Water instead of wire

Managing grazing by alternating waterpoints on the Barkly Tablelands, Northern Territory

Ken Scott[1], Harmony James[1], Suzanne Kearins[2] and Robyn Cowley[1]

[1]Northern Territory Government Department of Resources

[2]Australian Agricultural Company

Contact email: robyn.cowley@nt.gov.au

2010

This study was funded by Meat and Livestock Australia through the Producer Initiated Research & Development program (Project number: S2004/NT01).

mla MEAT & LIVESTOCK AUSTRALIA

Acknowledgements

Many people contributed to this project throughout its various activities. The authors wish to thank the Australian Agricultural Company and the previous managers of Rockhampton Downs (Jamie and Anne Robertson, and Ben and Heidi Wratten) for having the vision to establish the trial and the dedication to keep it going. Ellena Hannah and Suzie Kearins provided significant contributions to the design of the trial. For their long hours in the field and management of the project, we sincerely thank Chris Materne, Andy Bubb, Ruth Allan, Sarah Streeter, Jenny Purdie and Genevieve Nash. Neil MacDonald, Andy Bubb, Mark Hearnden and Sarah Streeter provided detailed comments on a previous draft. Tim Schatz wrote a draft of the animal production section and also reviewed a draft of the report. Mark Hearnden provided statistical guidance. Tracey May compiled Fig. 1. Thank you.

Executive summary

Background

As an alternative to traditional continuous stocking regimes, other grazing systems such as rotational grazing may provide an opportunity to increase production whilst also maintaining (or improving) rangeland condition. This study reports on a three-year, innovative rotational grazing trial conducted on Rockhampton Downs Station in the Barkly Tablelands region of the Northern Territory. Rather than the development of new fences to create multiple paddocks, cattle were rotated around a paddock by controlling the availability of water at each of several new and existing waterpoints. The central concept of the strategy involved having only one waterpoint operational at any given time.

Objective

The objective of the study was to determine the feasibility of such a rotational grazing regime facilitated by water availability in a commercial environment, through a consideration of pasture composition and yield, animal production, animal behaviour, labour requirements, and the general practicality of implementing such a system.

Results

The trial was completed successfully and thus demonstrates that such a rotational grazing system can indeed be implemented on commercial beef cattle properties. This represents a substantial mind-shift away from a continuous set-stocked regime traditionally employed throughout northern Australia. The principal findings of the study are presented below.

1. Infrastructure development, labour costs and management of cattle present challenges to such a strategy initially. Cattle behaviour was difficult to manage, particularly in the first two years. Cattle would often congregate at dry waterpoints, so frequent observation and intervention was required, making the trial very labour intensive. Over time though, managers devised a procedure whereby the next waterpoint was turned on, and the current waterpoint turned off, on the day prior to moving the cattle. This significantly reduced the labour required to implement the system. Managers used the rotational grazing system to have cattle closer to the yards at mustering times, thereby saving a significant amount of time and money. These cost savings, achieved through more efficient management, will help to offset the initial capital investment.

2. Infrastructure development (installation of new waterpoints) increased carrying capacity by increasing the watered area of the paddock. Higher stocking rates could be achieved in areas traditionally ungrazed (by virtue of their higher yield), but this bonus will be reduced over time if not managed in a sustainable manner.

3. Land condition (measured by species composition, yield and cover) associated with new waterpoints in the rotational grazing paddock appeared to follow a trajectory of degradation towards that shown around old waterpoints with a long history of continuous stocking.

4. The previously ungrazed pasture showed some initial resistance to grazing

effects following the introduction of rotational grazing although there were some signs of degradation over time. There was no significant reduction in total species richness during the three year trial, and the abundance of the dominant perennial Mitchell grasses was stable except for immediately adjacent the water points.

5. The rotational grazing strategy did not improve the existing land condition of old waterpoints during the period of the study.

6. The design and implementation of the trial (and problems with data quality) meant we were unable to reliably assess differences in animal production (individual liveweight gain and breeder performance) between the grazing systems.

7. At its completion, the trial gave station managers a better understanding of the possibilities of manipulating pasture utilisation and they expressed interest in applying that knowledge to future grazing management strategies.

Contents

Contents

1.0 Introduction

1.1 Background

A regime of continuous grazing dominates the extensive rangelands of northern Australia, whereby a constant number of beef cattle are placed within large paddocks for the entire year (e.g. Oxley *et al.* 2006). The grazing distribution patterns of cattle within those paddocks are not uniform, being influenced by factors such as animal behaviour, land type, pasture quality and quantity, and water availability (Tomkins *et al.* 2009, Hunt *et al.* 2007). As the daily water requirement for cattle is high (around 40-80 L per day, depending on the class of animal and season), cattle need to regularly return to water to drink. This results in a zone of concentrated activity around the waterpoint, with decreasing grazing pressure as the distance from the waterpoint increases (known as a *piosphere*; Lange 1969, Andrew 1988; Landsberg *et al.* 2003; Hunt *et al.* 2007).

Piospheres are evident in a range of parameters used to measure rangeland condition and biodiversity. For example, trampling by cattle in areas of high cattle activity can result in compacted soils with decreased infiltration (Andrew and Lange 1986b; Warren *et al.* 1986; Greenwood and McKenzie 2001), and increases in sediment and nutrient loss (O'Reagain *et al.* 2005; Bartley *et al.* 2006). The composition of ant and vertebrate fauna (particularly abundance rather than richness) has been shown to differ according to grazing intensity (distance to water; Hoffmann 1999; James *et al.* 1999; Fisher 2001). For plants, high grazing pressure is generally associated with a lower frequency and cover of palatable plants, perennial grasses, and the dominance of annual grasses (Andrew and Lange 1986a; Fensham and Skull 1999; Fisher 2001). Differences in composition can be attributed to differences between species in their palatability to cattle and ability to tolerate or avoid grazing, season of grazing, and extent of defoliation (Andrew 1986; Ash and McIvor 1998; James *et al*. 1999).

In addition to the impacts of grazing distribution on rangeland condition and biodiversity, the congregation of cattle around waterpoints results in sub-optimal use of the paddock, as areas a long distance from water (more than about 5 km) are only lightly grazed (Fisher 2001, Tomkins *et al.* 2008). This acknowledgement of sub-optimal production has been driving an effort to intensify northern Australian beef cattle operations. One of the most effective and widely implemented ways of increasing production is through the development of infrastructure, particularly the subdivision of large paddocks into more manageable areas, and the installation of new waterpoints (Bubb 2006; Bortolussi *et al.* 2005; Hunt *et al.* 2007).

As an alternative to the traditional continuous stocking regime, other grazing systems such as rotational and spell grazing may provide an opportunity to increase production and manage for climatic variability, whilst also maintaining (or even improving) rangeland condition (O'Reagain *et al.* 2009). These alternative grazing strategies have historically involved the development of a number of paddocks (e.g. 3-40) through the installation of additional, internal fencing. Cattle are rotated around the paddocks on a regular basis, although the rotations may be abandoned during the wet season when access is restricted and surface water is freely available.

Despite assertions by proponents of rotational grazing systems that intensive rotational grazing systems provide better production and natural resource management outcomes, when scientifically assessed, the vast majority of rotational grazing systems have demonstrated equal or lower plant and animal production compared to continuous grazing (Gammon 1978; Holechek *et al.* 1999; Briske *et al.* 2008). In general, there appears to be no major advantage of rotational grazing systems *per se*. Any difference in animal or plant production between a rotational and continuous grazing system is likely to reflect differences in stocking rates and spelling regimes between treatments (Heitschmidt *et al.* 1987; Heitschmidt *et al.* 1990; Ash and Stafford-Smith 1996; O'Reagain *et al.* 2009).

This study reports the findings of a three-year rotational grazing trial conducted on the Barkly Tablelands in the Northern Territory (NT). Rather than the development of new fences to create multiple paddocks, cattle were rotated around a paddock by controlling the availability of water at each of several new and existing waterpoints. The central concept of the strategy involved having only one waterpoint operational at any given time.

1.2 Project objective

The objective of this study was to determine the feasibility and impact of an alternate waters rotational grazing system in a commercial environment. Its impact was determined by assessing changes to pasture composition, yield, and animal production, while feasibility was assessed through a consideration of labour requirements, and the general practicality of implementing the system.

1.3 Producers' expectations

Producers expected this system to be cheaper than other rotational grazing strategies, because it required less fencing and lower labour costs (associated with moving cattle).

Station managers previously noted the resilience and good condition of pastures within holding paddocks when stocked heavily every year for short periods. Based on these experiences, producers expected the alternate waters rotational grazing trial to show:

- No improvement in land condition with continuous grazing,
- Improvement in land condition with the implementation of rotational grazing (in areas with a long history of continuous grazing), and
- No immediate decline in land condition following the introduction of rotational grazing in areas of the paddock traditionally ‘ungrazed’.

2.0 Methods

2.1 Site description

2.1.1 Location

The alternate waters rotational grazing trial was developed as a Producer-Initiated Demonstration (PIRD) Site on the Rockhampton Downs Pastoral Lease, approximately 100 km northeast of Tennant Creek in the Barkly Region of the Northern Territory (18.58° 29' S, 135.3° 43.6' E; Fig. 1).

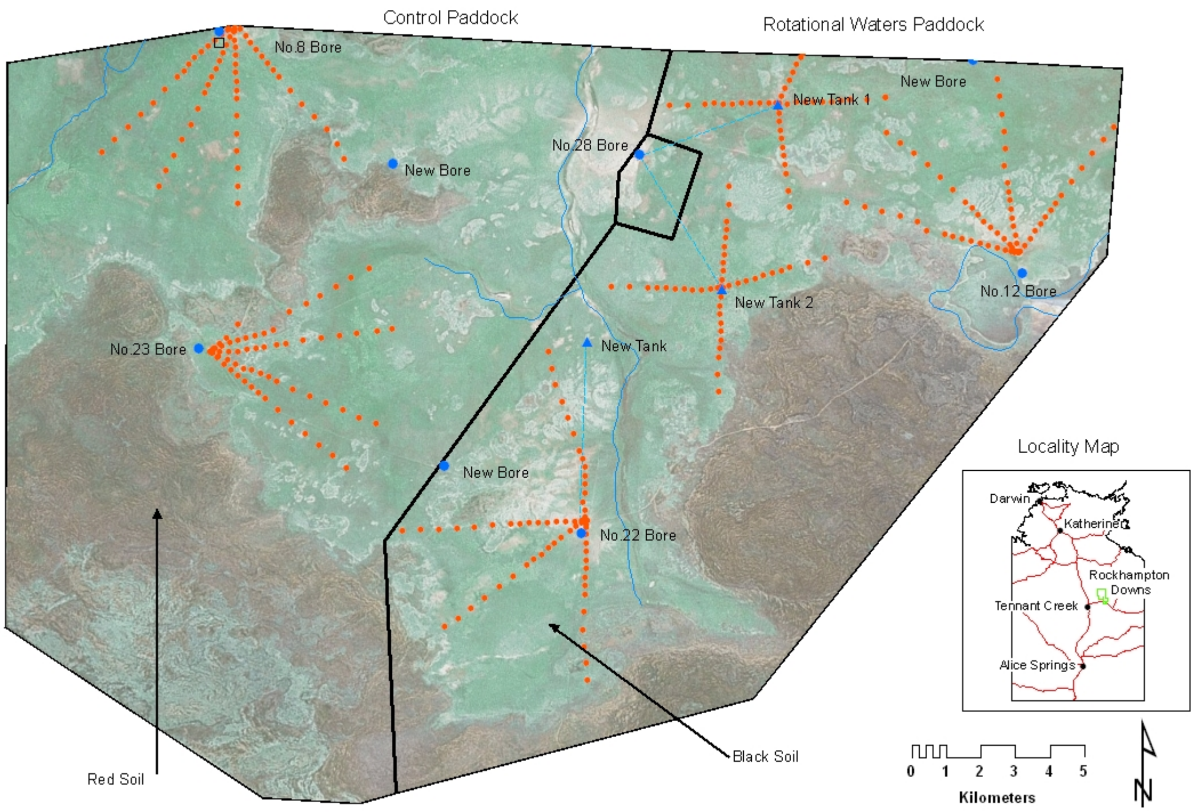


Fig. 1. The location of Rockhampton Downs where the alternate waters rotational grazing trial was conducted (inset), and soil types, infrastructure and the location of replicate quadrats (radiating dots) used for pasture sampling. Stock could access water from No. 8 Bore, No. 23 Bore and No. 28 Bore in the control paddock, and No 22 Bore, No. 12 Bore and the three New Tanks in the rotational grazing paddock.

2.1.2 Land systems

The trial was conducted in the Barkly (B2) land system (Christian *et al*. 1954), defined by a very gently undulating terrain and heavy grey pedocal soils with a covering of chert pebbles on the surface (Fig. 2). Vegetation was an *Astrebla pectinata* grassland, with the grass species *Astrebla elymoides*, *Astrebla squarrosa*, *Iseilema spp*., *Aristida latifolia*, and *Eulalia aurea* also common (see also Section 3.4.1). *Astrebla spp.* contributed on average 62% of the total yield.

Fig. 2. Typical vegetation of the trial site, showing the Barkly (B2) land system defined by a very gently undulating terrain and heavy grey pedocal soils. The pasture is dominated by *Astrebla pectinata*, *Astrebla elymoides*, *Astrebla squarrosa*, *Iseilema* spp., *Aristida latifolia*, and *Eulalia aurea*. This photograph was taken in March 2009 after above-average rainfall in the preceding months.

2.1.3 Climate and rainfall

Mean and median annual rainfall at Brunette Downs (approximately 100 km east of the site; 18.64° S, 135.95° E) is 415 mm and 373 mm respectively. Inter-annual rainfall variation is high, as is intra-annual variation with approximately 90% falling in the summer wet season months between November and April. Mean daily evaporation ranges between 5.7 mm in June and 10.6 mm in both October and November. Mean ambient temperatures range between 10.5 and 26.7° in July (mid-winter) and 24.5 and 37.2° in January (mid-summer).

Rainfall at Rockhampton Downs during the trial (2003-2007) reflected the seasonal variation described above. For the 12 months to June, rainfall at Rockhampton Downs was above the long term average (at Brunette Downs) in

2003-2004 and 2005-2006, but below the long term average in 2004-2005 and 2006-2007 (Fig. 3).

2.2 Experimental design

An existing paddock (538 km^2) was subdivided to create a control ("Number 8 paddock", 278 km^2) and treatment paddock ("Number 12 paddock", 253 km^2; Table 1 and Fig. 1). The control paddock employed a continuous grazing system (previously used at the site), while the treatment paddock employed the alternate waters rotational grazing system being tested. Three existing water-points were located inside the control paddock, whereas the treatment paddock utilised a network of both existing waterpoints and new 30 000 gallon (113,600 L) tanks with water troughs to which water was directed (5 waterpoints in total; Table 1). The central concept of the alternate waters rotational grazing strategy in the treatment paddock involved having only one waterpoint operational at any given time.

Cattle were moved by staff to new waterpoints every six weeks (approximately), generally in an anticlockwise direction. Intensive supervision was required to achieve the desired rotational policy. In the wet season, however, all bores were turned off following the first substantial rains that provided surface water. Cattle were then reliant on surface water and 2 semi-permanent dams south of No. 12 and No. 22 bores. Once surface waters had dried up, troughs were reactivated. In this way all water points in the rotational grazing treatment and much of the associated black soil areas were effectively spelled for up to 3 months during the wet season. During this time cattle tended to use the red soil areas to the south and east of the paddock (Ben Wratten, pers. observation).

In May 2004, 811 pregnancy-tested-in-calf (PTIC) Santa Gertrudis heifers (mean weight of 374.9 kg; age approximately 2.5 years) were placed in the control paddock, and 832 were placed in the treatment paddock (mean weight of 375.3 kg). One hundred heifers in each paddock were individually identified with ear tags and the performance of these tagged heifers was recorded throughout the trial. Mating was continuous and calves were weaned at musters in May and September. In May each year the weight, pregnancy status and lactation status of the tagged animals was recorded.

Fig. 3. Monthly rainfall totals at Rockhampton Downs recorded during the alternate waters rotational grazing trial, and the long-term median monthly rainfall measured at Brunette Downs, approximately 100 km northeast of the site. Inserted numbers are the wet season rainfall totals (July-June; mm) at Rockhampton Downs. At Brunette Downs, the mean annual rainfall is 415 mm and median annual rainfall is 373 mm.

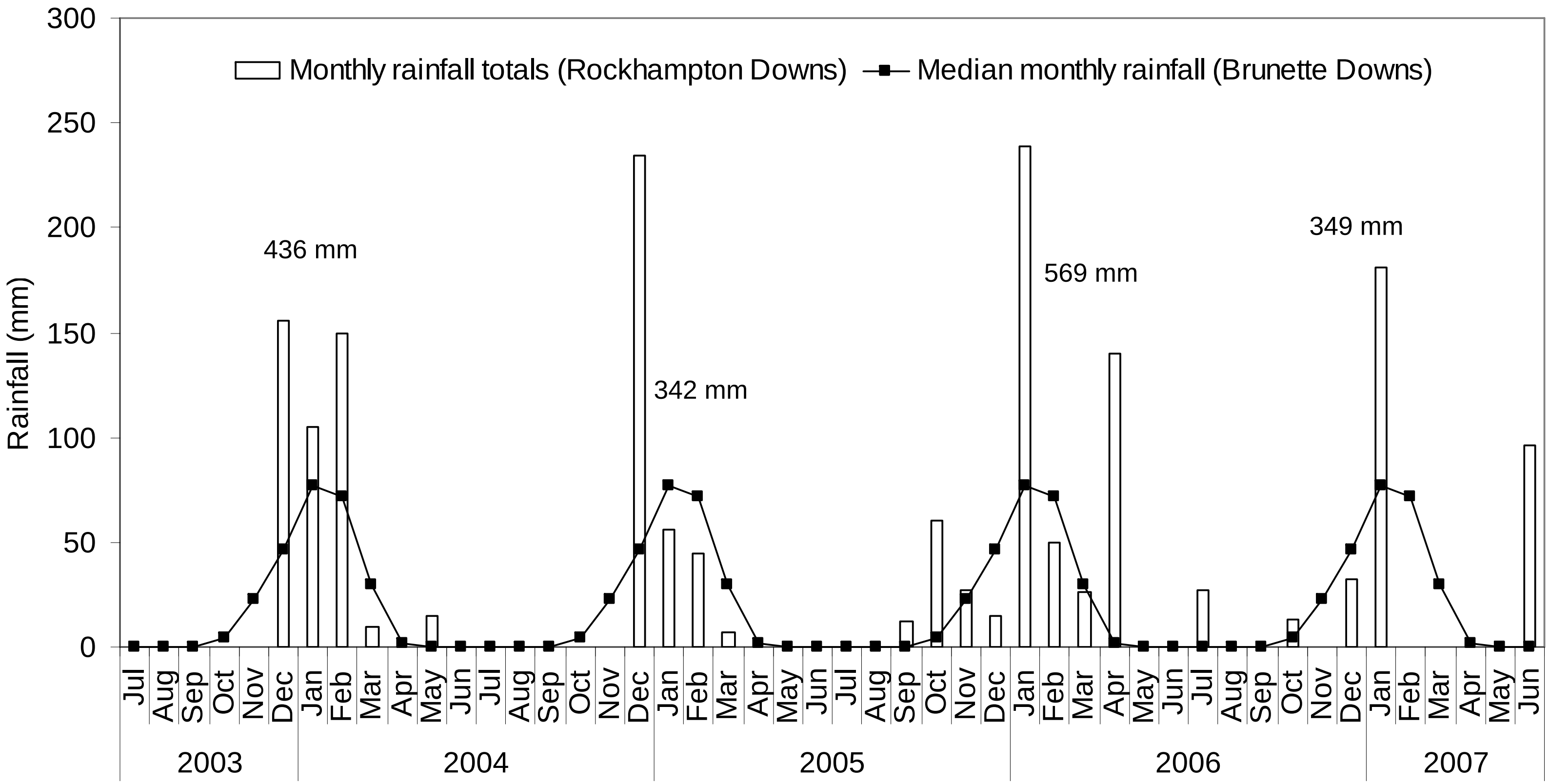


Table 1. Size, paddock infrastructure and watered area for paddocks in the alternate waters rotational grazing trial conducted at Rockhampton Downs. †Includes No. 28 holding paddock

	Paddock		
	Original	Control	Treatment
Size (km^2)	537.6†	279.6	253.2
Number of waterpoints	5	3	5
Watered area < 3 km from waterpoint. (km^2) (%)	121.5 (22.6%)	55.6 (19.8%)	117.3 (46.3%)
Watered area < 5 km from waterpoint. (km^2) (%)	314.7 (58.5%)	146.5 (52.4%)	201.9 (79.7%)

2.3 Data sampling

2.3.1 Pasture composition

The species composition of pasture at the site was recorded in the early (April-May) and late (October) dry season throughout the trial (2004-2006 inclusive; except the late dry season in 2005) using the BOTANAL technique (Tothill *et al*. 1992), to quantify changes in pasture composition and condition. At two (control paddock) or four (treatment paddock) waterpoints, four permanent transects were established, radiating away from the waterpoint, as shown in Fig. 1. The direction of transects were intended to follow four cardinal points of a compass (N, E, S, W), although were adjusted as necessary to ensure all quadrats were located on black soil (for the purpose of achieving uniformity of soil type). In the treatment paddock, two of the waterpoints sampled were the existing waterpoints, and the remaining two waterpoints were those newly established for the trial (both waterpoints in the control paddock were existing bores). On each transect, pasture was sampled in six 2 × 2 m (4 m^2) quadrats, at 50 m, 250 m, 500 m, 750 m, 1000 m, 1250 m, 1500 m, 1750 m, 2000 m, 2500 m and 3000 m from the waterpoint. At the existing waterpoints in the control paddock, additional sampling occurred at 3500 m, 4000 m, 4500 m and 5000 m from the waterpoint.

In each quadrat, the following data were recorded: grazing activity score (6-point scale based on cattle activity and pasture utilisation), ground cover (%), amount of rank grass (%, defined as “any attached plant material that has died and turned grey in colour due to the onset of the decaying process once being re-wet”, Materne 2006) and the presence and dry matter yield of each species (estimated kg DM / ha). Species were categorised as palatable or unpalatable, determined by consulting the literature. Yield estimates were calibrated by estimating and subsequently harvesting calibration quadrats. Two 2 x 2m calibration quadrats were estimated and cut each day to give a total of 10 to 12 quadrats each sampling period. A regression equation between observer yield estimates and actual yield for the sample period was calculated for each observer's estimates. This regression equation was then applied to the observer's estimates of yield to correct the initial quadrat yield estimate for observer bias.

2.3.2 Animal production

Animal production parameters (at the first round muster in May) were quantified annually between 2004 and 2006 (inclusive). Data collected included breeder weight, weaner weight, pregnancy status and foetal age, and lactation status (determined visually, by several operators, although breeders were not 'hand stripped' for confirmation).

2.4 Data analysis

Stocking rates, utilisation rates and short term carrying capacity were calculated for a whole paddock basis, as well as for the watered area with a 3 km and 5 km grazing radius assumption, as GPS collar data found that most grazing occurred within 4 km from water (Tomkins *et al.* 2008).

2.4.1 Stocking rates

The paddocks were stocked with breeders and bulls, and associated calves. Stocking rates for the trial paddocks were estimated from the number of breeders (cows and heifers) and an assumed number of bulls (number of bulls as a percentage of breeders = 3% (based on Bubb 2006)). Numbers of head (breeders and bulls) were converted to adult equivalents (AEs; 1 bull = 1.5 AEs, and breeder AEs were calculated based on their average weight and reproductive status (taken from monitored herd records) and expressed as AEs / km^2 for each paddock, using adult equivalent conversion factors (MLA 2004). Stocking rates were calculated for the entire paddock area and also for the watered area of each paddock (assuming cattle only grazed within 5 and 3 km from the permanent waters) (see Table 1), with all water points in the treatment paddock included in the watered area calculations at any given time.

2.4.2 Carrying Capacity

Short term carrying capacity was calculated as the number of AE/km^2 required to consume the amount of forage present at the start of the dry season (May), to achieve 20% utilisation, assuming an intake of 8kg / AE / day.

2.4.3 Utilisation

An estimate of the pasture utilisation rate (the percent of annual pasture growth that is consumed by cattle) was calculated in each season of the trial using the estimated stocking rates and pasture yield in May. Forage demand was assumed to be 8 kg DM / AE / day. Estimated pasture growth was calculated as the estimated intake over the wet season (kgDM) plus the total standing dry matter in May (kgDM). The date of the start of the wet season (growth period) was considered to be the 15th day of the month where total monthly rainfall exceeded 100 mm, as daily rainfall data were unavailable. Stock numbers are unavailable for between the start of the first wet season (December 2003) and sampling in May 2004. It was assumed that the stocking rate in this period was the same as later that year (between May 2004 and the start of the wet season in December 2004).

2.4.4 Pasture composition

Species richness (number of plant species), ground cover (%), total yield (kg DM / ha), rank material (%), and species abundance (frequency of occurrence in a cluster of 24 quadrats, at a given distance from a particular waterpoint) were interpreted graphically. For species abundance, two groups were chosen as 'indicator' species which represent contrasting responses to grazing pressure: *Astrebla spp.* (Mitchell Grasses) and *Brachyachne convergens* (Native Couch). *Astrebla spp.* are palatable perennials that decrease in abundance in response to grazing pressure, and *B. convergens* is a moderately palatable annual that increases in abundance with increasing grazing pressure (Partridge 1996).

Statistical analysis was performed on key parameters using analysis of variance (ANOVA) or the non-parametric Kruskal-Wallis ANOVA by Ranks. Data were log (x+1) transformed where necessary to satisfy the ANOVA assumption of normality. Transects (grazing score, cover, yield, rank material) or waterpoints (species richness) were used as pseudo-replicates. In all cases, values were compared between treatments (control paddock vs. treatment paddock old waterpoints vs. treatment paddock new waterpoints) for each year separately (seasons pooled, or the May / early dry season sampling period only) and at a given (usually 50 m) distance from the waterpoint.

2.4.5 Animal production

Mean weight, weight change (2004-2005 and 2005-2006), percentage calf loss and re-conception rate are presented for the first round (May) musters of 2005 and 2006. Lactation status is presented with an adjusted lactation status, where all heifers that lost more than 50 kg in one year were deemed to be wet (if not otherwise recorded). Animals without a complete data set were excluded from the analysis.

3.0 Results and Discussion

3.1 Stocking rates

The number of breeders (heifers or cows) increased (by 36-40% for the control and treatment paddocks respectively) as the trial progressed (Table 2). Whilst dry cows were removed from the trial, they did not outnumber additions to the trial. The number of breeders (and therefore estimated number of bulls) was relatively similar between the control and trial paddock. But the number of head per water point was 1.5 times higher in the control paddock (270 – 369 hd / wpt) than in the treatment paddock (166 – 233 hd / wpt).

Table 2. Number of breeders (heifers or cows) in each year of the alternate waters rotational grazing trial conducted at Rockhampton Downs. Only the number of breeders is known with some certainty and presented here; see text for assumptions underlying the numbers of other stock classes in the calculation of stocking rates.

Year	Control paddock	Treatment paddock
2004 (start)	811	832
2005 first round muster	902	906
2006 first round muster	1107	1168

The estimated stocking rate increased during the trial in both the treatment paddock (range: 3.5 – 6.5 AE / km^2) and control paddock (range: 3.1 – 5.2 AE / km^2) (figures consider the entire paddock area; Table 3). This was a direct response by management to the perceived benefits of the rotation system, and also a function of these paddocks being used to hold stock from other parts of the drought-affected station in 2006. In all years, the treatment paddock had a slightly higher estimated stocking rate than the control paddock. However, the *effective* stocking rates were much higher in the control paddock when taking into account the watered area of the paddock (3 or 5 km radius), due to fewer waters (3 vs. 5 in the treatment paddock) (Table 3).

Estimated stocking rates were well within the estimated short term carrying capacity of the paddocks assuming cattle had access to the entire paddock, or only grazed within 5 km from water. But if cattle are assumed to have only grazed within 3 km from water, then the stocking rates of the *control* paddock were much higher than the carrying capacity in 2005 and 2006 (Table 3).

Table 3. Estimated average stocking rates (SR) (AEs / km^2) and short term carrying capacity (AEs / km^2) for the whole paddock and the 5 and 3 km watered area, in the treatment and control paddocks. See text for details of assumptions when estimating SR.

Year	Paddock	Estimated Stocking rate (AE/km^2)			Short term carrying capacity (AE/km^2)
		Entire paddock area	5 km watered area	3 km watered area	Entire paddock area
2004	Control	3.1	6.0	15.7	13.3
	Treatment	3.5	4.4	7.6	12.3
2005	Control	3.5	6.7	17.5	9.5
	Treatment	3.9	4.9	8.5	10.1
2006	Control	5.2	10.0	26.3	12.4
	Treatment	6.5	8.2	14.1	13.7

Table 4. Estimated average pasture utilisation rate (%) based on the estimated stocking rates presented in Table 3, for the whole paddock, 3km and 5km watered area . See text for details of assumptions.

Season	Paddock	Entire paddock area	5 km watered area	3 km watered area
2004-2005	Control	4.6	8.6	21.5
	Treatment	5.5	6.8	11.5
2005-2006	Control	7.8	14.6	35.7
	Treatment	8.0	9.9	16.7
2006-2007	Control	7.2	13.5	33.5
	Treatment	8.0	10.0	16.9

3.2 Utilisation Rates

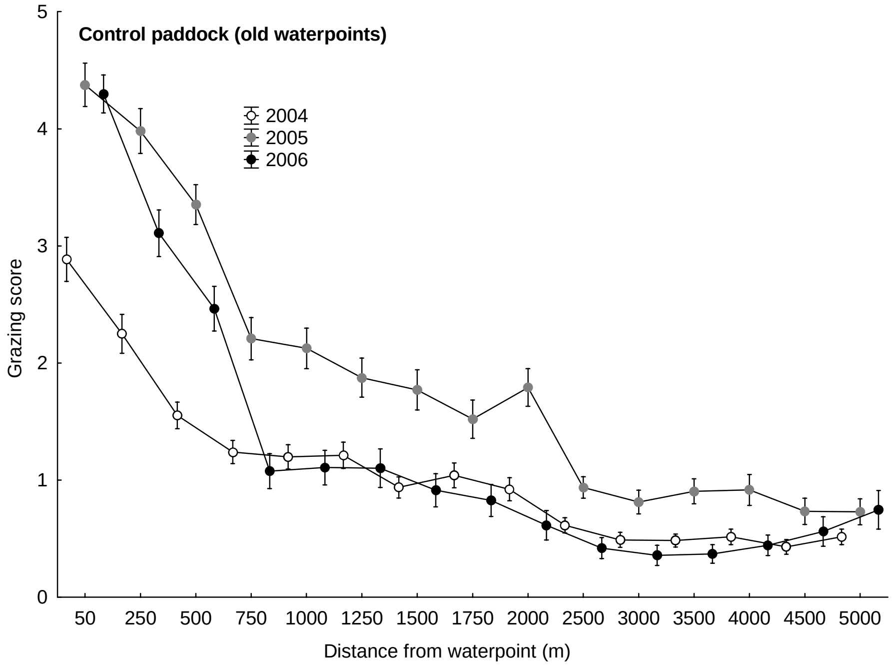
Utilisation rate was lowest in 2004-2005 (Table 4). Over the whole paddock area, the average utilisation rate was very low and similar between treatments ranging between 5-8%. The higher number of water points, and hence greater watered area in the treatment paddock led to lower estimated utilisation rates in the treatment paddock than the control paddock in all seasons of the trial. When taking watered area into account, (assuming cattle only grazed within 3 or 5 km from water), estimated average utilisation rates within the watered area was higher.

If the majority of grazing occurred within 5 km of water, then utilisation rates were within recommended guidelines of 20% for black soil pastures in the NT (Hunt *et al.* 2010 in prep).

If cattle only grazed within 3 km from water, then utilisation rates would have been considerably higher than recommended rates in the control paddock in 2005 and 2006 (Table 4), although up to 30% is recommended for Qld Mitchell grass pastures (e.g. Orr *et al.* 1986) in which case the control paddock utilisation would be close to Qld recommended levels. Although most grazing was found to occur within 3 km from water (Section 3.3), there was still light grazing evident beyond this. Indeed during the wet season cattle used areas quite distant from permanent waters. Hence the actual utilisation rates were probably somewhere between the 3 km and 5 km watered area estimates.

3.3 Grazing activity

In both the control and treatment paddocks, grazing activity (grazing score) was high adjacent to waterpoints, then decreased steadily as distance from waterpoints increased (Fig. 4). At old waterpoints, grazing score tended to attain the minimum value (‘level off’) at c. 3000 m from the waterpoint, suggesting the



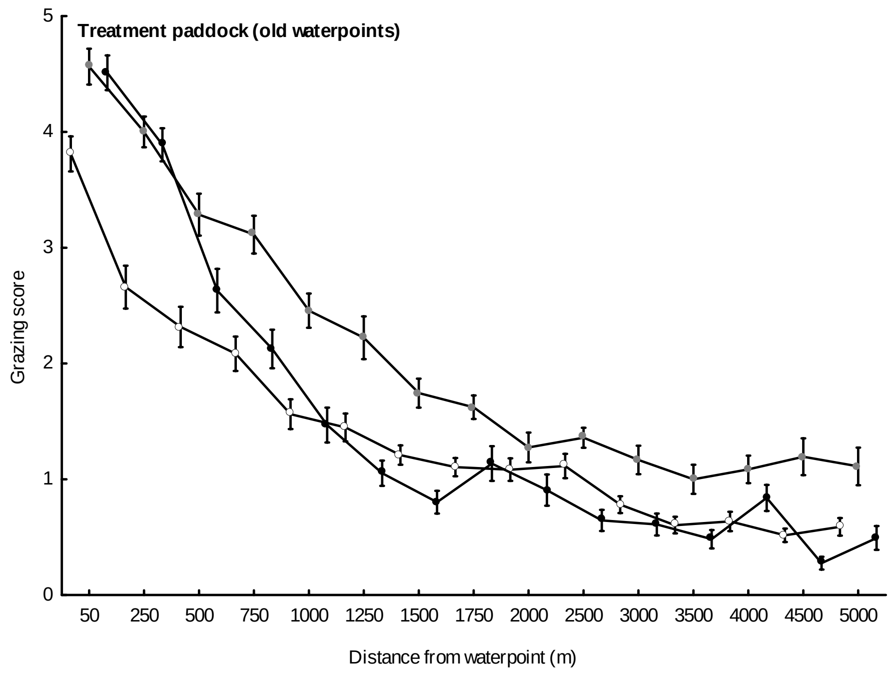


Fig. 4. Grazing score as a measure of cattle activity in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by treatment (data from early and late dry season sampling are pooled). Data are the mean ± 1

SE.

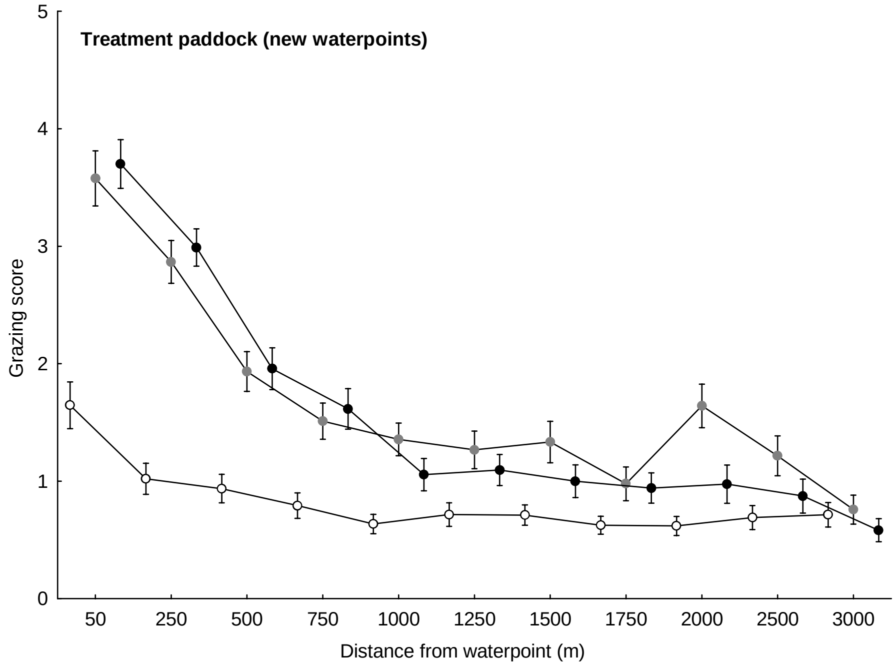


Fig. 4. *continued.*

zone of concentrated cattle activity is within 3 km from water. It was noted that cattle started using vehicle tracks made by vegetation monitoring as cattle pads, which may have influenced grazing scores, but patterns were consistent with previous findings at Rockhampton Downs where cattle activity was highest within 4 km from water (Fisher 2001).

Cattle fitted with GPS collars in a parallel study at the site showed a different use pattern with most animals at either 500 m (camping at water) or 3000-4000 m from water (peak periods of grazing) (Tomkins *et al.* 2008). The difference can be attributed to the timing of the GPS collar study, which only tracked movement in September and October of 2007, when cattle are likely to have already grazed preferred forage closer to water. In contrast, the grazing score in October provides a cumulative grazing index since the beginning of the previous growing season.

All treatments experienced their lowest mean grazing score at the start of the trial, and generally increased as the trial progressed (Fig.4), reflecting the increasing stocking rates during the trial. Grazing score associated with the newly established waterpoints was low in the first year (as expected in areas traditionally ungrazed), but then increased in subsequent years adjacent to waterpoints (50 m), to values similar to those associated with old waterpoints (grazing score of c. 3-4). In 2004, there was a significant difference in grazing score between treatments at 50 m (Kruskal-Wallis ANOVA by ranks, $H_{(2, N=48)} = 11.11$, $P < 0.01$), early and late dry season data pooled), which was not significantly different in subsequent years (Kruskal-Wallis ANOVA by ranks, 2005, $H_{(2, N=22)} = 2.09$, $P > 0.05$; 2006, $H_{(2, N=46)} = 2.30$, $P > 0.05$; early and late dry season data pooled in 2006).

The grazing piosphere that developed at new waterpoints was, however, smaller (shorter distance) than at old waterpoints, 'levelling off' at c. 1000 m. Such a pattern reflects the long history of grazing at old waterpoints, where cattle are forced to walk further from water to find better quality pasture.

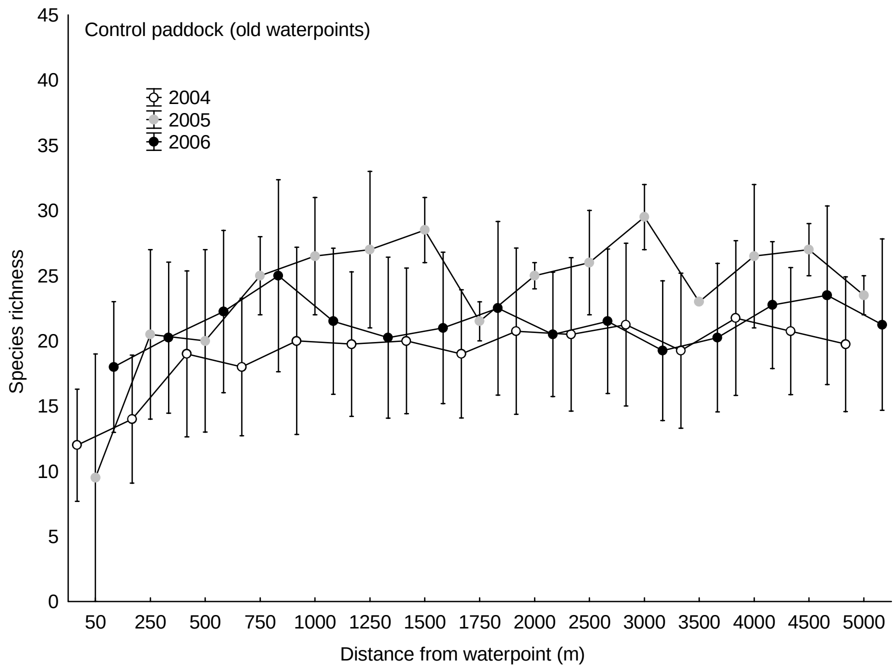
3.4 Pasture dynamics

3.4.1 Species richness

Sampling during the three years recorded a total of 111 herbaceous species at the site, comprising annual and perennial grasses, sedges and forbs (species richness analyses consider May data only). This is similar to total species numbers found previously in sites across the Barkly (between 105-116 depending on distance from water; Fisher 2001). The most common species were the grasses *Iseilema fragile* (Slender Flinders grass; present in 37.2% of quadrats; annual species), *Astrebla pectinata* (Barley Mitchell; 37.1%; perennial), *Aristida latifolia* (Feathertop; 32.4%; perennial), *Astrebla elymoides* (Hoop Mitchell; 26.3%; perennial) and *Iseilema vaginiflorum* (Red Flinders grass; 25.5%; annual). The majority of species (103) were present in all three treatments. This is similar to a north-eastern Australian savanna, where the species richness of native and exotic species was not significantly different between an area grazed by cattle and an area (inside the Great Basalt Wall) that excluded cattle (Fensham and Skull 1999). Conversely, a slight increase in species richness with increasing proximity to water was previously found at Rockhampton Downs (Fisher 2001) and some chenopod shrubland and acacia woodland sites (Landsberg *et al.* 2003).

At a moderate and extended distance from waterpoints (about 750 m and beyond), there was little difference in species richness between the three treatments (Fig. 5). By contrast, species richness adjacent (50 m) to waterpoints was higher at new waterpoints than at older waterpoints. The difference in species richness between treatments was significant at 50 m in 2004 (ANOVA, $F_{(2, 21)} = 12.95$, $P < 0.001$, early dry season data only), but not in 2006 ($F_{(2, 21)} = 0.53$, $P > 0.05$, early dry season data only). However, rather than indicate a reduction in species richness at 50 m over time, the non-significant result in 2006 appeared to be caused by an increase in species richness at old waterpoints in both the control and treatment paddock, from very low values in the previous two years, presumably in response to the exceptional growing conditions that year.

The trend of relatively high species richness close to the new waterpoints remained evident throughout the three-year trial, indicating short-term resistance of the pasture to species loss associated with the introduction of grazing in previously ungrazed areas. The resistance of species loss to grazing in this study reflects the result of Ash and McIvor (1998), where dry season grazing (*cf*. wet season grazing) had no effect on pasture species composition. The wet season spelling of treatment water points may be lending resilience to changes in composition (Andrew 1986; Ash and McIvor 1998).



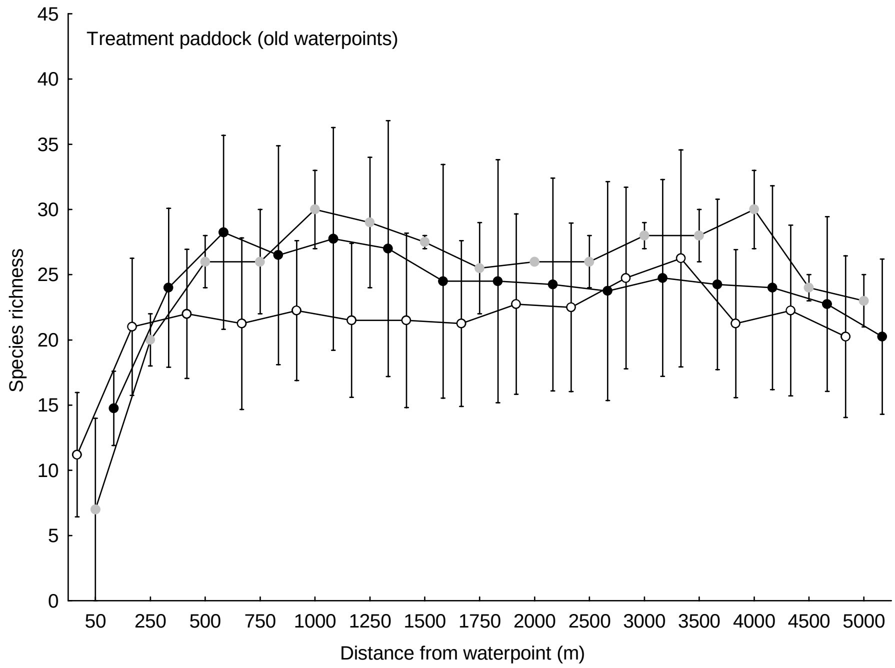


Fig. 5. Species richness (number of pasture species) in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment (data from early dry season sampling only, when annual plants are much more accurately identified). Data are the mean ± 1 SE.

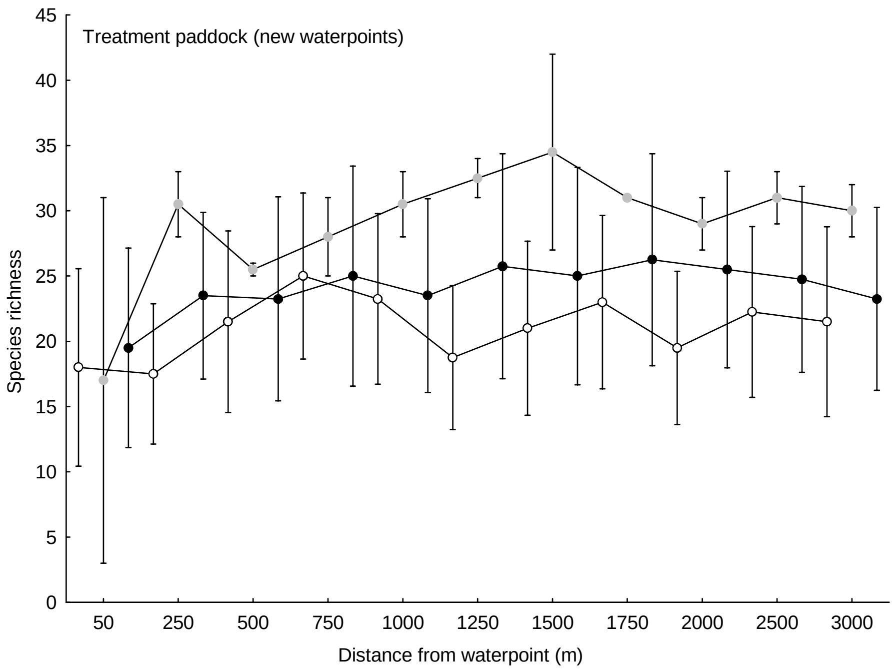


Fig. 5. *continued*.

There was some variation in species richness between years. Evidence elsewhere suggests that rainfall influences the abundance of existing species and species turnover more so than richness (Orr 1981; Foran and Bastin 1984). In the Pigeon Hole trial there was very little variation in species richness over five years, despite moderate fluctuations in rainfall amounts (Hunt *et al.* 2010 in prep.). Therefore in this trial, variation in species richness may have been a result of observer error (different observers were used in different years).

3.4.2 Cover

Total ground cover was strongly influenced by grazing intensity along a distance from water gradient. Cover was lowest adjacent to waterpoints (often < 20%) where cattle congregate and steadily increased as distance away from the waterpoint increased (Fig. 6). These patterns are consistent with cover trends out from waters seen elsewhere in the Mitchell grasslands (Fisher 2001).

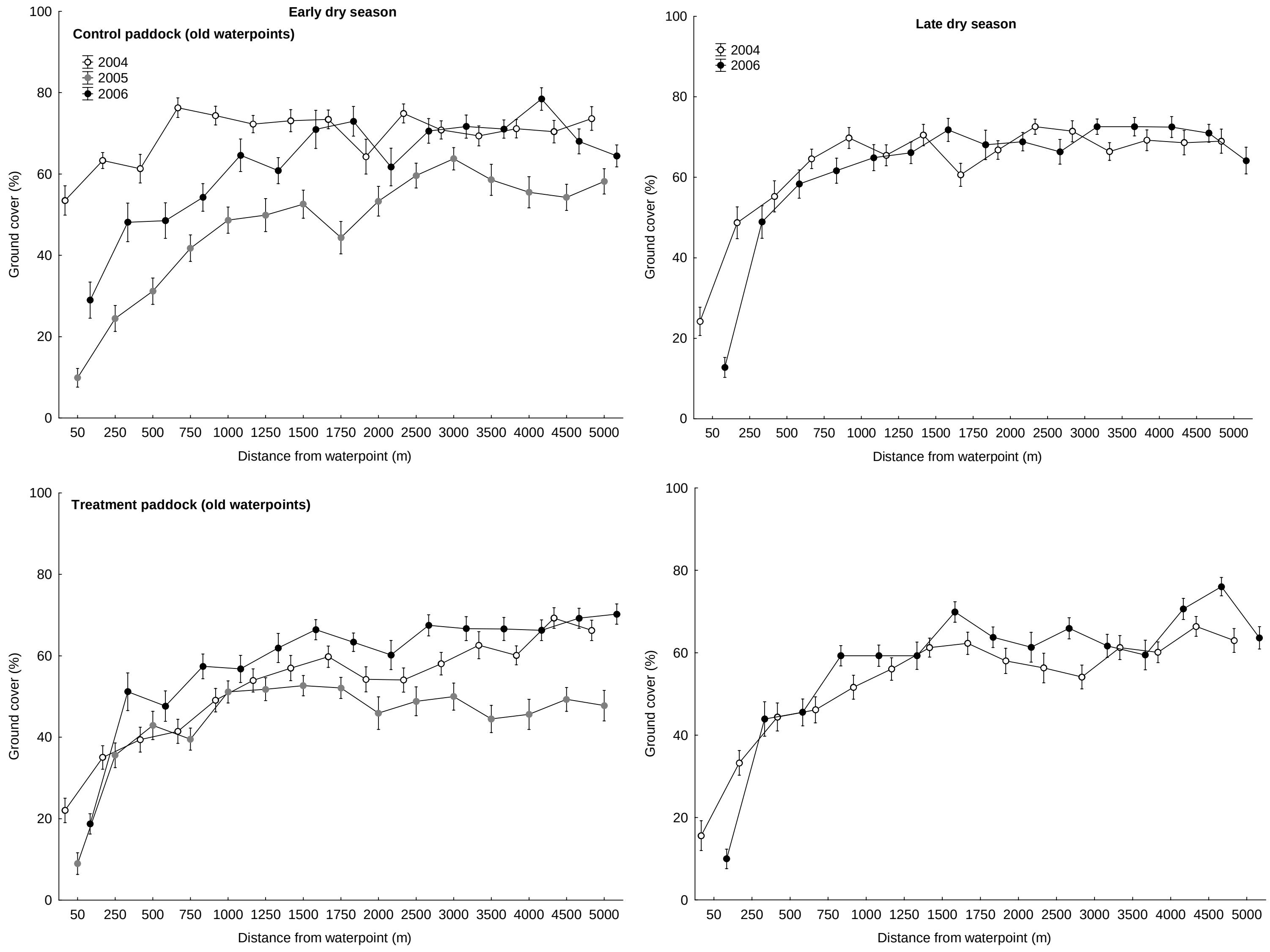


Fig. 6. Total ground cover (%) in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Data are the mean ± 1 SE.

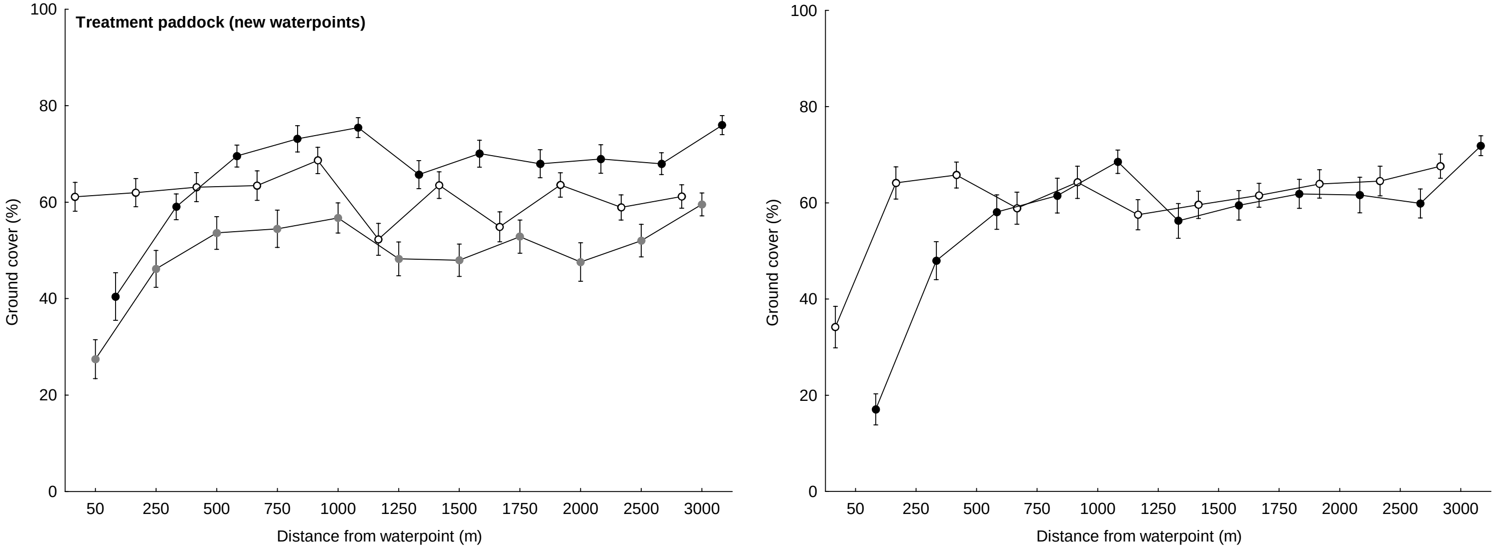


Fig. 6. *continued.*

At new waterpoints (treatment paddock), cover was high (c. 60%) at the beginning of the trial, like that of either paddock where cattle activity was lowest (i.e. 3000-5000 m from water). However, by the end of the first year, rotational grazing reduced cover in the treatment paddock to c. 20-40% within 50 m of the waterpoint, and cover remained at this lower level throughout the trial. There was a significant difference in cover between treatments at 50 m in the first year (ANOVA, $F_{(2,21)} = 10.76$, $P < 0.001$, early dry season data only), but not the second year (Kruskal-Wallis ANOVA by Ranks given non-normality, $H_{(2,\ N=22)} = 4.61$, $P > 0.05$, early dry season data only). The disparate recovery rates between treatments, from the very low cover in 2005, resulted in a significant difference in cover between treatments (at 50 m) in the last year of the trial (ANOVA, $F_{(2,20)} = 4.52$, $P < 0.05$, early dry season data only).

Maximum cover in the paddock tended to be attained further away from old waterpoints (c. 1500 m) compared to the new waterpoints in the treatment paddock (c. 750 m). At old waterpoints, cover showed no increase during the trial under rotational grazing. Rainfall tended to have a stronger effect on cover than grazing management, which is consistent with the results of Foran and Bastin (1984) over a similar time period (5 years). Drier conditions in the 2004-2005 wet season resulted in a decrease in ground cover in 2005 in all treatments, although particularly with continuous stocking in the control paddock. Even above-average rainfall in the wet season of 2005-2006 was unable to restore pre-trial (2004) cover values in the control paddock. Cover was generally highest in the treatment paddock following the high rainfall (2006).

3.4.3 Yield

Total DM yield during the trial showed similar responses to ground cover (there is a high correlation between cover and yield, Foran and Bastin (1984)). A distinct grazing piosphere was evident, with maximum total yield values tending to occur at 500-1500 m (and beyond) from waterpoints, depending on season and treatment (i.e. grazing history; Fig. 7).

At new waterpoints (treatment paddock), yield was high at the beginning of the trial (c. 2000 kg DM / ha; mostly palatable perennials, Appendix 1), like that of old waterpoints in either paddock where cattle activity was lowest (i.e. 3000-5000 m from water). Although a reduction in yield was evident close (50 m) to the new waterpoints in subsequent years with the implementation of rotational grazing (driven by a loss of palatable perennials; Appendix 1), total yield in those areas remained higher than adjacent to old waterpoints (in both paddocks). At 50 m there was a significant difference in yield between treatments in both 2004 (ANOVA, $F_{(2,21)} = 16.09$, $P < 0.001$, early dry season data only) and 2006 (ANOVA, $F_{(2,19)} = 5.94$, $P < 0.01$, early dry season data only), although not in 2005 (ANOVA, $F_{(2,19)} = 3.51$, $P < 0.05$, early dry season data only) where yield was low across all treatments. Pastures studied by Foran and Bastin (1984) at Helen Springs conversely showed inconsistent yield trends with distance to water that may reflect confounding factors like soil type and grazing history. The effect of having high pasture yields of good palatability in the immediate vicinity of new waterpoints decreases the time and distance cattle forage, resulting in lower foraging distances (and therefore lower energy expenditure, Bailey *et al.* 1996).

In the treatment paddock, total yield was generally highest in the last year of the trial (particularly at extended distances from waterpoints), following the highest wet season rainfall in the study. Nevertheless, unpalatable species appeared to contribute most of this increase (there were minimal increases over time for palatable species, Appendices 1 and 2). Drier conditions in the 2004-2005 wet season period (see Fig. 3) resulted in a decrease in total yield (driven by both palatable annuals and perennials; Appendices 1 and 2), particularly with continuous stocking in the control paddock.

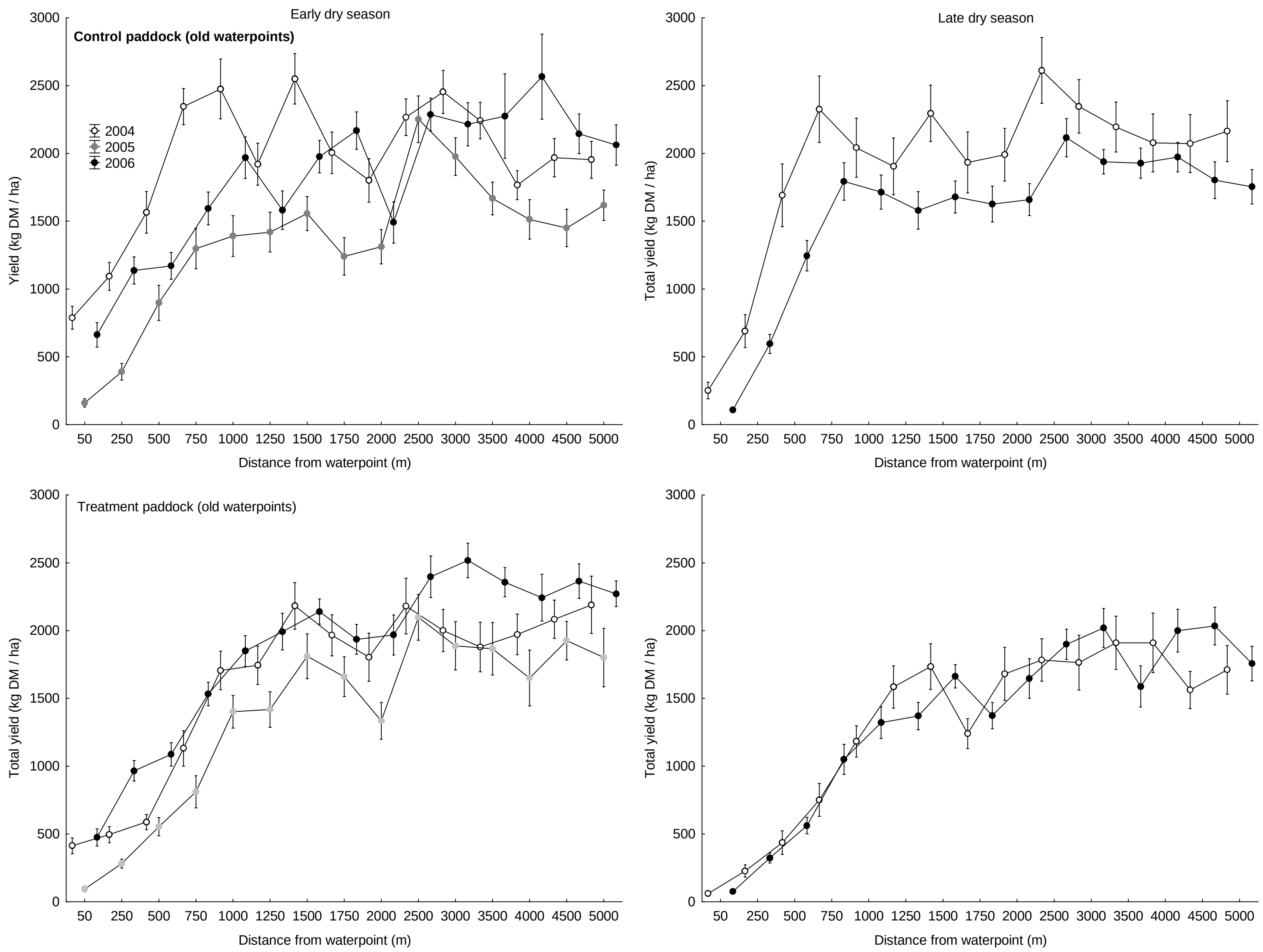
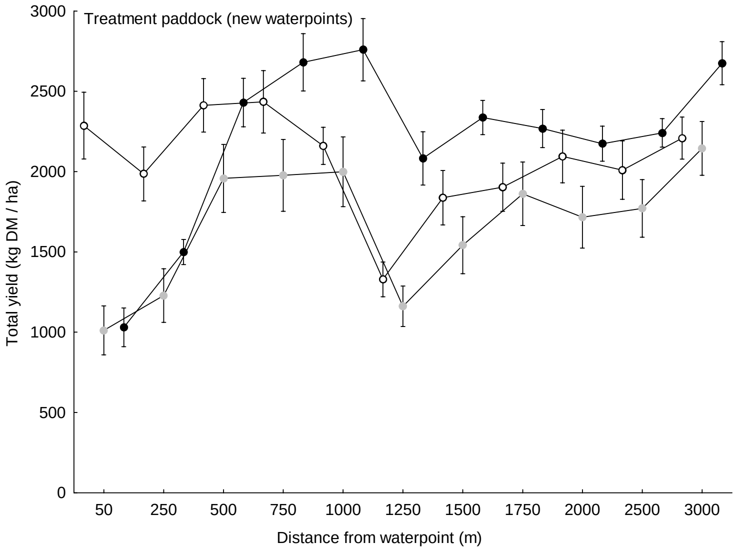


Fig. 7. Total yield (kg DM / ha) in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Data are the mean ± 1 SE.



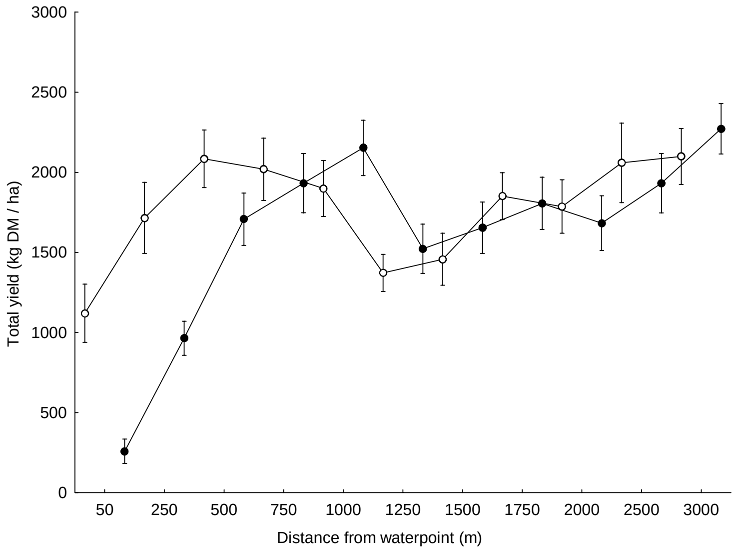


Fig. 7. *continued.*

3.4.4 Abundance (frequency of occurrence)

Abundance (frequency of occurrence) of the dominant perennial grasses at the site, *Astrebla spp.* (Mitchell Grasses) declined sharply closer to old waters (Fig. 8). With a long history of grazing at old waterpoints, *Astrebla spp*. were recorded in a very low number of quadrats (0-10% of quadrats) at 50 m and increased with distance from water. Greater than 750m from water *Astrebla* plants were very abundant (75% frequency) with little difference between treatments and age of waters.

Close to the *new* waters (50m) Astrebla frequency declined from c. 70% in May 2004 to 58% in May 2005 and 36% in May 2006. This is to be expected in such close proximity to water, due to trampling and camping. From 500 m out from the new waters *Astrebla spp*. frequency was stable during the trial, although it is unclear how long such a state can be maintained. Research in chenopod shrublands grazed by sheep (Andrew 1986; Hunt 2001) and Mitchell grasslands (Orr 1986) suggests that continual grazing could increase the piosphere over time, if grazing limits plant recruitment or persistence of dominant species. The implementation of rotational grazing in the treatment paddock did not increase the frequency of occurrence of *Astrebla* plants where previous grazing activity (old waterpoints) had previously reduced its presence.

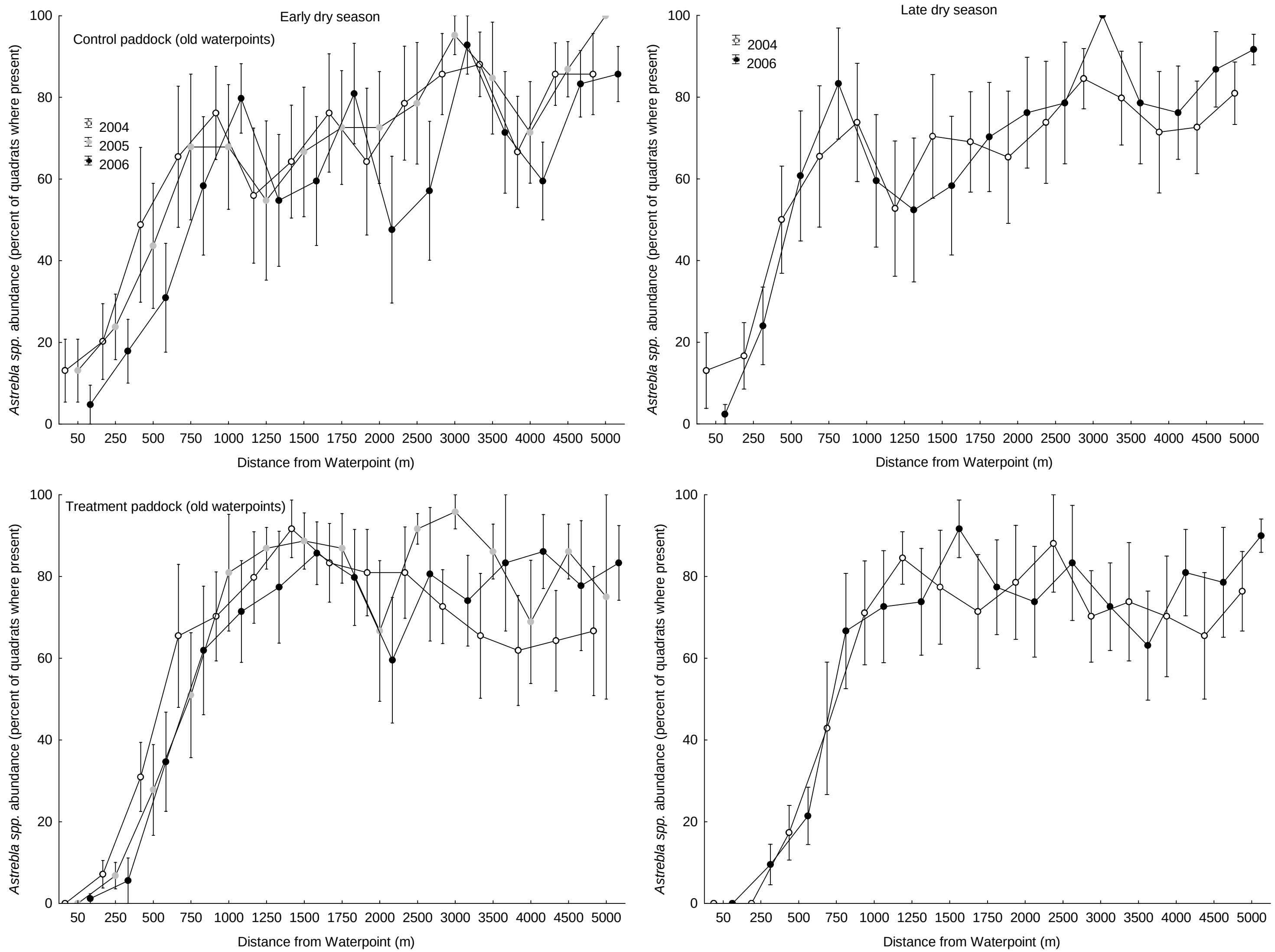


Fig. 8. Abundance of *Astrebla spp.* in each year of the rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Data are the mean ± 1 SE.

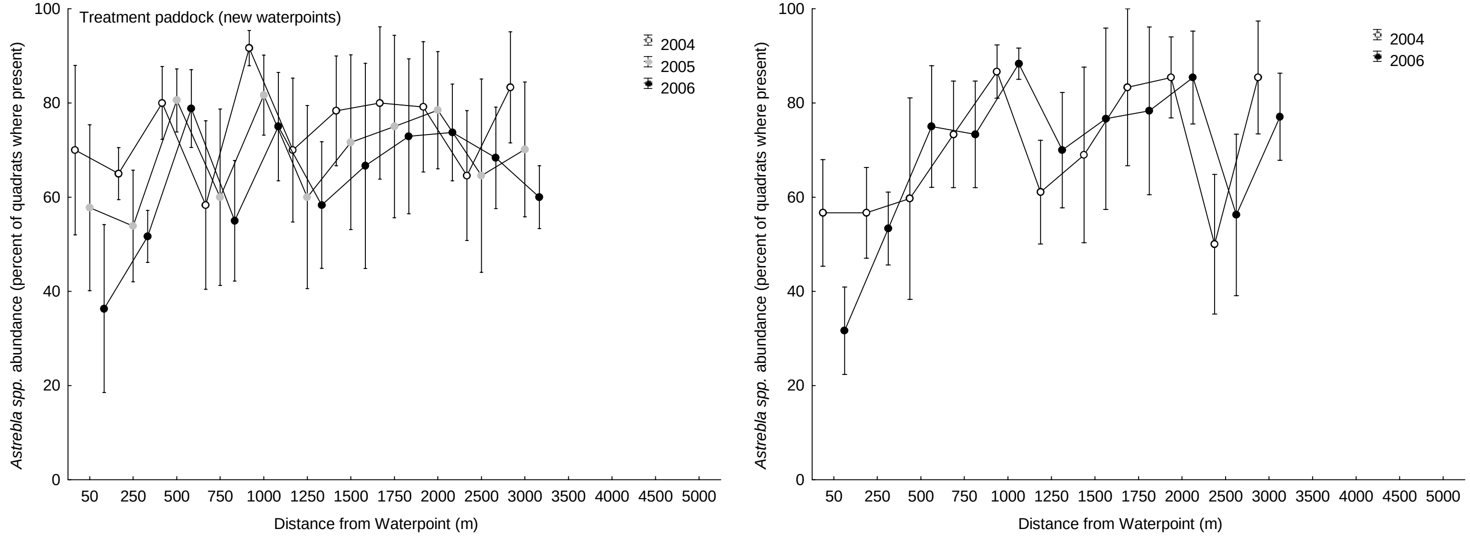


Fig. 8. *continued*.

Brachyachne convergens (Native Couch) was characteristic of species that increase in response to increasing grazing pressure. At old waterpoints with a long history of grazing, frequency of occurrence was generally highest at 250 m from the waterpoint (present in c. 40-70% of quadrats) and decreased to be present in < 10% of quadrats at 5000 m from the waterpoint (Fig. 9). The lower frequency of *B. convergens* at 50 m, in contrast to the trend outlined above, probably relates to the impact of grazing on total plant abundance (low cover and yield values at 50 m; see Figs. 6 and 7). The higher frequency of *B. convergens* closer to water is consistent with its increase under higher utilisation rates in grazing trials in the Victoria River District (Hunt *et al.* 2010 in prep).

With the implementation of rotational grazing at new waterpoints, frequency of occurrence of *B. convergens* remained relatively low (c. 20% or less of quadrats) in the first two years. However, close to waterpoints (50-250 m), frequency of *B. convergens* was highest in the last year of the trial, suggesting the development of a piosphere such as is evident at old waterpoints. This increase in the last year was in contrast to areas adjacent to old waterpoints (already somewhat degraded), where abundance was generally highest in the low rainfall year of 2005.

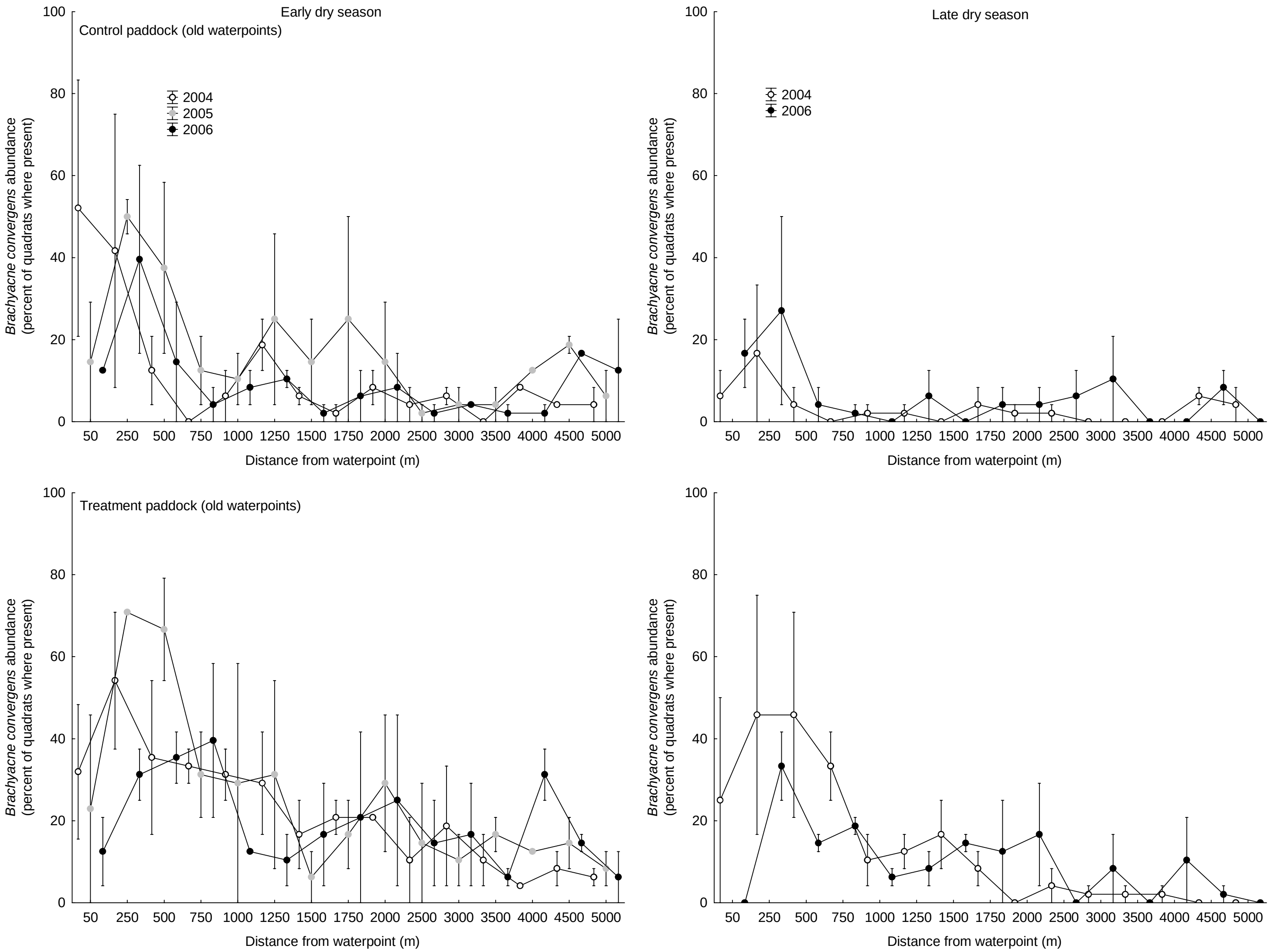


Fig. 9. Abundance of *Brachyachne convergens* in eac year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Data are the mean ± SE.

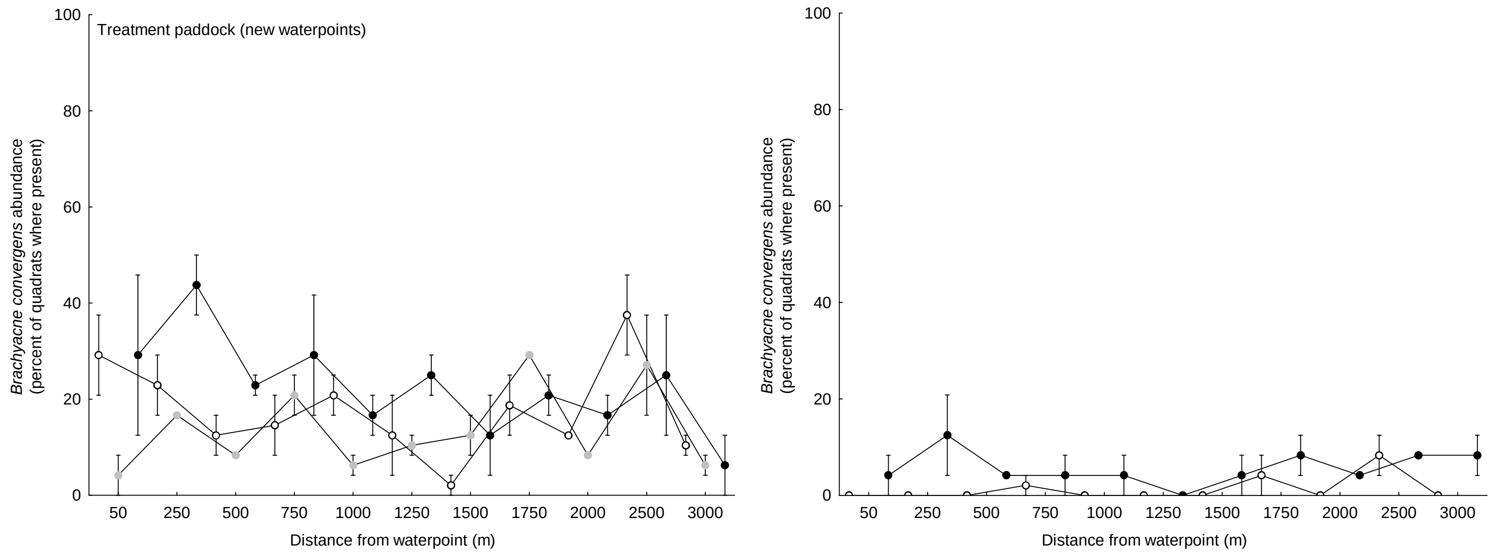


Fig. 9. *continued*.

Such a pattern may indicate a dominance of this species in low rainfall conditions (*cf. Iseilema* spp., Orr 1981). Areas with a long history of grazing (old water points in both paddocks) generally showed a decrease in the frequency of *B. convergens* over time adjacent to waterpoints (i.e. 50 m). The role of previous land condition and rainfall patterns is unclear in this timeframe. Continuous stocking in the control paddock did not increase the frequency of occurrence of *B. convergens* that was already present in the beginning of the trial.

3.4.5 Rank material

At old waterpoints, the amount of rank material (as a percent of the yield) in perennial grasses was lowest close to the waterpoints and gradually increased as distance away from the waterpoint (and yield) increased (Fig. 10). Unlike other parameters reported in this study, the increase in rank material with distance from water tended to be gradual. At these old waterpoints, there tended to be little difference between years at a particular location. Neither continuous (control paddock) or rotational grazing (treatment paddock) changed the amount of rank material over time.

At new waterpoints, the amount of rank material was high and consistent along the distance gradient in the first year of the trial (around 35-40%), then decreased in the second and third year of the trial (to around 10-20%). Only in 2004 was there a significant difference in rank material between treatments (Kruskal-Wallis ANOVA by ranks at 250 m with early dry season data only; 2004, $H_{(2,\ N=24)} = 8.99$, $P < 0.05$; 2005, $H_{(2,\ N=24)} = 5.16$, $P > 0.05$; 2004, $H_{(2,\ N=24)} = 2.80$, $P > 0.05$). By 2005 and 2006, a slight grazing piosphere appeared to have developed with respect to rank grass, where grazing pressure (around waterpoints) was an

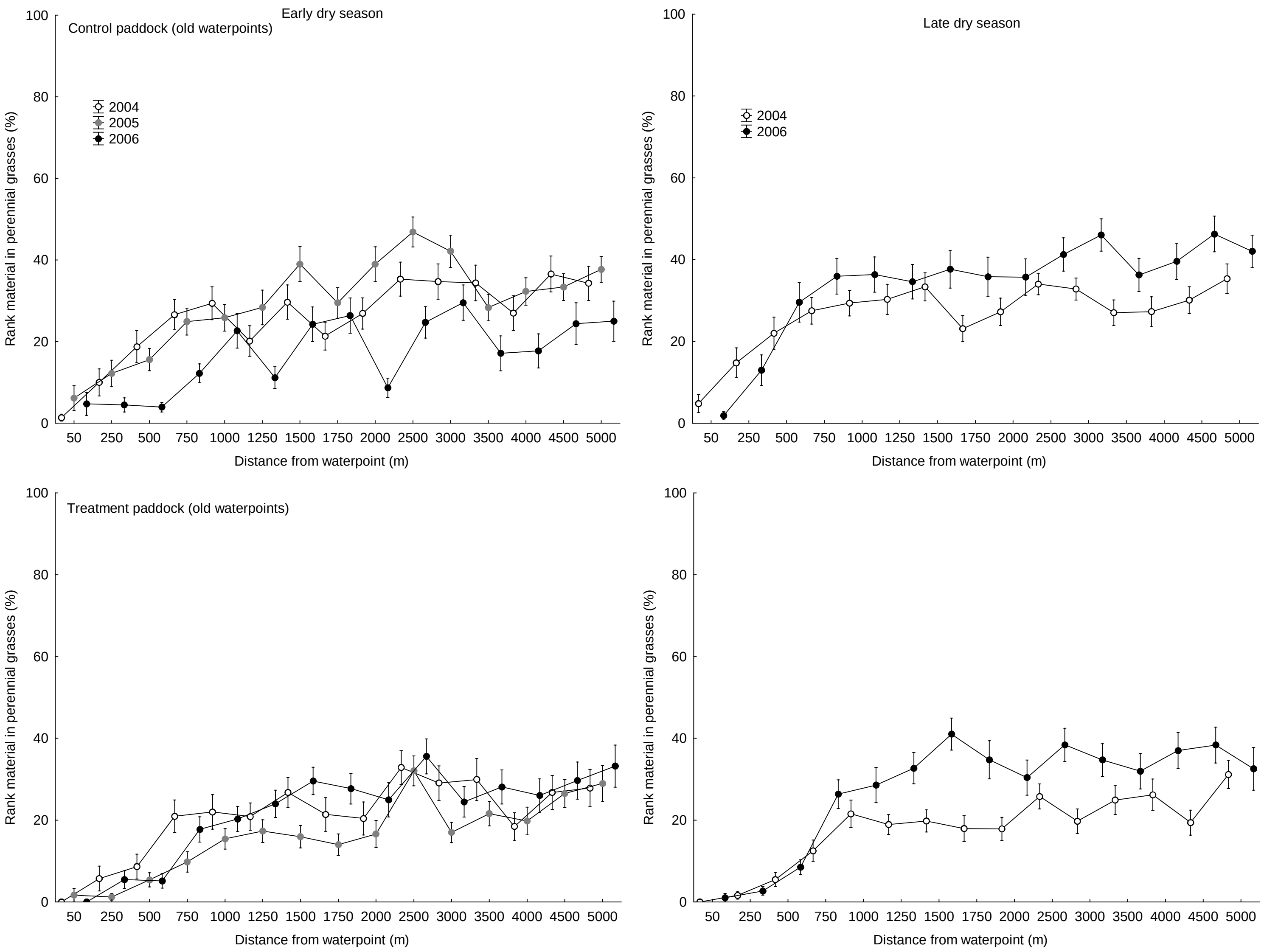


Fig. 10. Rank material in perennial grasses (% of yield) in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Rank material is defined as "any attached plant material that has died and turned grey in colour due to the on set of the decaying process once being re-wet. It is unpalatable and tends to accumulate in pastures following rain" (Materne 2006). Data are the mean ± 1 SE.

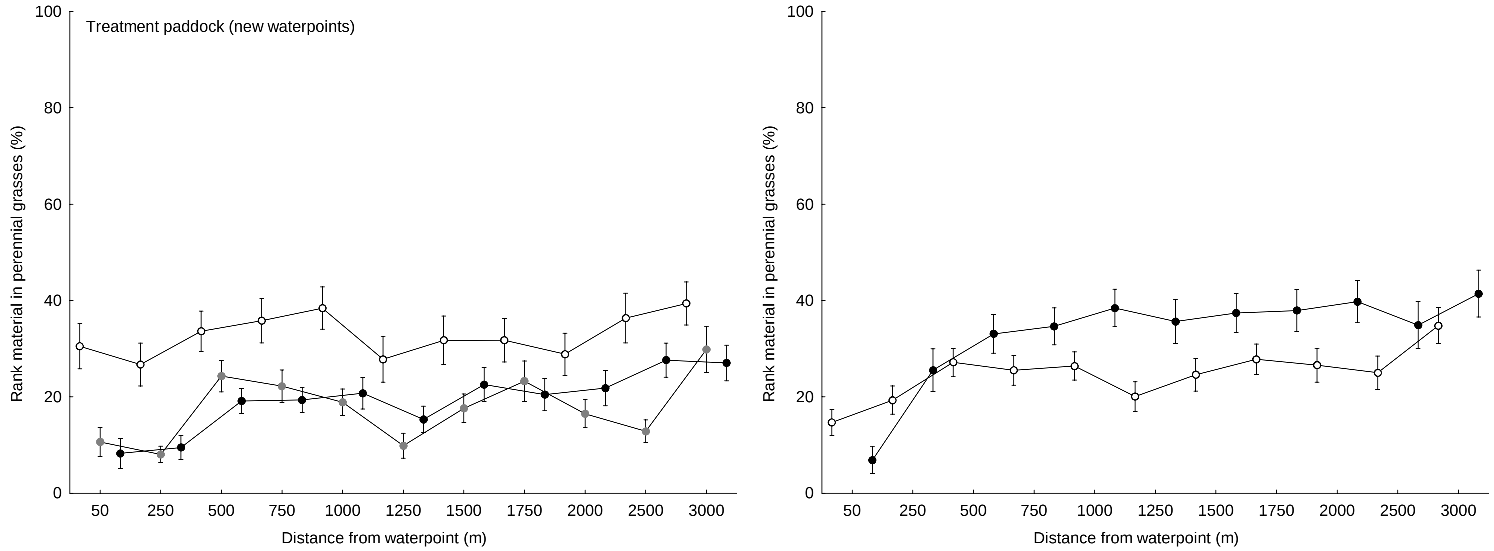


Fig. 10. *Continued*.

effective tool in reducing the amount of rank grass in the pasture. However, rather than consuming such material, cattle probably reduced the amount of rank grass by trampling (Materne 2006). Tussocks will eventually die unless the rank grass can be removed, such as with burning, which then stimulates tiller production (Scanlan 1980; Scanlan 1983; Materne 2006).

3.4.6 Limitations (vegetation)

The most important limitation in the interpretation of this study was that treatments (certain stocking rates in a paddock with waterpoints of a given age) are not replicated at the treatment-level. Paddock-specific factors or differences in stocking rates between paddocks may have overridden apparent treatment effects. However, the study was designed as a demonstration site, rather than a more rigorous scientific trial.

The short-term nature of this trial (3 years) reduces confidence in the ability to ascribe changes in pasture structure and composition due to the different management regimes. The timing and amount of rainfall may have had a strong, overriding effect on vegetation, and may even take several years to become evident (Orr 1981; Foran and Bastin 1984). Notwithstanding the costs involved, a view towards long term monitoring is considered preferable. It is important to note that this grazing trial was conducted in generally good rainfall years (at the very least, only moderately lower than average).

The monitoring design with transects radiating out only 5 and 3 km from old and new waters respectively, as well as the exclusion of red soil from monitoring sites will have influenced this study's findings, particularly as cattle were found to graze (albeit at low levels) up to 7 km from water in the late dry season at the site (Tomkins *et al.* 2008). Cattle are known to have also used the red soil areas, particularly in the wet season. Even so, this and other piosphere studies suggest that most grazing occurs within 5 km from water (Fisher 2001, Hunt *et al.* 2010).

Although total animal numbers were not recorded, we believe that the assumptions used in this study to calculate the animal equivalents based on the number of breeders in the paddock provide a reasonable estimate of likely grazing pressure in the trial paddocks.

Previous studies have shown that, in general, there is no major advantage (or disadvantage) of rotational grazing systems per se. Differences in animal or plant production between a rotational and continuous grazing system typically reflect differences in stocking rates between treatments (Heitschmidt *et al.* 1987; Heitschmidt *et al.* 1990; Ash and Stafford-Smith 1996; O'Reagain *et al*. 2009). Here the stocking rates across the entire paddock areas were quite similar. However, the greater availability of water in the rotational grazing paddock meant that stocking rates and utilisation rates were effectively lower in the treatment paddock. Permanent water points were also wet season spelled in the treatment paddock, which combined with lower utilisation rates may have contributed to differences in vegetation and animal production in addition to or instead of the rotation *per se*.

3.5 Animal production

Animal production parameters were analysed on a relatively small number of cattle; a total of 94 heifers in the control paddock and 89 heifers in the treatment paddock in 2005, and 71 and 68 respectively in 2006 (Table 5). This is because only 100 animals per treatment were initially identified for study and not all of these had complete records. At the time of the first round musters in 2005 and 2006, there was a higher proportion of pregnant (both dry and wet) heifers in the control paddock than in the treatment paddock. The re-conception rate of wet heifers was higher in the control paddock than in the treatment paddock (in both years). Calf mortality (defined as the number of dry heifers, as a proportion of females PTIC in the previous year) was similar between treatments in 2004-2005, but somewhat (10%) higher in the control paddock than the treatment paddock in 2005-2006 (this difference is not significant due to the low number of animals in the analysis).

The mean weight of heifers at the start of the trial was similar: 374.9 kg in the control paddock and 375.3 kg in the treatment paddock. Weight gain of dry heifers in 2004-2005 was higher in the treatment paddock, whereas weight performance of wet heifers was better in the control paddock.

Liveweight gain of dry heifers from May 2005 to May 2006 was 20 kg lower in the control paddock than the treatment paddock. However, the average weight of dry heifers in May 2006 was higher in the control paddock because of their higher liveweight at the start of the year. In 2006 there was little difference in weight (5 kg) or weight change (10 kg) between treatments for wet heifers.

Re-conception rates in first calf heifers (in 2005) were low but were comparable to other pastoral properties in the Northern Territory where first calf heifer re-conception rates are often low (Schatz and Hearnden 2008). Re-conception rates for wet heifers were higher in the control paddock than the treatment paddock in both years. Notwithstanding the limitations of the study design (see below), the higher re-conception rates in the control paddock compared to the treatment could be attributed to the higher mean weight of wet heifers, as there is a strong positive relationship between re-conception rate and first calf heifer weight at the time of weaning (Schatz and Hearnden 2008). The rates of calf mortality observed in this study are high but are not uncommon in first calf heifers on extensive cattle properties in this region (Schatz and Hearnden 2008). Lower calf mortality in the treatment paddock compared to the control paddock may have been a result of shorter distances between water and good quality pasture. Distances from water may be a contributing factor to calf mortality in first calf heifers (Schatz personal observation)

Weaning rate was slightly higher in the treatment paddock in 2005 due largely to the lower calf loss in the treatment paddock. Rates (62-70%) were similar to that found in the VRD (Hunt *et al.* 2010 in prep) and to that reported for the Barkly for heifers (62%) and cows (70%) (Oxley *et al.* 2006).

Table 5. Reproductive and growth performance of heifers in the first round musters of 2005 and 2006 (May), in the alternate waters rotational grazing trial at Rockhampton Downs. Data for 2004-2005 are displayed with the original lactation status and an adjusted lactation status in parenthesis, where all heifers that lost more than 50 kg were deemed to be wet. All heifers were pregnant with their first calf in May 2004, and should have had their first calf weaned in the May 2005 muster. Dry and empty heifers at the first round muster in 2005 were culled.

	First round muster 2005		First round muster 2006	
	Control paddock	Treatment paddock	Control paddock	Treatment paddock
Total number of heifers	94	89	71	68
Number of heifers empty and dry	7 (4)	14 (12)	2	9
Number of heifers pregnant and dry	29 (22)	13 (12)	22	13
Number of heifers empty and wet	41 (44)	55 (57)	26	30
Number of heifers pregnant and wet	17 (24)	7 (8)	21	16
Re-conception rate in wet heifers	29% (35%)	11% (12%)	45%	35%
Calf mortality	38% (28%)	30% (27%)	18%†	8%†
Weaning %	62%	70%	66%	68%
Mean weight of dry heifers (kg)	353 (373.0)	389 (404.0)	527.0	492.0
Mean weight of wet heifers (kg)	350 (344.0)	326 (323.0)	463.0	456.0
Mean weight change of all heifers (previous year; kg)	-17.0	-22.4	127.0	122.0
Mean weight change of dry heifers (previous year; kg)	-10.2 (26.0)	26.6 (45.0)	154.0	174.0
Mean weight change of wet heifers (previous year; kg)	-20.4 (-31.0)	-43.6 (-47.0)	118.0	108.0

†Number of dry heifers as a proportion of females PTIC in 2005.

There are several aspects of the trial results that are difficult to explain. Initially pregnancy of heifers and re-conception and weight gain of wet heifers were higher in the control paddock. However by 2006, there was no difference between treatments. Conversely, the weight gain of dry heifers was always highest in the treatment paddock.

There are several reasons animals in the treatment paddock may have initially struggled under the new rotational grazing regime. First, the treatment paddock had 3 new troughs in previously relatively ungrazed rank pastures (at least for 2004). Secondly, animals were more densely distributed around only one trough at a time. Although on average stocking rates were lower in the treatment paddock, because only one trough was available at any one time, this meant that the density of stock was much higher, albeit for short periods (22-40AE/kmsq within 5km from water) than in the control paddock. This may have reduced the ability of animals to select preferred pasture species and decreased their diet quality (e.g. Provenza 2003). Thirdly, both animals and their handlers take up to three years to adjust to any change in grazing regime (see 3.6), with initial increases in stress levels and reduced intake (Provenza 2003), so that animal performance declines before they adjust to their new situation (Provenza 2003).

The better performance of the dry heifers in the treatment paddock suggests that the wet heifers with calves at foot were more vulnerable to their changed circumstances, whereas the dry heifers that were able to move around more freely may have been able to graze further from water and escape the higher stock densities closer to troughs.

Incorrect assessment of lactation status and insufficient numbers cannot be discounted as the cause of this apparent effect (see Section 3.5.1 below). The low number of tagged animals in the trial precludes any firm conclusions about these reproductive and growth indicators.

3.5.1 Limitations (animal production)

The design and execution of this study prevented thorough analysis and firm conclusions of the effect of such a grazing strategy on animal production. Treatment prescriptions (stocking rates) changed throughout the trial. Heifers (dry and empty) were culled, and others added to the paddocks, at various times (and records for the number of each class of stock in the trial are poor). Such changes make comparing paddocks complicated, and ascribing results as treatment effects, difficult.

The number of tagged heifers in the study was well below that required to assess the range in variation within a mob (e.g. 68 in the treatment paddock in 2006). As well as a low number of tagged cattle in the beginning, many were culled (dry cows) during as the trial progressed. In hindsight many more animals should have been tagged for study.

An assessment of reproductive performance is difficult given that pregnancy and lactation status were only recorded once a year (rather than twice). In addition, lactation status was not confirmed by stripping milk from the udder, so in some cases may be incorrect. For example, there are a number of heifers which were recorded as pregnant at one muster and lost > 100 kg over the year, yet were recorded as dry (non-lactating) at the next muster. It is unlikely that this weight loss would occur without a heifer calving and lactating. Comparisons of weight gain between paddocks are unreliable, as the overall stocking rates and the proportion of wet and dry cows in each paddock must be similar for this to be done accurately (and this was not accurately known in this data set).

3.6 Animal behaviour

A major issue identified in this grazing trial was the difficulty in controlling cattle movement by simply turning waterpoints on or off. Frequent observation and interference was required to ensure cattle were not congregating at dry waterpoints. It was difficult to keep cattle at a particular waterpoint in the beginning of the trial (2004) as they tended to return to previous (dry) waterpoints. If cattle returned to a dry waterpoint, they were gathered and redirected to the current waterpoint. As this could happen daily for around two weeks, management was very labour-intensive. Thus, the trial proved to be labour-intensive and disruptive to the station's work program in the first year. The whole stock camp was required when moving cattle from one waterpoint to the next. In subsequent years a more effective procedure for moving the cattle was devised (see below) and only one staff member was required to monitor the treatment paddock for stray cattle. The sum of these required actions determined that the grazing strategy was difficult to implement in the first year without employing extra staff.

In subsequent years, the producer group devised a procedure to counteract this undesirable animal behaviour: water was turned on at the next waterpoint, and turned off at the current waterpoint, on the day prior to moving. The procedure acted as a cue for training cattle to move, and the task of rotating cattle was achieved by one staff member and a vehicle after two years. Following this procedure will ensure similar trials at other locations will run successfully from the outset.

The manager of Rockhampton Downs, Mr B. Wratten, observed changes in the herd dynamics of cattle in the treatment paddock. In 2006, treatment cattle were observed to stay together as a mob, where previously cattle tended to be scattered in small groups across a large area (evident in the control paddock).

> "*Bulls are with cows all the time, not hanging by themselves and cattle are not as spread out when grazing, but moving more as one mob*"
>
> Ben Wratten, Manager, Rockhampton Downs.

The alternate waters rotational grazing strategy is risky if water supply is unreliable, as the entire herd is concentrated at one waterpoint in the paddock. It was therefore necessary to check bores on a daily basis and move cattle immediately if the water supply was compromised (the capacity of the installed tanks could not supply enough water without constant pumping). Remote monitoring (telemetry) systems were considered by management to be beneficial and could be included in subsequent trials.

4.0 Implications for industry

4.1 Economics (the bottom line)

Whilst the improvement in individual animal performance in the treatment paddock was minimal during the early years of the trial (attributed to animal behaviour, see Chapter 3.5 above), the carrying capacity of the treatment paddock was increased. However, this increase is a direct result of infrastructure development, which doubled the paddock's watered area (see Table 1). In addition, higher stocking rates could be achieved in areas traditionally ungrazed by virtue of their higher pasture yield. For example, station staff observed that cattle had little impact on the pasture yield near the new waterpoints, and so additional cattle were added to the treatment paddock in 2006. The bonus of these high-yield pastures will, however, be reduced over time if pastures are not managed in a sustainable manner. The availability of high-yield pasture at the new waterpoints also saved cattle from walking large distances in hot weather to find good quality feed, potentially allowing greater liveweight gain with savings in energy expenditure (although this study is unable to quantify this).

There is potential to use this grazing system to reduce mustering costs. Managers used the rotational grazing system to their advantage by having cattle closer to the yards (reducing the need for helicopter use), thereby saving a significant amount of time and money.

4.2. Infrastructure development

The installation of new waterpoints in the treatment paddock opened up new areas for grazing, which were previously 'ungrazed' areas of a paddock. The producer group suggested careful consideration be given to the installation of new waterpoints, particularly with respect to tank capacity (in this case, 30 000 gallons was not considered large enough to ensure a reliable supply). Sinking a bore to supply the new tanks instead of relying on old bores that supplied other waterpoints was considered preferable. Additionally, the material and design of new tanks requires careful consideration. Several tanks installed on the cracking clay soils collapsed due to soil movement associated with changes in soil moisture. Managers firmly believed the large amount of standing dry feed remaining in the late dry season justified the cost of installation of waterpoints.

4.3 Future management

The Australian Agricultural Company indicated they gained a better understanding of the possibilities of manipulating pasture utilisation and have expressed interest in applying that knowledge to future grazing management strategies. Whilst drought suspended the trial in 2006 (Rockhampton Downs was de-stocked to 3000 head), its feasibility ensured that strong interest in alternative grazing strategies remains. An improvement to the system may include halving the size of the treatment paddock, to reduce the distance required to return stray cattle to the waterpoint. A simpler version of the alternate waters rotational grazing trial presented here could involve two waterpoints on either side of a paddock. For example, one waterpoint could be operational for the first half of the dry season, with the other waterpoint operational in the second half.

4.4 Best practice grazing management

In April 2009 a workshop was held in Tennant Creek for the MLA-funded Northern Grazing Systems project, which aims to compare current and best practice management in the Barkly Region using producer input, bio-economic modelling and an assessment of relevant literature (Scott 2009). The benefits of rotational grazing at Rockhampton Downs were discussed at the workshop, with most participants considering the grazing system best practice management. This was largely viewed to be a result of the infrastructure development, which increased the paddock's carrying capacity and enabled better utilisation of pastures at that scale.

Despite these benefits, very few producers in the region have adopted rotational grazing since the trial was completed. Besides a cell grazing system at Newcastle Waters between 2002 and 2005, the authors are not aware of any other grazing systems being used in the region that differ from continuous grazing. The most likely explanation for this lack of adoption is one of cost; infrastructure development is highly dependent on seasonal economic conditions and priority is usually given to very large paddocks.

It is also clear from this example (and the cell grazing trial at Newcastle Waters, Scott *et al.* in prep.) that the success of any novel grazing system depends on the enthusiasm of the managers running it. Drought in late 2006 and a change in management at Rockhampton Downs three years later determined that rotational grazing is no longer employed there.

4.5 Conducting research on pastoral leases

A major limitation of this trial was the lack of confidence in data relating to animal production. Such data are critical for the determination of the effect of grazing strategies on animal production and land condition. In this trial, stock numbers had to be estimated because accurate records of the number of animals removed and added to the paddocks were not kept. In future research it is suggested that Department staff regularly liaise with station managers to assist them keeping a detailed stock diary (with all additions and removals of each class of stock), and send results regularly to a project officer. The replacement of all culled monitored animals with new monitored animals is also imperative to keep sample sizes adequate for analysis.

5.0 Conclusions

The objective of this study was to determine the feasibility of an alternate waters rotational grazing system in a commercial environment. The successful completion of the project demonstrates that such a rotational grazing system can indeed be successfully implemented on commercial beef cattle properties in the Barkly Tablelands region. This represents a substantial mind-shift away from a continuous set stocked regime traditionally employed throughout northern Australia. Initial infrastructure development, labour costs and management of cattle present challenges to such a strategy initially. More efficient herd management is a key outcome of this system, although whether this translates into increased animal production (per head) is unknown with the current data set and its limitations.

Infrastructure development increased the carrying capacity of the treatment paddock. However, it is important to highlight such an increase in carrying capacity only reflects an increase in the landscape’s total watered area, as there was no evidence of improvement in land condition surrounding old waters.

The decrease in ground cover, total yield, species richness and abundance of desirable grasses close to the new waterpoints in the rotationally grazed paddock, and their lack of recovery with rotational grazing at old waterpoints, suggests that the rotational grazing system implemented at Rockhampton Downs created similar impacts on herbaceous vegetation to that of continuous stocking. In most cases, the impact of grazing at newly established waterpoints was evident in the first year of the trial, with a trajectory of change from an undisturbed state to a disturbed state already underway. Over a longer period of time, vegetation adjacent to new waterpoints in the treatment paddock may develop a similar structure and composition to that of the control paddock (although this may be reduced or slowed by the implementation of wet season spelling).

Despite this, the Mitchell grassland community appeared relatively resilient to disturbance in the time period studied (three years). The size of the grazing piosphere tended to be smaller in association with new waterpoints, compared to old waterpoints with a long history of grazing. This may be due to the small time period since waters were established, the wet season spelling of permanent waters, the fewer average head per water point and lower effective utilisation rates in the treatment paddock.

The management of waters in the treatment paddock meant that permanent waters were effectively spelled during the wet season (all troughs were turned off and cattle used surface water and dams during this time) and rotationally grazed during the dry season. Longer implementation of wet season spelling may be required to restore land condition in degraded areas adjacent to old waterpoints. Ultimately, wet season spelling and conservative stocking rates are more likely to improve land condition and animal production, regardless of which grazing system these management practices are implemented in (Ash and Stafford-Smith 1996; Ash and McIvor 1998; Briske *et al.* 2008).

The rotational waters grazing system applied here had the following strengths and weaknesses:

Strengths:

- In poorly watered paddocks the addition of waters without wire is a more cost effective way to increase carrying capacity than adding internal fencing as well

- Animals could be trained to move from water to water

- Rotating animals around the paddock enabled spelling around waters that were turned off

- Permanent waters were spelled during the wet season when cattle accessed surface waters

Weaknesses:

- Considerable time investment is required to adequately train animals to move to new water points

- There is more risk (in case of failure) associated with only having one water operational at any given time, which requires close monitoring to avoid stock losses

6.0 Literature cited

Adler PB and Hall SA. 2005. The development of forage production and utilization gradients around livestock watering points. *Landscape Ecology* 20: 319-333.

Andrew MH and Lange RT. 1986a. Development of a new piosphere in arid chenopod shrubland grazed by sheep. 1. Changes to the soil surface. *Australian Journal of Ecology* 11: 395-409.

Andrew MH and Lange RT. 1986b. Development of a new piosphere in arid chenopod shrubland grazed by sheep. 2. Changes to the vegetation. *Australian Journal of Ecology* 11: 411-424.

Andrew MH. 1986. Selection of plant species by cattle grazing native monsoon tallgrass pasture at Katherine, N.T. *Tropical Grasslands* 20: 120-127.

Andrew MH. 1988. Grazing impact in relation to livestock watering points. *Trends in Evolution and Ecology* 3: 336-339.

Ash AJ and McIvor JG. 1998. How season of grazing and herbivore selectivity influence monsoon tall-grass communities of northern Australia. *Journal of Vegetation Science* 9: 123-132.

Ash AJ and Stafford-Smith DM. 1996. Evaluating stocking rate impacts in rangelands: animals don't practice what we preach. *Rangeland Journal* 18: 216-243.

Bailey DW, Gross JE, Laca EA, Rittenhouse LR, Coughenour MB, Swift DM, and Sims PL. 1996. Mechanisms that result in large herbivore grazing distribution patterns. *Journal of Range Management* 49: 386-400.

Bartley R, Roth CH, Ludwig J, McJannet D, Liedloff A, Corfield J, Hawdon A, and Abbott B. 2006. Runoff and erosion from Australia's tropical semi-arid rangelands: influence of ground cover for differing space and time scales. *Hydrological Processes* 20: 3317-3333.

Bortolussi G, McIvor JG, Hodgkinson JJ, Coffey SG, and Holmes CR. 2005. The northern Australian Beef industry, a snapshot. 4. Condition and management of natural resources. *Australian Journal of Experimental Agriculture* 45: 1109-1120.

Briske DD, Derner JD, Brown JR, Fuhlendorf SD, Teague WR, Havstad KM, Gillen RL, Ash AJ, and Willms WD. 2008. Rotational grazing on rangelands: reconciliation of perception and experimental evidence. *Rangeland Ecological Management* 61: 3-17.

Bubb A. 2006. *Pastoral Industry Survey 2004, Barkly Region*. Northern Territory Government, Department of Primary Industry, Fisheries and Mines, Darwin.

Christian, CS, Noakes LC, Perry RA, Slatyer RO, Stewart GA and Traves DM. 1954. *Survey of the Barkly Region, Northern Territory and Queensland, 1947-48.* Land Research Series No. 3. CSIRO, Melbourne.

Fensham RJ and Skull SD. 1999. Before cattle: A comparative floristic study of *Eucalyptus* savanna grazed by macropods and cattle in northern Queensland, Australia. *Biotropica* 31: 37-47.

Fisher, A. 2001, *Biogeography and conservation of Mitchell grasslands in northern Australia*, PhD thesis. Northern Territory University, Darwin.

Foran BD and Bastin G. 1984. The dynamics of a Mitchell Grass (*Astrebla* spp.) rangeland on the Barkly Tableland, Northern Territory. *Australian Rangeland Journal* 6: 92-97.

Gammon DM. 1978. A review of experiments comparing systems of grazing management on natural pastures. *Proceedings of the Grassland Society of South Africa* 13: 75-82.

Greenwood KL and McKenzie BM. 2001. Grazing effects on soil physical properties and the consequences for pastures: a review. *Australian Journal of Experimental Agriculture* 41: 1231-1250.

Heitschmidt RK, Conner JR, Canon SK, Pinchak WE, Walker JW, and Dowhower SL. 1990. *Journal of Production Agriculture* 3: 92-99.

Heitschmidt RK, Dowhower SL, and Walker JW. 1987. Some effects of a rotational grazing treatment on quantity and quality of available forage and amount of ground litter. *Journal of Range Management* 40: 318-321.

Hoffmann B. 1999. Changes in ant species composition and community organisation along grazing gradients in semi-arid rangelands of the Northern Territory. *The Rangeland Journal* 22: 171-189.

Holechek JL, Gomez H, Molinar F, and Galt D. 1999. Grazing studies: what we’ve learned. *Rangelands* 21: 12-16.

Hunt LP. 2001. Heterogenous grazing causes local extinction of edible perennial shrubs: a matrix analysis. *Journal of applied Ecology* 38: 238-252.

Hunt LP, Petty S, Cowley R, Fisher A, Ash AJ, and MacDonald RN. 2007. Factors affecting the management of cattle grazing distribution in northern Australia: preliminary observations on the effect of paddock size and waterpoints. *The Rangeland Journal* 29: 169-179.

Hunt LP, Petty, S. Cowley RA, Fisher A, White IA, MacDonald RN, Pryor M, Ash AJ, McCosker KD, McIvor JG & MacLeod ND. 2010 (in prep) *Sustainable development of VRD grazing lands*. Meat and Livestock Australia, North Sydney.

James CD, Landsberg J, and Morton S. 1999. Provision of watering points in the Australian arid zone: a review of effects on biota. *Journal of Arid*

Environments 41: 87-121.

Landsberg J, James CD, Morton SR, Muller WJ, and Stol J. 2003. Abundance and composition of plant species along grazing gradients in Australian rangelands. *Journal of Applied Ecology* 40: 1008-1024.

Lange, RT. 1969. Sheep track and dung patterns. *Journal of Range Management* 22: 396–400.

Materne C. 2006. *Mitchell grasslands quality and quantity guide*. Department of Primary Industry, Fisheries and Mines, Tennant Creek.

MLA 2004. *The Nutrition Edge*: *Technical Manual*, Meat and Livestock Australia, Sydney.

O'Reagain P, Bushell J, Holloway C, and Reid A. 2009. Managing for rainfall variability: effect of grazing strategy on cattle production in a dry tropical savanna. *Animal Production Science* 49: 85-99.

O'Reagain PJ, Brodie J, Fraser G, Bushell JJ, Holloway CH, Faithful JW, and Haynes D. 2005. Nutrient loss and water quality under extensive grazing in the upper Burdekin river catchment, North Queensland. *Marine Pollution Bulletin* 51: 37-50.

Orr DM. 1981. Changes in the quantitative floristics in some *Astrebla* spp. (Mitchell Grass) communities in south-western Queensland in relation to trends in seasonal rainfall. *Australian Journal of Botany* 29: 533-545.

Orr DM. 1986. Factors affecting the vegetation dynamics of *Astrebla* grasslands. PhD thesis. University of Queensland, Brisbane.

Orr DM, Bowly, PS and Evenson, CJ. 1986. Effect of grazing management on the basal area of perennial grasses in *Astrebla* grassland. In *Rangelands a resource under siege* (Eds. P.J. Joss, P.W. Lynch and O.B. Williams) pp 56-57. Australian Academy of Science.

Oxley, TO, Leigo, S, Hausler, P, Bubb, A and MacDonald, NM. 2006. NT Pastoral Industry Survey 2004. NT Department of Primary Industry, Fisheries and Mines.

Partridge I. 1996. *Managing Mitchell grass, a grazier's guide*. Queensland Department of Industries, Brisbane.

Provenza FD. 2003. *Foraging Behaviour: Managing to Survive a World of Change*. Utah State University, Logan.

Scanlan J. 1980. Effects of spring wildfires on Astrebla (Mitchell Grass) grasslands in north-west Queensland under varying levels of growing season rainfall. *Australian Rangeland Journal* 2: 162-168.

Scanlan J. 1983. Changes in tiller and tussock characteristics of Astrebla lappacea (curly Mitchell Grass) after burning. *Australian Rangeland*

Journal 5: 13-19.

Schatz TJ and Hearnden MN. 2008. Heifer fertility on commercial cattle properties in the Northern Territory. *Australian Journal of Experimental Agriculture* 48: 940-944.

Scott KA. 2009. Northern Grazing Systems Project: Report of Workshop 1 for the Mitchell grasslands of the Barkly Tablelands (NT). Unpublished report held at Department of Regional Development, Primary Industry, Fisheries and Resources, 99 Patterson St, Tennant Creek NT 0860.

Tomkins NW, Williams S, Kearins S and James H. 2008. Preliminary observations using GPS on the grazing distribution around water points for the Barkly Tablelands. *Proceedings of the Australian Society of Animal Production* 27: 24.

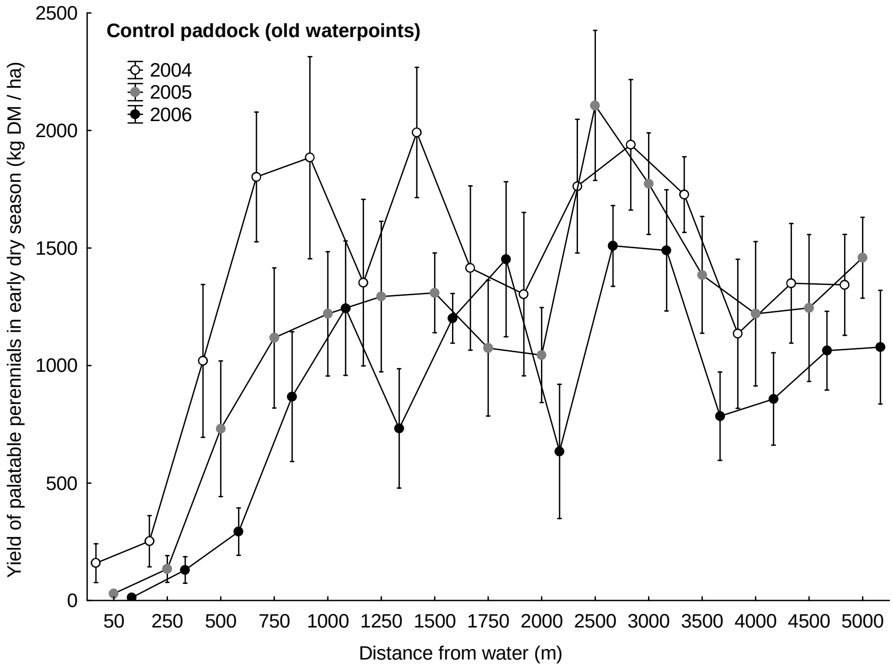
Tomkins NW, O'Reagain PJ, Swain D, Bishop-Hurley G and Charmley E. 2009. Determining the effect of stocking rate on the spatial distribution of cattle for the subtropical savannas. *The Rangeland Journal* 31: 267–276.

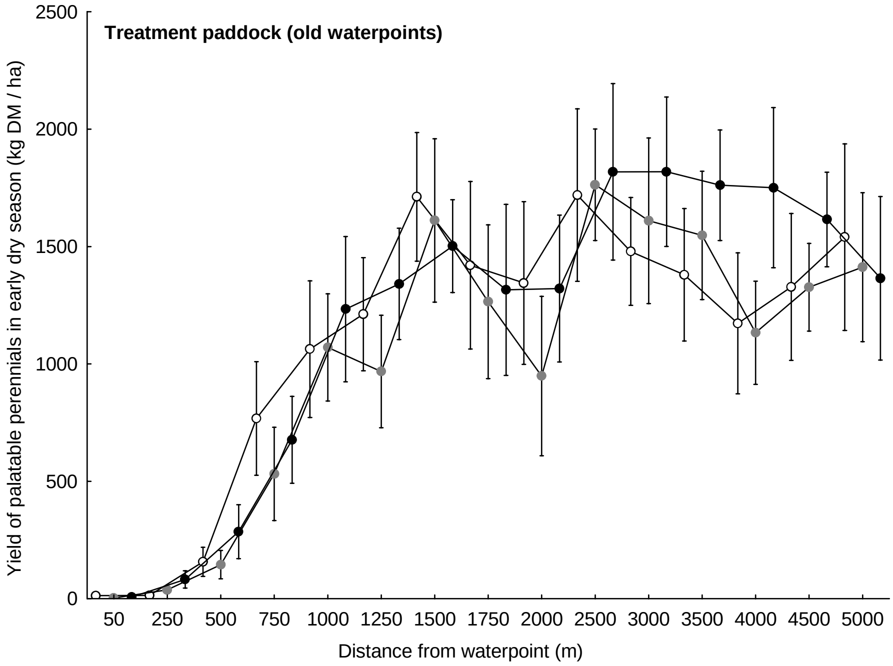
Tothill J, Hargreaves J, Jones R, and McDonald C. 1992. *BOTANAL – a comprehensive sampling and computing procedure for estimating pasture yield and composition. 1. Field sampling*. CSIRO Division of Tropical Crops and Pastures, Tropical Agronomy Technical Memorandum No. 78, Brisbane.

Warren SD, Thurow TL, Blackburn WH, and Garza NE. 1986. The influence of livestock trampling under intensive rotation grazing on soil hydrological characteristics. *Journal of Range Management* 39: 491-495.

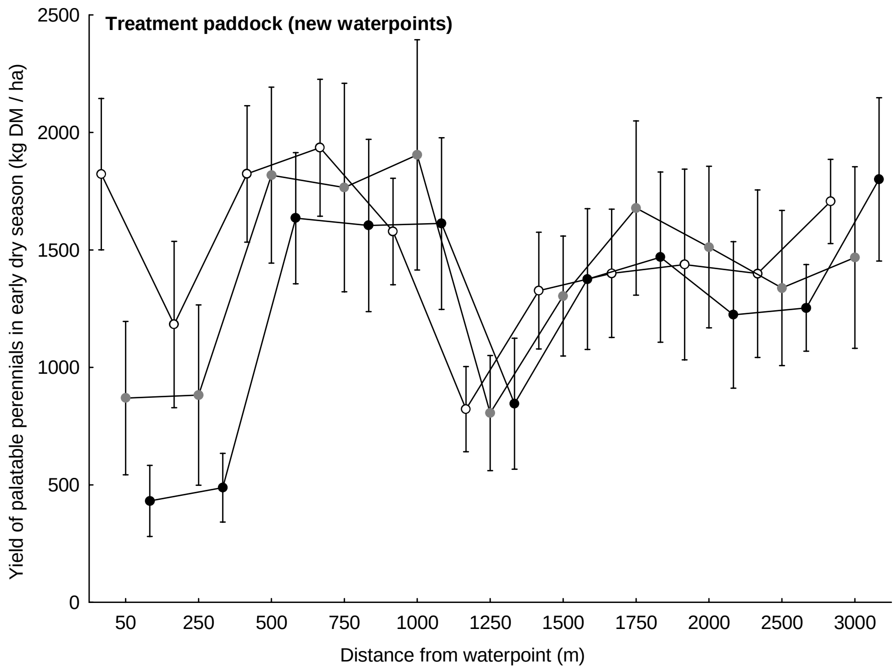
7.0 Appendices

7.1 Appendix 1



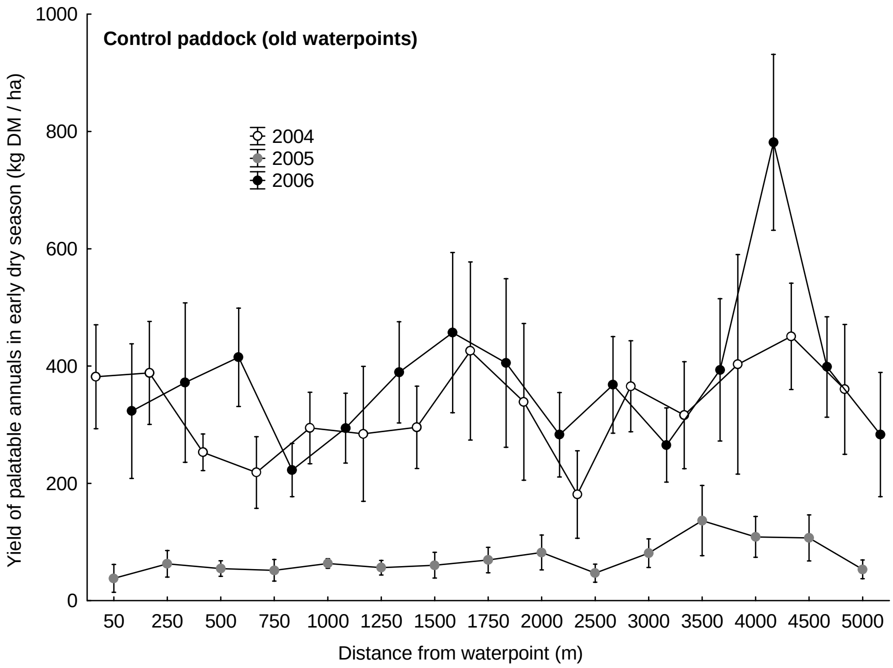


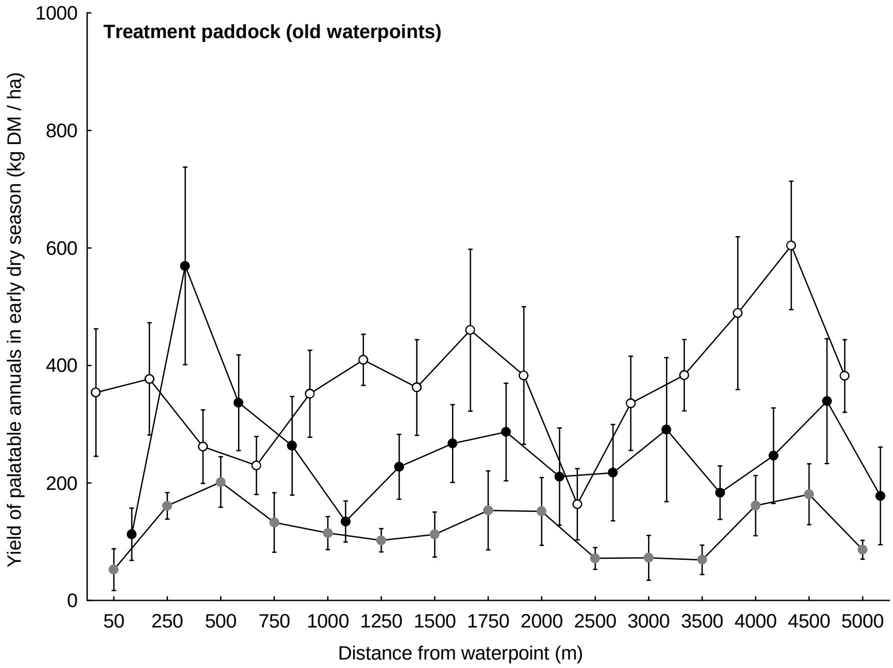
Appendix 1. Yield of palatable perennials (kg DM / ha) in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Palatability was determined by consulting literature. Data from early dry season sampling only. Data are the mean ± 1 SE.



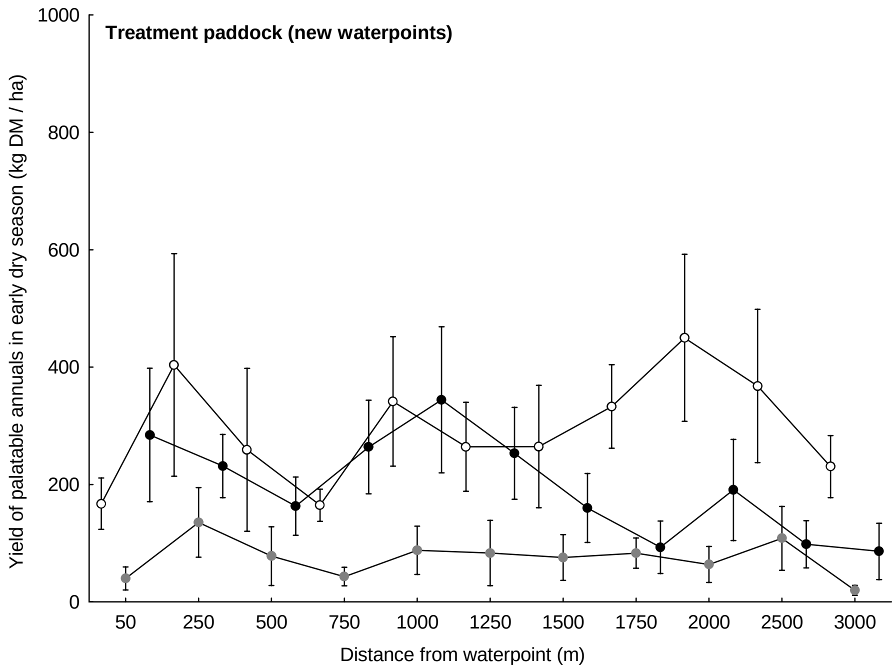
Appendix 1. *continued.*

7.1 Appendix 2





Appendix 2. Yield of palatable annuals (kg DM / ha) in each year of the alternate waters rotational grazing trial at Rockhampton Downs, categorised by season and treatment. Palatability was determined by consulting literature. Data from early dry season sampling only. Data are the mean ± 1 SE.



Appendix 2. *continued.*

7.4 Appendix 3

Communication outputs

Communication activities raised considerable awareness of the project and the features of such a rotational grazing strategy, amongst pastoralists on the Barkly Tablelands, in the Northern Territory, and to the beef industry in general. Communication to stakeholders (researchers, extension officers and producers) was achieved through papers submitted to scientific conferences, collaborative visits and various media outlets. Highlights included:

- Seminar presentations at the AACo. Head Stockman's Conference, 15th - 17th March 2005
- Poster and information displays at the Tennant Creek Show, 8th July 2005
- Visit by Professor Fred Provenza (Animal Behavioural Scientist) at Rockhampton Downs, 17th July 2005. He later used the trial to illustrate important themes in his animal behaviour workshops in Alice Springs
- AACo. Rangelands Officer and Tennant Creek DoR staff attended Professor Provenza's workshops at CSIRO and AZRI in Alice Springs, 20th July 2005, where progress and observations of the trial were discussed with other experts in the field
- Seminar presentation of the trial to the AACo. Natural Resource Management Advisory Committee, 3rd August 2005
- Coverage on ABC radio's Country Hour

- Article (see Appendix 4) and collaborative discussions with producers and researchers at the Pigeon Hole Field Day, 8th August 2007 (attendance: 152)

- Networking with colleagues at the North Australia Beef Research Update Conference, 2007 (attendance: 300)

- Conducting a highly successful field day at Rockhampton Downs in 2007 (attendance: 40)

- Networking with colleagues at the NTCA Annual Conference, 2008 (attendance: 300)

- 'Water strategy lifts carrying capacity', article in *Frontier*, Autumn 2009 (see Appendix 5).

7.5 Appendix 4

Rockhampton Downs Rotational Grazing Trial OBSERVATIONS & OUTCOMES

Susie Kearins, Australian Agricultural Company

Introduction

The Australian Agricultural Company (AAco.) in collaboration with the Northern Territory Department of Primary Industry, Fisheries & Mines (DPIFM) have been investigating the effect on reducing grazing pressure by spreading it more evenly throughout the large paddocks that are common in extensive pastoral regions.

Primarily, the investigation focuses on the feasibility of moving cattle around the paddock by turning on and off watering points to promote even grazing without having to resort to the expense of extra fencing. This system was developed by company managers following their observations of holding paddocks and their ability to respond to heavy grazing when given suitable periods of rest.

Method

A 536 km^2 paddock was divided into two paddocks. Cattle in the control paddock are managed under traditional continuous grazing practices. The treatment paddock operates under an alternating watering location management practice. Cattle are moved around the treatment paddock by only having one watering point within the paddock operating at any time. The new watering points were created by turning existing troughs at bores off and pumping the water to new troughs approximately four km away in areas traditionally not grazed.

At these locations water is stored in 30 000-gallon tanks. Cattle are held on the waters for six weeks which allows for the each watering point to be grazed once during an average dry season. During the wet season when surface water is present cattle grazing is uncontrolled.

The pasture is monitored using an intensive double sampling method at the beginning and end of the dry season. All transects originate at watering points and extend to a distance of three km at new watering points and five km at existing watering points. Sampling occurs at 250m intervals within two km of the watering point and at 500m intervals from then on. Cattle weights, pregnancy status and weaner weights were also collected. A management diary has also been kept to evaluate the impact of this grazing system on overall station operations allowing for a greater understanding of its impact.

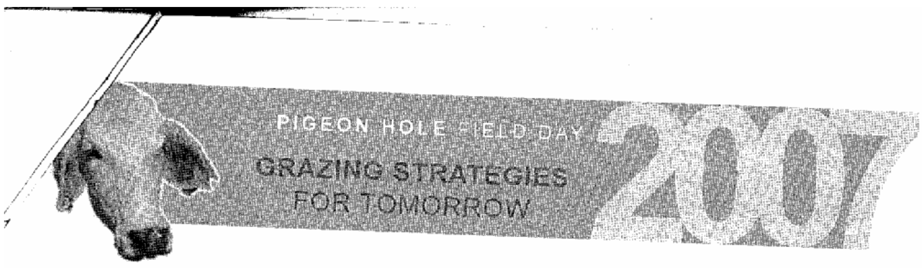
Results and Observations

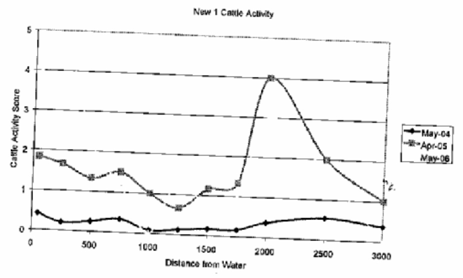
Grazing Impact

1. Installation of new watering points opened up new areas for grazing which were utilised by cattle and allowed areas that had been continuously grazed to be rested.

2. The increase in activity at or close to watering points was documented.

3. Data and observations show the sacrifice zone around new watering points to be much smaller than sacrifice zones around continuously grazed watering points.



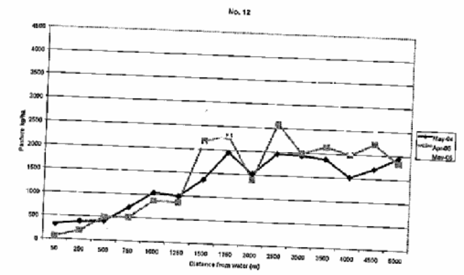


Graph 1: *Indicates the cattle activity impact on the watering points with 0 being no impact (untouched pasture) and 5 being high impact (heavy grazing or activity). Blue line represents the low levels of grazing present when the watering point was first added. The change in cattle activity over time can be compared and documents the increase of activity at or close to the watering point with the yellow line.*

Perennial grass tussocks were still present as close as 50m from the trough after two grazing events.

The greatest contrast exists when comparing the observations from May 2004 with May 2006. The seasonal effects contribute to the amount of pasture present although the trends emerging are an encouraging sign as to the benefits of the alternate waters management.

4. Recovery of and increase in perennial grass species close to those watering points which were previously continuously grazed. Observations in 2006 indicated the presence of perennial pasture species (Mitchell grass) within 250m of the watering points, and as close as 50m in areas, where the species was not present before.

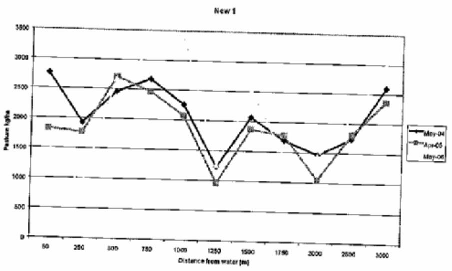


The increase in perennial grass species within traditional sacrifice zones represents an improvement in pasture composition. Increases in perennial grasses offer more feed towards the end of the dry season increasing the overall carrying capacity of the paddock

Graph 2: *This new watering point was established in the middle of Mitchell grass pasture that had experienced little to no grazing. The blue line on the graph indicates the state of the pasture before any grazing with the yellow line indicating the state of the pasture after 2 years. The change within 500 metres of the watering point is as expected with a net reduction in the amount of pasture present although the increase in pasture between 500 and 1250 metres may be as a result of the introduction of grazing.*

Cattle Performance

5. All cattle went into the treatment and control paddocks preg-tested in calf. The re-conception rate of the treatment cattle was significantly lower than the control cattle. This may have been a result of the treatment, compounded by a long dry season in 2004. Poor performance occurred during the first and second years of the trial and has been attributed to the change in behavioural patterns.



Graph 3: No. 12 watering point represents an existing water that was traditionally managed under a continuous grazing regime. The watering point is now managed under the alternate watering management and appears to be responding to the periods of plant rest that have been introduced. The increase in pasture between 50m and 1500m is significant and represents a vast improvement in the amount of feed available close to the watering point. The steep increase of the yellow line between 50m and 250m is consistent with other grazing trials where spelling has been introduced. This is in direct contrast to the blue line which represents the available pasture under the continuous grazing regime. There is also a significant increase in the amount of pasture present between 1750m and 4000m with increases of approximately 1800kg/ha at 3500m.

6. There was no significant difference between the average weight of cows from treatment or control paddocks (refer to Table 1). There was also no significant difference between the average weight of the weaners turned off from the treatment or control paddocks (refer to Table 1).

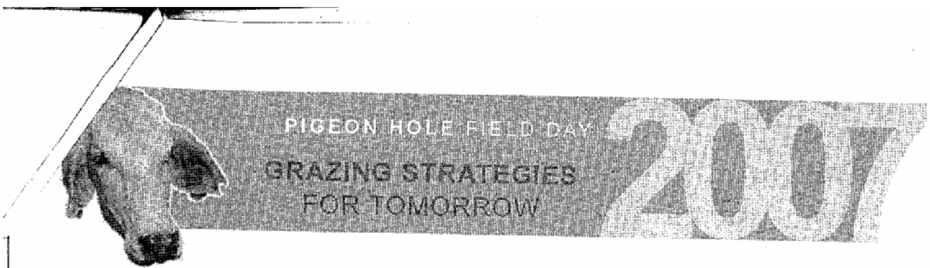
Manager observed that cattle were hardly impacting on the volume of feed near the new watering points. Number of cattle in treatment mob was increased to make more efficient use of pasture. So although individual performance was not increased during the early years of the trial, the overall kg/ha had increased in 2006 due to the increase in number of cattle that the treatment paddock could run.

7. Moving cattle more frequently (between two of the new watering points) was also tried during early 2006 to make use of the late wet and abundant soil moisture which promoted second phase of new growth of Mitchell grass.

8. Manager observed changes in the herd dynamics of cattle in the treatment paddock. In 2006 the treatment cattle were observed to stay together as a mob. Previously the cattle has been scattered in small groups across a large area, which is still seen in the control paddock. *"Bulls are with cows all the time, not hanging by themselves, (would expect this to have positive impact on calving rate) and cattle are not as spread out when grazing, but moving more as one mob." B.Wratten, Manager.*

Table 1

	2004		2005		2006	
	Trial No 12	Control No 8	Trial No 12	Control No 8	Trial No 12	Control No 8
number of cows	832	811	906	902		
average weight cow	375.31	374.88			465	487.2
av preg test result (months)	4	4				
number of calves			510	298		
calving per cent			56	33		
number of weaners			588	494		
average weight weaner			165	171	179	222



Impact on Station Management

9. Holding the cattle on watering points proved difficult during 2004 but was resolved in 2005 through the persistence of the manager. Problems were experienced in the first year of the new management system when trying to move the cattle from one watering point to the next. Cattle continually wanted to return to their home grounds, so staff had to stay with the cattle to hold them on the new watering point. A procedure was established whereby the watering point that the cattle were on was turned off the day prior to moving. This became the 'cue' into training the cattle to move. The persistence of the manger resulted in the cattle becoming easier to move and by the end of 2005 this task was able to be completed by an individual in a single 4WD or motorbike.

10. The problems experienced in the first year of the trial meant that the whole stock camp was required when moving cattle from one watering point to the next and to hold cattle on the new watering point. The high levels of labour required impacted on station operation, making it difficult to manage without employing extra staff. Training the cattle to move on cue solved this problem.

    It has been necessary for staff to check the treatment paddock each day to check the location of cattle and the water supply. Under continuous grazing practices the paddock would only be checked every few days. It was necessary to check paddock for strayed cattle for several days after moving them, and this was time consuming and took staff away from other activities. The station stock camp did not have enough people to cover this, so it would have been beneficial to have an extra staff member employed to assist with looking after cattle in the treatment paddock.

11. Problems were also encountered in relation to water storage. The tanks used to store water at the new watering points could not always keep up with demand and did not provide a safe amount of storage in case of problems with the bore or trough. If there was a problem with the water supply then management only had a day to find the problem and fix it before the water ran out. Hence the need to check the waters every day.

12. Manager has learned to use the rotational system to its best potential by controlling where cattle are grazing and having cattle closer to the yards at mustering time, reducing the need for helicopter use. This has lead to savings in time and money when mustering the treatment paddock.

Conclusion

Preliminary results and observations from the trial indicate that managing cattle by alternating watering points is possible within the extensive grazing systems of the Barkly Region.

Greater influence over the areas of the paddock that are grazed has been achieved through investing time in training cattle and modifying their behaviour. This investigation has been able to demonstrate that perennial grass species increased through the period of rest introduced by the alternate waters management system. Individual performance of cattle was not increased during the early years of the trial, but the overall kg/ha was increased by being able to run more cows due to more efficient use of the paddock.

The ability to manage the cattle alternating watering points represents a vast change from traditional grazing strategies and is considered a major achievement of the investigation. Continuation of the trial will allow us to obtain more results to see the impact on cattle performance and pasture condition over the long term.

7.6 Appendix 5

GRAZING MANAGEMENT

Water strategy lifts carrying capacity

AT 'ROCKHAMPTON DOWNS', ON THE SOUTHERN PART OF THE BARKLY TABLELANDS, ALTERNATING WATER AVAILABILITY ACROSS FIVE WATERING POINTS INCREASED ONE PADDOCK'S CARRYING CAPACITY BY 27%. IT'S A NOVEL GRAZING MANAGEMENT STRATEGY AKIN TO WIRELESS ROTATIONAL GRAZING.

The paddock was part of a trial by the Australian Agricultural Company (AAco) and the NT Department of Regional Development, Primary Industry, Fisheries and Resources – with funding from MLA – to control grazing distribution during the dry season (April-November).

AAco Rangelands Manager, Suzie Kearins, said that AAco had identified uneven grazing of pastures and overgrazing around watering points as limits to production.

"Great areas of the paddock weren't being used because they were too far from water," she explained.

"To address this, we wanted to gain control of grazing distribution."

Trial set-up

For the three-year trial, a paddock of 530km² was fenced into two paddocks. The control paddock was set stocked with 880 cattle and grazed continuously, with all watering points turned on. In the trial paddock, new watering points were installed – existing troughs were turned off at the bores and water was pumped to new troughs about 4km away in areas not traditionally grazed. It was originally stocked with 730 cattle, and only one of the five watering points was turned on at any time during the dry season.

Under traditional grazing practices, Suzie explained that the cattle created a sacrifice zone around each watering point in the paddock; a heavily grazed and trampled area within 100m of the water, and sometimes up to 1km out.

"We moved the cattle around the trial paddock to see if we could control their grazing to get more even utilisation of pastures across the paddock," she said.

In the trial paddock, the stock camp left the cattle to graze near a single operating watering point for six weeks before mustering them onto the next one. The cattle visited each watering point once during the dry season, which effectively spelled the pasture in other areas.

Preliminary results have revealed an increase in perennial grass species within the traditional sacrifice zones, which represents an improvement in pasture composition. Full analysis of the trial data is yet to be completed.

Increased beef production

In the first two years of the trial, there has been no increase in cattle or weaner weights, which was attributed to the stress of learning a new grazing behaviour.

However, by the third year, Suzie said that having access to a bulk of dry feed towards the end of the dry season increased the paddock's overall carrying capacity. For the third year, the stocking rate in the trial paddock was increased by 200 head.

"The biggest production benefit was that we were able to run higher numbers for shorter single periods of grazing activity. By moving the cattle from one part of the paddock to the next, we only used an area once during the season and used more of the paddock overall," she said.

"Towards the end of the dry season, we still had part of the paddock that contained a bulk of feed within a couple of kilometres of the watering point, which saved the cattle from walking great distances in the heat to find feed."

The project officers recorded cattle weights, pregnancy status and weaner weights in May of the third year. This data has not been analysed but the visual observations of the herd have been promising. Suzie said that they expected the data to show improvement in livestock condition at the end of the dry season, and possibly

"Towards the end of the dry season, we still had part of the paddock that contained a bulk of feed within a couple of kilometres of the watering point, which saved the cattle from walking great distances in the heat to find feed."

Improved pasture condition

Suzie said that project officers from the department monitored pastures in both paddocks during the trial using an intensive double sampling method at the beginning and end of the dry season.

"They were measuring pasture quantity, quality, species composition and cattle activity. They established transects from each watering point out to 3km at new watering points and 5km at old watering points, sampling every 250m."

KEY POINTS

- Cattle in extensive grazing situations tend to concentrate grazing around watering points and graze paddocks unevenly.
- Controlling availability of water during the dry season can be used as a grazing management strategy without additional fencing.
- This strategy reduced grazing pressure around watering points, fostered more even grazing and increased paddock utilisation, and ultimately increased carrying capacity.
- Management is considering wider adoption of a modified trial strategy for future grazing management.

a corresponding improvement in conception rates.

Behaviour, water and labour

In the first year, it was difficult to teach cattle how to move onto the next water and remain in that area, but the manager devised a simple solution. The watering point was turned off a day or two before the move, and the cattle soon learnt that they would be leaving their now-dry watering point for new water.

The main disadvantage of the watering-point strategy was the additional labour required to make the fenceless rotations and check on the water. With only one watering point operational, water security became a critical issue.

"The grazing strategy was very time consuming because staff were constantly checking on the water and moving cattle. The water had to be checked daily because the new tanks only held 30,000 gallons. If something went wrong, we only had a days worth of water," Suzie explained.

"In addition, some cattle often insisted on travelling back to favourite areas or watering points that weren't on, and the stock camp was constantly moving stray cattle back to the operating water. For up to two weeks after a move, it was fairly labour intensive to get the few stubborn cattle settled on the new water."

Station staff kept a diary to evaluate the impact of this grazing system on the whole enterprise but this information has yet to be accounted in the cost of implementing such a strategy.

Drought mitigation

AAco operates Rockhampton Downs as a breeding business and it usually carries around 34,000 head of cattle, but this year it was de-stocked to around 3,000 head due to the drought.

However, the 250km² trial paddock is still running around 700 head, which Suzie partly attributed to the improved condition of its pasture after the three-year trial.

"Due to the time constraints of managing the station during drought, staff were unable to make the rotations and the trial was put on hold," Suzie said.

"But the trial paddock still has grass because its pastures were in much better condition."

By comparison, the neighbouring control paddock was completely de-stocked.

Future plans

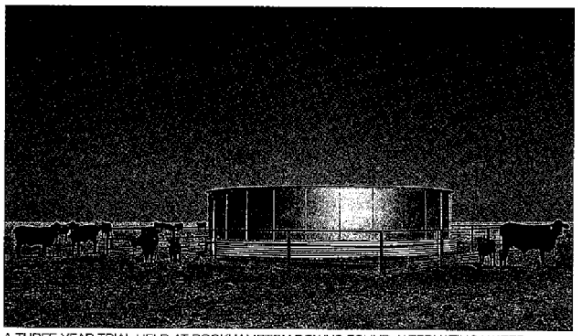
If AAco runs the trial again, Suzie said that each paddock might be halved to reduce the distance and time spent mustering stray cattle.

Regardless, the company has noted the value of controlling watering points to spell pastures without additional fencing. They are looking at controlling grazing of some livestock groups or in some of the larger paddocks by operating the waters at one end of a paddock for half of the dry season, then switching to the others for the rest of the season.

"This would effectively spell half of the pasture, retaining a bulk of feed at the end of the year without the labour-intensive rotations," Suzie said.

"After seeing the benefits of the system, the company supported the need for new waters. It gives us the ability to spell some areas and retain a bulk of feed so cattle don't have to walk huge distances to feed late in the year," she said.

"A lot of the really old bores or watering points have been turned off and the cattle have been pushed onto the new ones, allowing areas that have been continuously grazed a chance to regenerate."



A THREE-YEAR TRIAL HELD AT ROCKHAMPTON DOWNS FOUND ALTERNATING WATER AVAILABILITY TO LIVESTOCK INCREASED CARRYING CAPACITY BY 27%.

PRODUCER INFORMATION

PRODUCER
Australian Agricultural Company

LOCATION
Rockhampton Downs
160km north-east of Tennant Creek, NT

PROPERTY AREA
511,900ha (5,119km²)

ENTERPRISE Cattle breeding

GOAL
To increase pasture utilisation and spread grazing distribution

LIVESTOCK 34,000 head

PASTURES
Mitchell and flinders grasses, some spinifex and bluegrass

SOIL TYPES
Predominantly black soils, some red earths

ANNUAL RAINFALL 350mm

MORE INFORMATION

> Suzie Kearins, AAco
Phone: 08 8964 4681
Email: skearins@aaco.com.au