Responses of small mammals and lizards to cattle grazing and cattle removal in arid Australia

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RESPONSES OF SMALL MAMMALS AND LIZARDS TO CATTLE GRAZING AND CATTLE REMOVAL IN ARID AUSTRALIA

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INTRODUCTION

Arid Australia covers more than 70 percent of the Australian continent. As this vast region harbours more than half of Australia's endangered fauna and one third of its mammals are already extinct, it is a very important region for conservation (James *et al.* 1995). Pastoralism is not only the main landuse in arid Australia, it is also believed to be one of the biggest threats to the maintenance of biodiversity in arid Australia (Bastin *et al.* 1993) and to biota of the Simpson Desert (Shephard 1994).

Behavioural studies in central Australia have shown that cattle usually avoid spinifex (*Triodia basedowii*) grassland and prefer riverine zones and woodlands on richer soils (Tomkins & O'Reagain 2007, Low *et al.* 1881). Despite this, since the 1950s (Nolan 2003) cattle have been run over much of the Simpson Desert an area comprising 70% sand dunes covered with spinifex (Shephard 1994). Grazing and trampling can have several negative effects on small terrestrial vertebrates (Morton 1990, Landsberg *et al.* 1997). This is of particular concern in spinifex grassland as this habitat contains an extraordinary diversity of lizards (Pianka 1996) and small mammals (Dickman 2003), including threatened species such as mulgaras (*Dasycercus blythi* and *D. cristicauda*).

Since there is still not much known about the behaviour and effects of cattle grazing in arid Australia in general and due to the different grazing history of the Simpson Desert as well as its significance for biodiversity we aimed to investigate and answer the following questions: 1. Which habitats in the Simpson Desert do cattle use, and for which activities? 2. Are gidgee (*Acacia georginae*) woodlands an important habitat for small mammals and reptiles in the Simpson Desert? 3. How does the diversity and abundance of these small terrestrial vertebrates change after cattle are removed? 4. What consequences do our results have for the management of cattle and the protection of small mammals and reptiles in the Simpson Desert?

METHODS

Information on the climate, topography and vegetation of the Simpson Desert is given in Dickman *et al*. (1995). The three properties investigated, Carlo, Ethabuka and Cravens Peak, all share a similar history of beef cattle grazing. Carlo Station still runs cattle. Ethabuka Reserve, purchased by Australian Bush Heritage (ABH), removed the cattle at the end of 2004. Cravens Peak Reserve also was bought by ABH in 2005 and cattle were removed in September 2006. Frank *et al.* (2008) describe methods of assessing cattle habitat use and activity. Small vertebrates were live-trapped using pitfall traps in combination with drift-fences. Eight 1-ha-grids consisting of 36 traps were set in spinifex grassland to investigate the effects of cattle before and after removal in areas with high and low historical grazing impact. To compare gidgee and spinifex habitats we established two 0.5-ha-grids (18 traps) in gidgee and two 0.5-ha-grids (18 traps) in spinifex grassland, half on Carlo Station (grazed) and half on Ethabuka (no cattle grazing for about four years). Trapping took place over 3 consecutive days each season, 4 times a year over 2 years. All vertebrates caught were weighed, measured and marked to identify recaptures.

Analysis

For the analysis of cattle habitat use and activity see Frank *et al.* (2008). Small mammal and reptiles diversity was calculated in R 2.6.1 using the inverse Simpson diversity index (iSDI), in which higher numbers indicate higher diversity (Kindt & Coe 2005). To test for differences in captures of small mammals and reptiles between treatments two-factor ANOVAs were computed in R 2.6.1.

RESULTS

For the results on cattle habitat use and activity see Frank *et al.* 2008.

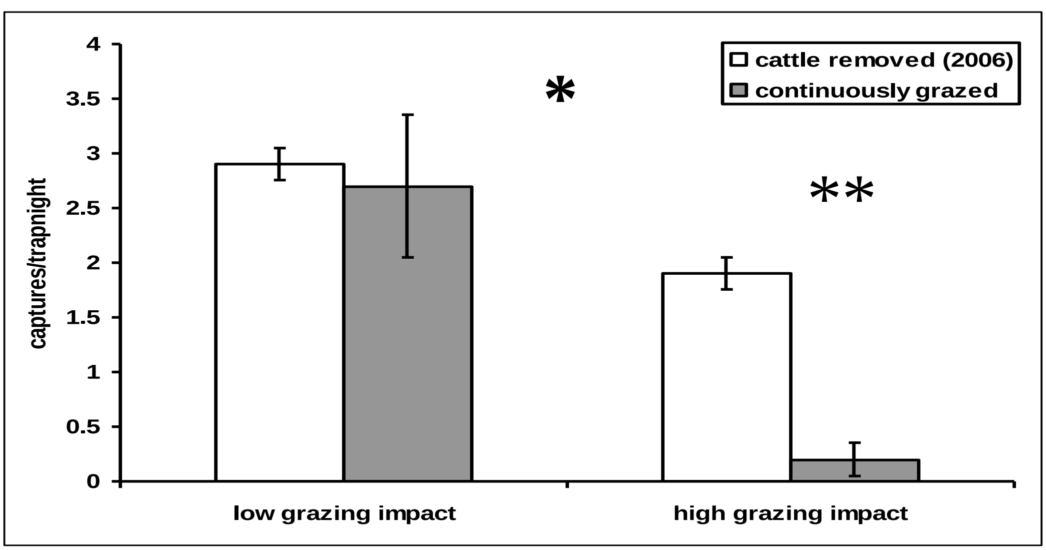
According to the inverse Simpson diversity Index mammal diversity was higher in spinifex than gidgee and higher where cattle had been removed in 2004 (Table 1).

Table 1. Effect of habitat, cattle removal at different times and grazing history on small vertebrate diversity.

Treatments	Inverse Simpson Diversity Index (rounded to 2 decimals)	
	Mammals	Reptiles
Grazed, spinifex	1.95	6.06
Grazed, gidgee	1.23	2.11
Ungrazed, spinifex	2.44	5.29
Ungrazed, gidgee	1.35	3.70
Low historical grazing impact, cattle removed	3.07	5.55
Low historical grazing impact, cattle present	2.08	6.07
High historical grazing impact, cattle removed	1.91	6.27
High historical grazing impact, cattle present	1.58	6.07

Mammal diversity was almost equal and highest on sites with a low historical grazing impact. The recent removal of cattle (2006) resulted in a slightly higher diversity compared to the diversity on still grazed sites. Reptile diversity was generally higher than mammal diversity. Reptiles diversity was also higher in spinifex compared to gidgee, but reptile diversity in ungrazed gidgee was much higher than in grazed gidgee. There was no strong difference in reptile diversity between grazed and ungrazed (2004) treatments or for low and high historical grazing impact. Reptile diversity was slightly higher on sites where cattle had been removed recently (2006) compared to sites still grazed.

Figure 1. Effect of grazing history and cattle removal on captures of small mammals.



Animal abundance fluctuated greatly being much lower during the drought at the beginning of the study than after rainfall at the beginning of 2007. There was no significant effect of different habitats on small mammals, but small mammals seemed to avoid gidgee woodland patches during drought. Two-factor

ANOVA showed that mammals were significantly affected by grazing history ($F_{3,1}$ = 14.477, $p < 0.05$), being more abundant where historical grazing impact was always low (Figure 1). Mammals were negatively affected by cattle removal in areas of high historical grazing impact (t_7 = 7.937, $p < 0.01$), but not in areas of low historical grazing pressure. The threatened mulgara *D. blythi* was only caught 11 times during this project – 8 captures occurred on Ethabuka, the property now grazing free for four years. No significant effects of cattle removal, habitat or grazing history could be found on reptile abundance. Some reptile species, for example the Victoria endangered Beaked Gecko (*Rhynchoedura ornata*) and some skinks, which are usually rare in spinifex grassland, have been trapped in the gidgee, but numbers have been too low to date to allow any statistical analysis.

DISCUSSION

The cattle behavioural observations support previous studies that show cattle spend most of their daytime resting (Albright & Arave 1997). Recently, Fensham & Fairfax (in press) found that cattle favoured the dune-swales in the Simpson Desert and that these probably function as "alleyways". Our study confirmed that most cattle prefer the swales and in particular the shade and shelter provided in gidgee compared to the open spinifex.

Mammal diversity responded to grazing history, cattle removal and habitat. Grazing history was more important than recent cattle removal as there was a significant negative effect of high historical grazing pressure on small mammal abundance, but not of cattle removal.

Whereas populations of small mammals are extremely variable and unpredictable in their abundance and distribution in the Simpson Desert (Dickman *et al*. 1995), reptiles are generally not as severely affected by environmental changes as mammals in arid regions (Bock *et al.* 1990, Read 2002); this could explain why reptiles seemed less affected by grazing than mammals. Although the effects of grazing on reptiles are not as well studied as those on mammals, a few studies have indicated that reptile species richness (James 2003) and abundance are influenced by grazing-induced habitat change (Bock *et al.* 1990, Frank & Croft in press, Jones 1981, Read 2002). Previous studies have suggested that periods (12-24 months) following flooding rains are critical times for small vertebrates in the Simpson Desert, as it is during these periods that the stresses of predation by introduced cats and foxes (Letnic & Dickman 2006) and grazing by cattle are likely to be greatest Stocking rate is highly variable on stations where cattle are still run in the Simpson Desert, and stocking rates typically increase after rain when more forage is available. Grazing pressure is thus likely to be greatest during the periods after rain and before stocking numbers get adjusted for dry conditions.

The lower diversity indices of small mammals and reptiles in grazed compared to ungrazed gidgee, and the lowest diversity index for grazed gidgee overall, suggest that "grazing" impact in terms of cattle presence on native animals is most negative in the gidgee woodlands.

Management Implications

We suggest that patches of gidgee woodland should be foci for cattle management and the protection of small mammals and reptiles due to the invasive use of these woodlands by cattle.

Further Research

This study is ongoing until the end of the year 2008. Further investigations are needed to qualify and quantify the impacts (competition for food, trampling, disturbance of wildlife, etc.) of cattle in gidgee woodlands and spinifex grassland. Research on habitat structure, vegetation composition, climatic context and food availability for small mammals and reptiles is currently being conducted and will be reported elsewhere.

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REFERENCES

Albright, J.L. and Arave, C.W. (1997). The Behaviour of Cattle. **University Press, Cambridge**.

Bock, C.E., Smith, H.M. and. Bock, J.H. (1990). The Effect of Livestock Grazing Upon Abundance of the Lizard, *Sceloporus scalaris*, in Southeastern Arizona. *J. Herpetol.* **24** (4): 445-446.

Dickman C.R., Predavec, M. and Downey, F.J. (1995). Long-range movements of small mammals in arid Australia: implications for land management. *J. Arid Environ.* **31**: 441-452.

Frank, A., and Croft, D. (*in press*). Small-scale effects of grazing on reptile diversity in an Australian arid zone habitat. *Wildl. Res.*

Frank, A., Dickman, C. and Wardle, G. (2008). Horns of Dilemma – Where do Cattle Forage in a Prickly Environment? Poster presentation. **ASSAB Conference, Coffs Harbour**.

Fensham, R.J. and Fairfax, R.J. (in press). Water-remoteness for grazing relief in Australian arid lands. *Biol. Cons.*

James, C.D. (2003). Response of vertebrates to fenceline contrasts in grazing intensity in semi-arid woodlands of eastern Australia. *Aust. J. Ecol.* **28**: 137-151.

Kindt, R. and Coe, R. (2005). Tree diversity analysis. A manual and software for common statistical methods for ecological and biodiversity studies. **World Agroforestry Centre (ICRAF), Nairobi**.

Landsberg, J, James, C.D., Morton, S.R., Hobbs, T.J., Stol, J., Drew, A. and Tongway, L. (1997). The Effects of Artificial Sources of Water on Rangeland Biodiversity. Final Report to the Biodiversity Convention and Strategy Section of the Biodiversity Group, Environmental Australia. **CSIRO Publishing. Canberra.**

Letnic, M. and Dickman, C.R. (2006). Boom means bust: Interactions between the El Niño/Southern Oscillation (ENSO), rainfall and the processes threatening mammal species in arid Australia. *Biodiversity Conserv.* **15**: 3847-3880.

Low, W.A., Dudziński, M.L. and Müller, W.J. (1981). The Influence of Forage and Climateic Conditions on Range Community Preference of Shorthorn Cattle in Central Australia. *J. Appl. Ecol.* **18:** 11-26.

Nolan, C. (2003). Sand Hills and Channel Country. **Diamantina Shire Council, Bedourie**.

Pianka, E.R. (1996). Long-Term Changes in Lizard Assemblages in the Great Victoria Desert: Dynamic Habitat Mosaics in Response to Wildfires. *In* 'Long-term Studies of Vertebrate Communities.' (Eds. M.L. Cody and J.A. Smallwood), **Academic Press, San Diego**, pp. 191-215.

R Development Core Team (2005). R: A language and environment for statistical computing. **R Foundation for Statistical Computing, Vienna,** Austria.

Read, J.L. (2002). Experimental trial of Australian arid zone reptiles as early warning indicators of overgrazing by cattle. *Aust. J. Ecol.* **27**: 55-66.

Tomkins, N. and O'Reagain, P. (2007). Global positioning systems indicate landscape preference of cattle in the subtropical savannas. *Rangel. J.* **29**: 217-222.