Preliminary analysis of fauna sampling for CALM's feral cat research program at Lorna Glen

Sminthopsis ooldea

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Abstract

Trapping sites were sampled on six occasions over a period of ten months to assess whether changes in abundances of small ground dwelling vertebrates could be detected after an area of predominantly spinifex sandplain was successfully baited for cats. Temporal variation in abundances of small mammals and reptiles was also documented to aid in refining optimal times for toxic cat bait delivery. An assessment of the effectiveness of two pit trap types, PVC pipe and 20L buckets was made in relation to captures of small ground dwelling vertebrates.
No changes in vertebrate abundances were detected in relation to the initial baiting but strong seasonal variation was observed with reptile peak activity over the November trapping period and the least activity for mammals and reptiles in late June and July.
The data collected from this work show a highly significant bias for mammals and reptiles towards 20L buckets as opposed to the narrower but deeper PVC pipe.

Introduction and objectives

Part of the SPA for Feral Cat Control Research undertaken at Lorna Glen Station involves assessments of small ground vertebrate fauna in relation to several different factors.

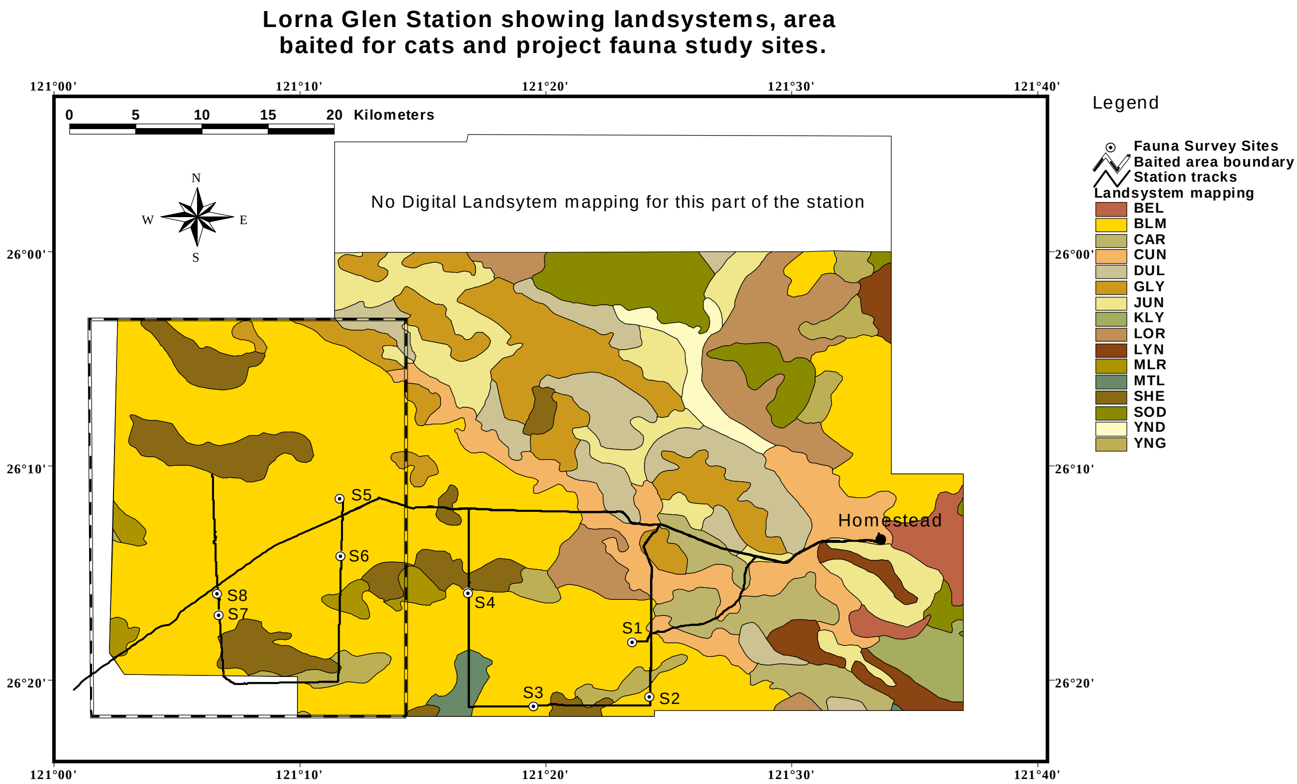
1. To test the hypothesis that the abundance of prey species, primarily small reptiles and mammals, is affected by time of year and will thus influence the effectiveness of bait uptake by feral cats.

2. To test the hypothesis that feral cats impact on the relative abundance of a variety of small terrestrial vertebrates by showing that removal of predation increases abundances.

3. Additional to the above primary objectives was the examination of the effectiveness of two different pit types, 20 Litre buckets and 154mm diameter by 500mm deep PVC pipes, in sampling ground vertebrates.

The project area is in the south western portion of Lorna Glen Station (Figure 1)- an area dominated by Spinifex (*Triodia basedowii*) sand plain (Bullimore Landsystem- BLM) with over stories of either scattered Marble Gum (*Eucalyptus gongylocarpa*) or Mulga (*Acacia aneura*). Interspersed through this landscape are low dune systems of varying length comprising deep red sands and supporting different vegetation from the surrounding country- predominantly *Aluta maissonneuvi* and *Triodia basedowii* along with mixed shrubs of Acacia, Grevillea and Eremophila.

Figure 1.



Methods

To achieve the outlined objectives, eight fauna trapping grids have been established across the study area with four of these (sites 1-4) in the control area and four analogue sites (sites 5-8) in the target area that was to be baited. Sites were selected in relation to aspects of topography, vegetation and/or post fire age which represented the major diversity of habitat over the sandplain (Table 1).
Sites three and seven, Marble Gum over Spinifex, have a relatively recent fire age (< 3 years) while all other sites are considerably older in relation to fire history with the exception of the dune system in the control area (Site 1). The plain adjacent to the dune system, which makes up the majority of the trapping site, has been burnt in the last 3 years. Photographs of control sites and their analogues in the area baited are shown in Figure 2.

Table 1.
Sites selected in the control area and their corresponding sites in the target area

Control Area	Target Area	Habitat Type
Site 1	Site 5	Dune and adjacent spinifex sandplain (sand plain burnt on Site 1 in previous 3 years)
Site 2	Site 8	Mulga over spinifex (scattered Marble Gum occur on site 8)
Site 3	Site 7	Marble Gum over spinifex with some scattered Mulga on site 7. Area burnt in past 3 years.
Site 4	Site 6	Marble Gum over spinifex. Unburnt for 10+ years

The trapping grid design is the same as that previously used in relation to vertebrate fauna monitoring for cat research work undertaken by SID in the Gibson Desert. One modification was made such that, rather than only utilizing 154mm diameter PVC pipe for pits, every second pit was a 20L bucket which would enable some assessment of objective 3, outlined above. Each trapping site consists of two parallel transects spaced approximately 100m apart, perpendicular to the road and starting approximately 25metres in from the road. Along each transect there are five fifteen metre drift fences with 15 metre breaks between the end of each fence and the beginning of the next. Four pits are spaced at 4 metre intervals along each of the drift fences starting 1.5 metres in from the beginning of the fence with the fourth pit positioned 1.5 metres before the end of the fence. The first pit on every fence line is a PVC pipe and then alternates between bucket and PVC pipe, thus always ending with a bucket. All pits were individually numbered so as to allow the collation of trapping data in relation to site (1-8), fence line (1-10) and individual pit (A-D).The trapping grids have been monitored on six separate occasions, each over 4 days/night's duration as outlined in Table 2.

Table 2.
Dates over which vertebrate trapping has been conducted

Trapping Period (pre baiting)	Date	Trapping Period (post baiting)	Date
1	3 Jun 03 – 6 Jun 03	4	25 Sep 03 – 28 Sep 03
2	24 Jun 03 – 27 Jun 03	5	26Nov 03–29 Nov 03
3	10 Jul 03 – 13 Jul 03	6	24 Mar 04 – 27 Mar 04

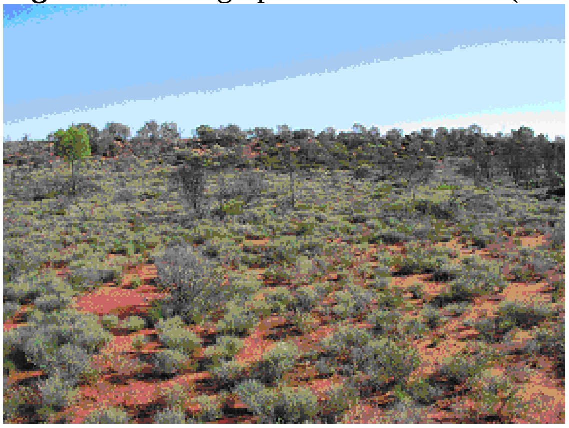
Results

Preliminary analysis of site assemblages

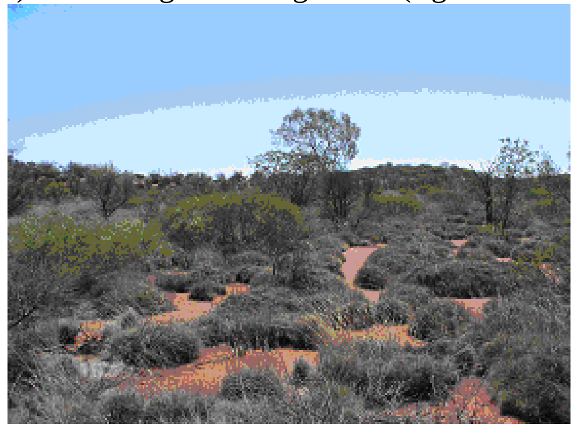
Over the course of all six surveys 1128 small ground dwelling vertebrates were trapped with 228 captures pre-baiting and 900 post. Only 36 (3.19%) of these were recaptures while only 3 (0.29%) of the total were recaptured mammals. All recaptures were excluded from any subsequent analysis. The most abundant family groups captured were Geckos (36.4%), skinks (32.7%), dragons (8.97%), dasyurids and rodents (both 6.3%) with the other six vertebrate families representing less than 3% each.

The initial cat baiting was undertaken in mid July such that the first three trapping periods were conducted pre-baiting with the other three trappings taking place post-baiting. Prior to assessing how ground dwelling vertebrates might respond to the exclusion of cats through baiting in differing habitats, it is necessary to examine the association of assemblages in control sites and their analogues. Given that the project began in June, which is outside the optimum times of the year for fauna activity and only one month prior to the baiting treatment, there is extremely limited scope for analysis. A similarity matrix using the Bray-Curtis distance coefficient was produced for vertebrate captures collected from all eight sites, pre and post baiting. Clustering was performed using UPGMA and is displayed in Figure 3.

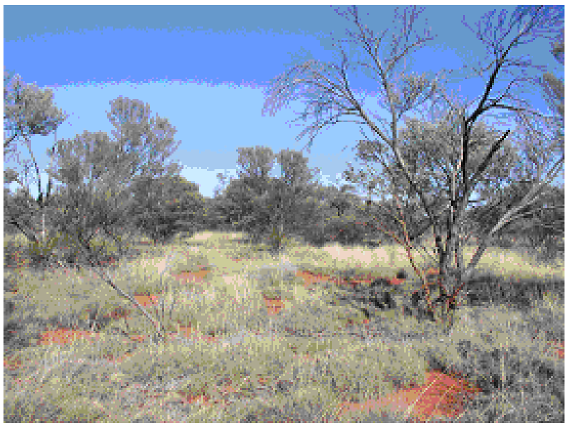
Figure 2. Photographs of control sites (left Column) and analogues in target area (right column)



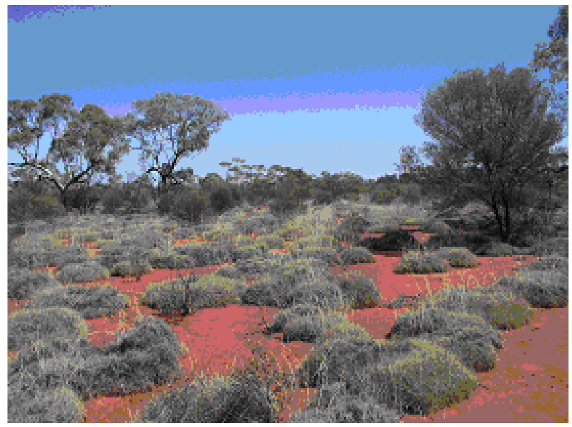
Site 1



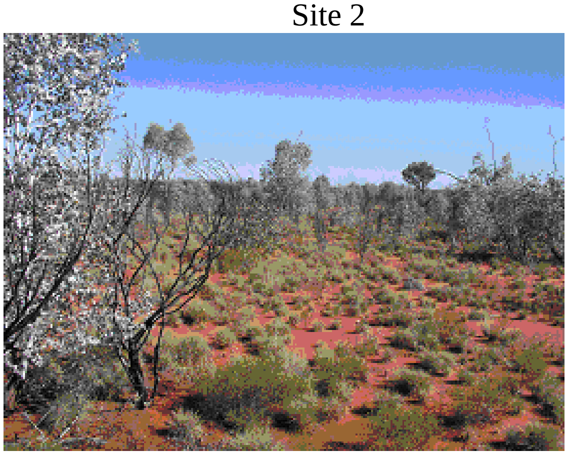
Site 5



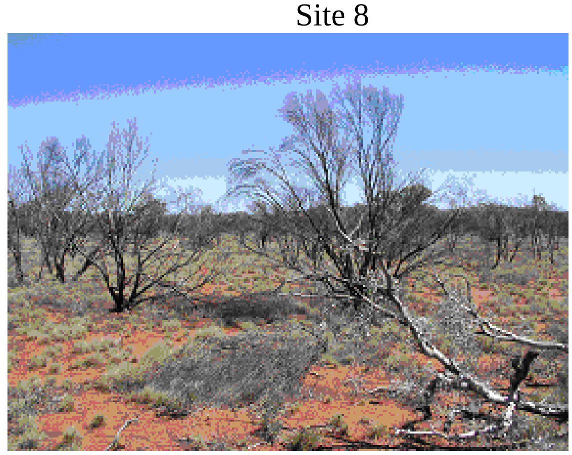
Site 2



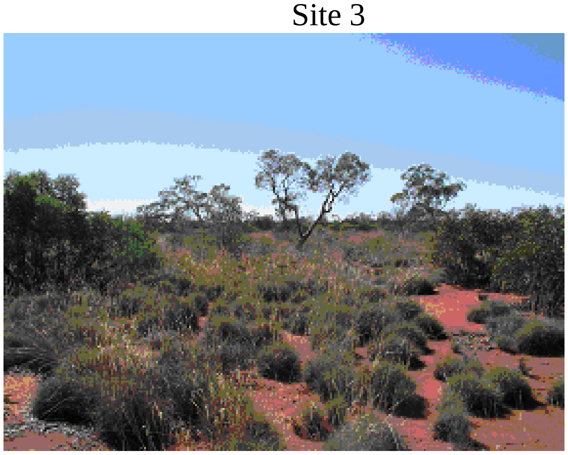
Site 8



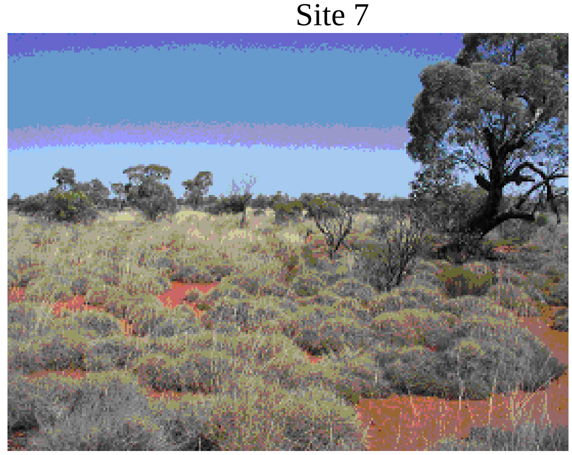
Site 3



Site 7



Site 4

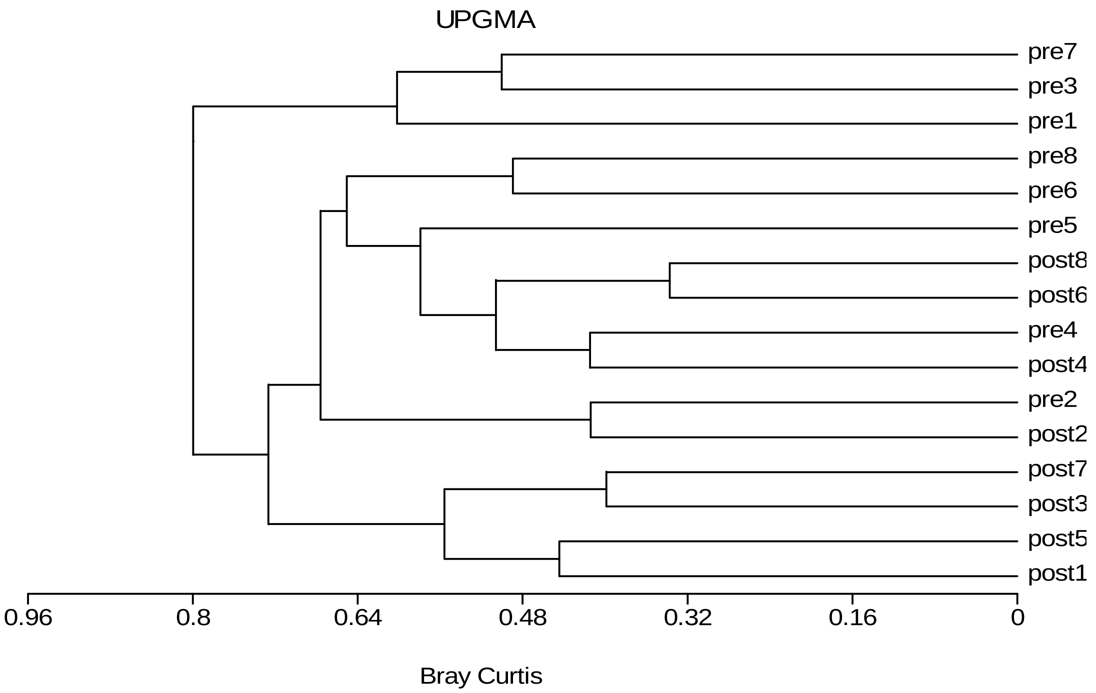


Site 6

The level of similarity between control sites and their analogues in the pre-baiting periods is low. All sites have less than 50% association with their analogues. This is partly due to the lack of data as capture rates are low in winter and many species were not caught. Similarity between sites increased post-baiting but was still low with only sites 3 and 7 having more than 40% similarity. This increase in association was probably due to increased activity and resultant larger sample sizes.

Figure 3.

Dendrogram of association between fauna monitoring sites using the Bray Curtis distance measure and unweighted pair group average (UPGMA) clustering. Abundance data from all six surveys was used.



The target sites, both pre and post baiting, show more association based on geographic location. Sites closest to each other in geographic space show the greatest association while the control sites show no particular pattern.

There are a number of reasons why there is a lack of interpretable pattern. These include variation in habitat structure between and within sites, only half of the sampling periods have been conducted in periods of peak activity, natural assemblage variability within similar habitats and that sampling has only been conducted over a total of 24 days. Due to the complex nature of vertebrate assemblage structures, to gain some accurate knowledge of relationships between control and target sites at least two years of pre-treatment data would be required

What is important to recognise is the implications of this on the primary objectives and how we might proceed and still achieve these primary objectives. It is only prudent at this stage, given these results, to consider all the control sites as a single sample and to treat the sites in the baited zone similarly. This will, to some extent, smooth out these differences and still allow analysis in relation to total abundance trends between the control and baited zones. Therefore all subsequent analysis here will look at the control and baited zone fauna sampling sites collectively. Sites 1-4 will be the control data and 5-8 the baited or target data.

Seasonal prey abundance

The effectiveness of the cat baiting regime works on the premise that bait uptake is greatest or most successful at the time when natural prey abundance is at its lowest. Since both reptiles and mammals are likely to make up the majority of prey items (not withstanding that both birds and invertebrates may also contribute significantly at times) the intent here is to determine periods of least activity for both these groups.
To examine the relationships between time of year and activity, captures from the control and the baited zone were plotted for each day of trapping conducted over all six surveys. The results for reptiles and mammals are displayed in Figures 4 and 5 respectively.

Figure 4

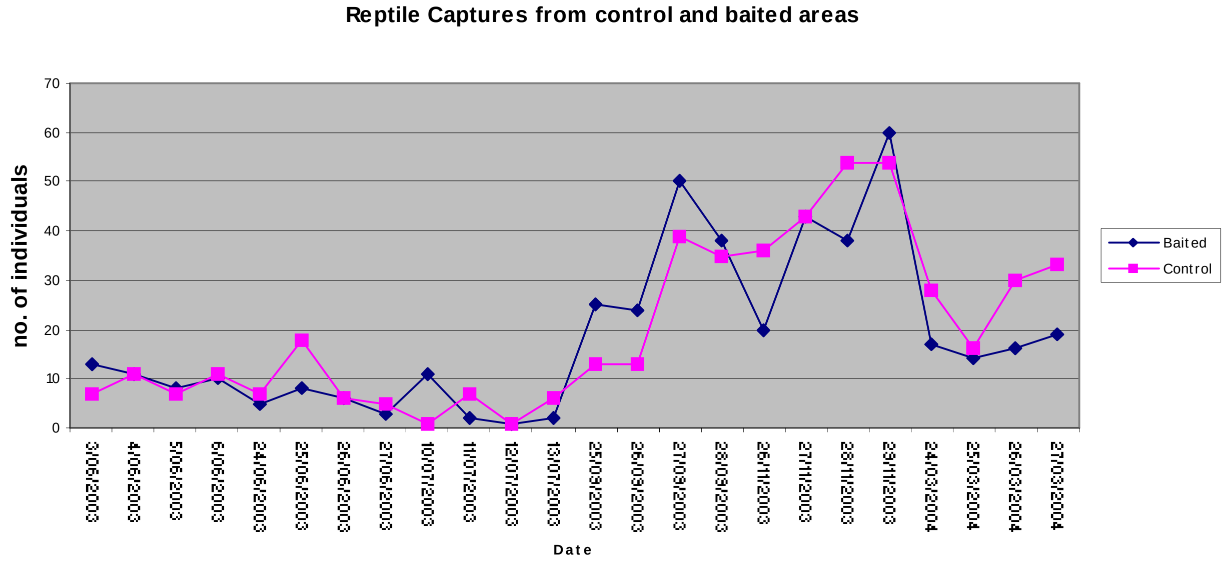
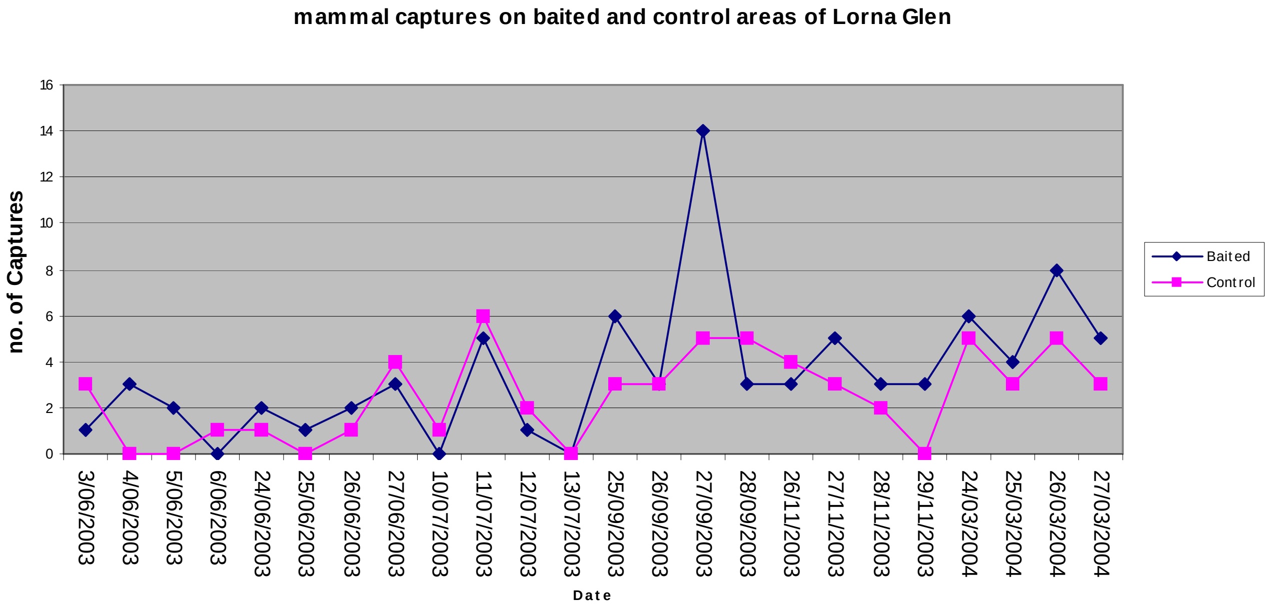


Figure 5



When interpreting these data it needs to be kept in mind that the x axis is not a continuum and that trapping occurred in discrete periods. Thus from the reptile data we can only conclude that reptile activity is less in July than September. However, since we know that on average July is the coldest month of the year and, as reptile activity is positively correlated to temperature increase, July appears to be the period of least reptile activity.

Patterns of mammal activity are relatively low across all trapping periods. Late June appears to be the period of least activity although given the small numbers captured it is difficult to analyse.

Activity patterns between the control and the baited zone are strongly correlated for the mammals with Spearman Rank Correlation coefficient, r =0.693, ($p<0.01$). Even more strongly correlated are the reptiles, r=0.864, ($p<0.001$). This confirms reasonably strong concordance in relation to activity patterns between the control sites and baited sites when individual grids are amalgamated.

Impacts of baiting on ground vertebrate abundances.

To determine if any trends in vertebrate abundances were detectable from the cat baiting that took place in early July, reptile and mammal data were subjected to a chi-square test to compare agreement between the observed frequency and the expected frequency of captures in each trapping period. For this analysis, reptile and mammal data were again treated separately. A 2 x 2 contingency table was created for each trapping period with columns representing control and baited zones and the rows defining number of pits with captures and number of pits empty. Since there are a total of 160 pits in each zone and trapping is conducted over 4 days the number of pits that may have captures is 640. The number of degrees of freedom for each test is 1. The critical values at both the 5% and 1 % levels are 3.84 and 6.63 respectively.

The raw data and calculated chi-square values are presented in the table below

Table 3.

Trapping period	Baited reptile captures	empty	Control reptile captures	empty	Chi squared value
1	42	598	36	604	0.49
2	22	618	36	604	3.54
3	16	624	15	625	0.03
4	137	503	100	540	7.09
5	161	479	187	453	2.67
6	66	574	107	533	11.24
Trapping period	Baited mammal captures	empty	Control mammal captures	empty	Chi squared value
1	6	634	4	636	0.4
2	8	632	6	634	0.29
3	6	634	9	631	0.61
4	26	614	16	624	2.46
5	14	626	9	631	1.11
6	23	617	16	624	1.3

The reptile analyses show significant levels of variation at the 1% level within both the 4th and 6th trapping periods. However, the significance switches between the baited zone and the control zone suggesting that this is not a response to baiting but more

likely increased activity patterns in the differing reptile assemblages that were identified from the initial site similarity analysis.

During none of the trapping periods, either pre or post baiting, does the calculated chi-square value for mammals exceed the critical value at the 5% significance level. It is concluded at this stage that there are no detectable trends in mammal abundances in relation to baiting.

These results are not unexpected at this stage of the project considering the brief length of time post baiting, and also that there has been some reinvasion by cats over this period. It is reasonable to assume that the low abundance of mammals found in the area would take some time to build up enough for increases from recruitment or decreases in direct cat predation to become detectable.

Changes in reptile abundance may also be detectable in the future, although again it is likely that exclusion of cats will have to extend over a longer period of time than currently is the case.

Differences in capture rates between PVC pipe and 20 Litre buckets.

For this analysis it is not necessary to distinguish between the control and baited zones, but only to determine total number of captures in either PVC or buckets. Data for each trapping period can also be assessed as well as whether particular species have a preference for one trap type or the other. A quick analysis for both mammals and reptiles show that there is a highly significant bias towards buckets for both groups (reptiles chi square=118.45 ($p<0.001$), mammals chi square=10.66 ($p<0.001$)) with buckets accounting for 67% of all reptile captures and 63.2% of all mammal captures (Table 4). It is impossible to make any assessment of preference for many individual species as their capture rates were too low, many species having only one capture! All of the more common mammal species, *Sminthopsis ooldea*, *Ningaui ridei* and *Pseudomys hermannsburgensis* show preference towards buckets. Faster moving diurnal reptiles also had much higher captures in buckets, including *Ctenotus pantherinus*, *Ctenophorus isolepis* and *Ctenotus ariadnae*. Almost all species of gecko had considerably higher capture rates in buckets compared to PVC. On the other hand pygopods have a slight bias towards PVC, although capture rates for pygopods are quite low in both trap types. *Litoria rubella* also had higher numbers in PVC however a single pit was responsible for almost all captures of this species suggesting that it was located close to their specific habitat.

It is quite likely this variation between trap types is a product of difference in surface area rather than any other particular factor. Opinion often states that PVC is more effective for mammals and although that isn't demonstrated here, that may be a result of the relatively shallow design- around 500mm as opposed to the more usual depth of 600mm

Table 4

Order	Family	TAXON	20L Bucket	PVC Pipe
ANURA	HYLIDAE	Litoria rubella	1	8
ANURA	MYOBATRACHIDAE	Neobatrachus sutor	2	

Order	Family	TAXON	20L Bucket	PVC Pipe
ANURA	MYOBATRACHIDAE	Notaden nichollsi	10	11
DASYUROMORPHIA	DASYURIDAE	Ningaui ridei	25	16
DASYUROMORPHIA	DASYURIDAE	Sminthopsis hirtipes		1
DASYUROMORPHIA	DASYURIDAE	Sminthopsis longicaudata		1
DASYUROMORPHIA	DASYURIDAE	Sminthopsis macroura		1
DASYUROMORPHIA	DASYURIDAE	Sminthopsis ooldea	19	9
RODENTIA	MURIDAE	Mus musculus	5	3
RODENTIA	MURIDAE	Notomys alexis	1	1
RODENTIA	MURIDAE	Pseudomys desertor	4	3
RODENTIA	MURIDAE	Pseudomys hermannsburgensis	35	17
SQUAMATA	AGAMIDAE	Ctenophorus isolepis	63	18
SQUAMATA	AGAMIDAE	Ctenophorus nuchalis	1	
SQUAMATA	AGAMIDAE	Diporiphora winneckei	3	3
SQUAMATA	AGAMIDAE	Lophognathus longirostris	1	
SQUAMATA	AGAMIDAE	Moloch horridus	3	
SQUAMATA	AGAMIDAE	Pogona minor	9	3
SQUAMATA	ELAPIDAE	Demansia psammophis	1	
SQUAMATA	ELAPIDAE	Pseudonaja modesta	3	
SQUAMATA	ELAPIDAE	Suta fasciata	3	5
SQUAMATA	GEKKONIDAE	Diplodactylus conspicillatus	71	29
SQUAMATA	GEKKONIDAE	Diplodactylus stenodactylus	65	17
SQUAMATA	GEKKONIDAE	Gehyra variegata	3	3
SQUAMATA	GEKKONIDAE	Nephrurus laevissimus	25	10
SQUAMATA	GEKKONIDAE	Nephrurus vertebralis	1	
SQUAMATA	GEKKONIDAE	Rhynchoedura ornata	37	11
SQUAMATA	GEKKONIDAE	Strophurus elderi	62	48
SQUAMATA	GEKKONIDAE	Strophurus strophurus	21	6
SQUAMATA	GEKKONIDAE	Strophurus wellingtonae	5	2
SQUAMATA	PYGOPODIDAE	Delma butleri	2	6
SQUAMATA	PYGOPODIDAE	Delma nasuta	7	10
SQUAMATA	PYGOPODIDAE	Lialis burtonis	5	5
SQUAMATA	SCINCIDAE	Ctenotus ariadnae	17	10
SQUAMATA	SCINCIDAE	Ctenotus calurus	13	13
SQUAMATA	SCINCIDAE	Ctenotus dux	6	1
SQUAMATA	SCINCIDAE	Ctenotus grandis	3	
SQUAMATA	SCINCIDAE	Ctenotus helenae	13	6
SQUAMATA	SCINCIDAE	Ctenotus pantherinus	84	48
SQUAMATA	SCINCIDAE	Ctenotus schomburgkii	1	1
SQUAMATA	SCINCIDAE	Egernia inornata	3	1
SQUAMATA	SCINCIDAE	Lerista bipes	38	34
SQUAMATA	SCINCIDAE	Lerista desertorum	5	1
SQUAMATA	SCINCIDAE	Lerista muelleri	10	3
SQUAMATA	SCINCIDAE	Menetia greyii	30	8
SQUAMATA	SCINCIDAE	Morethia ruficauda	12	2
SQUAMATA	SCINCIDAE	Tiliqua multiscutata		1

Order	Family	TAXON	20L Bucket	PVC Pipe
SQUAMATA	TYPHLOPIDAE	Ramphotyphlops waitii	3	2
SQUAMATA	VARANIDAE	Varanus brevicauda	4	1
SQUAMATA	VARANIDAE	Varanus caudolineatus	2	1
SQUAMATA	VARANIDAE	Varanus eremius	6	3
SQUAMATA	VARANIDAE	Varanus gouldii		1
SQUAMATA	VARANIDAE	Varanus tristis		1

Conclusions and Recommendations

The selection of control sites in relation to ecological assessments is a difficult process, particularly as there can be a high degree of natural variability in assemblages and abundances over relatively short ranges (Figure 3). Organisms frequently respond to environmental attributes at a smaller scale than the parameters we use for habitat selection. This is further compounded by episodic stochastic events in arid environments such that environmental influences may occur at relatively fine scales, i.e. localised thunderstorms having significant rainfall effects over very short ranges. As a result of this it is unlikely that we will be able to determine any specific impacts or responses of fauna across the individual habitat sites selected for this project. However, as previously mentioned, there is fairly strong correlation between general activity of mammals and reptiles across all the combined control and target sites and this will at least allow some assessment of changes in trajectory of abundances if these occur in response to baiting. Before we are likely to detect any trends of this nature though, it will be necessary to have exclusion of cats from the baited area for a longer period than was achieved with the first baiting. Assessments of fauna abundances will need to occur across at least a single breeding period (and probably several) as the abundance of mammals is already relatively low and responses to the removal of predation, if detectable, may have considerable lag. Due to the strong dependence of reptile activity on temperature and the variability of this activity already observed across sites, changes may be more difficult to detect here although a consistent chi-square value above the critical value for the 5% significance level for increases in the baited zone would be encouraging.

Since climate plays such a crucial role on reptile activity and maximum temperature can be highly variable over short temporal intervals, we should give some consideration to the adequacy of only four days/nights trapping in each period. Six or more days/nights are likely to give better sampling, particularly over the cooler months when activity is already much reduced.

The data gathered so far supports the hypothesis that prey abundance is at it’s lowest in the cooler weather and that the optimum time for baiting probably occurs between late June and mid July.

Recommendation 1: *Trapping should continue at a minimum of four but preferably six times per year starting from this June prior to cat baiting in July.*

This will allow a continued assessment of seasonal variability in activity. Consideration should be given to increasing the duration of each trapping period from four to six day/night’s duration. This will not only increase the amount of data for analysis but also overcome some of the variability observed in relation to short term temperature fluctuations and its effects on activity.

Recommendation 2: *No changes should be made to the established control area on Lorna Glen and monitoring of these sites to continue.*

To determine if predation removal has any observable impacts on extant fauna it will be necessary to have sustained cat control in the baited area over at least 12 months and quite possibly longer. As increases in recruitment are likely to be the source of detectable trends in faunal abundances this is not only dependant on environmental conditions but equally important is time. Monitoring the potential effects of cat predation/ removal will require a commitment to maintain the established control zone south of the access road into Lorna Glen for at least the next 3-4 years. Any changes made to this area will only complicate the interpretation of data, if not make it impossible to make any long term assessment in relation to objective 2- the hypothesis that feral cats impact on the relative abundance of a variety of small terrestrial vertebrates and that responses to removal of predation can be detected.

Recommendation 3: *Any further establishment of trapping sites for this project at Lorna Glen should use a combination of 600mm depth PVC and 20L buckets to ascertain if 500mm deep PVC pipe has been a shortcoming in relation to mammal trapping.*

The assessment of effectiveness of buckets versus PVC pipe is not critical to this study although for this area it does demonstrate that buckets have been significantly more efficient in captures of vertebrates. They have also provided us with considerably more data for analysis than would have been available if we had used PVC pipe alone.