GNSS TRACKING OF LIVESTOCK: TOWARDS VARIABLE FERTILIZER STRATEGIES FOR THE GRAZING INDUSTRY

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ABSTRACT

This study reveals the potential for GPS tracking in the grazing industry. By monitoring the locations and movement of livestock, times of peak grazing activity can be identified and these can in turn produce maps of preferred grazing areas, and by examining residency times provide an indication of spatial variability in grazing pressure. A comparison of grazing preference can be made to similarly inferred camping areas to understand the potential redistribution of nutrients within a paddock. This paper examines how simple GPS position records of livestock may be used to create a link in each of the aforementioned concepts with a view to using the data to produce maps of pasture utilisation and provide site specific fertilizer recommendations for livestock farmers.

Keywords: GPS, GNSS, livestock tracking, spatial livestock monitoring, precision pastures, site specific management, pasture utilisation.

INTRODUCTION

Yield monitors linked with GPS have revolutionised the grains industry and are one of the key drivers behind the adoption of site specific land management in agriculture. We suggest that spatial monitoring of livestock behaviour can provide graziers with the tools to similarly manage their grazing land culminating in reliable measures of true pasture utilisation and facilitate site specific management to account for nutrient removal and redistribution. This paper reports on an initial trial established to examine the potential for spatial livestock monitoring using a Global Navigation Satellite System (GNSS) tracking device developed at the University of New England (Australia) for determining the spatial variability in resource utilisation of pastures.

MATERIALS AND METHODS

The trial site was located at "Newstead", a property 40km east of Inverell on the Northern Tablelands of New South Wales on the East Coast of Australia. The paddock consisted of gently undulating hills predominantly sown to tall fescue (*Festuca arundinacea* var Fletcher), with several gullies and isolated timbered areas dominated by native grass species. GNSS tracking collars (UNEtracker: Trotter & Lamb 2008) were deployed on 6 steers in a herd of 220 for a period of 10 days during February and March of 2008. The 10 day deployment represented the usual grazing period for this field which is managed as part of a larger four paddock rotation.

The location of the six animals was logged every five minutes. The raw GPS records were analysed using ArcGIS (ESRI 2006) and Microsoft Excel. Displacement records were derived using "Hawths Tools", an add-in for ArcGIS designed to facilitate analysis of ecological and animal movement data (Beyer 2004). This information was exported to Excel and velocities calculated by dividing step length by the time interval recorded between each point. Microsoft Excel was used to graph mean daily velocities, distribution of velocities and instantaneous velocity (based on consecutive GPS records) as functions of hour of day to provide a diurnal activity chart.

Based on other studies (Ungar *et al.* 2005; Trotter & Lamb 2008) an average hourly velocity cut-off of 250 m/hr was used to categorise the locations into discrete activity sessions of Night Camping (NC), Peak Morning Grazing (PMG), Day Camping (DC) or Peak Afternoon Grazing (PAG). Raw data points for the PMG, PAG and NC sessions where then mapped as a livestock residence index (Trotter *et al.* 2010) on a fifty meter grid. The Livestock Residence Index for any given grid cell *x*, (LRI_x) was calculated using the following equation where n is the number of cells in the entire trial field:

$$LRI_x = \frac{\sum_x Raw\ point\ count}{\sum_n \sum_x Raw\ point\ count}$$

RESULTS AND DISCUSSION

The diurnal activity of the selected steers was found to be similar to that in many other studies (Trotter, 2008; Tomkins, 2006) with activity peaking at >250 meters per hour at two distinct times, one from 5 to 7am (PMG) the other from 1pm to 6pm (PAG). Observational studies have reported these times to correlate with peak grazing activity (Roath & Krueger 1982; Hinch *et al.* 1982) and therefore it is likely that these periods of activity also represent the peak time of grazing activity for the steers. The NC activity sessions are characterised by mean hourly velocities of approximately 50 meters per hour and although there is likely to be some true movement represented by these values the GPS accuracy is also likely to contribute this variation. The mean velocities for the DC session are higher than night (150-250 m/hr), the result of some mixed grazing and camping activities during this period.

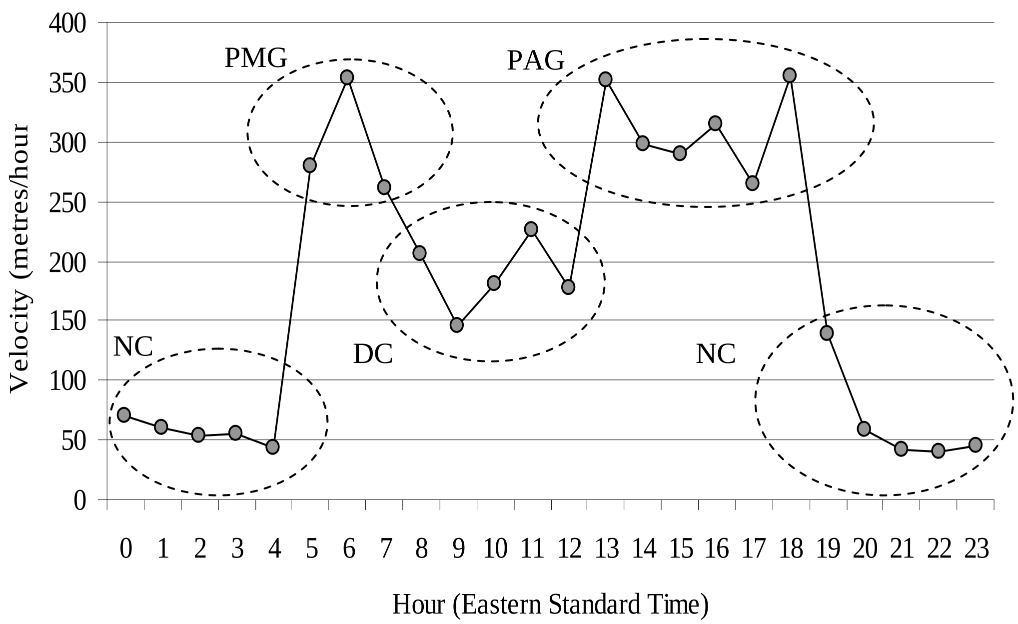

Figure 1. Diurnal activity of 6 steers tracked at 5 minute intervals over 10 day. Activity segments are circled as either Night Camping (NC), Peak Morning Grazing (PMG), Peak Afternoon Grazing (PAG) and Day Camping (DC).

By distinguishing the locations at which the steers were logged during the activity sessions a map revealing the preferred PMG, PAG and NC can be developed (Figures 2 - 4).

The NC map (Figure 2) demonstrates the steers preference to camp on the elevated areas of the paddock on the North East and Western sides of the paddock. As the night camping session covers a period of 10 hours (Figure 1) it is clear from Figure 2 that these animals have spent a large proportion of their time in a relatively small area of the paddock. This may have implications for nutrient redistribution as livestock defecation and urination patterns are known to be highly correlated with the distribution of the animals themselves (Ballard & Krueger 2005). These areas may well be receiving a proportionally larger deposition of nutrients through manure and urine than other unused areas of the paddock.

Figure 2. Spatial variation in paddock used by steers during Night Camping session expressed as a Livestock Residence Index on a 50 meter grid.

The PMG and PAG (Figures 3 and 4) show the primary grazing locations for the tracked steers. The PMG map (Figure 3) demonstrates the steers' preference to graze the North Eastern areas of the paddock with some utilisation of the Northern part of the centre of the paddock which is dominated by a gully during their morning grazing sessions. In contrast the PAG session focuses on the Southern and Eastern parts of the paddock. There is known to be considerable variation in both the forage selection of livestock and plant characteristics over a diurnal cycle (Gregorini *et al.* 2008) and it is likely that this spatial variation is a consequence at least in part, of the complex interaction of these factors.

Most importantly the PMG and PAG maps show a greater spatial distribution of time spent by the livestock over a larger area of the paddock compared to the NC map. It is from the areas showing high LRI in the PMG and PAG that the livestock are likely to be removing nutrients and whilst some nutrients are likely to be recycled to these locations the large proportion of time spent at the NC areas suggests that these areas may indeed receive a higher proportion of the nutrients removed from the grazing areas. These trends have been noted by other researchers who found an increased level of phosphorus around camp areas compared to the grazing areas of livestock (Gusewell *et al.* 2005).

Figure 3. Spatial variation in paddock used by steers during Peak Morning Grazing session expressed as a Livestock Residence Index on a 50 meter grid.

Figure 4. Spatial variation in paddock used by steers during Peak Afternoon Grazing session expressed as a Livestock Residence Index on a 50 meter grid.

There is considerable scope to use this information in the formulation of site specific fertiliser management strategies for the grazing industry. We believe that by correlating these data with spatial variability in pasture biomass, soil nutrient analysis and an understanding of the nutrient redistribution by livestock it may be possible for variable rate fertilizer recommendations and targeted fencing strategies to be developed for the grazing industry leading to increase pasture production and utilisation. Further research needs to focus on quantifying the redistribution of nutrients over the landscape and longer term monitoring of a larger proportion of the herd to understand the individual animal and seasonal variation in landscape utilisation.

CONCLUSIONS

GPS tracking devices can be successfully deployed to identify and quantify the spatial grazing patterns of livestock and there is potential for the development of site specific management strategies using this information. Further research is required to quantify the correlations of movement data with grazing activity and spatial variation in nutrient redistribution, pasture biomass and pasture quality.

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