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Full Length Research Paper

Seasonal habitat use and movement patterns of cattle grazing different rangeland types in the communal areas of the Eastern Cape, South Africa

Bethwell Moyo[1], Sikhalazo Dube[2]*, Mota Lesoli[1] and Patrick Masika[3]

[1]Department of Livestock and Pasture Science, University of Fort Hare, Alice 5700, South Africa.
[2]Animal Production Institute, Agricultural Research Council, Irene, 0062, South Africa.
[3]Agricultural and Rural Development Research Institute, University of Fort Hare, Alice 5700, South Africa.

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Understanding cattle ranging behaviour and habitat selection in African communal rangelands helps to inform resource management strategies. This study investigated seasonal variation in habitat selection and home range size of cattle in two rangeland types in communal areas of the Eastern Cape of South Africa. The average annual home range size of cattle was larger in the sweetveld than the coastal forest thornveld. Cattle ranged more widely in autumn and spring in the sweet and coastal forest thornveld respectively. Cattle preferred dense vegetation habitat dominated by shrubland in winter and spring in the coastal forest thornveld and the dense vegetation habitat was preferred in autumn and spring in the sweetveld. Kraaling in the coastal forest thornveld limited wide ranging because of better availability of good quality forage. Livestock utilize shrubland vegetation along water courses during the dry season and, therefore, management strategies should aim at preserving this key resource area through prevention of bush encroachment, overgrazing and soil erosion by allowing access to such areas during drier periods.

Key words: Communal areas, habitat selection, home range, spatial pattern, free-ranging cattle.

INTRODUCTION

The production potential of communal rangelands in South Africa is threatened by degradation (Hoffman and Todd, 2000; Ward et al., 2000; Solomon et al., 2007) that is thought to be caused by overgrazing and deforestation (Hoffman and Todd, 2000) due to increased human population (Hoffman and Todd, 2000) and high livestock numbers (Shackleton, 1993). The extent of degradation is estimated to be 25% of the magisterial or rural districts (EMG, 2000). The Food and Agriculture Organisation (FAO, 2005) reported a 0.4% increase in rural population between 1990 and year 2000, however, the major impact on the environment seems to be related to an increase in the number of households estimated at 45% between 1995 and 2005 (Pelser and Redelinghuys, 2009). Cattle numbers have increased from 13.3 million (FAO, 2005) in 1990 to an estimate of 14.1 million in 2006 (National Livestock Statistics, 2006). In most communal areas, betterment schemes, which involved subdivision of communal areas to small villages with their own associated grazing lands, reduced the size of grazing lands (Hoffman and Todd, 2000). Betterment schemes ware legislated in 1939 with continuous improvement and peak implementation in mid-1950s. They involved grazing procedures that entailed resting specified sections of the communal grazing area (commonage) for parts of the year (De wet, 1987), and also restricted the number of animals to be grazed in relation to the carrying capacity of the area. Furthermore, increase in human population resulted in the encroachment onto grazing lands. Kakembo and Rowntree (2003) reported an approximate 50% increase in the number of households between the years 1954 and 1988 in an area around Peddie town and at Shixini in the Eastern Cape Province of South Africa.

*Corresponding author. E-mail: dubes@arc.agric.za. Tel: +27 12 672 9295.

All these challenges have resulted in increasing calls for the introduction of rotational grazing management systems to curtail rangeland degradation and improve communal rangeland condition (Vetter and Goqwana, 2000).

The calls for the introduction of rotational grazing practices in communal areas ignore the fact that betterment schemes, which involved rotational grazing as part of their recommended management practices, failed to improve grazing management in these areas (Wisken, 1991; Ramagopa, 1993). The calls also fail to appreciate the concurrent increase in the area of grazing lands in the form of abandoned fields (Andrew and Fox, 2004), a common feature in the Eastern Cape due to declining levels of crop cultivation (Eckert and Williams, 1995; Mbuti, 2000). The use of cultivated fields after harvesting, which provide crop residues during the period of limited forage availability (Bennett et al., 2007) adds to the number of factors at play in shaping utilisation patterns of communal rangelands. In order to survive in these rangelands, animals adapt to the variability in forage in different seasons by switching their preference between different habitats (Scoones, 1995; Hendricks et al., 2005; Bennett et al., 2007) and or expanding their home ranges (Odendaal and Bigalke, 1979; Lazo, 1994).

Ecological and physical environmental factors influence adaptation patterns employed by free-ranging animals to variation in forage (Kauffman et al., 1983). Foraging strategies of herbivores are dependent on variation in forage quantity and quality as season progresses (De Miguel et al., 1991), and across rangeland types. Foraging strategies of livestock are also likely to differ according to the communities in which they are kept, which vary in number and type of habitats, livestock management system, such as kraaling, and a system where animals are kept in mountainous grazing areas all the time except when they are collected for dipping.

Habitat selection might occur in response to forage quantity and quality (Verner, 1975); cattle preferentially graze plant communities of high nutritive value (Anderson and Kothmann, 1980; Roath and Krueger, 1982). This preference seems to partially control spatial distribution of cattle (Putman et al., 1987). In drier areas water is a major contributing factor in habitat selection.

As already discussed, in order to cope with forage scarcity, herbivores expand their home ranges. Home ranges vary with an array of landscape features which vary with villages and they are also influenced by variables such as forage and water availability. Habitat selection and home ranges have been studied mostly in wildlife, especially as driven by food and water resource needs, including protection from predators (Thomas et al., 2008; Ryan et al., 2006). In free ranging livestock, studies have been done in the arid pastoralists' areas of East Africa (Basset, 1986; Hoffman, 2005), and semi-arid areas of Southern Africa (Scoones, 1995; Samuels et al., 2007). Very few studies have been conducted with free-ranging cattle in various communal rangeland types which differ in aridity and rangeland management set-up in South Africa. The prevalence of abandoned fields, utilisation of cultivated fields after harvesting and management strategies like kraaling and stockposts creates modified habitats and affects grazing patterns employed by cattle in communal areas.

The objective of the study was to determine cattle foraging patterns in different rangeland types and between seasons. It was hypothesized that cattle will change their habitat with season; they will prefer riparian areas, valleys or fields as the dry season progresses because it is assumed that the quantity and quality of forage would be high in these areas. It was further hypothesised that the size of home ranges will be larger under kraaling system, and in the sweetveld and smaller in areas with small grazing lands and presence of cultivated fields. Kraaling will cause cattle to travel further in search of sites with more forage, while decreased quantity of forage in the sweetveld will necessitate wider search for more forage. Smaller grazing lands will physically limit grazing to the size of the grazing lands, and cultivated fields will act as a feed source in winter months, hence limiting grazing area extent of the cattle.

MATERIALS AND METHODS

Study areas

This study was conducted in Magwiji and Mnyameni villages located in Ukhahlamba (formerly known as Herschel) and Amatole districts in the Eastern Cape Province of South Africa (Figure 1).

These two villages cover two rangeland types, namely sweetveld and coastal forest and thornveld (Acocks, 1988). A sweetveld area is characterized by low rainfall and the grasses retain palatability and high nutritive values throughout the winter season. Differences in rangeland types, presence of cattle projects, evidence of livestock keeping (from extension office records), and presence of stockpost grazing management system were criteria used in selecting the villages. Stockposts are grazing areas usually on mountains or along perennial rivers which are far from homesteads and animals are kept there with temporary housing structure for herders, and brought to the village for dipping. As is common in most communal areas of South Africa (Stats SA, 1999), both studied villages are poor and underdeveloped. The majority of villagers are unemployed, and the illiteracy level is high (Moyo et al., 2008). A detailed description of the communities is as follows: Magwiji (31°37'S, 27°22'E; altitude 1800 m a.s.l) is approximately 40 km south of Sterkspruit, and located in Ukhahlamba district (formerly known as Herschel) under Senqu local municipality and Jozana's Hoek administrative area (Figure 1). The district was first under the Ciskei Administration up to 1975, and then the Transkei Administration pre – 1994. Magwiji, adjoined by Sunduza village, was the object of the betterment scheme.

The area is bisected by rugged mountains of the Wittebergen range with deep and steep streams running north and is covered by sandy loam and sandy clay soils, which are very slowly draining and highly erodable. It is also underlain by sedimentary and volcanic rocks of the Karoo supergroup, laid down in the Triassic and Jurassic periods respectively (Govender, 1998). Lower areas are underlain by sandstones, grey mudstones and shales of molteno formation. Dolerite sills are prevalent and Quaternary alluvium deposits fill several of the valleys (Soil Classification

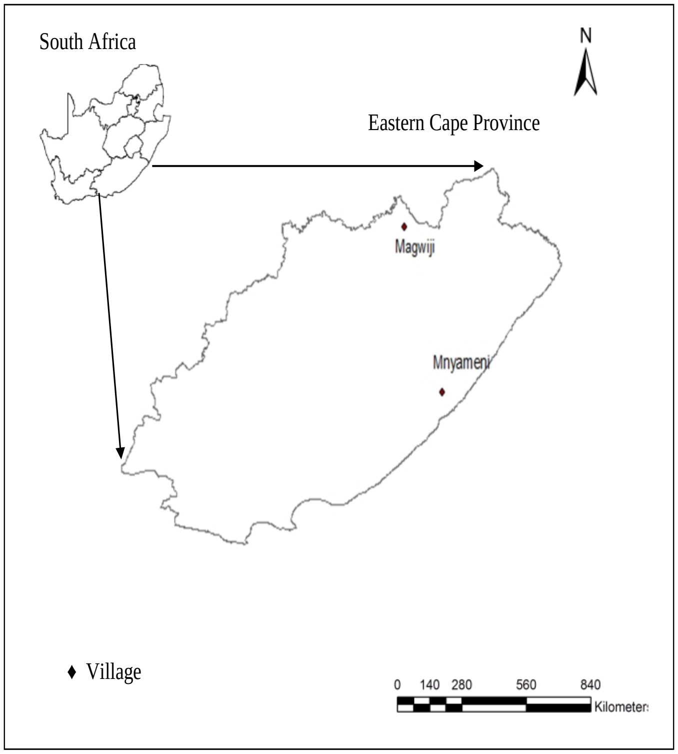

Figure 1. Location of study areas in South Africa.

Working Group, 1991).

The climate varies from hot in summer to extreme cold in winter with heavy frost and snowfall along the mountain area. Average annual rainfall is 640 mm, and most rain falls during the summer months from October to March, with frost and sometimes snow in winter (Schulze, 1997). The total rainfall received in 2006 and 2007 was 976.4 and 551.5 mm, respectively. Mean monthly temperatures range from 9°C in July to 22°C in January.

The area is in a sweet grassveld biome of a *Themeda-Festuca* Alpine Veld (Acocks, 1988). According to Acocks (1988), *Themeda triandra*, *Setaria sphacelata*, *Microchloa caffra*, *Elionurus muticus* and *Heteropogon contortus* are the most common grass species. Mnyameni (32°28'S, 28°13'E; altitude 565 m a.s.l) is approximately 30 km east of Butterworth in Amatole district under Mnquma Local Municipality (Figure 1). The area has been under the Transkei Administration pre – 1994. A subtropical climate prevails, with warm summers and cool winters. The mean annual temperature is between 18 and 19°C, with extreme maximum of 47.7°C and extreme minimum of 4.7°C having been recorded between 1961 and 1990 (Coastal and Environmental Services, 2010). The average annual rainfall is between 601 to 700 mm and the amounts recorded in 2006 and 2007 were 1056.4 and 876mm, respectively. The soils within this study area appear to be closely associated with the typical Eastern Cape coastal geology consisting of sedimentary formations such as sandstone, mudstone, limestone, conglomerate and tillite (Keyser, 1997). Soil depth ranges from 501 to 700 mm, clay content from 10.1 to 14.9% and silt content is more than 30%. The organic content of the soil ranges between 2 and 4%, while pH is within the range of 5.6 and 6.5. The area is in a coastal forest and thornveld type (Acocks, 1988). *Eragrostis plana, Paspalum dilatatum* and *Sporobolus africanus* are the most common grass species, with *Coddia rudis*, *Acacia karroo* and *Diospyros lycioides* dominating the woody species. The cattle management system in this village involves kraaling at night, and in the morning the animals are let out to freely graze.

Monitoring animal locations

Monitored animals were randomly selected from one herd of a farmer who continuously grazed his animals on the mountains at Magwiji, while at Mnyameni, the herd of the farmer who showed interest and agreed to participate in this study was chosen. Locations of cattle were monitored in the two villages from November 2006 to October 2007 by recording the position of a herd every 30 min for the duration of two consecutive days per season using a Garmin geko 201 hand held Global Positioning System (GPS). The seasons were, spring (November), summer (February), winter (June) and autumn (April). Two same animals, a steer and a dry cow of a non-descript genotype were selected and followed for recording the herd's location in each season. Each herd was followed on foot after being located in the grazing area at Magwiji where animals are free ranging, while at Mnyameni where cattle are kraaled, they were followed from the time they left the kraal in the morning (7:00 AM) until they returned late in the afternoon (18:00 PM) in all seasons. Two observers specifically focused on the same animal the whole day. The observations were only done during the day.

Classification analysis

Categories of vegetative cover were determined using three unsupervised classification methods, automatically categorizing raster cells from a Landsat TM 5 image, not including the thermal band, into twelve spectral classes. Additionally, a raster mask that eliminated cloud cover over the land was used to make the classification process more accurate. The unsupervised classification was run breaking out raster cells into forty different classes using an ISODATA classification method (Iterative Self Organising Analysis Technique), which determines the closest computed class center to a cell while splitting, combining, and discarding trial classes (Jensen, 1996).

The resulting ISODATA classification rasters, both a class raster categorizing each value from the classification, and the distance raster showing how well each cell fits its assigned class, were then used as inputs to further break down the image into twelve separate classes. The Fuzzy C Means classification method uses rules of fuzzy logic to calculate numerical grade of membership for each cell into a class by first allowing a cell to have partial membership in several classes (Bezdek, 1981). The Adaptive Resonance method is based on neural network computing techniques designed to recognize natural groups of spectral patterns in data and to produce the same class identification in response to input of similar patterns (Carpenter et al., 1991). The ISODATA classification method described above was used as the third classification procedure.

The error matrix is the standard way of presenting results of an accuracy assessment (Story and Congalton, 1986). It is a square array in which accuracy assessment sites are tallied by both their classified category in the image and their actual category according to the reference data (Lachowki and Maus, 1996). The overall accuracy of the final map was very good at 98% (Table 1).

Determining home ranges

The cattle position data was analyzed for home range size (total spread of GPS locations) for each of the selected animals. Because of its simplicity and agreement with adaptive kernel estimates, 95% minimum convex polygon (MCP) was used (Mohr, 1947; Southwood, 1966) to generate the home ranges of each animal.

The minimum convex polygon method uses all the locations

Table 1. Error matrix for the classes collected at the study site.

	Ground truth data							
	Name	Water	Builtup	Barren land	Grassland	Dense vegetation	Total	Accuracy (%)
Classification	1	471	0	0	0	0	471	100
	2	6	2857	65	1	67	2996	95.36
	3	2	61	5216	15	139	5433	96.01
	4	0	0	87	1093	1	1181	92.55
	5	5	36	66	0	20425	20532	99.48
	Total	484	2954	5434	1109	20632	30613	
	Accuracy (%)	97.31	96.72	95.99	98.56	99		

Overall accuracy = 98.2%; Khat Statistic = 96.44%

obtained from an individual animal forming an area defined by the outermost locations (White and Garrott, 1990). The MCPs were developed using a GIS. The generated home range polygons were then clipped to eliminate any area outside of the respective home ranges. Cattle home range size was estimated from combined home ranges for the two animals by computing separate MCPs for each animal and subtracting overlap between home ranges (Call et al., 1992).

Habitat assessment

Individual cattle locations were not used as recordings in this part of the study, because of the social facilitation or aggregation of the herd where for example calves followed their mothers and animals generally tended to graze as a herd, and hence did not make an independent choice of habitat. Because of this, observation on individual animals could not be taken as independent data points and a herd had to be recorded as a single unit. This problem was also encountered by Sinclair (1977) during a study of the habitat selection by buffalo in the Serengeti. The 30 min interval coordinate locations for the herd were used to analyse habitat selection using the classified image of the study site. Dense vegetation and grassland were the only habitats generated by the image classification based on vegetation structure. The grassland was the broadest habitat type in Mnyameni, and represented the abandoned arable lands currently used for grazing in addition to the natural grasslands. At Magwiji, there is no cultivation at mountain top; hence grasslands represented pure grass stands, while dense vegetation represented woody species.

All locations for each herd were overlayed on a classified satellite image of this study site. The number of locations of each herd within each of the two habitat types (dense vegetation, grassland) were counted in the herd`s home range. This study area was delineated as the area encompassed by the composite 95% minimum convex polygon home range of the herd.

Data analysis

The interaction between herbivores and their habitat can be analysed using numerous methods (Beardall et al., 1984; Von Holdt, 1999; Strauss, 2003), either qualitatively or quantitatively. The simplest of such methods is the proportion of the species locations in each habitat type (Duchamp et al., 2004).

Habitat preference were evaluated using the methods described by Neu et al. (1974) and Byers et al. (1984); whereby a chi-square goodness-of-fit test was used to determine whether a significant difference occurred between the expected utilization of habitat types and the observed frequency of their usage (Byers et al., 1984), after which Bonferroni confidence intervals were calculated to determine which habitat types were being preferred.

For both the chi-square and Bonferroni procedures, the observed number of instances of use and the “expected” number of occurrences based on the availability of each habitat type within this study area (Byers et al., 1984) were determined. The expected number of observations in each habitat type was determined by multiplying the proportional area of each habitat type by the total number of location observations in the home range of the herd. The Chi-square analysis was performed on the data using the expected and observed values:

$$\chi^2 = \Sigma (O_i - E_i)^2 / E_i$$

where: χ^2 is the chi-square value; O is the observed usage if the ith habitat type; and E_i is expected usage of the ith habitat type.
Simultaneous Bonferroni confidence intervals were calculated using the observed proportion of utilization of each habitat type separately. The observed proportion of utilization of each habitat type is the observed usage in that habitat type, divided by the total number of observations in all habitat types. The following formula (Litvaitus et al., 1996; Dellinger, 2003; Schindler, 2005) was used to calculate confidence intervals:

$$\bar{P}_i - Z_{\alpha/2k}\sqrt{\bar{P}_i\,(1-\bar{P}_i)/n} \leq P_i \leq \bar{P}_i + Z_{\alpha/2k}\sqrt{\bar{P}_i\,(1-\bar{P}_i)/n}$$

where: P_i is the observed proportion of utilization for the ith habitat type; Z is the Z score based on: the chosen α level (for example, 0.05) divided by two-times. k is the total habitat types; n is the total number of all observations in all habitat types.
If the expected proportion of observations is outside of the confidence interval of the observed proportion of observations, it can be determined that there is a significant difference between expected usage and observed usage, indicating that a habitat preference is occurring. Yates' correction was applied since only two categories were present (Fowler et al., 1998).The extent of available habitat was determined by the home range of the herd. Use (number of point location within a habitat relative to the total number of point locations) and availability data (proportion of habitat available to the cattle within the home range) (Duchamp et al., 2004) were manually calculated in ARCVIEW 3.2. A one-way ANOVA using SPSS version 14 (SPSS, 1999) was used to test for significant difference in mean size of home ranges between villages and also among seasons within a village. A Tukey's Test was conducted to determine significant differences among seasons. For habitat use, comparison within a season the χ^2 statistics, with Bonferroni correction criteria were calculated in Excel© (Microsoft Office 2007, Microsoft Corp, Redmond, WA).

Table 2. Seasonal home range sizes (± SE) for cattle in three villages of the Eastern Cape.

	Home range size (ha)							
Village	**Spring**	**n**	**Summer**	**n**	**Winter**	**n**	**Autumn**	**n**
Magwiji	44.2 ± 14.3[a]	4	103.8 ± 1.0[ab]	4	24.3 ± 5.1[a]	4	147.1 ± 52.4[b]	4
Mnyameni	79.8 ± 6.3[a]	4	34.9 ± 3.9[a]	4	57 ± 0.3[a]	4	55.5 ± 23.1[a]	4

[ab]Means within a row having similar superscripts are not significantly different.

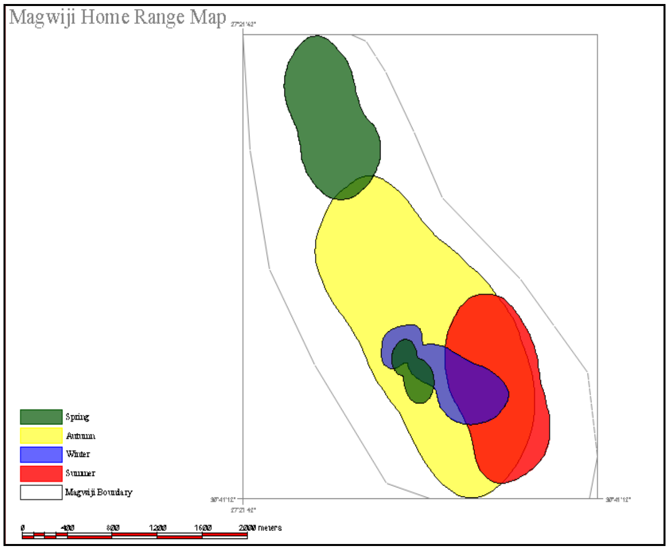

Figure 2. Seasonal range use by cattle at Magwiji, based on the 95% minimum convex polygon method.

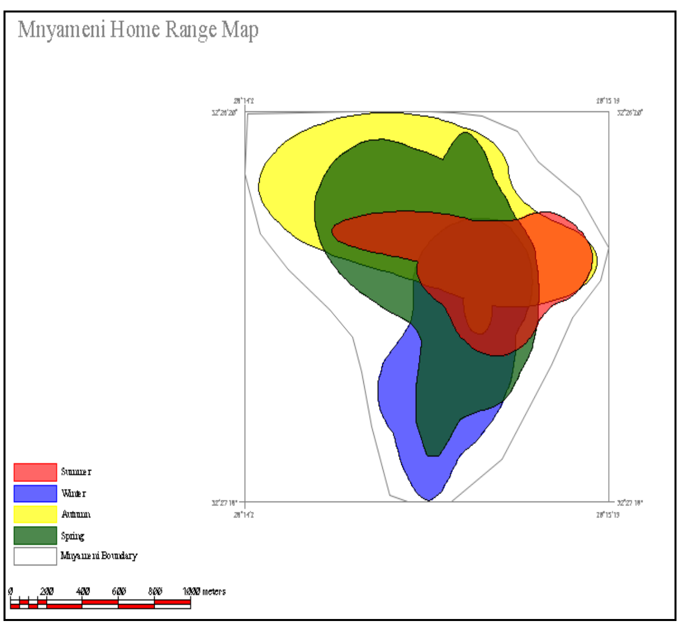

Figure 3. Seasonal range use by cattle at Mnyameni, based on the 95% minimum convex polygon method.

RESULTS

Home range size

A total of 370 locations for four animals, monitored for four seasons in two villages were used to determine cattle ranging behaviour. Magwiji and Mnyameni had 178 and 192 cattle location records respectively. Mean home range size of cattle significantly ($F_{2, 21}$ = 3.09; p < 0.05) varied among villages. Magwiji cattle's resource utilisation covered a larger (79 ha) area compared to a smaller area in Mnyameni (57 ha).

Home ranges in Magwiji varied considerably in size across seasons ($F_{3, 20}$ = 4.22; p < 0.05). Home ranges in autumn (147 ± 52.44 ha) were larger than winter (24.3 ± 5.12 ha) and spring (44.2 ± 14.30 ha) ones (Table 2 and Figure 2). The spring home range was separated into two because the points for the second day were far away from the first one and combining them would have compounded the results. No significant difference in home-range size was evident across seasons at Mnyameni (Figure 3).

Habitat use

The delineated study area was 368 and 797 ha in Mnyameni and Magwiji respectively (Table 3). The most abundant habitat type at Magwiji was that of grassland, which comprised 56% of this study site. Dense vegetation and bare ground comprised 31 and 13% respectively. On the other hand, dense vegetation habitat type extensively (55%) covered this study site at Mnyameni compared to the grassland (44%) and bare ground (0.9%). The bare ground region was not considered in the analysis of habitat use due to its unsuitability as a habitat, especially for cattle grazing. Most of the bareground at Magwiji might have been related to rocky areas, since the area is mountainous.

Site use by cattle showed distinct seasonal changes in both villages. There were significant differences (χ^2 = 10.31; df = 1; p<0.05) in expected and observed autumn use of grassland and dense vegetation habitats in Magwiji Dense vegetation habitat was used more than expected in autumn, while in other seasons there was no significant difference in observed and expected use of the two habitats (Figure 4).Selection of habitats by the herd

Table 3. Size of the study area and habitat (ha) at each of the villages.

Village	Habitat size (ha)			
	Study area size (ha)	Grassland	Dense vegetation	Bare ground
Magwiji	797.3	445.8	250.3	101.2
Mnyameni	368.3	162.9	202.6	2.8

Table 4. Seasonal patterns of habitat selection by cattle in Magwiji and Mnyameni villages.

Habitat	Winter			Autumn		
	Observed	Expected	95% CI	Observed	Expected	95% CI
Magwiji						
Dense vegetation	0.38	0.50	0.14 - 0.62	0.90	0.73[b]	-0.05 - 0.24
Grassland	0.62	0.50	0.38 - 0.86	0.10	0.27[a]	0.76 - 1.05
	Spring			**Summer**		
Dense vegetation	0.17	0.34	0.00 - 0.35	0.57	0.56	0.33 - 0.81
Grassland	0.83	0.65	0.65 - 1.00	0.43	0.44	0.19 - 0.67
Mnyameni						
	Winter			**Autumn**		
Dense vegetation	0.86	0.19[b]	0.71 - 1.01	0.38	0.52	0.17 - 0.60
Grassland	0.14	0.81[a]	-0.01 - 0.29	0.62	0.48	0.40 - 0.83
	Spring			**Summer**		
Dense vegetation	0.68	0.25[b]	0.45 - 0.92	0.35	0.47	0.09 - 0.61
Grassland	0.32	0.75[a]	0.08 - 0.55	0.65	0.53	0.39 - 0.91

[a]Observed usage is significantly lower than expected (p<0.05). [b]Observed usage is significantly higher than expected (p<0.05). CI: Confidence Interval. The table gives the 95% Bonferroni intervals for the observed proportions. The difference between the observed proportion and the expected value is significant when the expected value falls outside these limits.

within its home range at Mnyameni was significant in winter (χ^2= 7.45; df = 1; $p < 0.05$) and spring (χ^2= 19.11; df = 1; $p < 0.05$). Cattle used dense vegetation more than expected in winter and spring, while observed and expected use were not significantly different for other seasons (Figure 5).

Comparison of simultaneous confidence intervals to proportion of the area in each habitat at Magwiji (Table 4) indicated that the proportional use of the dense vegetation habitat in autumn was significantly greater ($p < 0.05$) than the proportion of the area occupied by this habitat class in the home range. Bonferroni confidence intervals also showed significant ($p < 0.05$) selection for dense vegetation habitat in spring, while in winter and summer there were no significant selection patterns between the two habitats (Table 4). At Mnyameni, Bonferroni confidence intervals revealed that cattle preferred ($p < 0.05$) dense vegetation in winter and spring (Table 4). There were no significant selection patterns in summer and autumn seasons.

DISCUSSION

The mean home range size at Mnyameni was within the range (5.7 to 53.56 ha) observed with free-ranging white cattle in Chillinghan Park in northern England (Hall, 1988). The size for Magwiji was within the home range sizes (37.2 to 167.9 ha) observed for goats after a drought in the semi-arid Paulshoek commons in South Africa (Samuels et al., 2007).

There is an established relationship between home range size and resource availability for many animal species, with home range size decreasing as resource availability in an area increase (Hodder and Low, 1978; Harestad and Bunnell, 1979; Damuth, 1991). The variation in home range size is related to the rangeland type and grazing management practices associated with these villages. Rangeland type is associated with the density and species of woody and herbaceous vegetation at an area, which is in turn affected by the rainfall, temperature and soil type among other factors. Livestock

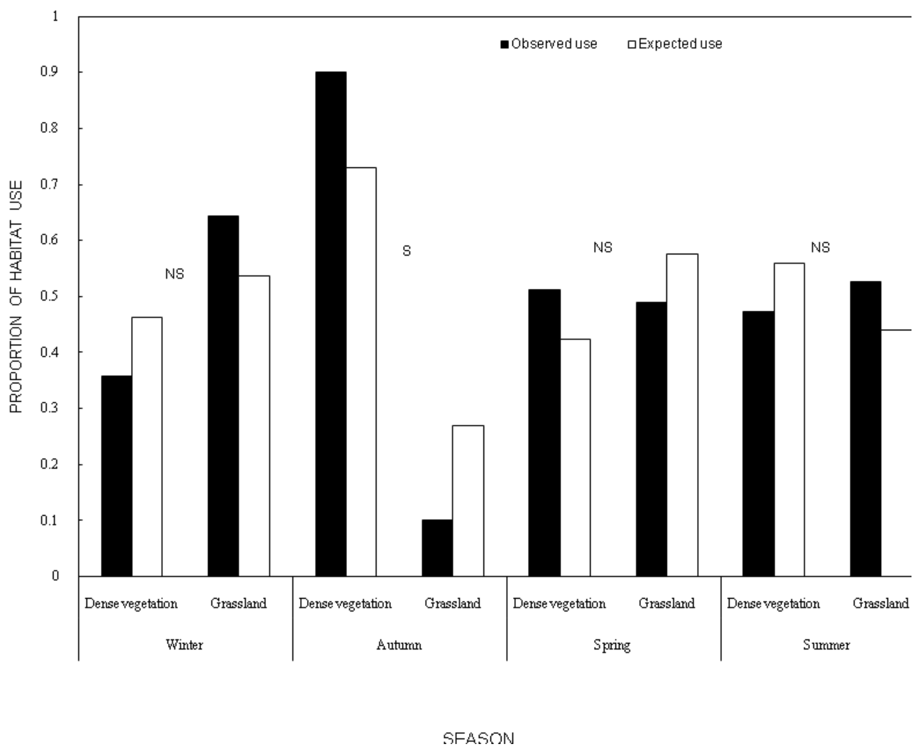

Figure 4. Differences in the observed and expected use of habitats by cattle across seasons in Magwiji. NS, Not Significant; S, significant.

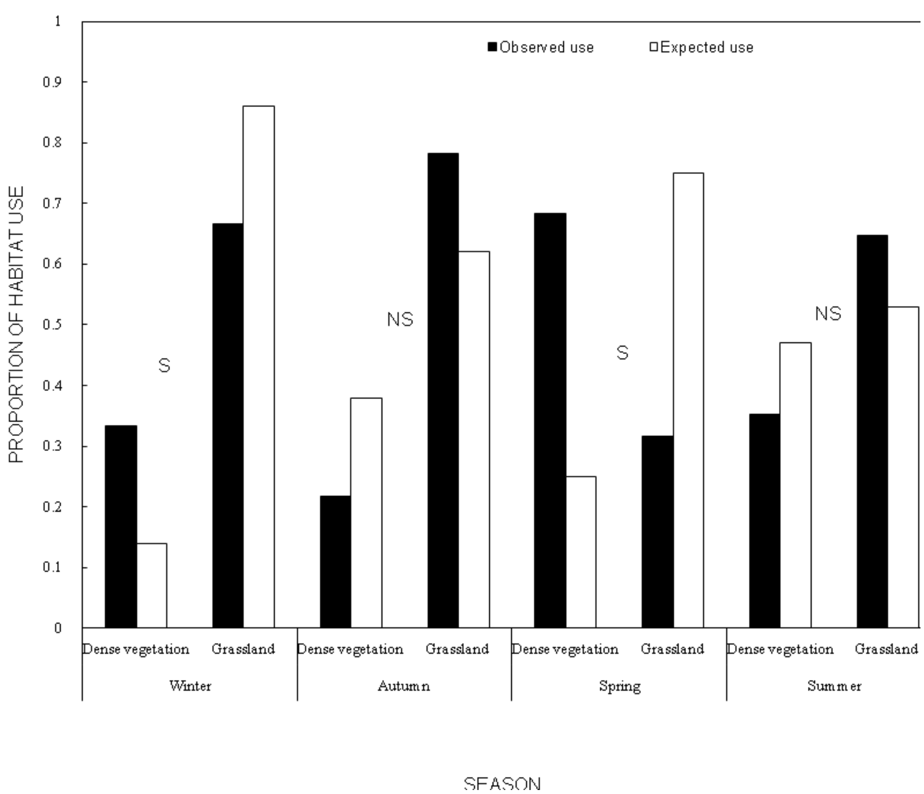

Figure 5. Differences in the observed and expected use of habitats by cattle across seasons in Mnyameni. NS, Not Significant; S, significant.

distribution has been reported to be affected by density of woody vegetation (Holechek et al., 1998) and plant community composition with its associated effects on forage quantity and quality (Smith et al., 1992). The coastal forest thornveld type (Mnyameni) is characterised by high rainfall that resulted in the high herbaceousbiomass reported by Lesoli (2008) compared to low biomassin Magwiji that is located in the sweetveld. The smallest (57 ha) home range size at Mnyameni is attributed to the high amount of forage available (Lesoli, 2008) which resulted in less movement in search of food. In addition, in this study year, Mnyameni received significantly higher rainfall, which might explain the high forage biomass and hence the small home range size.

It was expected that home range size would follow the typical trend in biomass fluctuations at Magwiji, with larger home range size in winter. Autumn home range size was, however, interestingly larger than in winter. A plausible explanation for this apparent contradictory result stems from a combination of a variation in autumn (14 to 23°C) and winter (9 to 20°C) temperatures and the onset of the dry season in autumn, which affects water drinking frequencies. Hendricks et al. (2005) found that the search for drinking water was the motivation for summer movements, and since autumn is immediately after summer, temperatures will still be high necessitating frequent drinking, hence movement to further water sources after drying up of the ephemeral ones (Bailey et al., 2001). Another explanation may be that since cattle were not kraaled at Magwiji, they maximized their food intake by grazing at a slower pace, hence spending more time grazing rather than walking, therefore, resulting in small winter home range. It is also suggested that the vegetation structure of the Magwiji mountainous grazing area characterised by a combination of riparian and thicket areas might have created a much localized state of forage availability and the mountainous topography might have restricted cattle movement.

Changes in home range size is more likely to occur in dry patchy semi-arid environments, as resource value changes within specific habitats due to grazing, than in humid homogenous environments. The humid coastal environment at Mnyameni necessitates availability of forage throughout the year. In addition the small size of Mnyameni rangelands due to surrounding villages limits the home range size. Even though kraaling of animals was part of grazing management in Mnyameni higher forage biomass led to small home range sizes, while a combination of kraaling and less forage caused animals to move wider in search of forage.

Although cattle are mainly grazers, the preference for dense vegetation habitat, characterised by shrubs and trees in spring and autumn at Magwiji is likely to be confounded by the presence of this habitat type along rivers and springs flowing down the mountains where cattle mainly grazed. Preference by large herbivores for riparian habitats is reported in a number of studies (Loft et al., 1991; Smith et al., 1992a; Pickup and Bastin, 1997). These areas are preferred because when other areas of vegetation in the grazing area are already dry, the riverside areas will still be green (Harris, 2001). In addition, grass species which grow under trees and at the river banks, such as *Panicum maximum,* provide nutritious graze for cattle in autumn (early dry season) and spring (late dry season). The dominant shrubs and trees at Magwiji are not browsed by cattle. Thus, it is likely that cattle were grazing the grass between and under trees. Rivers between former fields at Mnyameni were characterised by dense stands of *Acacia karroo*, which was occasionally cut down for fuelwood, hence creating a productive grazing patch for cattle.

Preference by cattle for moist and productive habitats along riparian areas is consistent with studies by Putfarken et al. (2007) in a nature reserve in northern Germany. Similarly, Pinchak et al. (1991) reported that cattle in a large, heterogeneous pasture landscape preferentially foraged in productive wetlands but avoided unproductive grasslands. These areas were termed “key resource areas” by Scoones (1995) after studies on habitat use by cattle in dryland Zimbabwe. Faftine et al. (2001) also observed that depressions and the Nkomati valley were essential for adequate forage intake during the dry season in a communal range of Mozambique.

Tufts of grass that grow in the shrub and tree dominated areas along rivers persist into the dry season with green growth, whereas more open areas simply lignify and become less nutritious (Utrilla et al., 2006). Thus, preferential selection for dense vegetation in the early to late dry seasons is unsurprising, despite the apparent unpalatability of the shrublands. There might have been other factors which might have influenced preferential selection of dense vegetation, and they include drinking water in the rivers with densely vegetated river banks and also shade availability. The optimum availability of forage in summer favours random selection of both habitats, as discovered by Loft et al.

Conclusion

Habitat use by cattle is characterised by a focus on dense shrubland vegetation along water courses during early dry season (autumn), winter and late dry season (spring). These riparian and thicket areas may be functioning as ‘key resource’ areas for cattle between autumn and spring when there may be less forage availability in grassland areas. The presence of dense vegetation along water courses seem to be highly valuable to cattle in both sweetveld and coastal forest thornveld. Because rangeland management success depends on effective manipulation of biotic components of the ecosystem, research and management efforts should be focused on areas of the landscape where such interactions are strongest. It may, therefore, be beneficial, in communal range management, to manage dense vegetation along water courses. A carefully planned spatial thinning of some woody vegetation along water courses can lead to an enhanced cattle habitat by increasing available forage in winter months. In addition, a preferential use of these 'key resource areas' should bedone during times of forage shortage.

Using remotely sensed vegetation data in prediction of cattle habitat use is complicated at a small temporal and geographic scale. The overriding preference for dense vegetation along water courses confounded interpretation of remotely sensed data in habitat selection, suggesting necessary refinement of habitat classification for such kind of studies.(1991) that cattle habitat selection did not vary in the summer season.

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