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GLOBAL POSITIONING SYSTEMS INDICATE LANDSCAPE SELECTION BY CATTLE IN THE TROPICAL SAVANNAHS

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ABSTRACT
This study investigated the distribution and landscape selection of grazing cattle using a global positioning system (GPS) to track cattle. Brahman cows were fitted with Bluesky™ GPS collars for 8 weeks. The study area had a single water point and contained a wide diversity of land types. The data indicated grazing preferences were initially limited to a 250 ha cleared area of clay soil sown with *Cenchrus cilliaris*. Thereafter, animals moved on to less fertile, outlying areas of *Eucalyptus* and *Acacia agyrodendron* native pasture woodland. Animals avoided areas dominated by steep terrain and travelled a maximum of 4.1 km from water. The study confirms that grazing preferences can be interpreted through GPS and satellite imagery for commercial operations. Areas susceptible to over-grazing can be identified and sustainable land management practices adopted accordingly.

INTRODUCTION
Variability in landscape productivity and the large scale of northern Australian beef properties provide challenges for sustainable landscape management. Commercial paddocks are often large and contain a mixture of land types, while water for livestock is often not evenly distributed. Paddock scale grazing patterns may be uneven, resulting in over- and under-use of different areas. This can result in a reduction in productive capacity and localised land degradation. Our current understanding of the main factors driving spatial selection by livestock is poor (O'Reagain 2001). Water has been identified as a primary determinant of cattle distribution in extensive landscapes (Ganskopp, 2001). Forage utilsation is often centred on artificial water sources, as grazing cattle may only travel 4 - 10 km per day from water (Hodder and Low, 1978; Ganskopp, 2001) and consequently the majority of grazing would occur within this distance. A piosphere effect often becomes apparent (Lange, 1969) and a logistic growth curve equation has been shown to describe the yield response of vegetation to grazing as a function of distance from water (Graetz and Ludwig, 1978). The positioning of water across arid-land pastures can thus be an effective tool for manipulating cattle distribution. Aside from water, grazing animals have been observed to spend the greatest proportion of their foraging time in areas offering the greatest rate of digestible energy intake, but they also spend a significant proportion of time in "sub-optimal" areas (Langvatn and Hanley 1993; Wilmshurst *et al.*, 1995). Areas close to water and/or dominated by palatable grass species are therefore grazed preferentially (O'Reagain, 2001). Foraging strategies used by the animal thus determine the intensity, timing and spatial location of plant defoliation and consequently the grazing impact on the pasture (O'Reagain 2001). Despite the importance of understanding spatial selection patterns over extensive landscapes, it is only since the commercial development of GPS for tracking animals (Rodgers, 2001; Udal, 1998) that a relatively reliable and easy method to measure the utilisation of different landscape units has existed.

This study investigated the distribution and landscape selection of grazing cattle over a large heterogenous pasture and was achieved by fitting cattle with GPS collars to quantify their activity in relation to a single water point.

METHODS

The investigation was conducted on Trafalgar Station, 60 km south-west of Charters Towers, Qld. Average annual rainfall is 642 mm. Soils are predominantly P deficient yellow earths. Brown cracking clays and texture contrast soils are also present. The study site was a 1530 ha paddock that contained a single water point located in the extreme SW of the paddock. The site contained a mixture of land types, ranging from cleared and uncleared *Acacia agyrodendron* communities on heavy clay soil, to shallow texture contrast soils dominated by *Eucalyptus melanophloia* to stony slopes dominated by *Spinifex* and *A. shirleyii* scrub. Paddock surveys and Landsat imagery were used to map dominant vegetation types. Pasture yield and composition were determined using the BOTANAL methodology (Tothill *et al.*, 1992) along six, 3-4 km transects that bisected all vegetation types.

Twelve Bluesky™ GPS collars were programmed to obtain a position from a minimum of 4 satellites every 30 min for 8 weeks. The collars were fitted to Brahman cows randomly selected from the breeding herd during a routine muster in November 2005. The data collected by each GPS unit was; date/time, latitude, longitude (WGS 84), number of satellites and operational status. After collars were removed from the animals, data was down-loaded using a wireless interface and converted to Eastings/Northings with CoordTrans™ to facilitate algebraic derivation of distances.

RESULTS & DISCUSSION

The performance of the GPS units was variable with units collecting data from 2 to 44 d. Data from all collars was used to determine mean values. This study involved mature cows with calves which, as a class of livestock, have been shown to travel less than yearling cattle (Arnold and Dudzinski, 1978). The age and sex of cattle may contribute to grazing distribution, but the general rate of herbage removal from any one site or patch will primarily influence progressive changes in grazing patterns. The mean distance travelled, m/h, over 24 h in this study is shown in Figure 1. Peak periods of travel per hour were confined to dawn and dusk, which were probably the main grazing times. During these periods animals travelled up to 800m in an hour. Mean total distance travelled between visits to water, range from water and minimum convex polygon (MCP) area is shown in Table 1. During the 8 weeks mean MCP area was 341 ± 85.5 ha and animals avoided areas dominated by steep stony terrain. This avoidance would have limited effective grazing opportunities. Figure 2 indicates the distribution of one animal across the study site. Animals accessed a maximum of 671 ha or 44 % of the study site. Spatial analysis of the GPS data indicated that grazing preferences were initially limited to a 250 ha cleared area of clay soil sown with *C. cilliaris* and relatively close (within 4.1 km) to water. Thereafter, animals moved on to less fertile, outlying areas of *Eucalyptus* and *A. agyrodendron* native pasture woodland. Overall animals largely ignored a large area of steeper, stony terrain in the NE of the study site. The selective concentration of grazing animals in certain areas can be regarded as a reflection of the extent of heterogeneity of the landscape and the multi level response of the animal to this environment.

Table 1: Mean (± sem), minimum and maximum distances travelled per day, range and return distance from a single water point for Brahman cows

	Mean ± sem	minimum	maximum
Distance travelled per day (m/24 h)	8127 ± 267	3648	14698
Range from water (m)	1464 ± 13.7	_	4125
Distance travelled between visits to water (m)	13811 ± 4770	5186	26670

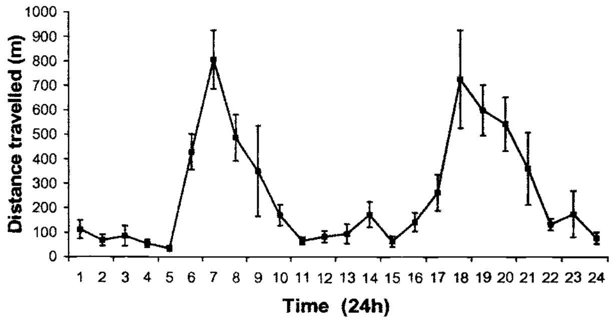

Figure 1: The mean (± sem) distance travelled per h over 24 h by Brahman cows fitted with GPS collars

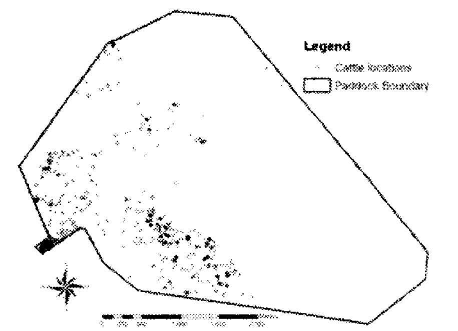

Figure 2: The grazing distribution of one animal fitted with a GPS collar. Location fixes at 30 min intervals over 8 weeks

Similar distances across different pastures from water have been reported elsewhere (Hart *et al.*, 1993; Hodder and Low, 1978). Drinking events, determined by proximity to water, were also evident during dawn and dusk. Mean distance travelled between visits to water was 13.8 ± 4.77 km. On occasions some animals would not return to the water point for up to 3 d. However, it is possible that they were watering from small ephemeral waterholes during this time.

Knowledge of pasture distribution and order of grazing preferences by cattle can be a useful tool in planning the location of water points and fence lines (Hodder and Low, 1978). This study clearly indicated a grazing preference initially limited to a cleared area of *C. ciliaris* that was located in relatively close proximity to a single water point with animals subsequently moving on to less fertile, outlying areas.

Lower GPS fix rates would maximise battery life and could be used in long term studies to reveal a hierarchy of grazing preferences across these variable landscapes typical of Northern Australia. However, accuracy of measurements of distances travelled would be reduced.

Further analysis of the data obtained in this study will explore changes in grazing preferences over time.

CONCLUSIONS

The study confirms that grazing preferences can be interpreted through GPS and satellite imagery for commercial operations. Areas susceptible to over-grazing can be identified, leading to more sustainable pasture and animal management.

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