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MAINTAINING BIODIVERSITY IN AUSTRALIAN RANGELANDS

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ABSTRACT

We outline the results of recent work aimed at determining the impact of grazing on biodiversity of the arid and semi-arid rangelands. We examined changes in the abundance and species composition of perennial plants, ephemeral plants, invertebrates and vertebrates using gradients of decreasing grazing intensity at greater distances from artificial sources of water. We sampled eight sites across Australia in Acacia *woodland and chenopod shrubland habitats. Different suites of species occur at different distances from water. Around 20% of species were only found at the sites most remote from water. We conclude that high densities of water points are disadvantaging large numbers of species through the maintenance of widespread, moderate to heavy grazing pressure. We conclude that while many species can persist under grazing, many cannot, and that conservation of biodiversity will not be satisfactorily achieved without explicitly planning to have areas that are not grazed within the matrix of grazed rangeland.*

INTRODUCTION

There has been a general tendency to claim that grazing is either 'good' or 'bad' for biodiversity. Apart from a dearth of data supporting either view, this simplistic dichotomy is flawed in that it assumes all species respond to grazing in the same way, and that the influence of grazing is uniformly distributed across the landscape. Neither of these assumptions is true. In the case of the first assumption, there is some evidence from studies of plants, invertebrates and vertebrates that population responses to grazing often vary among species or guilds (James *et al.* 1995a). The second assumption is also wrong: many studies have documented variation in grazing intensity in response to natural variation in the pattern of plants (palatable or unpalatable) across the landscape, and variation in the ability of animals to reach all areas. Thus, the answer to the question 'What is the effect of grazing on the biodiversity of rangeland ecosystems?' is not a simple one; different species are likely to respond differently to spatial variation in the distribution of grazing pressure across the landscape.

In this presentation it is our aim to present data on the effect of grazing on flora and fauna from our recent studies, and to suggest requirements for the maintenance of the natural biodiversity of rangeland ecosystems.

HOW HAS BIODIVERSITY FARED IN AUSTRALIAN RANGELANDS?

The rangelands of Australia have experienced many changes affecting biodiversity over the last 100 years. There have been changes caused by direct actions to foster the pastoral industry, and many changes either indirectly linked or unrelated to pastoralism (James *et al.* 1995a).

Some of the processes threatening native species are not directly related to grazing by domestic, native and feral mammalian herbivores (e.g. predation on endangered species of mammals) and will not be discussed further here. But grazing itself has been suggested as a process threatening biodiversity. We briefly discuss existing knowledge of the effects of grazing on native biota and summarise the results of our recent work (James, Landsberg and Morton, unpubl. data).

Existing Knowledge of the Effect of Grazing on Native Biota

Changes in the cover of perennial vegetation along grazing gradients are well documented for Australian rangelands. By contrast, very little is known about grazing impacts on ephemeral plants. The few studies examining changes in plant species composition deal only with responses within a few kilometres of water points, and demonstrate a range of responses for different species.

Most studies of the effects of grazing on animals concentrate on a small number of invertebrate species and guilds, mammals and birds. Most studies have been done by comparing grazed and ungrazed sites (James *et al.* 1995a). In response to grazing, some species increase in abundance, some decrease in abundance and others are unaffected.

There is one consistent result from existing studies: there is no single, simple response of *all* species to grazing. The existing studies fail to tell us much about changes to biodiversity, because they suffer from important shortcomings. First, there has not been a systematic evaluation of responses of *all* plant or animal species. Second, very few studies have examined a gradient of grazing intensity from true control areas, where grazing impact has been negligible, to heavily grazed areas.

New Insights into the Effect of Grazing on Biodiversity

The lack of data on the effect of grazing on biodiversity in Australian rangelands stimulated us to begin studies on this topic in 1993. The results of some of this work are currently available (James *et al.* 1995b, Landsberg *et al.* 1996) and the full data set will soon be prepared for publication.

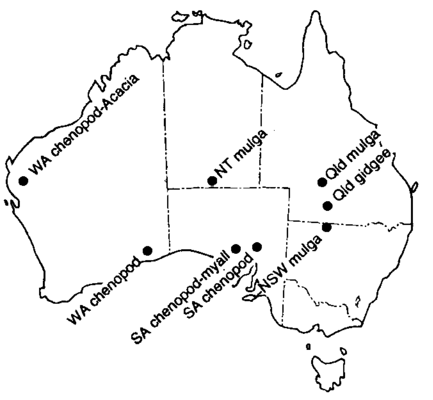

Figure 1. Location of eight sites where grazing gradients away from artificial water were studied during 1994-95.

The main set of results summarized here derives from an examination of assemblages of plants and animals at sites at increasing distances from artificial water points. The distance large grazing animals can travel away from water is limited because of their need to drink every few days. This tie to water creates a gradient of grazing intensity, which declines with increasing distance from water. We undertook systematic sampling of eight grazing gradients across Australia; four gradients each in *Acacia* woodlands and chenopod shrublands (Fig. 1). Selection of gradients was based primarily on the length of the gradient away from water: we searched for areas that were further from permanent water than most grazing animals would normally reach. For sheep, we looked for gradients >9 km in length and for cattle, >12 km. At each gradient we examined the diversity and abundance of species of perennial plants, ephemeral plants, invertebrates, reptiles, small mammals and birds. Details of our methods are given in James *et al.* (1995b).

Using correspondence analysis we are able to identify species associated with sites at different distances from water. A consistent result for all groups of plants and vertebrates (we have not yet analyzed the data for invertebrates) was the identification of a large group of species (from 15 to 30% of all those present depending on gradient and taxon) found only at the farthest one or two sites from water (Fig. 2). We also found similar proportions of species associated with the one or two sites closest to water, and a moderately high proportion of species that were not closely associated with any particular site or sites along the gradient. Thus, we did not detect any simple, overall pattern of response in

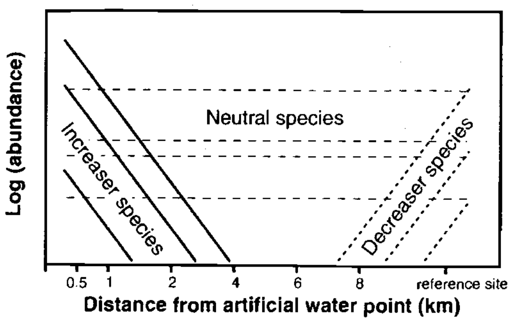

Figure 2. Schematic diagram showing responses to grazing as a function of distance from artificial water points. Increaser species are most abundant within a few kilometres of a water point; Decreaser species were only found at sites most remote from water; Neutral species did not have an obvious change in abundance with distance from water. Within each group, different species have different relative abundances.

terms of total numbers of species in response to grazing, but instead found that some species decreased, some increased and some were apparently neutral. Our results highlight the spatial variation in assemblages of plants and animals, as well as showing that grazing is having a major impact on the distribution and abundance of biota.

MANAGEMENT FOR BIODIVERSITY CONSERVATION

Management Options

Management for biodiversity conservation in the rangelands needs to be considered regionally, rather than at the scale of individual paddocks or properties (James *et al.* 1995a, Morton *et al.* 1995). The results of our current work reinforce this point because they demonstrate variation in the assemblages of species over large spatial scales, and in response to landscape heterogeneity. Although effective regional conservation will inevitably require some land to be managed with conservation as its primary goal (either national parks or conservation easements), it will also require sympathetic management of grazing on the majority of land where the primary goal is sustainable pastoralism (Morton *et al.* 1995). But a conservation strategy must: (1) not be overly taxing of existing labour and finance; (2) be easy to administer given current pastoral practices; (3) use areas that have experienced the very lightest grazing pressures; and (4) represent examples of all the major habitats in a regional network of ungrazed areas.

The principal message from our results is that achieving regional biodiversity conservation requires that the densities of grazing animals be kept very low in some areas. Fencing can effectively control the distribution of grazing animals, but it may be too expensive to use extensively for conservation. This is particularly true for fencing that will exclude all large herbivores, including kangaroos and feral animals. The alternative management approach that we see as most appropriate suggests itself from the design of our studies; that is, a focus on the availability of water.

Water, Water Everywhere . . .

To avoid localised degradation by promoting uniform grazing, managers have been encouraged to provide sufficient water points to ensure that the majority of grazing land is within 3 km of water for sheep or 5 km for cattle. In the arid mulga woodlands the average density of water points indicates that most of the sheep rangelands already lie within 3.5 km of water and most of the cattle lands within 5.6 km (Morrisey 1984).

For conservation, pastoral management that promotes sufficient spatial heterogeneity in grazing patterns to provide for very lightly grazed areas appears to be more important than promoting uniformity of grazing. Thus, our work leads us to suggest the need for a reconsideration of previous prescriptions for grazing management that promoted large numbers of closely-spaced water points across most of the rangelands.

An Implementation Strategy

Morton *et al.* (1995) outline a hierarchy of land allocation for conservation in arid and semi-arid rangelands, with representative large areas being managed primarily for nature conservation (e.g. in national parks and nature reserves), supplemented by smaller areas to be managed as conservation easements by pastoralists or other local land managers in return for financial remuneration. We suggest that land allocation based on the distribution and manipulation of water points is a practical and implementable strategy. We see these as the main steps (much summarised):

• *Information and community consultation.* It is essential to consult with local communities about the impacts of the provision of water points on the full range of biodiversity, as well as the ideas behind sustainable land management.

• *Recognising the natural value of ungrazed land.* Acknowledgement of the value for biodiversity of those remaining areas remote from water is essential.

• *Water-points in conservation reserves.* Planned, progressive shut-down of water points in national parks and nature reserves should be a high priority, because of the damage to biodiversity stemming from artificial water points.

• *Regional planning.* Regional land use plans, developed with stakeholder consultation, need to identify representative areas of potentially high conservation value in all major habitats.

• *Development of management plans.* Water and grazing management strategies need to be developed for areas selected as conservation easements which are to be managed by existing land managers as part of their enterprise.

• *Monitoring and adaptive management.* Monitoring, and subsequent adaptive management, is essential to determine whether the strategy for maintaining grazing-sensitive species is working.

• *Research needs.* Further research is needed to establish relationships among different species and response groups in different taxa, so that reliable surrogate taxa can be confirmed for monitoring.

CONCLUSIONS

The influence of grazing associated with water points is extremely widespread in the Australian rangelands and appears to be disadvantaging many native plant and animal species. The relatively high proportion of native species which appear to be in decline represents an early warning signal that the status quo is a risky strategy for future conservation of biodiversity. There are few feasible options for reducing grazing pressure across arid and semi-arid rangelands, thereby improving biodiversity conservation. We outline what we see as the most feasible implementation strategy for improving regional conservation — selective reduction in the density of water points.

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