ABUNDANCE AND SPATIAL DISTRIBUTION OF FIVE SMALL MAMMALS AT A LOCAL SCALE

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In an area of approximately 210 ha 5 km west of South Hedland in Western Australia the population density of *Dasycercus cristicauda* (mulgara) was higher than 0.23 per ha, *Dasykaluta rosamondae* (little red kaluta) was higher than 1.88 per ha and *Pseudomys hermannsburgensis* (sandy inland mouse) was higher than 4.90 per ha. Densities for *D. rosamondae* and *P. hermannsburgensis* were appreciably higher than those reported elsewhere in the Pilbara. *D. rosamondae* and *P. hermannsburgensis* appear to be evenly distributed across the site, whereas *D. cristicauda* were concentrated in the centre and the western edge away from areas of higher vehicle traffic. The spatial distribution of *Pseudomys desertor* (desert mouse) was focussed on two areas. A trapping effort of 9,900 trap-nights appears to have captured most of the *D. cristicauda* but not all of the *D. rosamondae*, indicating that their density was higher than reported above. Approximately five *D. cristicauda* were caught per 1000 trap-nights, and given that this species was not evenly spread across the site, these data suggest that the survey effort necessary to detect the presence of *D. cristicauda* needs to be much higher than is the current practice of environmental consultants.

Key words: *Dasycercus cristicauda, Dasykaluta rosamondae,* fauna survey, *Mus musculus,* Pilbara, *Pseudomys desertor, Pseudomys hermannsburgensis*, Western Australia.

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The density and distribution of small vertebrates, in particular mammals, varies temporally and spatially at the local, landscape and regional scales (Gaston and Blackburn 2000; Thompson and Thompson 2005). These variations are influenced by abiotic factors such as topography, soils and weather patterns, and biotic factors such as species breeding cycles, predator-prey interactions and vegetation. These variations have consequences when we endeavour to characterise faunal assemblages. For example, when undertaking terrestrial fauna surveys to support environmental impact assessments to report on biodiversity value at the species and ecosystems levels (Environmental Protection Authority 2002) it is necessary to sample fauna assemblages in each habitat in such a way as to take account of these temporal and spatial variations. However, few surveys have been undertaken with sufficient intensity over a large enough area to provide an indication of the relative abundance of small mammals and their temporal or spatial distribution. Therefore it is difficult to design surveys to account for spatial variations.

Our objective here was to report on an unusually high abundance and spatial distribution of four small mammal species caught in a trapping program in an area of about 210 ha approximately 5 km west of South Hedland in the Pilbara of Western Australia (UTM 7745500 N, 50 663000 E). One of these species, *D. cristicauda*, is listed as 'Vulnerable' under the Environment Protection and Biodiversity Conservation Act (1999) and as a Schedule 1 species under the Western Australian Wildlife Conservation Act (1950), and when located in a development area may need to be trapped and translocated.

METHODS

A site commonly known as the 'Loop', with an area of about 210 ha, was trapped during January–February and June 2007 for the purpose of translocating *D. cristicauda* from the area before the vegetation was cleared. Translocation of species of conservation significance was a commitment that the developer, Fortescue Metals Group Ltd., made to obtain the necessary approvals for its project. The Loop was surrounded by a 50 m wide gravel road and will be the site of a Fortescue Metals Group Ltd. railway line.

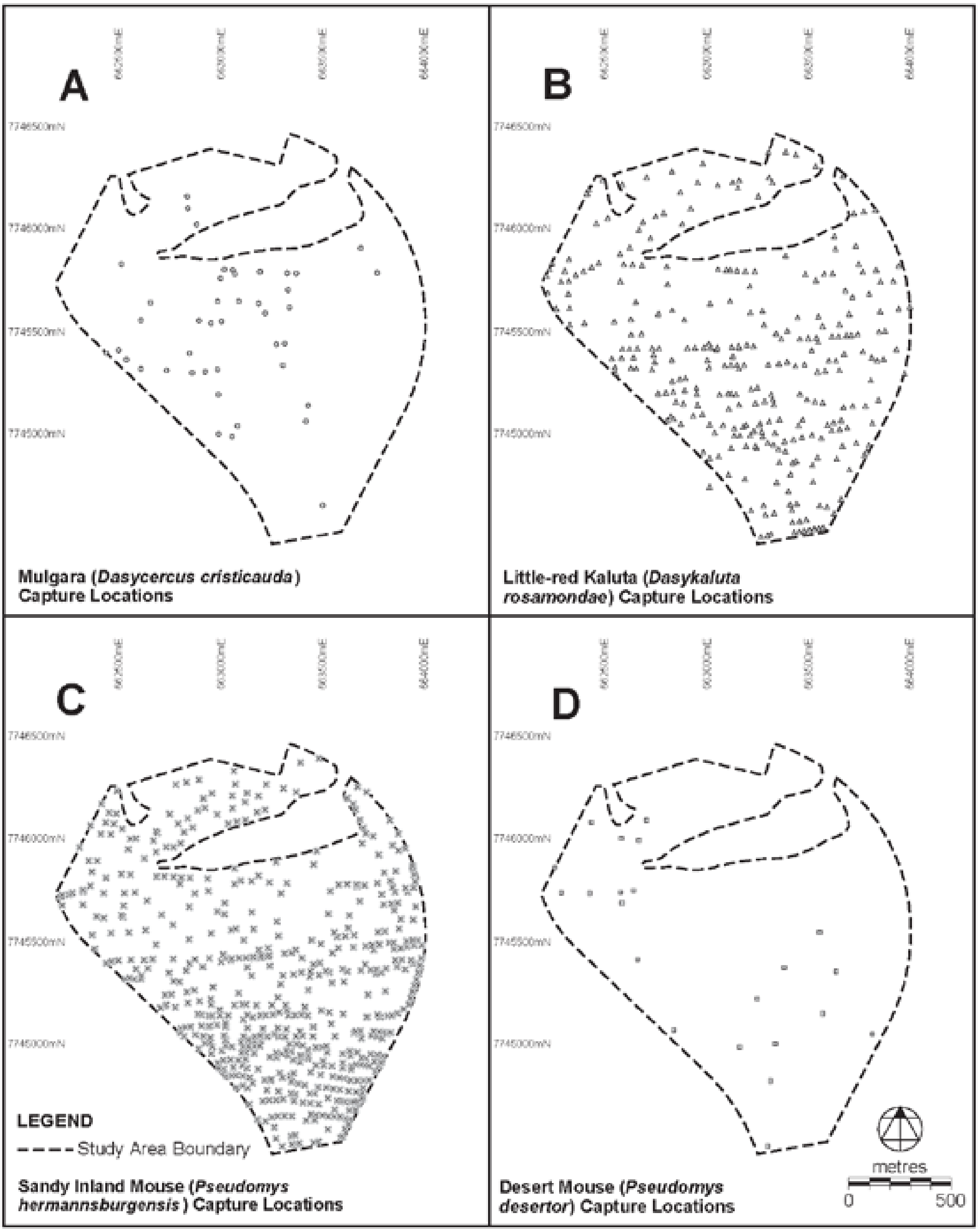

Fig. 1. Study site and capture locations for *Dasycercus cristicauda* (A), *Dasykaluta rosamondae* (B), *Pseudomys hermannsburgensis* (C) and *Pseudomys desertor* (D).

Most of the site was relatively flat with the vegetation dominated by an *Acacia stellaticeps* low open shrubland with scattered *Hakea lorea* and *Corymbia hamersleyana* over dense hummock grassland of *Triodia epatica* and *T. schinzii*. There were two low-lying drainage areas in the northern section of the site (Fig. 1) that were a samphire flat with limited or sparser vegetation than in the surrounding area. These areas were not trapped and were not included in the 210 ha assessment.

Between 30 January and 2 February 2007, 600 Elliott traps were deployed for a total of 2,100 trap-nights. Between 8 and 12 February 2007, 600 Elliott traps were deployed for a total of 2,400 trap-nights, and between 12 and 22 June 2007, 600 Elliott traps were deployed for a total of 5,400 trap-nights. This trapping effort provided a total of 9,900 trap-nights of data. During earlier grid searches of the area *D. cristicauda* burrows had been detected in the southern section of the Loop. As the primary purpose of the trapping program was to catch and translocate *D. cristicauda*, the traps were concentrated in the southern section during the January-February trapping programs. As *D. cristicauda* were caught across the entire site during January-February and not just in the areas containing burrows, traps were more evenly distributed across the entire site in the June trapping program.

In June 2007, Elliott traps were placed in east-west lines across the site and spaced so that there was a relatively even spread along each line and the general area. All traps were baited with a mixture of peanut butter, rolled oats and sardines, and rebaited every 2–3 days or when they were cleared of animals. Clearing of traps commenced at first light and continued until all traps were cleared which was mostly before 0900 hours. All *D. cristicauda, D. rosamondae* and *P. desertor* were translocated to a site approximately 5 km away, as these species have either a limited geographic distribution or have conservation significance. All other individuals were released near their point of capture but away from the trap to avoid instant recapture. Animals left on the site were not individually marked.

RESULTS

A total of 1,864 small mammals were caught consisting of 50 *D. cristicauda*, 395 *D rosamondae*, 179 *Mus musculus* (house mouse), one *Notomys alexis* (spinifex hopping-mouse), 27 *P. desertor* and 1,212 *P. hermannsburgensis*. The capture locations for *D. cristicauda*, *D. rosamondae*, *P. hermannsburgensis* and *P. desertor* are plotted in Fig. 1 to show the spatial distribution.

The catch rate per day for *D. cristicauda*, *D. rosamondae*, *P. desertor, P. hermannsburgensis* and *M. musculus,* shown in Table 1 for the June survey, indicates changes in the catch rate resulting from the removal of *D. cristicauda*, *D. rosamondae* and *D. desertor* from the site. There was a significant decline in the number of *D. cristicauda* caught over the last nine days of trapping (Table 1; $r^2 = 0.62$, $P = 0.01$), and there was a significant increase in the number of *P. hermannsburgensis* caught during the same period ($r^2 = 0.68$, $P = 0.01$), but there was no significant change in the catch rates for the other species.

DISCUSSION

There are at least two significant observations that can be made from these data. The first relates to the density of *D. rosamondae* and *P. hermannsburgensis*. We appreciate that there was a possibility that some individuals moved into the Loop from adjacent areas and thereby influencing the calculated density values. We believe this number is likely to be low as we saw no evidence of small mammal tracks in the fine sandy soil along the edge of the 50 m wide ring road around the Loop during the February and June surveys. As *D. rosamondae* were still being caught in high numbers during the last days of the trapping program (Table 1) it is apparent that there were many more individuals in the area that had not been caught. The number of individuals caught indicate that their density was greater than 1.9 per ha with a catch rate of 4.0 per 100 trap-nights for all surveys. Although Woolley (1991) did not indicate the area covered in her trapping program at four sites in the Pilbara, she did indicate that 30 individuals were

Species	**Days**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
*Pseudomys desertor**	1	1	2	2	2	0	5	3	1
*Dasycercus cristicauda**	4	5	3	2	0	2	0	1	1
Mus musculus	6	7	3	2	1	5	6	21	11
*Dasykaluta rosamondae**	21	14	21	33	22	17	35	21	17
Pseudomys hermannsburgensis	22	36	40	59	77	65	75	73	63

Table 1. Capture per species per day for the June trapping period, * species translocated from the site. Each day 600 Elliott traps were operated..

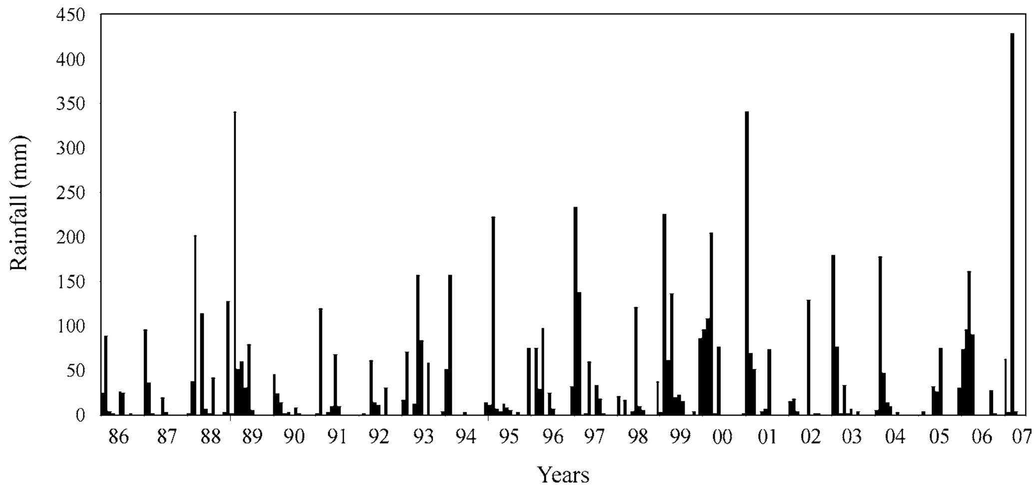

Fig. 2. Monthly rainfall totals for Port Hedland provided by the Bureau of Meteorology. Larger markers on the abscissa show the beginning of January for each year.

caught in 1,156 trap nights using Sherman and Elliott traps. This is much less than the 395 individuals caught in 9,900 trap-nights in the Loop over the entire survey. How and Cooper (2002), when surveying the Abydos Plain using both pit and Elliott traps, recorded between 0.08 and 1.19 *D. rosamondae* per 100 trap nights when sampled over seven survey periods. Their highest catch rate was in March (1.19 per 100 trap nights). Woolley (2000) reported that *D. rosamondae* mate in September, give birth in November and juveniles appear in the field in February and March. We caught no adult males, only adult females and juveniles during the January–February surveys, confirming Woolley's (1991) view that males die after a short but intense mating period. Both adult male and female *D. rosamondae* were caught in June, however no juveniles were present.

Presuming that *D. rosamondae* prey on small rodents and marsupials, then one possible reason for the high density of *D. rosamondae* may be the high number of *P. hermannsburgensis* also caught in the area. By way of contrast, Woolley (1991) caught 30 *D. rosamondae*, 4 *M. musculus*, 8 *P. hermannsburgensis* and one *Pseudantechinus macdonnellensis* in her trapping of four sites in the Pilbara. In the seven sites where How and Cooper (2002) caught 40 *D. rosamondae*, they also caught 63 *M. musculus*, 36 *Ningaui timealeyi*, 66 *P. hermannsburgensis* and 12 other small prey-sized mammals. Again the ratio of *D. rosamondae* to other prey-size small mammals was lower than the 395 *D. rosamondae* to 1212 *P. hermannsburgensis* and 179 *M. musculus* caught during our trapping program at the Loop. It is possible that *D. rosamondae* moved into the area from adjacent habitat. However, we found no tracks of small marsupials along the sandy edges of the 50 m wide ring road around the Loop during the February and June surveys to suggest animals were moving in and out of the area.

Pseudomys hermannsburgensis were not removed from the site when they were caught so it is highly probable that a number of individuals were recaught over the three trapping periods. However, we believe the number of recaptures was relatively low based on our trapping programs elsewhere (e.g. 11% of all small mammals trapped over 14 days at Ora Banda were recaptures). Presuming that 15% of all individual *P. hermannsburgensis* were recaptures, then the minimum density was 4.90 per ha with a capture rate of 10.41 per 100 trap-nights. During our trapping programs in other habitats where *P. hermannsburgensis* were caught (e.g. Ora Banda – 0.12 per 100 trap-nights, Wiluna – 1.61 per 100 trap-nights, Yakabindie – 0.04 per 100 trap-nights), we have never caught them in densities similar to that in this study. How and Cooper (2002) reported catching between 0.06 and 3.42 per 100 trap-nights on the Abydos Plain which is also well below the catch rate for the Loop. The reason for this high density is unknown but may relate to the high density of vegetation at ground level compared with that at the other sites surveyed. A dense cover of *T. epatica* and *T. schinzii* and low shrubs that extended almost to the ground may have provided shelter and better access to food at the Loop than at other sites. How and Cooper (2002) recorded catch rate variations 40–50 times higher in the peaks compared with the troughs on the Abydos Plain. They suggested that the increase in the population was in response to heavy rainfall 18 months earlier. They cited the arguments of Dickman *et al*. (1999) and concluded that much of the fluctuation in rodent numbers in arid and semi-arid areas of Australia is a response to rainfall. As our two survey periods were close together (January–February and June) we have no way of knowing whether the population sampled at the Loop represented a peak in a cycle or was normally at this level. However, the rainfall pattern in previous years (Fig. 2) seemed remarkably similar to that since 1986, when most of the rain fell in summer due to at least one cyclone crossing the coast. The higher rainfall in March 2007 reflects multiple cyclones crossing the coast during that period. These data do not suggest that the higher density of small mammals at the Loop was a response to rainfall, as is the situation in other arid habitats.

The second notable observation is that the catch locations for *D. rosamondae* (Fig. 1B) and *P. hermannsburgensis* (Fig. 1C) are relatively evenly distributed across the entire area trapped taking into account the concentration of the trapping effort in the January-February period was greater in the southern section than during the June trapping period. However, the catch locations for *D. cristicauda* (Fig. 1A) were concentrated in the centre and the western side of the Loop and there appeared to be two concentrations of captures of *P. desertor* (Fig. 1D), one in the north-west and the other in the south-east. We could see no obvious visual difference in the habitat that would suggest why *P. desertor* were in these two places and not others. There is more vehicle traffic along the eastern side of the road around the Loop and this may have influenced the location of *D. cristicauda*. However, there is little movement of vehicles at night when *D. cristicauda* are surface active, so it is probably other environmental variables that have influenced the location of this species.

During the January–February trapping program 32 *D. cristicauda* were caught, 9 between 30 January and 2 February and 23 between 8 and 12 February. Why more were caught in the second 4 days in summer was not obvious. During the trapping period in June, the number of *D. cristicauda* caught progressively declined ($r^2 = -0.62$, $P = 0.01$) as individuals were removed from the area.

Catch rates during June for *D. rosamondae* appeared to have been unaffected by the removal of the captured individuals as there was no obvious decline ($r^2 = 0.01$, $P = 0.78$) in the number being caught. As we saw no evidence to suggest that they were moving into the area from adjacent habitat, this suggests that the density of *D. rosamondae* in the Loop was much higher than estimated above. The capture rate for *P. desertor* was low over the June period (Table 1) but it did not seem to decline ($r^2 = 0.10$, $P = 0.41$) with the removal of captured individuals. *M. musculus* and *P. hermannsburgensis* were released on the site when caught and the data indicate that the catch rate for *M. musculus* increased from day six (Table 1). The catch rate for *P. hermannsburgensis* significantly increased over the last 9 days of trapping ($r^2 = 0.68$, $P = 0.01$), however, the relationship does not appear to be linear, as the catch rate remained relatively consistent after day five (Table 1). In contrast, Thompson *et al*. (2005) reported a progressive decline in the total number of mammal captures from day one to four (when no individuals were removed from this site), then an increase that was sustained from day five using pit-traps around Ora Banda. The reason for this difference may be due to the different trapping techniques (pit-traps vs Elliott traps), the greater abundance of small mammals in the Loop or that small mammals learnt they could find food in the Elliott traps.

The presence of *D. cristicauda* in the area was first suspected when burrows were located in a grid search of the southern section of the Loop, however, later trapping found this species to be concentrated in the centre and western side. The catch rate for *D. cristicauda* was approximately 5 individuals per 1000 trap-nights indicating that they were not easily caught and they were not evenly distributed across the site. This has significant implications for fauna surveys undertaken to detect the presence of *D. cristicauda*. We would advocate that a much higher trapping effort than is typically employed by environmental consultants (e.g. Biota Environmental Sciences 2004, 2005; Davis *et al*. 2005; Outback Ecology 2006) to detect the presence of *D. cristicauda*. The abundance of *D. rosamondae, P. hermannsburgensis* and *P. desertor* at the Loop was such that even a low level of trapping would have indicated their relatively high abundance.

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