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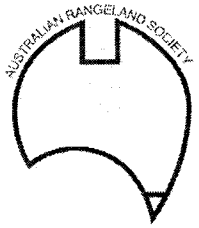

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SHORT-TERM RECOVERY OF SEMI-ARID WOODLAND RESERVED FOR CONSERVATION AFTER CESSATION OF GRAZING

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ABSTRACT

Small mammal, reptile, ant and plant diversity, soil health and landscape condition were compared at sites that were either 1) reserved for conservation, 2) currently stocked or 3) long-ungrazed National Parks. Park and reserve soils were more stable and had higher nutrient levels compared with grazed sites. Park sites had significantly greater patchiness, and, along with reserves, three times greater levels of plant cover and landscape organization, greater cryptogam cover, and less bare ground. Reserve sites supported 18% more plant species. We found few difference in ant, mammal or reptile fauna between treatments, and although skinks were more abundant on park and reserve sites. Overall our results indicate substantial better ecological health in the reserves compared with the grazed sites, which we attribute to the better health of reserves prior to fencing, and the declining condition of grazed sites due to drought.

INTRODUCTION

Grazing-induced disturbance is a major degrading process in Australia's woodlands reducing plant diversity and tree and shrub recruitment (Tiver and Andrew 1997). Trampling disturbs soil surfaces, reducing niches for the capture and storage of water, seed and sediment, alters soil surface temperature and nutrient levels, and reduces the number, arrangement and quality of fertile patches. Continual grazing leads to a loss of ecosystem function in terms of the ability of the site to cycle nutrients, conduct water and maintain stability, severely compromising the capacity of the landscape to sustain organisms and to recover from disturbance when conditions are favourable. Grazing is also implicated in the destruction or alteration of animal habitat (Dickman *et al.* 1993), reducing populations of small mammals, birds, reptiles and invertebrates.

In the Lower Murray-Darling in south-western NSW, Southern Mallee Agreements incorporate the concept of "trading off" or setting aside land for conservation in exchange for the approval to develop other land for farming. Up to 58,056 ha of belah (*Casuarina cristata*)-rosewood (*Alectryon oleifolius*) woodland has been reserved for conservation and added to the National Reserve Scheme (IUCN Category IV - Habitat Species Management Area). The reserves are fenced, domestic livestock removed, watering points closed, and pest species controlled.

The aim of the study reported here was to examine changes in soils and vegetation, and populations of small mammals, reptiles and ants in a subset of reserves after an initial period of 3-5 years. We used a chronosequence approach to compared attributes of the reserves with areas in the same vegetation community that are (1) currently grazed ('Grazed'), and (2) sites in Mallee Cliffs National Park that have not been grazed by domestic animals since 1977 ('Park').

METHODS

Twenty one sites were established on loamy calcareous plains in the belah-rosewood vegetation community near Buronga NSW. Seven sites were established each within Mallee Cliffs National Park (Park), conservation reserves gazetted about 5 years previously (Reserves), and pastoral properties that had been grazed continuously for the past 150 years (Grazed).

We established two 50 m by 20 m plots at each site within which we placed a smaller 20 m by 20 m plot to measure the cover of vascular plants (including trees and shrubs), litter, cryptogamic crusts and bare soil. We also enumerated the number of tree hollows and the total length of all surface logs >100 mm wide and 1 m long. A 50 m transect placed through the centre of the smaller plot was used to measure the diversity, number and width of patch types, and the distance between them. We assessed soil surface condition within the patches, and derived measures of soil stability, nutrients and infiltration using the method of Tongway and Hindley (1995). A 30 m pitfall line (5x 20L buckets) was established in each plot to sample reptiles and small mammals, and ants were assessed using five 0.1 L ethanol-filled vials.

We used one-way ANOVA or non-parametric Kruskal-Wallis tests to examine differences in the cover of soil, plants and patch types, and diversity of plants and animals between the three treatments. Indicator-Species Analysis was used to examine the degree of association of individual species, and Canonical Analysis of Principle Coordinates analysis used to examine relative differences in groundstorey plant composition between Grazed, Park and Reserve sites.

RESULTS

Patch types and landscape function

Eight patch types were identified, three of which (plains with cryptogams, plains with bare soil, tree hummocks) accounted for 80% of the soil surface. The cover of plains with cryptogams was significantly greater in Reserve and Park sites compared with Grazed sites. Conversely, cover of plains with bare soil was significantly greater in the Grazed sites compared with Reserve or Park sites. Shrub hummocks were recorded only in the Park and Reserve sites. The average derived stability index for Park and Reserve sites was about 12% higher than that on the Grazed sites. Nutrient index levels were marginally (but significantly) greater in Park and Reserve sites than Grazed sites. Tree hummocks, litter mounds and litter trains generally had the highest nutrient and infiltration values, while the most stable units were tree hummocks, litter mounds, litter trains and plains with cryptogams.

There were significantly more patches per 10 m length of transect at the Park sites compared with either the Grazed or Reserve sites. The increasing number of patches reflected a decline in the average fetch length from the Park, through Reserve to Grazed sites. Stable sites tended to have greater plant and cryptogam cover, and more patches. Sites with more patches had greater plant cover, and increasing fetch length was associated with increasing plant species richness and declining richness of ant functional.

Plant cover and composition

Plant cover was 2 ½ times greater on Park and Reserve sites compared with Grazed sites and there was more bare ground and less cryptogam cover at Grazed compared with other sites. The cover of five plant species (*Atriplex stipitata, Dodonaea viscosa* subsp. *angustissima, Chenopodium curvispicatum, Maireana appressa, Senna artemisioides* subsp. *filifolia*) was

significantly greater in Reserve and/or Park sites compared with Grazed sites. We recorded 18% more plant species in the Reserve sites compared with the Park or Grazed sites. There were no differences in the surface cover of logs or the number of tree hollows between the treatments ($P>0.61$).

The three treatments differed significantly in their complement of plant species ($P=0.037$). *Olearia muelleri* (Indicator Value=53.2%, $P=0.004$) was a good indicator of Park sites, and *Atriplex stipitata* (IV=56.9%, $P=0.033$) and *Chenopodium curvispicatum* (IV=55.8%, $P=0.014$) good indicators of Reserve sites. *Salsola kali* var. *kali* was a marginally (though significant) indicative of Grazed sites (IV=28.6%, $P=0.033$).

Ants, reptiles and mammals

Grazed sites supported fewer families compared with Park or Reserve sites, but there were no other treatment effects, irrespective of whether we classified to functional group, sub-family, genus or species level. We trapped a total of 327 (25 species) reptiles and 11 (three species) mammals. The reptile fauna was dominated by the Geckonidae (56% of captures) and the Scincidae (36%). Some species were only found within the Park (e.g. *Ctenotus brachyonyx*) or only within Grazed sites (e.g. *Diplodactylus damaeus*), but low capture rates at many sites precluded us from making definitive statements about their distribution in relation to grazing exclusion. Skink abundance was slightly greater in the Park and Reserve sites compared with the Grazed sites.

DISCUSSION

Park sites were substantially healthier in terms of soils, vegetation and landscape organisation compared with Grazed sites. However, we also recorded considerable improvement in Reserve sites despite the fact that grazing ceased less than a five years earlier. Indices of surface stability and nutrients, and cover of plants and cryptogamic crusts were all greater in Park and Reserve sites compared with Grazed sites, where the grazing management has been set stocking for the past 150 years. The fact that there were marked differences between the Park and Grazed sites despite the large numbers of kangaroos in the Park suggests that changes in kangaroo densities are not responsible for our observed results. Furthermore, Reserve sites supported a greater number of native plants than either the Park or Grazed sites.

Grazing leads to a decline in soil surface quality, particularly a reduction in cryptogam cover which is a critical component of surface stability, and likely influences germination and survival of vascular plants, and potentially, invertebrate communities. Unrestricted livestock grazing leads to a decline in landscape patchiness i.e. fewer permanent obstructions on the soil surface available to capture and retain essential resources such as water, seed and sediment. Grazing appears to have reduced the number and size of patches; hence more patches at Park sites compared with the other treatments, and a four-fold greater level of landscape organization on Park and Reserve sites compared with Grazed sites. Alteration to runoff-infiltration relationships likely results in greater infiltration in the shrub interspaces, less water reaching the shrubs, a breakdown in spatial organisation of patchiness, and thus a change in vascular plant floristics from perennial- to ephemeral-dominant. Thus grazing reduces not only the number and size of patches, but also their quality, configuration and function.

Despite plant and soil recovery, we found few difference in diversity or composition of the ant fauna, and few effects on mammal and reptiles. However, both arboreal and ground-dwelling skinks were well represented, similar to studies in other arid areas (Read 1992).

Increasing abundance of skinks at the Reserve and Park sites probably reflects increasing landscape structure, altering surface temperatures and providing protection from predators. The weak ant effect is consistent with data elsewhere suggesting that ant richness is largely independent of grazing (Bestelmeyer and Weins 2001). We conclude therefore that ant richness may not be a good indicator of landscape health in these woodlands.

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