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DISTRIBUTION OF SHEEP, GOATS AND KANGAROOS IN SEMI-ARID WOODLAND PADDOCKS

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ABSTRACT

The spatial distribution and relative abundance of sheep, goats and kangaroos were assessed from extensive dung surveys following dry and wet periods in two paddocks in the rangelands of north-western New South Wales. The average total grazing densities in the two paddocks were 0.53 and 0.29 hectares per sheep equivalent, compared with an accepted regional average of 0.25. Sheep accounted for less than half of the total density and goats for much of the remainder. Goat densities were much higher than indicated in a recent survey of pastoralists' perceptions. The pattern of distribution of sheep and goats was closely correlated in both paddocks, but there was little evidence of association between sheep and kangaroos. The pattern of distribution of dung was not uniform or easily predictable, but showed variable associations with distance from water, vegetation preference and cover.

INTRODUCTION

Overgrazing can undoubtedly lead to degradation of rangeland pastures. Pastoralists are generally aware of this and, where possible, adjust numbers of livestock to match perceived carrying capacities of pastures under different seasonal conditions. But livestock are seldom alone in utilising rangeland pastures. In the semi-arid woodlands of eastern Australia there are also medium to high densities of feral goats and native kangaroos. This paper is a preliminary report from a study of the distribution of these animals and their relative contribution to the total grazing impact in operational paddocks in this region.

METHODS

Surveys of animal dung and vegetation were conducted twice in each of two paddocks, "New Bore" and "Crossroads", in the Wanaaring district of north-western New South Wales. "Dry period" surveys were conducted in November-December 1991, following less than 4mm of rain in the preceding four months; "Wet period" surveys were conducted in April 1992 after more than 100mm. The annual average rainfall for the district is about 230mm. Both paddocks have only one permanent watering point.

New Bore consists of about 2400ha of sandplains and dunefields with patchy vegetation dominated by gidgee (*Acacia cambagei*), rosewood (*Heterodendron oleiofolium*), ironwood (*A. excelsa*), poplar box (*Eucalyptus populnea*), hopbush (*Dodonaea viscosa*) and turpentine (*Eremophila sturtii*). Mean cover of trees is about 5%; shrub cover tends to be bi-modal at either 6% or 15%. The dominant ground cover is woollybutt (*Eragrostis eriopoda*), though wiregrasses (*Aristida* spp.), copperburrs (*Sclerolaena* spp.) and other small chenopods are locally common. Mean ground cover ranged from about 5% in the dry period to about 13% following the wet period.

Crossroads consist of about 6110ha of rolling downs, dominated by extensive mulga woodlands, generally *A. aneura*, but changing to bastard mulga (*A. clivicola*?) on silcrete ridges. Other common woody species include harlequin fuchsia (*E. duttonnii*), poplar box, whitewood (*Atalaya hemiglauca*), leopardwood (*Flindersia maculosa*), punty bush (*Cassia nemophila*), turpentine, budda (*E. mitchellii*) and hopbush. Mean cover of trees is about 8%, and modal shrub cover is about 1%. The ground cover consists mostly of ephemerals and scattered, heavily grazed grass butts; its mean cover ranged from about 1% in the dry period to 2% following the wet.

Sheep, goat and kangaroo dung that retained a patina (and was therefore less than 80 days old) was counted in two metre swathes along parallel transect lines that crossed the paddocks at one kilometre intervals. The counts were recorded at 250m intervals, for pellet-groups, and excluded accumulations of dung in animal camps. Verified samples were collected weekly for three months prior to each survey, to determine decay patterns and average (oven dry) weights of pellets per pellet-group for each species.

Animal densities were estimated from the ratios of weights of pellet-groups. Goat pellet-groups weighed 0.6 as much as those from sheep, compared with 0.7 for kangaroos. These ratios were used to convert dung counts to "sheep-equivalent" values, which were then used to calculate approximate animal numbers, standardised against the number of sheep that the graziers estimated to have been in the paddocks. During the 1992 surveys, numbers of animals sighted from the transect lines were also recorded, as a rough check of the relative accuracy of dung counts.

A sheep activity index was calculated for each 250m x 2m quadrat, from the equation used in the **Paddock** module of **RANGEPACK**, a decision-support system for rangeland properties. The index is sensitive to distance from water, distribution of preferred vegetation, wind direction and water salinity.

RESULTS

Animal densities

Sheep accounted for less than half the total density of grazing animals in both paddocks, and goats accounted for far more of the remainder than did kangaroos in three of the four counts (**Table 1**).

Animal distributions

The numbers of sheep pellet-groups per quadrat were strongly correlated with the numbers of goats, but only weakly correlated, if at all, with the numbers of kangaroos (**Table 2**); sightings of animals were in general agreement with this finding, although we saw more goats than expected from the dung counts.

A suite of quadrat variables was tested for correlation with quadrat dung counts for the different animals. These included estimated cover of dominant plant species, both alone and in combination, calculated vegetation preference ratings, distance from water, and predicted activity indices.

The highest correlation measured ($r=0.43$, $P<0.01$) was for New Bore in the dry, between the density of sheep dung and the vegetation preference rating, which was based on cover, palatability, accessibility, shadiness and succulence of the dominant species in each quadrat. Vegetation preference was also significantly correlated ($P<0.02$) with the density of sheep dung in Crossroads, both in the dry ($r=0.25$) and wet ($r=0.18$), and with the total density of all animals in both paddocks ($r=0.39$ for New Bore in the dry and 0.30 for Crossroads during both periods).

Both sheep and goat dung were significantly correlated with various measures of woody cover in Crossroads. During the dry period highest correlations were with total tree cover ($r=0.29$ for sheep, 0.41 for goats; P,0.01). Following the wet period, this correlation remained high for goats ($r=0.36$, $P<0.01$), but was no longer significant for sheep ($P>0.05$); the best correlate for sheep dung at this time was ground cover ($r=0.32$, $P<0.01$).

Distance from water was significantly ($P<0.02$), but weakly correlated with distribution of sheep dung in Crossroads during both seasons ($r=0.28$ in the dry and 0.25 in the wet). Although there was no linear correlation between sheep dung and distance from water for New Bore, there was a significant polynomial regression for the dry season data ($r=.46$); sheep dung increased with distance from water for the first 3 kilometres and decreased thereafter.

The predicted activity index was correlated with sheep dung in New Bore during the dry ($r=0.31$, $P<0.01$), but not on other occasions.

Although there were other significant correlations between variables, none was consistent for the same animal in different paddocks or during different periods.

Table 1. Estimated stocking densities in both paddocks. Graziers' estimates are asterisked; all other animal numbers are calculated from dung counts standardised against these values. Sheep equivalents were converted to individual counts by assuming that a goat or kangaroo is equivalent to 0.7 sheep.

a) **New Bore Paddock**

Animal	**Season**	**Animal numbers (sheep equivalents)**	**Animal numbers (individuals)**	**Density (Sh. eq./ha)**	**% Total density**
sheep	dry	700*	700*	.29	46
goat		468	669	.19	31
red kangaroo		143	204	.06	10
grey kangaroo		196	280	.08	13
Total	**dry**	**1507**	**1853**	**.62**	**100**
sheep	wet	500*	500*	.21	49
goat		243	347	.10	23
red kangaroo		205	293	.08	19
grey kangaroo		90	129	.04	9
Total	**Wet**	**1038**	**1269**	**.43**	**100**

b) **Crossroads Paddock**

Animal	**Season**	**Animal numbers (sheep equivalents)**	**Animal numbers (individuals)**	**Density (Sh. eq./ha)**	**% Total density**
sheep	dry	1000*	1000*	.16	45
goat		849	1213	.14	40
red kangaroo		127	181	.02	6
grey kangaroo		158	226	.03	9
Total	**dry**	**2134**	**2620**	**.35**	**100**
sheep	wet	600*	600*	.10	44
goat		685	979	.11	51
red kangaroo		43	61	.007	3
grey kangaroo		24	34	.004	2
Total	**Wet**	**1352**	**1674**	**.22**	**100**

Table 2. Correlation coefficients for the number of pellet-groups per quadrat for different animals. Dry season values are shown in the top right of each matrix and wet season values in the bottom left. Asterisks indicate significance levels <0.05.

a) New Bore	Sheep	Goat	Red kangaroo	Grey kangaroo
Sheep	1	.36*	.13	.15
Goat	.85*	1	.12	.08
Red kangaroo	.07	.15	1	.32*
Grey kangaroo	.13	.01	.27*	1

b) Crossroads	Sheep	Goat	Red kangaroo	Grey kangaroo
Sheep	1	.83*	.30*	.35*
Goat	.56*	1	.27*	.22
Red kangaroo	.10	.35*	1	.46*
Grey kangaroo	.06	.06	.07	1

DISCUSSION

Animal densities

Sheep were responsible for less than half the estimated density of grazing animals monitored in this study (**Table 1**). Thus although New Bore was running sheep numbers similar to the regional average of 0.25 sheep/ha (Gibson and Young 1988), the real stocking density was up to two and a half times this level. Although the ground cover in the paddock responded reasonably well to rain, it is questionable whether its productivity can remain sustainable for very long under such high total stocking pressures. The manager has recognised this, and embarked on an intensive program of goat control.

Crossroads, which had very little ground cover in either season, was very conservatively stocked, with sheep numbers well below the regional average in recognition of its sparse ground cover. Despite this the total grazing density was nearly one and a half times the regional average during the driest period; this may partly account for the paddock's poor response to rainfall during the study.

Goats were the main competing grazer in these two paddocks, particularly in Crossroads. Even in New Bore paddock with its higher ground cover, kangaroos were responsible for only about a quarter of the total stocking pressure. This is contrary to regional perceptions ascertained in 1988 by Gibson and Young. At that time a survey of 52 pastoralists in the Wanaaring district showed that most of those surveyed rated kangaroos as a major constraint to livestock production, but few cited goats as a perceived problem. During out study goat density was 0.14 sh.eq./ha, nearly double that of kangaroos. Goat numbers have apparently increased in recent years (graziers' observations), but the discrepancies between recent perceptions and current reality are sufficiently large to indicate cause for concern.

The derivation of animal densities from dung counts assumes that an equivalent unit of food is converted to an equivalent weight of dung, regardless of species. Kangaroos and sheep have similar digestive efficiencies and food intakes, although kangaroos digest less fibre in high fibre diets (Edwards 1989). Thus kangaroo dung may weigh slightly more than the dung produced by sheep from an equivalent intake; if this is so our estimates of kangaroo densities may be rather high. None-the-less, our estimates were very similar to those of graziers in our study region (Gibson and Young 1988) and well within the range of broad-scale estimates (Caughley *et. al.* 1977).

While less is known of the relative digestive efficiencies of sheep and goats, goats are likely to have higher metabolic efficiencies than sheep on a browse-rich diet. Under these circumstances, our estimates of goat densities are likely to be rather low, since goats may be expected to produce lower weights of dung from equivalent food intakes. This accords well with our own observations of their relative numbers, and with numbers of goats mustered from New Bore Paddock: 1400 were mustered and removed from the paddock during the period of our study, compared with our estimated total of about 1000 (**Table 1**). Thus the errors inherent in our calculations of animal numbers mean that the pattern of relatively low kangaroo numbers and very high goat numbers may be even greater than we have estimated.

Animal distributions

The distribution of sheep and goat dung was strongly correlated in both paddocks and seasons during the survey (**Table 2**), indicating considerable potential for competition between these animals. The distribution of red and grey kangaroos was also often correlated, a pattern borne out by observations in favoured feeding areas (Landsberg, unpublished). However, there was little evidence of association between kangaroos and sheep or goats, particularly in New Bore Paddock where kangaroo numbers were much higher (**Tables 1 & 2**). Thus there does not appear to be any consistent overlap or separation between sheep and kangaroo distribution within these paddocks. However, the low numbers of kangaroos in Crossroads Paddock relative to New Bore, and other observations in the district, suggest that densities of kangaroos may be very low in paddocks with large numbers of sheep and goats and/or low ground cover.

The patterns of distribution were not uniform or consistently predictable for sheep, goats or kangaroos. Distribution of sheep dung was correlated with distance from water, but the associations were weak and the patterns complex. Although there were some correlations with vegetation preference and cover, the correlations were variable between animals, paddocks and survey periods, and never explained more than 20% of the variance in dung distribution.

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