Veterinary fence condition and permeability to buffalo *(syncerus caffer)* and cattle movement in Gonarezhou National Park, Zimbabwe

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1. Introduction

Veterinary fences have largely been erected around conservation area boundaries in Southern Africa as a mechanism to prevent the possible transmission of diseases such as bovine tuberculosis (BTB) and foot-and-mouth diseases (FMDs) from buffalo (*Syncerus Caffer*) to cattle and vice versa (Machange, 1997 and Bengis *et al* 2002). However, fences appear to have not produced the intended results as cases of FMD diseases outbreaks have increasingly been reported in the areas surrounding the conservation zones particularly in Zimbabwe (Sutmoller *et al*, 1999). The outbreaks are empirical evidence to suggest that the fences are damaged and buffalo/cattle seem to move from protected areas into communal grazing areas and vice versa. The evidence seems to have been more apparent in Zimbabwe especially during the economic crisis of 2000 to 2008 where lack of finance for fence management by the veterinary services largely resulted in fence failure. To date, little has been documented on the permeability of veterinary fences to buffalo and cattle movement as a result of fence failure, yet the spatially explicit understanding of fence condition is an important pre-requisite to enhancing a healthy wildlife and livestock production system in most African savannas, especially where diseases are increasingly threatening livestock production (Foggin, 1981).

A review of literature shows that most work has focused on the risk of wildlife diseases and possible pathway scenarios that threaten livestock production in areas surrounding wildlife conservation areas in Southern Africa particularly in Zimbabwe (Thomson *et al*, 1999 and Taylor *et al*, 1987). However, spatially explicit knowledge on fence condition has largely been ignored. In addition, to the best of our knowledge the spatial extent of fence damage has not yet been quantified. This quantification is important to explain any buffalo and cattle movements that may occur. It is reasonable to hypothesise that fence condition explain whether buffalo or cattle can or cannot cross it. To date, buffalo contact with cattle has been largely blamed as responsible for the outbreak of FMD in cattle within the Southeastern lowveld (SEL) of Zimbabwe. However, it is important to realise that this evidence has not been explicit but rather circumstantial. This is because the extent and magnitude of buffalo and cattle movement across different fence conditions has not been explicitly mapped and is therefore largely unknown. Thus, understanding of fence condition, as well as how this may be related to the magnitude of cattle and buffalo movement is critical.

In this study, we mapped the veterinary fence into four different strata i.e. undamaged, damaged, removed fence and fence across rivers (F.A.R) around the southern part of Gonarezhou national Park (GNP) in the SEL of Zimbabwe. We also determined the magnitude of buffalo movement outside the GNP, as well as the magnitude of cattle movement into the GNP by season as a way to test the extent to which the fence is permeable to both buffalo and cattle.

2. Materials and methods

2.1 The Study Area

We conducted our study in the SEL of Zimbabwe along the veterinary fence that separates communal lands from the GNP and Malipati Safari area (fig. 1). GNP was established in 1934 and Malipati safari area in 1968 in the SEL (Gonarezhou National Park Management Plan, 1998-2002). To enable disease monitoring, surveillance and control in Zimbabwe, the veterinary fence was erected around GNP in 1975 to control interspecies contact across the interface. This fence was theoretically different from the park boundary but practically just the same. Its structure included a three steel strand separated by steel poles was supposed to restrain large antelopes, with a width between strands too large to limit movements of carnivores and small antelopes. However, being a semi-arid area (less than 600mm of rainfall annually), grazing resources can be scarce during the dry season and cattle-owners tend to drive their cattle into the park in search of grazing and watering resources. Conversely wild grazers such as buffalo can be pushed outside the GNP in search of grazing resources as the status of the fence has deteriorated (partially functional to completely absent).

2.2Fence Mapping:

Ground coordinates (UTM format) of the selected veterinary fence were collected following curves of the veterinary fence using a hand-held Global Positioning System (GPS) receiver while in a vehicle. The length of the study area was computed from GPS ground measured coordinates through summing the lengths for a sequence of positions along the line in a Geographical Information System (GIS). After computing the total length of the fence, the total stretch was stratified into four different fence strata i.e. undamaged, damaged, removed fence, and F.A.R (Figure 2).

2.3 Buffalo and Cattle movement data collection

Field data collection of buffalo and cattle movement involved mainly a spoor survey. We conducted this fieldwork from the 15th-30th of April 2009 and 15th -30th of April 2010 for the wet season as well as from the 29th Oct-11th of Nov 2009 and 10th-24th of July 2009 for the dry season. Each fieldwork period covered 14 working days of buffalo and cattle movement surveillance along the stretch of the veterinary fence. For animal species movement data to be quantified; the direction of movement and the total number of spoors were recorded. The procedure followed several steps. Firstly, before an undertaking of fresh spoor surveys; a tree branch was tied at the back of a 4x4 vehicle and pulled along the 79.44 km stretch of the veterinary fence towards sunset i.e. between 4.30pm and 6.30pm. This was to enhance fresh spoor visualization and avoid repetitive counts. Spoor surveys were conducted from sunrise to mid-morning i.e. from 6am-11am and then in the afternoon from 3.30pm-6.30pm to accommodate movements of semi-free ranging animals like cattle. These particular times were selected in order to account for cattle. This is because in the SEL, cattle are semi-free ranging; they are driven back to the kraal for safe keeping during the night after each grazing day, making a survey beyond the survey times unsuitable for cattle spoor survey. A seat was mounted on the bonnet of a 4x4 vehicle in order to enhance accuracy in identifying animal spoors and this survey was undertaken with the aid of an experienced ranger from Zimbabwe National Parks and Wildlife Authority (ZNPWA) based in GNP. During the process of spoor sightings, the 4x4 vehicle was driven at a speed of 8km/hr; to ensure maximum spoor visibility.

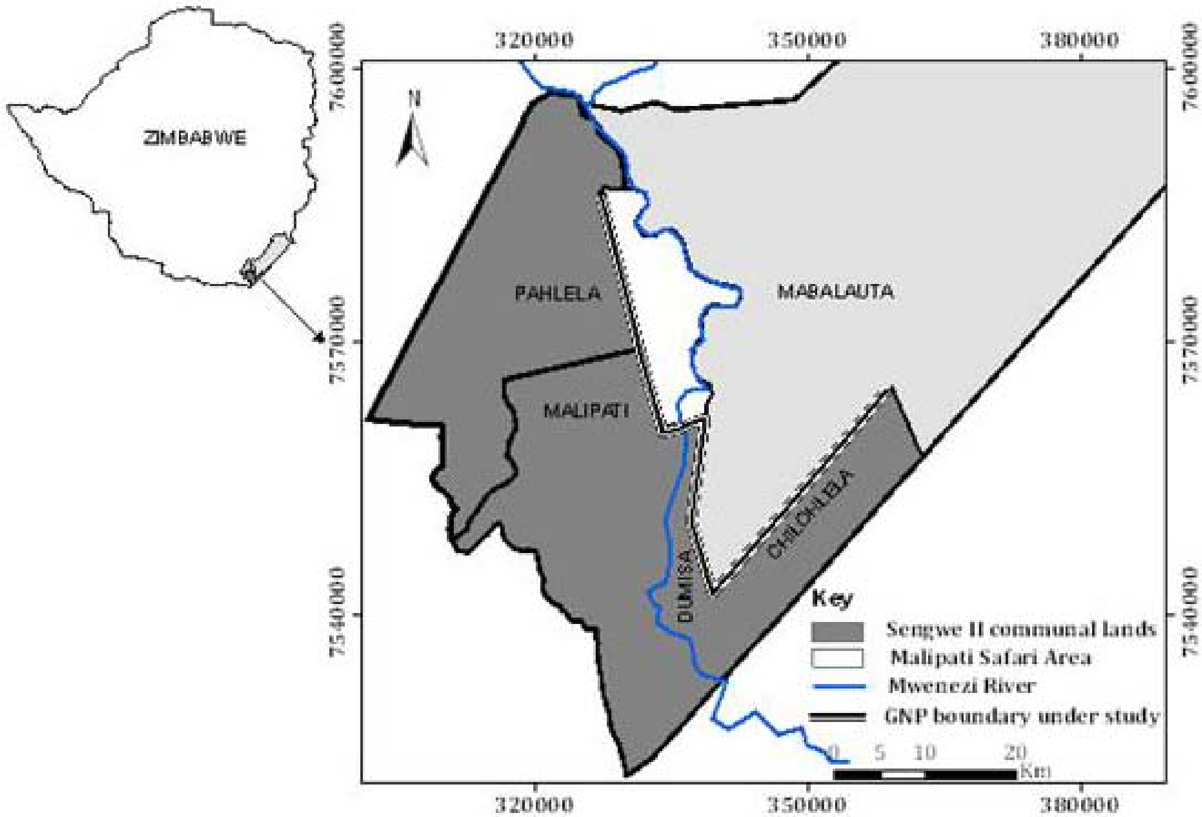

Figure 1: Map of the study area showing a distance of 79.44km under which buffalo and cattle movements were monitored in SEL during by season. Map coordinates are in metres, UTM Zone 36 based on the WGS 84 Spheroid.

Results

Figure 2 illustrates the four fence strata i.e. undamaged, damaged, removed fence and F.A.R found along the 79.44km stretch of the park boundary fence in which buffalo and cattle movement were monitored by season. It can be observed that of the total 79.44km stretch of the veterinary fence under study, 27.31km is undamaged, 30.19km is damaged, 21.63km is removed fence and finally 0.32km is F.A.R (Table 1). Thus, overall we observe that the damaged area occupies the largest portion of the fence and F.A.R being the least (Table 1). It can be observed that only the area around Chilohlela on the eastern side of the park and the extreme NW of Pahlela have removed fence. Moreover, the area between Dumisa and Manjinji pan in the southwestern part of the park has the longest damaged fence followed by the Nn section of Pahlela communal lands as illustrated by figure 2. Lastly, the area between Pahlela and Manjinji pan in the southewestern part of the park has the highest proportion of the undamaged fence compared with the area between Manjinji pan and Dumisa (fig. 2).

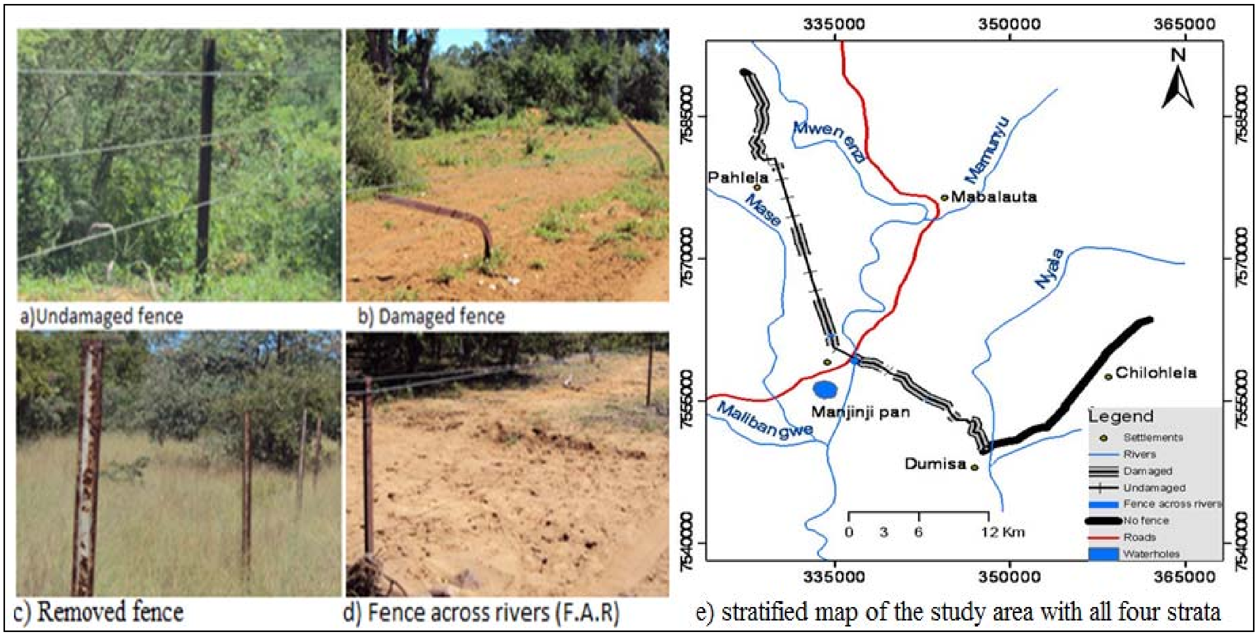

Figure 2: Four different strata characterizing veterinary fence around GNP.

Table 1: Pooled length (in km) of each stratum expressed as a percentage.

Fence category	Stratum length (km)	Percentage (%) area
Undamaged	27.31	34.38
Damaged	30.19	38.00
Removed fence	21.63	27.23
F.A.R	0.32	0.00

Table 2 illustrates pooled proportions and numbers of buffalo and cattle movement across the fence by season. It can be observed that cattle move into the park in both the wet and dry seasons, with a higher proportion of cattle moving during the dry season. However, for buffalo the pattern is different as the results show that the greater proportion of buffalo is moving out of the park during the dry season.

Table 2: Total number and pooled proportion of buffalo and cattle crossing the boundary into and out of the park during the both wet and dry season.

	Wet season			Dry season		
Animals species	Total movement	Movement into Park	Movement out of Park	Total movement	Movement into Park	Movement out of Park
Buffalo	47	30 (63.83%)	17 (36.17%)	31	09 (29.03%)	22 (70.97%)
Cattle	803	456 (56.79%)	347 (43.21%)	810	489 (60.37%)	321 (39.63%)
Total	850	486 (57.18%)	364 (42.82%)	842	478 (56.77%)	330 (39.19%)

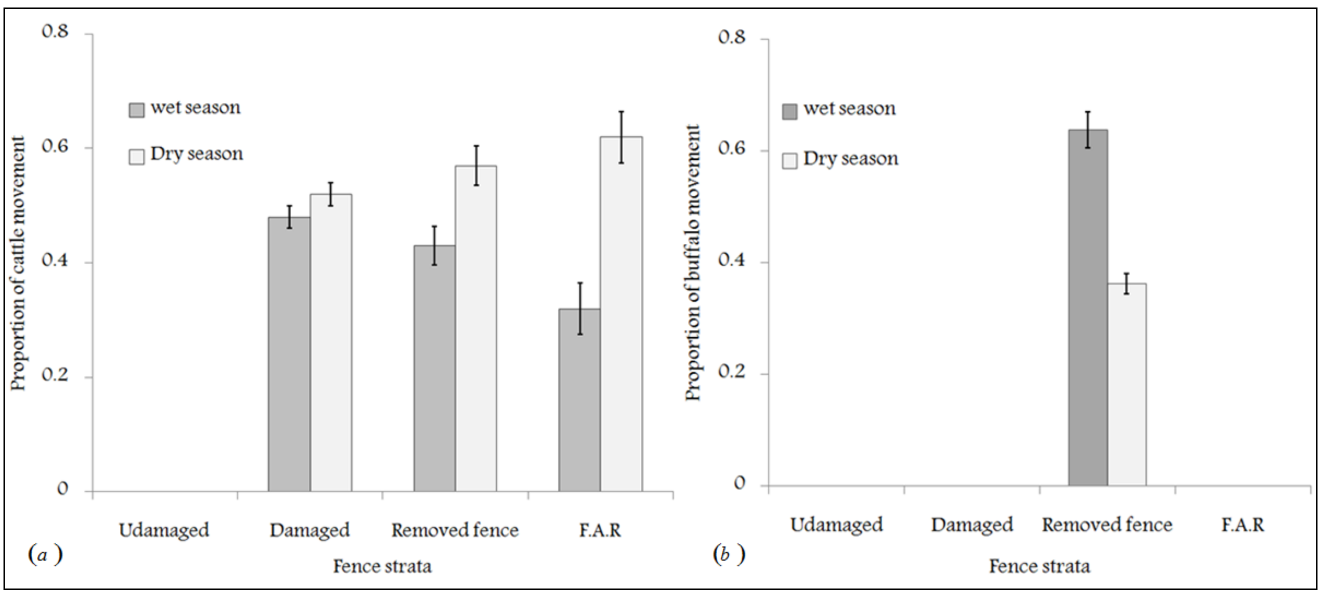

Figure 3: The proportion of a) cattle movement and b) buffalo movement across different fence strata by season. The whiskers represent 95% confidence intervals.

Figure 3 shows the proportions of buffalo and cattle movements across different fence strata by season. Results show that cattle move into the park across damaged, removed fence and F.A.R fence strata only (fig. 3a). It can be observed that the proportion of cattle movement across the fence is greater during the dry season across all the three strata with the highest proportion observed across rivers. However, buffalo only move across removed fence during both the wet and dry season and the pattern is different as the results show that the greater proportion of buffalo is moving out of the park during the dry season (fig. 3b). The proportion of out of park movement for buffalo in the wet season is twice that of the dry season.

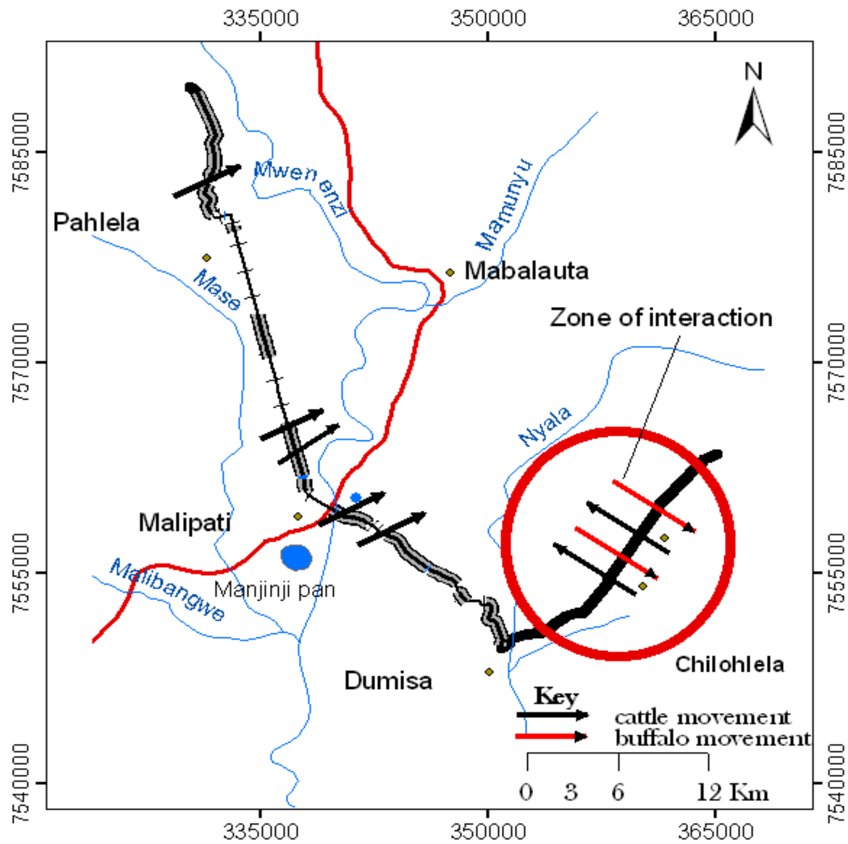

Figure 4: Shows possible areas of buffalo and cattle interaction by season. Map coordinates are in metres UTM zone 36 WGS84. The red circle indicates probable zone of interaction between buffalo and cattle.

Figure 4 illustrates the direction of movement of both buffalo and cattle. It can be observed that buffalo and cattle move across removed fence at the same place in Chilohlela in the southeastern corner of the study area (fig. 4). We further observe that this may be the probable zone of interaction between cattle and buffalo.

Discussion

For the first time around GNP, results of this study have empirically demonstrated that the damage along the veterinary fence is resulting in cattle moving into the GNP and buffalo moving out of GNP. This suggests that although fences have been one of the major conventional measures to control wildlife/livestock species movement and interaction across natural park boundaries, their efficacy has been reduced due to either damage or due to a condition that allows movement particularly at places where fence cross river channels. Buffalo and cattle movement does not occur randomly but is concentrated in places where the fence was either removed or damaged, as well as where the fence crosses main river channels.

Results of this study also show seasonality in buffalo and cattle movement. We claim that the seasonal patterns of cattle and buffalo movement are resource driven. For instance, during the dry season there is a relatively high proportion of cattle movement into the park and this is explained by the relatively high availability of grazing resources in the GNP. This is confirmed by reports from related work, suggesting that in Zakouma National Park (Chad) large herds of cattle move into the park from adjoining communal lands during the dry season in search of foraging resources (Maddock, 1979; Johnson 1992). In contrast, results indicate that more buffalo move out of the park during the wet than during the dry season. We also extend our resource gradient claim to explain the movement of buffalo. In fact, during the wet season water is not limiting so buffalo tends to expand its range. In contrast, during the dry season when water is limited to the main river channels which are mainly in the GNP and its immediate boundary, meaning less buffalo have an incentive of moving out of the GNP. This result is also confirmed by Lindeque & Lindeque, (1991), who noted that in most African national parks, wildlife concentrate around the water points during the dry season and scatter during the rainy season.

Conclusion

The main objective of this study was to map the veterinary fence into four different strata i.e. undamaged, damaged, removed fence and F.A.R around GNP in the SEL of Zimbabwe. Buffalo and cattle movements are only found in areas were the fence has been removed. In other words, in areas were the fence is still intact no animal movements were recorded. Based on this finding we can conclude that if there is improvement on fence maintenance buffalo and cattle movement across the fence can be regulated and disease transmission from wildlife-to-livestock and livestock-to-wildlife can as well be reduced. We also conclude that cattle

movement into the GNP dominates during the dry season while the dominant buffalo outward movement is during the wet season. The findings of this study are an important prelude to enhancing the understanding of the efficacy of fences as a predictor of wildlife and livestock disease surveillance. Based on these results, we recommend that fences are not supposed to be removed around GNP but rather be repaired and upgraded if disease prevalence between buffalo and cattle is to be minimised.

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