

CHAPTER 4

DESTOCKING EXPERIMENT

4.1 INTRODUCTION

My initial research interest at Currawinya focused on possible effects of destocking on the fauna (Section 1.3). This chapter discusses an experiment set up to test for such effects, specifically whether destocking Currawinya National Park affected the relative abundance of *G. variegata* and *R. ornata*, or gecko species richness, on the park prior to February 1996. The possible impact of grazing on gecko species richness is not investigated in later chapters, but has obvious relevance to the literature on stocking effects, and is easy to test in this analysis.

Data on the effects of domestic grazing on fauna are scarce, particularly for Australian conditions. Higher grazing pressure is frequently associated with decreased faunal abundance, biomass, biodiversity or species richness in north American studies (Fleischner 1994), though no single pattern emerges across all taxa (Friedel and James 1995). Results from Australian studies show a range of effects across and within taxa. Abensperg-Traun *et al.* (1996) found that stock disturbance of arthropod fauna in the Western Australian wheatbelt varied strongly across taxa, including increases, decreases and no change in abundance, richness, and diversity according to taxon. Sixteen invertebrate taxa showed similarly complex patterns in improved pasture in the New England Tablelands of NSW (Hutchinson and King (1980), and Abensperg-Traun (1992) concluded grazing had no clear effect on termite fauna in the Western Australian wheatbelt.

I am aware of only two Australian studies that relate grazing effects and lizard response. Smith *et al.* (1996) studied the effect of stock disturbance on lizard communities in woodland habitat isolates in the Western Australian wheatbelt. They were unable to find any effect on species richness, but suggested disturbance may reduce the persistence of some species in isolated habitats. Another unpublished study on the effects of grazing pressure on vertebrate and invertebrate taxa has identified few substantial changes in reptile communities, and suggests reptiles may be more resilient to domestic grazing effects than other taxa (C.D. James *pers. comm.*). The weight of evidence therefore suggests that lizard faunas are affected only minimally by grazing. However, given the complex array of responses in other taxa, and the limited results from reptile community studies, this conclusion can only be considered preliminary. Clearly any additional information represents a valuable addition to our knowledge, and the work in this chapter extends that knowledge base.

A broader issue also addressed in this chapter is that of whether the destocking action is beneficial to the studied fauna. There is a commonly held, often implicit belief in both the scientific and popular literature that the cumulative effects of biological disturbances such as grazing can be largely reversed by the removal of the disturbance agent (eg Bainbridge 1990, Ledger 1995). The idea of reversible disturbance is a simple and reassuring one for restoration ecologists. However, given evidence such as that reviewed above, the idea is clearly questionable, and this experiment provides another test of its veracity. The importance of such tests has clear and important implications for the way we deal with animal populations living in disturbed habitats.

4.2 METHODS

Destocking experiment sites were selected and sampled as described in Chapter 3. A total of 35 pairs of sites were sampled (Figure 4.1), with two pairs of sites sampled in every sampling month except January 1996 when flooding allowed sampling of only one pair of sites.

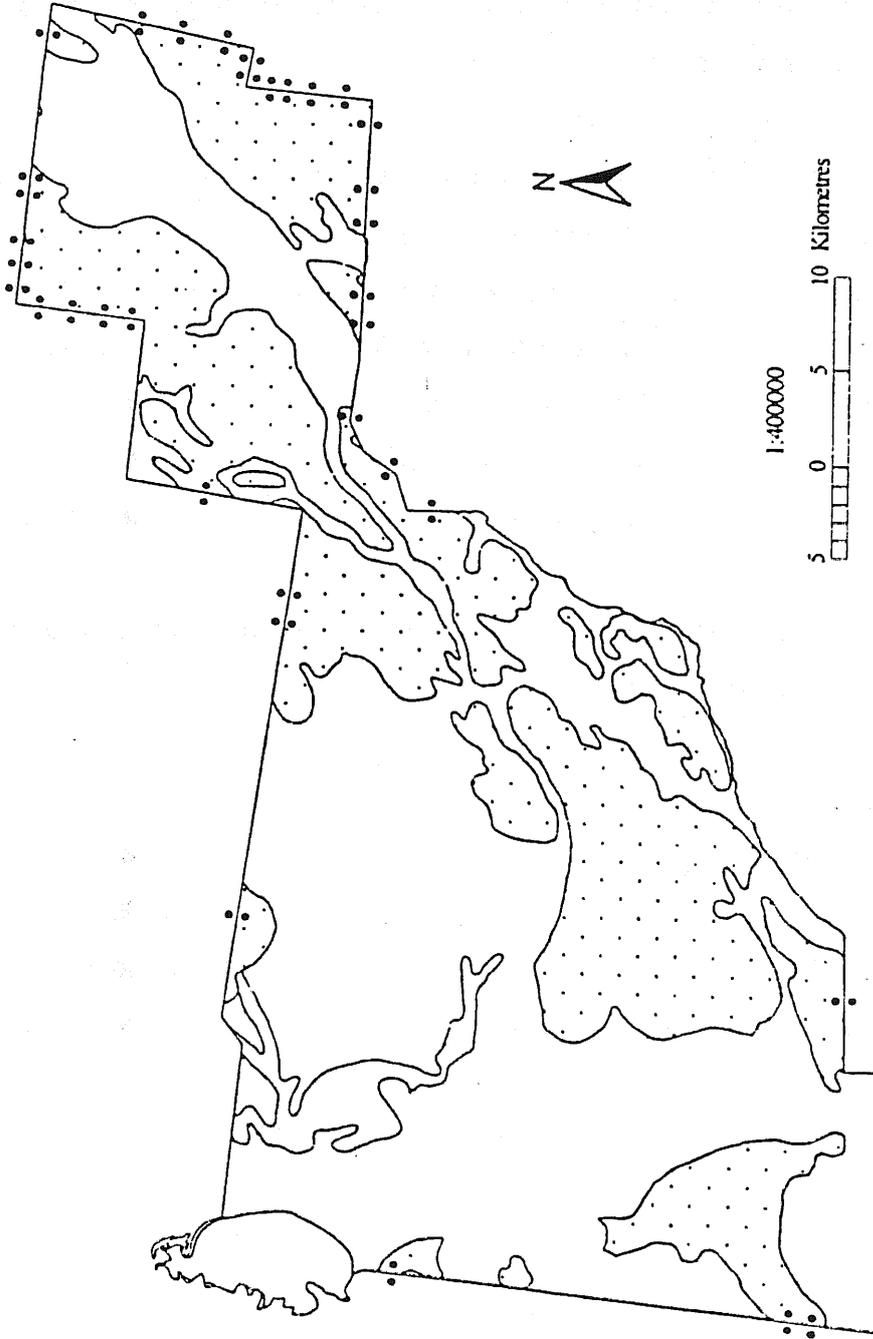


Figure 4.1: Distribution of destocking experiment sites on Currawinya National Park and neighbouring properties. S2 land system is indicated by stippling, and sites are indicated by filled circles.

Three analyses were conducted, one each for *G. variegata* relative abundance, *R. ornata* relative abundance, and gecko species richness. *G. variegata* and *R. ornata* relative abundance were measured as the total animals caught in the *a priori* plots of each site. Species richness was measured as the total number of gecko species caught on the *a priori* plots of each site.

I tested the effects of destocking in a matched sites nested within years design, using analysis of deviance, with an assumed poisson data structure. Poisson analyses were conducted because count data are often poisson distributed (McCullagh and Nelder 1996). Four terms were fitted to the data; *year* (factor coded 1, 2, or 3 as per Table 3.1), *year(pair)* (factor coded 1 up to 12 for pairs of sites nested within *year*), *stock* (0 = on-park, 1 = off-park) and *stock*park* (interaction term). In this analysis, the significance of *year(pair)* suggests only that certain pairs of sites are significantly different to other pairs, hardly surprising given the number of sites. Therefore *year(pair)* is a design variable, and its significance has little relevance to the underlying biological question of destocking effects.

Both absolute deviance residuals and deviance residuals were plotted against fitted values to assess homoscedasticity and to identify large residuals (Statistical Sciences 1994). I used a formal link test²³ to validate the selection of the poisson link (McCullagh and Nelder 1996), and Dean and Lawless' (1989) extra-poisson variation statistic (T_a) to test for over-dispersion where necessary.

4.3 RESULTS

4.3.1 *G. variegata*

Overall goodness-of-fit for the full *G. variegata* model was not significant ($G^2 = 49.64$, d.f. = 37, $p > .05$), and no individual terms were significant (Table 4.1). I was also unable to find any significant 1, 2 or 3 term subset of the 4 term model. Deviance

²³ Two formal link tests are described on p401 of McCullagh and Nelder (1996). I added the square of the linear fitted values ($\hat{\eta}^2$) to each model and examined the change in fitted deviance. A fall in deviance greater than 3.85 is significant at the $p < .05$ level, indicating the assumed link function is inappropriate.

residuals for the full model were approximately homoscedastic in the predicted values, and the link test was not significant (Δ deviance = 0.03, $p > .05$), justifying the selection of a poisson distributed model. Although residual deviance exceeded residual degrees of freedom, the model was not significantly over-dispersed ($T_a = 0.604$, $p > .05$).

Table 4.1: Analysis of deviance for effects of stocking regime and year of sampling on *G. variegata* relative abundance.

	Residual d.f.	Residual deviance	Δ deviance	d.f.	<i>p</i>
Null	69	94.22			
<i>year</i>	67	92.00	2.22	2	.3298
<i>year(pair)</i>	35	46.09	45.91	32	.0529
<i>stock</i>	34	44.70	1.39	1	.2384
<i>stock*year</i>	32	44.58	0.12	2	.9418

4.3.2 *R. ornata*

Overall goodness-of-fit for the *R. ornata* model was very significant ($G^2 = 78.07$, d.f. = 37, $p < .0001$), but no term except *year(pair)* contributed significantly to total deviance reduction (Table 4.2). No subset of the 4 terms in the full model which included the significant *year(pair)* term had any other term significant. As with the *G. variegata* model, diagnostic plots for the full model were acceptable, the link test indicated adequate choice of link (Δ deviance = 2.91, $p > .05$), and although residual deviance again exceeded residual degrees of freedom, the analysis was not significantly over-dispersed ($T_a = 0.759$, $p > .05$).

Table 4.2: Analysis of deviance for effects of stocking regime and year of sampling on *R. ornata* relative abundance.

	Residual d.f.	Residual deviance	Δ deviance	d.f.	<i>p</i>
Null	69	120.78			
<i>year</i>	67	117.92	2.86	2	.2393
<i>year (pair)</i>	35	43.28	74.64	32	.0000
<i>stock</i>	34	43.27	0.01	1	.9203
<i>stock*year</i>	32	42.71	0.56	2	.7558

4.3.3 Species richness

Goodness-of-fit for the species richness model was very poor ($G^2 = 29.20$, d.f. = 37, $p > .05$), and no term was significant (Table 4.3). No model including subsets of these terms was significant either. Diagnostic plots were adequate, and the link test was not significant (Δ deviance = 0.02, $p > .05$), indicating that the poisson link was an appropriate selection. The residual deviance for the full model was lower than the residual degrees of freedom, so no test for poisson over-dispersion was necessary.

Table 4.3: Analysis of deviance for effects of stocking regime and year of sampling on gecko species richness.

	Residual d.f.	Residual deviance	Δ deviance	d.f.	<i>p</i>
Null	69	52.81			
<i>year</i>	67	50.89	1.92	2	.3829
<i>year (pair)</i>	35	25.35	25.54	32	.7836
<i>stock</i>	34	23.73	1.62	1	.2031
<i>stock*year</i>	32	23.60	0.13	2	.9371

4.4 DISCUSSION

The results indicate no effect on gecko fauna by either *stock*, *year*, or their interaction, so species richness and both *G. variegata* and *R. ornata* abundance on Currawinya were unaffected by the destocking event up to February 1996. My results therefore concur with other Australian studies which indicate limited response from lizards to grazing effects (Smith *et al.* 1996, C.D. James unpublished data).

One implication of the results is that the removal of a disturbance agent does not necessarily benefit fauna. In this case, the results only suggest no change, and the possibility of longer term effects, positive or negative, cannot be rejected (see below). Obviously, domestic grazing has had deleterious effects on biological communities in the past, and its removal will form part of many wildlife management plans across the world's rangelands. However, destocking should not be viewed as a cure-all for the problems evident in arid and semi-arid grazing systems. This work has demonstrated

that some species will be unaffected by the removal of grazing pressure, at least in the short to medium term, and the possibility that some, potentially vulnerable species could be adversely affected, still exists.

If fauna does respond to disturbance and/or its removal, we clearly need more information about the nature of that change (Friedel and James 1990, Majer 1990), and the possibility that disturbance effects do not work along a reversible linear continuum invites the question of alternative outcomes. I suggest that faunal community change in arid and semi-arid Australia could be described in terms of states and transitions, because this is the current paradigm for vegetation change in the region, and vegetation change will presumably exercise substantial control over faunal change. Majer (1990) found insufficient evidence to support this idea, but given the questionability of the linear change hypothesis, the state and transition hypothesis deserves further examination. Similarly, other models, such as the intermediate disturbance hypothesis (James and Friedel 1990) also deserve further investigation.

Why might the study species not respond to the destocking of the park? Morton (1990) suggests two reasons as to why reptiles have fared comparatively well compared with mammals since European settlement of Australia. Firstly, reptiles have markedly lower metabolic rates than mammals, allowing reptiles to reduce activity and conserve energy in adverse conditions. Thus as grazing pressure reduces habitat quality, reptiles could be buffered from deleterious effects by their metabolic economy. Secondly, few reptiles are herbivorous (none in this study), and so avoid direct competition for food with grazing taxa. Thus the effects of destocking on the gecko fauna, if any, are likely to be indirect, coming possibly through changes in foraging or shelter habitat availability, and are therefore unlikely to manifest themselves over the life of a relatively short field study.

The detectability of any destocking effect may also have been reduced by variability in grazing pressure both on and off park. All off-park sites were grazed by sheep

during the study, and my informal observations of sheep and their droppings indicated frequently that off-park sites had been recently grazed. Unfortunately, stocking data for different off-park sites were unavailable, and field data such as dung counts were not collected. Since there were probably substantial differences in grazing impacts between grazed sites that would contribute error to off-park data and reduce the likelihood of detecting a grazing effect, the conclusions I have drawn here are tempered by the recognition that grazing impacts were not actually measured. On the park, the effect of destocking was probably reduced through compensatory grazing by macropods and feral grazers still on the park. Page (1997) identified very significant increases in grass coverage in exclosed areas compared with unprotected on-park areas in the S2 land system, indicating the existence of compensatory grazing. Since destocking effects on the vegetation were dampened, it seems likely that carry-over effects on the gecko fauna could also have been reduced and / or delayed, and this too, would have reduced the power of the analyses to detect an effect²⁴. Management, or even monitoring, of grazing regimes in field experiments which involve multiple stakeholders is difficult, but is an issue that should receive closer attention in future research.

Finding no effect in the first three years of destocking does not preclude the possibility of a future effect, particularly if that effect is weak or indirect as suggested above. Time lags are a common problem in field experiments, and alternative longer term responses cannot be rejected (Diamond 1983, Wiens *et al.* 1986). Page's (1997) concurrent analysis of vegetation dynamics in the S2 land system, found only small (but significant) increases in perennial grass coverage on, but not off the park, but no parallel change in either forbs or woody shrubs. Given the limited effect destocking had on vegetation during sampling, it is unlikely that the gecko fauna would have

²⁴ Power analyses are useful tools to examine the magnitude of experimental effect necessary for a significant result. Unfortunately power analysis was not feasible for these analyses because the analyses of deviance included two terms which might indicate some effect of grazing regime (*stock* and *stock*year*). A power analysis would therefore require simultaneous examination of minimum significant effects for both terms, and this is currently not possible. Individual analyses for each term are possible but virtually impossible to interpret in the absence of the other term.

responded significantly; but given also that future vegetation changes are likely, future changes in the gecko fauna are also possible.

The design I have used here is a field experiment, since I exercised control over only some experimental conditions (Diamond 1983). However, the results do highlight an inherent limitation of both field and laboratory experiments, namely, that since the observed patterns cannot be extrapolated beyond the range of the data, prediction beyond the life of the study is difficult. For example, if data from the first three years are extrapolated into the future, no change in gecko response seems likely. Unfortunately, extrapolation beyond the range of the data is fraught with danger (Brook and Arnold 1985). Implicit in extrapolation is the assumption that the (non)trend in gecko response observed during field work *is* representative of future changes, but there are no data to support this assumption and numerous alternative futures exist. The methodological approach used in this chapter is therefore inappropriate for detecting future change in gecko response to destocking.

4.5 CONCLUSIONS

I found nothing to indicate change in either the relative abundance of *G. variegata* or *R. ornata*, or in gecko species richness over the life of the study, on either side of the park boundary. Hypothesis 1 was therefore rejected.

In the next chapters I look at the use of wildlife-habitat models to predict faunal response to habitat and habitat disturbance. Models are not only potential tools to predict wildlife response to habitat disturbances such as the destocking of Currawinya, but also suggest possible mechanisms by which the response is influenced. They are thus potentially useful extensions to the type of experimental approach taken in this chapter.