The buffalo-cattle interface in Zimbabwe: a preliminary review

by

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1. Introduction

The interface between buffalo and domestic livestock, primarily cattle, can be viewed at different spatial and temporal scales. At a broad national scale the distribution of buffalo and cattle are seen to overlap, or at least be contiguous, when fences separating the two species are damaged or absent. At the local scale where the cattle and buffalo are apparently using the same area there may be spatial separation at a finer scale, with very little if any overlap. There may also be temporal separation in that they do not occur in the same vicinity, such as at a waterhole, at the same time.

This preliminary review presents recent information on the broad scale distribution of buffalo and cattle that was obtained during the 2014 aerial censuses of elephant range in Zimbabwe. Recent research on the more immediate interface between buffalo and cattle, conducted in the South East Lowveld (SEL) and in Northwest Matabeleland, is also reviewed.

Two management implications for reducing contact between cattle and buffalo emerge from this preliminary review. At a broad scale, the grazing of cattle in protected areas containing buffalo should be prevented. At a fine scale, cattle herders can minimise risks of FMD transmission from buffalo by avoiding areas where buffalo may graze and watering places where they may drink. Education, awareness and compliance by herders may contribute towards minimising the risk of FMD outbreaks at the interface.

2. Distribution of potential buffalo-cattle interfaces in Zimbabwe

The most recent aerial census of the elephant range in Zimbabwe (Dunham et al 2015) also provided estimates of buffalo and cattle numbers in the survey areas covered in the South East Lowveld, Northwest Matabeleland, the Sebungwe region, and the Lower Zambezi Valley **(Figure 1)**.

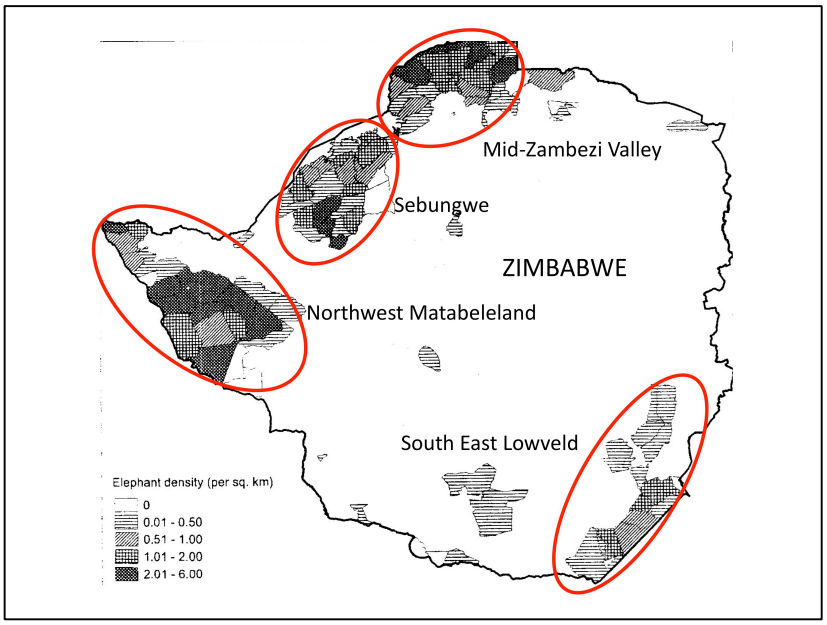

Figure 1. The four regional elephant population areas are encircled. Within these areas the strata surveyed are shown and elephant densities are indicated by patterns of cross-hatching within each stratum. Buffalo and cattle populations within these areas were also estimated.

The results of the surveys provide reasonably current evidence on where buffalo and cattle may be sharing the same range and where their distribution overlapped during the dry season of 2014. These results show that the areas where buffalo and cattle occur in the same area[1], other than in the

[1]/ i.e. within aerial survey strata that may vary in size from 70 to 2,000 km^2.

Sebungwe, are within state protected areas where cattle have been grazing illegally **(Table 1)**. In some protected areas, where both buffalo and cattle occurred, the numbers of cattle were substantial. In the southern sector of the Save Valley Conservancy, for example, the estimated number of buffalo was 1,005 compared to 15,098 cattle (**Table 1**).

Cattle were effectively absent from the Sebungwe before 1980 but, following the eradication of tsetse fly and rapid immigration of people during the 1980s and 1990s, cattle were widespread in the area by 1993 (Cumming and Lynam 1997). During the 2014 aerial survey cattle and buffalo were found in both state protected areas and in some areas of communal land in the Sebungwe (**Table 1**).

The following explanatory comments on particular areas correspond to the number provided in the right hand column of the table under "Note" and the distribution of the areas covered in **Table 1** are shown in **Figure 2**. The areas within the country presently holding buffalo populations are mapped in **Figure 3.**

1. Gonarezhou National Park (GNP). Cattle were recorded in the northern part of the national park adjacent to the Chitsa area and in the area near Chipinda Pools. Both cattle and buffalo were recorded in low numbers to the south of the national park in the Malapati Safari Area. Research on both cattle and buffalo movement has been carried out in the southern part of the GNP, the Malapati Safari Area, and in the adjacent communal lands (see Section 3 below).
2. Mahenye Ward. Although no buffalo were recorded in Mahenye during the survey they are likely to occur there and to overlap with cattle, both along the Save River and within the ward.
3. Save Valley Conservancy. The conservancy covers 3,500 km^2 and was established in 1991 by the amalgamation of some 27 properties that were ring-fenced and internal fencing was removed. Buffalo were re-introduced to the conservancy once a double game fence had been erected. During the fast track land reform programme in the early 2000s settlers from the neighbouring communal lands invaded the *southern part* of the conservancy and livestock were introduced in large numbers **(Table 1).** No cattle were recorded in the *northern sector* of the conservancy during the 2014 survey but contact between buffalo and cattle on the periphery of the northern sector is possible in parts where the fence may no longer be completely intact.
4. Malilangwe Wildlife Reserve. The area has a population of 1,600 buffalo and is securely fenced. The number of buffalo in the adjacent Hippo Valley game section and the security of that single fence, have still to be established.
5. Tuli Circle, Sentinel Ranch and Nottingham Estate are part of the Greater Mapungubwe Transfrontier Conservation Area and buffalo are no longer permitted, or present, in these areas. The Sentinel FMD free herd was moved to Wape Ranch in Mwenzi District and is no longer FMD free (V. Bristow, personal communication) .
6. Bishopstone and Mazunga-Cawood are recorded as FMD free herds and presumably have secure fencing and no contact with cattle but this remains to be determined.
7. Doddieburn. The herd has previously been recorded as FMD free but the current number of buffalo there has not been established and the herd is now probably infected.
8. Hwange National Park. Cattle were recorded within the Dzivanini stratum, which is in the southwest corner of the park and borders on the Tsholotsho Communal Land. Although no buffalo were recorded during the survey in the two Tsholotsho Communal Land strata bordering the National Park, they may occur there. No cattle were recorded in the remainder of the park. An early outbreak of FMD was recorded at Main Camp when the park warden kept a herd of cattle there in the 1950s.

Table 1. Estimated numbers of buffalo and cattle reported in the dry season 2014 aerial censuses undertaken by Dunham et al (2015) as part of the Great Elephant Census. Where "Overlap" is recorded as "Yes" both species were recorded in that area during the census. NP – National Park, SA – Safari Area, CL – Communal Land, RP – Recreational Park).

Area	Locality	No. Buffalo	No. Cattle	Overlap	Note
South East Lowveld	Gonarezhou NP	6,691	2,341	Yes	1
	Malapati SA	39	39	Yes	
	Mahenye CL	0	2,288	Likely	2
	Save Valley North	2,007	0	Possible	3
	Save Valley South	1,005	15,098	Yes	
	Malilangwe	1,630	0	No	4
	Bubye Valley	6,500	0	No	
	Nuanetsi Ranch	1,500	0	No	
	Sentinel/Nottingham	0	?	No	5
	Tuli Circle	0	?	No	
	Wape Ranch -Mwenezi	250?	?	?	
	Bishopstone	170	0	No	6
	Mazunga Cawood	?	0	No	
	Doddieburn	80	?	Yes	7
Northwest Matabeleland	Hwange NP	1,503	0	No	8
	- Dzivanini area	680	733	Yes	
	Matetsi Complex	1,733	0	?	9
	Sikumi Forest	1,228	0	Yes	10
	Ngamo Forest	0	0	?	
	Tsholotsho East CL	0	3,629	?	8
	Tsholotsho North CL	0	2,550	?	8
Sebungwe	Chizarira NP	1,297	124	Yes	11
	Matusadona NP	752	0	No	
	Chete SA	395	230	Yes	
	Chirisa SA	900	230	Yes	
	Nenyunga CL	23	747	Yes	
	Sampakaruma CL	239	1,490	Yes	
	Sibilobilo CL	158	463	Yes	
Lower Zambezi Valley	Charara to Chewore	6,330	0	No	12
	Dande SA	0	0	?	
	Angwa to Msengesi (CL)	0	17,896	?	
Other Areas	Umfurudzi (FMD free)	171	0	No	13
	Kyle Recreational Park	40	?	No	14
	Simply Free	50	?	No	14
	TOTAL No.	33,744	47,395		

9. The Matetsi Complex includes gazetted forest areas and the Zambezi National Park. Although no cattle were recorded in the survey area, contacts between buffalo and cattle are likely to occur on the border between the safari area and forest areas and the adjacent resettlement areas. Grazing of cattle is also permitted in the forest areas. A 2012 map showing the movements of two satellite-collared buffalo in the northern Matetsi Complex indicates likely overlap between buffalo and cattle on the border with the resettlement area (C. Foggin. Personal Communication).
10. Sikumi Forest. No cattle were seen in the forest area at the time of the survey but they regularly graze in the northern sector of the park. A recent a detailed study of buffalo-cattle-elephant

movements in the northern part of Sikumi Forest area indicates little if any overlap between cattle and buffalo (see Section 3 below).

11. Sebungwe. With the exception of Matusadona National Park both buffalo and cattle were recorded in several strata in both communal lands and in state protected areas during the 2014 dry season survey.
12. Lower Zambezi Valley. Buffalo and cattle were not found in the same areas in any of the strata. There may, however, be contact between buffalo and cattle adjacent to the Dande Safari Area and areas to the east of Kanyemba. However, buffalo were not observed in those strata during the 2014 aerial survey.

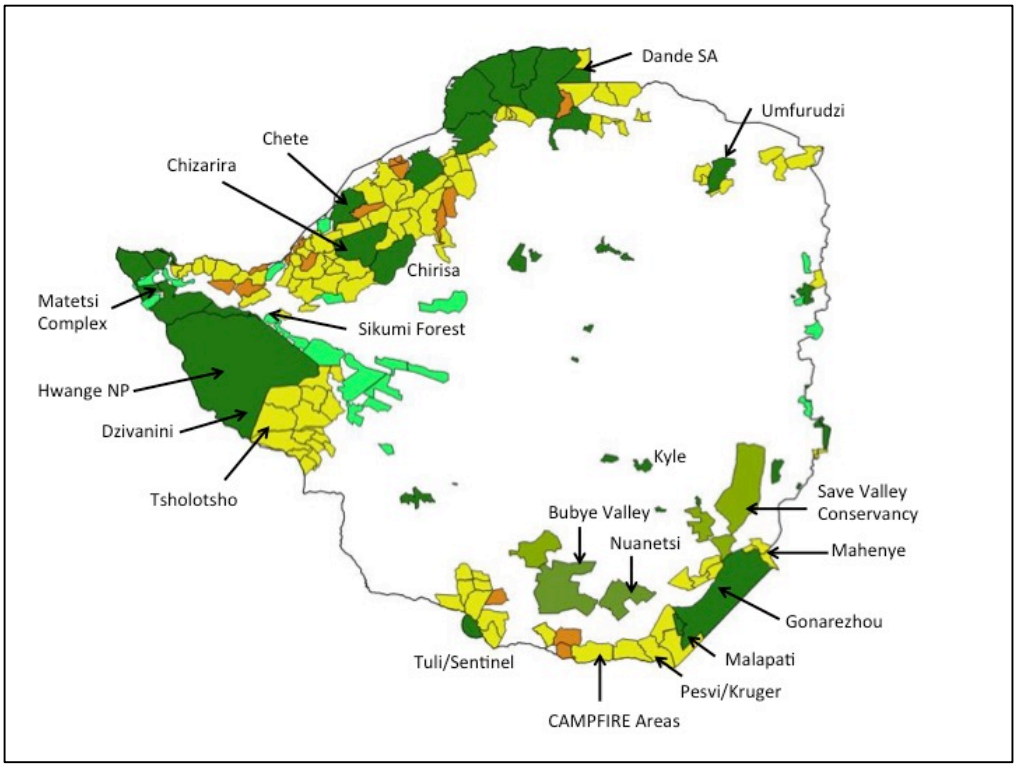

Figure 2. Map of Zimbabwe showing protected areas, forest areas, and CAMPFIRE areas in the communal lands. Names and areas refer to areas mentioned in Table 1 and the notes on pages 2-4.

13. Umfurudzi Safari Area. Part of this area has been fenced with a double fence that encloses an FMD free buffalo herd. A private company, in partnership with ZPWMA, manages the Safari Area.
14. Kyle Recreational Park, near Masvingo, has a herd of about 40 buffalo that are probably FMD free but they have not been tested recently. The herd was moved from Mushandike Sanctuary where a tame, FMD free, herd was established by John Posselt in the 1970s. The original founder calves were captured in Hwange National Park. An adjacent farm (Simply Free - Sparrow) has a herd of 50 supposedly FMD free buffalo that occasionally cross the fence and mingle with the Kyle buffalo (Mr. Shoshai, Warden, Kyle RP personal communication, May 2016).

There several small, supposedly FMD free, herds of buffalo in the country on private properties (**Figure 3**) and one in the Kyle Recreational Park. Some of these small herds have become infected and their locations are also indicated in **Figure 3**. The initial focus of FMD outbreaks (i.e. primary outbreaks) in the country between 1931 and 2002 are indicated in **Figure 4.**

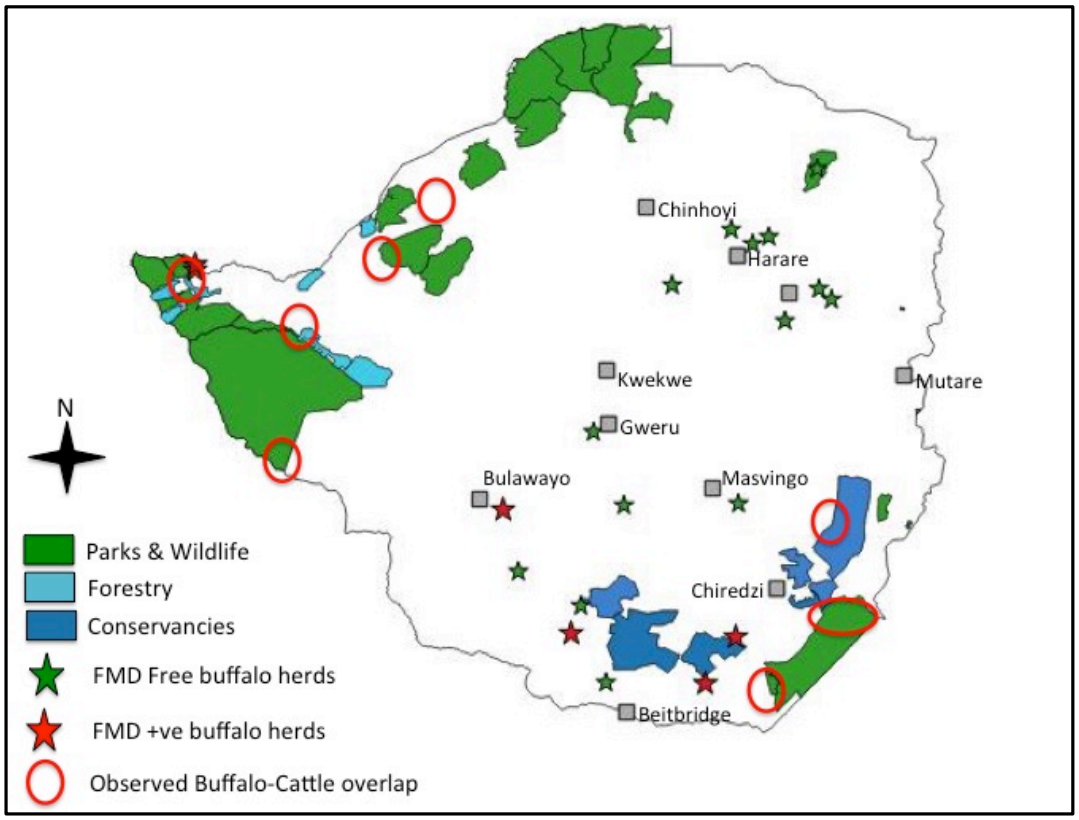

Figure 3. Distribution of areas that hold buffalo populations within Zimbabwe and areas where both cattle and buffalo were record in the same stratum during the 2014 aerial survey.

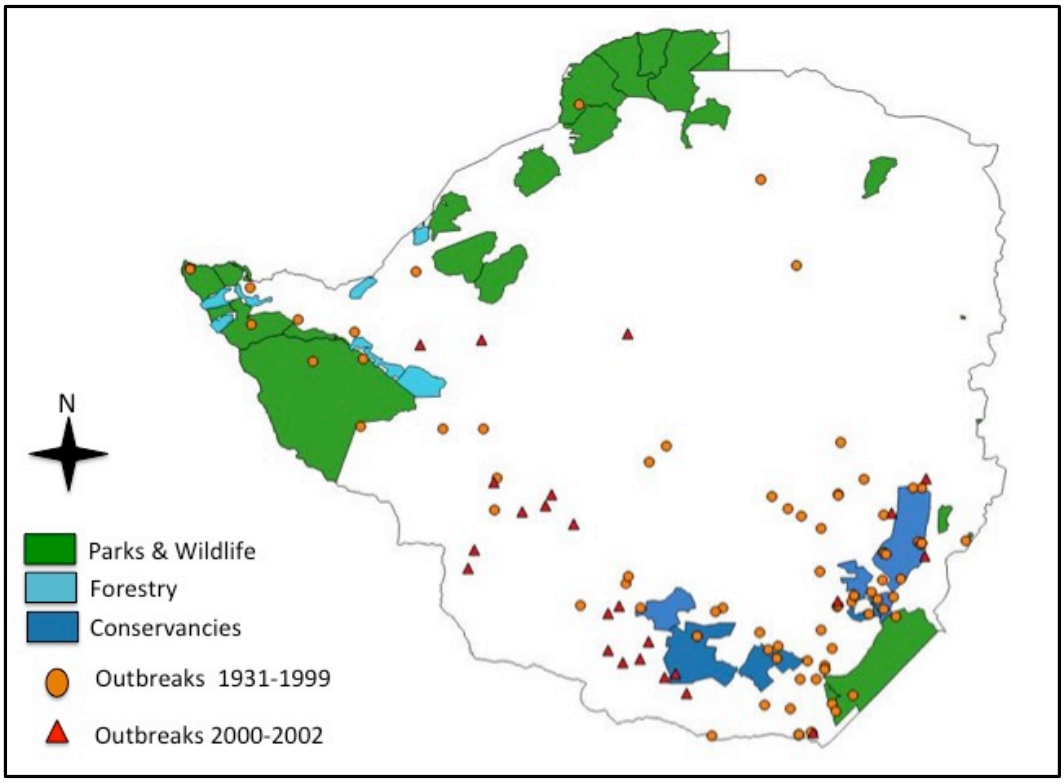

Figure 4. Distribution of initial foci of FMD outbreaks in Zimbabwe between 1931 and 1999, and between 2000 and 2002.

3. Local scale interactions between buffalo and cattle

Recent studies of the movements of buffalo and cattle using GPS satellite collars have been conducted in two interface areas in Zimbabwe. One covers the boundary between Gonarezhou NP, Malapati Safari Area and the Sengwe Communal Land. The other covers the northern part of the Sikumi Forest area and the adjacent Hwange Communal Land. These studies are summarised below.

3.1 *Gonarezhou-Malapati-Sengwe Communal Land interface*

Two adjacent interface areas between buffalo and cattle were examined by Miguel et al (2013) using GPS collared buffalo and cattle. One area was on the Limpopo River where it formed the boundary between Kruger National Park to the south and the Pesvi area in the Sengwe Communal to the north of the river. The second area was on the southern boundary between the Gonarezhou/Malapati protected areas and the adjacent Sengwe Communal Land. There were five collared cattle and seven collared buffalo in the Kruger-Pesvi area and five collared cattle and five collared buffalo in the Gonarezhou-Sengwe area. Contact between cattle and buffalo was considered to have occurred when a cattle GPS position was within 300m of a buffalo position during a subsequent period of less than 15 days. Despite the fifteen-day window and radius of 300m, "contacts" were extremely low (between 1.13×10^{-4} and 6.63×10^{-8}). A buffalo contact index was therefore developed that ranged from a score 1 to 8. For each site the average buffalo contact index tended to be highest during the hot dry season and lowest during the rainy season, and generally higher in the Kruger-Pesvi site than the Gonarezhou-Sengwe site.

Waterholes form one of the sites at which livestock and wild herbivores are most likely to share resources or to interact. In a study, by Zvidzai et al (2016), waterholes were monitored for 12 hours by day and less frequently for 24 hours during full moon periods to test whether there was any significant overlap between wild and domestic herbivores using them. Waterholes were observed during both wet and dry seasons between 2008 and 2011 and the number of 12-hour counts per waterhole varied between 8 and 36. Five waterholes were located in the agricultural area in the adjacent Sengwe Communal Land area, four were on the border of the protected area, and five were within the park. Buffalo drank at all of the waterholes within the Park, but were not recorded at those on the boundary or at those in the agricultural area. Cattle were not seen drinking at the waterholes within the park but used those on the boundary and in the agricultural area. Thus, during a total period of 3,348 hours spent monitoring wild and domestic herbivores at waterholes, neither spatial nor temporal overlap between cattle and buffalo was observed.

Chigwenhese et al (2016) examined spoor crossings on the southern boundary of Gonarezhou National Park. They found that cattle and buffalo used different sections of the boundary depending on the extent and type of damage to the boundary fence. Cattle used the section of the fence that had been damaged by humans while buffalo used the section that had been more completely damaged by elephant. Spoor crossing revealed little overlap between buffalo and cattle.

Zengeya et al (2015) used GPS satellite collars to examine cattle and buffalo movements in relation to resource gradients between the Gonarezhou National Park and the surrounding communal land. Twelve cattle herds, each with a GPS collar on a leading cow, and four buffalo herds, each with GPS collars on three buffalo cows were monitored. The cattle positions were recorded at hourly intervals between August 2008 and November 2009, and buffalo positions between October 2008 and November 2009. Cattle and buffalo were spatially segregated during the wet season and during the late dry season, but aggregated during the early dry season. Overlap between cattle and buffalo was relatively high in preferred habitats during the early dry season. The measure used to test for

aggregation/separation between points[1] at which the animals were recorded differed from those used by Miguel (2013). Aggregation between points was determined at distances (i.e. annuluses) of between 100m and 2,800m. The distances varied during the year and it is not clear from the results presented how frequently cattle and buffalo were within a particular annulus.

There is an additional interface along the Limpopo River between Kruger National Park and the Sengwe Communal Land. Movement of collared buffalo between Kruger National Park and Gonarezhou National Park has been observed and the infection of buffalo in Gonarezhou National Parks with bovine tuberculosis has been traced to Kruger National Park (Caron, et al (2016).

3.2 *Sikumi Forest-Hwange Communal Land interface*

Valls Fox et al (2015) studied the movements of elephant, buffalo and cattle fitted with GPS satellite collars in the north-western section of Sikumi Forest and the bordering Hwange Communal Land. The study involve five collared buffalo cows that were in a single herd of about 500 animals that stayed within the forest area. The collars operated between November 2012 and July 2014. Collars were fitted to cattle in different herds. Five were tracked in 2010 and nine in 2012 to 2014. Cattle were permitted to graze in Sikumi Forest and made daily incursion in to the area that varied between 2 and 6 hours per day. The study found that during the wet and cold-dry seasons buffalo successfully avoided cattle at both large and fine scales. By the end of the dry season buffalo still avoided the edge of the forest area but tolerated a greater, but still low, overlap with cattle. "In addition, buffalo stay away from waterholes during the day and come to drink at dusk after cattle have left during the rainy season and the cold dry season. Interestingly, buffalo select areas close to water during their morning bout in the hot dry season at a time of the year when cattle no longer select these areas." (Valls Fox et al, 2015).

An earlier study (Miguel et al 2013) was conducted in the same area using 3 collared buffalo and 11 collared cattle. Contact was considered to have occurred when a cattle GPS position was within 300m of a buffalo position during a period of less than 15 days. Even given this spatial window the contact rates were extremely low, and lower in this area than in the other two sites studied.

4. FMD transmission and weather patterns

The model of contact and transmission of viruses from buffalo to cattle in which buffalo calves are expected to secrete significant quantities of virus during the winter period (University of Pretoria/Agricultural Research Council 2014) is possibly linked with brief periods of winter precipitation. In the SEL this precipitation frequently takes the form of cool overcast weather with light drizzle covering one to several days, with associated low temperatures and high humidity – a pattern locally referred to as "guti". The association between FMD outbreaks and season indicates that between 1931 and 2002 most primary outbreaks[2] occurred during the winter months, namely between May and August (**Figure 5**).

The possible association between weather conditions that favour the survival of FMD virus in the field and FMD outbreaks was examined. The relationship between the number of outbreaks in each decade between 1930 and 1999 (and three-year period 2000 to 2002) and the mean decadal

[1]/ For further details of the method used the reader can refer to the original paper and to Condit et al (2000), and Perry et al (2006).

[2]/ The term "primary outbreak" is used to denote spatially and temporally independent outbreaks of FMD, which were referred to as "Original foci of all FMD outbreaks" by Condy 1979.

precipitation for West Nicholson[1] for the months of May-August were examined (**Figure 6**). Excluding the outlier for the 1940s of six outbreaks and a mean total precipitation of 25.2 mm during the May-August period, these data indicate that there may well be a relationship between winter precipitation and the number of primary outbreaks of FMD in livestock in the SEL. A more detailed examination of the link between weather and outbreaks would be merited. The changes in the effectiveness of control measures during the period 1930 to 2002 should also be taken into account.

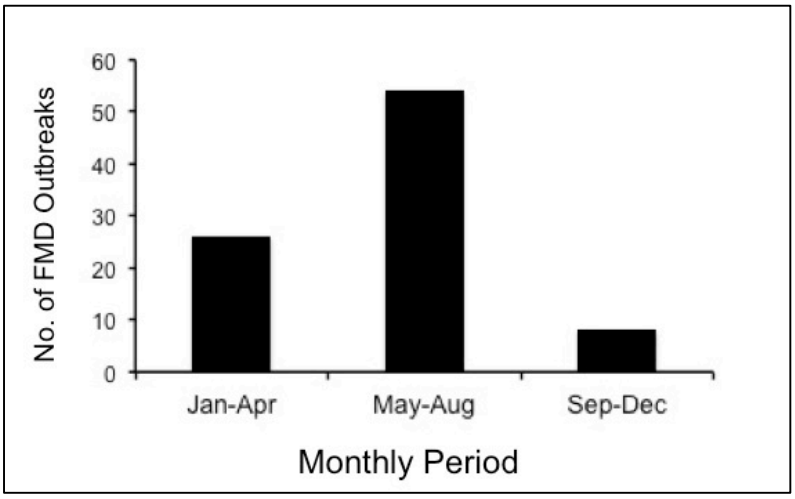

Figure 5. Seasonal distribution of primary FMD outbreaks in Zimbabwe during the period 1931 to 2002.

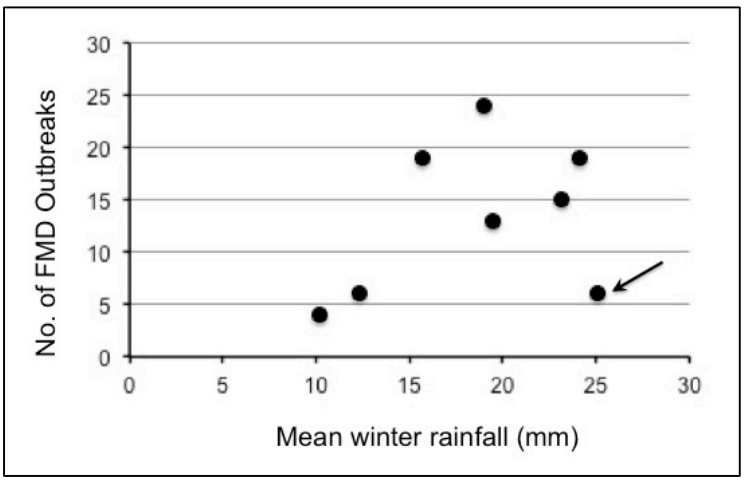

Figure 6. The numbers of primary FMD outbreaks in each decade between 1930 and 1999, and for 2000-2002, in relation to total mean annual precipitation during these periods for the months of May to August, i.e. mean winter rainfall. An arrow indicates the outlier for the 1940s.

Given these albeit very preliminary findings, closer attention to cattle herding strategies that avoid potential overlap with buffalo during the winter months (and periods of "guti") may contribute greatly to reducing the risk of FMD transmission between buffalo and cattle where the interface is not demarcated by secure double fences.

[1]/ Rainfall data for the 1930s and 1940s for stations such as Chiredzi that are closer to the main outbreak areas was not available.

5. FMD viral strains in buffalo and cattle

Brito et al (2016) examined the recent phylogeny and distribution of SAT 2 viruses (Topotypes I, II, and III) in relation to the Great Limpopo (GL) and Kavango-Zambezi (KAZA) transfrontier conservation areas (TFCAs). The complex dynamics of virus evolution within Zimbabwe and between the two TFCAs is likely to be associated with the fast track land reform programme in Zimbabwe, the collapse of fences separating buffalo and cattle, and the breakdown of controls on the movement of livestock. Associated with these changes there has been an upsurge in FMD outbreaks in cattle within Zimbabwe since the early 2000s and an urgent need to extend the sampling and genomic analysis of FMD strains now present in buffalo and cattle in Zimbabwe.

Missing from the Brito et al (2016) paper is information on the translocation of buffalo within Zimbabwe. The buffalo population in Gonarezhou National Park collapsed during the 1991-92 drought and showed little sign of recovery by 1998. To remedy this situation buffalo were translocated from the Zambezi Valley to GNP during 1998-2000 (**Table 2)**. At the time an outbreak of FMD in neighbouring cattle populations was regarded by local farmers as being more severe than previous outbreaks and they associated it with the introduction of buffalo from the Zambezi Valley. Several other translocations from the northwest of the country took place during the 1990s and early 2000s (**Table 2)**. As a result of these translocations not only were FMD viruses transferred from the northwest to the southeast of Zimbabwe, but genetically distinct buffalo (Smitz et al 2014) were also transferred.

Table 2. Major translocations of buffalo within Zimbabwe: 1991 to 2014.

Year	Area of Capture	No. of Buffalo	Notes
To Save Valley Conservancy (Source: R. du Toit 2016)			
1991	?	91	
1993	Gonarezhou NP	30?	Hargreaves et al (2004) – Mkwazi herd (c.50 in 1997)
1994	Hwange NP	30?	Hargreaves et al (2004) –Mukazi herd (c.50 in 1997)
1995/97	?	28	
2000	?	221	
2002	Malilangwe	26	
To Gonarezhou National Park (Source: C. Foggin 2016 and The Herald)			
1998	Charara Safari Area	200(?)	
1999	Chizarira NP	250 ?)	
2000	Sengwa Wildlife Research Area	166	Planned to move 250 (The Herald, Oct 2000)
To Bubye Valley Conservancy (Source: P. Trethowan (2016)			
1995	Gwaai Forest	54	
1995	Matopos	5	
1997	Anfrey, Mwenezi	7	
1998	Hwange NP	38	
1998	Chete SA (Mujere)	133	
1999	Kariba islands	73	
1999	Sengwa Wildlife Research Area	151	
2002	Sentinel Ranch	42	
2009	Triangle	126	
2010	Malilangwe	211	
2011	Malilangwe	300	
To Nuanetsi Ranch (Source: B. Lees-May 2016)			
2009	Hwange Nat Park	500	
2012	Malilangwe	300	
2013	Malilangwe	199	
Various smaller moves (Source: N. La Grange 2016)			
2010	Marula to Doddieburn	18	FMD Free
2011	Thetford (Mazoe) to Doddieburn	7	FMD Free
2011	Masvingo to Umfurudzi – small herd	?	FMD Free
2012	Beitbridge to Umfurudzi Safari Area	20	FMD Free
2014	Beitbridge to Wape Ranch (Mateke)	177	Formerly a FMD free herd from Sentinel Ranch

6. Discussion

At a broad scale there are several areas in the country where buffalo and cattle distributions overlap. Other than within the communal lands of the Sebungwe, where both cattle and buffalo distributions have overlapped since the eradication of tsetse fly in the 1970s and 1980s, the remaining areas of overlap in the country are where cattle are being grazed illegally in protected areas that carry buffalo. Buffalo herds have been found to avoid cattle and remain within protected areas, although single buffalo, or small herds, may make occasional forays outside the boundaries of protected areas (e.g. Caron et al 2016)

At a finer scale, recent research at the interface between cattle and buffalo in the SEL and in the northwest of Zimbabwe shows that buffalo avoid cattle – a finding that agrees with research carried out elsewhere in Africa (e.g. Hibert et al 2010). In the five fine scale studies outlined above none observed direct contact between cattle and buffalo. Only one of the studies, where waterholes were monitored, involved direct observation of animals in the field. The remaining studies relied on locations of tagged animals as determined by GPS collars. The frequency with which buffalo and cattle were recorded in the same vicinity (e.g. within 300m) was extremely low even within a window of 15 days in one study. It would be useful to know how frequently the two species were located within, say 300m, of each other on the same day in the various studies that have used GPS collars.

7. Conclusion

Two management implications for reducing contact between cattle and buffalo emerge from this preliminary review. At a broad scale, the grazing of cattle in protected areas containing buffalo should be stopped. At a fine scale, cattle herders can minimise risks of FMD transmission by avoiding areas where buffalo may graze and watering places they may use. Education, awareness and the adoption of appropriate cattle herding strategies may go a long way towards reducing the risk of FMD outbreaks at the interface while contributing to improved pasture management.

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