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Managing grazing by alternating water points – determining the effect on grazing patterns, Rockhampton Downs

[Managing water to manage grazing]

Abstract

Managing water supply between multiple sources could be an effective tool for manipulating cattle distribution across extensive paddocks. This report describes the spatial distribution of cattle on Rockhampton Downs Station, Northern Territory during April – November 2007 in commercial sized paddocks when water was available from one or three water points.

A pronounced bimodality was observed in movement by all collared animals. Cattle given access to three water points travelled significantly further over 24 h than animals in a similar sized paddock where there was only one water source. While this study has demonstrated that providing additional water points can increase the distance animals travel from water (4.6 *v.* 4.0 km) and their home range (19% *v*. 16% of available area), the difference was not significant ($P > 0.05$).

The project has demonstrated that GPS locational data for cattle can be captured in an extensive grazing environment and the extent of animal distribution relative to property infrastructure can be identified. Further replication across seasons, land types and combinations of water point arrangement/access is required to elucidate any statistically significant effect on grazing distribution for large commercial herds typical of the northern beef industry.

Executive Summary

Installing multiple water points in large (>120 km^2) paddocks requires additional labour and capital, but can influence grazing distribution and improve pasture utilisation. Managing water supply between a number of sources could also be an effective tool for manipulating cattle distribution across extensive paddocks typical of Australia's rangelands. Grazing animal distribution and pasture utilisation are valuable measures of how well rangelands are managed.
With the availability of GPS devices for tracking livestock there is a relatively reliable and easy method to quantify the utilisation of different landscape units and distances travelled by cattle based on managing water availability. The current use of GPS tracking devices for livestock provides a direct measure of cattle distribution across different landscapes. These devices have been used to measure landscape preferences of Brahman cattle in the subtropical savannas (Tomkins and O'Reagain 2007) and provide an invaluable tool in measuring livestock distribution patterns relative to property infrastructure and changes in management.

This report describes the spatial distribution of 13 breeder cows from two herds of approximately 1000 animals for 8 weeks in 253 km^2 and 280 km^2 paddocks when water was available from one or three water points, respectively. The study used archival GPS units and was conducted on Rockhampton Downs Station (18°56′S, 135°11′E) 160 km north-east of Tennant Creek, on the Barkly Tableland Northern Territory, during April – November 2007 (dry season).

The three initial objectives of this project were to:

1. Quantify the effect of two rotations in water point access, in a paddock where only one of several watering points operates for a six week period only, on grazing patterns and compare animal distribution across commercial sized paddocks to those in a control paddock, where water is available from a number of sources, over the same time.
2. Relate the effect of managing water availability to measured patterns of biomass availability and pasture utilisation.
3. Speculate on the effects of the grazing system as a whole on grazing distribution through-out the year relative to the control paddock.

This study was among the first of its kind (see also Hunt *et al*. 2007) to be applied in an extensive commercial situation in northern Australia. Objectives outlined in the initial proposal relied entirely on functionality of property infrastructure and replication of previous activities where water was managed in a control manner to effect the movement of cattle across the landscape. The project was not able to meet its objectives in terms of quantifying animal distribution as a result of two six week rotations of water point access at different sites. Cattle management was affected by the collapse of bores and inability to supply water to nominated tanks. Cattle generally returned to water points they had been accessing prior to the study period and intermittent storms were also reported to scatter cattle across one of the paddocks.
The planned second rotation and deployment of GPS units was not conducted due to below average seasonal rainfall and a management decision to destock Rockhampton Downs.

Nevertheless, positional data collected during the 8 week period indicated a pronounced bimodality in movement by all collared animals. Cattle travelled between 1.0 and 1.4 km/h when moving between water and grazing areas at dawn and dusk and moved considerably less (0.2 to 0.4 km/h) at other times. Cattle given access to three water points travelled significantly further over 24 h than animals in a similar sized paddock where there was only one water source. While this study has demonstrated that providing additional water points in large paddocks can increase the distance animals travel from water (4.6 *v.* 4.0 km) and their home range (19% *v*. 16% of area), the difference was not significant ($P > 0.05$).

Pasture availability (TSDM) in both paddocks increased from <200 kg / ha to ~1700 kg / ha as distance from water increased to 3 km. Cattle expressed preference for areas within 500 m of water, appeared to avoid areas between 500 and 3000 m, but also expressed preference for areas 3000 to 4000 m from water.

The project has clearly demonstrated that GPS locational data of grazing cattle can be captured in an extensive grazing environment and the extent of animal distribution relative to property infrastructure, such as water points, can be identified.

In time, it is expected that GPS technologies will be developed to such an extent that individual producers will have access to devices and software that would allow for on farm assessment of grazing distribution. This however, is reliant on a significant reduction in cost of devices and possible integration with RFID devices. An additional factor that will restrict adoption of this technology for commercial application is power management for long term deployments and continuous use in commercial situations.

Further replication across seasons, representative land types and combinations of water point arrangement/access is required to elucidate any statistically significant effect on grazing distribution for large commercial herds typical of the northern beef industry.

Contents

1 Background

1.1 Background to managing water points at Rockhampton Downs

Grazing animal distribution and pasture utilisation are valuable measures of how well rangelands are managed. However, the availability of water limits the season of use of pastures in arid regions and the distance to water is a major factor in livestock grazing distribution (Bailey 2005).

The use of a single water point in extensive paddocks results in over-grazing close to water and under-utilization further away. Installing multiple water points requires additional labour and capital. However, the management of water availability at alternative points has been shown to influence grazing distribution and improve pasture utilisation. Since water can act as an attractant in the landscape, alternating supply between a number of water sources could be an effective tool for manipulating cattle distribution across the extensive paddocks typical of Australia's rangelands.

Australian Agricultural Company Ltd (AACo) is responsible for over 7 million ha of land across Queensland and Northern Territory. AACo has an established project on Rockhampton Downs; "Managing grazing by alternating watering points in the Barkly region". Grazing activity around single water points has been managed in 6 week periods during the dry season by having one of 5 watering points operating at any one time. Pasture surveys in these large paddocks dominated by *Astrebla* spp. and *Iseilema* spp. grass pastures have indicated that the positioning of water in the landscape can alter grazing animal distribution (Kearins and Bubb 2006). Initial observations have suggested that cattle utilise more areas of the paddock than before, there is an improvement in pasture condition close to water and carrying capacity could be increased by approximately 30%. Therefore better positioning of water points has the potential to improve livestock productivity and reduce land degradation in certain areas. However, only pasture monitoring, at the beginning and end of the dry season, and visual observations have been used to support claims of changes in grazing animal activity and pasture utilisation.

With the availability of GPS devices for tracking livestock there is a relatively reliable and easy method to quantify the utilisation of different landscape units and distances travelled by cattle based on managing water availability. The current use of GPS tracking devices for livestock provides a direct measure of cattle distribution across different landscapes. These devices have been used to measure landscape preferences of Brahman cattle in the subtropical savannas (Tomkins and O'Reagain 2007) and provide an invaluable tool in measuring livestock distribution patterns relative to property infrastructure and changes in management.

The project reported here was initially intended to compliment the existing pasture monitoring project, conducted by the Northern Territory Department of Primary Industry, Fisheries and Mines (DPIFM) and use GIS information (satellite imagery, vegetation and soil maps) and GPS tracking of cattle to spatially and temporally quantify the effect of alternating water points on grazing distribution compared to an adjacent paddock where water was available continuously from several sources.

2 Project Objectives

2.1 Managing water

The three main initial objectives of this project were to:

1. Quantify the effect of two rotations in water point access, in a paddock where only one of several watering points operates for a six week period only, on grazing patterns and compare animal distribution across commercial sized paddocks to those in a control paddock, where water is available from a number of sources, over the same time.

2. Relate the effect of managing water availability to measured patterns of biomass availability and pasture utilisation.

3. Speculate on the effects of the grazing system as a whole on grazing distribution through-out the year relative to the control paddock.

3 Methodology

3.1 Study area

The study was conducted on Rockhampton Downs Station (18°56′S, 135°11′E) 160 km north-east of Tennant Creek, Northern Territory, between September and November 2007. Mean annual rainfall for the site is 348 mm. The region experiences distinct wet and dry seasons with 95% of the average annual rainfall occurring from November to April. Mean annual minimum and maximum temperatures are 19°C and 34°C, respectively.

Rockhampton Downs Station is located on the Barkly Tableland, namely the Barkly Tablelands / Wonorah land-system and is dominated by red massive earths and grey self-mulching cracking clays. The grassland savanna typical of this region is dominated by *Astrebla* spp. and *Iseilema* spp.

A single paddock of approximately 530 km^2, dominated by *Astrebla* spp. and *Iseilema* spp. grass pastures was divided into two paddocks; one of 280 km^2 and the other 253 km^2 (Figure 1). In the first paddock (No. 8) three water points, 6.8 to 9.6 km apart operated at all times. In the second paddock (No. 12) only one water point was operational during the study period.

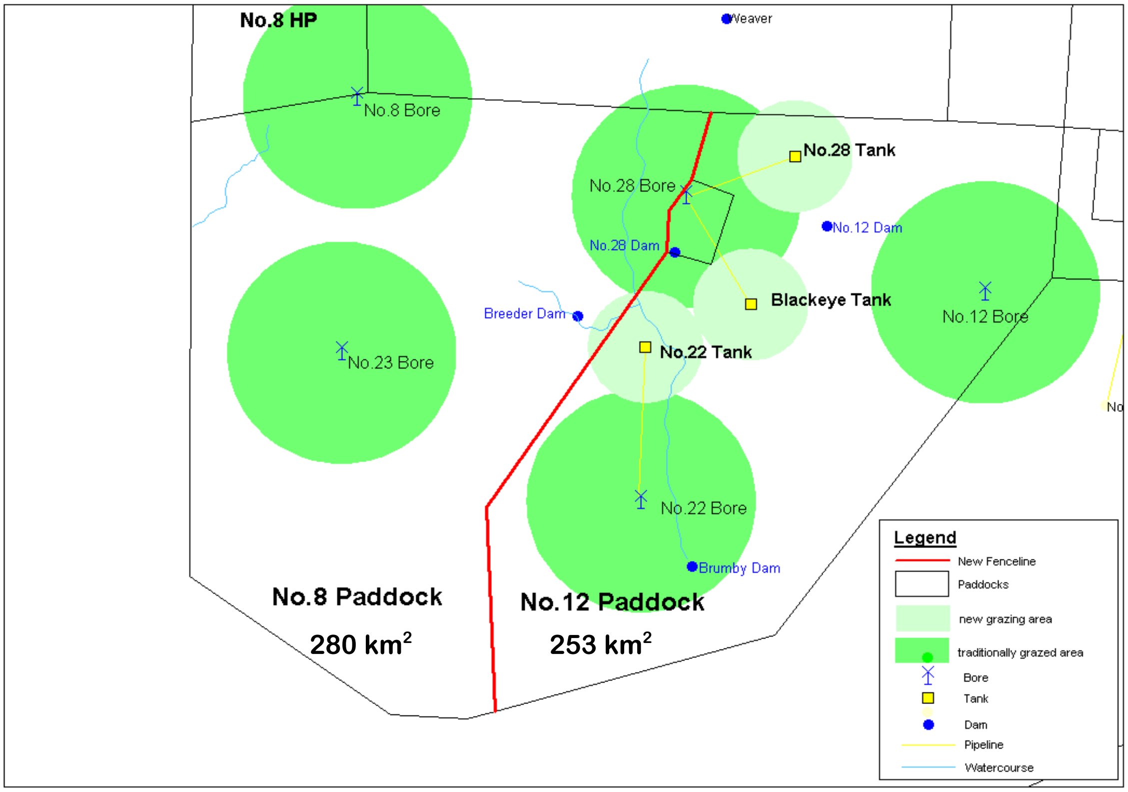

Figure 1 Study site indicating the two paddocks used in the trial, Rockhampton Downs. Grazing areas shown are indicative only and are based on previous total standing dry matter (TSDM, kg/ha) estimates and AACo visual observations not related to the current project.

3.2 Animal distribution

Nine breeder composite cows (50% Santa Gertrudis cross) were randomly selected from each of two breeding herds of 973 and 1081 cows during a routine muster in September 2007, late dry season. Each cow was fitted with an archival GPS unit (L400, BlueSky Telemetry Ltd, Scotland) mounted on a neck collar (Figure 2). The GPS receiver unit was a μ-Blox 16 channel receiver with 2Mb of flash memory. Each unit was programmed to collect a 3-dimensional position at 15 min intervals for a maximum of 300 sec, from ≥4 satellites, together with date, time, and number of satellites, ambient temperature and operational status (Tomkins and O'Reagain 2007). Horizontal dilution of precision (HOD) was restricted to <10. Animal activity could not be measured directly. GPS collars were removed from the animals in October 2007 after 54 days and positional data downloaded with a wireless interface.

Figure 2 GPS units mounted on neck collars were fitted to free ranging breeder cows.

3.3 Pasture monitoring

Pasture monitoring was conducted by the Northern Territory Department of Primary Industry, Fisheries and Mines (DPIF&M) using an intensive double sampling method at the beginning and end of the dry season (Kearins and Bubb 2006) to estimate total standing dry matter (TSDM, kg/ha). Transects originated at each watering point with sampling at 250m intervals up to 2 km and at 500m intervals there after to a maximum distance of 5 km from water.

Only data from the pasture surveys conducted in October 2007 were used in the project reported here.

3.4 Analysis of GIS and GPS tracking data

Property infrastructure, major soil types and animal position data were imported into ArcMAP™9.2 (ESRI®, Redlands, Calif.) to calculate kernel density, distances travelled and grazing range from individual water points. The distance travelled by an animal in an hour was defined as the sum of the straight-line distances between successive GPS locations. This value was calculated for each hour of the day for each animal. The distances between individual water points and each animal GPS position were calculated and these values averaged over the study period for each animal. The range from water (the maximum distance from the water point reached by an animal over the study period) was calculated. Standard errors of these variables (distance travelled per hour, average distance from water and range from water) were based on the number of animals in the analysis.

Spatial Analyst tools in ArcMap™9.2 (ESRI, Australia) were used to calculate 95% isopleths (kernel analysis) as an approximation of total home-range area (Worton 1989).
One way analysis of variance procedure was used to determine treatment effects (GenStat® 10 VSN International) between paddocks. Differences between means were considered significant at $P < 0.05$.

4 Results and Discussion

4.1 Animal distribution

The results presented here are based on positional data acquired by only 13 GPS units. GPS data could not be downloaded from one unit from each paddock. One unit, collected data for less than 24 h and was not included in the statistical analysis. In addition, one unit was lost during the study period and one unit was damaged beyond repair and data could not be retrieved. The results are also only preliminary in nature and do not capture a second deployment which was scheduled for March-May 2008 (end of wet season).

A pronounced bimodality was observed in movement by all collared animals in this study. Activity peaked during the early mornings (0530- 0900 h) and evenings (1700-2000 h) and distinct temporal dispersion patterns away from water were identified (Figure A9.1a – A9.1d).

Cattle travelled between 1.0 and 1.4 km/h when moving between water and grazing areas at dawn and dusk and moved considerably less (0.2 to 0.4 km/h) at other times. The location of water is generally recognised as the major factor affecting cattle utilisation patterns across pastures (Pinchak *et al*. 1991). Providing adequate amounts of drinking water is important for grazing animals (Vallentine 1990). Cattle given access to three water points travelled significantly further over 24 h than animals in a similar sized paddock where there was only one water source (Table 1). While this study has demonstrated that providing additional water points in large paddocks can increase the distance animals travel from water (4.6 *v.* 4.0 km) and their home range (19% *v*. 16% of available area) (Table 1), the difference was not significant ($P > 0.05$).

The distances from water reported here are similar to those of Hunt *et al*. (2007) for 57 km^2 paddocks with five water points, but less than those reported by Schmidt (1969) and Hodder and Low (1978). Nevertheless, similar temporal patterns of activity are apparent.

Table 1. Mean (± s.e.) range from water, distance travelled per day and home range estimates for free ranging cattle in paddocks with one or three water points.

	Paddock 8	Paddock 12
n	*7*	*6*
Area, km^2	280	253
Number of water points	3	1
Range$^{\wedge}$ from water, m	4621 ± 155.1	4001 ± 323.5
Distance travelled per 24 h, m	9350^{a} ± 211	7981^{b} ± 202
Home range$^{\#}$, km^2	54 ± 3.5	41 ± 6.3
% total paddock area	19 ± 1.3	16 ± 2.5

$^{\wedge}$calculated as the maximum Euclidean distance from water, $^{\#}$ based on 95% kernel analysis. Means with different superscripts are significantly different ($P < 0.05$).

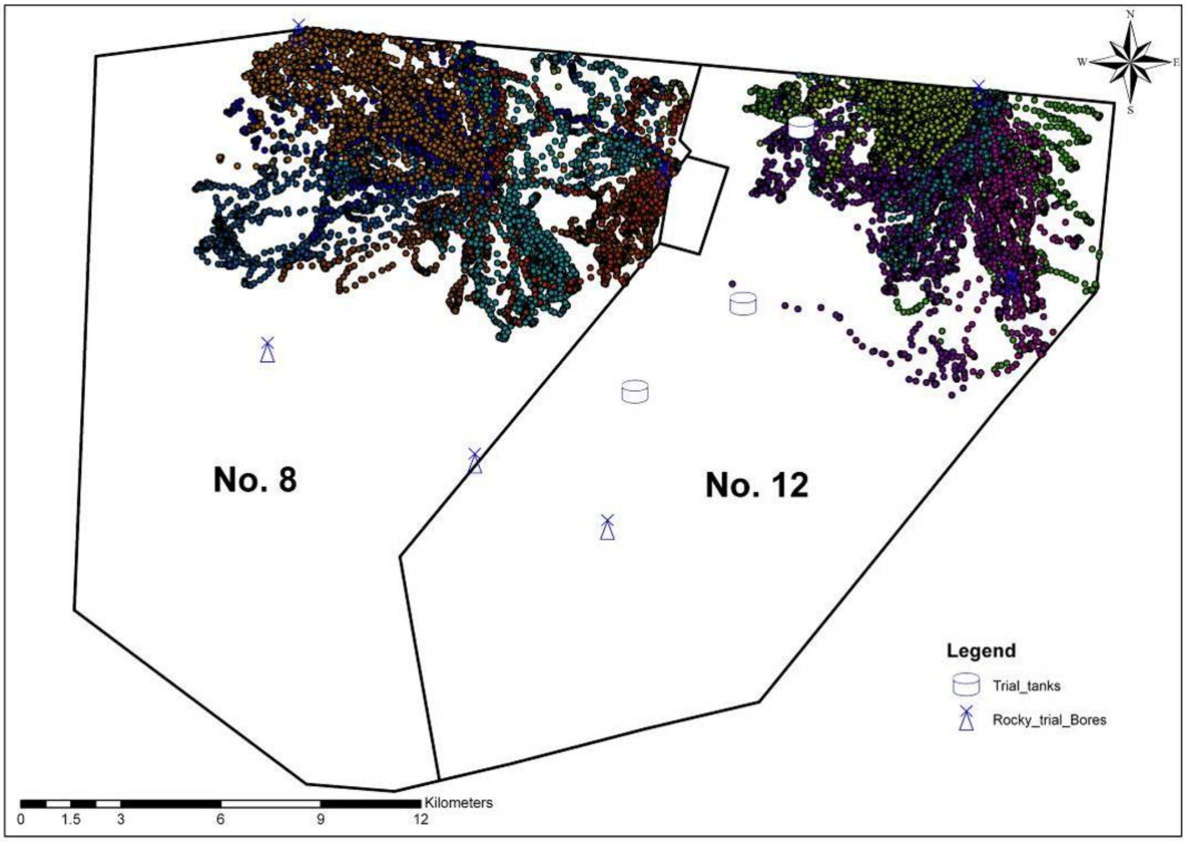

Figure 3 The spatial distribution of cattle fitted with GPS collars for the September- November 2007 deployment in each trial paddock. Each coloured point represents a position for each animal collected every 15 mins for 54 days using archival GPS units.

4.2 Pasture utilisation

The distance at which the majority of cattle are prepared to graze out from water can be directly related to the quantity and quality of available forage (Hodder and Low 1978). The relationship between the mean count of locational data for collared animals from water and TSDM is shown in Figure 4. While winter rainfall in northern Australia generally results in an increase in annual grasses, ephemeral forbs and native legumes, this study was conducted in September/October (end of the dry season). The prevalence of forbs and native legumes at other times of the year, namely after wet season rains, are known to play an important role in improving diet quality in the Mitchell grasslands (Lorimer 1978) and may result in considerably different grazing patterns, especially where ephemeral water exists. Consequently, similar studies need to be replicated across seasons.

Pasture availability (TSDM) for both paddocks increased from <200 kg / ha to ~1700 kg / ha as distance from water increased to 3 km. In these paddocks cattle expressed preference for areas within 500 m of water, appeared to avoid areas between 500 and 3000 m, but also expressed preference for areas 3000 to 4000 m from water. Where extensive shade is generally not available, cattle are more prone to loiter around water (Arnold and Dudzinski 1978), as has been observed in

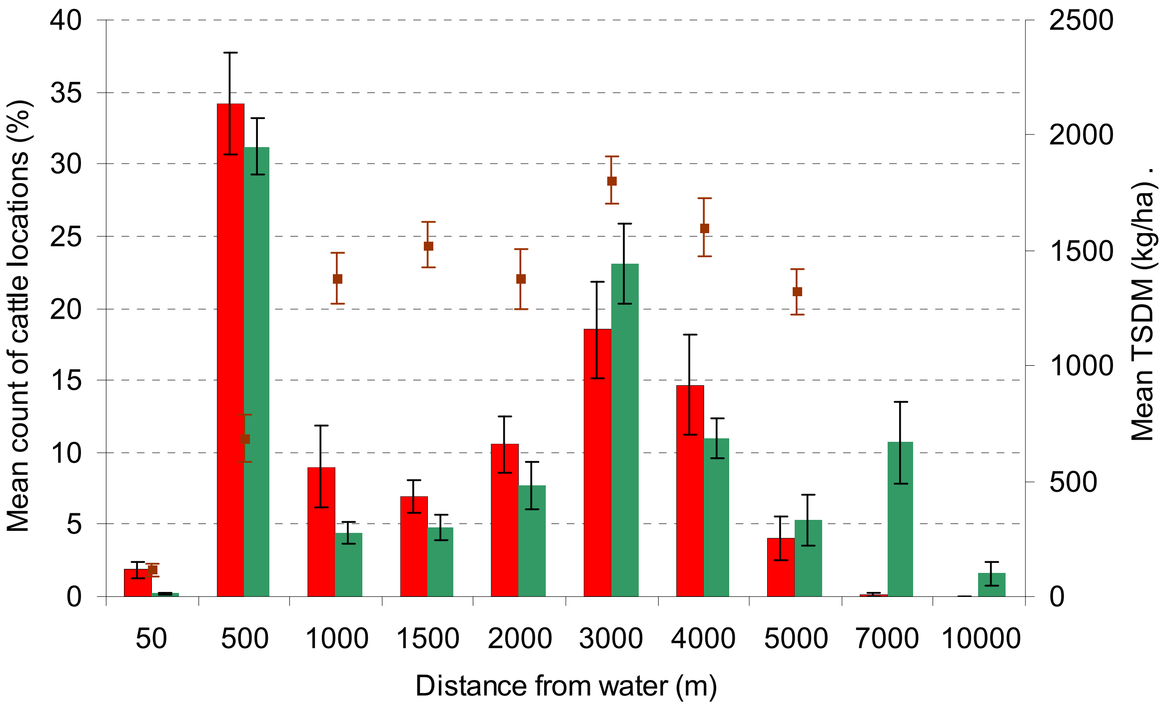

Figure 4 Mean (± s.e.) count of positional data for collared cows in paddocks with one (■) or three (■) water points related to mean (± s.e.) TSDM (■, kg/ha) with increasing distance from water.

this study where peak counts of cattle locations were recorded within 500 m of water for both paddocks.

Similarly, peak counts of cattle locations 3000 to 4000 m from water corresponded to pasture yields of up to 1700 kg / ha and could be associated with peak periods of grazing. However, it must be noted that these observations are site specific and the trial was conducted at the end of the dry season. Preference for areas at distance from water may be substantially different during the wet season or in situations where paddocks have received little grazing and pasture yields are higher within 3000 m from water compared to the results presented here.

4.3 Additional comments

These paddocks and water points were established before the study commenced. The intent was to manage grazing across paddocks by sequentially turning a number of water points on and off. While the location and number of watering points on grazing lands is important in controlling the movement, distribution, and concentration of grazing animals (Vallentine 1990, Ganskopp 2001), the location of the water points used in this study was not ideal and constrained by available water sources and proximity to fence lines. In both paddocks animals exhibited a clear preference (0.7 and 0.9; standardised selection index, Manly 2002) for areas associated with grey self-mulching cracking clays. Only one water point was not associated with this soil type. Although cattle had unlimited grazing opportunity in both paddocks and access to three water sources in one of the paddocks, the areas actually used, over 54 d, remained close to water and individual animals demonstrated a degree of fidelity to certain water points. Similar observations have been reported for free ranging cattle in extensive paddocks (Hodder and Low 1978).

5 Success in Achieving Objectives

This study was among the first of its kind (see also Hunt *et al*. 2007) to be applied in an extensive commercial situation in northern Australia. Objectives outlined in the initial proposal relied entirely on functionality of property infrastructure and replication of previous activities where water was managed in a control manner to effect the movement of cattle across the landscape. The project was not able to meet its objectives in terms of quantifying animal distribution as a result of two six week rotations of water point access at different sites. Cattle management was affected by the collapse of bores, leaking dams and inability to supply water to nominated tanks. In addition, it was observed that mobs of cattle generally returned to water points they had been accessing prior to the muster in September despite at least one bore having been turned off. Intermittent storms were also reported to scatter cattle across paddock 12.

Nevertheless, the project has clearly demonstrated that GPS locational data of grazing cattle can be captured in an extensive grazing environment and the extent of animal distribution relative to property infrastructure, such as water points, can be identified. Distances travelled per day, range from water points and kernel analysis indicating area of paddock accessed are potentially useful metrics in managing grazing across large (>120 km^2) paddocks. Further work is required to quantify the distribution of grazing animals where water is managed with the intent to modify pasture utilisation.

In consultation with AACo staff and MLA the project was terminated in March 2008. The second, late wet season, deployment was not initiated.

6 Impact on Meat and Livestock Industry – now & in five years time

This project was intended to demonstrate that animal distribution and pasture utilisation could be more evenly distributed in large extensive paddocks when water was managed on a rotational basis. However, results reported here indicate animal distribution for only one deployment and in a situation where water was available from either one or three sources in similar paddocks.
The use of GPS technology in association with GIS has been used to understand animal distribution in relation to infrastructure, namely water, in a commercial environment.

In five years time, it would be expected that GPS technologies would be developed to such an extent that individual producers will have access to devices and software that would allow on farm assessment of grazing distribution. This however, is reliant on a significant reduction in cost of devices and possible integration with RFID devices. An additional factor that will restrict adoption of this technology for commercial application is power management for long term deployments and continuous use in commercial situations.

Extensive spatial data acquisition will continue to be useful in rangeland grazing situations where development of infrastructure, namely water points, is justified by a quantified improvement in pasture utilisation. Increased interest in minimising the environmental impact and maintaining biodiversity associated with grazing activities across Australia's northern rangelands will make the use of the technology described here more common place in the industry.

7 Conclusions and Recommendations

The results obtained from this project are based on a small data set and represent animal distribution for the end of the dry season only. The paddocks and water points were established before the study commenced and available water points were restricted to those available at the time of the study due to circumstances described.

Achieving more even pasture utilisation in extensive paddocks is challenging. Determining the optimum arrangement of infrastructure that can be matched with appropriate stocking rate is yet to be determined. In this study it has been shown that similar patterns of animal distribution (home range) were achieved within paddocks with one or three water points. Water continues to be the limiting factor in spatial grazing patterns for extensive situations. The optimum distance between water in large (>120 km^2) paddocks is yet to be determined, however, it is likely that the distance between water points in the paddocks of the size used in this study could extend to > 9.6 km.

Behavioural differences between animals have also been cited as having potential to manage pasture utilisation as individual animals clearly demonstrate fidelity to single water points.

Satellite imagery of pasture dynamics and GPS technologies matched with behavioural data will prove to be a useful combination in identifying the best management options for grazing cattle across Australia's northern rangelands.

Further replication across seasons, representative land types and combinations of water point arrangement/access is required to elucidate any statistically significant effect on grazing distribution for large commercial herds typical of the northern beef industry.

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9 Appendices

9.1 The temporal distribution of cattle in trial paddocks, Rockhampton Downs

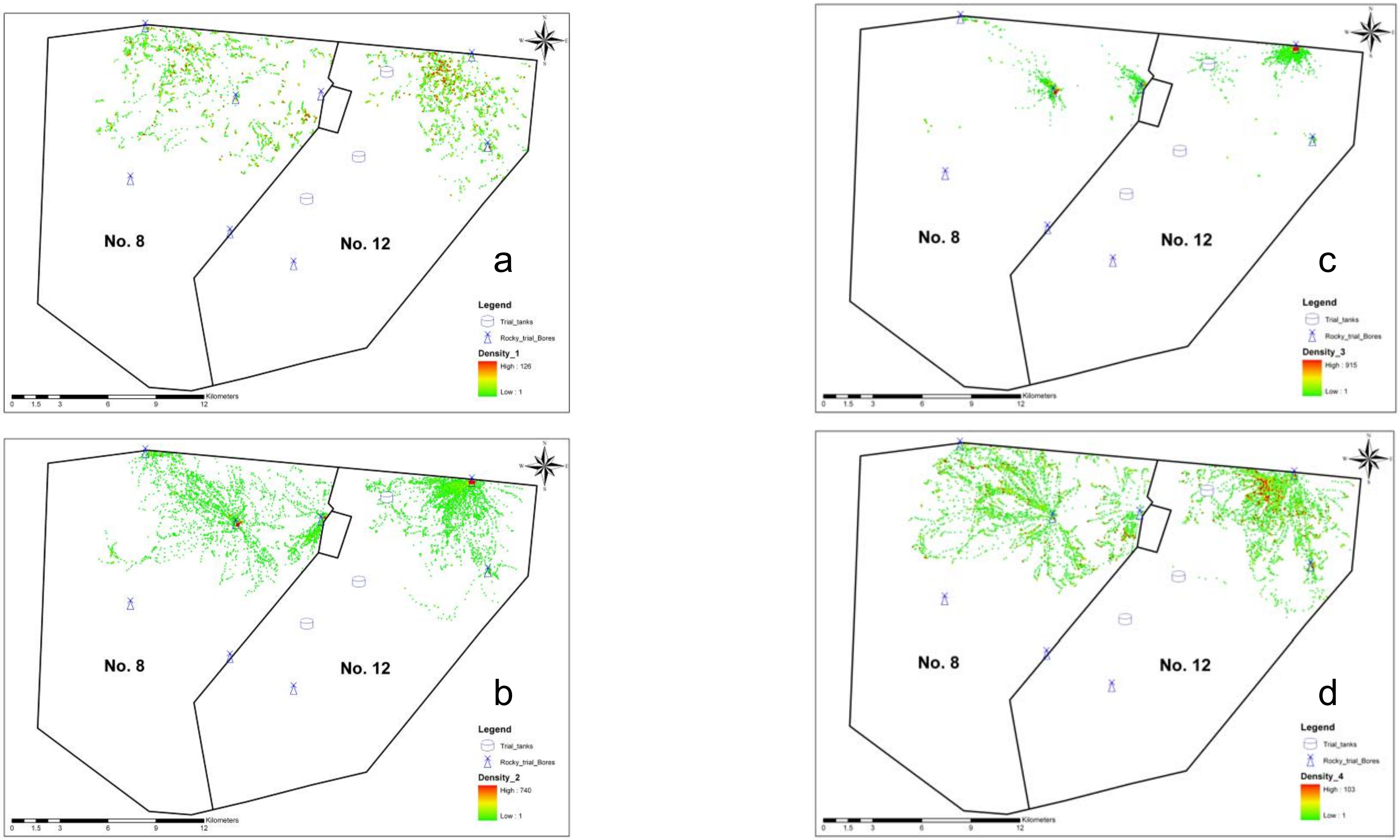

Figure A9.1 The temporal distribution of cattle fitted with GPS collars for 54 days in trial paddocks based on the number of locational points per cell (density) for time periods of a) 2400 – 0500 h, b) 0500 – 0900 h, c) 0900 – 1600 h and d)1600 – 2400 h. Each period is based on distances travelled per hour that indicate periods of estimated grazing activity (b and d) or non-grazing/camping (a and c).