A palaeoecological investigation of the small vertebrate mammals of Fossil Chamber, Victoria Fossil Cave, Naracoorte, SA

Thesis submitted in accordance with the requirements of the University of Adelaide for an Honours Degree in Environmental Geoscience

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October 2018

THE UNIVERSITY of ADELAIDE

TITLE

A palaeoecological investigation of the small vertebrate mammals of Fossil Chamber, Victoria Fossil Cave, Naracoorte, SA.

RUNNING TITLE

Analysis of small mammals, Naracoorte

ABSTRACT

Victoria Fossil Cave has had extensive excavation done on the fossil deposits located within. Much of this work has taken place around the Fossil Chamber, recognised as the main and most accessible deposit for material, ranging from around 100-400 thousand years of age. The focus has been primarily directed at the megafauna, the larger and more charismatic animals of the region. Unfortunately, this leaves the smaller species, quolls, rodents, bettongs, sugar gliders, and bandicoots, unanalysed and missing from the ecological timeline. This project seeks to remedy this gap in knowledge by analysing the small mammal material from a previous excavation in Pit E of Fossil Chamber, undertaken in 2002. This material was sorted meticulously over several months, analysed for statistical relevance, and reviewed using the *Rcommander* software. The material came in 5 layers, which were split into two Units, 7 and 8, to retain statistical relevance. The results suggested a massive presence of muridae, consistent through both units, with varying levels of increase/decrease and presence/absence of many other species between units. This information was used to determine the likelihood that the depositional environment of the system resulted from a pitfall trap and whether the system was open or closed between depositions. Results were compared with the previous Cathedral Cave excavation, and anomalies between the two Units were analysed with suggestions being made to explain them. Suggestions were made for future work and how to improve upon the methods used for this project.

KEYWORDS

Analysis, cave, fossil, mammal, Naracoorte, palaeoecology, small, vertebrate, palaeontology.

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INTRODUCTION

Victoria Fossil Cave is a large limestone cave system located in the Naracoorte region of South Australia. Discovered in 1969, the cave forms a large series of depositional environments where organisms have met their end for at least 300 thousand years, creating a deposit of sediment representing the ecology of the local region through time. The Naracoorte caves are significant in that they contain some of the most extensive Quaternary vertebrate fossils known in the Southern Hemisphere (Reed and Bourne, 2000), and thus they tell us a great deal about the past ecology of the region. However, despite the richness of the location, which harbours one of the largest collections of Pleistocene fossils in Australia (Wells *et al*. 1984), there has arguably not been enough research done on the region, specifically the Fossil Chamber of Victoria Fossil Cave. So far, much of the research has been done around the larger and more charismatic megafauna (Macken *et al.* 2012), with the numerous small mammal fauna has often been left untouched. The aim of this project is to alleviate this lack of knowledge by analysing the small mammal material of Pit E in the Fossil Chamber as previously excavated by E. Reed (Reed, personal communications, 2018). Only material from Grid 7 of Pit E will be analysed in this study, though a much larger sample size could be achieved with future research into the several remaining grid squares. Once sorted and identified, the small mammals of Grid 7 can be analysed for similarities between then and now, via comparisons between small specimens of roughly the same age such as those found in Cathedral Cave (Brown & Wells, 2000; Grun *et al.* 2001). The results may aid in reconstruction of ecological interactions of the past environment with reference to current ecology and environmental parameters (e.g. temperature).

With the Fossil Chamber serving as only a small piece of the puzzle, further research into the surrounding areas will allow a greater understanding of the region as a whole. The material of Pit E is estimated to span somewhere between 213 thousand and 282 thousand years of age, as shown in Figure 1 below (Reed, unpublished, 2003).

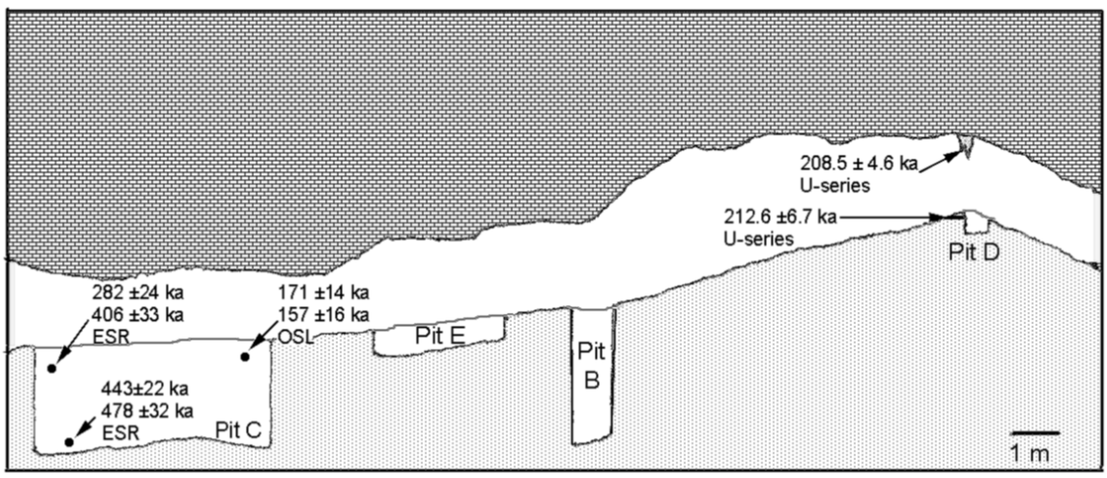


Figure 1: Longitudinal section of the middle portion of the Main Fossil Chamber showing excavation pits and locations of sampling and ages obtained from Ayliffe *et al.* (1998), Grun *et al.* (2001), and Roberts *et al.* (2001). Between other dating sites, Pit E is seen to fall somewhere between 213k and 282k years in age. Extracted with permission from E. H. Reed, unpublished.

These ages are constraining only, due to the limited dating done to the site, which was outside the range of this study. The two given ages come from the closest nearby dated points around Pit E, suggesting that the pit does indeed fall around the 250 thousand year mark. This is a small snapshot of time within the preserved history of Naracoorte, and as of this project, the aforementioned time period has yet to have any small mammals placed within the timeframe of the cave.

The outcome of this project is hypothesised to have the following several results: primarily, faunal composition from the ancient material may reflect the current or similar faunal composition of the modern above-ground environment. Additionally, a method of deposition may be deduced as a result of the total composition. Primarily believed to be a pitfall trap, it has also been suggested in the past that some of the fossils have accumulated as a result of owl deposition, however due to the palaeo-entrance of the chamber this latter assumption seems unlikely. An account of the ratio of possible native owls at the time, and their prey, may help define the main depositional method, as would analysis of corrosion found on these recognised prey species. Finally, it is assumed the results will show bias to ground-dwelling and smaller species, as they are more likely to fall into a pitfall and be unable to either survive the fall or escape the cave.

The specific aims of this project are to identify as much of the supplied small mammal material as possible, calculating both a number of identified species (NISP) and a minimum number of individuals (MNI). From this data, relative abundance can be determined, displaying each species as a percentage of total identified species found within the deposit. All of this will be compared relative to the differences between Unit 8 and Unit 7, as this will provide the largest amount of data for each comparison and thus provide what will likely be the most unbiased results. This will also prevail to be more statistically relevant as it will be analysing the difference between two visually distinguishable units, rather than arbitrary man-made layers. Rarefaction of the data and chi-squared tests between each layer will be performed using the R software package Rcommander (Fox & Bouchet-Valat, 2018), in order to make sure the data and correlation of the data is statistically relevant. Constraints will be analysed to assess if the primary accumulation mode was pitfall or owl derived. Building on this, the taphonomy will be briefly inspected, including any fracturing present on larger specimens as well as manganese staining found throughout the material. Finally, a conclusion will be drawn as to the most likely deposition model, the possible environment and species distribution of the time and how it changed between the event that separates Unit 8 and Unit 7, and finally what future research can be done to further elaborate on this deposition.

BACKGROUND OF VICTORIA FOSSIL CAVE

Past Excavations

Victoria Fossil Cave is a massive sprawling network of limestone caverns, with Fossil Chamber being one of the many large fossil deposition zones within the system (Reed & Bourne, 2000). Originally believed to have accumulated via collapsed cave roofs, the majority of fossil deposition has likely been via solution pipes (Reed 2008), narrow chambers that lead from the surface to the cave roof, forming as the calcite rock is slowly eroded. The system extends into many notable chambers, many of which are a difficult crawl to reach but bare some of the densest depositions of fossil material in Australia, recalling a history of approximately 300 thousand years of ecology (Reed & Bourne, 2000); see figure 2.

Figure 2: A map showing the extensive limestone corridors of Victoria Fossil Cave, and the location of the Fossil Chamber deposit.

A study was done on the site in 1971, where Smith and Wells underwent an excavation of the first 80 centimetres of a site in Fossil Chamber, now known as Pit A. Here they found elements of extinct macropods and other large megafauna, all the way down to quolls and rodents (Smith, 1971). As time went on, new excavations occurred, including electron spin resonance dates (ESR dates) taken by Grun *et al.* (2001) and excavations of other pits, including an extension of the initial Pit E dig (Reed, unpublished, 2003). The large amount of work on Fossil Chamber has been productive, however, beyond the initial dig in 1971 by Smith and Wells, the small mammal fauna of Fossil Chamber has been largely untouched.

The Study Site – Pit E

Within the Fossil Chamber have been several excavations capitalising on the sheer size of the deposit. There are pits spanning from A through to E, each with the intention on revealing a new piece of the history of the deposit. Pit E is the focus of this project. It was excavated over several years, starting in 1999 and finishing around 2002 (Reed, personal communications, 2018), though work had been done on the first 16 centimetres of the site prior to the main dig. The material excavated from 1999-2002 was analysed for megafaunal material, which confirmed the existence of some of the larger species that once existed in the local region at that time. The small mammal material was left mostly untouched to be analysed at a later date. The Pit E excavation separated the study site into 9 grids at approximately 1 by 1 metre each (see figure 3 below).

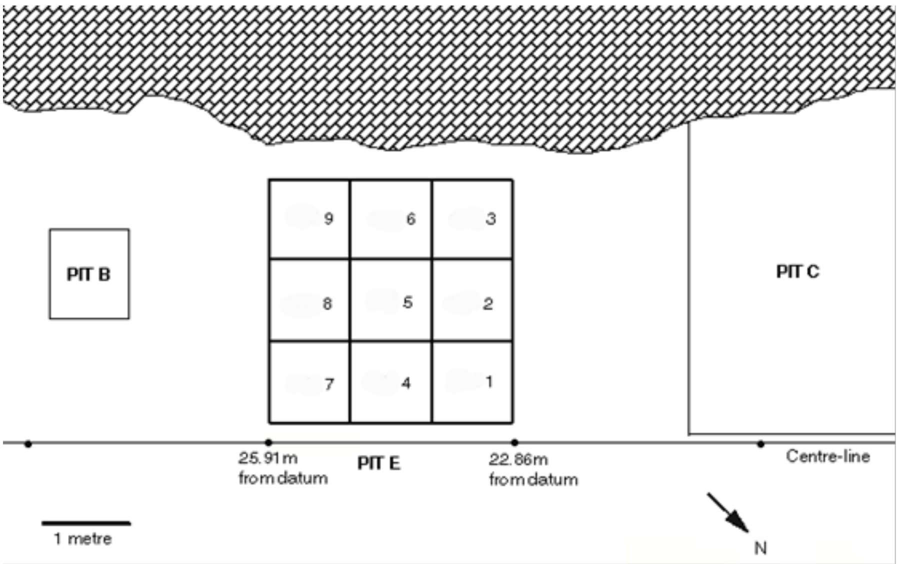


Figure 3: A diagram showing the layout of the taphonomic excavation (Pit E) and its relation to the previous excavation pits. Grid 7 was the source of the material analysed in this project. Extracted with permission from E. H. Reed, unpublished.

Within the 1999 dig, it became apparent that at the boundary of Layer 3 was a change in the sediment composition. The upper half of this layer retained the familiar dark-brown colour, while below the separation the material became lighter and differed in texture (Reed, unpublished, 2003). It is believed that the separation of these two units marks a significant event at that point in time. There is a distinct colour difference observable in the deposit (see figure 4 below), which suggests a significant environmental change occurring. This is likely a result of variations in clay and carbonate content (Forbes & Bestland, 2007) and thus, it can be assumed that such a change would be reflected in the fauna of the location.

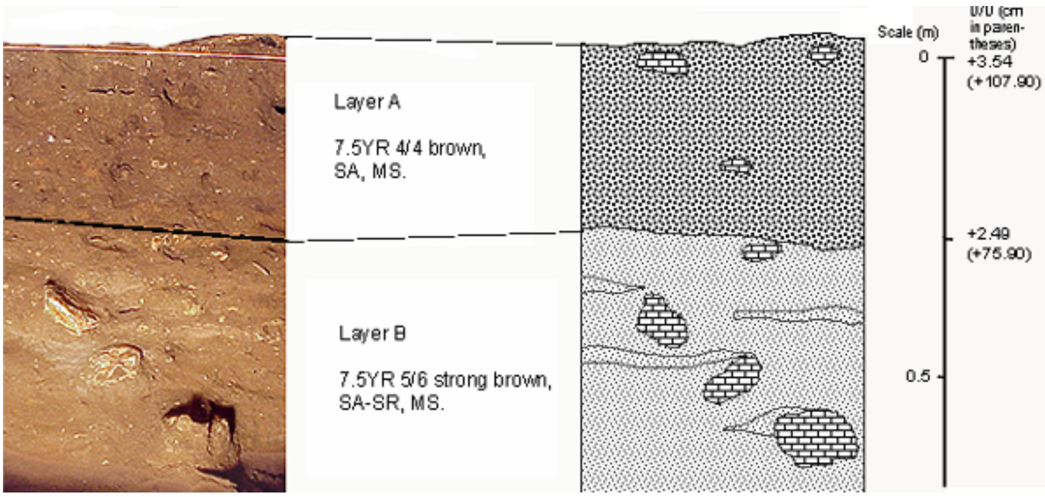


Figure 4: stratigraphic section from the north-eastern wall of Pit E. The two distinct geological layers can be observed as Unit 8 (Layer A) and Unit 7 (Layer B). Left shows a photograph of the distinct colour change, while the right shows a visual breakdown of what can be observed. Extracted with permission from E. H. Reed, unpublished.

The importance of excavating such deposits comes from the implications they can give to the modern day. Fossils show the preservation of a once living system, which was adapted to the environment of its time. Being 200-300 thousand years ago, the selected study site reflects the biological history of the Naracoorte region at the aforementioned time. From this, the ecology, weather and temperature of the area can be found reflected upon the remains of the creatures that once lived there, and their composition relative to current-day ecology can give insight towards how the local environment has changed in the time span of 200 thousand years. These changes can then reflect on the presence of events such as glacial maximums that have been inferred from other sources (Kaufman & Jacobsen, 1992).

METHODS

The method of accumulating the desired data starts with acquiring the material. Grid 7 of Pit E had already been excavated prior to this project, and had been sorted for megafaunal material. Thus, the focus of this study fell on the smaller fossils that had yet to be analysed. The material was sorted using brushes and forceps, as to not damage the fragile specimens. After the diagnostic pieces have been removed (cranial and dentary pieces, and vertebrae), they were meticulously analysed and identified to the highest precision possible with what can be gathered from fossil remains. Most were identified down to family only, due to the inherent damage previously sustained by the material and the resulting lack of remaining identifiable features. However, much of the material was in a desirable condition, resulting in genus and species being identified. Other non-diagnostic fossil material, of which there was a large amount, was gathered but put aside for potential future use. This included taphonomic pieces, manganese staining, and preserved charcoal. Finally, palaeoecological analyses were performed from the resulting material, compared to previous work done on and around the site. Current-day faunal compositions as well as ancient compositions extracted from papers on Cathedral Cave in Naracoorte were used in this process. The resulting numbers from Pit E provided statistical values such as the Number of Identified Specimens (NISP) and the Minimum Number of Individuals (MNI). Chi-squared testing was performed on the resulting data to determine the statistical significance between layers, and rarefaction was used to affirm statistical relevance between the two units. In addition to this, these numbers gave an idea of the small mammal faunal composition as it was 250 thousand years ago, building upon the palaeoecological knowledge of this region of South Australia at that time period.

OBSERVATIONS AND RESULTS

As previously noted, the most distinguishing feature of Pit E was the contrasting material between Unit 7 and Unit 8. These units were made up of the excavated layers: layers 1 and 2 in Unit 8, and layers 3, 4 and 5 in Unit 7. Despite the difference between units, the overall bulk of the material came with a massive amount of rock debris and finer-grained sand. The sheer volume of larger grains made it unsurprising to discover the state of the fossil material was mostly average. Many of the fossils were damaged beyond identification, resulting in a large proportion of the specimens receiving identification to family level only. Amongst the fossil remains was evidence of manganese staining. Some specimens had dark grey splotches, while some were stained completely black. This was a common occurrence throughout all layers, however they were not statistically analysed. Similar to this staining, several of the rarely occurring larger pieces showed evidence of greenbone fractures; that is, fracturing that transpired prior or during the deposition of the organism. Spiral fractures as well as flaking was observed, albeit quite rarely.

Table 1: A table of NISP values showing all bags from each layer individually collated to display the number of total diagnostic elements found within each layer. The final row shows a total of all diagnostic elements found within the Grid 7 material (See Appendix A for complete table displaying entire NISP for all identified material).

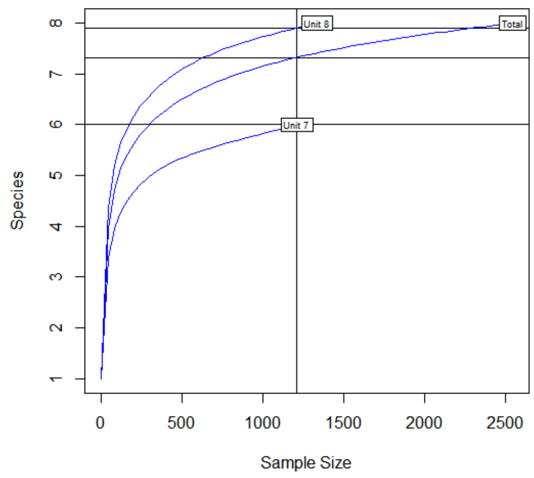
Layer	Bag #	Burramyidae	Dasyuridae	Miniopteridae	Muridae	Peramelidae	Petauridae	Potoroidae	Pseudocheiridae	Total
1	Total	24	81	3	655	44	4	15	1	827
2	Total	18	34	0	425	22	3	4	0	506
3	Total	10	24	0	466	30	1	3	0	534
4	Total	1	29	0	372	14	0	1	0	417
5	Total	3	14	0	224	17	0	1	0	259
1 to 5	Total	56	182	3	2142	127	8	24	1	2543

Table 1 shows the NISP values gathered from the analysed material. Due to a lack of a labelling system present on the bags, an arbitrary system was created and, for this table, all of the bags were grouped accordingly. The result was 29 bags of material ranging extensively in size. As this would skew the results, with each bag analysed without regard to their total capacity, all bags have been grouped to fulfil the entirety of their designated layer. Layers range from 1 through to 5, with layer 1 being the top layer originally worked on prior to the main dig and ranging from 0 to 16 centimetres in depth. Layer 2 holds material from 17 to 26 centimetres, layer 3 from 27 to 36 centimetres, layer 4 from 37 to 46 centimetres, and layer 5 from 47 to 56 centimetres depth from the surface of the dig.

In addition, the number of bags present was not evenly accounted for. Layer 1 had a much greater number of bags than any other layer at a total of 15, likely due in part to its additional 6 centimetres of depth, while layer 5 had only a singular large bag to draw results from. To alleviate this, the layers were grouped by their overlying units: layers 1 and 2 were identified as Unit 8, while layers 3 through 5 fell to Unit 7. Furthermore, the data was analysed both with and without being normalised by the lowest number of bags (see table 2). While the data remained skewed, future rarefaction tests would conclude that the data remained statistically relevant both with and without normalisation.

Table 2: A table of NISP values grouped by the two distinct layers forming Unit 7 (layers 3 to 5) and 8 (layers 1 and 2). The first two rows display comparisons of the two units without normalisation, while the final two rows include normalisation by the unit with the lowest number of bags (i.e. Unit 7).

Layer	**Bag #**	**Burramyidae**	**Dasyuridae**	**Miniopteridae**	**Muridae**	**Peramelidae**	**Petauridae**	**Potoroidae**	**Pseudocheiridae**	**Total**
1 to 2	Total	42	115	3	1080	66	7	19	1	1333
3 to 5	Total	14	67	0	1062	61	1	5	0	1210
1 to 2	Total	4.285714286	10.6428571	0.214285714	107.5	6.285714286	0.71428571	1.64285714	0.071428571	131.3571
3 to 5	Total	6.583333333	29.25	0	472.333	30.5	0.33333333	2.25	0	541.25



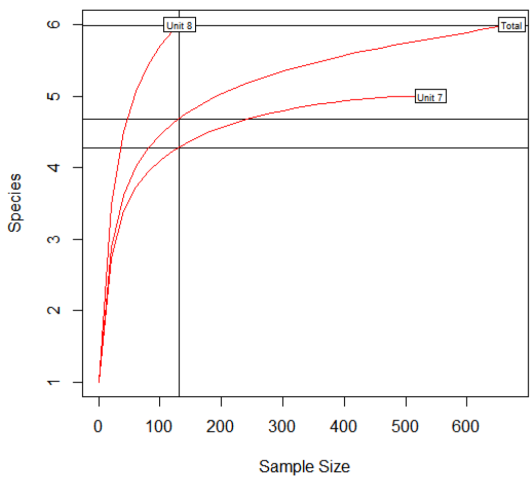


Figure 5: Rarefaction curves performed in Rcommander (Rcmdr) using the 'vegan' package. The left graph shows basic data, while the right graph shows data normalised by the lowest bag count.

The Units 7 and 8 were normalised by the lowest bag count (that is, the 8 bags of Unit 7) to provide an averaged specimen output for the NISP across layers. Using Rcommander to produce several rarefaction curves, figure 5 shows that whether normalised or left as basic data, the sample size of both Unit 7 and Unit 8 fall within the minimum number of specimens required for statistical significance.

Next, each layer was compared to every other layer in a series of chi-squared tests, once again using the Rcommander plugin of R (Fox & Bouchet-Valat, 2018). This was done to determine and statistical difference that may have occurred between layers, which in turn would reflect on changes in the faunal composition through time.

Table 3: A table displaying the output of the Rcommander chi-squared tests of each laver against every other layer. A statistical difference is identified by a p-value of 0.05 or lower.

Species Assemblage (Layer):	X-squared:	df:	p-value:
1v2	4.5956	7	0.7092
1v3	13.413	7	0.06266
1v4	16.772	7	0.01893
1v5	11.294	7	0.1263
2v3	3.7249	5	0.5897
2v4	10.552	5	0.06102
2v5	6.6854	5	0.2451
3v4	6.9881	5	0.2215
3v5	1.4218	5	0.9219
4v5	4.9474	4	0.2927

Table 3 shows the results from all chi-squared tests. The p-value is the significant part of the output, with any number below 0.05 indicating a statistically significant difference between two layers. Layers 1 and 4 showed the largest difference, the only pair which fell below the 0.05 threshold. Layers 1 and 3, and layers 2 and 4 also provide p-values close to the 0.05 threshold relative to the rest of the comparisons. Layers 1 and 2, and 3 and 5 were among the least different between layers.

The following two tables display the MNI and relative abundance of all small mammal species found throughout the entire Grid 7 square.

Table 4: A table displaying the minimum number of individuals of each identified species collated by layers, units, and as a grand total (See Appendix B for complete table displaying calculations of MNI for all identified material).

Identified species			Number of individuals per species							
FAMILY	**GENUS**	**SPECIES**	**Layer 1**	**Layer 2**	**Layer 3**	**Layer 4**	**Layer 5**	**Total**	**Unit 8**	**Unit 7**
Burramyidae	*Cercartetus*	*lepidus*	5	5	7	1	2	20	10	10
Burramyidae	*Cercartetus*	*nanus*	5	4	0	0	0	9	9	0
Burramyidae	*Cercartetus*	*sp.*	1	1	0	0	0	2	2	0
Burramyidae			2	0	0	0	0	2	2	0
Dasyuridae	*Antechinus*	*flavipes*	2	0	0	0	0	2	2	0
Dasyuridae	*Antechinus*	*sp.*	2	0	1	1	4	8	2	6

Dasyuridae	*Dasyurus*	*viverenus*	1	0	1	1	1	4	1	3
Dasyuridae	*Ningaui*	*yvonneae*	2	1	0	0	0	3	3	0
Dasyuridae	*Phascogale*	*calura*	2	2	1	0	0	5	4	1
Dasyuridae	*Phascogale*	*sp.*	1	0	0	0	0	1	1	0
Dasyuridae	*Phascogale*	*tapoatapha*	1	1	0	0	0	2	2	0
Dasyuridae	*Sminthopsis*	*crassichordata*	2	2	1	0	0	5	4	1
Dasyuridae	*Sminthopsis*	*murina*	2	1	0	0	0	3	3	0
Dasyuridae	*Sminthopsis*	*sp.*	4	1	0	0	0	5	5	0
Dasyuridae			23	7	9	10	3	52	30	22
Miniopteridae	*Miniopterus*	*orianae*	2	0	0	0	0	2	2	0
Muridae	*Mastacomys*	*fuscus*	5	3	13	28	10	59	8	51
Muridae	*Notomys*	*mitchellii*	0	3	2	0	0	5	3	2
Muridae	*Pseudomys*	*auritus*	2	0	0	2	0	4	2	2
Muridae	*Pseudomys*	*australis*	5	6	4	4	3	22	11	11
Muridae	*Pseudomys*	*cf. apodemoides*	45	35	40	13	18	151	80	71
Muridae	*Pseudomys*	*cf. gouldii*	0	0	0	1	0	1	0	1
Muridae	*Pseudomys*	*fumeus*	5	7	2	4	8	26	12	14
Muridae	*Pseudomys*	*gouldii*	1	0	0	0	0	1	1	0
Muridae	*Pseudomys*	*shortridgeii*	1	6	0	0	0	7	7	0
Muridae	*Pseudomys*	*sp.*	4	0	0	0	0	4	4	0
Muridae	*Rattus*	*sp.*	14	7	2	2	2	27	21	6
Muridae			184	129	109	91	63	576	313	263
Peramelidae	*Isoodon*	*obesulus*	1	2	2	2	1	8	3	5
Peramelidae	*Perameles*	*bougainville*	6	2	3	1	3	15	8	7
Peramelidae	*Perameles*	*gunnii*	5	2	6	4	3	20	7	13
Peramelidae	*Perameles*	*sp.*	1	0	0	2	0	3	1	2
Peramelidae			8	7	10	1	3	29	15	14
Petauridae	*Petaurus*	*breviceps*	3	2	1	0	0	6	5	1
Potoroidae	*Bettongia*	*gaimundi*	0	0	0	0	1	1	0	1
Potoroidae	*Bettongia*	*penicillata*	2	0	1	0	0	3	2	1
Potoroidae	*Bettongia*	*sp.*	1	0	0	0	0	1	1	0
Potoroidae	*Potorous*	*cf. platyops*	0	0	1	0	0	1	0	1
Potoroidae	*Potorous*	*tridactylus*	5	2	1	1	0	9	7	2
Potoroidae			3	1	0	0	0	4	4	0
Pseudocheridae	*Pseudocheirus*	*peregrinus*	1	0	0	0	0	1	1	0
TOTAL			359	239	217	169	125	1109	598	511

Table 5: A table displaying the relative abundance of each identified species collated by layers, units, and as a grand total. The highlighted cells indicate an absence of the indicated species from that grouping.

Identified species			Percentage of total composition per species							
FAMILY	GENUS	SPECIES	% Layer 1	% Layer 2	% Layer 3	% Layer 4	% Layer 5	% Total	% Unit 8	% Unit 7
Burramyidae	*Cercartetus*	*lepidus*	1.39%	2.09%	3.23%	0.59%	1.60%	1.80%	1.67%	1.96%
Burramyidae	*Cercartetus*	*nanus*	1.39%	1.67%	0.00%	0.00%	0.00%	0.81%	1.51%	0.00%
Burramyidae	*Cercartetus*	*sp.*	0.28%	0.42%	0.00%	0.00%	0.00%	0.18%	0.33%	0.00%
Burramyidae			0.56%	0.00%	0.00%	0.00%	0.00%	0.18%	0.33%	0.00%
Dasyuridae	*Antechinus*	*flavipes*	0.56%	0.00%	0.00%	0.00%	0.00%	0.18%	0.33%	0.00%
Dasyuridae	*Antechinus*	*sp.*	0.56%	0.00%	0.46%	0.59%	3.20%	0.72%	0.33%	1.17%
Dasyuridae	*Dasyurus*	*viverenus*	0.28%	0.00%	0.46%	0.59%	0.80%	0.36%	0.17%	0.59%
Dasyuridae	*Ningaui*	*yvonneae*	0.56%	0.42%	0.00%	0.00%	0.00%	0.27%	0.50%	0.00%
Dasyuridae	*Phascogale*	*calura*	0.56%	0.84%	0.46%	0.00%	0.00%	0.45%	0.67%	0.20%
Dasyuridae	*Phascogale*	*sp.*	0.28%	0.00%	0.00%	0.00%	0.00%	0.09%	0.17%	0.00%
Dasyuridae	*Phascogale*	*tapoatapha*	0.28%	0.42%	0.00%	0.00%	0.00%	0.18%	0.33%	0.00%
Dasyuridae	*Sminthopsis*	*crassichordata*	0.56%	0.84%	0.46%	0.00%	0.00%	0.45%	0.67%	0.20%
Dasyuridae	*Sminthopsis*	*murina*	0.56%	0.42%	0.00%	0.00%	0.00%	0.27%	0.50%	0.00%
Dasyuridae	*Sminthopsis*	*sp.*	1.11%	0.42%	0.00%	0.00%	0.00%	0.45%	0.84%	0.00%
Dasyuridae			6.41%	2.93%	4.15%	5.92%	2.40%	4.69%	5.02%	4.31%
Miniopteridae	*Miniopterus*	*orianae*	0.56%	0.00%	0.00%	0.00%	0.00%	0.18%	0.33%	0.00%
Muridae	*Mastacomys*	*fuscus*	1.39%	1.26%	5.99%	16.57%	8.00%	5.32%	1.34%	9.98%
Muridae	*Notomys*	*mitchellii*	0.00%	1.26%	0.92%	0.00%	0.00%	0.45%	0.50%	0.39%
Muridae	*Pseudomys*	*auritus*	0.56%	0.00%	0.00%	1.18%	0.00%	0.36%	0.33%	0.39%
Muridae	*Pseudomys*	*australis*	1.39%	2.51%	1.84%	2.37%	2.40%	1.98%	1.84%	2.15%
Muridae	*Pseudomys*	*cf. apodemoides*	12.53%	14.64%	18.43%	7.69%	14.40%	13.62%	13.38%	13.89%
Muridae	*Pseudomys*	*cf. gouldii*	0.00%	0.00%	0.00%	0.59%	0.00%	0.09%	0.00%	0.20%
Muridae	*Pseudomys*	*fumeus*	1.39%	2.93%	0.92%	2.37%	6.40%	2.34%	2.01%	2.74%
Muridae	*Pseudomys*	*gouldii*	0.28%	0.00%	0.00%	0.00%	0.00%	0.09%	0.17%	0.00%
Muridae	*Pseudomys*	*shortridgeii*	0.28%	2.51%	0.00%	0.00%	0.00%	0.63%	1.17%	0.00%
Muridae	*Pseudomys*	*sp.*	1.11%	0.00%	0.00%	0.00%	0.00%	0.36%	0.67%	0.00%
Muridae	*Rattus*	*sp.*	3.90%	2.93%	0.92%	1.18%	1.60%	2.43%	3.51%	1.17%
Muridae			51.25%	53.97%	50.23%	53.85%	50.40%	51.94%	52.34%	51.47%
Peramelidae	*Isoodon*	*obesulus*	0.28%	0.84%	0.92%	1.18%	0.80%	0.72%	0.50%	0.98%
Peramelidae	*Perameles*	*bougainville*	1.67%	0.84%	1.38%	0.59%	2.40%	1.35%	1.34%	1.37%
Peramelidae	*Perameles*	*gunnii*	1.39%	0.84%	2.76%	2.37%	2.40%	1.80%	1.17%	2.54%
Peramelidae	*Perameles*	*sp.*	0.28%	0.00%	0.00%	1.18%	0.00%	0.27%	0.17%	0.39%
Peramelidae			2.23%	2.93%	4.61%	0.59%	2.40%	2.61%	2.51%	2.74%
Petauridae	*Petaurus*	*breviceps*	0.84%	0.84%	0.46%	0.00%	0.00%	0.54%	0.84%	0.20%
Potoroidae	*Bettongia*	*gaimundi*	0.00%	0.00%	0.00%	0.00%	0.80%	0.09%	0.00%	0.20%
Potoroidae	*Bettongia*	*penicillata*	0.56%	0.00%	0.46%	0.00%	0.00%	0.27%	0.33%	0.20%
Potoroidae	*Bettongia*	*sp.*	0.28%	0.00%	0.00%	0.00%	0.00%	0.09%	0.17%	0.00%
Potoroidae	*Potorous*	*cf. platyops*	0.00%	0.00%	0.46%	0.00%	0.00%	0.09%	0.00%	0.20%

Potoroidae	*Potorous*	*tridactylus*	1.39%	0.84%	0.46%	0.59%	0.00%	0.81%	1.17%	0.39%
Potoroidae			0.84%	0.42%	0.00%	0.00%	0.00%	0.36%	0.67%	0.00%
Pseudocheridae	*Pseudocheirus*	*peregrinus*	0.28%	0.00%	0.00%	0.00%	0.00%	0.09%	0.17%	0.00%

These two tables are sourced from the same values, both indicating how species distribution was observed to have occurred in Grid 7. Table 4 shows the potency of unidentified muridae, making up a minimum total of 1109 individuals taken from each layer's largest specimen count from left and right mandibles and maxillae. As seen in table 5, this makes up a minimum of 50.4% and a maximum of 53.97% between all layers. *Cf. apodemoides* varies greatly between layers; a low of 7.69% and a high of 18.43%, yet when compared as Unit 7 and 8, the total distribution becomes 13.89% and 13.38% respectively, displaying very little difference between these two periods. Other species, such as *Mastacomys fuscus*, have significantly different outputs between Unit 7 and 8, at 9.98% and 1.34% respectively. This observable disparity is indicative of a significant difference between the two units.

Finally, a look at the small mammal assemblage from Cathedral cave (Brown & Wells, 2000), see figure 6, shows a very similar composition to the resulting fauna from Pit E. Notable points include the similar high concentration of *Mastacomys fuscus* as seen in Unit 7, as well as the complete lack of *cf. apodemoides* in Cathedral compared to the relatively large presence of it throughout all of Pit E.

TABLE 5. *Minimum number of individuals (MNI) for small mammals, reptiles, amphibians and birds from all fossiliferous sedimentary units, Cathedral Cave, Naracoorte. Indeterminate family or class individuals were not included in total extinct/extant species calculations.*

Pit Unit	A 1	A 2	B 1	B 2	B 3
Sminthopsis murina		1			
Antechinus flavipes			1		
Antechinus sp. Indet.		1		1	
Phascogale calura		1	1	1	
Dasyurus viverrinus	1	1			
Dasyurus maculatus			1		
Total Dasyuridae MNI	1	4	3	2	
Perameles bougainville	3		1		
Perameles gunnii	2	2		1	
Perameles sp. Indet.	6	1	1	3	
Peramelidae Indet	3	5		1	1
Total Peramelidae MNI	15	8	2	4	1
Cercartetus nanus		1			
Total Phalangeridae MNI		1			
Bettongia penicillata	1	1		1	
Potorous platyops	2			2	1
Potorous tridactylus					1
Bettongia sp. Indet.		1		1	
Total Potoroidae MNI	3	2		4	2
Mastacomys fuscus	8	3	4	5	1
Pseudomys australis	5	1		8	
Pseudomys shortridgi	1				
Notomys mitchelli		1		2	
Pseudomys sp.	2				
Total Muridae MNI	16	5	4	14	1

Figure 6: An extract of the MNI from the Fossil Chamber of Cathedral Cave (Brown & Wells, 2000), a dig site with similar dates to Fossil Chamber in VFC. The extracted table shows similar species to those found in the Pit E deposit.

DISCUSSION

Statistics

The resulting figures from this study appear to retain statistical relevance. This is observable in the rarefaction curves calculated in Rcommander, as well as the chi-squared tests that were done, in which there is an observable significance between material from Unit 7 and Unit 8. This indicates that there is indeed some variation in ecology occurring at this time, assuming the data collected holds true. The most significant variation is found between layers 1 and 4. Further notable dips in p-values occur between 1 and 5, 2 and 4, and 1 and 3. Interestingly, there is a disparity between 1 and 3, which should be from the same unit. It is possible that the initially dug material from 1971 may have mixed overburden material in and addled the results, or possibly the material from layer 3 may have been unintentionally mixed, as the boundary between Unit 7 and 8 is found within layer 3. This would justify why the differences between 2 and 4, 1 and 4, and 1 and 5 remain close to statistical relevancies, as all are layers outside of layer 3.

There is an intriguing presence/absence ratio to be found between certain species within the deposit. Some dasyurids, such as *Ningaui yvonneae*, have a small presence in the younger Unit 8, but no presence at all in the older Unit 7. Many other species follow this trend; some of the burramyidae (excluding *Cercartetus nanus*, which nearly doubles across some layers), a large portion of dasyurids, and *gouldii* and *shortridgeii* of the *Pseudomys* also appear absent in the older years. It is possible that this is the origin point for some of these species, or even that they simply appeared physiologically different to what they do today, and thus were harder to identify in the older unit. It is also possible that they did not exist locally until this point in time. The darker material may suggest more fertility in the soil compared to the lighter sediment, which may suggests the nearby land became more supportive of new species after the event that separates Units 7 and 8. The case may however, simply be that much of the material from the older layers was damaged beyond identification prior to excavation, and much of the species recognised as absent are in fact present in a much more difficult to recognise form.

On the other side of the argument, we see several species that decrease substantially or disappear entirely after the Unit gap. Some potoroidae, as well as several muridae decrease or disappear entirely from the record as time progresses. Again, this could potentially be due to degradation of material or sub-par analyses, however the trend should not be dismissed for that reason. The most intriguing of these is *Mastacomys fuscus*, a species endemic to south-eastern Australia (*The Mammals of Australia* 2008), which appears highly prevalent during the older unit, only to become highly scarce during the younger unit, relative to other muridae species.

Additionally, the overall massive presence of muridae throughout both units can be seen as one of the more striking elements of the data. As this site is proposed to be a pitfall, as evidenced by a solution pipe remaining near the Pit E dig, it would make sense to see a large proportion of smaller, ground-dwelling animals, as they would be the most likely to fall into such a hole. Additionally, muridae are a family of high population density, and are thus likely to be far more numerous and over-represented compared to other families of ground-dwelling mammals. It is worth noting that, in total, the muridae family occupies 84.23% of all identified elements in the Grid 7 deposit. This would perhaps then suggest that there is some form of owl deposition occurring, as muridae would fall into the diet of native owl species. This would require that owls were taking up residence within the solution pipe or ceiling of the cave.

In the 1971 paper by Smith, it is suggested that owl deposition may have taken place, due to a larger proportion of younger individuals being identified from their dentary maturity (Smith 1971). Later, Wells *et al.* (1984) suggested that much of the juvenile specimens likely accumulated via owl pellets. However, contrary to this, the vast majority of muridae, as well as other younger species that may have fallen as prey to an owl, lacked much of any sign of corrosion. Prey specimens would succumb to damage from the digestive juices of a predatory bird, however such markings were few and far between on the material found in the Pit E deposit.

In continued argument against owl deposition having any input, the megafauna within the material that had already been excavated showed a large number of sthenurine kangaroos and other large mammals. This is significant as it continues to suggest that terrestrial species were more likely to end up in the deposit. A kangaroo hopping along would most likely fail to see a pitfall and accidentally jump or fall into it. Once such a large animal is too far down a pitfall, there is very little chance of them getting back out, as the megafaunal data suggests (Reed 2006).

The Cathedral Cave dig site, excavated by Bourne and Wells in 2000, aimed to turn up similar results to the various digs taking place in Victoria Fossil Cave, albeit on a smaller scale. The small mammal numbers brought up by their dig are intriguingly similar to Pit E in some aspects. This is especially true of *Mastacomys fuscus*, which has an overwhelming presence in Cathedral Cave relative to the rest of the identified species. This shares a similarity with Unit 7 of Pit E, where the number of *M. fuscus* far outweighs much of the other muridae species during that time period. The only to-species muridae of greater frequency that could be identified was *cf. apodemoides*, which, strikingly, is marked as being completely absent from Cathedral Cave. It could be possible then that *cf. apodemoides* was regionally restricted to VFC and nearby systems, whilst absent from Cathedral Cave. The dates for Cathedral suggest a deposit age between roughly 159.2 and 279.2 thousand years, once again suggesting similarities between it and the Pit E deposit material.

It is worth noting that some of the material displayed taphonomic anomalies. Common throughout almost every bag of all five layers was a number of manganese-stained specimens. They resulted in the blackening of parts or all of a fossil, most commonly being very small fragments or individual teeth. The presence of manganese staining is indicative of water flow throughout the deposit, suggesting that the cave may have seen irregular entrance of rainfall. The level of staining was surprisingly frequent, and while the amount was not analysed statistically, manganese-stained specimens were sorted out for potential future analysis. From what was observed, it appears water may have pooled for some time in certain areas of the deposit, resulting in partial or total staining of some of the material. The presence of this suggests a pitfall deposit, as for the fossils to become stained, they would have to be in line with the natural water flow from outside rainfall. Additionally, some rare, larger pieces were found to have greenbone fracturing. Flaking and spiral fractures were the most commonly found amongst these rare occurrences, which likely resulted from the trauma sustained when the animals fell into the pitfall initially. It is possible that some of these were also sustained prior to falling into the deposit, possibly even suggesting a reason for falling in the pitfall to begin with. An injured animal may have been incapable of avoiding or climbing their way out of the chamber, and saw their final days at the bottom of the deposit. Finally, several specimens were recognised to have pathogenic anomalies. This was most common with muridae, where some rodent skulls were recognised to have been deformed, likely from a disease or infection the animal sustained whilst alive. Drawing a similar conclusion to the fracturing, the observed pathogenic damage may have hindered the survival of the animal and resulted in it being unable to avoid or escape the deposit.

Future Directions

There were several limiting factors to this project. One such major hindrance was the state of the bagged material. Much of the sediment had been untouched since the early 2000s where a group of volunteers had sorted through some of the material for miscellaneous fossils (Reed, personal communications, 2018). The result was a largely scattered and hard to track down arrangement of the bags, where some of the material is believed to have been absent during analysis. Building on this, much of the Layer 1 material did not display any coordinates and material could only be assumed to have come from Layer 1 due to external labelling of each bag. Some bags appear to have also been mislabelled, with coordinates seemingly did not match the rest of the material derived from the same layer. The unfortunate reality of this is that greater care would need to be taken in the past for issues such as these to be remedied or fixed. As it stands currently, there is little that can be done for missing or mislabelled material beyond and extensive and time-consuming search for bags that may or may not exist – time being a major limiting factor of this project. In future projects an in-depth search to check all material is available for analysis should be performed prior to taking on such a project that may be greatly compromised by missing data.

The second prevalent issue was the amount of damage much of the material had previously sustained, likely a result of the huge duration of time that had taken place between deposition and excavation. As is the nature of a pitfall, it is likely that much of the material was shifted around in-situ due to additional fauna falling into the cave, surviving, and then moving around in the dark, disturbing the material that had previously settled. Additionally, movement from water as suggested by manganese staining and continual movement of sediment by similar means suggests that the state of the material would not hold up, especially due to the smaller and fragile stature of the deposited fossil material. This was an issue not just during deposition, but also post-excavation. Handling the material was a delicate process, and at times it was impossible to avoid additional breakages when attempting to handle the fragile specimens. The NISP and by extension, the MNI are undoubtedly effected by the quality of material, and while Fossil Chamber has a bountiful amount of material to work with, it does not all remain in pristine condition. In the future, the impact these issues have on research can be reduced through greater care in handling material, as well as reducing the amount of time material needs to be handled. One such way would be to employ the use of 3D-modelling software, which is becoming more popular, to scan specimens and use digital or 3D-printed models of fossils when they require handling for taphonomic or other physiological analysis. This technology is already being used in the field of palaeoecology (Palci *et al.* 2018), and so it remains a feasible improvement to see continued usage.

CONCLUSIONS

This project has been successful in both identifying and understanding small mammal composition of Victoria Fossil Cave, as well as continuing to affirm the method of deposition was a pitfall trap via solution pipes. The material reflects similar results to the previous work done in both VFC and Cathedral Cave. A significant difference between Units 7 and 8 was confirmed, reflected by the changing composition of several species between the two units. Restrictions of the project was mostly a result of resource constraints. A larger allocation of time may have allowed for a more thorough analysis of the material for taphonomics, corrosion, and staining, with the possibility of additional work done to investigate reptile and avian statistics. Future analysis would require a much greater sample size to prevent any skewed results becoming prevalent within the data. Additionally, 8 of the 9 grid squares of Pit E still remain untouched, and additional work in the future would be relatively simple to undergo.

ACKNOWLEDGMENTS

I would like to acknowledge all those that helped in the fulfilment of this project. Primarily my main supervisor, Dr. Liz Reed, for her immense insight and understanding of the material and the invaluable assistance she provided throughout the year despite constant difficulties.

In addition, I acknowledge:

- My secondary supervisor Dr. Lee Arnold, lab assistant Alexandra Randell, fellow colleagues and honours students Patrick Tavasci and Nerita Turner, and a special thanks to PhD student Jessie-Briar Treloar, for using her own valuable time towards hosting workshops and providing assistance in Liz Reed's absence.
- Naracoorte Caves heritage site for providing the material for this project and being gracious hosts during my numerous visits to the location.
- The South Australian Museum and its staff for access to fossil collections and providing insight on fossil identification.
- And of course the University of Adelaide and the Geology school staff for providing this honours opportunity.

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APPENDIX A: FULL TABLE OF NISP

Layer	Bag #	# fossils	Side (L/R)	Element	Family	Genus	Species	Subspecies
1	4	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	9	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	14	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	6	2	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	8	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	9	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	13	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	6	2	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
1	2	1	L	Max	Burramyidae	*Cercartetus*	*lepidus*	
1	2	4	R	Max	Burramyidae	*Cercartetus*	*lepidus*	
1	4	1	L	Man	Burramyidae	*Cercartetus*	*nanus*	
1	3	1	R	Man	Burramyidae	*Cercartetus*	*nanus*	
1	9	2	R	Man	Burramyidae	*Cercartetus*	*nanus*	
1	13	2	R	Man	Burramyidae	*Cercartetus*	*nanus*	
1	8	1	R	Max	Burramyidae	*Cercartetus*	*sp.*	
1	9	2	L	Max	Burramyidae			
1	2	1	R	Max	Dasyuridae	*Antechinus*	*flavipes*	
1	9	1	R	Max	Dasyuridae	*Antechinus*	*flavipes*	
1	2	1	R	Max	Dasyuridae	*Antechinus*	*sp.*	
1	3	1	R	Max	Dasyuridae	*Antechinus*	*sp.*	
1	8	1	L	Man	Dasyuridae	*Dasyurus*	*viverenus*	
1	14	1	R	Max	Dasyuridae	*Dasyurus*	*viverenus*	
1	9	2	L	Man	Dasyuridae	*Ningaui*	*yvonneae*	
1	9	2	R	Man	Dasyuridae	*Ningaui*	*yvonneae*	
1	9	1	R	Man	Dasyuridae	*Phascogale*	*calura*	
1	14	1	R	Man	Dasyuridae	*Phascogale*	*calura*	
1	13	1	R	Man	Dasyuridae	*Phascogale*	*sp.*	
1	9	1	L	Man	Dasyuridae	*Phascogale*	*tapoatapha*	
1	4	1	L	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
1	6	1	L	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
1	4	1	R	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
1	6	1	R	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
1	6	1	L	Max	Dasyuridae	*Sminthopsis*	*crassichordata*	
1	13	1	R	Max	Dasyuridae	*Sminthopsis*	*crassichordata*	
1	2	1	L	Man	Dasyuridae	*Sminthopsis*	*murina*	
1	6	1	L	Man	Dasyuridae	*Sminthopsis*	*murina*	
1	6	1	R	Man	Dasyuridae	*Sminthopsis*	*murina*	
1	8	1	R	Man	Dasyuridae	*Sminthopsis*	*murina*	
1	3	1	R	Man	Dasyuridae	*Sminthopsis*	*sp.*	

1	6	3	R	Man	Dasyuridae	*Sminthopsis*	*sp.*	
1	13	1	L	Max	Dasyuridae	*Sminthopsis*	*sp.*	
1	1	1	L	Man	Dasyuridae			
1	13	1	L	Man	Dasyuridae			
1	3	2	L	Man	Dasyuridae			
1	6	3	L	Man	Dasyuridae			
1	8	3	L	Man	Dasyuridae			
1	9	3	L	Man	Dasyuridae			
1	2	5	L	Man	Dasyuridae			
1	10	5	L	Man	Dasyuridae			
1	2	1	R	Man	Dasyuridae			
1	4	1	R	Man	Dasyuridae			
1	10	1	R	Man	Dasyuridae			
1	14	1	R	Man	Dasyuridae			
1	8	2	R	Man	Dasyuridae			
1	13	2	R	Man	Dasyuridae			
1	3	5	R	Man	Dasyuridae			
1	9	5	R	Man	Dasyuridae			
1	6	1	L	Max	Dasyuridae			
1	8	1	L	Max	Dasyuridae			
1	9	1	L	Max	Dasyuridae			
1	14	1	L	Max	Dasyuridae			
1	11	3	L	Max	Dasyuridae			
1	2	1	R	Max	Dasyuridae			
1	6	1	R	Max	Dasyuridae			
1	8	1	R	Max	Dasyuridae			
1	9	1	R	Max	Dasyuridae			
1	10	1	L	Man	Miniopteridae	*Miniopterus*	*orianae*	*bassanii*
1	1	1	R	Man	Miniopteridae	*Miniopterus*	*orianae*	*bassanii*
1	10	1	R	Man	Miniopteridae	*Miniopterus*	*orianae*	*bassanii*
1	3	1	L	Man	Muridae	*Mastacomys*	*fuscus*	
1	4	1	L	Man	Muridae	*Mastacomys*	*fuscus*	
1	1	2	L	Man	Muridae	*Mastacomys*	*fuscus*	
1	9	1	R	Man	Muridae	*Mastacomys*	*fuscus*	
1	1	2	L	Max	Muridae	*Mastacomys*	*fuscus*	
1	1	1	R	Max	Muridae	*Mastacomys*	*fuscus*	
1	2	1	R	Max	Muridae	*Mastacomys*	*fuscus*	
1	8	2	R	Max	Muridae	*Mastacomys*	*fuscus*	
1	9	2	R	Max	Muridae	*Pseudomys*	*auritus*	
1	1	1	L	Max	Muridae	*Pseudomys*	*australis*	
1	2	1	L	Max	Muridae	*Pseudomys*	*australis*	
1	3	1	L	Max	Muridae	*Pseudomys*	*australis*	
1	9	2	L	Max	Muridae	*Pseudomys*	*australis*	

1	1	1	R	Max	Muridae	*Pseudomys*	*australis*	
1	3	1	R	Max	Muridae	*Pseudomys*	*australis*	
1	9	2	R	Max	Muridae	*Pseudomys*	*australis*	
1	4	1	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	10	3	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	14	3	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	13	4	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	8	5	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	3	7	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	2	8	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	9	12	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	4	1	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	5	1	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	8	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	10	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	13	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	14	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	1	5	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	2	9	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	9	9	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	3	12	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
1	4	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
1	8	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
1	9	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
1	13	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
1	14	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
1	2	1	R	Max	Muridae	*Pseudomys*	*fumeus*	
1	3	1	R	Max	Muridae	*Pseudomys*	*fumeus*	
1	13	1	R	Max	Muridae	*Pseudomys*	*fumeus*	
1	9	2	R	Max	Muridae	*Pseudomys*	*fumeus*	
1	3	1	L	Max	Muridae	*Pseudomys*	*gouldii*	
1	9	1	R	Max	Muridae	*Pseudomys*	*gouldii*	
1	9	1	R	Max	Muridae	*Pseudomys*	*shortridgeii*	
1	6	4	R	Max	Muridae	*Pseudomys*	*sp.*	
1	1	1	R	Man	Muridae	*Rattus*	*sp.*	
1	3	1	L	Max	Muridae	*Rattus*	*sp.*	
1	4	1	L	Max	Muridae	*Rattus*	*sp.*	
1	9	1	L	Max	Muridae	*Rattus*	*sp.*	
1	14	1	L	Max	Muridae	*Rattus*	*sp.*	
1	2	2	L	Max	Muridae	*Rattus*	*sp.*	
1	3	1	R	Max	Muridae	*Rattus*	*sp.*	
1	9	2	R	Max	Muridae	*Rattus*	*sp.*	
1	2	4	R	Max	Muridae	*Rattus*	*sp.*	

1	13	7	R	Max	Muridae	*Rattus*	*sp.*	
1	7	1	L	Man	Muridae			
1	12	2	L	Man	Muridae			
1	5	3	L	Man	Muridae			
1	10	3	L	Man	Muridae			
1	11	3	L	Man	Muridae			
1	1	9	L	Man	Muridae			
1	4	9	L	Man	Muridae			
1	6	10	L	Man	Muridae			
1	14	10	L	Man	Muridae			
1	2	18	L	Man	Muridae			
1	13	20	L	Man	Muridae			
1	8	21	L	Man	Muridae			
1	3	27	L	Man	Muridae			
1	9	30	L	Man	Muridae			
1	5	1	R	Man	Muridae			
1	12	1	R	Man	Muridae			
1	11	3	R	Man	Muridae			
1	1	5	R	Man	Muridae			
1	14	7	R	Man	Muridae			
1	10	8	R	Man	Muridae			
1	4	9	R	Man	Muridae			
1	6	23	R	Man	Muridae			
1	13	23	R	Man	Muridae			
1	2	24	R	Man	Muridae			
1	8	24	R	Man	Muridae			
1	3	26	R	Man	Muridae			
1	9	30	R	Man	Muridae			
1	1	1	L	Max	Muridae			
1	12	1	L	Max	Muridae			
1	14	2	L	Max	Muridae			
1	4	3	L	Max	Muridae			
1	10	3	L	Max	Muridae			
1	13	3	L	Max	Muridae			
1	11	5	L	Max	Muridae			
1	2	7	L	Max	Muridae			
1	8	9	L	Max	Muridae			
1	3	12	L	Max	Muridae			
1	6	12	L	Max	Muridae			
1	9	13	L	Max	Muridae			
1	12	1	R	Max	Muridae			
1	1	2	R	Max	Muridae			
1	11	2	R	Max	Muridae			

1	10	3	R	Max	Muridae			
1	14	5	R	Max	Muridae			
1	4	6	R	Max	Muridae			
1	2	7	R	Max	Muridae			
1	13	7	R	Max	Muridae			
1	6	10	R	Max	Muridae			
1	8	10	R	Max	Muridae			
1	9	16	R	Max	Muridae			
1	3	17	R	Max	Muridae			
1	2	1	L	Man	Peramelidae	*Isoodon*	*obesulus*	
1	1	1	L	Man	Peramelidae	*Perameles*	*bougainville*	
1	3	1	L	Man	Peramelidae	*Perameles*	*bougainville*	
1	10	1	L	Man	Peramelidae	*Perameles*	*bougainville*	
1	8	2	L	Man	Peramelidae	*Perameles*	*bougainville*	
1	1	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
1	2	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
1	3	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
1	13	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
1	9	2	R	Man	Peramelidae	*Perameles*	*bougainville*	
1	9	1	L	Max	Peramelidae	*Perameles*	*bougainville*	
1	9	2	R	Max	Peramelidae	*Perameles*	*bougainville*	
1	6	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
1	8	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
1	9	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
1	2	1	R	Man	Peramelidae	*Perameles*	*gunnii*	
1	6	1	R	Man	Peramelidae	*Perameles*	*gunnii*	
1	9	1	R	Man	Peramelidae	*Perameles*	*gunnii*	
1	13	1	R	Man	Peramelidae	*Perameles*	*gunnii*	
1	14	1	R	Man	Peramelidae	*Perameles*	*gunnii*	
1	9	1	L	Max	Peramelidae	*Perameles*	*gunnii*	
1	13	1	L	Man	Peramelidae	*Perameles*	*sp.*	
1	13	1	R	Man	Peramelidae	*Perameles*	*sp.*	
1	1	1	L	Man	Peramelidae			
1	14	1	L	Man	Peramelidae			
1	9	2	L	Man	Peramelidae			
1	8	4	L	Man	Peramelidae			
1	3	1	R	Man	Peramelidae			
1	8	2	R	Man	Peramelidae			
1	9	2	R	Man	Peramelidae			
1	14	3	R	Man	Peramelidae			
1	6	1	L	Max	Peramelidae			
1	9	1	L	Max	Peramelidae			
1	8	1	L	Man	Petauridae	*Petaurus*	*breviceps*	

1	9	1	L	Man	Petauridae	*Petaurus*	*breviceps*	
1	13	1	L	Man	Petauridae	*Petaurus*	*breviceps*	
1	9	1	R	Max	Petauridae	*Petaurus*	*breviceps*	
1	3	1	L	Max	Potoroidae	*Bettongia*	*penicillata*	
1	13	1	L	Max	Potoroidae	*Bettongia*	*penicillata*	
1	6	1	R	Max	Potoroidae	*Bettongia*	*penicillata*	
1	6	1	R	Man	Potoroidae	*Bettongia*	*sp.*	
1	2	1	L	Man	Potoroidae	*Potorous*	*tridactylus*	
1	9	1	L	Man	Potoroidae	*Potorous*	*tridactylus*	
1	12	1	L	Man	Potoroidae	*Potorous*	*tridactylus*	
1	13	2	L	Man	Potoroidae	*Potorous*	*tridactylus*	
1	3	1	L	Man	Potoroidae			
1	4	1	L	Man	Potoroidae			
1	6	1	L	Man	Potoroidae			
1	4	1	R	Man	Potoroidae			
1	3	1	L	Max	Potoroidae			
1	6	1	R	Max	Potoroidae			
1	14	1	L	Max	Pseudocheridae	*Pseudocheirus*	*peregrinus*	
2	15	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	18	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	21	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	16	2	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	15	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	18	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	16	3	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
2	19	1	L	Man	Burramyidae	*Cercartetus*	*nanus*	
2	20	1	L	Man	Burramyidae	*Cercartetus*	*nanus*	
2	19	1	R	Man	Burramyidae	*Cercartetus*	*nanus*	
2	20	1	R	Man	Burramyidae	*Cercartetus*	*nanus*	
2	15	2	R	Man	Burramyidae	*Cercartetus*	*nanus*	
2	15	1	L	Max	Burramyidae	*Cercartetus*	*sp.*	
2	15	1	R	Max	Burramyidae	*Cercartetus*	*sp.*	
2	18	1	L	Man	Dasyuridae	*Ningaui*	*yvonneae*	
2	15	1	L	Man	Dasyuridae	*Phascogale*	*calura*	
2	20	1	L	Man	Dasyuridae	*Phascogale*	*calura*	
2	19	1	L	Max	Dasyuridae	*Phascogale*	*calura*	
2	20	1	L	Max	Dasyuridae	*Phascogale*	*calura*	
2	20	1	R	Max	Dasyuridae	*Phascogale*	*calura*	
2	15	1	L	Man	Dasyuridae	*Phascogale*	*tapoatapha*	
2	20	1	L	Max	Dasyuridae	*Phascogale*	*tapoatapha*	
2	15	1	R	Max	Dasyuridae	*Phascogale*	*tapoatapha*	
2	16	1	L	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
2	20	1	L	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	

2	15	1	R	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
2	15	1	L	Max	Dasyuridae	*Sminthopsis*	*crassichordata*	
2	15	1	R	Max	Dasyuridae	*Sminthopsis*	*murina*	
2	20	1	R	Max	Dasyuridae	*Sminthopsis*	*sp.*	
2	15	2	L	Man	Dasyuridae			
2	17	2	L	Man	Dasyuridae			
2	20	3	L	Man	Dasyuridae			
2	15	1	R	Man	Dasyuridae			
2	16	1	R	Man	Dasyuridae			
2	18	1	R	Man	Dasyuridae			
2	20	2	R	Man	Dasyuridae			
2	15	1	L	Max	Dasyuridae			
2	17	1	L	Max	Dasyuridae			
2	16	1	R	Max	Dasyuridae			
2	18	1	R	Max	Dasyuridae			
2	15	3	R	Max	Dasyuridae			
2	15	2	L	Man	Muridae	*Mastacomys*	*fuscus*	
2	15	1	R	Man	Muridae	*Mastacomys*	*fuscus*	
2	20	1	L	Max	Muridae	*Mastacomys*	*fuscus*	
2	15	2	L	Max	Muridae	*Mastacomys*	*fuscus*	
2	16	1	R	Max	Muridae	*Mastacomys*	*fuscus*	
2	15	2	R	Max	Muridae	*Mastacomys*	*fuscus*	
2	19	1	R	Max	Muridae	*Notomys*	*mitchellii*	
2	20	2	R	Max	Muridae	*Notomys*	*mitchellii*	
2	15	5	L	Max	Muridae	*Pseudomys*	*australis*	
2	16	1	R	Max	Muridae	*Pseudomys*	*australis*	
2	15	5	R	Max	Muridae	*Pseudomys*	*australis*	
2	19	1	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	17	2	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	15	5	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	20	5	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	16	8	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	18	10	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	19	3	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	15	4	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	17	4	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	16	7	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	20	7	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	18	10	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
2	15	2	L	Max	Muridae	*Pseudomys*	*fumeus*	
2	20	2	L	Max	Muridae	*Pseudomys*	*fumeus*	
2	15	1	R	Max	Muridae	*Pseudomys*	*fumeus*	
2	20	6	R	Max	Muridae	*Pseudomys*	*fumeus*	

2	20	1	L	Max	Muridae	*Pseudomys*	*shortridgeii*	
2	15	2	L	Max	Muridae	*Pseudomys*	*shortridgeii*	
2	15	1	R	Max	Muridae	*Pseudomys*	*shortridgeii*	
2	20	5	R	Max	Muridae	*Pseudomys*	*shortridgeii*	
2	15	1	L	Man	Muridae	*Rattus*	*sp.*	
2	17	2	L	Man	Muridae	*Rattus*	*sp.*	
2	15	1	R	Man	Muridae	*Rattus*	*sp.*	
2	16	1	L	Max	Muridae	*Rattus*	*sp.*	
2	15	3	L	Max	Muridae	*Rattus*	*sp.*	
2	20	3	L	Max	Muridae	*Rattus*	*sp.*	
2	16	1	R	Max	Muridae	*Rattus*	*sp.*	
2	18	1	R	Max	Muridae	*Rattus*	*sp.*	
2	21	1	R	Max	Muridae	*Rattus*	*sp.*	
2	20	3	R	Max	Muridae	*Rattus*	*sp.*	
2	21	2	L	Man	Muridae			
2	18	6	L	Man	Muridae			
2	17	7	L	Man	Muridae			
2	19	8	L	Man	Muridae			
2	16	14	L	Man	Muridae			
2	15	41	L	Man	Muridae			
2	20	51	L	Man	Muridae			
2	21	3	R	Man	Muridae			
2	17	5	R	Man	Muridae			
2	16	8	R	Man	Muridae			
2	19	9	R	Man	Muridae			
2	15	35	R	Man	Muridae			
2	20	41	R	Man	Muridae			
2	18	2	L	Max	Muridae			
2	19	2	L	Max	Muridae			
2	16	3	L	Max	Muridae			
2	15	13	L	Max	Muridae			
2	20	17	L	Max	Muridae			
2	18	2	R	Max	Muridae			
2	20	2	R	Max	Muridae			
2	16	4	R	Max	Muridae			
2	19	5	R	Max	Muridae			
2	20	9	R	Max	Muridae			
2	15	10	R	Max	Muridae			
2	15	1	L	Man	Peramelidae	*Isoodon*	*obesulus*	
2	20	1	L	Man	Peramelidae	*Isoodon*	*obesulus*	
2	15	1	R	Man	Peramelidae	*Isoodon*	*obesulus*	
2	18	1	L	Man	Peramelidae	*Perameles*	*bougainville*	
2	20	1	L	Man	Peramelidae	*Perameles*	*bougainville*	

2	18	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
2	20	2	L	Man	Peramelidae	*Perameles*	*gunnii*	
2	20	1	R	Man	Peramelidae	*Perameles*	*gunnii*	
2	17	1	L	Man	Peramelidae			
2	20	2	L	Man	Peramelidae			
2	15	4	L	Man	Peramelidae			
2	20	1	R	Man	Peramelidae			
2	15	3	R	Man	Peramelidae			
2	16	1	L	Max	Peramelidae			
2	16	1	R	Max	Peramelidae			
2	15	1	L	Man	Petauridae	*Petaurus*	*breviceps*	
2	20	1	L	Man	Petauridae	*Petaurus*	*breviceps*	
2	20	1	R	Man	Petauridae	*Petaurus*	*breviceps*	
2	15	1	L	Man	Potoroidae	*Potorous*	*tridactylus*	
2	20	1	L	Man	Potoroidae	*Potorous*	*tridactylus*	
2	15	1	R	Man	Potoroidae	*Potorous*	*tridactylus*	
2	15	1	R	Man	Potoroidae			
3	22	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
3	23	1	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
3	23	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
3	22	6	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
3	22	1	L	Max	Burramyidae	*Cercartetus*	*lepidus*	
3	23	1	L	Max	Dasyuridae	*Antechinus*	*sp.*	
3	22	1	R	Man	Dasyuridae	*Dasyurus*	*viverenus*	
3	22	1	L	Max	Dasyuridae	*Dasyurus*	*viverenus*	
3	22	1	R	Max	Dasyuridae	*Phascogale*	*calura*	
3	23	1	L	Man	Dasyuridae	*Sminthopsis*	*crassichordata*	
3	23	1	L	Max	Dasyuridae	*Sminthopsis*	*crassichordata*	
3	22	1	R	Max	Dasyuridae	*Sminthopsis*	*crassichordata*	
3	23	2	L	Man	Dasyuridae			
3	22	3	L	Man	Dasyuridae			
3	22	4	R	Man	Dasyuridae			
3	23	5	R	Man	Dasyuridae			
3	23	1	L	Max	Dasyuridae			
3	22	2	R	Max	Dasyuridae			
3	22	1	L	Man	Muridae	*Mastacomys*	*fuscus*	
3	23	8	L	Man	Muridae	*Mastacomys*	*fuscus*	
3	22	2	R	Man	Muridae	*Mastacomys*	*fuscus*	
3	23	11	R	Man	Muridae	*Mastacomys*	*fuscus*	
3	22	3	L	Max	Muridae	*Mastacomys*	*fuscus*	
3	23	5	L	Max	Muridae	*Mastacomys*	*fuscus*	
3	22	3	R	Max	Muridae	*Mastacomys*	*fuscus*	
3	23	5	R	Max	Muridae	*Mastacomys*	*fuscus*	

3	22	1	L	Max	Muridae	*Notomys*	*mitchellii*	
3	23	1	L	Max	Muridae	*Notomys*	*mitchellii*	
3	23	4	L	Max	Muridae	*Pseudomys*	*australis*	
3	23	2	R	Max	Muridae	*Pseudomys*	*australis*	
3	24	1	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
3	22	12	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
3	23	15	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
3	22	19	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
3	23	21	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
3	22	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
3	23	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
3	22	2	R	Max	Muridae	*Pseudomys*	*fumeus*	
3	22	2	R	Max	Muridae	*Rattus*	*sp.*	
3	24	1	L	Man	Muridae			
3	22	42	L	Man	Muridae			
3	23	66	L	Man	Muridae			
3	24	3	R	Man	Muridae			
3	22	41	R	Man	Muridae			
3	23	60	R	Man	Muridae			
3	24	1	L	Max	Muridae			
3	22	25	L	Max	Muridae			
3	23	33	L	Max	Muridae			
3	22	24	R	Max	Muridae			
3	23	50	R	Max	Muridae			
3	23	2	L	Man	Peramelidae	*Isoodon*	*obesulus*	
3	23	1	R	Man	Peramelidae	*Isoodon*	*obesulus*	
3	22	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
3	23	2	R	Man	Peramelidae	*Perameles*	*bougainville*	
3	22	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
3	23	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
3	22	2	R	Man	Peramelidae	*Perameles*	*gunnii*	
3	23	4	R	Man	Peramelidae	*Perameles*	*gunnii*	
3	22	1	L	Man	Peramelidae			
3	23	1	L	Man	Peramelidae			
3	23	4	R	Man	Peramelidae			
3	22	6	R	Man	Peramelidae			
3	23	3	L	Max	Peramelidae			
3	23	1	R	Max	Peramelidae			
3	23	1	L	Man	Petauridae	*Petaurus*	*breviceps*	
3	22	1	L	Max	Potoroidae	*Bettongia*	*penicillata*	
3	23	1	R	Man	Potoroidae	*Potorous*	*cf. platyops*	
3	23	1	R	Man	Potoroidae	*Potorous*	*tridactylus*	
4	27	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	

4	25	1	R	Max	Dasyuridae	*Antechinus*	*sp.*	
4	28	1	L	Man	Dasyuridae	*Dasyurus*	*viverenus*	
4	28	1	R	Man	Dasyuridae	*Dasyurus*	*viverenus*	
4	26	1	L	Man	Dasyuridae			
4	28	1	L	Man	Dasyuridae			
4	25	3	L	Man	Dasyuridae			
4	27	5	L	Man	Dasyuridae			
4	25	2	R	Man	Dasyuridae			
4	27	4	R	Man	Dasyuridae			
4	28	4	R	Man	Dasyuridae			
4	26	2	L	Max	Dasyuridae			
4	28	2	R	Max	Dasyuridae			
4	25	5	L	Man	Muridae	*Mastacomys*	*fuscus*	
4	26	7	L	Man	Muridae	*Mastacomys*	*fuscus*	
4	27	7	L	Man	Muridae	*Mastacomys*	*fuscus*	
4	28	9	L	Man	Muridae	*Mastacomys*	*fuscus*	
4	26	2	R	Man	Muridae	*Mastacomys*	*fuscus*	
4	25	4	R	Man	Muridae	*Mastacomys*	*fuscus*	
4	27	4	R	Man	Muridae	*Mastacomys*	*fuscus*	
4	28	5	R	Man	Muridae	*Mastacomys*	*fuscus*	
4	26	3	L	Max	Muridae	*Mastacomys*	*fuscus*	
4	28	4	L	Max	Muridae	*Mastacomys*	*fuscus*	
4	27	7	L	Max	Muridae	*Mastacomys*	*fuscus*	
4	26	3	R	Max	Muridae	*Mastacomys*	*fuscus*	
4	25	4	R	Max	Muridae	*Mastacomys*	*fuscus*	
4	28	4	R	Max	Muridae	*Mastacomys*	*fuscus*	
4	27	10	R	Max	Muridae	*Mastacomys*	*fuscus*	
4	26	2	L	Max	Muridae	*Pseudomys*	*auritus*	
4	26	1	R	Max	Muridae	*Pseudomys*	*auritus*	
4	25	1	L	Max	Muridae	*Pseudomys*	*australis*	
4	26	1	L	Max	Muridae	*Pseudomys*	*australis*	
4	27	2	L	Max	Muridae	*Pseudomys*	*australis*	
4	25	1	R	Max	Muridae	*Pseudomys*	*australis*	
4	26	1	R	Max	Muridae	*Pseudomys*	*australis*	
4	27	2	R	Max	Muridae	*Pseudomys*	*australis*	
4	26	1	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	27	3	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	25	4	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	28	5	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	25	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	26	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	27	2	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
4	28	3	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	

4	28	1	L	Max	Muridae	*Pseudomys*	*cf. gouldii*	
4	27	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
4	28	1	L	Max	Muridae	*Pseudomys*	*fumeus*	
4	26	1	R	Max	Muridae	*Pseudomys*	*fumeus*	
4	27	3	R	Max	Muridae	*Pseudomys*	*fumeus*	
4	26	1	L	Man	Muridae	*Rattus*	*sp.*	
4	27	2	L	Max	Muridae	*Rattus*	*sp.*	
4	26	14	L	Man	Muridae			
4	25	21	L	Man	Muridae			
4	28	21	L	Man	Muridae			
4	27	35	L	Man	Muridae			
4	26	15	R	Man	Muridae			
4	28	15	R	Man	Muridae			
4	27	19	R	Man	Muridae			
4	25	21	R	Man	Muridae			
4	28	7	L	Max	Muridae			
4	26	10	L	Max	Muridae			
4	25	11	L	Max	Muridae			
4	27	12	L	Max	Muridae			
4	25	10	R	Max	Muridae			
4	27	11	R	Max	Muridae			
4	26	14	R	Max	Muridae			
4	28	15	R	Max	Muridae			
4	26	2	L	Man	Peramelidae	*Isoodon*	*obesulus*	
4	27	1	R	Man	Peramelidae	*Perameles*	*bougainville*	
4	27	1	L	Max	Peramelidae	*Perameles*	*bougainville*	
4	27	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
4	28	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
4	26	2	L	Man	Peramelidae	*Perameles*	*gunnii*	
4	25	1	L	Max	Peramelidae	*Perameles*	*gunnii*	
4	26	1	R	Max	Peramelidae	*Perameles*	*gunnii*	
4	28	2	R	Man	Peramelidae	*Perameles*	*sp.*	
4	28	1	L	Max	Peramelidae	*Perameles*	*sp.*	
4	28	1	R	Man	Peramelidae			
4	27	1	L	Max	Peramelidae			
4	27	1	R	Max	Peramelidae			
4	27	1	L	Man	Potoroidae	*Potorous*	*tridactylus*	
5	29	2	L	Man	Burramyidae	*Cercartetus*	*lepidus*	
5	29	1	R	Man	Burramyidae	*Cercartetus*	*lepidus*	
5	29	4	L	Max	Dasyuridae	*Antechinus*	*sp.*	
5	29	1	L	Man	Dasyuridae	*Dasyurus*	*viverenus*	
5	29	1	R	Max	Dasyuridae	*Dasyurus*	*viverenus*	
5	29	2	L	Man	Dasyuridae			

5	29	3	R	Man	Dasyuridae			
5	29	1	L	Max	Dasyuridae			
5	29	2	R	Max	Dasyuridae			
5	29	10	L	Man	Muridae	*Mastacomys*	*fuscus*	
5	29	9	R	Man	Muridae	*Mastacomys*	*fuscus*	
5	29	7	L	Max	Muridae	*Mastacomys*	*fuscus*	
5	29	8	R	Max	Muridae	*Mastacomys*	*fuscus*	
5	29	2	L	Max	Muridae	*Pseudomys*	*australis*	
5	29	3	R	Max	Muridae	*Pseudomys*	*australis*	
5	29	12	L	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
5	29	18	R	Max	Muridae	*Pseudomys*	*cf. apodemoides*	
5	29	2	L	Max	Muridae	*Pseudomys*	*fumeus*	
5	29	8	R	Max	Muridae	*Pseudomys*	*fumeus*	
5	29	1	L	Max	Muridae	*Rattus*	*sp.*	
5	29	2	R	Max	Muridae	*Rattus*	*sp.*	
5	29	63	L	Man	Muridae			
5	29	52	R	Man	Muridae			
5	29	12	L	Max	Muridae			
5	29	15	R	Max	Muridae			
5	29	1	L	Man	Peramelidae	*Isoodon*	*obesulus*	
5	29	1	L	Man	Peramelidae	*Perameles*	*bougainville*	
5	29	3	R	Man	Peramelidae	*Perameles*	*bougainville*	
5	29	1	L	Man	Peramelidae	*Perameles*	*gunnii*	
5	29	3	R	Man	Peramelidae	*Perameles*	*gunnii*	
5	29	2	L	Man	Peramelidae			
5	29	1	R	Man	Peramelidae			
5	29	3	L	Max	Peramelidae			
5	29	2	R	Max	Peramelidae			
5	29	1	R	Max	Potoroidae	*Bettongia*	*gaimundi*	

APPENDIX B: FULL TABLE OF MNI

Totals by Species/Layer	Family	Element	Side ((L/R)	MNI/Species	MNI/Layer	MNI/Unit
	Burramyidae	Man	L			
	Burramyidae	Man	L			
	Burramyidae	Man	L			
5	Burramyidae	Man	L			
	Burramyidae	Man	R			
	Burramyidae	Man	R			
	Burramyidae	Man	R			
5	Burramyidae	Man	R			

1	Burramyidae	Max	L			
4	Burramyidae	Max	R	5		
1	Burramyidae	Man	L			
	Burramyidae	Man	R			
	Burramyidae	Man	R			
5	Burramyidae	Man	R	5		
1	Burramyidae	Max	R	1		
2	Burramyidae	Max	L	2		
	Dasyuridae	Max	R			
2	Dasyuridae	Max	R	2		
	Dasyuridae	Max	R			
2	Dasyuridae	Max	R	2		
1	Dasyuridae	Man	L			
1	Dasyuridae	Max	R	1		
2	Dasyuridae	Man	L			
2	Dasyuridae	Man	R	2		
	Dasyuridae	Man	R			
2	Dasyuridae	Man	R	2		
1	Dasyuridae	Man	R	1		
1	Dasyuridae	Man	L	1		
	Dasyuridae	Man	L			
2	Dasyuridae	Man	L			
	Dasyuridae	Man	R			
2	Dasyuridae	Man	R			
1	Dasyuridae	Max	L			
1	Dasyuridae	Max	R	2		
	Dasyuridae	Man	L			
2	Dasyuridae	Man	L			
	Dasyuridae	Man	R			
2	Dasyuridae	Man	R	2		
	Dasyuridae	Man	R			
4	Dasyuridae	Man	R			
1	Dasyuridae	Max	L	4		
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
23	Dasyuridae	Man	L			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			

	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
18	Dasyuridae	Man	R			
	Dasyuridae	Max	L			
	Dasyuridae	Max	L			
	Dasyuridae	Max	L			
	Dasyuridae	Max	L			
7	Dasyuridae	Max	L			
	Dasyuridae	Max	R			
	Dasyuridae	Max	R			
	Dasyuridae	Max	R			
4	Dasyuridae	Max	R	**23**		
1	Miniopteridae	Man	L			
	Miniopteridae	Man	R			
2	Miniopteridae	Man	R	**2**		
	Muridae	Man	L			
	Muridae	Man	L			
4	Muridae	Man	L			
1	Muridae	Man	R			
2	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
4	Muridae	Max	R	**4**		
2	Muridae	Max	R	**2**		
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
5	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
4	Muridae	Max	R	**5**		
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
43	Muridae	Max	L			
	Muridae	Max	R			

	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
45	Muridae	Max	R	**45**		
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
5	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
5	Muridae	Max	R	**5**		
1	Muridae	Max	L			
1	Muridae	Max	R	**1**		
1	Muridae	Max	R	**1**		
4	Muridae	Max	R	**4**		
1	Muridae	Man	R	**1**		
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
6	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
14	Muridae	Max	R	**14**		
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			

	Muridae	Man	L			
	Muridae	Man	L			
166	Muridae	Man	L			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
184	Muridae	Man	R			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
71	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
86	Muridae	Max	R	**184**		
1	Peramelidae	Man	L	**1**		
	Peramelidae	Man	L			
	Peramelidae	Man	L			

	Peramelidae	Man	L			
5	Peramelidae	Man	L			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
6	Peramelidae	Man	R			
1	Peramelidae	Max	L			
2	Peramelidae	Max	R	6		
	Peramelidae	Man	L			
	Peramelidae	Man	L			
3	Peramelidae	Man	L			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
5	Peramelidae	Man	R			
1	Peramelidae	Max	L	5		
1	Peramelidae	Man	L			
1	Peramelidae	Man	R	1		
	Peramelidae	Man	L			
	Peramelidae	Man	L			
	Peramelidae	Man	L			
8	Peramelidae	Man	L			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
	Peramelidae	Man	R			
8	Peramelidae	Man	R			
	Peramelidae	Max	L			
2	Peramelidae	Max	L	8		
	Petauridae	Man	L			
	Petauridae	Man	L			
3	Petauridae	Man	L			
1	Petauridae	Max	R	3		
	Potoroidae	Max	L			
2	Potoroidae	Max	L			
1	Potoroidae	Max	R	2		
1	Potoroidae	Man	R	1		
	Potoroidae	Man	L			
	Potoroidae	Man	L			
	Potoroidae	Man	L			
5	Potoroidae	Man	L	5		
	Potoroidae	Man	L			

	Potoroidae	Man	L			
3	Potoroidae	Man	L			
1	Potoroidae	Man	R			
1	Potoroidae	Max	L			
1	Potoroidae	Max	R	3		
1	Pseudocheridae	Max	L	1	359	
	Burramyidae	Man	L			
	Burramyidae	Man	L			
	Burramyidae	Man	L			
5	Burramyidae	Man	L			
	Burramyidae	Man	R			
	Burramyidae	Man	R			
5	Burramyidae	Man	R	5		
	Burramyidae	Man	L			
2	Burramyidae	Man	L			
	Burramyidae	Man	R			
	Burramyidae	Man	R			
4	Burramyidae	Man	R	4		
1	Burramyidae	Max	L			
1	Burramyidae	Max	R	1		
1	Dasyuridae	Man	L	1		
	Dasyuridae	Man	L			
2	Dasyuridae	Man	L			
	Dasyuridae	Max	L			
2	Dasyuridae	Max	L			
1	Dasyuridae	Max	R	2		
1	Dasyuridae	Man	L			
1	Dasyuridae	Max	L			
1	Dasyuridae	Max	R	1		
	Dasyuridae	Man	L			
2	Dasyuridae	Man	L			
1	Dasyuridae	Man	R			
1	Dasyuridae	Max	L	2		
1	Dasyuridae	Max	R	1		
1	Dasyuridae	Max	R	1		
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
7	Dasyuridae	Man	L			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
5	Dasyuridae	Man	R			
	Dasyuridae	Max	L			

2	Dasyuridae	Max	L			
	Dasyuridae	Max	R			
	Dasyuridae	Max	R			
5	Dasyuridae	Max	R	**7**		
2	Muridae	Man	L			
1	Muridae	Man	R			
	Muridae	Max	L			
3	Muridae	Max	L			
	Muridae	Max	R			
3	Muridae	Max	R	**3**		
	Muridae	Max	R			
3	Muridae	Max	R	**3**		
5	Muridae	Max	L			
	Muridae	Max	R			
6	Muridae	Max	R	**6**		
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
31	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
35	Muridae	Max	R	**35**		
	Muridae	Max	L			
4	Muridae	Max	L			
	Muridae	Max	R			
7	Muridae	Max	R	**7**		
	Muridae	Max	L			
3	Muridae	Max	L			
	Muridae	Max	R			
6	Muridae	Max	R	**6**		
	Muridae	Man	L			
3	Muridae	Man	L			
1	Muridae	Man	R			
	Muridae	Max	L			
	Muridae	Max	L			
7	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			

	Muridae	Max	R			
6	Muridae	Max	R	**7**		
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
129	Muridae	Man	L			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
101	Muridae	Man	R			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
37	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
32	Muridae	Max	R	**129**		
	Peramelidae	Man	L			
2	Peramelidae	Man	L			
1	Peramelidae	Man	R	**2**		
	Peramelidae	Man	L			
2	Peramelidae	Man	L			
1	Peramelidae	Man	R	**2**		
2	Peramelidae	Man	L			
1	Peramelidae	Man	R	**2**		
	Peramelidae	Man	L			
	Peramelidae	Man	L			
7	Peramelidae	Man	L			
	Peramelidae	Man	R			
4	Peramelidae	Man	R			
1	Peramelidae	Max	L			
1	Peramelidae	Max	R	**7**		
	Petauridae	Man	L			
2	Petauridae	Man	L			

1	Petauridae	Man	R	**2**		
	Potoroidae	Man	L			
2	Potoroidae	Man	L			
1	Potoroidae	Man	R	**2**		
1	Potoroidae	Man	R	**1**	239	598
	Burramyidae	Man	L			
2	Burramyidae	Man	L			
	Burramyidae	Man	R			
7	Burramyidae	Man	R			
1	Burramyidae	Max	L	**7**		
1	Dasyuridae	Max	L	**1**		
1	Dasyuridae	Man	R			
1	Dasyuridae	Max	L	**1**		
1	Dasyuridae	Max	R	**1**		
1	Dasyuridae	Man	L			
1	Dasyuridae	Max	L			
1	Dasyuridae	Max	R	**1**		
	Dasyuridae	Man	L			
5	Dasyuridae	Man	L			
	Dasyuridae	Man	R			
9	Dasyuridae	Man	R			
1	Dasyuridae	Max	L			
2	Dasyuridae	Max	R	**9**		
	Muridae	Man	L			
9	Muridae	Man	L			
13	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Max	L			
8	Muridae	Max	L			
	Muridae	Max	R			
8	Muridae	Max	R	**13**		
	Muridae	Max	L			
2	Muridae	Max	L	**2**		
4	Muridae	Max	L			
2	Muridae	Max	R	**4**		
	Muridae	Max	L			
	Muridae	Max	L			
28	Muridae	Max	L			
	Muridae	Max	R			
40	Muridae	Max	R	**40**		
	Muridae	Max	L			
2	Muridae	Max	L			
2	Muridae	Max	R	**2**		

2	Muridae	Max	R	**2**		
	Muridae	Man	L			
	Muridae	Man	L			
109	Muridae	Man	L			
	Muridae	Man	R			
	Muridae	Man	R			
104	Muridae	Man	R			
	Muridae	Max	L			
	Muridae	Max	L			
59	Muridae	Max	L			
	Muridae	Max	R			
74	Muridae	Max	R	**109**		
2	Peramelidae	Man	L			
1	Peramelidae	Man	R	**2**		
	Peramelidae	Man	R			
3	Peramelidae	Man	R	**3**		
	Peramelidae	Man	L			
2	Peramelidae	Man	L			
	Peramelidae	Man	R			
6	Peramelidae	Man	R	**6**		
	Peramelidae	Man	L			
2	Peramelidae	Man	L			
	Peramelidae	Man	R			
10	Peramelidae	Man	R			
3	Peramelidae	Max	L			
1	Peramelidae	Max	R	**10**		
1	Petauridae	Man	L	**1**		
1	Potoroidae	Max	L	**1**		
1	Potoroidae	Man	R	**1**		
1	Potoroidae	Man	R	**1**	217	
1	Burramyidae	Man	R	**1**		
1	Dasyuridae	Max	R	**1**		
1	Dasyuridae	Man	L			
1	Dasyuridae	Man	R	**1**		
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
	Dasyuridae	Man	L			
10	Dasyuridae	Man	L			
	Dasyuridae	Man	R			
	Dasyuridae	Man	R			
10	Dasyuridae	Man	R			
2	Dasyuridae	Max	L			
2	Dasyuridae	Max	R	**10**		

	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
28	Muridae	Man	L			
	Muridae	Man	R			
	Muridae	Man	R			
	Muridae	Man	R			
15	Muridae	Man	R			
	Muridae	Max	L			
	Muridae	Max	L			
14	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
21	Muridae	Max	R	**28**		
2	Muridae	Max	L			
1	Muridae	Max	R	**2**		
	Muridae	Max	L			
	Muridae	Max	L			
4	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
4	Muridae	Max	R	**4**		
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
13	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
9	Muridae	Max	R	**13**		
1	Muridae	Max	L	**1**		
	Muridae	Max	L			
2	Muridae	Max	L			
	Muridae	Max	R			
4	Muridae	Max	R	**4**		
1	Muridae	Man	L			
2	Muridae	Max	L	**2**		
	Muridae	Man	L			
	Muridae	Man	L			
	Muridae	Man	L			
91	Muridae	Man	L			
	Muridae	Man	R			

	Muridae	Man	R			
	Muridae	Man	R			
70	Muridae	Man	R			
	Muridae	Max	L			
	Muridae	Max	L			
	Muridae	Max	L			
40	Muridae	Max	L			
	Muridae	Max	R			
	Muridae	Max	R			
	Muridae	Max	R			
50	Muridae	Max	R	**91**		
2	Peramelidae	Man	L	**2**		
1	Peramelidae	Man	R			
1	Peramelidae	Max	L	**1**		
	Peramelidae	Man	L			
	Peramelidae	Man	L			
4	Peramelidae	Man	L			
1	Peramelidae	Max	L			
1	Peramelidae	Max	R	**4**		
2	Peramelidae	Man	R			
1	Peramelidae	Max	L	**2**		
1	Peramelidae	Man	R			
1	Peramelidae	Max	L			
1	Peramelidae	Max	R	**1**		
1	Potoroidae	Man	L	**1**	169	
2	Burramyidae	Man	L			
1	Burramyidae	Man	R	**2**		
4	Dasyuridae	Max	L	**4**		
1	Dasyuridae	Man	L			
1	Dasyuridae	Max	R	**1**		
2	Dasyuridae	Man	L			
3	Dasyuridae	Man	R			
1	Dasyuridae	Max	L			
2	Dasyuridae	Max	R	**3**		
10	Muridae	Man	L			
9	Muridae	Man	R			
7	Muridae	Max	L			
8	Muridae	Max	R	**10**		
2	Muridae	Max	L			
3	Muridae	Max	R	**3**		
12	Muridae	Max	L			
18	Muridae	Max	R	**18**		
2	Muridae	Max	L			

8	Muridae	Max	R	**8**		
1	Muridae	Max	L			
2	Muridae	Max	R	**2**		
63	Muridae	Man	L			
52	Muridae	Man	R			
12	Muridae	Max	L			
15	Muridae	Max	R	**63**		
1	Peramelidae	Man	L	**1**		
1	Peramelidae	Man	L			
3	Peramelidae	Man	R	**3**		
1	Peramelidae	Man	L			
3	Peramelidae	Man	R	**3**		
2	Peramelidae	Man	L			
1	Peramelidae	Man	R			
3	Peramelidae	Max	L			
2	Peramelidae	Max	R	**3**		
1	Potoroidae	Max	R	**1**	125	511
2543				1109	1109	1109