Department of
Parks and Wildlife

Lorna Glen (Matuwa) small vertebrate fauna monitoring program 2002-2010 – preliminary analysis and review

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Contributions and acknowledgments

Mark Cowan designed the trapping program and conducted the monitoring program from 2002 to 2008. Karl Brennan supervised the monitoring program in 2009 and 2010. Tamra Chapman analysed the data and prepared the report with statistical advice from Matthew Williams. Mark Cowan produced Figure 8 and Figure 9 and Neil Burrows prepared the new monitoring plan based on the outcomes of a workshop attended by Tamra Chapman, Lesley Gibson, Ian Kealley, Keith Morris and Colin Yates. The Department wishes to thank the many Parks and Wildlife officers and volunteers who participated in the trapping program. Cover photograph by Judy Dunlop.

Table of Contents

1 Background and trends

1.1 Introduction

Prior to the commencement of Operation Rangeland Restoration, small vertebrate fauna had not been systematically surveyed at Lorna Glen. A baseline survey of small vertebrate fauna was established in 2001 and conducted in 2001 and 2002. Thereafter, the survey program was extended as a means of monitoring relative abundance and species richness and continued until 2010.

This preliminary analysis aims to:

1. Determine if any broad trends in relative abundance and richness can be identified.
2. Examine species assemblages and test for responses to environmental variables and feral cat activity.
3. Critically review the analysis and the monitoring program.
4. Develop an alternative monitoring program.

1.2 Methods

Fauna trapping was conducted at 24 sites shown Figure 1 with rangeland systems. Monitoring was undertaken twice per year, in spring and autumn, between 2002 and 2010, excluding autumn 2010 (Table 1). Each site had 12 traps, set in two lines of six, consisting of 20 litre plastic buckets, spaced 10m apart, with centre drift fences. Traps were open for seven nights per site per trapping round and the nights during which the sites were in operation are shown in Appendix 1.

Trapping was conducted by one Regional Ecologist for round 1-13 and by a second Regional Ecologist for rounds 14-17. The original datasheets could not be located, but the data for rounds 1-13 were available in a Microsoft Access Database (Table 1). The data from rounds 14-17 had not been entered into a database, but were available as photocopied datasheets (Table 1) and these data were entered into the database. All data included taxa, site, sex and re-captures, but weights and measures were only available for rounds 15-17 (Table 1). Consistency of vouchering is unknown for rounds 14-17.

Table 1. Summary of data formats and availability. Db = database, P/C = photocopied.

Round	Year	Season	Data	Site	Trap No.	Weights	Measures	Vouchering / notes
1	2002	Autumn	MS Access Db	✓	×	×	×	✓
2	2002	Spring	MS Access Db	✓	×	×	×	✓
3	2003	Autumn	MS Access Db	✓	×	×	×	✓
4	2003	Spring	MS Access Db	✓	×	×	×	✓
5	2004	Autumn	MS Access Db	✓	×	×	×	✓
6	2004	Spring	MS Access Db	✓	×	×	×	✓
7	2005	Autumn	MS Access Db	✓	×	×	×	✓
8	2005	Spring	MS Access Db	✓	×	×	×	✓
9	2006	Autumn	MS Access Db	✓	×	×	×	✓
10	2006	Spring	MS Access Db	✓	×	×	×	✓
11	2007	Autumn	MS Access Db	✓	×	×	×	✓
12	2007	Spring	MS Access Db	✓	×	×	×	✓
13	2008	Autumn	MS Access Db	✓	×	×	×	✓
14	2008	Spring	MS Access Db	✓	×	×	×	?
15	2009	Autumn	P/C datasheets	✓	✓	✓	✓	?
16	2009	Spring	P/C datasheets	✓	✓	✓	✓	?
17	2010	Spring	P/C datasheets	✓	×	✓	✓	?

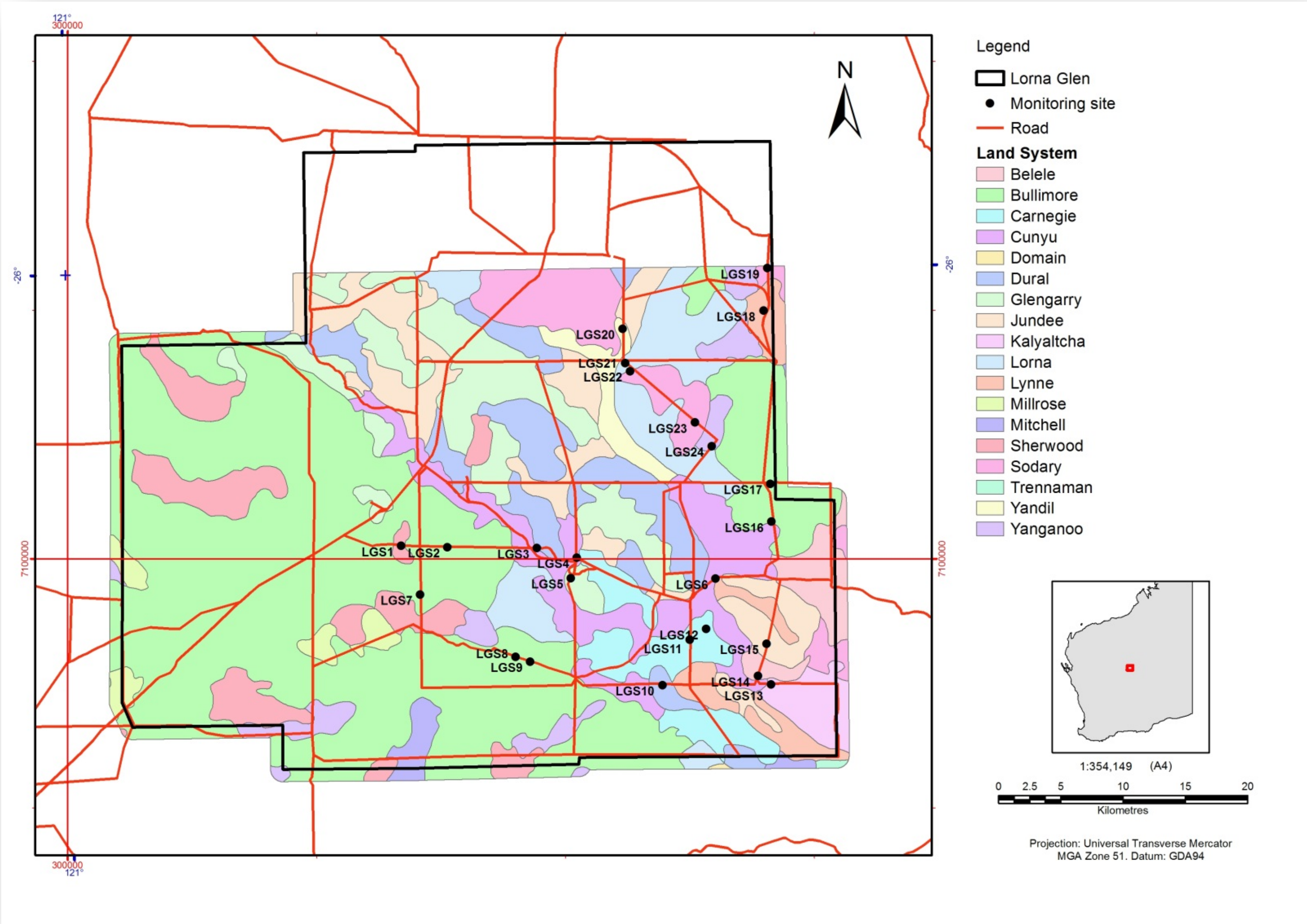


Figure 1. Lorna Glen shown with monitoring sites, roads and rangeland systems. Note that only relevant land systems are shown and that spatial data for land systems is limited to 26ºS.

Frogs and pythons were removed from the trend analysis because they are unreliably trapped. *Mus musculus* was also excluded, because few were recorded in rounds 14-17, and it was not clear if it had been excluded or mis-identified by some observers. In total, 11 mammal and 70 reptile species were recorded and a species list is provided in Appendix 2.

The number of captures and species per 100 trap nights (TN) per site was calculated for all species combined, families and the 10 most abundant species. The data were then Johnson Sl transformed to ensure they met the assumptions of the test and linear regression was used to test for trends in relative abundance and species over time. Inter-annual and seasonal variation in the number of captures and species per site per 100 TN was examined using repeated measures ANOVA, with year as the repeated factor (as suggested by Green 1993). Tukey-Kramer honestly significant difference (HSD) tests ($P = 0.05$) were used to rank years on the basis of the relative number of captures and species. Data for round 17 was excluded from the analyses because trapping was not conducted in autumn that year.

1.3 Results

Trends

Relative abundance and richness varied widely between years and and seasons (Figure 2). The mean number of captures per 100 TN ranged from around 360 in spring 2004 to around 129 in spring 2010. The number of species per 100 TN per site varied from around 182 in spring 2004 to around 64 in autumn 2009. The number of captures per 100 TN per site ($R^2 = 0.017$, $F = 6.72$, d.f. = 1,382, $P = 0.0099$; Johnson Sl Transform Captures per 100TN = 0.2891089 - 0.0279211*Round) and the number of species per 100 TN per site ($R^2 = 0.040$, $F = 16.01$, d.f. = 1,382, $P < 0.0001$, Johnson Sl Transform Species per 100TN = 0.3698082 - 0.0435068*Round) followed a declining trend (Figure 3), but the models were not strong.

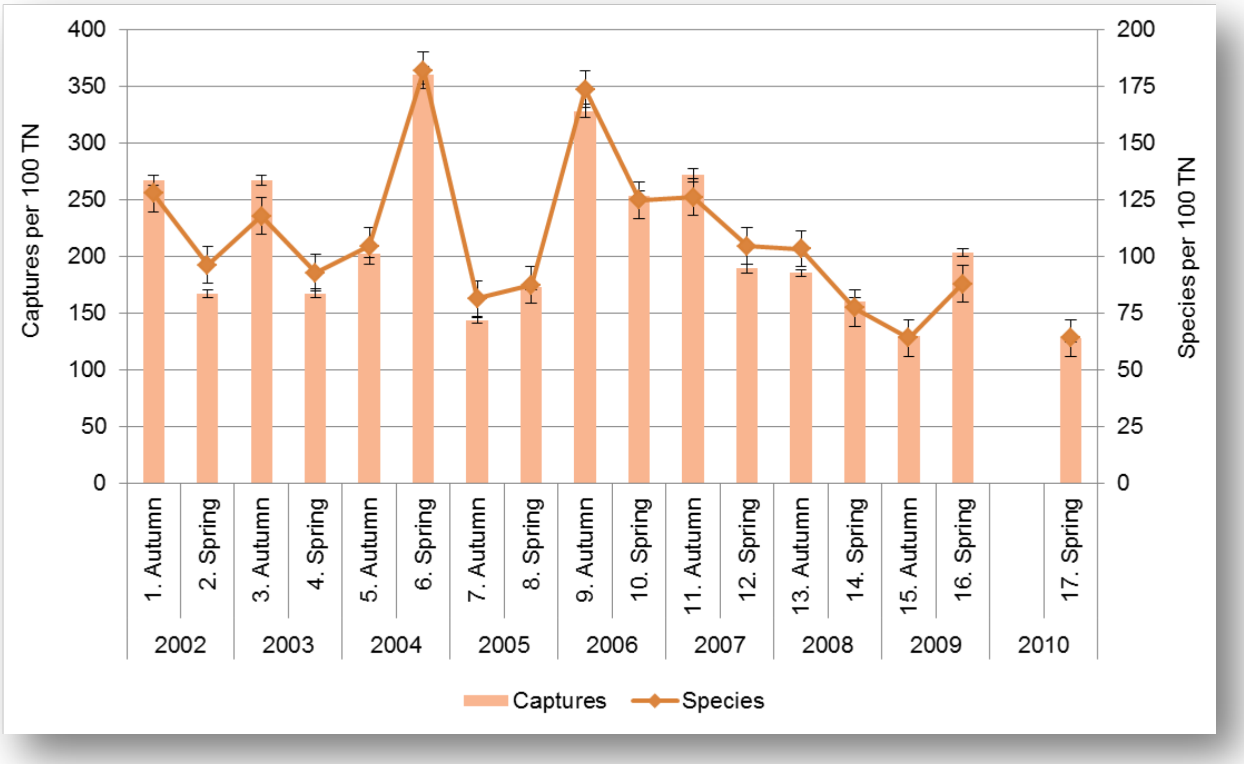
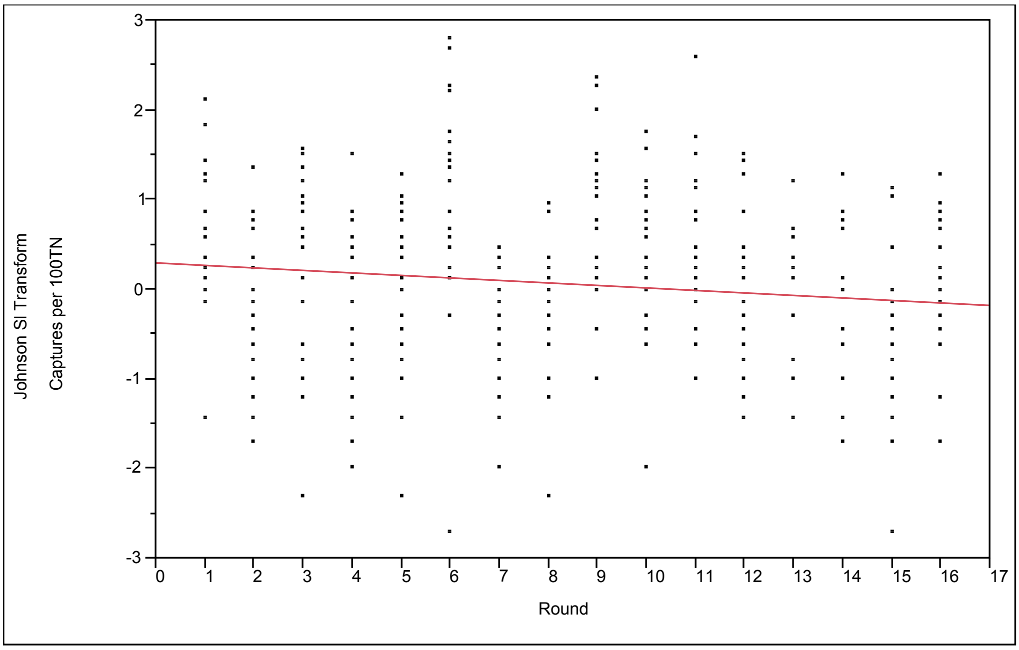


Figure 2. Mean number of captures and species per 100 trap nights (TN) per site (bars show standard error and numbers show round of trapping).



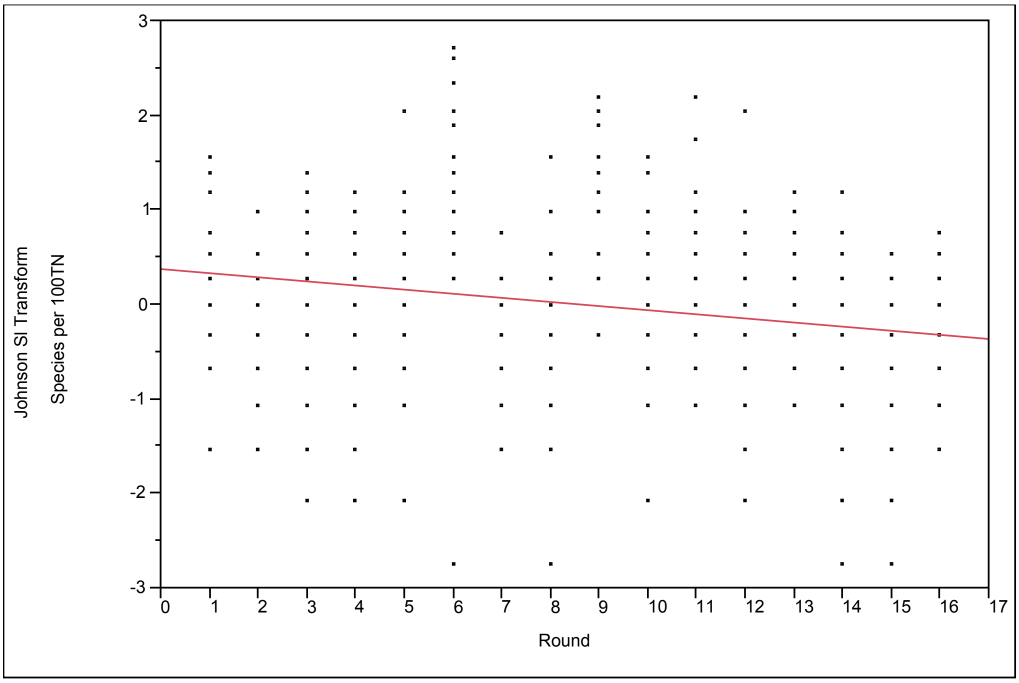
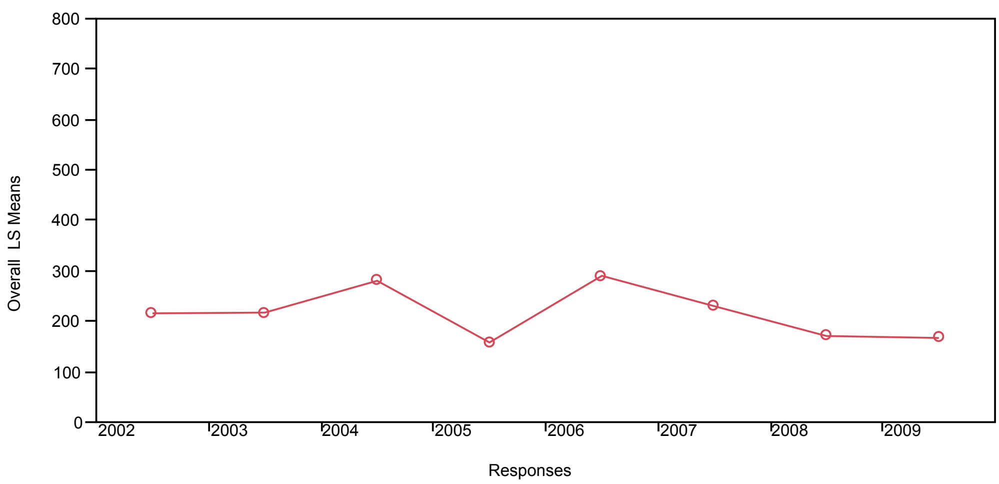


Figure 3. Linear regression models for the relative number of captures and species.

Relative abundance

The number of captures per 100 TN varied significantly between years ($F = 9.86$, d.f. = 7,40, $P < 0.001$, Figure 4), but not seasons ($F = 0.5912$, d.f. = 1,46, $P = 0.4459$) and there was an interaction between year and season ($F = 13.69$, d.f. = 7,40, $P < 0.001$). From highest to lowest, the ranking of years for the number of captures was 1. 2006; 2. 2004; 3. 2007; 4. 2003 and 2002; 5. 2008 and 2009 and 6. 2005 (Tukey HSD test $P = 0.05$).



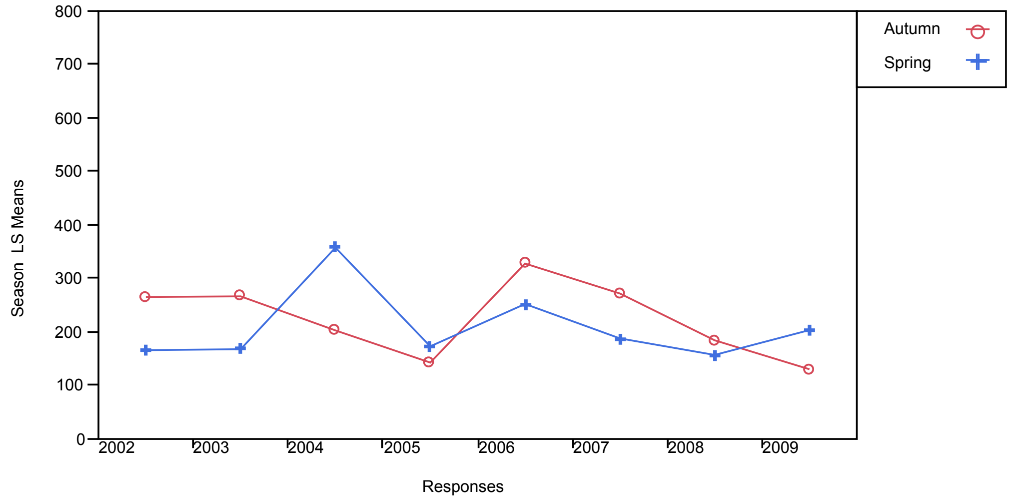
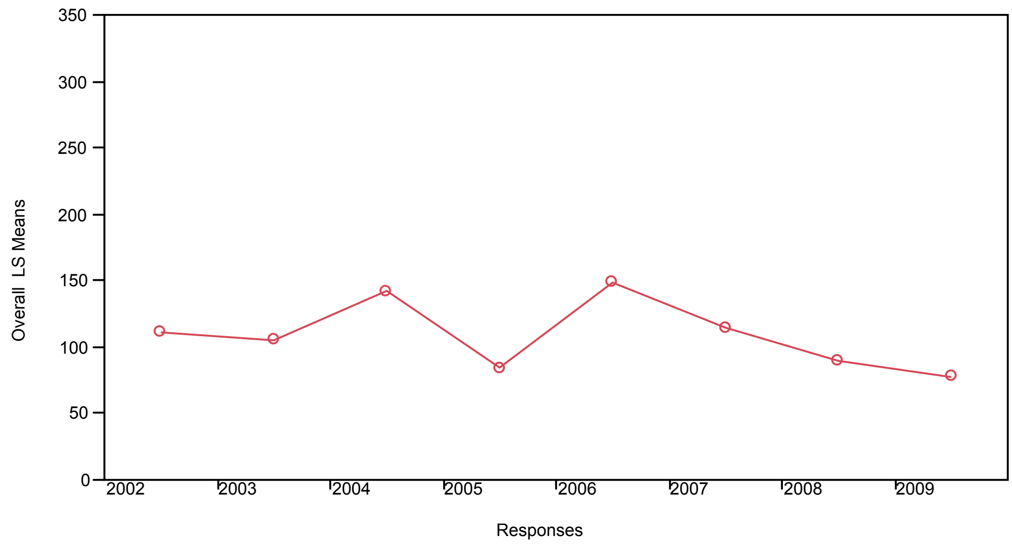


Figure 4. Variation in Least Square (LS) Means for captures per 100 TN between years (above) and seasons (below).

Relative richness

The number of species per 100 TN varied significantly between years (F = 17.34, d.f. = 7,40, P < 0.0001, Figure 5), but not seasons (F = 0.5135, d.f. = 1,46, P = 0.4773) and there was an interaction between year and season (F = 14.21, d.f. = 7,40, P < 0.0001). From highest to lowest, the ranking of years for the number of species per 100 TN was 1. 2006; 2. 2004; 3. 2007; 4. 2002; 5 2003; 6. 2008; 7. 2005; and 8. 2009 (Tukey HSD test P = 0.05).



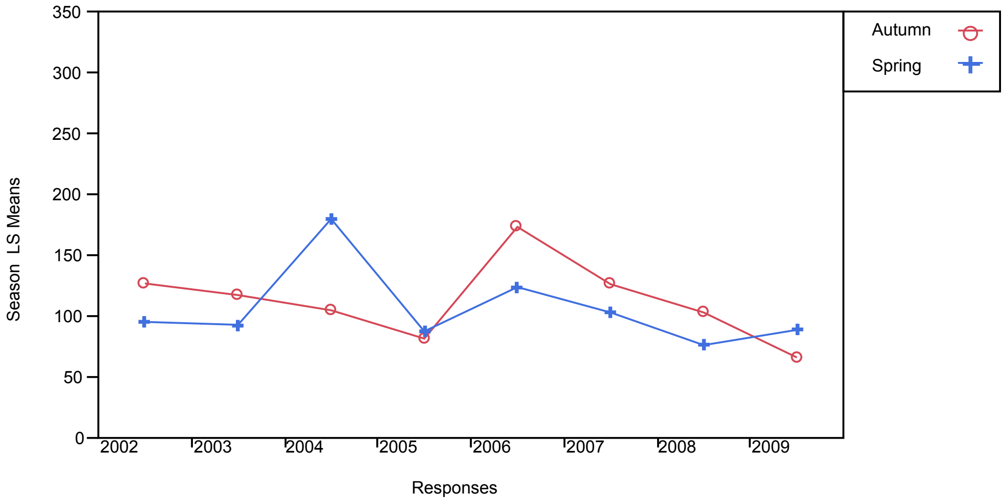
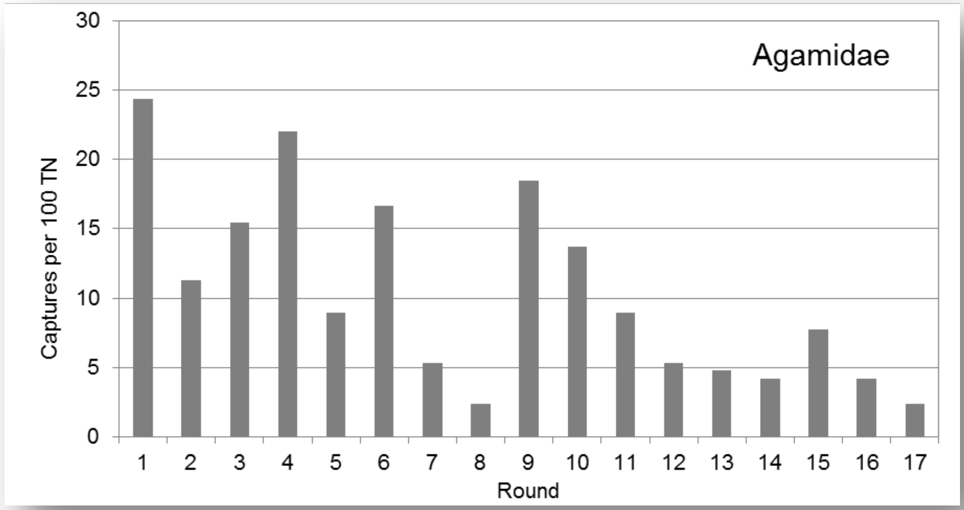


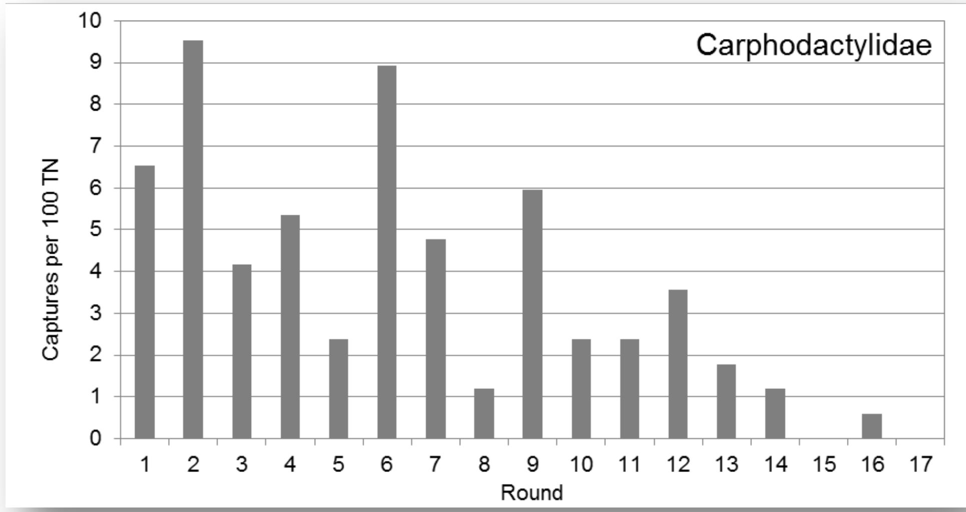
Figure 5. Variation in Least Square (LS) Means for species per 100 TN between years (above) and seasons (below).

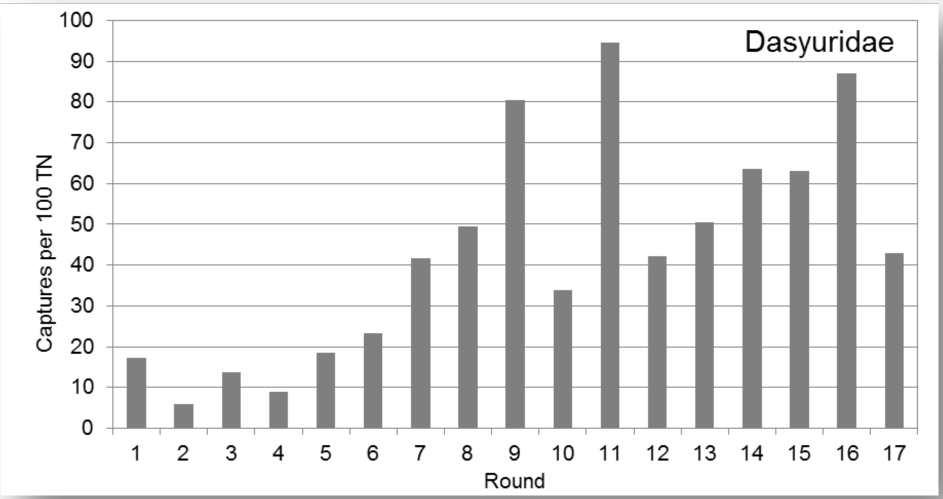
Variability in captures for families and species

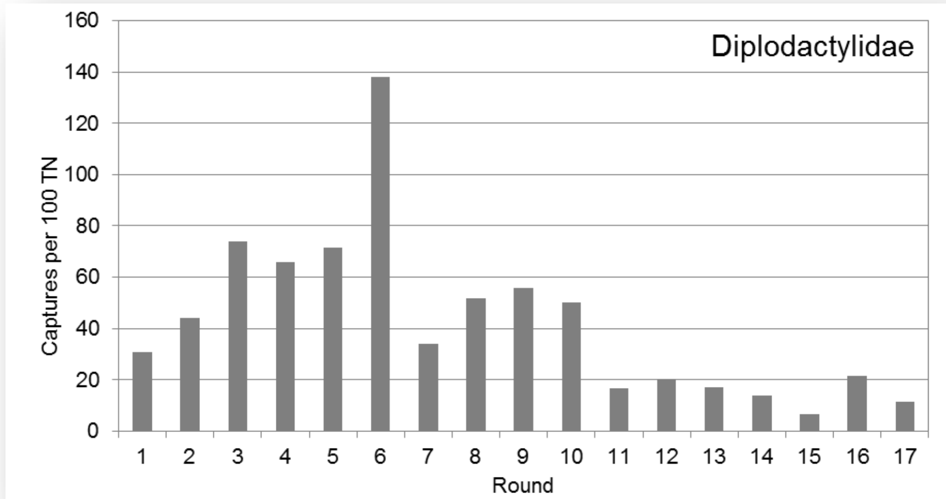
Figure 6 shows variation in captures per 100 trap nights for each family. Families showing a declining trend were dragon lizards (Agamidae) and geckoes (Carphodactylidae, Diplodactylidae, Gekkonidae). Dunnarts (Dasyuridae) showed an increasing trend, while rodents (Muridae) and legless lizards (Pygopodidae) were variable to decreasing. Families for which captures were variable between years included snakes (Elapidae), blind snakes (Typhlopidae) and monitors (Varanidae).

Species for which captures declined during the observation period included *Ctenotus leonhardii*, *Lucasium squarrosum*, *Rhynchoedura ornata* and *Pseudomys hermannsburgensis* (Figure 7). *Sminthopsis macroura* showed an increasing trend and captures for *Ctenotus pantherinus*, *Lerista bipes*, *Menetia greyii*, *Sminthopsis ooldea* were variable but steady (Figure 7).

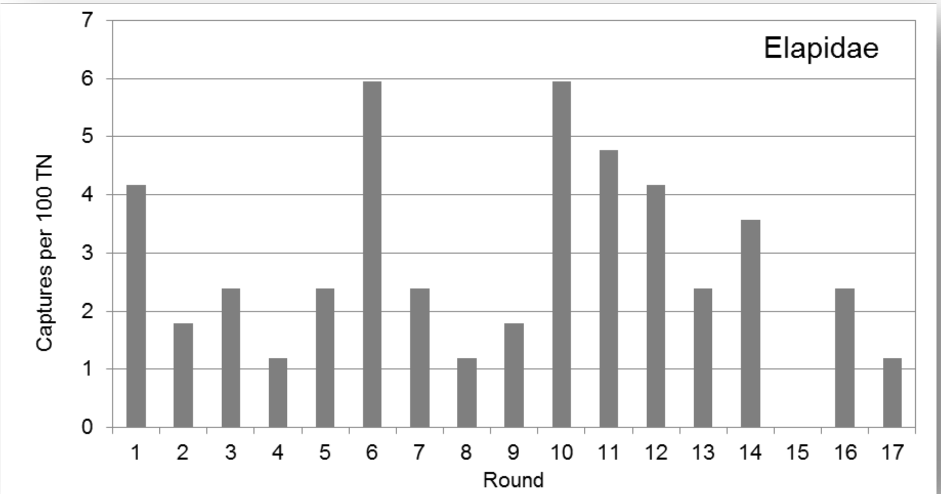

Agamidae
Captures per 100 TN
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round

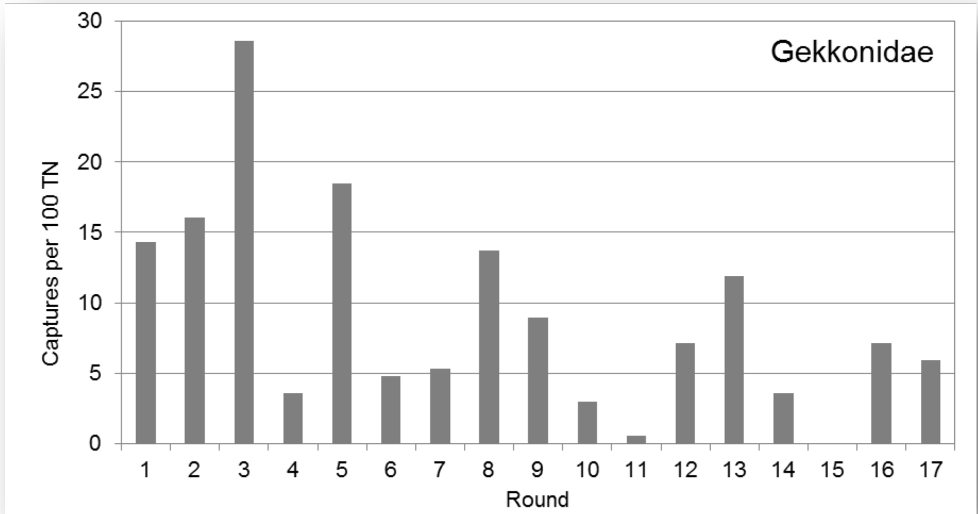

Carphodactylidae
Captures per 100 TN
10
9
8
7
6
5
4
3
2
1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round

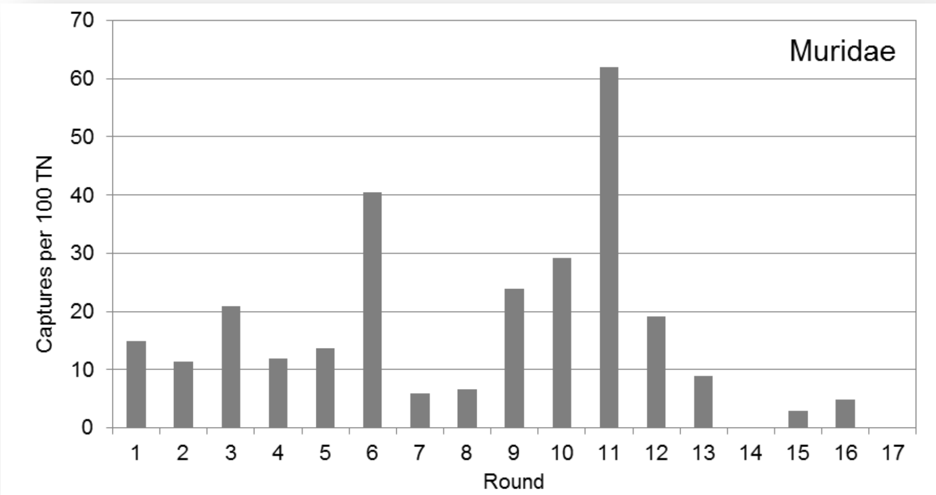

Dasyuridae
Captures per 100 TN
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round

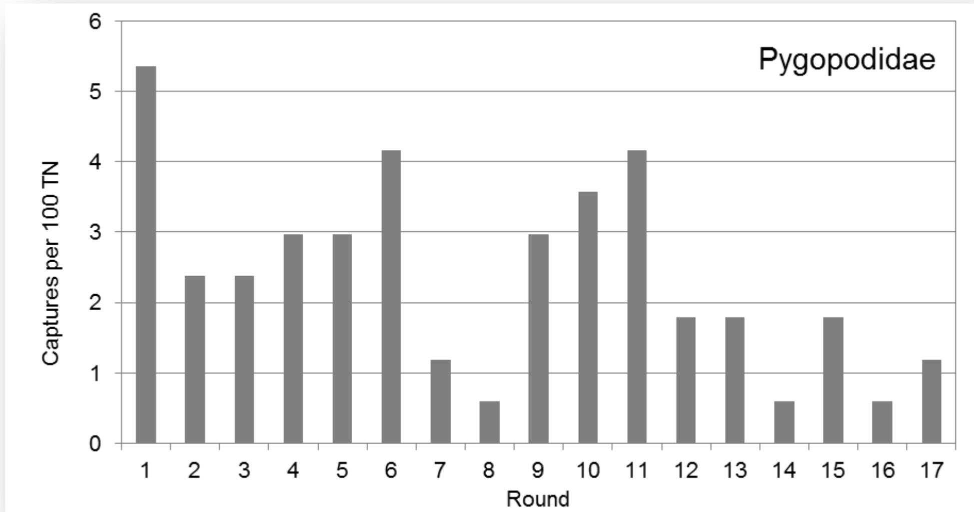

Diplodactylidae
Captures per 100 TN
160
140
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round

9.


Elapidae
Captures per 100 TN
Round


Gekkonidae
Captures per 100 TN
Round


Muridae
Captures per 100 TN
Round


Pygopodidae
Captures per 100 TN
Round

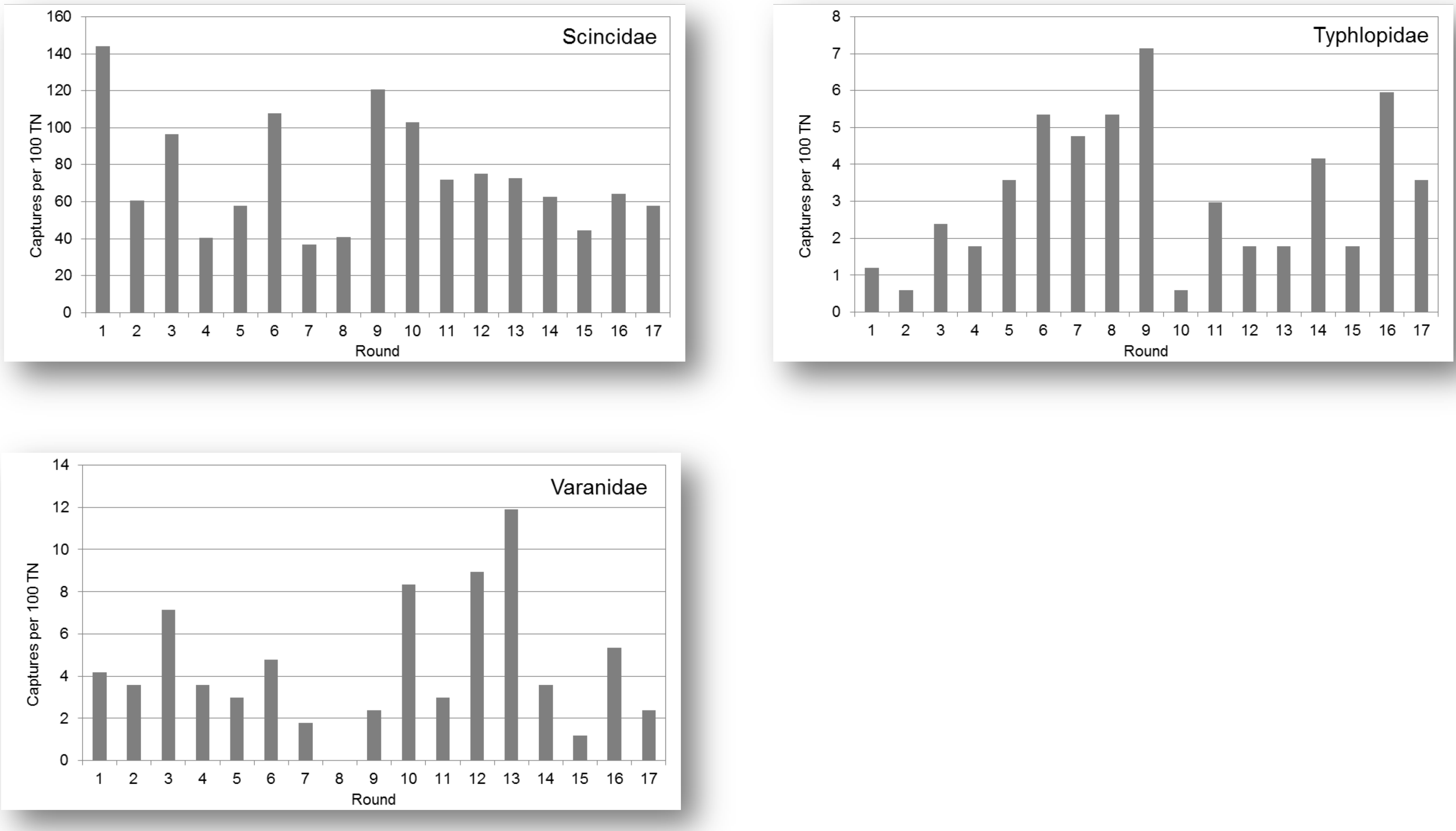
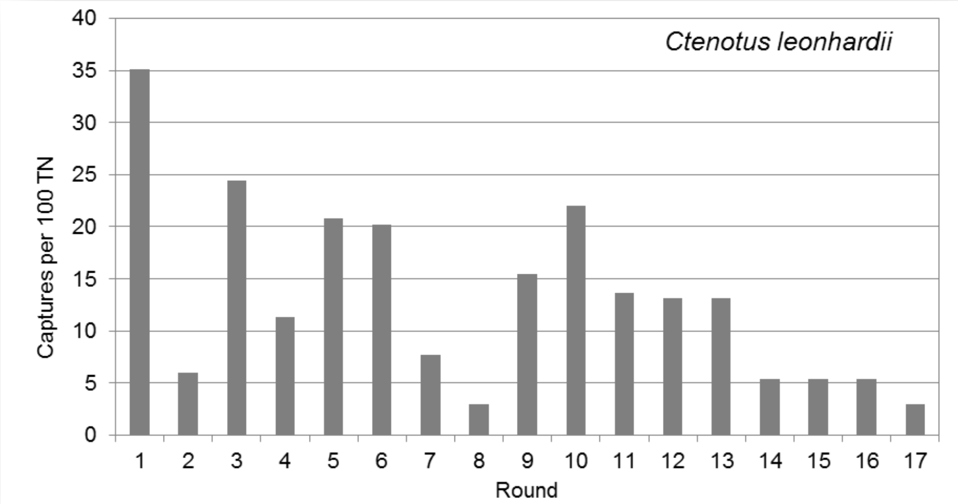
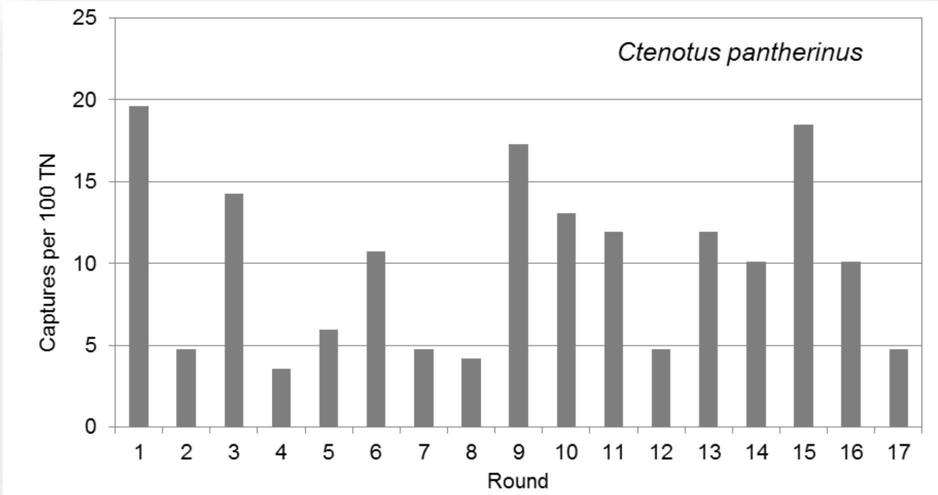
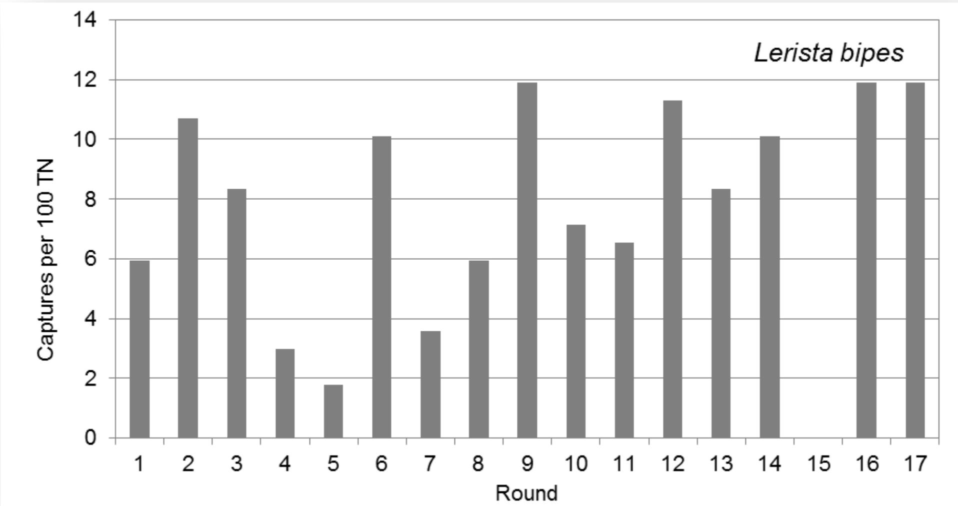


Figure 6. Number of captures per 100 trap nights for the 24 sites combined for each round of trapping by family.


Ctenotus leonhardii
Captures per 100 TN
Round
0 5 10 15 20 25 30 35 40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


Ctenotus pantherinus
Captures per 100 TN
Round
0 5 10 15 20 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


Lerista bipes
Captures per 100 TN
Round
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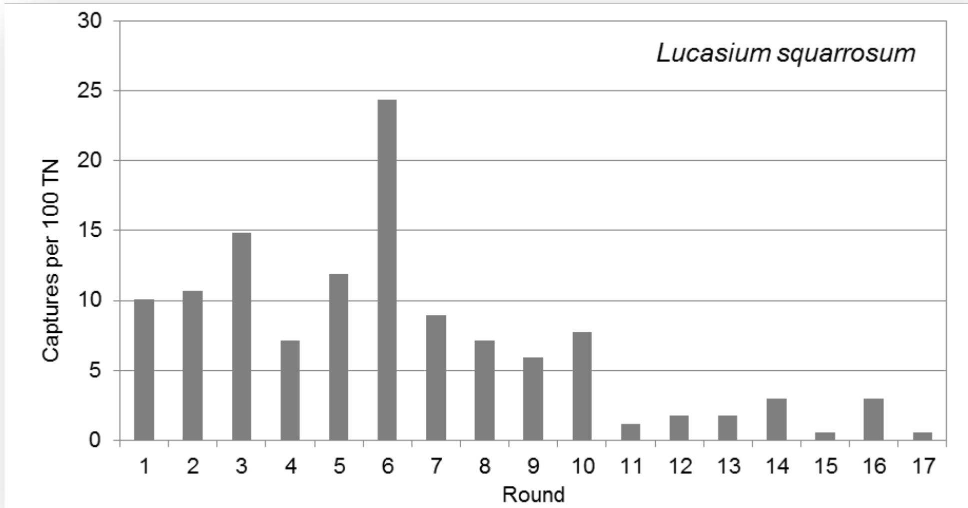
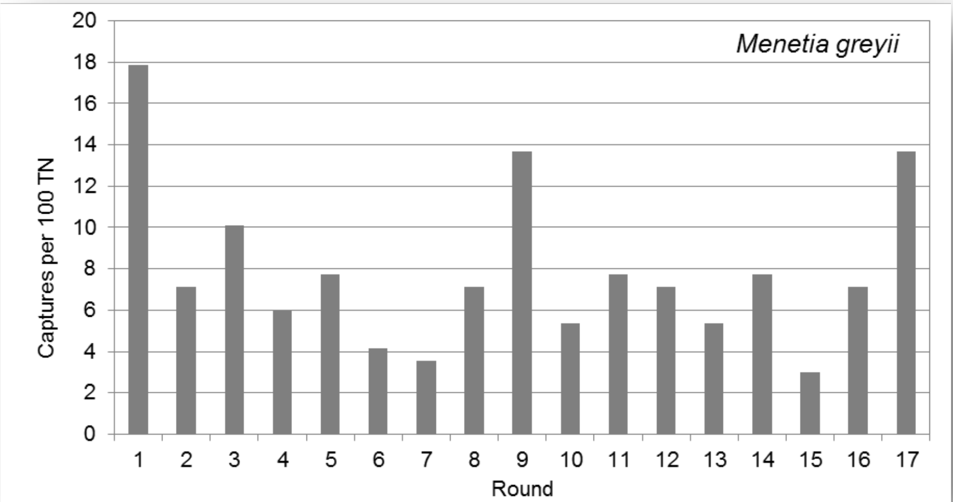
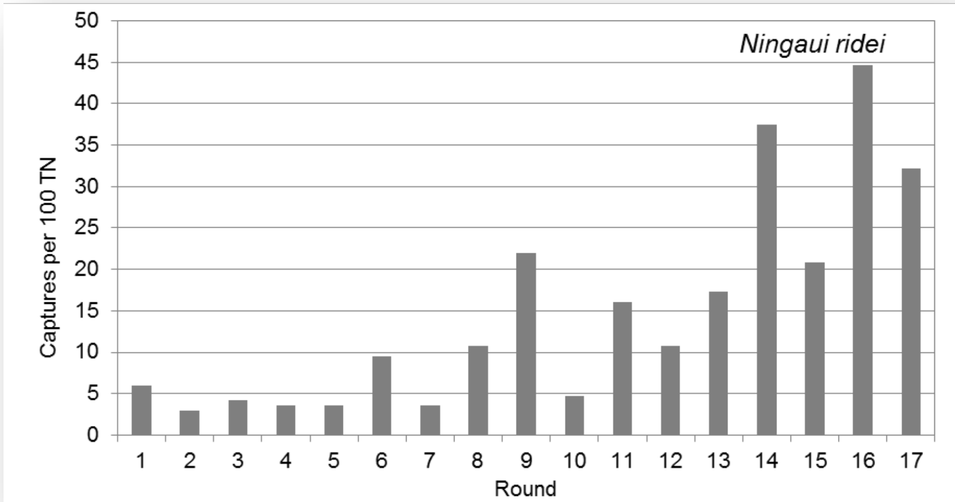
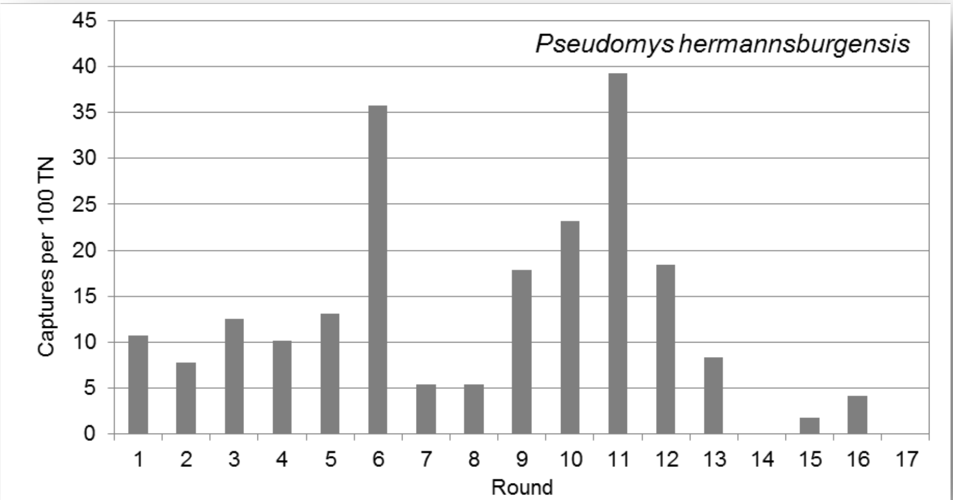
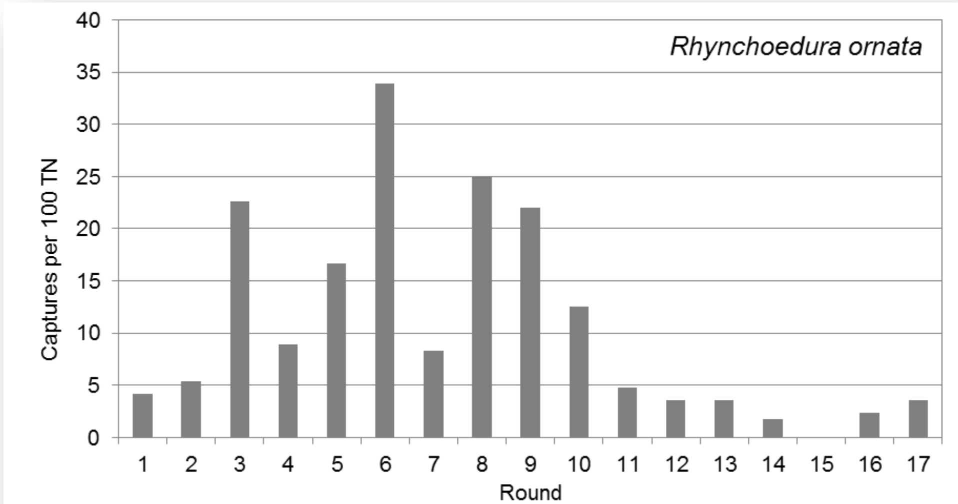
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


Lucasium squarrosum
Captures per 100 TN
Round
0 5 10 15 20 25 30
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17


Menetia greyii
Captures per 100 TN
0
2
4
6
8
10
12
14
16
18
20
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round


Ningaui ridei
Captures per 100 TN
0
5
10
15
20
25
30
35
40
45
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round


Pseudomys hermannsburgensis
Captures per 100 TN
0
5
10
15
20
25
30
35
40
45
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round


Rhynchoedura ornata
Captures per 100 TN
0
5
10
15
20
25
30
35
40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Round

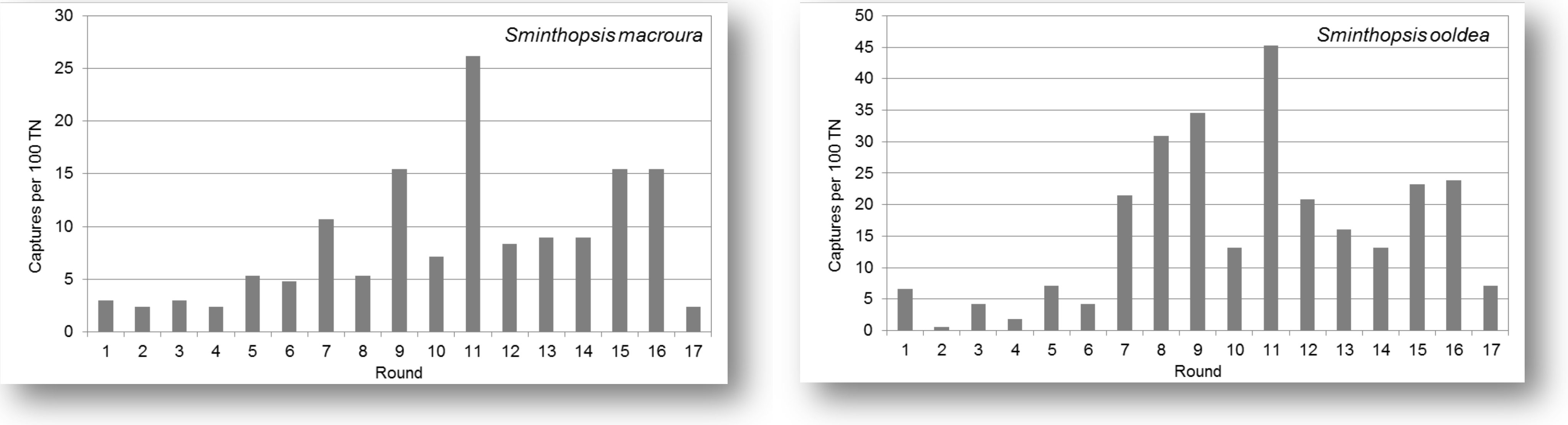


Figure 7 Number of captures per 100 trap nights for the 24 sites combined for each round of trapping for the ten most abundant species.

1.4 Discussion

Overall, relative abundance and rcihness showed a declining trend over the observation period. However, the models were not strong, probably because of the high variability between between years, families and species. These patterns of variation are common for small vertebrate fauna in Australia's semi-arid and arid ecosystems (Dickman *et al.* 1999; Letnic and Dickman 2005; Moseby *et al.* 2009; Pavey and Nano 2013). The varibability is likely to be due to a number of intrinsic and environmental factors, such as the phylogeny and life history of the fauna, rainfall, fire, availability of food resources, habitat type, and predation pressure (Letnic and Dickman 2010). Some of the variables that may influence abundance and diversity will be tested in the following chapter of this report.

2 Responses to environmental variables

2.1 Introduction

The Lorna Glen adaptive management program aims to improve and maintain habitat quality and to monitor resource condition so that adjustments can be made to the management program (Burrows 2007). Management of small mammal and reptile communities, and their habitats, requires an understanding of the environmental drivers of variation in abundance and species richness (Elzinga *et al.* 2001). This helps predict the likely responses of small fauna to changes in habitat heterogeneity, composition and condition, which may result from management actions or other factors that cannot be controlled by managers. The purpose of this chapter is to assess population responses of small mammals and reptiles to environmental variables at Lorna Glen.

2.2 Methods

Bray Cutis similarity (square root transformed) was used to prepare a two way table of similarity between sites and species and multi-dimensional scaling was used to examine similarity of species abundance for sites. These analyses were conducted on the total number of observations for each species across all observation periods using Primer-e.

Total abundance and the Chao 1 richness estimator were calculated for each site using Biodiversity R (Kindt 2004). The Chao 1 algorithm (Chao 1984) estimates the number of species that may be present, but which may not have been observed (Colwell *et al.* 2004) as follows:

$$\hat{S}_{Chao\ 1} = S_{obs} + a1^2/(2*a2)$$

where S_{obs} is the observed number of species in the dataset, $a1$ and $a2$ are the number of species occurring in only one or two sites.

The monitoring sites were mapped with layers representing environmental data in ArcMap 10.0, and each site was classified according to its IBRA region, rangeland system, regolith type, geology code, soil unit, habitat type, vegetation code and fire status (as defined in Appendix 4). For fire status, monitoring sites were mapped with fire scars either from natural fires or controlled burns conducted under the Lorna Glen fire management plan (DEC 2003), between 1998 and 2010. A spatial query was then used to identify sites within 500 m and

2,000 m of a fire scar. These sites were classified as mosaic and those outside these distances were classified as non-mosaic.

Repeated measures ANOVA was used to examine the relationship between captures per 100 TN and species per 100 TN with round of monitoring as the repeated (time) factor, using JMP 9 software (SAS Institute Inc.). Post-hoc Tukey's HSD tests were used to rank variables on the basis of captures and species.

2.3 Results

In total 6,052 captures were made for 81 species across the 24 monitoring sites (Appendix 3). The distribution of the total number of observation for each species across sites is shown in Appendix 3. Figure 8 shows two way similarity between sites and species and Figure 9 shows similarity between sites for species abundance.

The environmental variables for each monitoring site are shown in Table 2 with total abundance and Chao 1 richness. Definitions for the environmental variable codes are shown in Appendix 4 and photographs of local habitat at each site are shown in Figure 10.

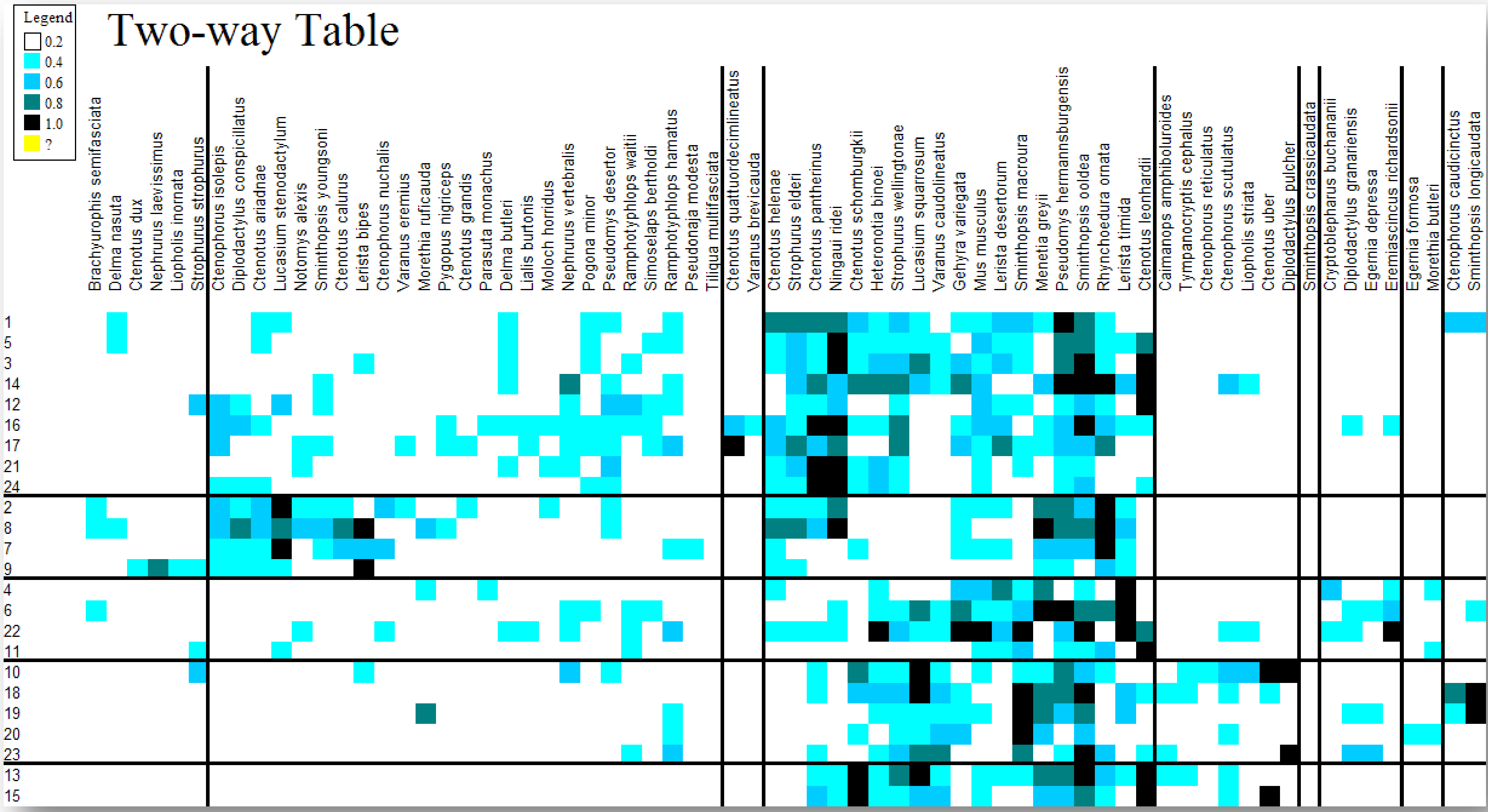


Figure 8 Similarity between sites and species based on total abundance using Bray-Curtis similarity (excluding species recorded only once or twice).

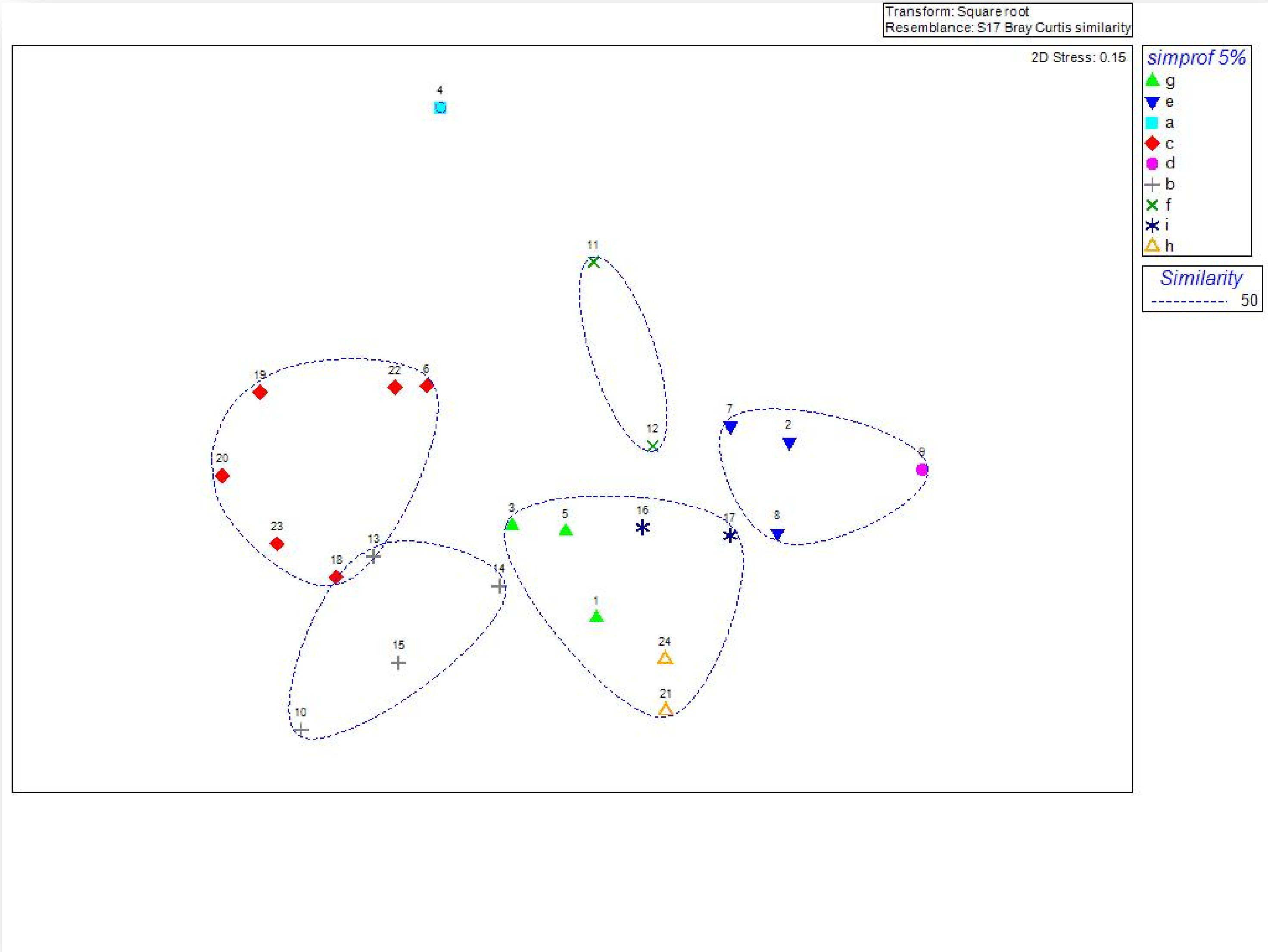


Figure 9 Similarity between sites for species abundance using multi-dimensional scaling. Ellipses show 50% similarity.

Table 2. Environmental variables for the monitoring sites (see Appendix 4 for the definitions), shown with total abundance and Chao 1 richness.

Site	IBRA region	Land system	Regolith type	Geology code	Soil unit	Habitat	Vegetation code	Fire mosaic (500m)	Fire mosaic (2,000m)	Total abundance	Chao 1 richness
LGS1	Murchison	Sherwood	Exposed	PLEy	BE2	Hummock grassland	a1e21Sr t2Hi	Mosaic	Mosaic	211	31.25
LGS2	Murchison	Bullimore	Sandplain	Czs	AB14	Hummock grassland	a1e21Sr t2Hi	Mosaic	Mosaic	256	36.00
LGS3	Gascoyne	Cunyu	Colluvium	Czc	Fa8	Shrubland	a1Si	Non mosaic	Mosaic	201	36.43
LGS4	Gascoyne	Cunyu	Calcrete	Czp	SV5	Succulent steppe	k3Ci	Non mosaic	Non mosaic	109	31.00
LGS5	Gascoyne	Glengarry	Calcrete	Czc	Fa8	Shrubland	a1Si	Non mosaic	Non mosaic	261	47.17
LGS6	Gascoyne	Cunyu	Calcrete	Czk	BB9	Low woodland	a1Li	Non mosaic	Non mosaic	246	30.67
LGS7	Murchison	Bullimore	Sandplain	Czs	BE2	Hummock grassland	a1e21Sr t2Hi	Mosaic	Mosaic	400	45.50
LGS8	Murchison	Bullimore	Sandplain	Czs	AB14	Hummock grassland	a1e21Sr t2Hi	Mosaic	Mosaic	354	74.00
LGS9	Murchison	Bullimore	Sandplain	Czs	AB14	Hummock grassland	a1e21Sr t2Hi	Mosaic	Mosaic	423	47.25
LGS10	Gascoyne	Dural	Colluvium	Czc	Oc49	Shrubland	a1Si	Non mosaic	Non mosaic	252	31.00
LGS11	Gascoyne	Carnegie	Lacustrine	Czb	SV5	Succulent steppe	k3Ci	Non mosaic	Non mosaic	245	36.00
LGS12	Gascoyne	Carnegie	Lacustrine	Qg	SV5	Succulent steppe	k3Ci	Non mosaic	Non mosaic	248	45.17
LGS13	Gascoyne	Kalyaltcha	Colluvium	Qc	Oc49	Succulent steppe	a1Si k2Ci	Non mosaic	Non mosaic	221	22.86
LGS14	Gascoyne	Belele	Colluvium	Qc	Oc49	Low woodland	a1Lp	Non mosaic	Non mosaic	306	62.00
LGS15	Gascoyne	Jundee	Colluvium	Qc	Oc49	Low woodland	a1Lp	Non mosaic	Non mosaic	283	47.00
LGS16	Gascoyne	Bullimore	Colluvium	Qz	AB14	Hummock grassland	anSr t2Hi	Non mosaic	Mosaic	300	46.50
LGS17	Gascoyne	Bullimore	Sandplain	Qs	AB14	Hummock grassland	anSr t2Hi	Mosaic	Mosaic	254	43.50
LGS18	Gascoyne	Lynne	Exposed	P_Ew	Oc49	Shrubland	a1Si	Non mosaic	Non mosaic	247	48.33
LGS19	Gascoyne	Sodary	Colluvium	Qc	Oc49	Low woodland	a1Li	Non mosaic	Non mosaic	177	48.50
LGS20	Gascoyne	Yandil	Alluvium	Qa	BE6	Succulent steppe	a1Li k3Ci	Non mosaic	Non mosaic	154	34.43
LGS21	Gascoyne	Lorna	Alluvium	Czl	Oc49	Succulent steppe	a1Si k2Ci	Non mosaic	Non mosaic	252	35.20
LGS22	Gascoyne	Sodary	Colluvium	PLEd	Oc49	Bare areas	sl	Non mosaic	Mosaic	161	51.00
LGS23	Gascoyne	Sodary	Colluvium	Qc	Oc49	Low woodland	a1Li	Mosaic	Mosaic	173	54.50
LGS24	Gascoyne	Yanganoo	Colluvium	Qz	Oc49	Low woodland	a1Li	Non mosaic	Non mosaic	318	78.50


LGS1


LGS2


LGS3


LGS4


LGS5


LGS6

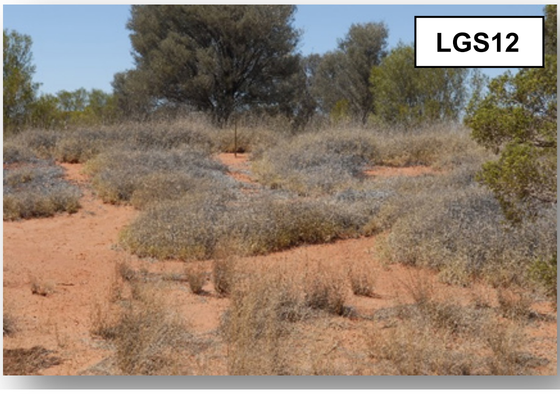

LGS7


LGS8


LGS9


LGS10


LGS11


LGS12


LGS13


LGS14


LGS15


LGS16

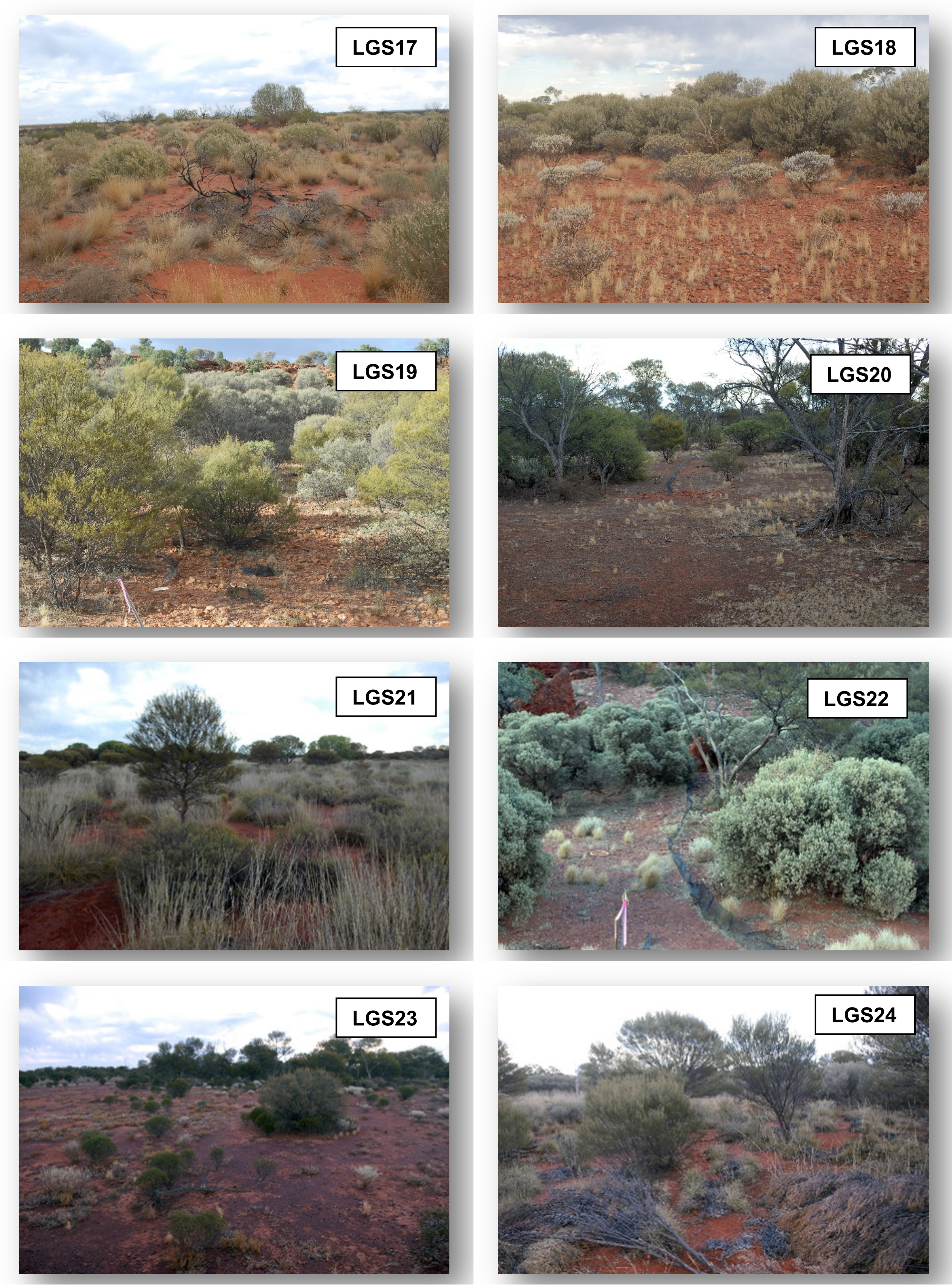


Figure 10. Photographs of the monitoring sites showing local habitat type.

Captures per 100 TN varied significantly between IBRA region and habitat (Table 3). Species per 100 TN varied significantly between IBRA region, soil unit, habitat, vegetation code and fire mosaic within 500 m (Table 4).

Table 3. Results of repeated measures ANOVA models comparing captures per 100 TN with environmental variables (significant relationships are shown in bold). Contrasts result from Tukey's HSD tests (P = 0.05) and n.s.d. = no significant difference.

Parameter	F	d.f.	P	Contrasts
IBRA region	9.00	1,22	**0.0066**	Murchison > Gascoyne
Land system	1.95	13,10	0.1477	n.s.d.
Regolith type	2.35	5,18	0.0821	n.s.d.
Geology code	2.18	13,10	0.1117	n.s.d.
Soil unit	1.66	6,17	0.1911	n.s.d.
Habitat	2.97	6,19	**0.0464**	Hummock grassland > Low woodland, Shrubland > Succulent steppe, Bare areas
Vegetation code	0.985	8,15	0.1457	n.s.d.
Fire mosaic 500 m	0.173	1,22	0.0638	n.s.d.
Fire mosaic 2,000 m	0.0634	1,22	0.2489	n.s.d.

Table 4. Results of repeated measures ANOVA models comparing species per 100 TN with environmental variables (significant relationships are shown in bold). Contrasts result from Tukey's HSD tests (P = 0.05) and n.s.d. = no significant difference.

Parameter	F	d.f.	P	Contrasts
IBRA region	5.66	1,22	**0.0265**	Murchison > Gascoyne
Land system	2.19	13,10	0.1092	n.s.d.
Regolith type	0.614	5,18	0.0984	n.s.d.
Geology code	1.67	13,10	0.2108	n.s.d.
Soil unit	2.74	6,17	**0.0478**	AB14 > BE2 > BB9 > Oc49, Fa8 > SV5, BE6
Habitat	4.88	4,19	**0.0071**	Hummock grassland > Low woodland > Shrubland, Bare areas > Succulent steppe
Vegetation code	3.05	8,15	**0.0298**	anSr t2Hi, a1Lp, a1e21Sr t2Hi > a1Si > a1Li > a1Si k2Ci, sl > k3Ci > a1Li > k3Ci
Fire mosaic 500 m	4.10	1,22	**0.0553**	Mosaic > non-mosaic
Fire mosaic 2,000 m	3.71	1,22	0.0672	n.s.d.

2.1 Discussion

Both abundance and richness varied widely across the study area and the sites fell into five primary groups of similarity, while site LGS 4 was an outlier. Relative abundance and richness were significantly higher for the Murchison, than Gascoyne IBRA region and this is likely to be reflective of the habitat types that occur in these regions. The Murchison is characterised by hummock grasslands on sandplains and low woodland on alluvial and eluvial surfaces, while the Gascoyne region is comprised of open mulga woodlands and mulga scrub on shallow loams over hardpan soils and salt lakes with succulent steppes (Appendix 4). Hummock grassland and low woodland were predictors of high relative abundance and richness, followed by low woodland and shrubland and lowest for succulent steppe and bare areas (salt lakes). Although not demonstrated in this study, these patterns are likely to reflect a gradient of resource availability since soil fertility, moisture and other resources, like seeds and prey for small vertebrates are more abundant in habitats with grass hummocks, shrubs and trees, than sparsely vegetated areas in arid ecosystems (Garner and Steinberger 1989; Soliveres *et al.* 2011).

While the influence of habitat was relatively strong in this study, particularly for species richness, other studies have yielded variable results. For example, Read (1992) found no relationship between habitat and small vertebrate abundance or diversity in arid South Australia, while Paltridge and Southgate (2001) found abundance was higher for sandplain than palaeodrainage habitat in the Northern Territory, but only for small replies and not small mammals.

Letnic and Dickman (2010) pointed out that the evidence for variation in abundance and diversity with habitat type is not strong for small mammals, but the majority of the studies they reviewed were designed to test other effects such as rainfall and fire and thus often contrasted only two habitat types. This may be because of a lack of heterogeneity in the subject study areas or because the researchers sought to maximise statistical power for the subject variable by limiting the number of habitat types compared.

The responses of small vertebrates to fire is complex, probably because of the large number of variables and interactions involved (Bradstock *et al.* 2012). The statistical tests conducted in this study showed that while abundance was marginally higher, richness was significantly higher for sites within 500 m of a fire mosaic and the pattern was continued for sites within 2,000 m of a fire mosaic ($P = 0.0571$). However, fire scars primarily occurred in association with hummock grasslands, which were also associated with high richness (see Figure 11). A post-hoc likelihood ratio test showed that habitat type explained 31 % of the variation in richness, while proximity to a mosaic within 500 m explained only 2 % of the variation in richness. In addition, when both habitat and fire status were included in an ordinal logistic regression model, richness varied significantly with habitat type (d.f. = 4, ChiSq = 10.93, $P = 0.0273$), but not fire status (d.f. = 1, ChiSq = 0.0023, $P = 0.9614$). These post-hoc analyses suggested that habitat type was more likely to have been the driving factor predicting richness than proximity to a fire mosaic in this study, but this does not entirely eliminate fire status as having an influence.

One of the limitations of this study is that spatial intersects were used to classify the habitat types for the sites and these data may not accurately represent local habitat type. This is because habitat types were assigned using corporate datasets mapped at scales of 1:250,000 or 1:100,000. After the analyses had been undertaken, photographs of the study sites were obtained (Figure 10), and these showed that the spatial datasets did not accurately represent the local habitat type shown in the photographs for many of the study sites. This would almost certainly have reduced the accuracy of the assessment of the influence of habitat on relative abundance and richness. It also shows the importance of documenting and storing survey information in corporate data repositories.

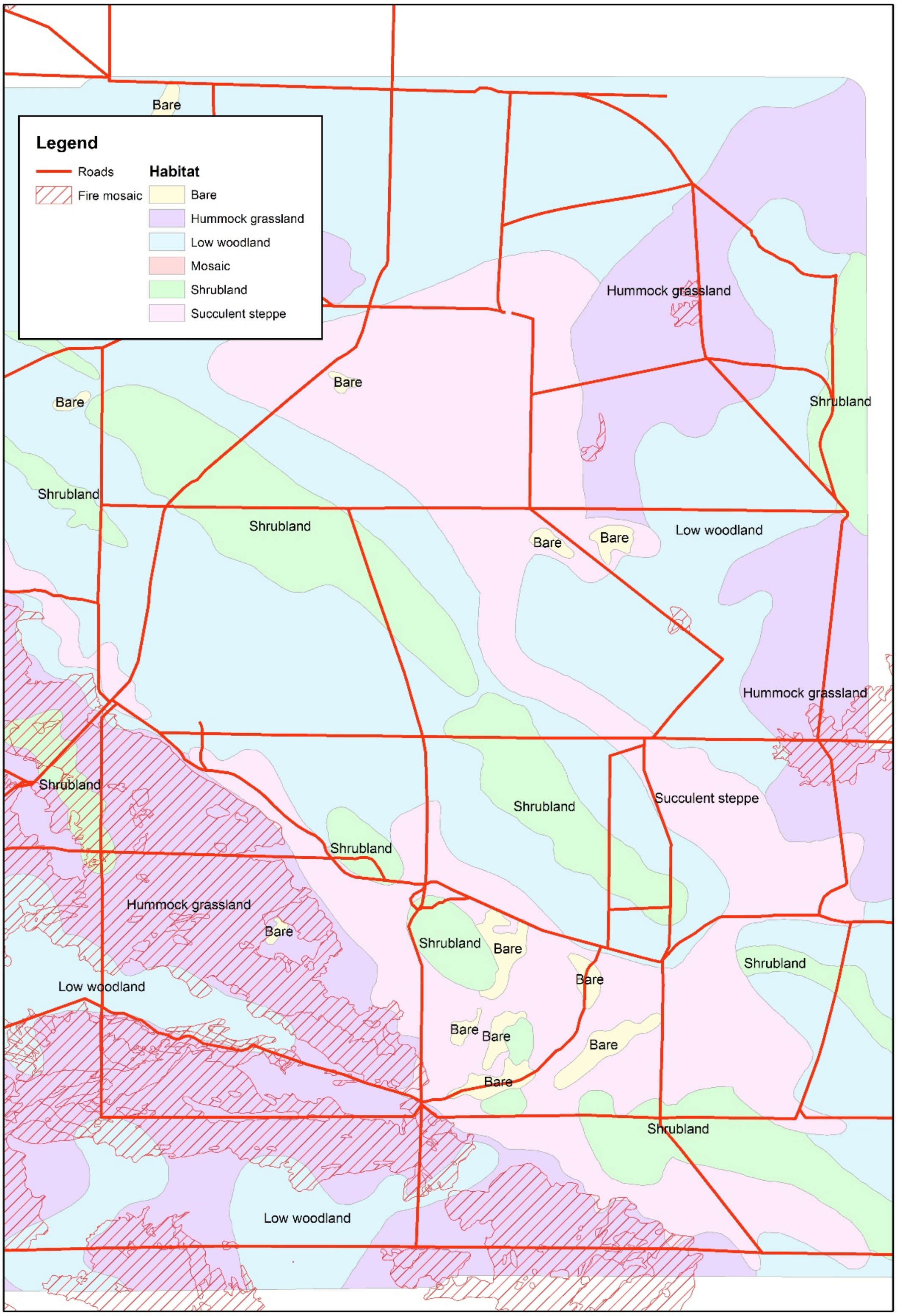


Figure 11. Spatial relationship between habitat type and fire mosaic (sites burnt since 1998).

3 Responses to rainfall and cat activity

3.1 Introduction

Patterns of rainfall at Lorna Glen were examined and models were assessed to determine the influence of rainfall on the relative abundance of small vertebrate fauna. Patterns of variation in relative abundance of fauna with cat control data were also examined.

3.2 Methods

Records for monthly rainfall for Lorna Glen were obtained from the Australian Bureau of Meteorology. Missing values were substituted with those from the nearest station, Wongawol, which is 43km east of Lorna Glen. Rainfall was charted and seasonal trend decomposition based on Loess (Cleveland *et al.* 1990) was used to examine seasonal rainfall patterns and trends using R 3.0.1. Long-term trend in rainfall was tested using log-linear fit in JMP 9 (SAS Institute Inc.).

Time series analysis was employed using JMP 9 (SAS Institute Inc.) to determine the 'lag' time between relative abundance of fauna and total monthly rainfall. First, relative abundance of fauna and total monthly rainfall were correlated and missing values for abundance were interpolated. The two datasets were then tested for autocorrelation and seasonality. Autoregressive integrated moving average (ARIMA) models were tested to determine which transformation would be needed to ensure the data were de-trended (Shumway and Stoffer 2011). A number of autoregressive terms, non-seasonal differences, and the number of lagged forecast errors were used in the prediction equations and the best fitting models were chosen on the basis of the R^2 value and Akaike information criterion (AIC), which is a measure of the relative quality of a statistical model (Shumway and Stoffer 2011). The required transformations were applied, the data were Johnson Sl transformed and cross-correlation was then used to examine the relationship between observed rainfall and observed captures per 100TN (excluding the interpolated values). The cross-correlation period identified, along with two cumulative periods of rainfall; the preceding 9 months and 12 months were compared with captures using Kendall's rank correlations. These periods were chosen because they are commonly associated with the abundance of small vertebrate fauna in other studies for arid Australia (Dickman *et al.* 1999; Dickman *et al.* 2001; Greenville *et al.* 2012; Bennison *et al.* 2013; Kelly *et al.* 2013).

The Southern Oscillation Index (SOI) is calculated using the pressure differences between Tahiti and Darwin and is a predictor of the development and intensity of El Niño or La Niña events in the Pacific Ocean (El Niño–Southern Oscillation (ENSO), Bureau of Meteorology). El Niño is associated with drought conditions and La Niña is associated with wet conditions, but patterns can vary locally with other factors (Holmgren *et al.* 2006a). Variation in the relative abundance of fauna between El Niño, La Niña and regular rainfall events were tested using a non-parametric Wilcoxon Rank-Sum Test.

Cat baiting and activity data were obtained from Algar *et al.* (2013) and relative abundance was tested between pre- and post-cat baiting periods using a non-parametric Wilcoxon Rank-Sum Test. The relationship between relative abundance and two measures of cat activity, Track Count Index and Plot Activity Index (see Algar *et al.* 2013 for details), was examined using Kendall's rank correlations.

3.3 Results

Observed rainfall

Observed rainfall for Lorna Glen is shown in Figure 12 and the long term mean monthly rainfall was 21.5 mm (s.e. = 1.2, n = 876). No long-term trends in rainfall were detected (F= 1.902, R^2 = 0.0023, P = 0.1683) and the equation was Log (Monthly rainfall) = 1.0828094 + 0.0001256*month. Rainfall showed a seasonal irregular variation, and was relatively high in January, February and March and relatively low from August to October (Figure 13). The trend cycle in rainfall was irregular (Figure 14).

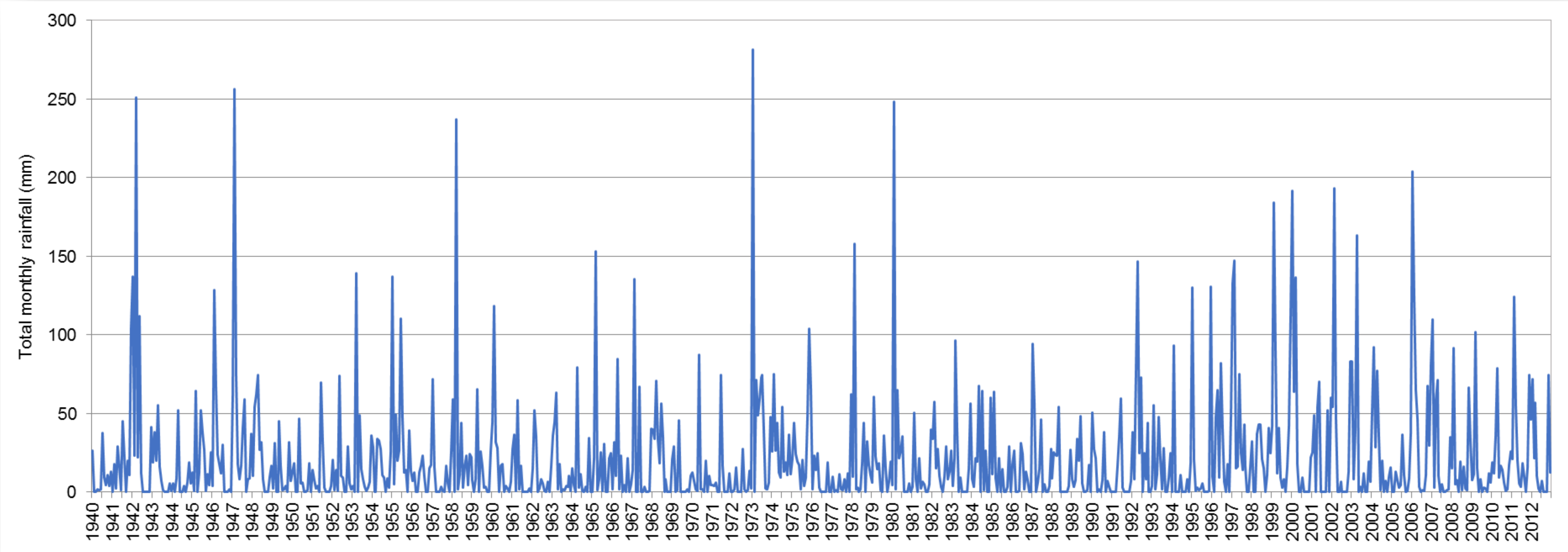


Figure 12. Observed rainfall for Lorna Glen 1940-2012.

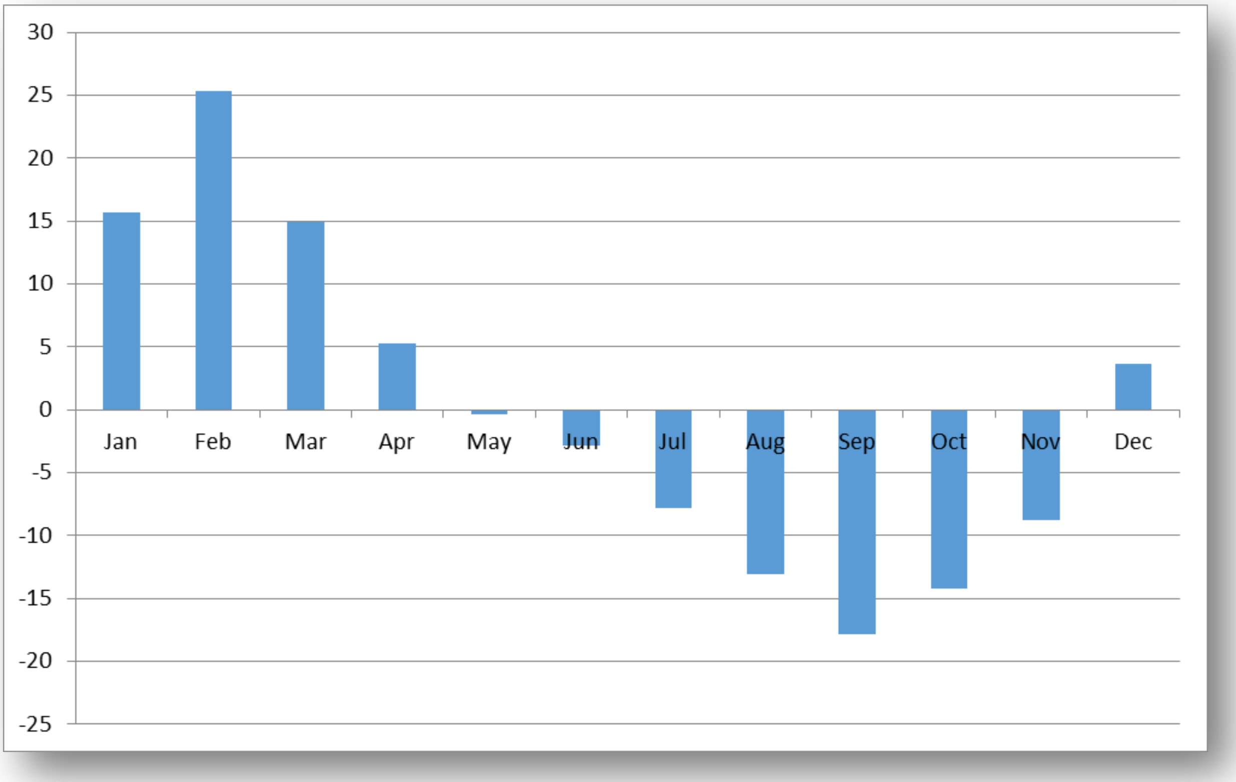


Figure 13. Seasonal decomposition plot of monthly rainfall for Lorna Glen 1940-2012.

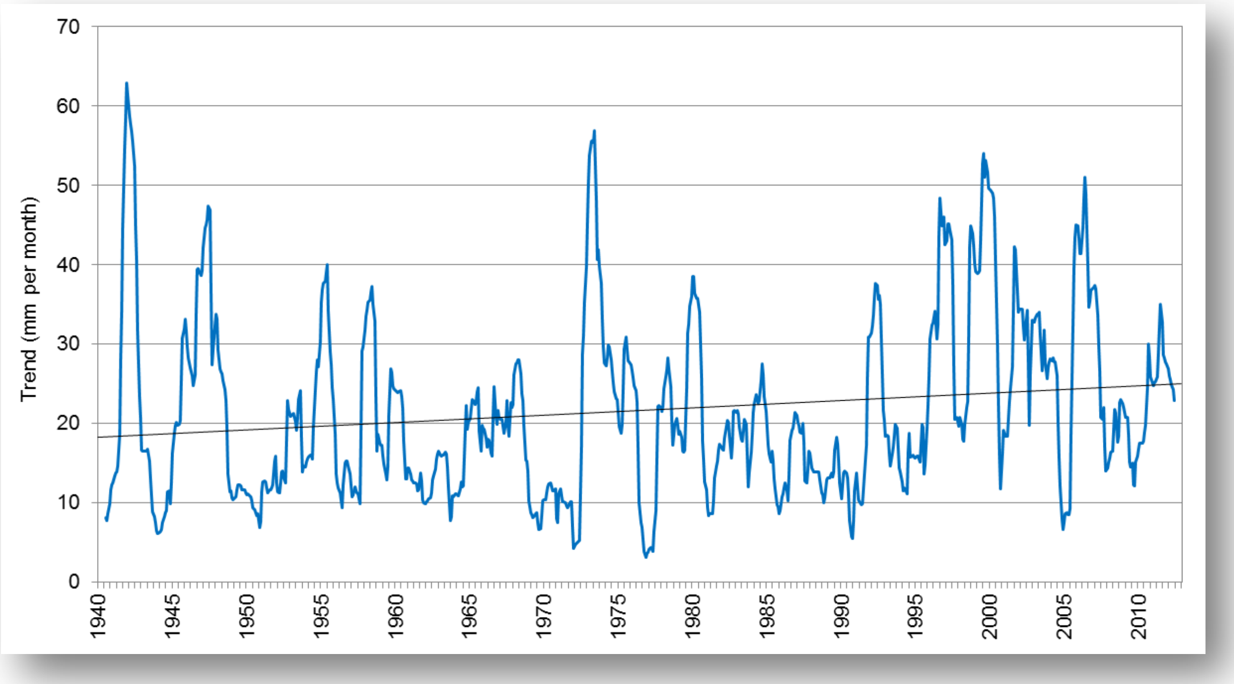


Figure 14. Trend cycles for monthly rainfall for Lorna Glen 1940-2012.

During the monitoring period, annual rainfall was highly variable and was above the average of 312 mm in 2002 and 2011 and more than twice the average in 2006 (Figure 15). Annual rainfall was below average in 2005, 2008, 2009 and 2010 (Figure 15).

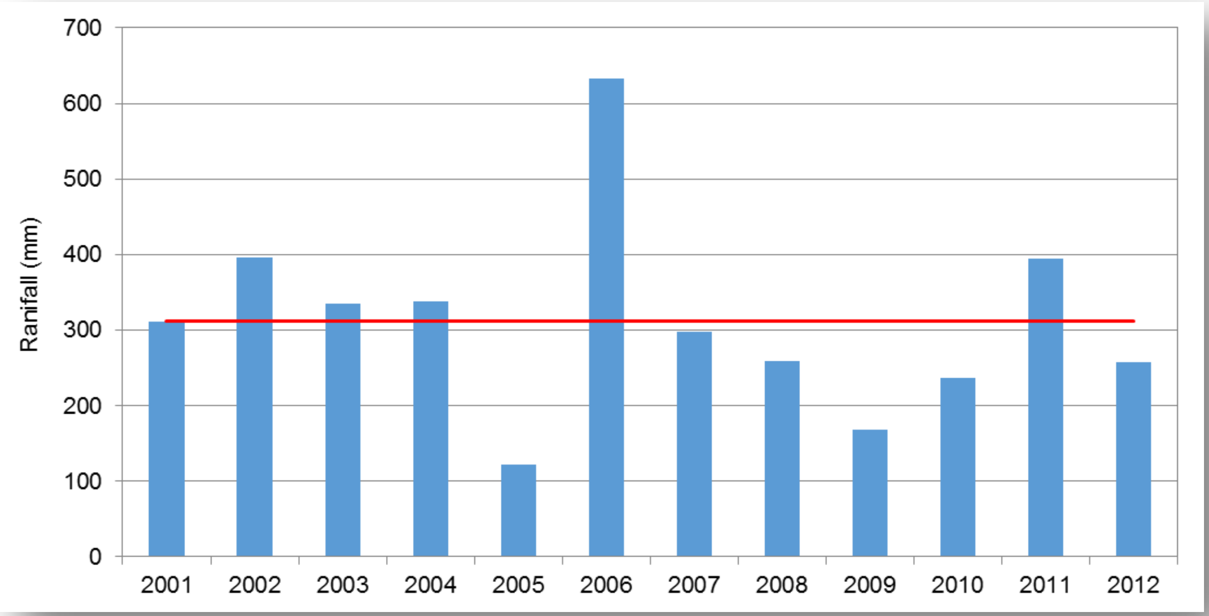


Figure 15. Total annual and mean annual rainfall (red line) for the monitoring period.

Figure 16 shows the mean number of captures per 100 trap nights relative to total monthly rainfall and El Niño, La Niña and regular rainfall events.

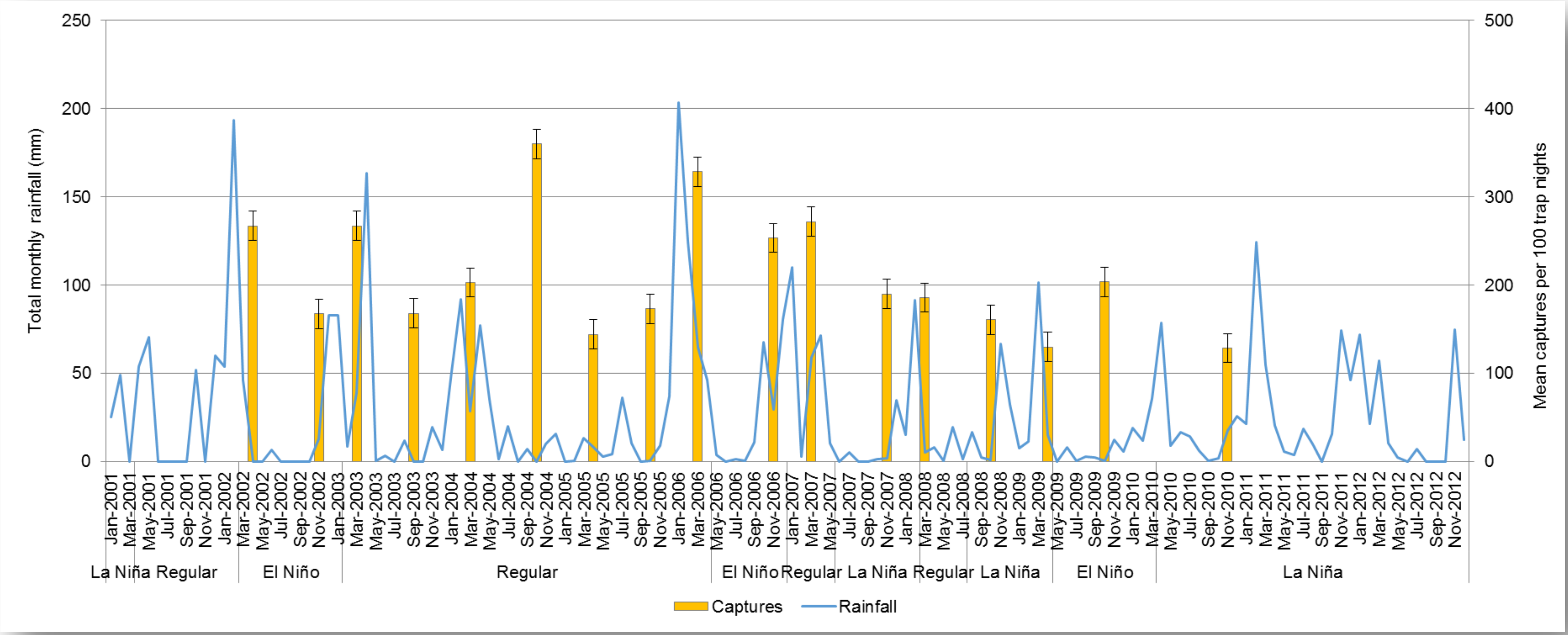


Figure 16. Comparison of observed rainfall and mean captures per 100 trap nights for the monitoring period. Bars show standard error.

Time series analysis of relative abundance and rainfall

The results of the ARIMA models tested for rainfall and imputed captures per 100 trap nights are shown in Appendix 6. The resulting time series analysis showed that strongest positive correlation between abundance and rainfall were in the five months around the month in which trapping was undertaken (Figure 17).

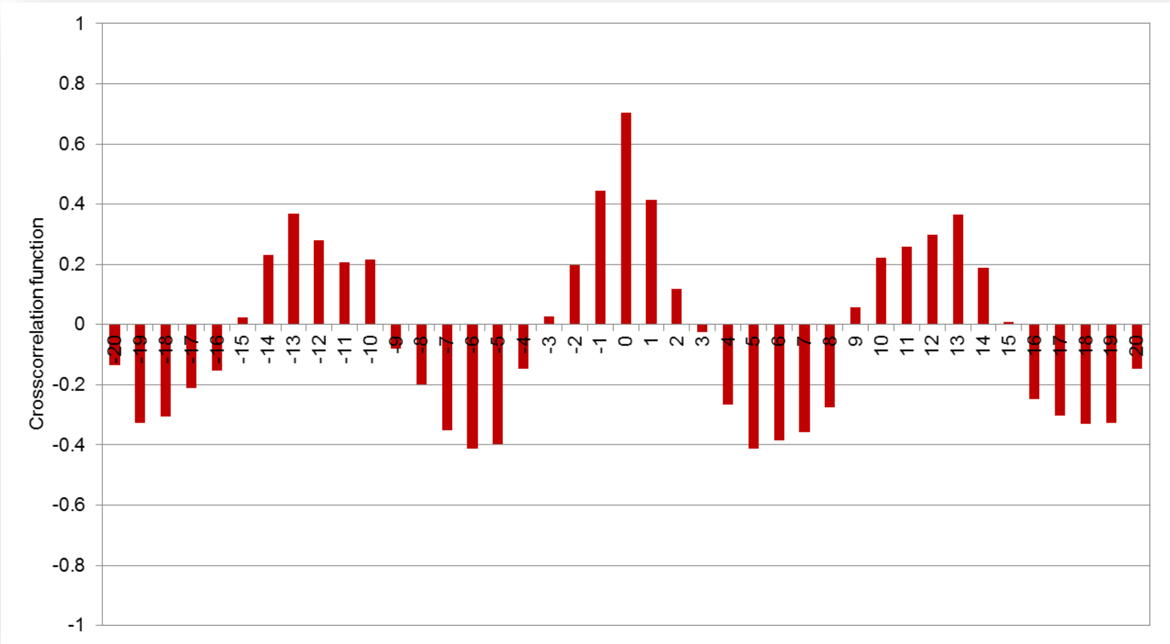


Figure 17. Cross-correlation for observed rainfall and captures per 100TN (horizontal axis shows lag in months).

Figure 18 shows three scenarios comparing relative abundance and rainfall and post-hoc testing showed that the strongest relationship was the sum of the five months around the trapping months and the nine months prior to trapping (Figure 19, Table 5). The log linear model was $R^2 = 0.36$, $P = 0.0115$ (Ln(Captures per 100TN) = 3.4766394 + 0.3146385*Ln(5 m + -9m)).

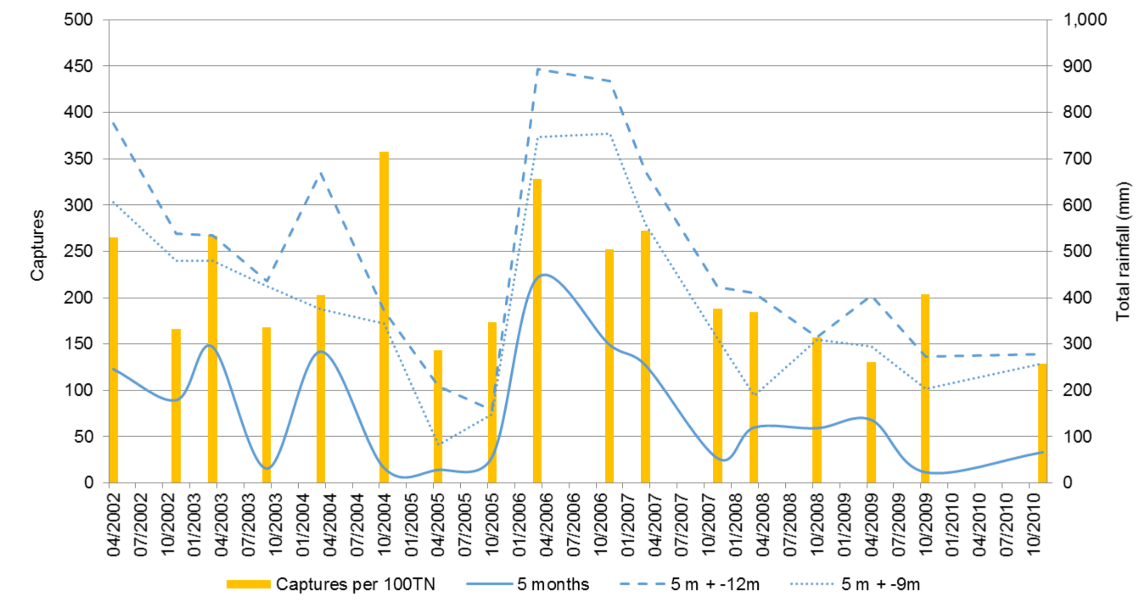


Figure 18. Comparison of captures per 100 trap nights, total rainfall in the five month period around the trapping month and five month period around the trapping month, plus the previous 9 and 12 months.

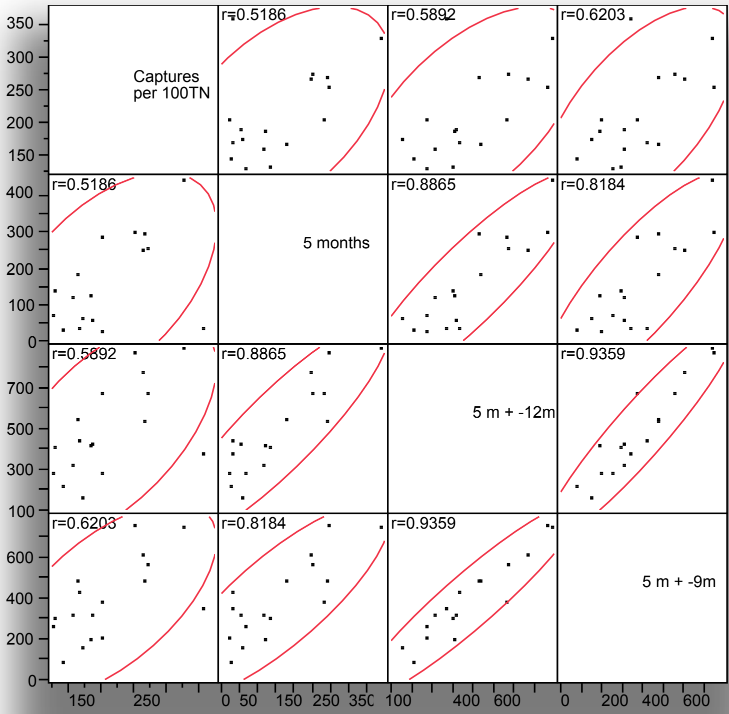


Figure 19. Correlations between captures per 100 trap nights, total rainfall in the five month period around the trapping month and five month period around the trapping month plus the previous 9 and 12 months.

Table 5. Results of Kendall's non-parametric correlations between captures per 100 trap nights, total rainfall in the five month period around the trapping month and five month period around the trapping month plus the previous 9 and 12 months (n = 17).

Sum of	Kendall's τ	P
5 months	0.2941	0.0994
5 m + - 12 m	0.3824	0.0211
5 m + - 9 m	0.4412	0.0135

Captures per 100 trap nights was related to SOI event, with the lowest number of captures during La Niña (Figure 20). However, the probability value exceeded 0.05 and the model was not strong (R^2 = 0.31, X^2 = 0.0763, d.f. = 2,14, P = 0.0763).

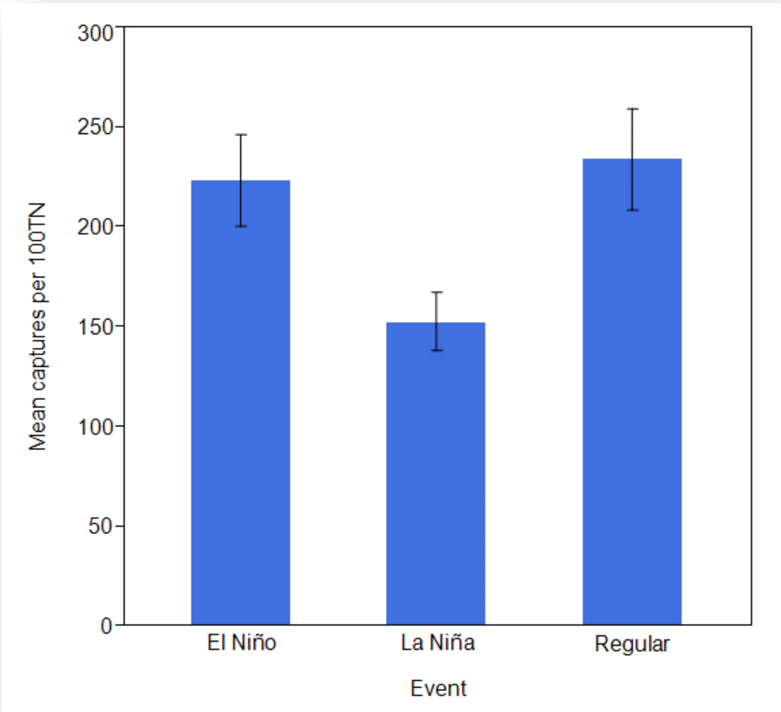


Figure 20. Comparison of captures per 100 TN pre and SOI periods, showing mean and standard error.

Responses to feral cat activity

Relative abundance is shown with cat baiting data, from Algar *et al.* (2013), in Table 6. Analyses were hampered by small sample sizes, but captures per 100 trap nights did not differ significantly between cat baiting period ($R^2 = 0.02$, $X^2 = 0.0476$, d.f. =1,5, P = 0.8273, Figure 21) or the two measures of cat activity (Table 7).

Table 6. Captures per 100 trap nights shown with cat control data from Algar *et al.* (2013).

Year	Season	Cat baiting period	Captures per 100TN	Track count index (TCI)	Plot activity index (PAI)
2002	Autumn		265		
2002	Spring		166		
2003	Autumn		267		
2003	Spring		168		
2004	Autumn		203		
2004	Spring		358		
2005	Autumn		143		
2005	Spring		173		
2006	Autumn		328		
2006	Spring		252		
2007	Autumn	Pre	272	8.33	0.046
2007	Spring	Post	188	7.43	0.044
2008	Autumn	Pre	185	6.29	0.03
2008	Spring	Post	157	2.43	0.02
2009	Autumn	Pre	130	7.33	0.032
2009	Spring	Post	204	3.7	0.016

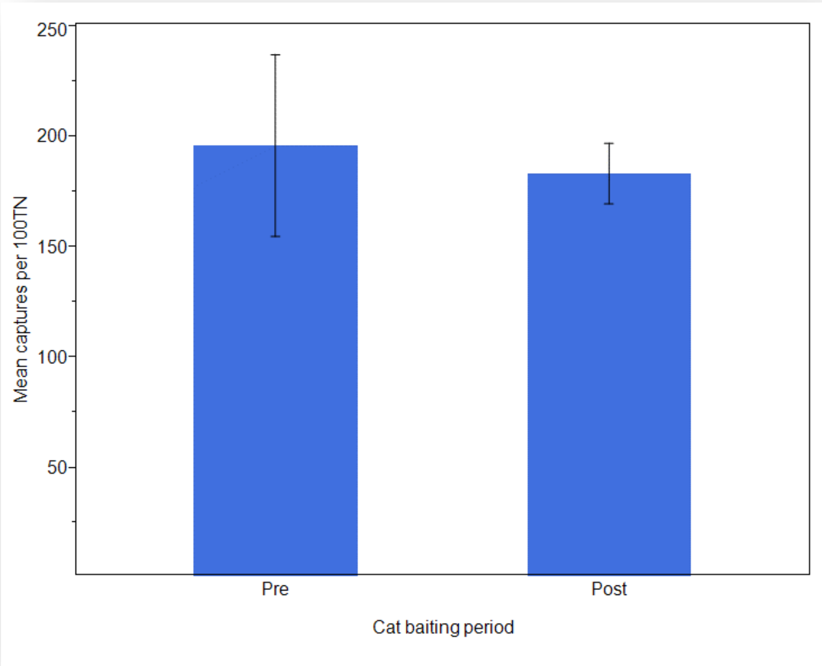


Figure 21. Comparison of captures per 100 TN pre and post cat baiting, showing mean and standard error.

Table 7. Results of non-parametric correlations between captures per 100 tap nights and measures of cat activity.

Captures correlated with	Kendall τ	P
Pre-Track count index	0.4286	0.1765
Plot activity index	0.2000	0.5730

3.4 Discussion

The commonly accepted model of the effects of climate and predators on arid- and semi-arid ecosystems is as follows: pulses of rainfall during La Niña events increase resource availability and fauna populations, which is followed by increases in predator populations, leading to fauna population crashes during El Niño events (Holmgren *et al.* 2006b). While there are examples of increases in fauna populations in response to rainfall following La Niña events (Lima *et al.* 2002; Holmgren *et al.* 2006b), reviews often include single species studies or include medium to large mammals (McCarthy 1996; Short *et al.* 1997) and waterbirds (e.g. Kingsford *et al.* 1999). However, responses of small reptiles and mammals, like those in the present study are more complex, paticularly when species assemblages are taken into account (see discussion by Letnic and Dickman 2010).

In this study, there was no detectible association between relative abundance and ENSO events, which would be indicative of the 'boom' and 'bust' model. One reason for this may be because the entire population was included in this analysis and many of the examples of the effects of ENSO cycles on fauna have been for single species and groups of species. It may be that phylogenetic groups of fauna at Lorna Glen respond differently to ENSO cycles. For example, while rodents commonly increase in number after high rainfall events (Holmgren *et al.* 2006b), other groups like insectivorous dasyurids do not follow this scenario and may even decline after high rainfall (Letnic and Dickman 2010). In this study, although the model was weak, captures were relatively low during La Niña, or wet, conditions and this may be related to finer scale factors such as climatic conditions during the days when trapping was conducted. As Fox (2011) pointed out, this state-and-transition model (as it was termed by Letnic *et al.* (2004)), is very complex and may not be obvious in low frequency trapping designs such as the present study. Establishing the influence of rainfall would require more detailed long term study of taxa dependent responses and analysis of local rainfall at the monitoring sites.

Similar to other studies in semi- and arid environments of Australia (see Letnic *et al.* 2011), this study showed that rainfall prior to trapping was probably the strongest regulator of small vertebrate fauna abundance at Lorna Glen. Specifically, rainfall in the nine months prior to trapping, plus the five months about the time of trapping showed the strongest relationship with fauna abundance. This suggests that above average rainfall prior to and cumulative 'follow-up' rains, during trapping may be the key predictors of population increases.

Cat baiting is conducted in winter at Lorna Glen, when prey abundance is relatively low, and bait uptake is maximal (Algar *et al.* 2013). Thus, it might be expected that, if cats had an influence on small fauna populations and baiting is effective at negating the impact of cats, the relative abundance of fauna would be relatively low in autumn and high in spring. However, there were no detectible relationship between measures of cat activity and small vertebrate fauna abundance at Lorna Glen. This may be because the sample size to test this relationship was too small (n = 6). Alternatively, as has been demonstrated for similar studies (Moseby and Hill 2011), it may be that the aerial baiting techniques employed at Lorna Glen are not effective in reducing the impacts cats have on small fauna populations.

Direct relationships between predator and prey abundance have been demonstrated overseas e.g. rodents and raptor abundance in Chile (Lima *et al.* 2002). However, the strength of the relationship between feral cat and small fauna abundance is not usually strong for studies in arid Australia (Letnic *et al.* 2011) and there may be a number of reasons for this. First, irregular trapping, fauna behaviour and associated lags in response to rainfall may mean that the effects of predators on small animal populations are not readily detectible (Letnic *et al.* 2011). Second, irruptions of preferred prey species, like rodents, may result in positive correlations between predator and prey and this may counter any patterns showing prey increases during periods when feral cat activity is in decline (Letnic *et al.* 2011). Third, the direct relationship between predators and prey may be obscured by other regulators of small fauna and predator populations, such as resource availability, competition and disease (Letnic *et al.* 2011).

Although six of the seven baiting events resulted in a measurable reduction in cat activity at Lorna Glen (Algar *et al.* 2013), there was no relationship between measures of cat activity and relative abundance of small fauna. Given that small mammals and reptiles are an important prey item for feral cats in arid Australia (Paltridge *et al.* 1997), these results suggest that even though cat activity declined after baiting (Algar *et al.* 2013), the level of control was not sufficient to result in an increase in small mammal and reptile populations. It may be, therefore, that small fauna populations may increase only in circumstances where feral cats are sufficiently supressed or excluded entirely. In support of this hypothesis, other studies of cat control programs have shown that while the baiting regimes employed had limited effectiveness for controlling feral cats (e.g. Moseby and Hill 2011), cat exclusion can result in increases in small fauna populations (Risbey *et al.* 2000; Moseby *et al.* 2009; Read and Cunningham 2010).

4 Review of the monitoring program

4.1 Introduction

Following the purchase of former pastoral leases Lorna Glen (Matuwa) and Earaheedy (Karrara Karrara) by the state government in 2000, in partnership with the Wiluna Aboriginal Community, the Department of Parks and Wildlife established 'Rangelands Reconstruction (RR)', an holistic, integrated adaptive management program. The aim was to improve ecosystem health and resilience (Burrows 2007), and protect and enhance Martu cultural values. The wildlife conservation efforts are focused on medium size mammals – an element of the biota that has been most significantly impacted since European settlement (McKenzie *et al.* 2007). Figure 22 conceptualises the management model for fauna conservation.

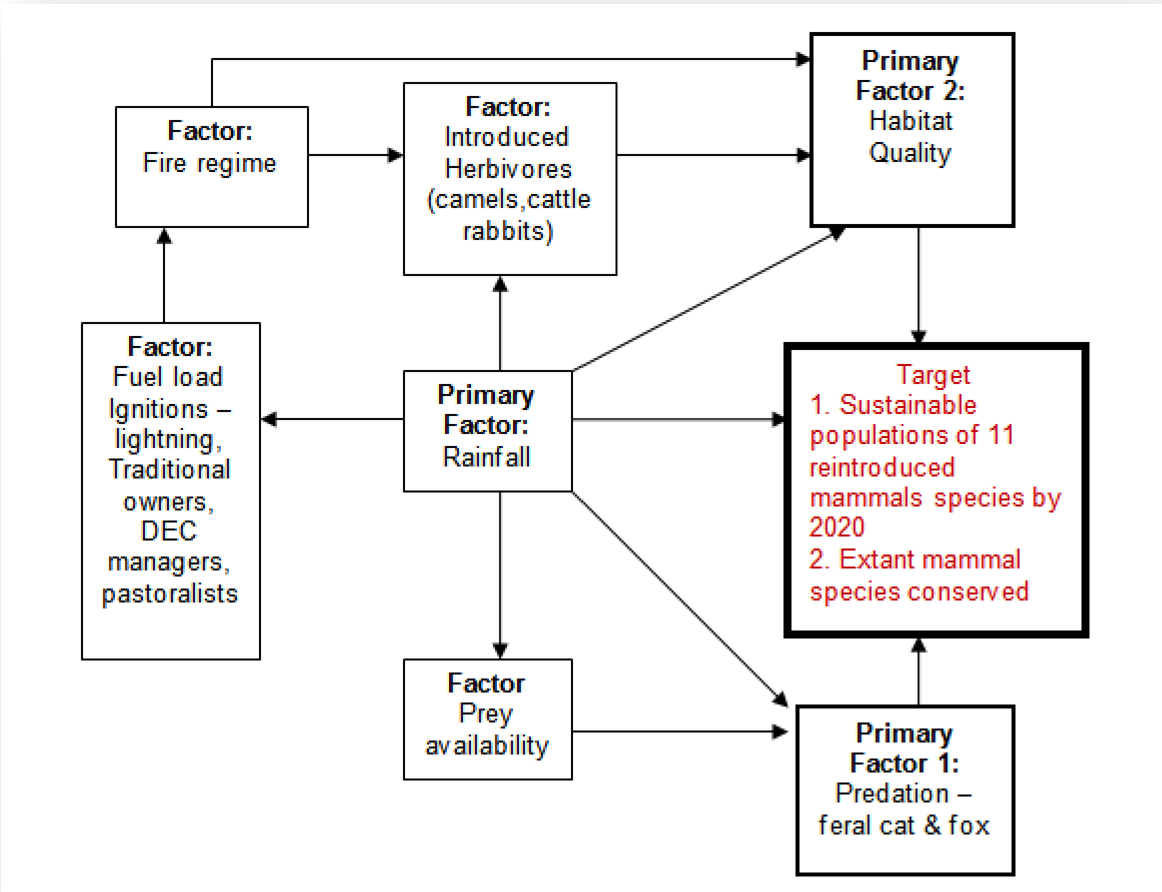


Figure 22 Conceptual model for the management and conservation of medium sized mammals in the Rangelands Reconstruction program.

Consistent with the model at Figure 22, the first stage of RR (on Matuwa) included the following key management actions:

a. Managing threatening processes / factors (introduced herbivores, fire, introduced predators).

b. Reintroducing threatened arid zone mammals – both free range and within a predator-free enclosure.

c. Facilitating the protection and maintenance of Martu cultural values and activities.

d. Facilitating ecological research.

e. Developing infrastructure to support these activities.

Since 2000, major achievements include:

- Significant reduction in populations of introduced herbivores (cattle, camels) and introduced predators (cats, foxes).
- Preparation and implementation of a fire management plan (Burrows and Butler 2011).
- Successful reintroduction of two free-ranging mammal species (bilby and brushtail possum) (Morris and Dunlop 2008).
- Successful reintroduction of four threatened mammal species into a predator enclosure (boodie, golden bandicoot, mala, Shark Bay mouse) (Miller et al. 2010).
- Establishment of productive partnerships with Wiluna Martu, resulting in training and employment opportunities as well as opportunities to 'get back on country' and care for cultural values.
- Upgrade of infrastructure, including boundary fencing.
- Establishment of a network of biodiversity monitoring sites, building on the biological survey sample grids (Cowan 2008).

The long term goal, with respect to arid zone mammal conservation, is to reintroduce a total of 11 threatened medium size species, either free ranging or in an expanded predator free enclosure by 2020.

Consistent with adaptive and accountable management, monitoring and reporting on the effectiveness of management, with respect to established objectives or targets (Figure 22), is fundamental. In the absence of perfect knowledge, monitoring is also important to test assumptions about ecological relationships that drive management actions and to change management in response to the results of testing.

4.2 Review of the current monitoring program

The preliminary analysis presented in this report has not detected any responses to management activities and there was an overall decline in both captures and species (all species combined) from 2002-2010. However, changes were variable between taxonomic groups and apart from habitat type / productivity, no significant drivers of population change could be identified. Analyses presented at a workshop conducted in September 2014 also showed there may have been issues associated with species identification by different observers. This would affect analyses of abundance and richness over time and shows accurate monitoring of small mammal and reptile abundance and richness requires highly trained and skilled observers.

It was decided that the BioMonitoring program, based on pitfall trapping of small mammals and reptiles, should be discontinued at Lorna Glen for the following reasons:

- No significant responses to management actions were detected, suggesting either that the species being monitored (small mammals and reptiles) are not significantly affected by the threatening processes being managed or this group of species is not suitable for monitoring responses to management.
- The group of fauna targeted does not include medium size mammals, or other groups such as ground nesting birds and some plant species that are known to have declined due to the threatening processes currently being managed.
- Very long-term datasets are needed to detect trends in populations of small vertebrates (minimum of 10 years depending on variability).
- The protocol does not include a ‘control’ or reference (unmanaged) area and no before and after intervention comparisons can be made.
- The protocol is resource-intensive, relatively complex and requires highly skilled people to implement effectively.

- Data analysis is complex due to the large number of interacting factors and requires highly skilled people to complete effectively.
- A Native Title Determination was made for Matuwa and Karrara Karrara; but the current program does not include culturally significant species and does not readily facilitate Martu participation.

4.3 Proposed new monitoring protocol

A new monitoring protocol is proposed, which addresses the problems with the current protocol (above) and accounts for the Native Title Determination at Matuwa and Karrara Karrara. The primary purpose of the new protocol is to determine whether management of threatening processes is resulting in an increase in relative abundance and richness of the following target or focal species:

- Threatened and conservation significant species including mulgara, bilby, golden bandicoot, malleefowl, brush-tailed possum and other re-introduced mammals.
- Fire sensitive keystone plants (such as mulga *Acacia aneura*).
- Culturally significant species including red kangaroo, emu, perenti, sand goanna, echidna and bustard.

In addition to monitoring these target species, it is also important to monitor primary drivers of rangeland ecosystems and threatening processes:

- Bushfire
- Rainfall
- Introduced predators (cat, fox, dog)
- Introduce herbivores (camel, cattle, rabbit, donkey, horses, etc.)

Target species

Three methods are proposed for monitoring free the range target species shown in Table 8.

Table 8 Free range species targeted for monitoring.

Focal Species	Culturally significant species	Threat species
Bilby Brush tail possum Golden bandicoot Malleefowl Mulgara	Bustard Echidna Emu Kangaroo Perenti Sand goanna	Cat Camel Cattle Fox Horse / donkey Rabbit Wild dog

1. **Two hectare track plots (Southgate 2013 protocol)**

This involves establishing a network of permanent plots on soft / sandy substrates as a basis for recording signs of target species including footprints, diggings, scats and burrows. A network of these plots has already been established in the arid zone beyond Matuwa (Southgate 2013), including on nearby Jundee. Standardising the protocol will facilitate data comparisons across broad spatial and temporal scales. Specifically:

- 30 100 m x 200 m permanent plots will be established on Matuwa and 30 plots on Karrara Karrara
- Plots will be located on soft / sandy substrates at least 30 m off access tracks and ~ 5 km apart
- Plots will be divided into four quadrants and signs recorded in each quadrant as a measure of relative abundance and presence / absence
- Tracks, digs, burrows and scats of target species will be recorded as fresh (1-2 days), medium (3-7 days), old (> 7 days), annually in spring.
- Data will also be recorded on 200 m of nearby access track.
- Habitat quality will be documented by measuring height and cover of vegetation using a 50 m continuous line transect (ends permanently marked) along the short axis of each plot. This will be documented at the first assessment, then biennially.

Metrics and data analysis: relative abundance and richness, abundance per unit area, distribution, habitat use (time since last fire, etc.) and spatial and temporal trends. It is estimated that two people could score a plot in ~30 minutes. Thus, including travel time two people should be able to assess 30 plots (60 ha) in ~4 days.

2. Remote cameras

- A network of 60 cameras will be established on access tracks on each of Matuwa and Karrara Karrara covering major land systems and the number of cameras deployed will be proportional to the area of land system.
- Cameras will be placed ~2 km apart and set at correct height, angle etc. for 20 days prior to aerial baiting then for 20 days, 2 weeks after baiting.

Metrics and data analysis: Species occurrence, activity index, frequency of occurrence, probability of detection, habitat preferences.

3. Trapping

- A network of box traps will be established on Matuwa and Karrara Karrara targeting medium size mammals such as mulgara.
- 25 traps will be placed 50 m apart on a 5 x 5 grid, opposite / near each camera and running for five consecutive nights.

Metrics and data analysis; Capture-mark-release, species, sex, weight, breeding condition, tail condition, relative abundance and trap rate.

Mulga

- Remote sensing (satellite imagery or aerial photography) will be used to monitor mulga groves in spinifex-dominated land systems. Baseline data has already been collected and should be analysed at 5 year intervals.

Metrics and data analysis: Number of groves and vegetation cover trends.

Fire

- Spatial and temporal records of fires and prescribed burns on Matuwa and Karrara Karrara will be maintained.
- Remote sensing will be used to prepare annual fire history / fuel age maps.

Metrics and data analysis: Area / proportion of various spinifex growth stages / fuel ages, fire size in space and time (mean size, perimeter, number, season, cause).

Other issues

Once the monitoring protocol has been finalised, other important project management tasks will be to:

- Determine a custodian / leader / coordinator of the program
- Develop a schedule
- Identify resources / capacity (people, equipment, budget, training etc.)
- Co-ordinate with Martu Rangers, Northern Star and the 'Southgate (2013)' program
- Decide on data and information management protocols and custodian
- Determine evaluation, reporting and publication arrangements, including time-lines.

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Appendix 1

Dates of trapping for each site. A tick denotes traps open and a cross denotes traps closed during the previous night.

Round	Season	Date \ Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Autumn	7/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		8/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		9/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		10/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		11/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		12/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		13/04/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Spring	1/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		2/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		3/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		4/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		5/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		6/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		7/11/2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Autumn	13/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		14/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		15/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		16/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		17/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		18/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		19/03/2003	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Spring	4/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		5/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		6/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		7/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		8/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		9/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		10/09/2003	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		23/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
		24/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
		25/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
		26/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
		27/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
		28/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
		29/09/2003	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Round	Season	Date / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
5	Autumn	8/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		9/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		10/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		11/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		12/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		13/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		14/03/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Spring	27/10/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		28/10/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		29/10/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		30/10/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		31/10/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		1/11/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		2/11/2004	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Autumn	6/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		7/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		8/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		9/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		10/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		11/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		12/04/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Spring	12/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		13/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		14/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		15/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		16/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		17/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		18/10/2005	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Autumn	23/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		24/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		25/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		26/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		27/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		28/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		29/03/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Round	Season	Date / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
10	Spring	7/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		8/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		9/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		10/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		11/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		12/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		13/11/2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	Autumn	22/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		23/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		24/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		25/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		26/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		27/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		28/03/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	Spring	15/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		16/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		17/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		18/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		19/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		20/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		21/11/2007	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
13	Autumn	12/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		13/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		14/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		15/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		16/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		17/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		18/03/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
14	Spring	24/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		25/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		26/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		27/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		28/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		29/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		30/10/2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Round	Season	Date / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
15	Autumn	22/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		23/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		24/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		25/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		26/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		27/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		28/04/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
16	Spring	17/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		18/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		19/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		20/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		21/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		22/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		23/10/2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
17	Spring	4/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		5/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		6/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		7/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		8/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		9/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		10/11/2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Appendix 2

List of species trapped in accordance with the WA Museum vertebrate Checklist January 2013, for all sites combined (vernacular in accordance with the Australian Faunal Directory).

Class	Taxon	Vernacular
Mammalia	*Ningaui ridei*	Wongai Ningaui
	Notomys alexis	Spinifex Hopping-mouse
	Pseudantechinus woolleyae	Woolley's Pseudantechinus
	Pseudomys bolami	Bolam's Mouse
	Pseudomys desertor	Desert Mouse
	Pseudomys hermannsburgensis	Sandy Inland Mouse
	Sminthopsis crassicaudata	Fat-tailed Dunnart
	Sminthopsis longicaudata	Long-tailed Dunnart
	Sminthopsis macroura	Stripe-faced Dunnart
	Sminthopsis ooldea	Ooldea Dunnart
	Sminthopsis youngsoni	Lesser hairy-footed Dunnart
Reptilia	*Antaresia stimsoni*	Stimson's Python
	Brachyurophis fasciolatus	Narrow-banded Snake
	Brachyurophis semifasciata	Southern shovel nosed snake
	Caimanops amphiboluroides	Mulga Dragon
	Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink
	Cryptoblepharus plagiocephalus	Péron's Snake-eyed Skink
	Ctenophorus caudicinctus	Ring-tailed Dragon
	Ctenophorus isolepis	Military Dragon
	Ctenophorus nuchalis	Central Netted Dragon
	Ctenophorus reticulatus	Western Netted Dragon
	Ctenophorus scutulatus	Lozenge-marked Dragon
	Ctenotus ariadnae	Ariadna's Ctenotus
	Ctenotus calurus	Blue-tailed Ctenotus
	Ctenotus dux	Fine Side-lined Ctenotus
	Ctenotus grandis	Grand Ctenotus
	Ctenotus helenae	Helen's Ctenotus
	Ctenotus leonhardii	Leonhardi's Ctenotus
	Ctenotus pantherinus	Leopard Ctenotus
	Ctenotus quattuordecimlineatus	Fourteen-lined Ctenotus
	Ctenotus schomburgkii	Barred Wedgesnout Ctenotus
	Ctenotus uber	Spotted Ctenotus
	Delma butleri	Unbanded Delma
	Delma nasuta	Sharp-snouted Delma
	Demansia psammophis	Yellow-faced Whipsnake
	Diplodactylus conspicillatus	Fat-tailed Gecko
	Diplodactylus granariensis	Wheat-belt Stone Gecko
	Diplodactylus pulcher	Fine-faced Gecko
	Egernia depressa	Southern Pygmy Spiny-tailed Skink
	Egernia formosa	Goldfields Crevice-skink
	Eremiascincus richardsonii	Broad-banded Sand Swimmer
	Furina ornata	Moon Snake
	Gehyra purpurascens	Purplish Dtella
	Gehyra variegata	Tree Dtella
	Heteronotia binoei	Bynoe's Gecko
	Lerista bipes	Two-toed Lerista

	Lerista desertorum	Central Deserts Robust Slider
	Lialis burtonis	Burton's Snake-lizard
	Liopholis inornata	Desert Skink
	Liopholis striata	Night Skink
	Lucasium maini	Main's Ground Gecko
	Lucasium squarrosum	Mottled Ground Gecko
	Lucasium stenodactylum	Crowned Gecko
	Menetia greyii	Grey's Menetia
	Moloch horridus	Thorny Devil
	Morethia butleri	Woodland Morethia Skink
	Morethia ruficauda	Lined Firetail Skink
	Nephrurus laevissimus	Pale Knob-tailed Gecko
	Nephrurus vertebralis	Midline Knob-tail
	Parasuta monachus	Monk snake
	Pogona minor	Dwarf Bearded Dragon
	Pseudonaja modesta	Ringed Brown Snake
	Pseudonaja nuchalis	Gwardar
	Pygopus nigriceps	Hooded Scaly-foot
	Pygopus nigriceps	Western hooded scaly-foot
	Ramphotyphlops hamatus	Pale-headed Blind Snake
	Ramphotyphlops waitii	Beaked Blind Snake
	Rhynchoedura ornata	Western Beaked Gecko
	Simoselaps bertholdi	Jan's Banded Snake
	Strophurus elderi	Jewelled Gecko
	Strophurus strophurus	Western Spiny-tailed Gecko
	Strophurus wellingtonae	Western Shield Spiny-tailed Gecko
	Suta fasciata	Rosen's Snake
	Tiliqua multifasciata	Central Blue-tongue
	Tympanocryptis cephalus	Pebble Dragon
	Varanus brevicauda	Short-tailed Pygmy Monitor
	Varanus caudolineatus	Stripe-tailed Monitor
	Varanus eremius	Pygmy Desert Monitor
	Varanus gouldii	Bungarra or Sand Monitor
	Varanus panoptes	Yellow-spotted Monitor
	Varanus tristis	Racehorse Monitor

Appendix 3

Distribution of observations for species across monitoring sites.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Antaresia stimsoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Brachyurophis fasciolatus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Brachyurophis semifasciata	1	2	0	0	1	2	0	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Caimanops amphiboluroides	0	0	0	0	0	0	0	0	1	1	0	0	3	0	2	0	0	4	0	2	0	0	3	1	17
Cryptoblepharus buchananii	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Cryptoblepharus plagiocephalus	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	0	0	5
Ctenophorus caudicinctus	9	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	15	5	0	0	0	0	0	32
Ctenophorus isolepis	0	12	0	0	0	0	7	10	16	0	0	14	0	1	0	15	8	0	0	0	2	0	0	4	89
Ctenophorus nuchalis	0	15	0	0	0	0	14	0	1	0	4	0	0	0	0	0	1	0	0	0	0	1	0	1	37
Ctenophorus reticulatus	0	0	0	0	0	0	0	0	0	5	3	0	0	1	2	0	0	0	0	2	0	0	1	0	14
Ctenophorus scutulatus	0	0	0	0	0	0	0	0	0	15	0	0	4	7	3	0	0	5	0	3	0	3	1	0	41
Ctenotus ariadnae	4	12	0	0	4	0	7	6	7	0	0	1	0	0	0	5	0	0	0	0	2	0	0	7	55
Ctenotus calurus	0	5	0	0	2	0	23	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	51
Ctenotus dux	1	0	0	0	1	0	1	0	12	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	16
Ctenotus grandis	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	5
Ctenotus helenae	13	2	2	2	3	0	11	20	7	0	0	1	0	0	1	11	8	1	0	0	4	1	0	6	93
Ctenotus leonhardii	0	1	37	0	26	0	3	0	0	1	101	60	40	36	48	2	0	2	1	0	0	8	4	8	378
Ctenotus pantherinus	16	4	4	0	4	0	3	8	2	2	3	8	2	14	13	43	7	3	1	0	61	3	3	82	286
Ctenotus quattuordecimlineatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	41	0	0	1	1	0	0	0	57
Ctenotus schomburgkii	6	0	3	0	3	0	6	1	0	19	0	1	33	21	51	4	1	8	0	3	6	0	1	12	179
Ctenotus uber	0	0	0	0	0	0	0	0	0	29	0	1	0	1	55	0	0	3	0	0	0	0	1	0	90
Delma butleri	3	0	2	0	4	0	0	0	2	0	0	0	0	4	0	2	1	0	0	0	4	1	1	2	26
Delma nasuta	2	0	0	0	3	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	13
Demansia psammophis	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Diplodactylus conspicillatus	1	5	0	0	0	0	11	18	11	0	4	7	0	1	0	8	0	1	1	0	0	0	0	9	77
Diplodactylus granariensis	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6	0	0	3	2	1	3	6	3	27
Diplodactylus pulcher	0	0	0	0	0	0	0	0	0	38	0	0	0	1	0	0	0	0	1	1	0	0	34	0	75
Egernia depressa	0	0	1	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	4	2	0	0	8	0	19
Egernia formosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	8
Eremiascincus richardsonii	0	0	0	3	1	8	1	0	0	0	0	0	0	0	0	3	0	0	1	1	0	19	1	0	38
Furina ornata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Gehyra purpurascens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Gehyra variegata	2	2	7	8	2	18	6	3	0	1	2	2	1	15	1	7	9	4	4	13	1	19	1	1	129
Heteronotia binoei	4	0	8	4	6	6	0	0	0	4	2	0	5	19	5	3	0	7	2	1	15	13	4	19	127
Lerista bipes	0	0	2	1	1	1	23	28	152	2	0	2	0	1	0	1	0	0	0	1	0	0	0	1	216
Lerista desertorum	8	7	8	18	6	4	11	1	1	0	15	8	2	1	0	12	21	0	0	0	0	5	1	1	130
Lerista timida	0	4	0	29	4	38	6	8	12	0	0	0	2	11	0	4	1	12	7	0	0	17	0	0	155
Lialis burtonis	0	1	1	0	1	0	0	1	1	0	0	1	0	1	0	2	2	0	0	0	0	2	0	1	14
Liopholis inornata	0	0	0	0	0	0	0	0	13	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	15
Liopholis striata	0	0	0	0	0	1	0	0	0	15	0	0	0	4	1	0	0	0	0	0	0	1	0	0	22
Lucasium maini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Lucasium squarrosum	5	1	17	0	4	19	1	1	1	44	0	0	26	8	13	0	0	35	5	6	0	1	16	0	203

Lucasium stenodactylum	2	32	1	1	0	0	85	15	8	1	6	10	0	0	1	1	0	1	0	1	1	0	0	1	167
Menetia greyii	2	28	0	13	2	26	20	37	9	5	0	1	17	6	11	2	3	15	18	9	0	0	1	1	226
Moloch horridus	1	2	0	0	2	0	2	1	0	0	0	0	0	0	0	3	1	0	0	0	5	0	0	1	18
Morethia butleri	0	0	1	3	0	0	0	0	0	0	9	0	0	0	0	0	0	1	0	3	0	0	0	0	17
Morethia ruficauda	0	1	0	2	0	0	3	9	1	0	0	0	0	0	0	0	1	0	15	0	0	0	0	0	32
Nephrurus laevissimus	1	1	0	0	0	0	1	1	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59
Nephrurus vertebralis	0	0	0	0	1	3	0	1	1	8	1	5	0	13	1	2	3	0	0	0	3	1	0	0	43
Ningaui ridei	23	17	26	0	62	3	3	34	3	0	1	20	2	8	3	44	18	1	1	1	70	1	1	78	420
Notomys alexis	0	3	0	0	0	0	2	7	6	0	1	0	0	0	1	1	5	0	0	2	3	1	0	3	35
Parasuta monachus	0	1	0	2	0	1	0	0	1	0	0	0	1	0	1	3	1	0	0	0	0	0	0	1	12
Pogona minor	4	0	4	0	3	4	3	1	0	1	1	1	0	1	0	3	5	0	0	0	1	0	1	4	37
Pseudantechinus woolleyae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pseudomys bolami	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pseudomys desertor	4	3	1	1	2	1	2	2	2	2	1	19	0	4	0	2	2	1	0	0	14	0	0	6	69
Pseudomys hermannsburgensis	36	21	15	0	24	32	19	20	16	23	6	3	21	29	14	14	10	20	11	2	6	5	4	8	359
Pseudonaja modesta	0	0	1	0	0	0	6	1	1	0	1	2	0	1	2	1	1	0	0	0	1	0	0	0	18
Pseudonaja nuchalis	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
Pygopus nigriceps	0	0	0	0	0	0	2	2	4	0	0	2	0	0	0	2	3	0	0	0	0	0	0	0	15
Ramphotyphlops hamatus	2	0	0	1	4	0	9	0	0	0	1	3	0	3	0	1	8	1	4	3	1	4	6	0	51
Ramphotyphlops waitii	0	0	2	1	1	4	1	1	1	0	9	14	1	0	0	2	0	0	1	0	0	1	2	0	41
Rhynchoedura ornata	2	44	2	0	3	17	55	30	34	6	20	6	7	32	4	8	22	0	0	1	2	0	6	0	301
Simoselaps bertholdi	0	0	1	1	3	5	0	1	2	0	3	4	0	0	1	2	6	0	0	0	0	0	0	0	29
Sminthopsis crassicaudata	0	0	0	0	0	0	0	0	0	0	2	1	0	0	2	0	0	0	0	0	0	0	0	0	5
Sminthopsis longicaudata	12	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	26	28	0	0	0	0	0	68
Sminthopsis macroura	11	1	5	4	6	11	3	1	2	2	28	6	4	0	2	1	2	25	37	54	8	14	17	0	244
Sminthopsis ooldea	13	14	31	4	36	21	29	21	4	9	8	12	30	25	21	30	12	27	14	14	11	20	28	26	460
Sminthopsis youngsoni	0	5	0	0	0	0	11	9	2	0	0	3	0	2	1	0	4	1	0	1	0	0	0	1	40
Strophurus elderi	15	2	6	0	20	0	1	19	9	0	0	8	0	6	1	7	18	0	0	1	19	1	0	12	145
Strophurus strophurus	0	0	1	0	1	0	0	0	16	10	11	14	0	0	0	0	0	0	0	0	0	0	0	0	53
Strophurus wellingtonae	6	0	8	0	6	6	0	1	0	2	0	3	15	21	6	19	20	12	5	5	6	7	6	12	166
Suta fasciata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Tiliqua multifasciata	0	0	1	0	0	0	2	0	0	0	1	0	0	1	1	1	0	1	0	0	1	0	0	3	12
Tympanocryptis cephalus	0	0	0	0	0	0	0	0	0	2	0	1	2	1	2	0	0	2	1	0	0	0	0	0	11
Varanus brevicauda	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	7	0	0	0	0	1	0	0	0	10
Varanus caudolineatus	0	0	2	0	6	2	1	1	0	3	0	1	2	3	10	1	0	11	5	11	0	1	15	1	76
Varanus eremius	0	5	0	0	0	0	2	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	12
Varanus gouldii	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	6
Varanus panoptes	0	0	1	1	0	2	1	0	0	0	0	0	1	2	0	0	0	1	0	0	0	1	0	0	10
Varanus tristis	0	0	0	1	1	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	12
Total	**211**	**256**	**201**	**109**	**261**	**246**	**400**	**354**	**423**	**252**	**245**	**248**	**221**	**306**	**283**	**300**	**254**	**247**	**177**	**154**	**252**	**161**	**173**	**318**	**6,052**

Appendix 4

Parameter	Category	Definition
Interim Biogeographic Regionalisation for Australia (IBRA)	Gascoyne	Rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys. Open mulga woodlands occur on shallow earthy loams over hardpan on the plains, with mulga scrub and Eremophila shrublands on the shallow stony loams of the ranges. The Carnegie Salient, in the east, is characterised by extensive salt lake features supporting succulent steppes. Arid.
	Murchison	Mulga low woodlands, often rich in ephemerals, on outcrop hardpan washplains and fine-textured Quaternary alluvial and eluvial surfaces mantling granitic and greenstone strata of the northern part of the Yilgarn Craton. Surfaces associated with the occluded drainage occur throughout with hummock grasslands on Quaternary sandplains, saltbush shrublands on calcareous soils and Halosarcia low shrublands on saline alluvia. Areas of red sandplains with mallee-mulga parkland over hummock grasslands occur in the east.
Land system	Belele	Hardpan wash plains interspersed by low sandy (wanderrie) banks supporting tall shrublands of mulga with understorey shrubs on the hardpan plains and non-saline shrubs with perennial grasses on the banks.
	Bullimore	Extensive sand plains supporting spinifex hummock grasslands.
	Carnegie	Salt lakes with extensively fringing saline plains, dunes and sandy banks, supporting low halophytic shrublands and scattered tall acacia shrublands; lake beds are highly saline; gypsiferous and mainly unvegetated.
	Cunyu	Calcrete platforms and intervening alluvial floors and minor areas of alluvial plains, including channels with acacia shrublands and minor halophytic shrublands.
	Dural	Strongly undulating terrain on weathered mudstone and basalt supporting open mulga shrublands with mallee and spinifex.
	Glengarry	Sandstone plateaux, summits and hillslopes supporting mainly dense mulga and other acacia shrublands, spinifex, and numerous low shrubs.
	Jundee	Hardpan plains with ironstone gravel mantles and occasional sandy banks supporting mulga shrublands.
	Kalyaltcha	Stony erosional plains, alluvial plains and drainage floors supporting open mulga shrublands with undershrubs including blue bush.
	Lorna	Gently undulating, sandy plains with mulga shrublands and spinifex.
	Lynne	Stony plateaux, summits and hillslopes with minor flood plains and drainage floors supporting open mulga and other acacia shrublands and minor saltbush and bluebush shrublands.
	Sherwood	Breakaways, kaolinised footslopes and extensive gently sloping plains on granite supporting mulga shrublands and minor halophytic shrublands.
	Sodary	Stony uplands and plains supporting mulga shrublands with non-halophytic and halophytic undershrubs.
	Yandil	Flat hardpan wash plains with mantles of small pebbles and gravels; supporting groved mulga shrublands and occasional wanderrie grasses.
	Yanganoo	Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting mulga shrublands and wanderrie grasses on banks.
Regolith	Alluvium	Alluvium in drainage channels, floodplains, and deltas.
	Calcrete	Calcrete, including massive, nodular, and sheet-like accumulations of carbonate, usually alluvial-colluvial, but locally residual; minor

Parameter	Category	Definition
		opaline silica and chalcedony.
	Colluvium	Slope deposits, including colluvium and sheetwash.
	Exposed	Exposed rock, saprolite, and saprock.
	Lacustrine	Lacustrine deposits, including lakes, playas, and fringing dunes.
	Sandplain	Sandplain, mainly eolian, including some residual deposits.
Geology	Czb	Ephemeral lake and dune deposits - clay, silt, and sand; in drainage basins adjacent to playa lakes.
	Czc	Colluvium-variably cemented outwash talus; dissected by present-day drainage.
	Czk	Calcrete-massive, nodular, and vuggy limestone; some surface silicification.
	Czl	Laterite-ferruginous duricrust, massive to pisolitic.
	Czp	Playa deposits - saline and gypsiferous evaporites, clay, and sand in playa lakes.
	Czs	Sandplain - yellow sand with limonitic pisoliths near base.
	P_Ew	Wandiwarra formation: fine to coarse-grained quartz sandstone and shale; locally glauconitic.
	PLEd	Windidda formation: limestone and shale.
	PLEy	Yelma formation: sandstone, shale, and minor conglomerate.
	Qa	Alluvial deposits-silt, sand, and gravel; in drainage channels and on floodplains.
	Qc	Colluvium-locally derived sand and gravel; in scree and outwash-fan deposits.
	Qg	Quartz sand and gypsum deposits marginal to salt lakes; eolian.
	Qs	Eolian deposits-sand, includes sheets and dunes within intervening sandy valleys.
	Qz	Colluvium - clayey to sandy loam; sheet-wash deposit; commonly contains hardpan.
Soil	AB14	Upland sand plains with occasional dunes and minor inclusions of associated plains units: chief soils are red earthy sands (Uc5.21) with red sands (Uc5.11) and (Uc1) on the dunes; both (Gn) and (Um) soils of associated units occur.
	BB9	Narrow plain associated with the major river systems, usually occurring upstream of unit Oc47 and characterized by frequent outcrops of calcrete (kunkar): chief soils are probably brown calcareous loams (Um5.11) and calcareous earths (Gc1.12) and (Gc2.21). There are frequent inclusions of (Dr1) and (Dr2) soils of unit Oc47 and some (Gn2) soils associated with adjoining units, especially (Gn2.13).
	BE2	Generally undulating terrain on granites with rocky granitic hills, bosses and tors, some breakaways, and a surface stone mantle: chief soils seem to be shallow earthy loams (Um5.3) underlain by a red-brown hardpan. Associated are shallow (Uc5.21 and Uc5.22) soils both underlain by a red-brown hardpan; some (Gn2.1) soils underlain by a red-brown hardpan; and shallow (Uc1.43) and (Um5.41) soils on the hills (no hardpan).
	BE6	Extensive flat and gently sloping plains, which sometimes have a surface cover of gravels and on which red-brown hardpan frequently outcrops: chief soils are shallow earthy loams (Um5.3), with associated (Gn) soils of units My5O and Mz23 of Sheet 6. As mapped, there are inclusions of units Oc47 and BB9.
	Fa8	Steep ranges comprising fine-grained sedimentary rocks along with basic dykes; extensive portions of this unit are without soil cover: chief soils are shallow stony earthy loams (Um5.51) on the steep slopes while shallow stony (Uc1.43) and (Uc5.11) soils occur in similar situations. Associated are a variety of soils including (Dr2.32 and Dr2.33) on dissected pediments and small areas of shallow (Um5.3) soils on narrow valley plains within this unit.

Parameter	Category	Definition
	Oc49	Partially dissected pediments with some low stony hills on fine-grained sedimentary rocks and basic dykes, frequently flanking areas of unit Fa8: hard alkaline red soils (Dr2.33) are dominant along with some areas of (Dr2.32), (Dr2.52), and (Dr2.72) soils. Shallow stony soils (Um5.41) and (Uc5.1 l) occur on the steeper slopes, and (Um5.3) and (Gn2.12) soils with red-brown hardpan occur on the lower slopes and on small areas of valley plains.
	SV5	Saline soils associated with salt lakes; sand and kopi gypsum dunes, and intervening plains: soils are mixed but chief soils are probably shallow (Um1), with various (Dr1) and (Dr2) soils, together with saline (Gn2.13), (Uc1.23), and (Um5.11) soils that sometimes overlie red-brown hardpan, and the soils of unit B39.
Habitat	Bare areas	Bare areas; salt lakes.
	Hummock grassland	Hummock grasslands, shrub steppe; acacia and grevillea over *Triodia basedowii*.
	Low woodland	Low woodland; mulga (*Acacia aneura*); sparse low woodland; mulga, discontinuous in scattered groups.
	Shrubland	Shrublands; mulga scrub.
	Succulent steppe	Succulent steppe; samphire.
Vegetation	a1e21Sr t2Hi	Hummock grasslands, shrub steppe; mulga and *Eucalyptus kingsmillii* over hard spinifex.
	a1Li	Low woodland; mulga (*Acacia aneura*).
	a1Li k3Ci	Succulent steppe with low woodland; mulga over samphire.
	a1Lp	Sparse low woodland; mulga, discontinuous in scattered groups.
	a1Si	Shrublands; mulga scrub.
	a1Si k2Ci	Succulent steppe with scrub; mulga over bluebush.
	anSr t2Hi	Hummock grasslands, shrub steppe; acacia & grevillea over *Triodia basedowii*.
	k3Ci	Succulent steppe; samphire.
	sl	Bare areas; salt lakes.
Fire status	Mosaic	Within 500 m of habitat burnt between 1998 and 2007.
	Non mosaic	More than 500 m from habitat burnt between 1998 and 2007.

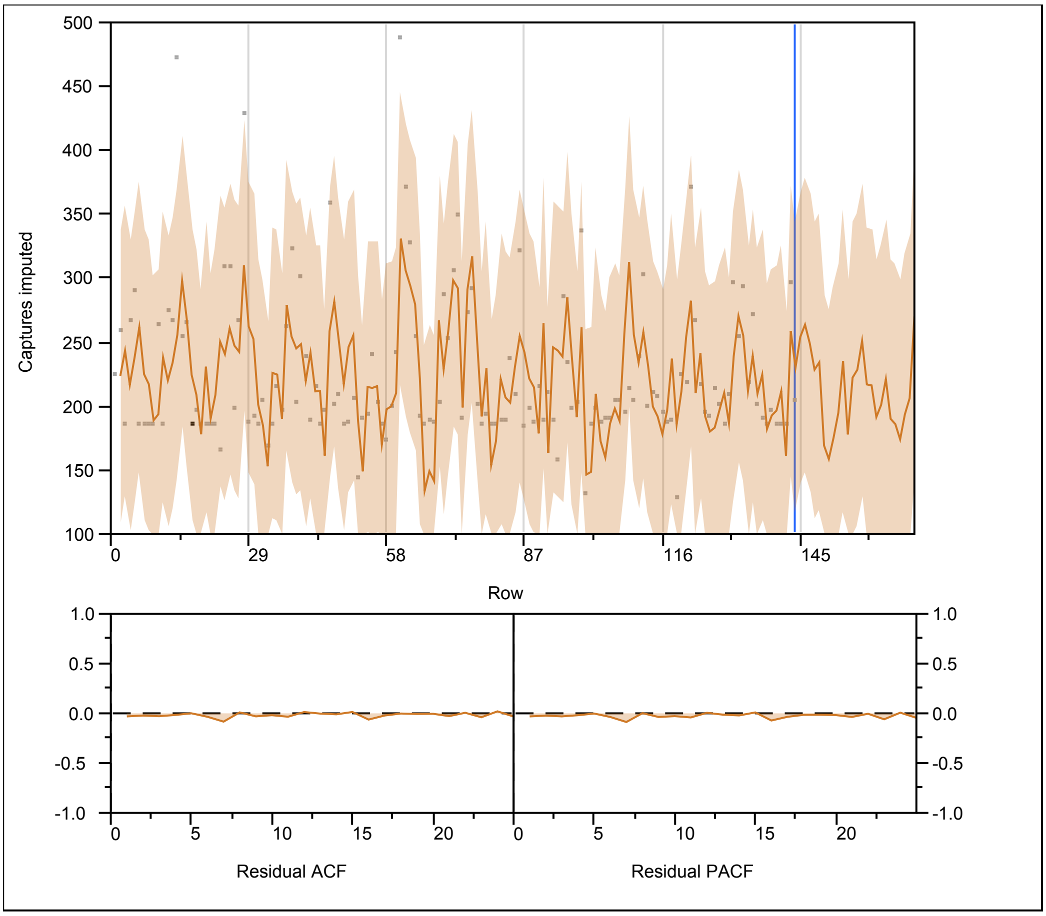
Appendix 6

Time series model results and plot for captures per 100 trap nights (imputed)

Table 9 shows the models tested and the graphs show the time series plot of the data using the chosen model. Graph above shows the time series plot, forecasts, and confidence limits and the graphs below show autocorrelation function (ACF) and partial autocorrelation function (PACF).

Table 9. AutoRegressive Integrated Moving Average (ARIMA) models (p,d,q)*n* where p = autoregressive order, d = differencing order, q = moving average order and *n* = number of months per season. The chosen model is shown in bold.

Model	d.f.	Variance	Akaike's Information Criterion (AIC)	R^2
AR(4)	139	3286.27	1579.76	0.09
Seasonal ARIMA(50, 1, 0)(0, 0, 15)3	77	1690.89	1612.19	0.40
Seasonal ARIMA(50, 1, 0)(1, 0, 15)5	**76**	**1564.90**	**1615.31**	**0.41**
Seasonal ARIMA(50, 1, 0)(1, 0, 15)3	76	2253.21	1623.90	0.38
Seasonal ARIMA(50, 1, 0)(1, 0, 15)6	76	1648.54	1625.70	0.37
Seasonal ARIMA(50, 1, 0)(1, 0, 15)4	76	3372.48	1637.74	0.35

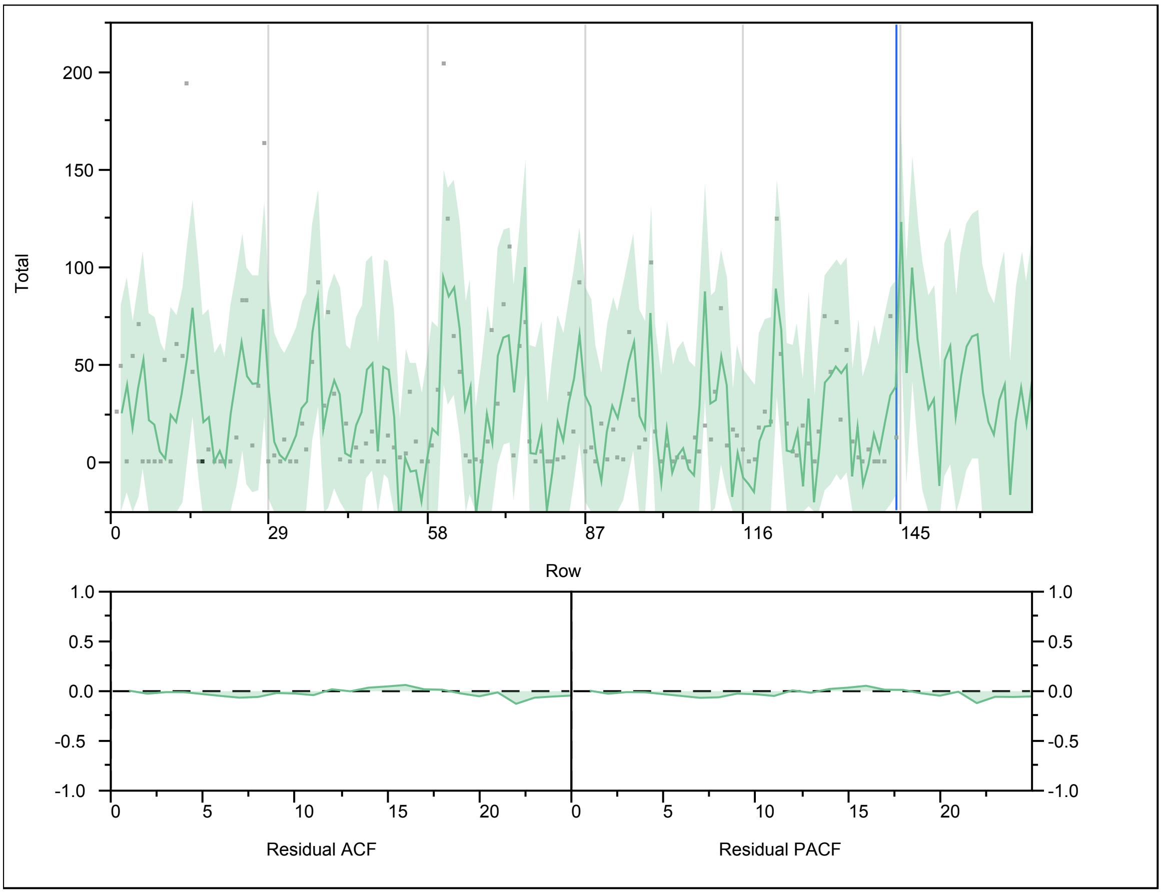


Time series model results and plot for total monthly rainfall

Table 10 shows the models tested and the graphs show the time series plot of the data using the chosen model. Graph above shows the time series plot, forecasts, and confidence limits and the graphs below show autocorrelation function (ACF) and partial autocorrelation function (PACF).

Table 10. AutoRegressive Integrated Moving Average (ARIMA) models (p,d,q)*n* where p = autoregressive order, d = differencing order, q = moving average order and *n* = number of months per season.

Model	d.f.	Variance	Akaike's Information Criterion (AIC)	R^2
AR(6)	137	1242.04	1441.92	0.16
AR(12)	131	1226.07	1446.06	0.21
ARI(12, 1)	130	1324.58	1448.80	0.14
AR(20)	123	1236.65	1455.17	0.24
ARI(20, 1)	122	1346.02	1458.79	0.17
Seasonal ARIMA(15, 1, 0)(0, 0, 20)3	107	991.59	1464.70	0.28
Seasonal ARIMA(50, 1, 0)(0, 0, 5)4	87	900.87	1473.11	0.40
Seasonal ARIMA(50, 1, 0)(0, 0, 5)3	87	967.79	1475.58	0.39
Seasonal ARIMA(50, 1, 1)(0, 1, 15)3	73	859.54	1476.75	0.29
Seasonal ARIMA(50, 1, 0)(0, 0, 6)3	86	974.27	1477.38	0.39
Seasonal ARIMA(50, 1, 0)(0, 0, 10)3	82	797.18	1481.16	0.40
Seasonal ARIMA(50, 1, 0)(1, 0, 15)2	**76**	**851.85**	**1482.17**	**0.44**
Seasonal ARIMA(50, 1, 0)(0, 0, 16)3	76	763.09	1485.81	0.42
Seasonal ARIMA(50, 1, 0)(1, 0, 15)4	76	795.46	1487.68	0.41
Seasonal ARIMA(50, 1, 0)(0, 0, 15)3	77	785.58	1488.55	0.40
Seasonal ARIMA(50, 1, 0)(3, 0, 15)3	74	801.77	1488.75	0.43
Seasonal ARIMA(50, 1, 0)(1, 0, 15)3	76	789.64	1490.13	0.41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29
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87
116
145
Row
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0.5
0.0
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-1.0
0
5
10
15
20
Residual ACF
Residual PACF