ECOSYSTEM RESPONSE TO CELL GRAZING

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INTRODUCTION

Grazing management has conventionally involved continuous or rotational systems. These may result in strong grazing gradients from watering points and accentuation of problems relating to selective grazing. In the temperate Nthn Tablelands of NSW, Earl and Jones (1996) found that simple rest periods provided little benefit compared to un-rested paddocks. This contrasts with the benefits of wet season spelling for northern Australia recommended by Ash, Corfield and Ksiski (2002).

Consideration of cell grazing in Australia was presented in the mid-1980s (Alchin, 1986). Proponents facilitated its introduction to pastoralists in the early 1990s (McCosker, 2000). Cell grazing has been criticised by some rangeland scientists. However, the pastoral industry has generally accepted cell grazing as having a role in the options for management, based largely on the observed improvements in rangeland condition and profitability in various locations.

Cell grazing is continually evolving as new knowledge is implemented in its application. The following principles of cell grazing are adapted from McCosker (2008): (1) adjustment of rest/graze periods in relation to plant growth rates, (2) matching stocking rate to carrying capacity, (3) planning-monitoring-managing, (4) effective management of livestock, (5) short graze period, (6) high stock density for minimum time and (7) use of biodiversity to improve ecological health.

Norton and Bartle (2002) noted that cell grazing minimises selective grazing while Earl and Jones (1996) reported that lengthening of the rest period resulted in improved plant regeneration and increased herbage yield. However, Jones (1993) considered cell grazing would have limited application where pasture growth was seasonal. He also noted the risk of mis-management of pastures because of the high stock density over the short grazing periods. Bartle (2002) noted the limitations of cell grazing potential in Australian rangelands because of the large size of holdings.

There is a dearth of scientific data on ecosystem responses and changes under cell grazing. The aim of this research was to develop an understanding of the ecosystem response to cell grazing; it included a comparison with conventional grazing systems.

METHODS AND RESULTS

Study sites were established on paired sites where commercial scale cell grazing was adjacent to conventional grazing (Table 1). The study sites run cattle and are located across different rangeland types and climatic variability in the summer-dominant rainfall zone of northern Australia.

Data was collected using Landscape Function Analysis (LFA) (Tongway and Hindley, 2004) and measurements of soil bulk density (Anderson and Ingram, 1993), microbial activity (Chilcott and King, 2000), perennial grass density and biological soil crust species, cover and distribution.

Table 2 summarises the LFA data. The number of patches was higher for cell grazing at all sites, particularly for the vertosols. Compared to rotational grazing, the patch area index was tripled under cell grazing for the vertosol and doubled for the kandosol sites. All the LFA indices were equal to or higher for the cell grazing compared to the rotational/continuous grazing; the increase was most marked in the brigalow country.

The soil property data is presented in Table 3. The bulk density was significantly lower under cell grazing for the two vertosol sites, but there was no difference on the kandosol site. Other data for site

4 (Moree) showed that there were no significant changes in bulk density over the graze-rest period under cell grazing. However, the infiltration rate was significantly higher at the end of the rest period compared to the end of the previous graze period. Microbial activity was greater for cell grazing on sites 2 (Emerald-kandosol) and 3 (Wandoan), but rotational grazing had higher activity on site 1 (Emerald-vertosol).

Table 1: Study sites for ecosystem assessment

Site	Location	AAR (mm)	Soil	Vegetation	Stocking rate (ha/AE/year)	
					conventional	cell
1.	Emerald, Qld	670	Vertosol	bloodwood, Qld bluegrass	4.0	1.7
2.	Emerald, Qld	670	Kandosol	ironbark, buffel grass	6.4	12.8
3.	Wandoan, Qld	490	Vertosol	brigalow, Qld bluegrass	4.3	1.7
4.	Moree, NSW	590	Vertosol	poplar box, Qld bluegrass	4.0	1.0
5.	Katherine, NT	660	Vertosol	savanna, Mitchell grass	8.3	5.5

Table 2: Landscape Function Analysis data for the Emerald and Wandoan sites

Site	Grazing system	Patches[1] (no./10 m)	Patch area Index[2]	Indices (%)[3]		
				Stability	Infiltration	Nutrients
1.	Rotational	2.9	0.04	53	33	23
	Cell	5.1	0.12	58	33	26
2.	Rotational	2.6	0.03	51	27	21
	Cell	2.9	0.06	51	30	26
3.	Continuous	10.0	-	35	37	31
	Cell	22.0	-	59	57	54

[1]patches are grasses, etc that increase infiltration; measured in no's/10 m of transect length.
[2]index = actual area/potential area of patches; measured on 10 m wide belt transect.
[3]indices relate to ranking and summation of contributing factors expressed as % of potential maximum

Table 3: Soil Properties for the Emerald, Wandoan and Moree sites

Site	Grazing	Bulk density (0-10 cm) (g/cm^3)	Microbial activity (0-10 cm) (g cellulose used)
1.	Rotational	1.68	0.04
	Cell	1.54	0.02
2.	Rotational	1.47[a]	0.01
	Cell	1.53[a]	0.21
3.	Continuous	-	12.14[1]
	Cell	-	9.29[1]
4.	Continuous	1.44	-
	Cell	1.22	-

[a]Figures with same letters not significantly different; [1]Tensile strength of a cotton strip

Table 4 shows the pasture data for the different grazing systems on four sites. Plant density was higher under cell grazing except for the Emerald/Qld bluegrass site. Other data showed a 50% increase in the frequency of *Rhynchosia minima* for cell grazing on the same site. On the Moree site (4), other data showed that selective grazing was clearly evident in both grazing systems.

Biological Soil Crusts (BSC)

Cyanobacteria were the main BSC component recorded at any site. The nitrogen-fixing Microcoleus spp. were present under both grazing systems at both the Emerald sites. The cyanobacteria

Table 4: Perennial grass density for the Emerald and Wandoan sites

Site	Grazing	Perennial grass density (no./m^2)
1.	Rotational	3.0
	Cell	2.0
2.	Rotational	2.6
	Cell	3.3
3.	Continuous	12.1
	Cell	21.6

Chroococcales and Oscillatoriales were present only on the cell grazed kandosol site. These particular cyanobacteria may precede *Microcoleus* as early colonisers. The importance of their presence on only the cell grazed kandosol site and not on the rotationally grazed kandosol site, nor on either grazing system for the vertosol sites is uncertain - more research is required to clarify this. BSC were present under cell grazing but not under conventional grazing on Site 3 (Wandoan). At Site 5 (Katherine), well developed cyanobacteria-dominated soil crusts were present (Table 5) and these are the first records of its existence for this region (Victoria River Downs [VRD]). Three species are nitrogen-fixing in grazing ecosystems and, although it is uncertain if the other two species present can fix nitrogen, all cyanobacteria contribute to soil nutrients. There was a clear gradient of increasing presence/abundance of cyanobacteria away from the watering points under both grazing systems with the presence of cyanobacteria being very limited until distances >100-200 m out from the water. Overall, the continuous grazing system supported better developed cyanobacterial soil crusts closer to water compared to cell grazing. The reason for this is not evident and definitive conclusions cannot be drawn from one site. (It was reported that there were difficulties in the management of the cell grazing site (Symes, 2007) and this may have confounded the data).

Table 4: Cyanobacteria distribution under continuous and cell grazing on the VRD

BSC (cyanobacteria)	Grazing	Distance from water (m)									
		0	20	50	100	200	500	1000	1500	2000	3000
Cover (%)	Ungrazed	30									
	Continu's	<1	<1	<1	<1	5	10	>50	>50	>50	40
	Cell	<1	<1	<1	<1	<1	<1	20	>50	-	-
Abundance											
Scytonema[1]	Ungrazed	uncommon	uncommon	uncommon	uncommon	uncommon	uncommon	uncommon	uncommon	uncommon	uncommon
	Continu's	absent	absent	absent	absent	common	common	common	abundant	abundant	abundant
	Cell	uncommon	uncommon	absent	uncommon	absent	absent	common	common	-	-
Porphyrosiphon[2]	Ungrazed	abundant	abundant	abundant	abundant	abundant	abundant	abundant	abundant	abundant	abundant
	Continu's	absent	absent	uncommon	uncommon	common	abundant	abundant	abundant	common	absent
	Cell	absent	absent	uncommon	uncommon	absent	absent	abundant	abundant	-	-
Nostoc[1]	Ungrazed	common	common	common	common	common	common	common	common	common	common
	Continu's	uncommon	uncommon	uncommon	uncommon	uncommon	common	abundant	abundant	common	common
	Cell	absent	uncommon	uncommon	uncommon	uncommon	uncommon	uncommon	common	-	-
Microcoleus[1]	Ungrazed	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
	Continu's	absent	absent	absent	absent	common	common	common	abundant	abundant	abundant
	Cell	absent	uncommon	uncommon	uncommon	common	uncommon	abundant	abundant	-	-
Phormidium[2]	Ungrazed	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
	Continu's	absent	absent	absent	absent	absent	absent	absent	absent	common	abundant
	Cell	absent	absent	absent	absent	absent	absent	common	common	-	-

Key: absent (white), uncommon (light grey), Common (mid grey), abundant (dark grey)

[1]known to be nitrogen-fixing; [2]nitrogen-fixing capacity uncertain

DISCUSSION ANDCONCLUSIONS

The results indicate that, under a well-managed grazing enterprise and in a range of environments, a number of ecosystem parameters performed at a higher level under cell grazing compared to continuous or rotational grazing. The preliminary work on BSC suggests that different grazing systems may influence the cyanobacteria species presence, distribution and abundance. Current work includes a wider range of environments and includes a focus on whether the rest-graze periods under cell grazing can enhance the activity of biological soil crusts, particularly the nitrogen-fixing cyanobacteria. The latter may be a vital source of nitrogen in many rangeland ecosystems. It is anticipated that further results may provide additional guidelines for grazing management to enhance ecosystem functioning and consequent sustainable livestock productivity - this relates particularly to critical timing and periods of resting and grazing. These guidelines could apply to different grazing systems under 'adaptive grazing management'.

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