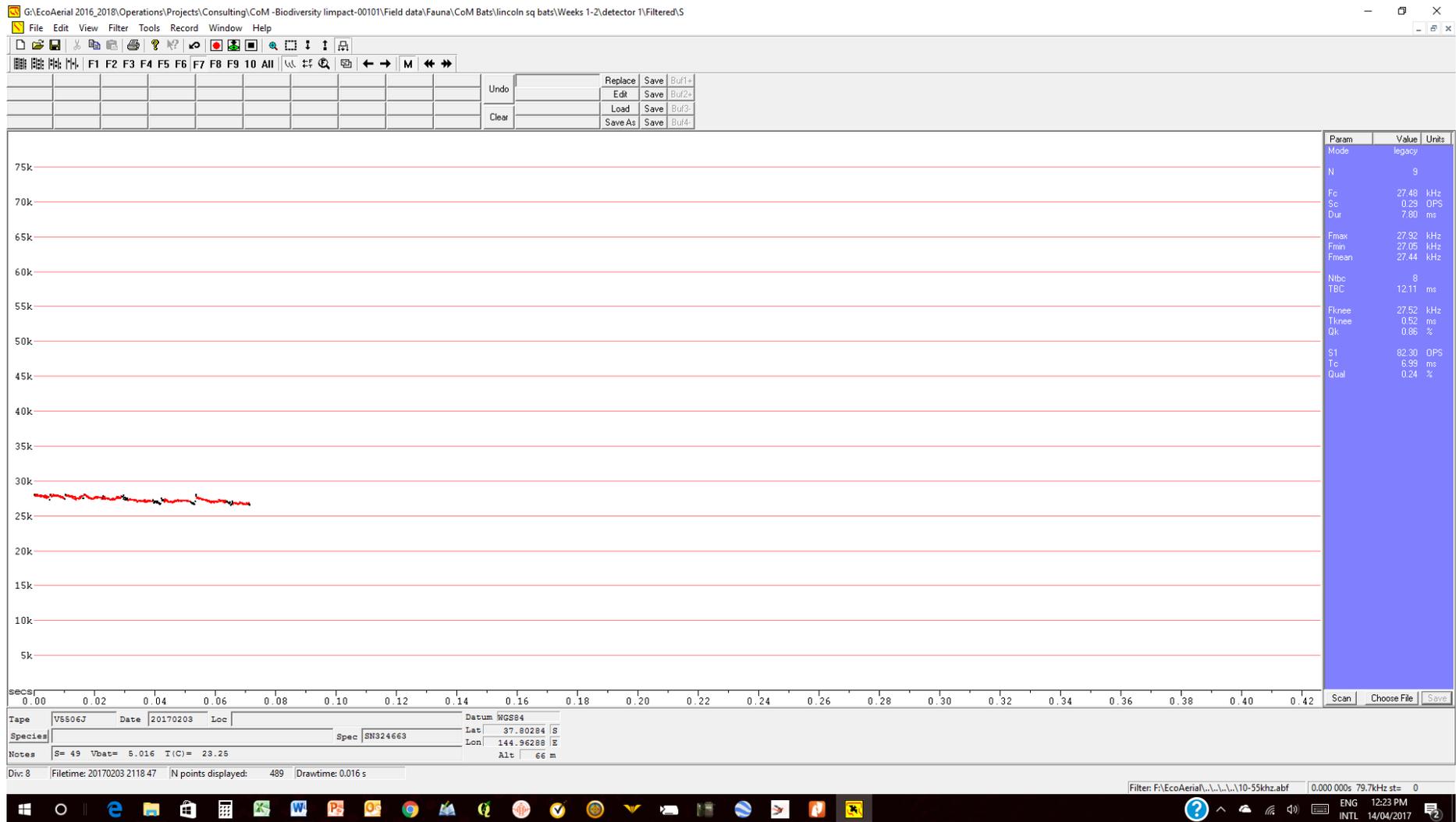
### Lincoln Square

<b>Study site</b>	<b>Lincoln Square</b>				
<b>Species</b>	<b>Week 1 8/01/2017</b>	<b>Week 2 16/01/2017</b>	<b>Week 3 24/01/2017</b>	<b>Week 4 31/01/2017</b>	<b>Total</b>
<b>Number of files</b>	<b>134</b>	<b>159</b>	<b>956</b>	<b>787</b>	<b>2036</b>
<b>Identified to species level</b>	<b>134</b>	<b>159</b>	<b>956</b>	<b>787</b>	<b>2036</b>
<b>Calls positively identified</b>	<b>100.00%</b>	<b>100.00%</b>	<b>100.00%</b>	<b>100.00%</b>	<b>100.00%</b>
<b>Yellow-bellied Sheathtail Bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>
<i>Saccolaimus flaviventis</i>					
<b>White-striped Freetail Bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>
<i>Tadarida australis</i>					
<b>Southern Freetail bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>10</b>	<b>10</b>
<i>Mormopterus planiceps</i>					
<b>Gould's Wattled Bat</b>	<b>134</b>	<b>159</b>	<b>956</b>	<b>773</b>	<b>2022</b>
<i>Chalinolobus gouldi</i>					
<b>Identified to call complex</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Percentage</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0.00%</b>
<b>Mormopterus spp.</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Mormopterus sp2 &amp; sp4</i>					
<b>Gould's Wattled Bat / Mormopterus sp.</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Chalinolobus gouldi</i> / <i>Mormopterus sp2 &amp; sp4</i>					
<b>Long-eared Bat</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Nyctophilus sp.</i>					
<b>Forest Bat sp.</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<i>Vespadelus darlingtoni</i> / <i>V. Regulus</i> / <i>V. vulturnus</i>					

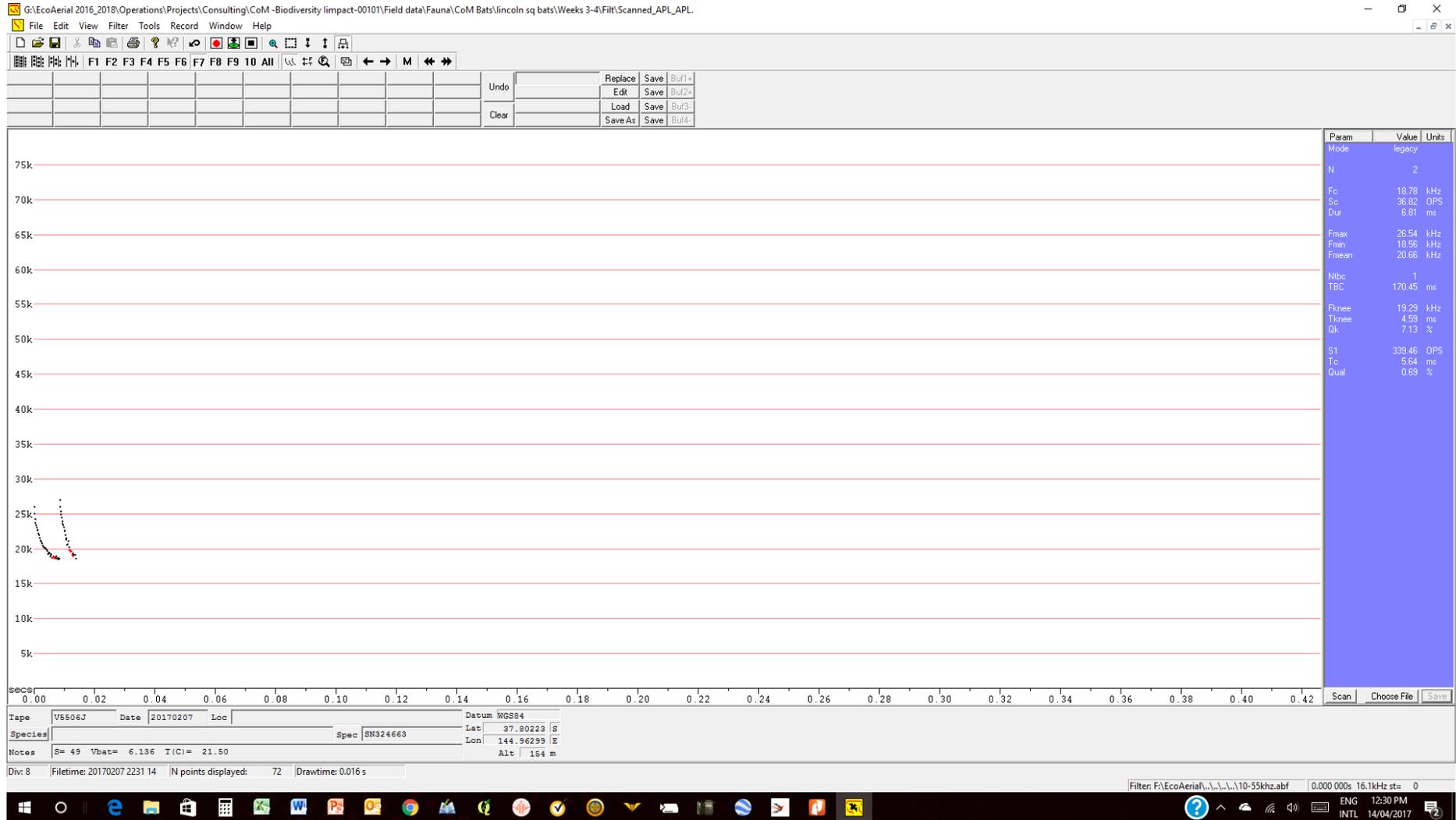
# Bat Call Images



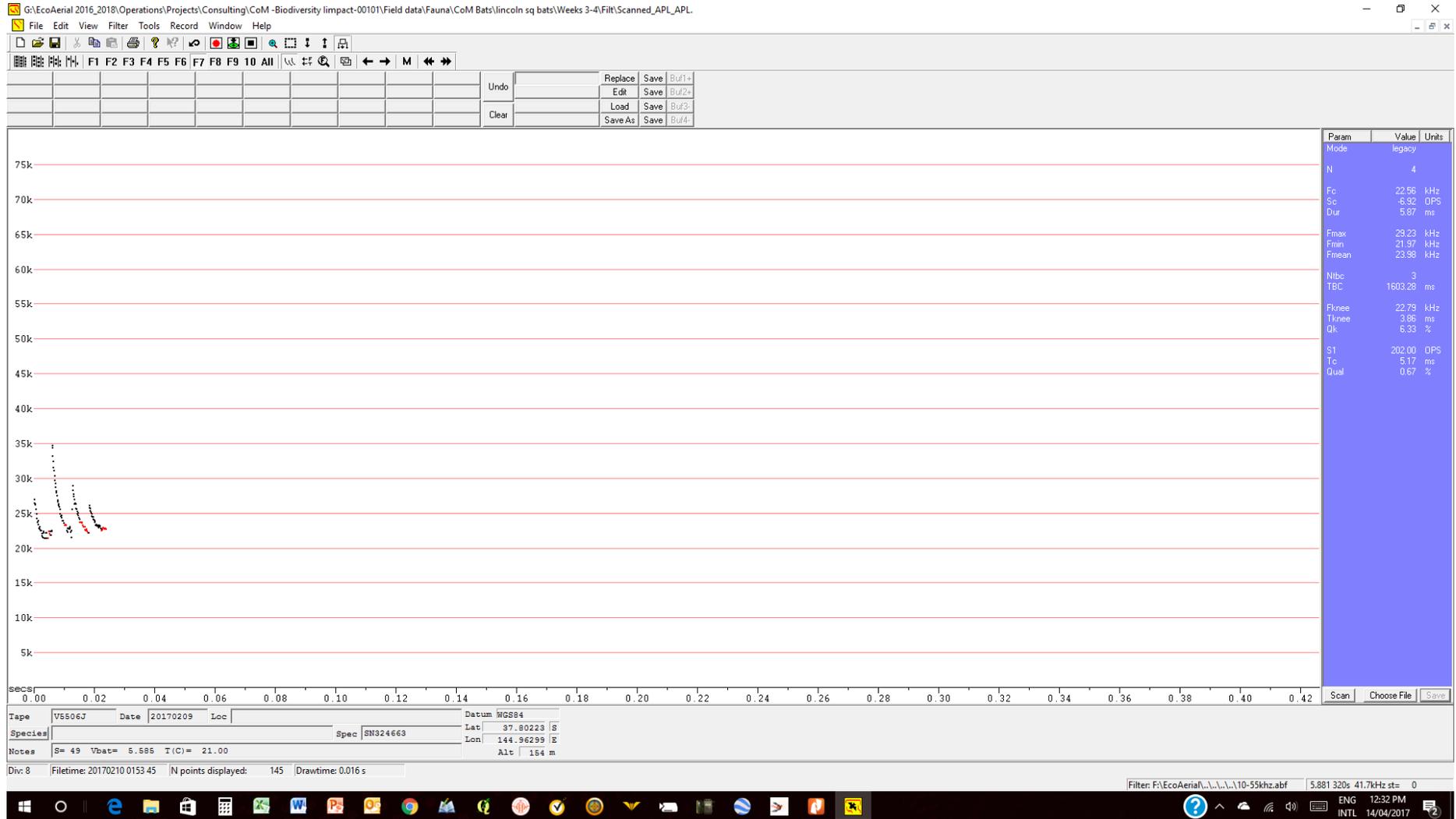
Gould's Wattled Bat - *Chalinolobus gouldi*



Southern Freetail Bat - *Mormopterus planiceps*



White-striped Freetail-bat - *Tadarida australis*



Yellow-bellied Sheathtail-bat – *Saccolaimus flaviventris*

## Bird Surveys

Survey Date: 17/11/2016

Species	Melbourne University	University Square	Lincoln Square
Australian Magpie			3
Blackbird #			
Corella sp.	1		3
Eastern Rosella			
European Starling #	2		
Feral Pigeon #	1	20	4
Grey Butcherbird			
Indian Mynah #		3	
Little Raven	1	4	2
Little Wattlebird	1		
Magpie-lark	4	1	
Masked Lapwing	2		
Peregrine Falcon			
Pied Currawong	1		
Purple-crowned Lorikeet			
Rainbow Lorikeet	2	4	4
Red-rumped Parrot			
Red Wattlebird	4	1	2
Silver Gull		1	
Spotted Turtle Dove #	1	1	
White-plumed Honeyeater			
Tawny Frogmouth			
<b>Total</b>	<b>20</b>	<b>35</b>	<b>18</b>

Survey Date: 4/12/2016

Species	Melbourne University	University Square	Lincoln Square
Australian Magpie			1
Blackbird #	2		
Corella sp.			
Eastern Rosella			
European Starling #	2		
Feral Pigeon #		9	6
Grey Butcherbird			
Indian Mynah #	5		1
Little Raven	4		1
Little Wattlebird			

Magpie-lark	9	1	
Masked Lapwing			
Peregrine Falcon			
Pied Currawong	2		
Purple-crowned Lorikeet			
Rainbow Lorikeet	6	1	1
Red-rumped Parrot			
Red Wattlebird	7	7	5
Silver Gull			1
Spotted Turtle Dove #	2	3	
White-plumed Honeyeater			
Tawny Frogmouth			
<b>Total</b>	<b>39</b>	<b>21</b>	<b>16</b>

Survey Date: 18/12/2016

Species	Melbourne University	University Square	Lincoln Square
Australian Magpie			
Blackbird #			
Corella sp.			
Eastern Rosella			
European Starling #	3		
Feral Pigeon #		18	
Grey Butcherbird	1	1	
Indian Mynah #			1
Little Raven	2	5	3
Little Wattlebird			
Magpie-lark		1	
Masked Lapwing			
Peregrine Falcon			
Pied Currawong	2		
Purple-crowned Lorikeet			4
Rainbow Lorikeet	4	4	2
Red-rumped Parrot			
Red Wattlebird			7
Silver Gull	1		1
Spotted Turtle Dove #			5
White-plumed Honeyeater			
Tawny Frogmouth			
<b>Total</b>	<b>13</b>	<b>29</b>	<b>23</b>

Survey Date: 23/01/2017

Species	Melbourne University	University Square	Lincoln Square
Australian Magpie	1		2
Blackbird #			
Corella sp.			
Eastern Rosella	2		
European Starling #			
Feral Pigeon #	1	20	1
Grey Butcherbird			
Indian Mynah #	5		
Little Raven			
Little Wattlebird			
Magpie-lark	6	1	
Masked Lapwing			
Peregrine Falcon			
Pied Currawong			1
Purple-crowned Lorikeet			
Rainbow Lorikeet	5	12	10
Red-rumped Parrot			
Red Wattlebird	4	1	3
Silver Gull	2		1
Spotted Turtle Dove #	1		
White-plumed Honeyeater			
Tawny Frogmouth			1
<b>Total</b>	<b>26</b>	<b>34</b>	<b>16</b>

Survey Date: 5/02/2017

Species	Melbourne University	University Square	Lincoln Square
Australian Magpie			
Blackbird #			
Corella sp.			
Eastern Rosella			
European Starling #	2		
Feral Pigeon #	2	12	
Grey Butcherbird			
Indian Mynah #			
Little Raven			
Little Wattlebird			
Magpie-lark	4		2

Masked Lapwing	2		
Peregrine Falcon			2
Pied Currawong	2		
Purple-crowned Lorikeet			
Rainbow Lorikeet		4	6
Red-rumped Parrot		2	
Red Wattlebird	3		2
Silver Gull		3	2
Spotted Turtle Dove #	2	2	
White-plumed Honeyeater	2		2
Tawny Frogmouth			1
<b>Total</b>	<b>19</b>	<b>23</b>	<b>17</b>

Species recorded incidentally outside of formal surveys

