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South Australian Arid Lands Natural Resources Management Board

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May 2013

South Australian Arid Lands Natural Resources Management Board

Ampurta (*Dasycercus cristicauda*) southern range monitoring and genetic sample collection

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This report may be cited as:

Moseby, K. (2013) Ampurta (*Dasycercus cristicauda*) southern range monitoring and genetic sample collection: Report by Ecological Horizons to the South Australian Arid Lands Natural Resources Management Board, Port Augusta]

Cover images:

Left: Ampurta habitat in Canegrass dunefields, Right; Ampurta captured near William Creek during the survey.

Summary

The ampurta (*Dasycercus cristicauda*) is a small carnivorous marsupial that inhabits canegrass (*Zygochloa paradoxa*) sandhills in arid Australia. The species has declined since European settlement possibly due to the introduction of cats and foxes and habitat degradation. It is currently nationally listed as a threatened species (Vulnerable). A survey was conducted in 2006 to determine the southerly limit of the range of the ampurta and the species was found as far south as Stuarts Creek pastoral station. This was a considerable range extension from previous records possibly due to the release of calicivirus in 1995 and resultant decline in rabbit, cat and fox abundance. The method used during the survey was 30 minutes searches for tracks of the ampurta on 2ha plots located on canegrass sand dunes. The ampurta has distinctive tracks, scats and burrows that allow it to be easily identified if present. Sites stretched from the Peake Station in the west to Mungerannie Station in the East and formed a southerly arc around Lake Eyre.

In May 2013, this survey was repeated to determine if the ampurta had maintained or expanded its southerly range expansion. The survey also aimed to collect DNA samples from ampurta to increase our understanding of the taxonomy of the species. Of the 103 track plot sites common to both surveys, 28% of sites contained ampurta tracks, compared to 25% in 2006. A total of 109 sites were searched for tracks, scats and burrows of ampurta with sign found at 47 (42%) sites. The broad distribution of the species remains similar to 2006 levels with a slight further range extension to the south around Lake Eyre South. The three good seasons from 2009-2012 may have assisted in the species maintaining its range extension. There was no correlation between the presence or abundance of ampurta sign on a dune and the amount of canegrass cover or total vegetation cover, suggesting that other factors are influencing the distribution of the species. There is some indication that isolated dunes at the edge of dunefields were less likely to support ampurta with the highest densities recorded further into extensive dune systems. Rabbit, dingo and cattle sign was abundant at plots sampled during the survey. The presence of fox, cat, dingo, cattle or rabbit sign was not a good indicator of ampurta presence or absence but there was a significant association between ampurta presence and the presence of the spinifex hopping mouse.

Three female ampurta were trapped near William Creek on the main access track to Lake Eyre North. Despite trapping at three other locations, no other ampurta were captured. Scats were collected from 25 sites with 17 of these lodged with the S.A. museum for future DNA analysis. The remaining older scats were sent off for macroscopic dietary analysis.

Despite finding ampurta sign at nearly half the sites sampled, trap success and the abundance of sign were generally low. The ampurta appears to be widely distributed in patchy, low abundance throughout areas of continuous canegrass sand dunes in the Lake Eyre region. Future work should concentrate on determining the factors influencing the fine scale occupancy of ampurtas at individual canegrass dunes as no association was detected between ampurta presence and vegetation characteristics or the presence or absence of predators or introduced herbivores.

Introduction

The ampurta (*Dasycercus cristicauda*) is a small carnivorous marsupial that inhabits canegrass sandhills in the desert regions of Australia. Once found over most of the sandy inland deserts, the species has declined since European settlement. It is now restricted to a small patch in north west Western Australia, southern Northern Territory and Queensland and northern South Australia. In South Australia, Ampurtas are known from the Simpson Desert, Tirari Desert and western margin of the Strzelecki Desert. In recent years they have also been found on the western side of Lake Eyre and as far south as the William Creek area and southern Birdsville Track. The species once had a wider distribution in South Australia, with historic records from as far west as Ooldea.
Ampurtas are found mainly in sandy habitats, including sandhills with canegrass (*Zygochloa paradoxa*). They may also inhabit sand plain or sand mound areas (often with Nitrebush, *Nitraria billadierei*) or even sandy watercourses.

Ampurtas are about the size of a small guinea pig, with a short fat tail. They have a crest of dark black hair along the top of their tail forming a 'mohawk'. They shelter during the day in small burrows, often found at the base of shrubs and emerge at night to capture their prey. Unlike reptile burrows which are low and wide, ampurta burrows have a similar height and width and often have elongated curved scats at the burrow entrance. The diet of the ampurta includes a range of insects and arthropods including beetles, crickets, grasshoppers, centipedes, spiders and scorpions. They also prey on geckoes and skinks and occasionally small birds, rodents and marsupials
Threats to ampurtas are poorly understood. However, it is likely that their decline is linked to the introduction of predators such as foxes and cats. Rabbits and possibly domestic stock are also thought to have impacted ampurtas through habitat degradation which impacts the insects and other small reptiles and mammals that are part of ampurta diet. In recent years it is thought that ampurtas may have reoccupied parts of their former range following the introduction of Rabbit Calicivirus Disease which lowered rabbit numbers for over a decade.
There has been some confusion over the taxonomy of the different species of *Dasycercus* with the crest-tailed and closely related species, the brush-tailed mulgara, difficult to tell apart in the field. DNA analysis has been used to separate the species which can now be differentiated in the field using teat and teeth characteristics. However, some taxonomic questions remain unanswered and because of the cryptic nature of the species more ampurta DNA samples are needed, particularly from the southern parts of their range.

The aims of this study were to

1) Ascertain whether the previous southern expansion of the ampurta has been sustained or expanded after the recent rains and RCD-induced rabbit decline. Recent large rainfall events between 2009 and 2012 have led to a boom in local rodent abundance and other native species. However, recent records suggest that fox and cat numbers have built up after the recent good rains and could now be exerting pressure on newly expanded mammal populations. To determine if the ampurta's south westerly range expansion has been sustained or potentially even expanded further, resampling of the track plots surveyed in 2006 (Southgate 2006) was conducted.

2) Determine if the presence or abundance of ampurta sign correlates with vegetation cover or presence/absence of other fauna species. The presence of predators such as cats, foxes and dingoes may influence the distribution of ampurta and/or ampurtas may be more abundant in areas with higher canegrass cover. Any changes in distribution

between 2006 and the present study were also compared with changes in abundance of species such as rabbits, cats, foxes, dingoes and cattle.

3) Collect DNA and voucher specimens to assist in the genetic management of the species. This is particularly relevant as previous genetic work by Pat Woolley (2005) has led to reclassification of the mulgara species complex which is still under debate. The closely related species (brush-tailed mulgara, *Dasycercus blythiii*) prefers *triodia* sand habitat and formerly occurred in South Australia but there have been no recent records from the state.

4) Speak to and where possible involve local landholders and/or schools in the survey to increase awareness of the species.

Methods

2 ha plots - tracks

A total of 126 track plots were sampled in 2006 by Rick Southgate of Envisage Environmental Services. In May 2013, an attempt was made to resample all 126 plots but some were not resampled, either due to inaccessibility or excessive spacing of sites.

Each plot was searched for the equivalent of 25- 30 minutes by one person. When two people were present this equated to approximately 15-20 minutes. The abundance and age of tracks, scats, burrows and sign of a range of species was recorded onto standard datasheets using the method outlined in the Tales in the Sand tracking booklet (Moseby et al. 2009).

Rabbit, hopping mouse, cat, fox, dingo, cattle, small rodent, emu, kangaroo and sign were all recorded and compared with presence and abundance of ampurta sign to determine if there was any correlation.

Plate 1: Tracks of many species are easy to identify on the soft orange sand dunes in the Lake Eyre region

2ha plots - vegetation cover

The patchiness and cover of canegrass and other vegetation categories was estimated for each 2 ha plot using a series of two square metre quadrats placed along four transects (Fig. 1). Parallel transects traversed the dune and were spaced 50m apart and each contained five quadrats spaced 20m apart. Transects started slightly up from the base of the dune where trackable sand started and went over the crest of the dune and down the other side. If the dune was too narrow to fit five quadrats without extending onto the hard swale, extra transects were added to accommodate the whole 20 quadrats.

The projected foliage cover of vegetation was estimated in each quadrat. All live and dead cover was included in the projected cover estimate as long as the plant was still rooted to the ground. Cover was divided into vegetation classes with cover in each class rounded to the nearest 5%. Vegetation classes were as follows;

Forbs – short lived perennials, annuals, ephemeral veg
Grasses-all species
Canegrass- *Zygochloa paradoxa*
Small shrubs – long lived shrubs growing less than 1 m tall at maturity
Large shrubs – long lived shrubs growing greater than 1m tall at maturity. For example: juvenile *Acacia ramulosa* still counted as a large shrub despite size at time of survey.

The average total vegetation cover for each site was calculated using the 20 quadrats. The average canegrass cover was also calculated. To estimate patchiness of canegrass the percentage

of quadrats that contained canegrass was also recorded. A species list (at least to genus) was noted for each plot. In the case of forbs, this information may be indicative of seasonal conditions at each site rather than vegetation condition.

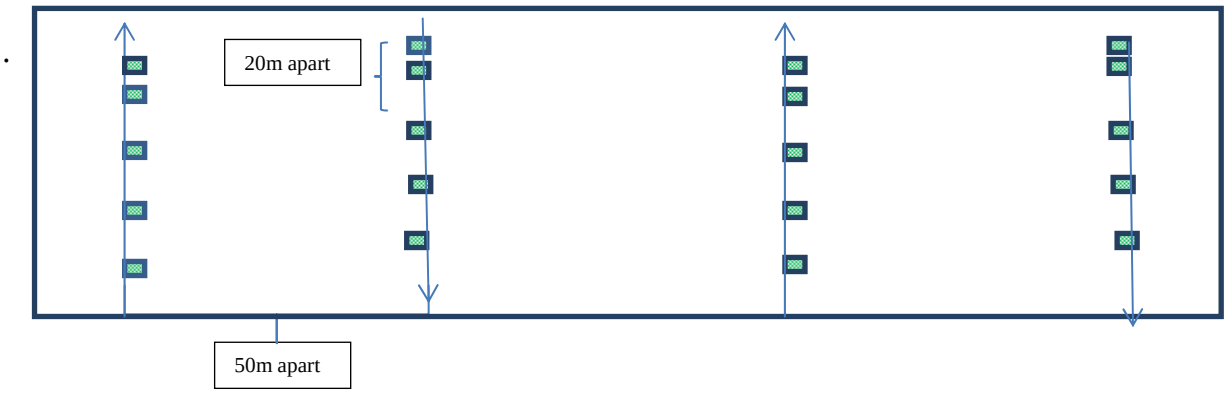

Fig. 1: Diagram of vegetation quadrats spaced along parellel transects that bisected the dune DNA sampling

Traps were set for ampurta at sites where abundance was estimated as high based on the proportion of the 2 ha plot that contained tracks, scats and burrows. In particular, sites in the western and southern section of the sampling area were targeted as these represent areas where few DNA samples exist. A mixture of large, deep pitfall traps (600mm deep and 250mm wide) and Elliott traps were used with Elliott traps baited with a mixture of rolled oats, peanut paste and sardines. Traps were set for 1-2 nights; if fresh tracks were observed on the first morning of trapping then traps were left open for a second night. An absence of fresh tracks near the traps suggested that ampurtas were not in the immediate vicinity and traps were closed and removed.

Captured ampurtas were weighed, sexed, checked for reproductive status and either collected for museum specimens or released after taking a small piece of ear tissue as a DNA sample. Collected specimens were ethically euthanased using a CO_2 chamber obtained from the SAAL NRM board. They were then placed in plastic ziplock bags and frozen in the car freezer. At sites where ampurta were not captured, fresh scats were collected as DNA samples. All DNA samples were placed in eppendorfs filled with alcohol and placed in the fridge or freezer. Specimens and DNA samples (including scats) were lodged with the SA museum.

Plate 2: A deep (60cm) pitfall trap dug between canegrass hummocks during the survey

Local Involvement

In conjunction with Reece Pedler and Perri Carter from the SAAL NRM Board, the Oodnadatta School and School of the Air were contacted to organise visits or field trips with the students. A project outline and datasheet was formulated for use during the visits but unfortunately the Oodnadatta School visit did not eventuate but continuing discussions are occurring between the school and the NRM board. However, assistance was given at a SAAL board ampurta display at the Oodnadatta Races during the field trip where locals were given information about the ampurta and other local species.

All pastoral stations where plots were located were contacted by letter and phone prior to the field surveys. The purpose of the survey and location of plots was discussed with each landholder individually as well as general information given about the ampurta. Notice was also given by phone or email immediately prior to each station visit and all station homesteads were visited during the survey. A copy of the ampurta fact sheet was given to pastoralists during visits and the location of plots was discussed. Advice was obtained from landholders regarding track accessibility and tracks were not used if requested by landholders. Interested pastoralists were invited to assist with the surveys.

Personnel

The 2 ha tracking plots were surveyed by Katherine Moseby (84 plots) and John Read (25 plots) of Ecological Horizons Pty. Ltd. Plant identification and quadrats were conducted by Andrea Tschirner of Acacia Park Consulting (84 plots) and John Read (25 plots).

Results

2 ha track plots

During May 2013, 109 2ha plots were surveyed including 103 of the 126 plots established in 2006 (Fig. 2) and 6 new plots (Appendix 1). Twenty three plots from 2006 were not resampled due to inaccessibility (either due to wet weather, old tracks no longer present or erosion) or close spacing of plots. Four of the six new plots were established on Mungerannie Station to replace plots located along a sandy track that was overgrown and no longer used by local station owners.

Plate 3: Typical ampurta habitat sampled during the survey consisting of canegrass dominated longitudinal sand dunes.

Comparison of 2006 and 2013 data was problematic as only ampurta tracks were used to determine presence in 2006 whilst the presence of ampurta tracks, scats and burrows were recorded separately in 2013. When only the presence of ampurta tracks was compared on the 103 plots sampled in both 2006 and 2013, ampurta tracks were present at 25% of plots in 2006 and 28% in 2013 indicating a slight increase in detection rates (Fig. 3, Appendix 2). When the presence of tracks, scats and burrows were all used to determine ampurta presence at all of the 109 plots sampled in 2013, 42% (47) of the sampled plots contained ampurta sign (Fig. 4). Recent sign (less than a week old) was found on 33% (36) of plots.

A comparison of the distribution of ampurta sign between 2006 and 2013 suggests no broad change in distribution although there was a slight increase in the southerly distribution of the species in 2013 (Fig. 3). More sites to the west of Lake Eyre South contained ampurta sign as well as between Lake Eyre South and North. Although the percentage of sites with ampurta tracks changed little between the two sampling periods, only half (13 of the 26 sites) of the sites where ampurta tracks were present in 2006 also contained tracks in 2013. This change was mainly due to less sites to the west of Lake Eyre containing tracks in 2013 and more sites to the south. However, heavy rain was experienced just prior to sampling at sites to the west of Lake Eyre making tracking difficult. When the presence of scats and burrows was also used to indicate ampurta presence, there was no decline in ampurta distribution to the west of Lake Eyre (Fig. 4). Ampurta sign was patchy within their distribution with some sites having scats, burrows and abundant tracks and others recording only a single ampurta track running across the plot (Fig. 4).

Plate 4: Active ampurta burrow with fresh scat outside the entrance.

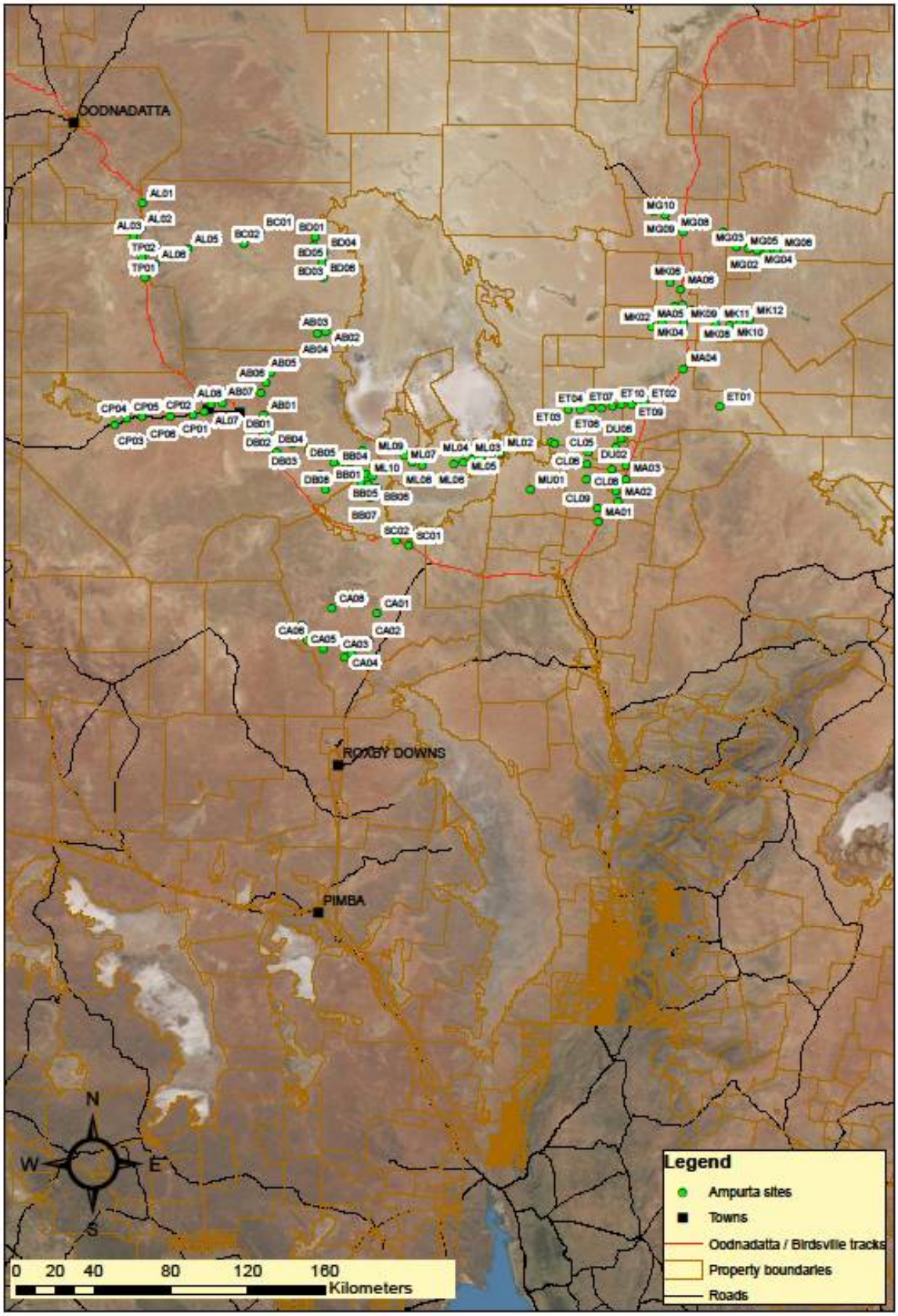

Fig. 2: The location of the 126 track plots sites established in 2006. 103 of these were revisited in May 2012 and an extra 6 sites established (total 109).

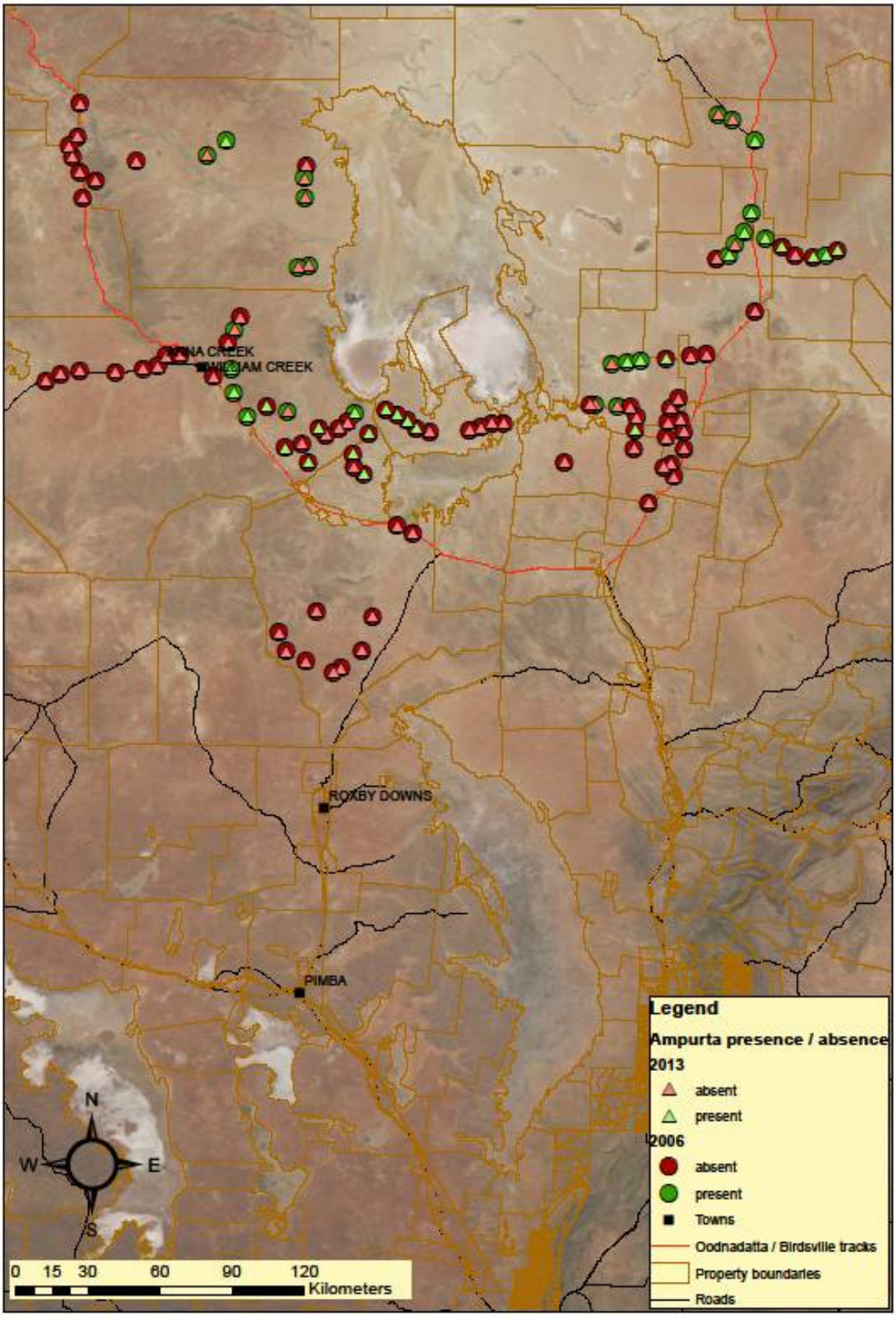

Fig. 3: Comparison of fresh ampurta tracks at sites sampled in 2006 (circles) and 2013 (triangles). Green depicts fresh sign present and red depicts fresh sign absent.

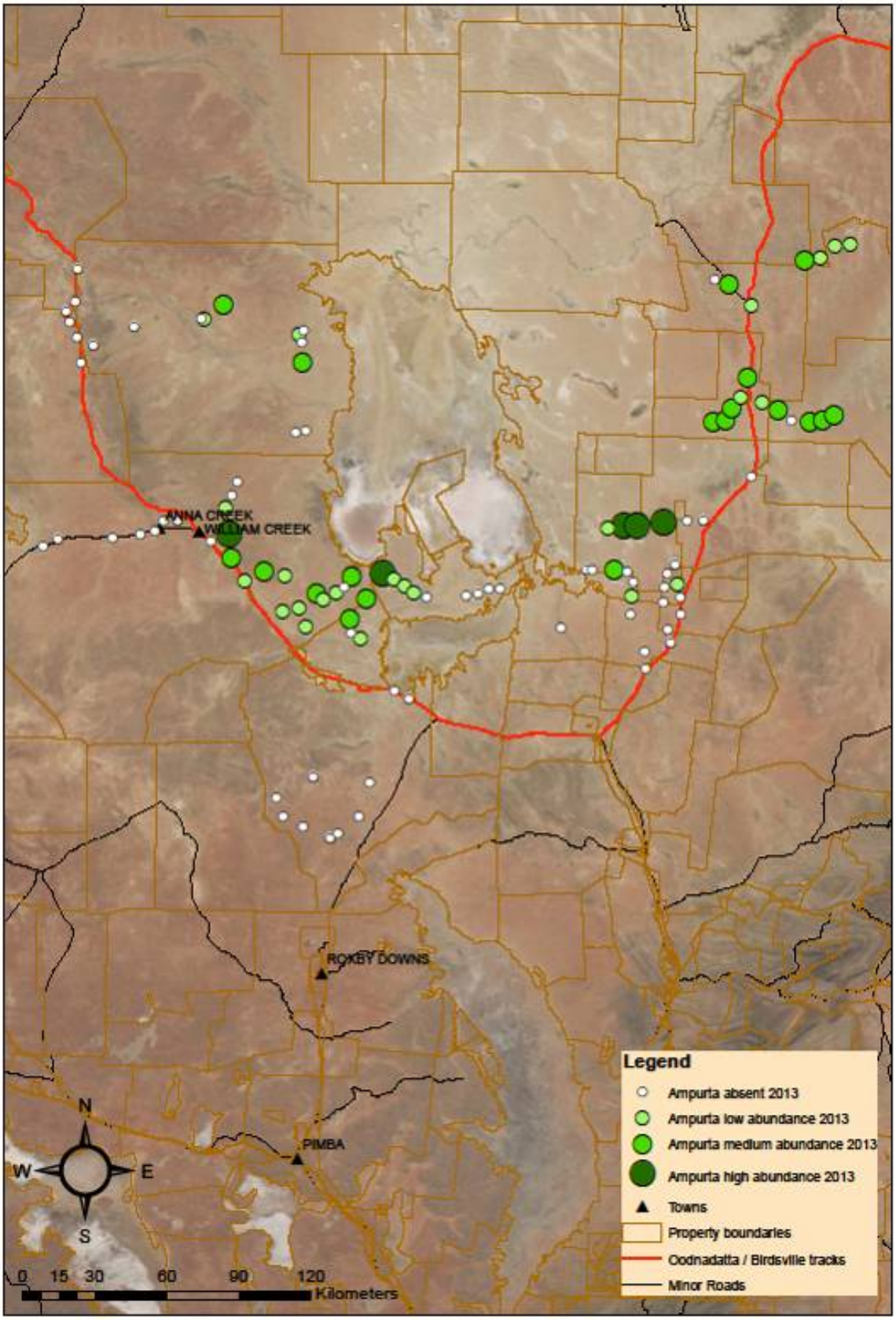

Fig. 4: Abundance of all fresh (less than 1 week) ampurta sign (tracks, scats, burrows) at the 109 plots sampled in 2013

The percentage of plots with fresh fox tracks declined between 2006 and 2013 from 76% to 52% but the presence of dingo and cat tracks increased by 32 and 25 % respectively (Table 1). The incidence of hopping mice tracks also increased by nearly 20% with more than half of the surveyed plots containing hopping mice tracks in 2012. Rabbits were ubiquitous during both surveys (more than 90% of plots) and were recorded in high abundance at 54% of the 103 plots resampled in 2013. Red Kangaroos and Cows were recorded at less plots in 2013 than in 2006 (Table 1). Old scats and burrows of the plague rat (*Rattus villosissimus*) were found at a number of sites on both the East and West side of Lake Eyre.

The proportion of sites with fresh (less than 1 week) ampurta sign was compared at sites with and without fresh cat, fox, dingo, cattle, hopping mouse or rabbit sign to determine if these species were associated with ampurta presence or absence (Appendix 3). Chi-squared tests were used and there was no significant difference in the proportion of plots with and without ampurta sign when fox, cat, dingo, cattle or rabbits were present (Table 2). However, significantly more plots with ampurta sign contained hopping mice sign suggesting a positive association between these two species. Fresh hopping mice sign was present at 32 of the 36 sites where fresh ampurta sign was present.

Table 1: Percentage of plots with fresh (less than a week) tracks or sign* of species recorded during the 2006 and 2013 surveys. Only the 103 plots common to both surveys are included.

	2006 (%)	2013 (%)	Difference
Ampurta	25	28	+3
Fox	76	52	-24
Cat	14	39	+25
Dingo	52	84	+32
Hopping mouse	35	54	+19
Red Kangaroo	7	3	-4
Cow*	62	40	-22
Camel*	9	10	+1
Rabbit*	91	95	+4

Table 2: The association of dingo, fox, cat, cattle, rabbit and hopping mice with ampurta presence on all plots surveyed in 2013. Values are the proportion of ampurta-present (36 plots) and ampurta-absent (73) plots with fresh sign of each associated species. Total plots is 109.

	Dingo	Fox	Cat	Cattle	Rabbit	Hopping Mouse
Ampurta presence	94	58	36	25	97	89
Ampurta absence	71	51	32	44	93	42
Chi-squared	1.6	.27	.15	2.27	0.04	8.99
Significance	ns	ns	ns	ns	ns	<0.01

Vegetation sampling

Canegrass cover and patchiness was very variable between sites (Appendix 4). The observed soil colour, texture, height and width of the sand dunes also differed significantly between sites. There were notable differences in seasonal conditions with some sites to the east of the Birdsville track on Mungerannie and Mulka stations sites experiencing recent growth of forbs and ephemerals and fresh growth on canegrass clumps. Fifty four species of vegetation were opportunistically identified during the survey (Appendix 5).

It was also evident that there were significant differences in vegetation condition between sites. Most sites visited had been heavily grazed by rabbits, and many sites had been grazed or disturbed by cattle. Vegetation characteristics were recorded at 107 of the 109 survey sites visited in 2013 (Appendix 3). Canegrass cover ranged from 0 to 24% and averaged 9%. Total vegetation cover ranged from 11 to 40%. A one way ANOVA was used to test for significant differences between sites with and without ampurta sign. There was no difference in the average canegrass cover, average total vegetation cover or number of quadrats containing canegrass between sites with and without ampurta presence (Table 3). Ampurta were recorded at five sites where no canegrass was recorded in the 20 quadrats. Canegrass was present in very low abundance at three of these five sites with the remaining two sites supporting *Nitraria* (Nitre Bush) hummocks.

Table 3: Vegetation characteristics recorded at survey sites where ampurta were present and absent.

	No. sites	Average Canegrass cover	Average total veg cover	Total no. of quadrats with canegrass present
Ampurta present	46	9	22	11
Ampurta absent	61	9	23	10
Total sites sampled	107			

Plate 5: Many sites supported sparse overstorey of Acacias or other long lived plant species

DNA sampling

Trapping was conducted at four sites, BC02, AB01, ML11 and MK02 (Table 4). Three female ampurta were captured in Elliott traps from site AB01, located just south of William Creek along the main access track to Lake Eyre North (Table 4). The two oldest females were taken for museum specimens and the young female with an immature pouch was released after an ear tissue sample was taken. All three females had 8 teats and a very small bud third premolar tooth indicating that they were ampurtas. The 3rd premolar was very difficult to see in live specimens. The tail crest was also consistent with that found in ampurtas and ran along the top distal section of the tail. No other ampurta were captured during the survey despite trapping at 3 other sites. Hopping mice tracks were present at all trap sites but animals were only captured at BC02 and ML11. A list of all animals captured during the survey is presented in appendix 6. A spinifex hopping mouse specimen was collected at site AB01 and a DNA ear sample from the single Desert Mouse capture was collected from site ML11. In addition, ampurta scats were collected from 25 sites, with samples from 17 sites stored in alcohol tubes and deposited at the SA Museum for future DNA analysis. The remaining older scat samples were sent to Desert Wildlife Services for macroscopic diet analysis. A list of all DNA samples lodged at the S.A. Museum is listed in appendix 7.

Table 4: Trap effort and captures recorded during the survey

Site	Date	No. nights	Elliott trap nights	Deep pitfall trap nights	Ampurta captures (trap success)	Hopping mouse captures (trap success)	Desert Mouse captures (trap success)
BC02	13/5/2013	1	40	6	0	0	0
AB01	16/5/2013	1	60	3	3 (5%)	7 (11%)	0
ML11	17/5/2013	1	60	0	0	7 (11%)	1
MK02	19/5/2013	1	20	0	0	0	0

Plate 6: Tail of a captured ampurta showing the black crest at the tip

Conclusion

Sampling during 2013 indicates that the ampurta has maintained its 2006 distribution around Lake Eyre in South Australia. A slight southerly range extension was recorded with the species now present between Lake Eyre South and Lake Eyre North and also in sand dunes to the west of Lake Eyre South. The species was patchily distributed within its range and varied considerably in its abundance at sampled sites. The presence of ampurta was positively associated with the presence of *Notomys alexis* but there was no association with any introduced predator or herbivore. Ampurtas were recorded from canegrass sand dunes and occasionally from sand plains with nitre bush hummocks. There was some indication that the species was more common in large patches of wide, high, longitudinal canegrass dunes but there was no association with canegrass cover, total projected vegetation cover or canegrass patchiness.

Plate 7: The spinifex hopping mouse (*Notomys alexis*) was the most common mammal species captured during the survey.

Plate 8: An immature female ampurta captured at AB01.

References

Southgate, R. (2006). Investigation of *Dasycercus* distribution on canegrass sand dunes in the Lake Eyre region. Report prepared for the South Australian Department for Environment. Envisage Environmental Services, South Australia.

Moseby, K.E., Southgate, R. and Nano, Theresa (2009). Tales in the Sand. A guide to identifying arid zone species using tracks and other sign. Ecological Horizons, South Australia.

Woolley, P.A. (2005). The species of *Dasycercus* Peters, 1875 (Marsupialia: Dasyuridae). Memoirs of Museum Victoria **62**: 213-221.

Appendix 1: Sites sampled during the 2006 and 2013 surveys including the reason for excluding sites or adding new ones. Rain refers to either sites that were temporarily inaccessible due to rain or missed due to leaving early due to forecasted significant rainfall event. No access means sites are no longer accessible due to permanent road closures. Close spacing refers to sites that were very close together and so only a portion of the sites were visited.

Site Name	Zone	Easting	Northing	Property	2006	2013	Reason
AB01	53	643087	6800572	Anna Creek	1	1	
AB02	53	676187	6835872	Anna Creek	1	0	rain
AB03	53	675233	6843767	Anna Creek	1	1	
AB04	53	670847	6843116	Anna Creek	1	1	
AB05	53	646792	6822282	Anna Creek	1	1	
AB06	53	644267	6817033	Anna Creek	1	1	
AB07	53	641697	6811660	Anna Creek	1	1	
AC01	53	694304	6782615	Anna Creek	1	1	
AC02	53	691222	6778634	Anna Creek	1	1	
AC03	53	687820	6775947	Anna Creek	1	1	
AC04	53	682401	6773310	Anna Creek	1	1	
AL01	53	580071	6911107	Allandale	1	1	
AL02	53	579117	6897497	Allandale	1	1	
AL03	53	575438	6893506	Allandale	1	1	
AL04	53	576809	6889130	Allandale	1	1	
AL05	53	603493	6887120	Allandale	1	1	
AL06	53	586556	6879300	Allandale	1	1	
AL07	53	615703	6806194	Anna Creek	1	1	
AL08	53	621678	6806511	Anna Creek	1	1	
BB01	53	697519	6764726	Stuarts Creek	1	0	close spacing
BB02	53	693625	6765408	Stuarts Creek	1	1	
BB03	53	696044	6769952	Stuarts Creek	1	0	close spacing
BB04	53	700256	6773833	Stuarts Creek	1	1	
BB05	53	699680	6768821	Stuarts Creek	1	0	close spacing
BB06	53	701826	6762325	Stuarts Creek	1	0	close spacing
BB07	53	698008	6757267	Stuarts Creek	1	1	
BB08	53	694077	6759849	Stuarts Creek	1	1	
BC01	53	640912	6895581	Peake	1	1	
BC02	53	632834	6889545	Peake	1	1	
BD01	53	669843	6893315	Peake	1	0	rain
BD02	53	668880	6888699	Peake	1	0	rain
BD03	53	666671	6883756	Peake	1	0	rain
BD04	53	674248	6885411	Peake	1	1	
BD05	53	673386	6880229	Peake	1	1	
BD06	53	673710	6871996	Peake	1	1	
BW01	53J	672250	6883100	Peake	0	1	New site
CA01	53	701806	6697560	Stuarts Creek	1	1	
CA02	53	697218	6683520	Stuarts Creek	1	1	
CA03	53	688670	6676359	Stuarts Creek	1	1	

CA04	53	685310	6674515	Stuarts Creek	1	1	
CA05	53	674051	6678917	Stuarts Creek	1	1	
CA06	53	665712	6683169	Stuarts Creek	1	1	
CA07	53	662842	6690992	Stuarts Creek	1	1	
CA08	53	678368	6699977	Stuarts Creek	1	1	
CL01	54	209885	6786035	Clayton	1	1	
CL02	54	207804	6786056	Clayton	1	1	
CL03	54	219220	6785917	Clayton	1	1	
CL04	54	224656	6785856	Clayton	1	1	
CL05	54	227420	6781781	Clayton	1	1	
CL06	54	227107	6776100	Clayton	1	1	
CL07	54	226947	6768442	Clayton	1	1	
CL08	54	242780	6762832	Clayton	1	1	
CL09	54	233715	6753054	Clayton	1	0	no access
CL09A	54J	239681	6761374	Clayton	0	1	replacement for CL09
CP01	53	612190	6801933	Anna Creek	1	1	
CP02	53	606289	6800873	Anna Creek	1	1	
CP03	53	565756	6795604	Anna Creek	1	1	
CP04	53	571925	6798739	Anna Creek	1	1	
CP05	53	579868	6799897	Anna Creek	1	1	
CP06	53	594709	6799498	Anna Creek	1	1	
CP07	53	635638	6797770	Anna Creek	1	1	
DB01	53	644077	6790661	Anna Creek	1	1	
DB02	53	649685	6781004	Anna Creek	1	1	
DB03	53	657776	6785207	Anna Creek	1	1	
DB04	53	666442	6783168	Anna Creek	1	1	
DB05	53	679488	6776118	Anna Creek	1	1	
DB06	53	672263	6769700	Anna Creek	1	1	
DB07	53	665418	6768040	Anna Creek	1	1	
DB08	53	674999	6761945	Anna Creek	1	1	
DU01	54	245709	6781707	Dulkaninna	1	1	
DU02	54	247197	6776530	Dulkaninna	1	1	
DU03	54	240171	6773905	Dulkaninna	1	1	
DU04	54	240505	6780295	Dulkaninna	1	1	
DU05	54	241319	6785949	Dulkaninna	1	1	
DU06	54	244395	6790185	Dulkaninna	1	1	
ET01	54	294329	6809092	Etadunna	1	0	isolated
ET02	54	255174	6809025	Etadunna	1	1	
ET03	54	215853	6803581	Etadunna	1	1	
ET04	54	222310	6804441	Etadunna	1	1	
ET05	54	227869	6805223	Etadunna	1	1	
ET06	54	233195	6805955	Etadunna	1	0	rain
ET07	54	238528	6806701	Etadunna	1	1	
ET08	54	243475	6807399	Etadunna	1	0	rain
ET09	54	248479	6808098	Etadunna	1	1	
ET10	54	252859	6808714	Etadunna	1	0	rain

MA01	54	234285	6746418	Muloorina	1	1	
MA02	54	244181	6757609	Clayton	1	1	
MA03	54	247737	6769352	Dulkaninna	1	1	
MA04	54	274317	6828064	Etadunna	1	1	
MA05	54	273532	6851686	Mulka	1	0	close spacing
MA06	54	270801	6868919	Mulka	1	1	
MD01	53J	631730	6890392	Peake	0	1	New site
MG01	54	291659	6900136	Mungerannie	1	0	no access
MG02	54	298953	6892281	Mungerannie	1	0	no access
MG03	54	305061	6892311	Mungerannie	1	0	no access
MG04	54	309790	6891139	Mungerannie	1	0	no access
MG05	54	314949	6891102	Mungerannie	1	0	no access
MG06	54	320175	6891078	Mungerannie	1	0	no access
MG07	54	295689	6897114	Mungerannie	1	0	no access
MG08	54	270835	6898871	Mungerannie	1	1	
MG09	54	255094	6908929	Mungerannie	1	1	
MG10	54	260968	6907176	Mungerannie	1	1	
MG11	54J	291799	6918038	Mungerannie	0	1	replacement for MG01
MG12	54J	298458	6920144	Mungerannie	0	1	replacement for MG02
MG13	54	304179	6924802	Mungerannie	0	1	replacement for MG03
MG14	54J	310660	6926189	Mungerannie	0	1	replacement for MG04
MK01	54	272277	6860998	Mulka	1	0	missed
MK02	54	257254	6849198	Mulka	1	1	
MK03	54	262338	6850872	Mulka	1	1	
MK04	54	264588	6855520	Mulka	1	1	
MK05	54	268245	6860518	Mulka	1	1	
MK06	54	265489	6872773	Mulka	1	0	no access
MK07	54	277117	6858414	Mulka	1	1	
MK08	54	284071	6855529	Mulka	1	1	
MK09	54	289909	6851982	Mulka	1	1	
MK10	54	297364	6851696	Mulka	1	1	
MK11	54	302646	6852975	Mulka	1	1	
MK12	54	307267	6855080	Mulka	1	1	
ML02	53	765775	6780699	Muloorina	1	0	locked gate
ML03	53	756108	6778357	Muloorina	1	1	
ML04	53	751488	6778186	Muloorina	1	1	
ML05	53	746840	6776285	Muloorina	1	1	
ML06	53	742049	6775350	Muloorina	1	1	
ML07	53	725425	6774555	Muloorina	1	1	
ML08	53	719981	6775831	Muloorina	1	1	
ML09	53	716217	6779209	Muloorina	1	1	

ML10	53	711899	6781952	Muloorina	1	1
ML11	53	707167	6783838	Muloorina	1	1
MU01	53	781507	6761769	Muloorina	1	1
SC01	53	718317	6732579	Stuarts Creek	1	1
SC02	53	711941	6735497	Stuarts Creek	1	1
TP01	53	581310	6871891	Peake	1	1
TP02	53	579831	6882629	Peake	1	1
TOTAL					126	109

Appendix 2: Sites with fresh (less than 1 week old) ampurta tracks that were sampled in 2006 and 2013 (n=103). Does not include burrows or scats recorded during the 2013 survey.

site	2006	2013
AB01	1	1
AB03	1	0
AB04	1	0
AB05	0	0
AB06	1	0
AB07	0	0
AC01	1	1
AC02	0	0
AC03	0	0
AC04	0	0
AL01	0	0
AL02	0	0
AL03	0	0
AL04	0	0
AL05	0	0
AL06	0	0
AL07	0	0
AL08	0	0
BB02	0	1
BB04	0	1
BB07	0	1
BB08	0	0
BC01	1	1
BC02	1	0
BD04	0	0
BD05	1	0
BD06	1	0
CA01	0	0
CA02	0	0
CA03	0	0
CA04	0	0
CA05	0	0

CA06	0	0
CA07	0	0
CA08	0	0
CL01	1	0
CL02	0	0
CL03	1	0
CL04	0	0
CL05	0	0
CL06	0	1
CL07	0	0
CL08	0	0
CL09A	0	0
CP01	0	0
CP02	0	0
CP03	0	0
CP04	0	0
CP05	0	0
CP06	0	0
CP07	0	0
DB01	1	1
DB02	1	1
DB03	0	1
DB04	1	0
DB05	0	1
DB06	0	0
DB07	0	1
DB08	0	1
DU01	0	0
DU02	0	0
DU03	0	0
DU04	0	0
DU05	0	0
DU06	0	0
ET02	0	0
ET03	1	0
ET04	1	1
ET05	1	1
ET07	0	1
ET09	0	0
MA01	0	0
MA02	0	0
MA03	0	0
MA04	0	0
MA06	1	1
MG08	1	1
MG09	1	0
MG10	1	0

MK02	0	0
MK03	1	1
MK04	1	0
MK05	1	1
MK07	1	1
MK08	0	1
MK09	0	0
MK10	0	1
MK11	1	1
MK12	0	1
ML03	0	0
ML04	0	0
ML05	0	0
ML06	0	0
ML07	0	0
ML08	0	1
ML09	0	1
ML10	0	1
ML11	0	1
MU01	0	0
SC01	0	0
SC02	0	0
TP01	0	0
TP02	0	0
	26	29

Appendix 3: fresh (1-2 days = 1, 3-7 days = 2) sign of animals recorded on the 109 plots sampled in 2013. Sign includes tracks, scats, burrows and sightings

Site Name	Dingo	Fox	Cat	Cow	Rabbit	Ampurta	Hopping Mouse
AB01	1				1	1	1
AB03	1		1		1		1
AB04		2			1		
AB05	1	2		2	1		
AB06	1			2	1		
AB07	1				1		1
AC01	1	1			1	1	1
AC02					1		1
AC03	1				1		1
AC04	1	1			1		
AL01				2	1		1
AL02			1	1	1		1
AL03					1		
AL04				1	1		
AL05	1	1		2	1		
AL06	2			2	1		2
AL07	1				1		

AL08	1				1		2
BB02	1	1			1	1	1
BB04	1	1			1	1	1
BB07	1		1		1	1	1
BB08	1						1
BC01	1	2			1	1	1
BC02	1	1		2	1	1	1
BD04	2		2	2	1		
BD05	1	1	1	1	1		1
BD06					1		
BW01					1		
CA01	1	1	1		1		
CA02	1	2	1		1		
CA03	1	1	2		1		1
CA04			1				
CA05	1	2			1		
CA06		1			1		
CA07		2			1		
CA08	1	1			2		
CL01	1	2			1		
CL02	1	2			2		
CL03				1			
CL04	1			1	1		
CL05	1	2	1		1		1
CL06	1				1	2	1
CL07	1				1		
CL08		2			2		
CL09A			2		1		
CP01	1			2	1		
CP02		1	1	1	1		1
CP03		1	1	1	1		1
CP04	1	2	1	2	1		1
CP05		1		1	1		1
CP06		1	2		1		2
CP07	1	1		2	1		1
DB01	1		1		1	1	1
DB02	1	1	1	2	1	1	1
DB03	1	1	1	2	1	1	1
DB04	1	2	1	1	1	2	1
DB05	1	1			1	1	1
DB06	1	1			1		1
DB07	2	1			1	1	1
DB08	1	1			1	1	1
DU01	2			2	1		
DU02	1	2	1	1	1		
DU03	2	1		1	1		
DU04	2	2		1	1		

DU05	2	2		1	1		2
DU06	1	1		1	1		
ET02	1		1	2	1		1
ET03	1		1		1		1
ET04	1			1	1	1	1
ET05	1		1		1	1	1
ET07	1		1		1	1	1
ET09	1			1	1		1
MA01		1	1		1		
MA02	1	1	2	1	1		
MA03	1			2	1		1
MA04	1			2	1		
MA06	1	2			1	1	1
MD01	1	1			1	2	
MG08	1	1			1	1	1
MG09	1		2		1		1
MG10	1				1		
MG11		1			1	1	
MG12	1	1			1	2	1
MG13						1	1
MG14	1	1			1	1	
MK02	1						1
MK03	1		1		1	1	1
MK04	1	1	1		1		1
MK05	1				1	1	1
MK07	1		1	2	1	1	1
MK08	1		2	2	1	2	1
MK09	1	1		1	1		1
MK10	1			1	1	1	1
MK11	1	1		1	1	1	1
MK12	1		1		1	1	1
ML03	1						1
ML04	1				1		
ML05	1				1		1
ML06	1	1			1		
ML07	1	1			1		
ML08	1	1	1		1	1	
ML09	1	1	1		1	1	1
ML10	1	1			1	1	1
ML11	1				1	1	1
MU01		2	1	1	2		
SC01	1	1			1		
SC02	1	1			1		1
TP01	2		2	2	2		
TP02				1	1		
	86	58	36	41	103	36	63

Appendix 4: Vegetation characteristics and ampurta presence/abundance recorded during the 2013 survey. Abundance scores, 1=sign on all 4 quarters of the plot, 2= sign on ½ of plot, 3= sign on ¼ of plot or one individual

Site	Ampurta presence	Ampurta abundance	canegrass cover (%)	total veg cover (%)	No. quadrats with canegrass present (total 20)
ML09	1	3	0	16.75	15
CL06	1	3	0	19.10	14
DB03	1	2	0	22.95	12
MK12	1	2	0	25.75	7
AL03	0	0	0	27.45	15
ML11	1	1	0	27.60	17
CA01	0	0	0	30.80	10
MU01	0	0	0	33.05	16
CP05	0	0	1	35.75	14
CA08	0	0	1	34.70	14
BB08	0	0	1	20.30	0
AL01	0	0	2	19.70	7
MA06	1	2	3	20.95	16
SC01	0	0	3	14.05	10
MK08	1	2	3	15.55	11
AC04	1	3	3	29.30	17
AL04	0	0	3	24.55	2
CA05	0	0	4	26.40	0
MG08	1	3	4	25.90	13
DU05	0	0	4	20.00	7
MA02	0	0	4	29.60	10
AL07	0	0	4	11.00	8
DB06	1	3	4	19.10	10
TP02	0	0	4.6	17.00	3
MA04	0	0	5	26.75	19
AB06	0	0	5	13.05	3
ET04	1	1	5	23.00	13
DU02	0	0	5	24.00	9
ET07	1	1	5	29.80	7
AC01	1	2	6	22.70	13
AL06	0	0	6	29.10	0
MK05	1	3	6	13.95	14
AB05	0	0	6	14.50	6
ET09	0	0	6	25.45	18
MK02	1	2	7	16.00	12
BC02	1	3	7	28.50	11
MA03	0	0	7	18.95	11
AL05	0	0	7	21.95	0
MK04	1	2	7	19.35	8
BB04	1	2	8	20.30	15

CL01	0	0	8	26.25	12
DU04	0	0	8	27.00	6
ET03	1	3	8	19.85	12
CP01	0	0	8	20.70	12
TP01	0	0	8	21.30	13
CL05	0	0	9	20.00	13
CA02	0	0	9	13.55	0
CP07	0	0	9	16.50	9
CP03	0	0	9	25.00	9
MA01	0	0	9	26.00	20
MK10	1	2	9	30.90	8
ET02	0	0	9	36.45	16
MK09	0	0	9	16.95	10
AL08	0	0	9	17.90	9
ML10	1	3	10	22.20	15
BB07	1	3	10	36.40	19
CA06	0	0	10	33.45	8
CA04	0	0	10	28.45	0
DB05	1	2	10	15.20	2
CL09A	0	0	10	20.35	13
ET05	1	1	11	20.25	11
DB01	1	2	11	15.95	11
SC02	0	0	10.65	21.85	12
DU01	1	3	11	11.00	6
MG12	1	3	11	22.30	15
CP02	0	0	11	13.50	7
ML08	1	3	11	25.05	16
ML07	0	0	11	18.70	20
AB07	1	3	11	19.30	7
DB07	1	3	11	20.85	11
BB02	1	2	11	33.00	16
DU06	0	0	11	18.00	11
MK11	1	2	11	22.35	8
MK07	1	3	11	22.40	13
DU03	0	0	11	22.50	9
MG13	1	3	11	26.05	9
AB01	1	1	12	19.95	13
CL07	0	0	12	15.65	7
CL02	0	0	13	28.00	13
ML03	0	0	13	14.55	1
MG14	1	3	13	31.15	8
CL03	1	2	13	19.80	0
MG11	1	2	14	16.45	13
CA03	0	0	14	19.45	9
CP04	0	0	14	32.55	11
MK03	1	2	14	19.65	8
DB02	1	3	14	15.35	8

BD04	0	0	14	23.20	15
AL02	0	0	14	23.90	11
ML05	0	0	15	23.50	14
ML04	0	0	15	35.65	18
MG10	1	2	16	22.80	10
AB04	0	0	16	21.30	14
CL08	0	0	16	25.00	15
AC02	0	0	17	19.60	0
ML06	0	0	17	26.10	14
AC03	1	3	18	13.70	14
BD05	0	0	18	20.00	12
AB03	0	0	19	15.65	10
DB08	1	3	19	22.65	14
CA07	0	0	20	39.75	8
MD01	1	3	20	27.30	17
CL04	0	0	20	23.40	14
MG09	0	0	21	32.25	9
CP06	0	0	22	26.20	11
BD06	1	2	23	11.90	4
DB04	1	3	24	25.05	15

Appendix 5: Vegetation species recorded opportunistically at survey sites during the study.

Abutilon	*sp.*
Acacia	*aneura*
Acacia	*ligulata*
Acacia	*ramulosa*
Acacia	*tetragonophila*
Acacia	*murrayana*
Aristida	*sp.*
Atriplex	*numularia*
Atriplex	*nummularia ssp. Omissa*
Atriplex	*spongiosa*
Boerhavia	*sp.*
Cenchrus	*ciliaris*
Chenopodium	*sp.*
Crotalaria	*sp.*
Cucumis	*sp.*
Cynanchum	*floribundum*
Dactyloctenium	*radulans*
Dicrastylis	*lewellinii*
Digitaria	*sp.*
Dodonaea	*viscosa*
Enchylaena	*tomentosa*
Enneapogon	*sp.*
Eragrostis	*sp.*

Eremophila	*longifolia*
Euphorbia	*sp.*
Gunniopsis	*quadrifida*
Hakea	*leucoptera*
Halosarcia	*sp.*
Indigofera	*sp.*
Lechenaultia	*divaricata*
Maireana	*georgii*
Maireana	*pyramidata*
Monachaterh	*sp.*
Muehlenbeckia	*florulenta*
Nicotiana	*sp.*
Nitraria	*billardierei*
Panicum	*decompositum*
Paractaenum	*refractum*
Portulacca	*oleraceae*
Ptilotus	*sp.*
Rhagodia	*spinescens*
Salsola	*kali*
Santalum	*lanceolatum*
Scaevola	*sp.*
Scaevola	*aemala*
Sclerolaena	*sp.*
Senna	*sp.*
Sida	*sp.*
Solanum	*sp.*
Tribulus	*sp.*
Trichodesma	*zeylanicum*
Triraphis	*mollis*
Zygochloa	*paradoxa*
Zygophyllum	*sp.*

Appendix 6: Animals trapped during the survey

Species	Site	Date	Method	Sex	Weight	Testes	Teats	Vag	Pouch	Comments
Notomys alexis	AB01	16/05/2013	Elliott	f	39.9		button	imp		
Notomys alexis	AB01	16/05/2013	Elliott	f	37.5		button	imp		
Notomys alexis	AB01	16/05/2013	Elliott	f	38.2		button	imp		
Notomys alexis	AB01	16/05/2013	Elliott	f	35.6		button	imp		
Notomys alexis	AB01	16/05/2013	Elliott	f	44.5		button	imp		
Notomys alexis	AB01	16/05/2013	Elliott	f	31.5		button	imp		
Notomys alexis	AB01	16/05/2013	Elliott	m	33	scrotal				
Dasycercus cristicauda	AB01	16/05/2013	Elliott	f	76		button		not developed	ear tissue
Dasycercus cristicauda	AB01	16/05/2013	Elliott	f	83.2		regressed		developed	museum
Dasycercus cristicauda	AB01	16/05/2013	Elliott	f	96.6		regressed		developed	museum
Notomys alexis	ML11	18/05/2013	Elliott	m	34.7	scrotal				
Notomys alexis	ML11	18/05/2013	Elliott	f	32.4		button	imp		
Notomys alexis	ML11	18/05/2013	Elliott	m	39.4	scrotal				
Notomys alexis	ML11	18/05/2013	Elliott	f	42		button	imp		
Notomys alexis	ML11	18/05/2013	Elliott	f	38		button	imp		
Notomys alexis	ML11	18/05/2013	Elliott	m	37	scrotal				
Notomys alexis	ML11	18/05/2013	Elliott	f	31		button	imp		
Pseudomys desertor	ML11	18/05/2013	Elliott	m	25.7	scrotal				ear tissue

Appendix 7: DNA samples lodged with the S.A. Museum

Type of Sample	Species	Collector	Organisation	Date	Site	AMG zone	Easting	Northing
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MG11	53	643087	6800572
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	AC01	53	694304	6782615
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	BB07	53	698008	6757267
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MG10	54	260968	6907176
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MK10	54	297364	6851696
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	ET04	54	222310	6804441

scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	DB08	53	674999	6761945
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	ET07	54	238528	6806701
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MK03	54	262338	6850872
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	ML11	53	707167	6783838
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	BB04	53	700256	6773833
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MK08	54	284071	6855529
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	BC01	53	640912	6895581
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MK05	54	268245	6860518
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MK04	54	264588	6855520
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	MK12	54	307267	6855080
scats	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	AC03	53	687820	6775947
ear clip	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	AB01	53	643087	6800572
ear clip	Pseudomys desertor	K Moseby	Ecol Horizons	May-13	ML11	53	707167	6783838
specimen	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	AB01	53	643087	6800572
specimen	Dasycercus cristicauda	K Moseby	Ecol Horizons	May-13	AB01	53	643087	6800572
specimen	Notomys alexis	K Moseby	Ecol Horizons	May-13	AB01	53	643087	6800572