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UNDERSTANDING HERBIVORE BEHAVIOUR IN RANGELANDS: DEVELOPING MORE ACCURATE RESOURCE SELECTION FUNCTIONS

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INTRODUCTION

Uneven use of the landscape by grazing herbivores leads to some areas being over utilised whilst others are under utilised (Andrew 1988). Understanding the scale and impact of preferential selection provides the basis for developing sustainable land management practices. Resource selection functions correlate animal location data with landscape features. Robust resource selection functions require accurate animal location data (Hulbert and French 2001). Recent studies have used satellite based global positioning systems (GPS) to provide data on animal locations (Swain *et al.* 2008). Whilst detailed research has been completed to explore the spatial accuracy of GPS data, it is only recently that the problem of temporal accuracy and its impact on the predictive ability of GPS data has been investigated.

Location error or spatial accuracy is the difference between the animals ‘true’ position and the position estimated by the GPS fix. It has been shown that ordinary GPS data can only provide spatial accuracy to within between 5 and 10 m, differentially corrected GPS has slightly better accuracy and is accurate to within approximately 3 and 7 m (Swain *et al.* 2008). Variations in absolute GPS accuracy are in part caused by the GPS chip but can also be affected by satellite orientation and environmental factors including prevailing climatic conditions. Temporal accuracy is the error associated with varying sample intervals. Varying sample rate errors relate to the distance an animal might move between fixes and the degree to which the data represents an animal’s true patch selection. Using high sample rate GPS data it has been shown that at fix rates of one hour it is only possible to estimate selection of a one hectare patch with 10% accuracy (Swain *et al* 2008)

The natural drift in a static GPS position or spatial error impacts on the accuracy of relative positions. To date, no work has been done to explore the relationship between fix rate and the accuracy of relative positions. This paper presents mean spatial error data derived from static GPS receivers and then explores how varying sample rates effect the relative positions. The implications of the findings are discussed in relation to resource selection functions and calculation of animal speeds.

MATERIALS AND METHODS

The experiment was carried out on Belmont Research Station (150°13’E, 23°8’S). Three GPS devices were used to generate a 2 Hz (twice per second) dataset over 6 hours from 09:00 to 15:00 on 15th March 2008. Preliminary data analyses were completed using ArcGIS version 9.2 (ESRI Australia Pty Ltd, 2007) software to map the spread of values, identify the mean centre and standard distances (one, two and three). One standard distance represented one standard deviation. In a normal distribution, each standard distance has a statistical distribution of points. Plotting the points in ArcGIS provided a useful graphical aid in visualising the drift of the GPS data, and was used to numerically determine the radius of the circle which encompassed 95.45% (2 standard distributions in normally distributed data) of points. The distance of each point from the mean centre was calculated and plotted on a histogram along with standard deviations.

The 2 Hz data were sub-sampled at 1 Hz, 5 s, 10 s, 30 s, 1 min and 5 min intervals and the mean distance between consecutive points calculated to illustrate the effect of temporal resolution on relative precision of a fixed data point. These data were graphed to determine the optimal fix rate that maintained temporal precision whilst optimising GPS battery life.

RESULTS

The variation in the recorded position of a series of locations from a stationary GPS device reflects the spatial error associated with GPS data (Table 1). The histogram shows a maximum drift of approximately 4.4 m, this is a measure of the absolute positional accuracy of the GPS device (Figure 1). Ninety five percent of points are within 1.6 m of the mean centre. That is, a circle 3.2 m in diameter encompasses 95% of the values of the stationary GPS devices.

Table 1: Mean position and standard deviations (s.d.) and mean distance from mean centre and standard error of the mean (s.e.m.)

	Mean position (m)				Mean distance from mean centre	
GPS device	Northing	Northing (s.d.)	Easting	Easting (s.d.)	(m)	s.e.m
299	7429972.71	1.900	232368.11	1.067	1.8405	0.00561
353	7430630.78	1.339	232737.57	0.770	1.3673	0.00346
380	7430203.64	1.608	232395.27	1.060	1.6463	0.00481
Mean					1.6180	0.00463

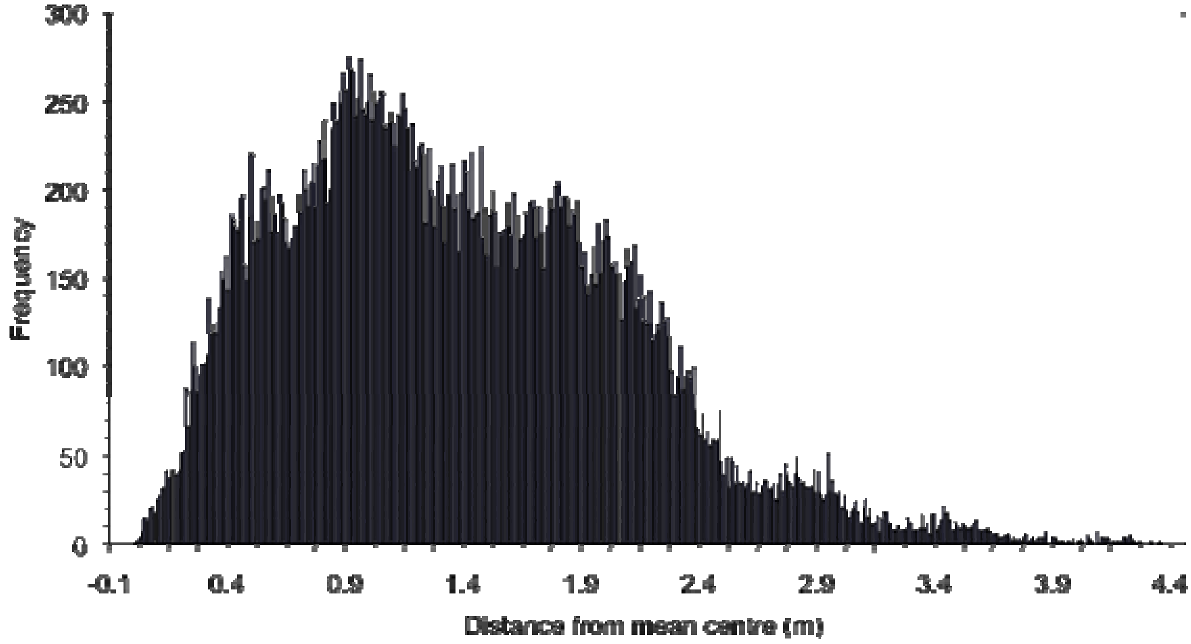

Figure 1: Histogram showing the distance from the mean centre of GPS points over 6 hours for one GPS device.

As sample interval increases, the distance (relative error) between consecutive points increases (Figure 2). For fix rates greater than 1 min there is little improvement in the relative accuracy of the GPS data. However, as the fix rate decreases below one minute there are significant improvements in the relative accuracy of consecutive fixes. At fix rates below 10 seconds the relative error decreases to below 0.5 metres.

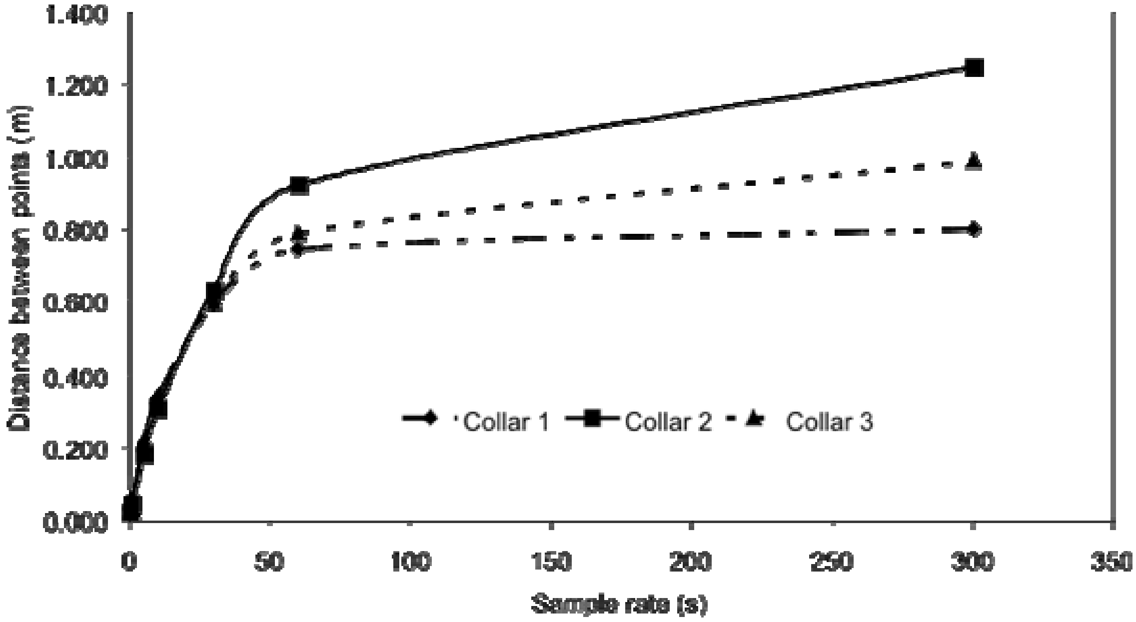

Figure 2: Relative accuracy of GPS positional data for varying fix intervals for three GPS devices. As fix rate decreases there is an associated decrease in the relative accuracy of the data.

DISCUSSION

The accuracy of GPS data has most often been explored in relation to absolute spatial precision. It is well established that GPS data drift; the data we present here substantiate this claim. Higher sample rate GPS data are being used to calculate speed based on the relative positions of consecutive GPS fixes and distance based on the relative position of animals using GPS fixes from two or more devices. The temporal relationship between sample rate and GPS error has received little attention. These results demonstrate that when high sample rate data are used to calculate speed or inter-animal distances then the precision of the data is significantly better. As the sample interval increases, the precision of the data decreases.

To obtain the most accurate speed (calculated using distance per unit time) and inter-animal distances this study as shown that the GPS sample interval should be below 10 seconds. For high sample interval studies animal speed could interact with GPS errors to cause erroneous speed and inter-animal distance results (Swain *et al.* 2008). As the sample interval increases the speed and inter-animal distance errors approach the maximum error derived from GPS drift. The relative benefits of using lower fix intervals to improve the accuracy of speed and inter-animal distances calculations is less pronounced for sample intervals greater than one minute. The GPS drift error will interact with the distance travelled by the animal to increase the error (Ganskopp and Johnson 2007). The shorter the distance an animal moves the greater the impact the GPS drift will have on speed calculations.

We conclude that GPS drift can cause errors for absolute spatial precision, animal speed estimates and inter-animal distance calculations. The interaction between distance travelled and GPS errors causes the greatest likelihood of speed errors to occur at intermediate GPS sample intervals. The data collected in this study didn't quantify the upper sample interval errors associated with the distance an animal travels. However, the results did demonstrate that behavioural studies should use sample intervals of less than 10 seconds to minimise animal speed and inter-animal distance calculation errors associated with GPS drift.

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