MONITORING AND MANAGING GRAZING DISTRIBUTION OF CATTLE ON THE BARKLY TABLELANDS

N.W. Tomkins[A], S. Williams[A], S. Kearins[B] and H. James[C]

[A]CSIRO Livestock Industries, Rockhampton, Qld. 4701.
[B]Australian Agricultural Company Ltd, PMB 5 Mount Isa, Qld. 4825.
[C]Dept of Primary Industry, Fisheries & Mines, Tennant Creek, NT. 0860.

Email: Nigel.Tomkins@csiro.au

INTRODUCTION
The conservation of Australia's northern rangelands is important research. Grazing animal distribution and 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). Pasture surveys in large (> 120 km^2) 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 in pastures typical of black soil plains in northern Australia (Kearins and Bubb 2006). Better positioning of water points has the potential to improve livestock productivity and reduce land degradation in certain areas. 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 aims of this study were to quantify the spatial distribution of cattle to pasture availability when water is supplied from single or multiple points in paddocks typical of the Barkly Tablelands.

MATERIALS AND METHODS
The study site, on Rockhampton Downs Station (18°56′S, 135°11′E), is part of the Barkly Tablelands/Wonorah land-system and includes red massive earths and grey self-mulching cracking clays. A single paddock, 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. In the first paddock 3 water points, 6.8 to 9.6 km apart operated at all times. In the second paddock only one water point was operational. Eight cows (Senepol x Charolais x Santa Gertrudis) from each paddock of approximately 1000 cows with calves were randomly selected during a routine muster and fitted with archival GPS units (Bluesky Telemetry Ltd, UK) in September 2007, late dry season. 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. Horizontal dilution of precision (HOD) was restricted to <10. The collars were removed after 54 days and positional data downloaded with a wireless interface. Pasture surveys at fixed intervals up to 5 km from each operational water point assessed total standing dry matter (TSDM) in October 2007. 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 kernel method (95% isopleth) was used as an approximation of total home-range area (Worton 1987). 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 $P < 0.05$.

RESULTS AND DISCUSSION
The results presented here are based on positional data acquired by only 13 GPS units; data could not be downloaded from one unit from each paddock. One unit, used in paddock 1, collected data for less than 24 h and was not included in the statistical analysis.

A pronounced bimodality was observed in movement by all collared animals in this study. Activity peaked during the early mornings (05:30- 09:00 h) and evenings (17:00-20:00 h) and distinct temporal dispersion patterns away from water were identified. Further spatial analysis of the data will examine these relationships. 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 (Table 1). While this study has demonstrated that providing additional water points in large (>120 km^2) 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 ($P > 0.05$). Further replication is required to elucidate any statistical differences between paddocks with different spatial arrangement of infrastructure. 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 watering points.

	Paddock 1	Paddock 2
n	*7*	*6*
Area, km^2	280	253
Number of water points	3	1
Range^ 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 available area	19 ± 1.3	16 ± 2.5

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

Providing adequate amounts of drinking water is important for grazing animals (Vallentine 1990). The location of water is generally recognised as the major factor affecting cattle utilisation patterns across pastures (Pinchak *et al.* 1991). 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 1. 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 3000 m. 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 shade is generally not available, as in this case, cattle are more prone to loiter around water (Arnold and Dudzinski 1978), as has been observed where peak counts of cattle locations were within 500 m of water. 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

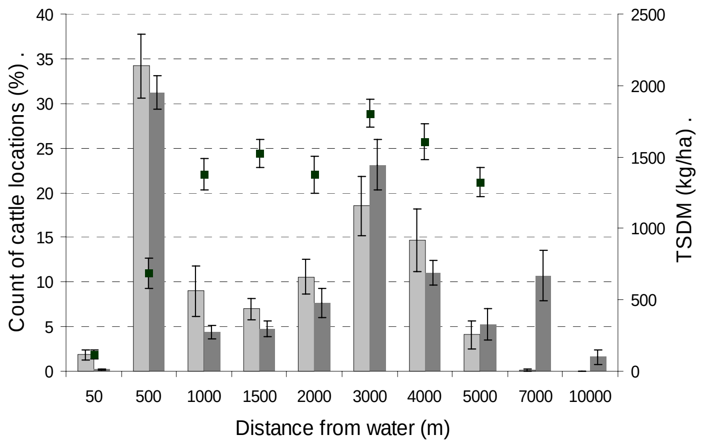

Fig. 1. Mean (± s.e.) count of positional data for collared cows in paddocks with one ( ) or three ( ) water points and mean (± s.e.) TSDM (■, kg/ha) with increasing distance from water.

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. It is likely that the animals had already grazed out the area within 3000 m of water and were now travelling further to maintain intakes. Preference for areas at distance from water may be substantially different during the wet season or in situations where paddocks receive little grazing and pasture yields are higher within 3000 m from water compared to the results presented here.

These paddocks and water points were established before the study commenced. The intent was to manage grazing pressure 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 fidelity to certain water points. Similar observations have been reported for free ranging cattle in extensive paddocks (Hodder and Low 1978).

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, and others, water continues to be the limiting factor in spatial grazing patterns. Behavioural differences between animals have also been cited as having potential to manage pasture utilisation. 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 northern Australia's extensive pastures.

ACKNOWLEDGEMENTS

This research was partly funded by Meat & Livestock Australia. Ben Wratten and staff at AACo, Rockhampton Downs provided invaluable assistance in handling cattle and assisting with fitting and removing GPS units.

REFERENCES

Arnold, G.W. and Dudzinski, M.L. (1978). Ethology of free-ranging domestic animals. **Elsevier, Amsterdam**.

Bailey, D.W. (2005). Identification and creation of optimum habitat conditions for livestock. *Rangel. Ecol. Manage.* 58, 109-118.

Ganskopp, D. (2001). Manipulating cattle distribution with salt and water in large arid-land pastures: a GPS/GIS assessment. *App. Anim. Behav. Sc.* 73,251-262.

Hodder, R. M. and Low, W.A. (1978). Grazing distribution of free-ranging cattle at three sites in the Alice Springs district, Central Australia. *Aust. Rangel. J.* 1, 95-105.

Hunt, L.P., Petty, S., Cowley, R., Fisher, A., Ash, A. and MacDonald, N. (2007). Factors affecting the management of cattle grazing distribution in northern Australia: preliminary observations on the effect of paddock size and water points. *The Rangel. J.* 29, 169-179.

Kearins, S. and Bubb, A.J. (2006). Managing grazing by alternating watering points in the Barkly region. 14th Biennial Australian Rangeland Conference, Renmark, SA. pp. 239-241.

Lorimer, M.S. (1978) Forage selection studies 1. The botanical composition of forage selected by sheep grazing *Astrebla* spp. pasture in north-west Queensland. *Tropical Grasslands* 12, 97-108.

Manly, B.F., McDonald, L.L., Thomas, D.L., McDonald, T.L. and Ericksen, P.W (2002). Resource selection by animals. Statistical design and analysis for field studies. 2nd Ed. **Kluwer Academic, Dordrecht** Netherlands.

Pinchak, W.E., Smith, M.A., Hart, R.H. and Waggoner, J.W. (1991). Beef cattle distribution patterns on foothill range. *J. Range Management* 44, 267-275.

Schmidt, P.J. (1969). Observations on the behaviour of cattle in a hot dry region of the Northern Territory, with particular reference to walking, watering and grazing. M.Ru.Sc. Thesis, UNE Armidale NSW.

Tomkins, N.W. and O'Reagain, P.O. (2007). Global positioning systems indicate landscape preferences of cattle in the subtropical savannas. *Rangel. J*. 29, 217-222.

Vallentine, J.F. (1990). Grazing Management. **Academic Press, San Diego Calif**.

Worton, B.J. (1987). Kernel methods for estimating the utilisation distribution in home-range studies. *Ecol*. 70, 164-168.