The quantification of cattle movement in the Bushbuckridge Local Municipality, Mpumalanga, and implications for trade and disease control

By

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I would like to dedicate this thesis to the people of Bushbuckridge.

You have embraced me as a daughter and given me purpose in serving you.

DECLARATION

I, Oonagh Pretorius hereby declare that the research entitled "The quantification of cattle movement in the Bushbuckridge Local Municipality, Mpumalanga, and implications for trade and disease control" presented in this dissertation, in partial fulfilment of the requirements for the degree MSc (Tropical Animal Health) was executed by myself, under the guidance of my supervisors.

I further declare that this dissertation has not been submitted in the past or is submitted for a degree at the University of Pretoria or any other university.

Oonagh Pretorius (BSc, BVSc)

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Date

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LIST OF ABBREVIATIONS

- % Percentage
- & And
- AHEAD Animal & Human Health for the Environment and Development
- AHT Animal health technician
- APNR Adjoining Private Nature Reserves
- BBR E Bushbuckridge East state veterinary area
- BBR N Bushbuckridge North state veterinary area
- BBR S Bushbuckridge South state veterinary area
- BBR Bushbuckridge
- BLM Bushbuckridge Local Municipality
- CBT Commodity based trade
- Comm. Communication
- CSA Conservation South Africa
- DA Dip tank assistant
- DAFF Department of Agriculture, Forestry & Fisheries
- DARDLEA Department of Agriculture, Rural Development, Land & Environmental Affairs (Mpumalanga)
- Dept. Department
- e.g. Example given
- EU European Union
- FAO Food and Agriculture Organisation of the WHO
- Fig. Figure
- FMD Foot and mouth disease
- FMDV Foot and mouth disease virus
- FZ FMD Free Zone
- GKNP Greater Kruger National Park
- GPP Game processing plant
- IDS Institute for Development Studies
- Inf. Infinity
- IP Inspection point
- IQR Inter-quartile range

- IUCN International Union for Conservation of Nature
- IZ FMD infected Zone
- km Kilometre(s)
- KNP Kruger National Park
- LCDD Local and community driven development
- LED Local economic development
- Med. Median
- mm Millimetres
- MMAP Mnisi mobile abattoir project
- MVS Mpumalanga Veterinary Services
- OIE World Organisation for Animal Health
- p Probability value
- Pers. Personal
- PZ FMD Protection Zone without vaccination
- PZV FMD Protection Zone with Vaccination
- RSA Republic of South Africa
- SADC Southern African Development Community
- SAFAIS South African FMD Animal Identification Scheme
- SANParks South African National Parks
- SPS Sanitary and Phyto-Sanitary agreement of WTO
- Stats SA Statistics South Africa
- SVO State Veterinary Official
- Tab. Table
- TAD Transboundary animal disease
- TAHC Terrestrial Animal Health Code of the OIE
- TFCA Transfrontier conservation area
- VAT Value added tax
- VPH Veterinary Public Health
- WTO World Trade Organisation
- μ Mean
- σ Standard deviation

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ABSTRACT

'The quantification of cattle movement in the Bushbuckridge Local Municipality, Mpumalanga, and implications for trade and disease control' by Oonagh Pretorius

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In the Bushbuckridge Local Municipality (BLM), Mpumalanga, the size and economic importance of the local, mostly informal, cattle trade has been considered negligible to date by local policy makers. Opportunities for the local cattle farmers to access formal live or product markets remain severely limited, mainly as a result of movement restrictions associated with foot-and-mouth disease (FMD) control. Data, in the form of movement permits and monthly cattle registers were used to analyse movement and trade activity in the area over a four-year period (May 2015 - April 2019). The population fluctuated around 77 166 head of cattle, distributed between 9739 emerging rural livestock farmers. The proportion of animals/products moved ranged between 3.1 and 7.2 percent (0.04 ± 0.02). Movements were found to be highly seasonal ($p < 0.001$) with the 'cool dry' season (April-July) being the most active. Most movements consisted of live cattle which were herded to their destinations. The vast majority of trade did not leave Bushbuckridge and was informal in nature. Farmers moved animals and products much further to access formal markets ($p < 0.001$) than informal markets, and generally required use of motorised transport to do so.

The FMD outbreak of 2017 did not prove detrimental to the local cattle industry in the medium term. However, distinct changes to the overall Bushbuckridge herd dynamics were noted, with small scale farmers most severely affected. As a direct result of the heightened movement restrictions in this period, an estimated 96% of formal trade; 85% of informal trade, and 54% of local trade were lost. In 2018, an improvement in cattle prices stimulated farmers to access the formal marketplace, and an increase in the proportion of the cattle population moved was observed.

It was concluded that farmers pursue formal marketing options only when financially incentivised or pressurised by adverse conditions such as environmental factors or disease outbreaks. Growing established local markets is likely the best way to assist the local population with market access, development and poverty reduction. The key constraints to marketability of animals/products originating in the BLM were identified as the absence of a competitive

market system and associated infrastructure such as FMD designated abattoirs, disease control regulations, poor carcass quality, and seasonality of offtakes. These limitations will need to be considered when policy decisions are made. Context-specific solutions should be generated to address local needs and effectively support development of a sustainable cattle trade going forward.

CHAPTER I: INTRODUCTION

A controlled disease is defined in the Animal Diseases Act 36 of 1984 as "any animal disease in respect of which any general or particular control measure has been prescribed, and any animal disease which is not indigenous or native to the Republic" (Republic of South Africa Government Gazette 1984). Foot and mouth disease (FMD) is a controlled, highly infectious viral disease affecting cloven-hoofed animals (Thomson 1994).

The African buffalo, *Syncerus caffer,* is the natural reservoir host of the FMD virus in the Republic of South Africa (RSA) (National Department of Agriculture n.d.). FMD eradication is made unrealistic due to its endemicity in nearly all buffalo populations in southern Africa (Scoones *et al.* 2010). In South Africa specifically, FMD-infected buffalo are limited to Ndumo Game Reserve and Thembe Elephant Park in northern KwaZulu-Natal Province (DAFF 2012; Zokwana 2015); and the Kruger National Park (KNP), a South African National Park (SANPark), and its adjoining private nature reserves (APNR) which lie in the north-eastern corner of South Africa (Jori *et al.* 2009). The boundaries of the aforementioned FMD endemic areas clearly demarcate South Africa's FMD Infected Zone (IZ) (Fig. 1) due to the occurrence of FMD carrier buffalo populations within (Zokwana 2015).

FMD is not lethal to the majority of animals but does decrease production in infected herds and has the ability to spread very quickly over vast distances (Zokwana 2015). Many developed countries have devoted significant resources in order to root out FMD and ensure that it does not return. It has thus become a global disease of primarily economic importance and although the South African government has instituted a wide range of control measures to prevent FMD transmission from the infected areas, outbreaks do occur in cattle sporadically and jeopardise the country's ability to trade in animal products with other nations. When outbreaks do occur in the FMD Free Zone (FZ), immediate trade bans are placed on agricultural exports from the affected country, which consistently have significant agro-economic impacts (Thomson 2008).

The study area encompasses the Bushbuckridge Local Municipality (BLM) which is situated in the north-eastern corner of Mpumalanga province, RSA. A game-proof fence acting as the western boundary of the Greater Kruger National Park (GKNP) generates 400 (kilometres) km (Jori *et al.* 2009) of wildlife-livestock interface with the adjacent, largely rural and impoverished, communities such as Bushbuckridge. This proximity to the FMD-infected GKNP has led to Bushbuckridge's classification in the FMD Protection Zone with Vaccination (DAFF 2014b). In

2006, the South African National Government Monitor Group recognized Bushbuckridge as a rural poverty node, earmarked for rural economic development and upliftment.

In the BLM, the size and economic importance of the local, mostly informal, cattle trade has been considered negligible to date by local policy makers. In its 2010 strategy for local economic development (LED), the Local Municipality concluded that livestock farming in the area lacked the potential for development as the keeping of livestock was strictly for cultural and subsistence reasons and did not warrant further financial investment.

Uninformed policy decisions such these are baseless. The dearth of information available to policy-makers stems directly from a lack of scientific inquiry (Perry & Grace 2009, Scogings *et al.* 1999) regarding the extent to which cattle or cattle products are moved and, by extension, the level of the cattle trade. This oversight has resulted in cattle trade being neglected in the local policy for economic development and not receiving adequate budgetary support.

Opportunities for the local cattle farmers to access formal live or product markets outside of the PZV remain severely constrained due to FMD-linked movement restrictions which inhibit agro-economic development within the municipality. A lack of registered red meat abattoirs and butcheries also limits local marketing options for animal products. Considering that the BLM cattle population fluctuates around 77 000 head of cattle (DARDLEA 2015-2019), for which there are very few formal marketing opportunities, the ripple effect on the reliant farmers is substantial.

FMD outbreaks persistently threaten the viability of the marketing systems available to marginalised communities at the wildlife-livestock interface of southern Africa (Sibanda 2008). More information is necessary to assess the impact of FMD outbreak control measures on rural cattle trade. Research into the specific, local effects of FMD outbreaks on cattle herd dynamics and commerce is limited (Tekleghiorghis *et al*. 2014). This being principally due to challenges associated with collecting, or gaining access to, reliable data on livestock movements and commerce in deeply rural communities affected by such disease events.

The objectives of this study are to describe the movement activity of cattle in the BLM and by extension, estimate the level of the formal and informal cattle trade during the period May 2015 to April 2019. By examining these factors, it is possible to analyse, and to determine the impact of, an FMD outbreak-induced movement standstill on the local cattle industry, the overall implications for market access, local economic development and animal disease control.

The outcomes of this investigation are to be utilised as a means of informing local policy makers on the number of cattle movements that occur in the BLM and the disease risk linked to animal movement and trade in this area.

CHAPTER II: LITERATURE REVIEW

2.1 The wildlife-livestock interface

According to the Merriam-Webster dictionary (2019), an interface is defined as 'the place at which independent and often unrelated systems meet and act on or communicate with each other'. Defining the wildlife-livestock-human interface has proved slightly more complicated. To describe it simply as the landscape where humans, their livestock and wildlife meet does not clearly illustrate the complex and often precarious relationships between role-players, based on much more than just the physical aspects of competing for natural resources.

The increase of wildlife-livestock-human interface areas throughout Africa can be attributed to the establishment and enlargement of transfrontier conservation area (TFCA) initiatives in parallel with the expansion of rural populations (van Rooyen 2016). The promotion of TFCAs for biodiversity conservation has been firmly supported by conservationists, the eco-tourism industry and the general public alike. Advocates of the movement, such as Osofsky *et al.* (2005), maintain that the removal of fences between wildlife and livestock is the best way to preserve Africa's rich and invaluable biodiversity. Some even argue that the expansion of wilderness areas would lead to sustainable economic development of marginalised pastoral communities through change in land-use and development of ecotourism enterprises (Chardonnet *et al*. 2002, Cumming & Bond 1991, Cumming 2008, Jansen *et al*. 1992). The resultant animal health implications however, are often overlooked (Bengis 2005).

2.1.1 Disease control at the wildlife-livestock interface

It is true that hard interfaces, such as fences, play a substantial role in defining the demarcation between the two areas, but when considering disease transmission, Kock (2005) argues that when defining this interface several other potential interactions between these parties must also be addressed. These include the various important diseases transmitted at the physical interface which have a bearing on the trade of animals; the influence of vector-borne disease prevalence in the associated populations and the overall impact of this on the transmission thereof between livestock and wildlife on all coteries; as well as the competition for shared resources.

Common diseases of concern at interfaces include vector-borne diseases such as corridor disease, African horse sickness and African swine fever; viruses with potential aerosol transmission means such as bovine malignant catarrhal fever and FMD; bacterial pathogens with hugely detrimental effects on livestock production such as bovine brucellosis and bovine tuberculosis (bTB); and of course, anthrax.

It is important to be aware that disease transmission at the interface is multi-directional. While many diseases of concern to both human populations and their livestock originate from wildlife, there are a number of pathogens originating in human settlements that threaten wildlife populations. For example, rabies and canine distemper are regularly diagnosed in dogs from communal areas abutting the KNP, both of which pose enormous threats to the survival of endangered African carnivores such as the African wild dog, *Lycaon pictus*, (van de Bildt *et al.* 2002) in adjacent wildlife conservation areas.

State veterinary services are designated as the custodians of disease control at these junctures. It is a critical role, the management of which is not only logistically complex but requires significant investment by governments, both financially and in terms of human resources in order to function effectively. In southern Africa, the ability of state veterinary services to keep controlled animal diseases in check has been questioned increasingly by international markets such as the European Union (EU) (Cassidy 2010). This is not surprising considering escalating outbreaks of economically prominent diseases such as FMD combined with the pervasive lack of capacity and declining budgets experienced by veterinary services across the Southern African Development Community (SADC) region (Scoones *et al.* 2010).

2.1.2 The fence

The foremost principle of disease control has long been separation. If an infected individual cannot come into contact with a naïve individual, directly or indirectly, then no diseases transmission can occur. Whilst the logic behind this is sound, the creation of an impermeable barrier is practically unfeasible and, it could be argued, that it has proven to be impossible given the continued FMD outbreaks throughout the region where game-proof fences occur.

Fences have been used to separate wildlife from livestock at interface areas in southern Africa since the colonial era (Scoones *et al.* 2010). Motivated by disease control and the possibility of securing lucrative export markets, national governments often take financial responsibility for erecting and maintaining these fences. In Namibia, for example, a veterinary cordon fence

plainly bisects the country between the communal farming areas of the north and the largely commercial farming enterprises of the south (Bishi & Kamwi 2008), affording a small minority the opportunity to access international beef markets.

In South Africa, the 400 km of KNP'S western boundary fence has been primarily responsible for preventing contact between buffalo and cattle since the 1960s (Jori *et al.* 2009, Scoones *et al.* 2010). Although the KNP fence was built specifically with disease control in mind, it provides several other key benefits; shielding wildlife from poaching and protecting communities on the boundary from damage causing animals such as elephants and predators (van Schalkwyk 2015).

Disease control fences, no matter how well constructed, are not impermeable. Stray buffalo are often sighted in livestock rangelands on the periphery of the KNP. Damage to fencing is common due to a variety of reasons including flooding, elephant and other large ungulate damage, vandalism and theft (van Schalkwyk 2015). Maintenance, repair and general upkeep of the KNP fence falls to the national Department of Agriculture Forestry and Fisheries (DAFF) and is managed locally by their Skukuza state veterinary office (SVO).

Proponents of TFCAs like Fenner (1982) and Kock (2005) argue that even in the absence of fencing, wildlife and livestock generally choose to avoid direct physical contact or sharing the same space concurrently. According to this research, the majority of infectious diseases affecting wildlife and livestock are much more likely to be spread via indirect means such as vectors, intermediate hosts or through fomites contaminated by various bodily secretions. Despite this it is unlikely that the concerns of international trade and disease regulation bodies such as the World Organisation for Animal Health (OIE) and EU would be placated by the assurances of developing countries that a transboundary animal disease (TAD) control system does not need a fence to be successful.

2.1.3 Bushbuckridge: a rural community living on the edge

In Bushbuckridge (BBR), the historical local cattle trade allows the tradition of livestock-keeping to be passed on to future generations of the community, hereby providing numerous significant social and cultural benefits (Ainslie 2013). Cattle provide a multitude of benefits to low-income, rural communities like BBR. These include milk, meat, hides, horns, cash income, dung as manure, fuel, and for flooring, draught power, as well as serving a diverse range of socio-cultural functions (Musemwa *et al*. 2008).

Farming in the BLM is mainly subsistent in nature. Agro-pastoralists make use of communal grazing to raise their cattle, goats and sheep. According to Scogings *et al.* (1999), communal rangelands, are 'areas of veld that are not privately owned but belong to entire communities whose members have equal access to free resources'. Whilst grazing on communal rangeland provides all farmers with feed for their livestock, uncontrolled access to this precious resource place it at risk of over-use and irreversible land degradation (Scogings *et al.* 1999).

As a result of the geographic proximity of the BLM to the FMD-endemic KNP, local cattle farmers are subject to strict movement control policies (Republic of South Africa Government Gazette 1984) enforced specifically in an effort to maintain the national foot-and-mouth-disease-free status which was accepted by the OIE in 1995 (National Department of Agriculture n.d.). If South Africa does not comply sufficiently with these stringent regulations, it risks the country's ability to trade with international partners such as the EU and the United Kingdom (Thomson *et al*. 2003). This means that no cloven-hoofed animals or animal products may leave the protection zone without a movement permit issued by the responsible State Veterinarian.

The sheer size of the wildlife-livestock interface, which defines the BLM's southern and eastern boundaries, increases the chances of close contact between wildlife and livestock. This, in turn, exponentially increases the risk of the transmission of controlled and notifiable animal diseases such as FMD and African swine fever (Michel & Bengis 2011).

2.2 Local economic development constraints at the wildlife-livestock interface

2.2.1 Poverty alleviation and rural development

In the last two decades, the world's outlook on poverty alleviation has undergone a definitive shift (Deepa 2002, The World Bank 2002). Modern approaches to poverty reduction emphasise sustainable solutions such as improving the capabilities of the impoverished, over the traditional 'hand-out' policies which have repeatedly proven ineffective in the long term. In so doing, the poor are empowered not only to rise above their circumstances financially but retain control over communal resources and all dimensions of the decision-making processes (Binswanger-Mkhize *et al.* 2009, Shakleton *et al.* 2000, Twine 2013, Vetter 2013). Many studies have conclusively shown that communities will only take ownership of and responsibility for poverty alleviation efforts if they are the majority stakeholder (Binswanger-Mkhize *et al.* 2009; Perry & Grace 2009, van Rooyen 2016) such as in Local and Community Driven Development (LCDD) schemes. LCDD is based on real participation; improving accountability; technical

soundness and sustainability (Binswanger-Mkhize *et al.* 2009). Although this approach is more successfully sustained, utilising LCDD principles requires policy to be tailor-made specifically to local requirements (Hodge and Midmore 2012) which is more labour intensive than generating broader or centralised economic development policies.

Like many rural areas in South Africa (Coetzee *et al*. 2005), the cattle trade in the BLM remains informal despite some farmers being eager to expand their small-scale production into fully-fledged agri-businesses. Informal trade is defined by the Food and Agriculture Organisation of the United Nations (FAO) (2017) as 'all economic activities by workers or economic units that are – in law or practice –not covered or sufficiently covered by formal arrangements', includes legitimately-produced goods and services that do not necessarily follow formal processes such as standards regulations, business registration or operational licenses." In the 2002 census on commercial agriculture, a commercial farm was defined as one registered for value added tax (VAT) (Kirsten & Moldauer 2006). Not a single cattle farm in the BLM is currently farmed 'commercially' by this definition (Dept. Agriculture, Rural Development and Environmental Affairs (DARDLEA) 2016-2017). Lack of budgetary support and infrastructure (Bushbuckridge Local Municipality 2010), combined with poor levels of service delivery and improper resource management on the part of the local government continue to limit the success of local cattle farmers. Combined, these constraints continue to impede socio-economic development of the area (Perry & Grace 2009) and have firmly sequestered the BLM livestock farming community in a poverty trap.

2.2.2 Current BLM policy for local economic development

In rural settings, human nutrition, health, poverty relief and economic development are intrinsically linked to agriculture (Randolph *et al.* 2007). Pastoral livelihoods in BBR depend largely on subsistence agriculture (Shackleton *et al.* 2005) and, we suspect, on trade of livestock within BLM and other areas of the FMD protection zone with vaccination. Rural household decision-making has been shown to be based largely on complex relationships between livestock, health and well-being (Osofsky et al. 2012; Randolph *et al.* 2007; Shackleton *et al.* 2005). Improved trade opportunities for the livestock farmers of BBR would no doubt improve their household's financial resilience, and the health and well-being of their families as a result.

Key projects highlighted by the local government to promote LED are focused on tourism, irrigation and citrus farming. Key investment opportunities identified also include citrus related

products, tourism, honey and mushroom farming projects (Local Government n.d.). No mention is made of supporting the local cattle trade (or any form of animal agriculture for that matter) in any of the current plans for LED described in detail in an official newsletter published by the BLM in March 2016. In the LED strategy (BLM 2010), local government described cattle farming as 'essentially not beef production per se since these small, scattered herds serve primarily as a store of wealth and not as a commercial asset'.

It is clear that policy makers consider the local cattle trade as only subsistence in nature and of little importance for economic development, which results in the sector being under-appreciated and inappropriately funded (Perry & Grace 2009). Yet, without creating feasible opportunities for sustainable rural development of the cattle trade, the efforts of the local government regarding poverty alleviation are likely to remain unrealised.

Emerging farmers in Bushbuckridge require political, financial, social and educational support if they are to become economically successful. The term emerging farmers is very broad and can be defined in various ways in South Africa. Often it is simply used as the more politically correct way of saying 'black farmer'. This is an oversimplified, largely incorrect way of applying the term, considering that neither all black farmers are emerging, nor are all emerging farmers black (Mabaya *et al.* 2011). Senyolo (2007) defined emerging farmers as 'those farmers that are participating in the market and have intentions to produce and sell more'. This study defines emerging livestock farmers as those farmers attempting to transition from subsistence agriculture to commercial agriculture through the aid of external facilitators such as the South African government. It is important to note that by this definition, not all farmers in Bushbuckridge should be termed 'emerging', as many have no intention of growing a commercially viable agribusiness.

2.3 Foot and mouth disease control in South Africa

Effective FMD control measures rely on four mechanisms, namely, cattle identification; surveillance; vaccination; and separation through movement control (DAFF 2014b). Based on the local risk attributed to FMD, South Africa is divided into five FMD zones (Fig. 1). From highest to lowest risk, these are: the FMD Infected Zone (IZ); the FMD Protection zone; the FMD High Surveillance Area with movement control; the FMD High Surveillance Area; and the FMD Free Zone (FZ) (DAFF 2014b). The FMD Protection Zone is further subdivided into the Protection Zone with Vaccination (PZV) and the Protection Zone without Vaccination (PZ).

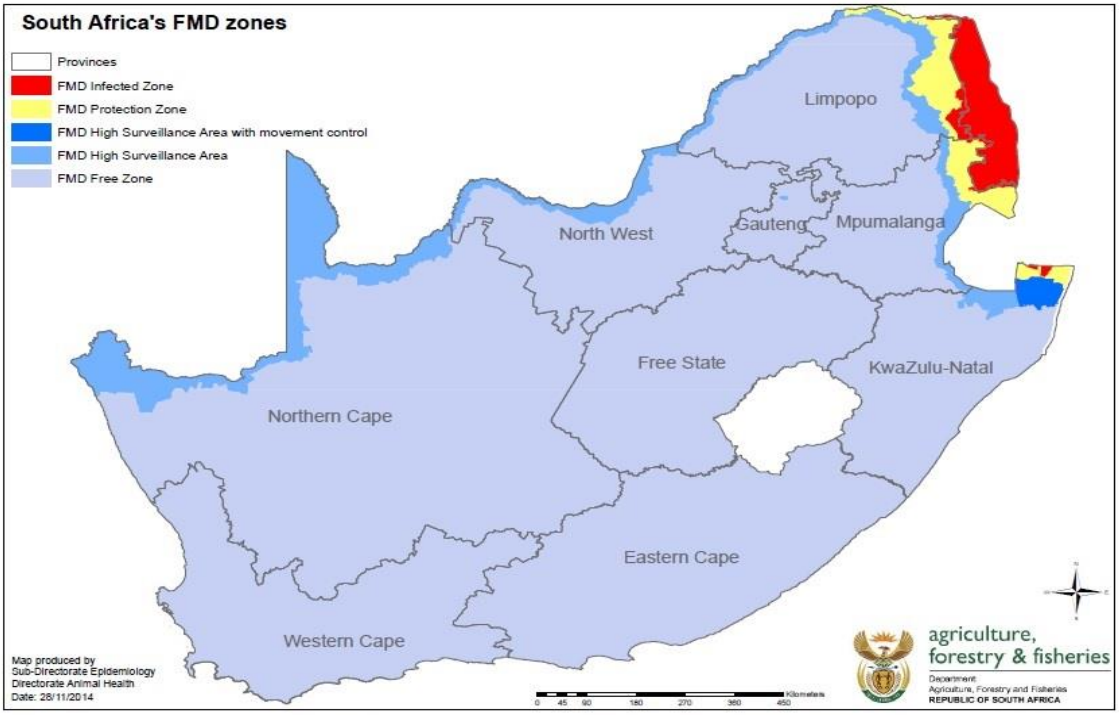

Figure 1: Map of South Africa's FMD Zones (DAFF 2014b).

2.3.1 Cattle identification

Following the 2011 outbreak, South Africa's national FMD disease-free status was only reinstated by the OIE in February 2014. In an effort towards achieving and maintaining FMD-free status by complying with OIE standards, the South African Foot and Mouth Identification Scheme (SAFAIS) was instituted for animals residing in the FMD Protection Zones. SAFAIS entailed individual ear-tag identification with an associated traceability system. This approach made it possible to effectively identify individual cattle and their FMD zone of origin by utilising custom-made ear tags in zone-specific colours with a 2D barcode, unique number and a country specific logo; all to prevent counterfeiting (Appendix A) (DAFF 2014a). In addition to this, all cattle are also required to be individually branded with a registered owner brand mark (DAFF 2001) and an F-brand on the right side of the neck if the cattle originate from the PZV to indicate that they have been vaccinated against FMD (DAFF 2014a).

A similar identification and traceability system which feeds into databases administered by state veterinary departments is used in Namibia (Scoones *et al.* 2010). In the past, Botswana placated European Union (EU) Council regulations by means of a Livestock Identification and Trace-back System (LITS) whereby a tamper-proof, micro-chipped reticular bolus, was inserted into every animal, facilitating the traceability of beef from abattoir back to individual animal level

(Botswana Ministry of Agriculture n.d.). Due to some logistical challenges with LITS however, the system has now been replaced by the Botswana Animal Information and Traceability System (BAITS), for individual cattle identification utilising electronic ear tags (Animal & Human Health for the Environment and Development (AHEAD) Programme 2019). A remotely accessible central computer database stores owner information and location to facilitate trace-back operations.

2.3.2 Foot and mouth disease surveillance

Ongoing physical inspection of cattle in FMD-endemic and high-risk areas is practiced by all SADC member countries (Thomson 2008).

In RSA, clinical FMD surveillance of cattle is performed by government animal health technicians every seven days in the PZV; every fourteen days in the PZ and every 28 days in the high surveillance zone. Inspection of small stock, which includes sheep, goats and pigs, occurs every 28 days. Routine mouthing examinations on ten randomly selected cattle are also performed during every inspection. Serological and virological surveillance are beyond the scope of this study and will not be discussed.

2.3.3 Foot and mouth disease vaccination

All cattle in the PZV are required to be vaccinated against FMD every four months. Cattle outside the PZV are not allowed to be vaccinated routinely (DAFF 2014b). Other cloven-hoofed domestic species such as pigs, sheep and goats are not routinely vaccinated.

This is a comparatively high vaccination requirement compared to other southern African countries which only vaccinate animals in close proximity to buffalo on a biannual basis (Thomson 2008). The reason being that the Botswana Vaccine Institute vaccine currently in use in South Africa, designed specifically to combat FMD topotypes found in Botswana, is not able to confer long-lasting, protective levels of immunity against local topotypes of foot and mouth disease virus (FMDV) (Scoones *et al.* 2010).

2.3.4 Movement control and permitting

Movement control in southern Africa is implemented via strict permit systems regulated by state veterinary services and enforced by veterinary roadblocks, to differing degrees of effectiveness.

In South Africa, all cloven-hoofed animal movements from and within the FMD protection zones (Fig. 1) are subject to state veterinary movement permits and written, pre-approved FMD inter-state veterinary or inter-zonal movement applications (DAFF 2014b). SAFAIS ear tags are used to identify the individual cattle for movement, alongside F-brands and individual owner brandmarks. The purpose of this is to prevent illegal movements of cloven-hoofed animals from the FMD protection zones into the FMD free zone where they may compromise the integrity of South Africa's FMD free zone. Movement of FMD-susceptible livestock from the PZV is only permitted from inspection points with an inspection turnout and frequency greater than 50% in the preceding 30 days (DAFF 2014b). Tables provided in the FMD Veterinary Procedural Notice (VPN) of 2014 (DAFF b) detail movement conditions for all eventualities.

In order to ensure that animals or products originating in the protection zones reach their approved destination, a red-cross veterinary movement permit is used. Red-cross permits require consignments to be sealed by a state veterinary official at origin, where the permit is issued, and which is then unsealed at destination by another state veterinary official. The permit is made in triplicate. Seal numbers; animal or product identification; owner and vehicle details; and movement conditions are detailed on the document. The original permit travels with the owner. The first copy is sent electronically to the receiving official to compare to the original upon arrival. If the consignment has not been tampered with and all permit details correlate, the official at destination must sign and stamp the first copy and return it to the issuing official. The second copy is retained by the issuing official for record-keeping purposes. In this way, all movements within and from the FMD control areas are regulated and recorded for traceability purposes.

According to the national FMD VPN (DAFF 2014b), live cattle, sheep, goats and pigs may only be moved out of the protection zone without vaccination (PZ) and into the FZ, if the animals are found negative on serological testing for FMDV and undergo 21 days of quarantine.

2.4 Cattle trade and market access in the BLM

Gaining international or even just national market access remains an insurmountable hurdle for rural cattle farmers from marginalised pastoral areas in Africa such as BBR (Rota and Sperandini 2010). There are several factors that contribute to a lack of formal cattle trade in the BLM. Firstly, the KNP is recognised as an FMD IZ due to the presence of persistent carriers of the disease within the game reserve, namely the African buffalo, *Syncerus caffer* (National Department of Agriculture n.d.). Secondly, the lack of registered red meat abattoirs within the protection zones severely constrains growth and commercialisation of the livestock industry because animals cannot be slaughtered locally and meat can never leave the PZV.

Movement control restrictions and lack of abattoirs inhibit commercial cattle trade, yet informal trade still occurs between livestock owners within the area (DARDLEA 2015-2019). Van Rooyen (2016) concluded that there are significant levels of trade in the Mnisi study area of Bushbuckridge East (BBR E), hence the need to expand the research to cover the entire BBR area. Trade is largely underestimated by the local government in terms of potential for LED and a high level of risk is incurred with regard to control of infectious diseases.

2.4.1 Geographic trade restrictions

Geographic trade standards are the traditional method by which global trade is regulated and protected by the World Trade Organisation's (WTO) Sanitary and Phyto-sanitary (SPS) Agreement. Based on this document, the OIE's Terrestrial Animal Health Code (TAHC) sets standards for the facilitation of safe international trade of livestock and livestock products (Thomson *et al.* 2004). With regard to FMD control in RSA, this method of regulating trade only benefits commercial farmers in the FMD FZ. The inequality associated with such systems has led many modern-day sources to express the view that trade-restrictions based on this type of disease control methodology are socially insensitive to impoverished communities that are denied market access based solely on where they happen to live (Scogings 1999, Thomson *et al*. 2003). Osofsky *et al*. (2012) describes geographic trade as a large barrier to livestock- based economic development initiatives.

Negative outcomes associated with geographic trade include:

- increased trade restrictions and trade barriers
- strict movement controls

- decreased local animal off-take within controlled areas
- increased state resource requirements for disease regulation
- increase in illegal trade and animal movement
- OIE compliance is challenging in rural African settings
- requirement for ecologically insensitive fencing
- effectiveness of control measures debatable e.g. vaccination coverage or inspection efficacy
- severe disadvantage to emerging livestock farmers
- constraints placed on religious and traditional cultural practices
- limited access to alternative seasonal grazing sites for livestock utilised historically
- barrier to rural communities accessing livestock markets and other formal income streams
- impediment to poverty alleviation efforts

A more modern, socially aware school of thought focuses on non-geographic trade standards for trade which are not based on the disease status of the origin of a commodity (OIE TAHC 2019b). Commodity-based trade (CBT) is a good example of this and a possible alternative approach for use in rural communities affected by FMD-related restrictions (Thomson *et al.* 2004, Thomson *et al.* 2013, van Rooyen 2016).

Non-geographic trade has a particularly important potential for application in sub-Saharan Africa due to the large numbers of TFCA conservation areas present throughout, and by extension the expansive livestock-wildlife interfaces created as a result. It is considered so integral to the future success of Africa's rural livestock production, that in 2012, SADC endorsed the Phakalane Declaration which directly promotes non-geographical trade approaches such as CBT.

Not discriminating against products based on their area of origin, gives often marginalised producers the opportunity to access markets they have not been privy to previously (Thomson *et al.* 2004; Scoones *et al.* 2010). Disease control strategies are then adapted to ensure that the product is of an acceptably low level of risk to be deemed 'safe' to be imported. This requires

various intensive steps called critical control points throughout the value chain, which are highly regulated and logistically complicated. Substantial infrastructure and manpower are necessary to support this process.

Barriers to achieving CBT are multi-fold, some of which have been well described by Rich and Perry (2011): generally poor carcass quality of communal beef cattle; the substantial investment that would be required to implement and monitor risk management systems throughout the supply chain and concerns regarding productivity and efficiency. Complying with SPS control measures and quality standards required by CBT incurs such a significant cost. So much so, that recent models assessing cost-benefits of employing such a system in the communal areas of Namibia found that returns would be modest at best (Naziri *et al.* 2015) which is not a good motivator for future adoption and implementation in southern Africa.

2.4.2 A national shortage of FMD designated abattoirs

An FMD designated abattoir is essentially a non-export abattoir, which the Dept. Animal Health has authorised to slaughter FMD infected or potentially infected game or livestock, under very specific conditions. In cases where the animals originate in the IZ, the abattoir may only be located in the FMD IZ or PZ, but if the animals originate in the PZ, then the abattoir may also be in the FZ (DAFF 2014b).

Registering an abattoir as FMD designated requires many additional facilities; protocols and paperwork as outlined in the 'Standard operating procedure for the registration and maintenance of registration of foot and mouth disease designated abattoirs' (DAFF 2015). Some requirements which might dissuade abattoir owners from registering their facilities as designated FMD abattoirs include (but are not limited to) needing separate lairages and carcass storing facilities for animals originating from the different FMD zones; preferential slaughter by zone; intensified cleaning protocols with virucidal chemicals effective against FMDV; additional documents traceability systems; and additional waste disposal protocols. Government does not provide financial incentives to make up for all the additional inputs required of designated abattoirs to limit FMD transmission and spread via carcasses. As a result, profit margins are narrower for these facilities. In and of itself, the human resources and capital inputs required to register an abattoir as FMD designated in the absence of substantial fiscal returns make for an unattractive business model.

Consequently, it is not surprising that in South Africa, not a single abattoir is currently registered as FMD designated (Dr M. Gobiye [National FMD Co-ordinator, DAFF] pers. comm., 17 October 2019).

2.4.3 Marketing options in and around the BLM

As a rule, cattle farmers in BBR do not slaughter cattle very often. Instead they prefer to amass as many cattle as possible. This is partly due to the cultural tradition and prestige associated with owning larger herds of cattle, and partly because cattle are considered to be an inflation-free, financial asset that can be liquidated easily (Musemwa *et al.* 2008, Scogings *et al*. 1999). Within such a large human population there exists a high cultural demand for cattle. Cattle are kept for socio-cultural functions, live animals are often required to pay the bride price, *lobola*, and cattle are traditionally slaughtered for special ceremonial gatherings such as weddings, funerals and circumcision. When cattle are slaughtered for ritual purposes, it is habitually done outside under a large tree. Cattle also play a role in strengthening communal ties and family relationships and may be given as gifts and starting capital for recently married youth. In addition to this, cattle improve the resilience of rural pastoralists to the effects of unpredictable external pressures, by acting as a means of insurance (Musemwa *et al.* 2008).

When owners fail to free up capital in the informal marketplace, or need to sell larger numbers of animals, they are forced to turn to the limited available formal market. Incidents which put additional pressure on owners such as disease outbreaks (Scoones *et al.* 2010) and adverse environmental conditions appear to be the main reasons that convince farmers to sell using formal market pathways.

2.4.2.1 Local options for marketing cattle

Within the BLM, two rural red meat abattoirs are registered, namely, Mhaleni Red Meat Rural Abattoir at Zola and Mbumba Rural red Meat Abattoir at Mambumba. These abattoir locations both fall under the epidemiological unit of Songeni, on the outskirts of the district capital, Thulamahashe (Dr K. Singh [Mpumalanga Veterinary Public Health (VPH)] pers. comm., 10 October 2019).

The animals slaughtered are sourced from the local farmers of BBR. Both local abattoirs supply meat to their own butcheries which sell to the public. The abattoirs each slaughter an average of four to six animals per week which generally yield C-grade carcasses (Dr K. Singh [Mpumalanga Veterinary Public Health] pers. comm., 10 October 2019). According to the South

African Red Meat Regulations (RSA Government Gazette 2004), a rural red meat abattoir may slaughter up to two units, equivalent to two cattle, per day. Demand for meat from the butcheries increases annually over holiday seasons such as Easter and Christmas, at which times a temporary increase of throughput to three or four animals a day is permitted by VPH (Dr K. Singh [Mpumalanga Veterinary Public Health] pers. comm., 30 October 2019).

2.4.2.2 Regional options for marketing cattle

The Skukuza Game Processing Plant (GPP) is a game processing facility within the KNP, in the heart of the FMD Infected Zone. It was previously registered as an FMD Designated Abattoir catering exclusively to wildlife species sourced from within the KNP.

The Nkomazi Red Meat Abattoir in Mzinti, in the Ehlanzeni district of Mpumalanga, also falls in the FMD protection zone, south of the KNP. It was established in 1999 as a co-operative of 350 members which eventually whittled down to 162 (DARDLEA 2015). The original funding was provided by DARDLEA and the National Development Agency. In February 2013, the project was tested and commissioned. After a less than successful succession of strategic partners appointed to assist the owners with management of the project, a total 14 cattle and 100 pigs were slaughtered in December 2014. Three months after opening the project became non-operational due to member infighting, financial and technical constraints. Fortunately, the project was since partially resuscitated and provides slaughter services sporadically to the communities in the Nkomazi state veterinary area (Dr B.J.A. du Plessis [Deputy Director Animal Health Ehlanzeni, MVS] pers. comm., 18 October 2019). The abattoir is currently classified as active for the slaughter of sheep, pigs and cattle (DAFF 2018).

Gaza Beef is a low-throughput red meat cattle abattoir situated in Giyani, Limpopo (DAFF 2018) which falls in the PZ. Gaza Beef has historically been the largest buyer of cattle from the eastern Limpopo and BBR region (Dr B.O. Rikhotso [MVS: Ehlanzeni North] pers. comm., 14 March 2016). With the assistance of local DARDLEA officials, cattle sales are organised periodically at the behest of cattle farmers in BBR E. Cattle derived from several owners, mainly in BBR E, contribute to the group sold. Cohorts must number at least 40 animals in order to fill one truck. Animals are then transported to the Gaza Beef quarantine facility in Giyani where they undergo 21 days of quarantine (DAFF 2014b) before entering the feedlot.

Phalaborwa abattoir in the town of Baphalaborwa, Limpopo (DAFF 2018) is a high-throughput red meat abattoir for cattle in the PZ. It currently does not source animals from BBR specifically,

but through the inter-state veterinary movement application process, owners could potentially move cattle there to be slaughtered.

2.4.2.2 Novel approaches for market access

In 2017, the University of Pretoria's Herding for Health programme, led by the Hans Hoheisen Wildlife Research Platform of the Faculty of Veterinary Science, launched a mobile abattoir pilot project in association with Conservation South Africa (CSA) (University of Pretoria Dept. of Veterinary Tropical Diseases 2017). The project aim was to provide the communities of the Mnisi area of Bushbuckridge with opportunities to market their cattle commercially and in so doing, promote sustainable agricultural practices. Their reasoning being that if cattle could not go to the abattoir, they would bring the abattoir to the cattle using mobile abattoir technology. Cattle could then be slaughtered at their respective IPs after which carcasses would be transported into the KNP to the Skukuza GPP in the FMD IZ for further processing. Meat was sold to KNP staff for consumption within the Park and made into products such as break-dry biltong which were considered of low enough FMD transmission risk (DAFF 2014b) that they would be allowed to enter the FMD FZ. Hides were sold to community craftsmen (Meat Naturally PTY 2018). Overall, the Mnisi Mobile Abattoir Project (MMAP) pilot successfully purchased 15 animals in 2017 at R17.50/kg and 14 animals in 2018 at R18/kg for the trial (M. Grover [CSA: Kruger 2 Canyons Landscape Director] pers. comm. 11 October 2019).

2.5 Effects of FMD outbreaks on the beef market in South Africa

If an outbreak was confirmed in the FMD FZ and then reported, the OIE would immediately either temporarily suspend or completely revoke the national 'FMD-free' status, depending on the extent of the outbreak. Subsequently, export of products originating from FMD-susceptible species would be subject to strict trade bans which invariable cut off access to the majority of international markets (Scoones *et al.* 2010), and ensuant massive losses in revenue to the national economy.

In the event of an FMD outbreak occurring in the FMD protection zones, the national FMD-free status remains intact provided the outbreak does not spread to the FZ.

Outbreak response is described in Foot-and-Mouth Disease: A Proposed Outbreak Contingency Plan (du Plessis 2000). A brief summary of the plan is as follows:

Once an outbreak has been declared and the relevant persons have been informed, a local campaign co-ordinator is appointed and a Veterinary Operational Committee (VOC) is established to oversee and manage the outbreak respectively. The next step is the definition of the Infected Area to determine extent of the outbreak and the Quarantine Zone which is also called the Rest of Quarantine. Ideally in communal grazing areas the Quarantine Zone should include an area of at least three to four IP areas wide; roughly 10 km around the Infected Area. Surrounding the Quarantine Zone, the Surveillance Zone is declared, measuring roughly 20 km from the Quarantine Zone outwards.

All cattle are closely examined through visual inspection and mouthing to determine whether they present with clinical signs of FMD. The blood, saliva, tissue and vesicular fluid of suspect individuals are tested for presence or response to FMDV. Persons handling FMD infected or suspect animals are regarded as potentially infectious for five days and are prohibited from coming into contact with susceptible species for the duration of this period. Outbreaks are managed through strict movement control in the quarantined area established. A separate protocol for the movement control of susceptible animals in each of the defined areas and zones is compiled by the VOC. All permissible movements are permitted, thoroughly documented and carefully monitored by SVOs to ensure compliance with movement conditions.

In the FMD controlled areas, all cattle, goats and sheep are vaccinated (or otherwise as determined by the National Director of Animal Health, DAFF). The need for repeat vaccination rounds will be determined by the National Director depending on the length of the campaign. Three rounds of vaccination, one month apart are generally deemed acceptable to impart adequate immunity to cattle.

Stamping out is instituted at the discretion of the National Director. In the FMD control areas, particularly the PZV, stamp out measures are rarely employed.

Closure of the outbreak and cancelation of quarantine must be declared by the National Director, not less than three months after the last recorded clinical case, termed the ‘clinical endpoint’, was reported. The clinical end point of the outbreak cannot be established unless all susceptible animals in the Infected Area and Quarantine Zone have been mouthed and no lesions have been found.

It has been estimated that the 2011 FMD outbreak in northern Kwa-Zulu Natal’s FZ cost the South African national economy nine billion Rand as a result of the trade embargoes on red

meat alone (DAFF 2014a). Hence, due to the economic importance of preserving the country's FMD-free status recognition, FMD control is prioritised by the South African government.

2.6 The importance of this research with regards to future LED policy development

The aim of this research is to assist in guiding local policy towards social and economic development through the political and financial support of local livestock production, specifically the cattle trade. The local government requires credible data on which to base poverty reduction strategies (Kirsten & Moldauer 2006) and strengthen rural-urban linkages. Without investment in local infrastructure and improving government service delivery, land-based livelihoods cannot be augmented (Shackleton, Shackleton & Cousins 2000).

A positive change in LED policy has the potential to improve the following:

- The availability of water and feed at the end of the dry season or in times of drought (Scogings 1999)
- Increased access to key resource areas in order to allow cattle to move around freely to adapt to seasonal and environmental changes.
- Education and skills development of the local livestock owners
- Sustainable resource management and decrease land degradation
- Poverty alleviation
- Job creation
- Community empowerment
- Preservation of local cultural heritage

Economically, it makes sense for the local government to invest in enterprises that make use of natural resources as they have the power to simultaneously alleviate poverty, mitigate inequality and nurture LED (Shackleton, Shackleton & Cousins 2000). In order for this to happen, government and other stakeholders need to be educated on the level and ultimately, the value of cattle trade in the BLM which they currently view only as a 'missed opportunity for commercialisation', while producing little and degrading the land (Goqwana *et al.* 2008). The

general paucity of data quantifying this existing monetary value, makes the potential benefit of a more successful cattle trade negligible to local policy makers (Shackleton & Shackleton 2005).

If these efforts are successful, it will go a long way towards aiding poverty alleviation (Thomson *et al*. 2013) amongst the local peoples, whilst preserving the social and cultural importance of cattle farming in the BLM (Ainslie 2013).

Other potential beneficiaries of this research would be individuals working with state controlled, infectious diseases of cattle such as FMD, corridor disease, bovine brucellosis, bovine tuberculosis and many more. By law all cattle movements in the PZV must be recorded. At the moment this information is mainly used when there are disease outbreaks and where there is a need to back-trace movements in order to determine the origin and extent of disease. These data might, however, also be used to quantify animal trade indirectly. By quantifying the movement of cattle and carcasses within the district, informed disease control strategies, based on reliable data, could then be developed and incorporated more effectively.

2.7 Study objectives

The use of red-cross movement permits for transport or trade of cattle in the BLM is a legal requirement in terms of South African national FMD control policies. Data contained in the permits quantify, qualify and provide spatio-temporal information on all legal cattle movements. However, these data remain unevaluated. Cattle movements and thus their implications for trade, market access, disease control and local economic development have remained unanalysed variables. Additionally, the specific, local impact of FMD outbreak control measures on rural cattle herd dynamics and trade have not been determined.

The objectives of this study are the following:

i. To describe the movement activity of cattle
ii. To estimate the level of the informal and formal cattle trade
iii. To determine the impact of an FMD outbreak-induced movement standstill on the local cattle industry.

Knowledge of the level and nature of cattle movements could be used to challenge misconceptions regarding the level of the cattle movement and by extension, trade in the BLM; to identify key areas for LED including improving market access; and advise policy makers on effective and cost-effective disease control strategies.

CHAPTER III: MATERIALS AND METHODS

3.1 Study area

The Bushbuckridge Local Municipality (BLM), a constituent of the Bohlabela District Municipality is situated in north eastern corner of Mpumalanga province, South Africa. It comprises of 2417 km^2 of land (Shackleton & Shackleton 2005) within the Kruger to Canyon biosphere. The KNP demarcates its eastern and southern boundaries and Mbombela Local Municipality lies to the south-west. Limpopo province borders on the north and the Mpumalanga Drakensberg escarpment forms the western boundary.

In 2011, the population consisted of more than 540 000 people, of which more than 52% were unemployed (Statistics South Africa (Stats SA) 2011). The national community survey performed in 2016 revealed that 79.8% of total income in Bushbuckridge was received as grants and subsidies. The poverty head count decreased from 11.8% in 2011 to 9.7% in 2016, while the Intensity of Poverty increased from 41% to 41.8% (Stats SA 2016).

According to census information (Statistics South Africa 2011), almost 40% of Bushbuckridge households take part in an agricultural activity. Of these, 49.3% farm exclusively with animals and 16.5% of households participate in mixed-farming activities. In the study area, livestock owners reside in permanent dwellings whilst animals make use of the local communal grazing areas in a low input, low output system. Livestock farming in the area can be classified as extensive, which, according to the Dictionary of Agroecology (2019) is 'characterised by a low productivity per animal, per surface'. For the purposes of this study, Bushbuckridge livestock farming will be defined as extensive resident farming.

Roughly 77 000 cattle (DARDLEA 2015-2019*)* are farmed extensively on communal rangelands which comprise 85% of the area (Shackleton & Shackleton 2005). In 2011, 7431 farmers owned cattle, of which 5992 owned between one and ten cattle; 1419 owned between 11 and 100 cattle; and 21 owned more than 100 cattle (Stats SA). Cattle breeds include mostly Sanga type animals such as Nguni and Afrikaner, or crosses thereof (Gaudex 2014). Nguni cattle are hardy, small-frame animals which have the ability to flourish under the low input systems commonly found in communal areas (Musemwa *et al*. 2008). While larger framed, Afrikaner cattle are well adapted to the subtropical bushveld as they have dark hides and smooth red coats for optimal protection against the severe heat and damaging ultra-violet radiation (Bonsma 1949). Both Ngunis and Afrikaners are highly fecund, resistant to water and nutritional deprivation and possess large dewlaps and umbilical folds which facilitate heat loss via radiation (Bonsma 1949).

The study area's characteristic hot, wet summers and cool, dry winters have led to its climate classification as sub-tropical. This savanna ecosystem of South Africa's semi-arid region receives between 860 millimetres (mm), in Bushbuckridge town (SA Explorer 2000-2017) in the west, and 550 mm, of annual rainfall in the drier north-east (Treydte *et al.* 2013) bordering on the KNP. The region experienced severe drought conditions as a direct result of repeatedly poor annual rainfall conditions in 2015 and 2016 (Dr I.J.P. Smit [Science Manager: Systems Ecology, GIS and Remote Sensing, Kruger National Park, SANParks], pers. comm., 1 September 2017).

The entire BLM is classified under the national VPN for FMD control in South Africa (DAFF 2014b) as an FMD PZV (Fig. 1). There exist 117 FMD inspection points (IPs) throughout the BLM which are considered epidemiological units (Fig. 2). These fall under the provincial management and control of Mpumalanga Veterinary Services (MVS).

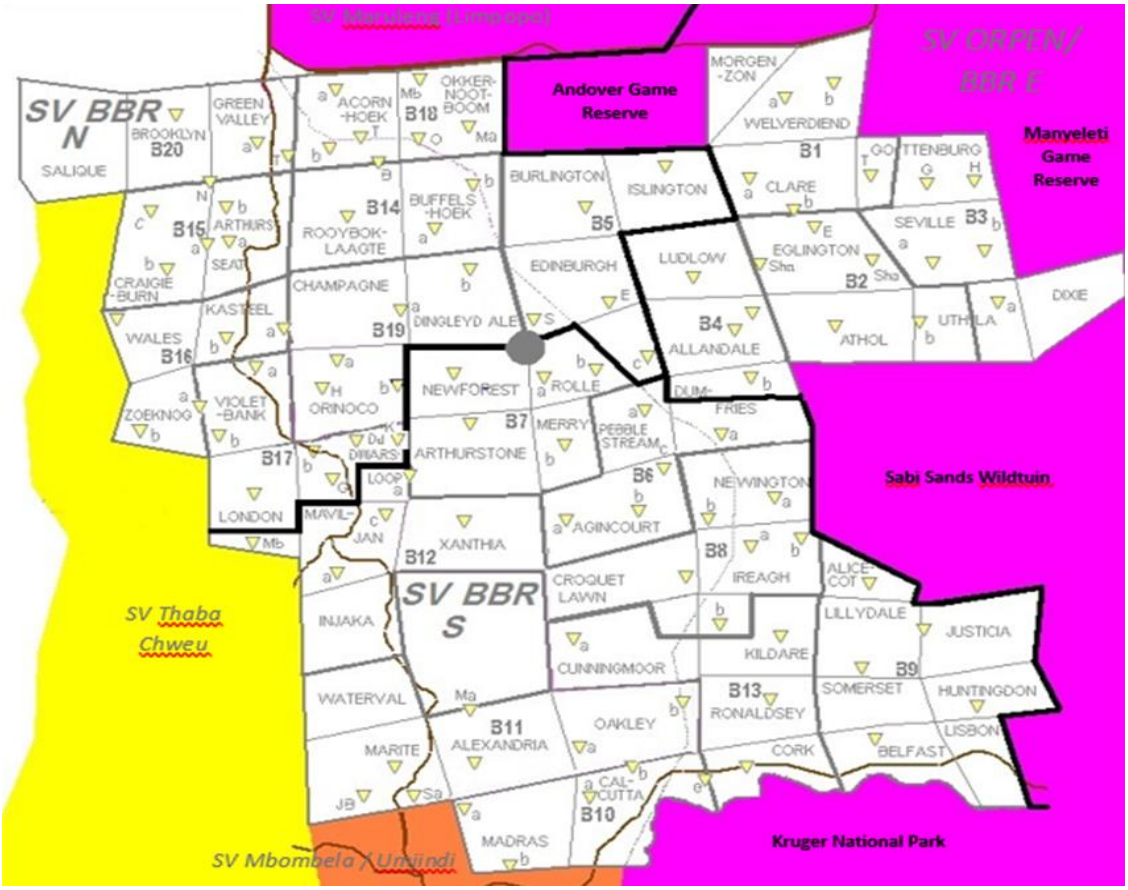

Figure 2: Map of the Bushbuckridge study area indicating the geographical distribution of the inspection points and the local State Veterinary Areas (DARDLEA 2017a).

For the purposes of Provincial disease control, the BLM was divided into three state veterinary areas, namely Bushbuckridge North (BBR N), Bushbuckridge East (BBR E) and Bushbuckridge South (BBR S). These areas are further sub-divided into twenty Animal Health Wards – Bushbuckridge-1 to Bushbuckridge-20 (Appendix B) which each contain at least five IPs. Mandatory clinical inspection for FMD is conducted at the IPs every seven days and vaccination every four months by the ward's animal health technician (AHT) and dip tank assistant (DA). Farmers are encouraged to attend inspections by the governmental provision of free acaricide dips to control ticks and tick-borne diseases which are prevalent in the study area (Murapa 2017).

AHTs conduct surveillance for other controlled diseases such as bovine brucellosis and bovine tuberculosis when cattle are presented for inspection. Additionally, the provision of veterinary movement permits and primary animal healthcare services are provided to farmers free of charge at the IP.

Cattle registers are used by local AHTs to record cattle numbers, number of cattle owners, population increases and decreases, inspection rates, vaccinations and tests performed at the weekly inspections. Owners are provided with stock cards in which their weekly attendance of cattle is recorded and whether their animals have been tested or vaccinated for controlled diseases.

Movement is strictly controlled within and out of the BLM. Farmers wishing to move their animals or animal products* within or out of the BLM must apply for a red-cross movement permit from their local AHT. For a movement to be approved, live cattle must meet the following conditions according to the national FMD VPN (DAFF 2014b):

- SAFAIS ear tag
- Registered owner brand mark
- F-brand
- Complete vaccination history of herd and IP
- Absence of FMD clinical signs on visual inspection and mouthing examination

*For animal product requirements, please refer to the FMD VPN (DAFF 2014b).

3.2 Study design

A longitudinal, retrospective study was conducted over a period of 48 months to describe the level and nature of cattle movements in the BLM, estimate the level of the informal and formal cattle trade and to determine the impact of an FMD outbreak-induced movement standstill on the local cattle industry. Monthly State Veterinary Area Reports as well as monthly movement Permit Registers from May 2014 to April 2019 were utilised.

3.3 Sample size

Due to the completeness of the dataset, the entire cattle population of the BLM could be obtained from the MVS monthly inspection reports. The cattle population fluctuates around an average of 77 000 head of cattle (DARDLEA 2015-2019).

3.4 Data collection

AHTs complete paper-based cattle registers on a daily basis while performing their weekly FMD inspections in their Ward's designated IPs. At the end of each month, hard copies of these figures are submitted to the local state veterinary office for inclusion into the monthly State Veterinary Area Report. The data are captured into Microsoft Excel and entered into a standardised 'FMD inspection summary' template used by all state veterinary offices in the province of Mpumalanga (Appendix C).

Movement permits (Appendix D) are issued by AHTs at the request of cattle owners, if cattle or cattle products meet all the relevant movement conditions. Movement permits are always written in triplicate. The original permit accompanies the animals or product being moved; the first copy is submitted to the local state veterinary office at the end of every month and entered into the monthly official 'Permit Register' (Appendix E) of the electronic State Veterinary Area Report; and the second copy remains in the veterinary official's permit book as a personal record. Permits are given sequential unique numbers by their issuer.

A complete electronic dataset for each of the three state veterinary areas in the study area for the study period was kindly provided by MVS. The data are in the form of 144 monthly State Veterinary Area Reports which include official 'Permit Registers' and 'Dip and Inspection Summaries' from the 117 Bushbuckridge government FMD inspections points.

The data required for this analysis were extracted from the monthly State Veterinary Area Reports and cleaned before statistical analysis commenced. All electronic movement permit data were cross-checked with the original permit duplicates (available at the MVS district office in Thulamahashe) to validate their accuracy. Only these secondary data were analysed. Undocumented (illegal) movements could not be included in this study.

Movement permit data preparation consisted of the following steps:

- All permit records for biological samples and live or product records for species other than bovines were discarded.
- If more than one record existed for a particular permit number, date and location, then it would be considered a duplicate permit and removed from the dataset.
- If more than one record existed for a particular permit number but the dates and other details on the permit were different, then the permit number would be considered a duplicate or erroneous number but the data would remain in the dataset. Numbers of animals or products recorded in words were changed to numerals.
- If any information fields on the movement permit including permit number, destination IP, origin IP, number of animals, or product type were missing, then the record was considered incomplete and removed from the dataset.
- One (1) record where the destination IP was entered as Pietersburg was discarded as it was not a valid destination.
- In total, nine (9) records were removed out of the original 3136 records. Analyses were performed on the remaining 3127 records.
- If an IP consisted of more than one portion (e.g. Dwarsloop A and Dwarsloop B), but the portion was not specified on the permit, then an aggregate IP was created (Dwarsloop) for which a GPS co-ordinate was generated as an average between those of the two actual IP locations, which could then be used to estimate the distance moved.
- Months were numbered from 1 to 12.
- Seasons were defined as 'cool dry' (April to July), 'hot dry' (August to November) and 'hot wet' (December to March).

Demographic data preparation consisted of the following steps:

- Data were retrieved from the MVS' monthly 'FMD inspection summary' sheets in Excel.
- Data read into R were values for the IP, year, month, total cattle recorded at the beginning of the month, mortalities, slaughter, and number of cattle owners at the end of the month.

- If cattle number values at the beginning of a month were not complete, then the information was retrieved from the previous month's population data for the cattle total at the end of the month.

The data extracted from the archived records was consolidated into a Microsoft Excel master spreadsheet under the following headings:

i. Name of origin IP; name of destination IP; year; month; season and date of movement
ii. Permit number; permit type; issuing official
iii. Owner; species; product type; number
iv. District, SV area, FMD zone, and co-ordinates of origin IP and destination IP respectively
v. Reason for movement; transport type used; and trade type
vi. Total cattle at the beginning of the month; number of mortalities suffered during the month; amount of cattle slaughtered; and total number of cattle owners for the month

Classification of the variables are described in Table 1.

Red cross movement permits do not require a reason for movement or transport type to be specified. As such, only a subset of permits contained information pertaining to transport type was utilised, movement reason and, by extension, trade type. A reason for movement was supplied for 50.8% of animals/products moved and 47.6% of permits. Of this data subset, 77% and 23% of trade in the BLM can be classified as informal and formal respectively. For the purposes of this study, the formal trade of cattle and their products will be defined as those where sales involve regulated and registered processes such as meat inspection, carcass classification and sales through commercial market chains. Informal trade will be defined as unregulated, unregistered, small-scale trade. Means of transport was specified for 66% of animals/products moved and 54% of permits. In cases where no means of transport was specified, but a vehicle registration was recorded, the method of transport was classified as 'vehicle'.

Table 1: Data variables and explanatory remarks on their classification

VARIABLE	CLASS	EXPLANATORY REMARK
Season	Hot wet	December to March
	Cool dry	April to July
	Hot dry	August to November
Product type	Live	Live bovine
	Product	Product of bovine origin
Reason for movement	Commercial slaughter	Live bovine or product moved for *processing* of meat*;* to an *abattoir* or for sale at a *butchery*
	Feedlot	Live bovine or product moved for a*uction* or sold directly to a *feedlot*
	Herd movement	Temporary movement of an entire cattle herd without changing ownership for the sole purpose of gaining access to alternative grazing areas.
	Husbandry	Live bovine or product moved for *breeding*; *farming; rearing*; or *retrospective movement* (cattle moved illegally and permit issued *post facto*)
	Own consumption	Live bovine or product moved for o*wn consumption*; *home slaughter*; or *direct slaughter* (slaughter upon arrival at destination).
	N/A	Reason for movement not disclosed on movement permit
Method of transport	Herded	Live animals transported *on foot*; *per hooves* and *herded* to destination.
	Vehicle	Live animal or product transported by *mechanical transport*, *truck* or *trailer*.
	N/A	Method of transport not disclosed on movement permit
Trade type	Formal trade	Cattle moved for *commercial slaughter* and *feedlot* purposes
	Informal trade	Cattle moved for *own consumption* or *husbandry* purposes

During the study period, an FMD outbreak occurred within the BLM (Appendix F). The outbreak, which was investigated on 1 March 2017, was officially confirmed on 3 March 2017 and concluded on 7 December 2017 (OIE 2017). As the outbreak was located in South Africa's FMD PZV, which lies outside the FMD FZ, it therefore did not affect South Africa's OIE recognised FMD free status. However, in BBR itself, for the duration of the outbreak, cattle owners were subjected to varying levels of movement restrictions on live animals and products.

Throughout the initial control period, no animals/products could be moved from their IP for any reason. Once the extent of the outbreak had been established by the Veterinary Operations Committee and vaccination rounds had been completed, movement restrictions became slightly more relaxed (Relaxation 1) in unaffected areas of the Quarantine Zone. The movement of live cattle and products resumed in the Rest of Quarantine under strict provisos (DARDLEA 2017b). When no new cases had been found by the end of August permission to move cattle and products within BBR was granted (DARDLEA 2017c) (Relaxation 2). Eventually, in early December 2017, the outbreak was declared closed and the last remaining movement restrictions were lifted. These movement restriction time-frames are detailed in Table 2.

Table 2: Movement restriction instituted as a direct result of the FMD outbreak of 2017 in Bushbuckridge.

Movement Restriction	From	To
Overall standstill	2017-03-03	2017-08-06
Relaxation 1	2017-08-07	2017-08-31
Relaxation 2	2017-09-01	2017-12-07

3.5 Data analysis

3.5.1 Overall statistical analysis

Permit and population data from 144 monthly State Veterinary Area Reports, including all of the 117 inspection points in the BLM was analysed over the 48 months of the study period. A descriptive analysis was performed. In addition, non-parametric statistical methods were used to compare between groups as the data were not normally distributed. These included the Kruskal-Wallis rank sum test, Conover's all-pairs rank comparison test and the Wilcoxon rank sum test.

All statistical analyses were done using R and R Studio (R Core Team 2018). Various R packages were employed: descriptive statistics were performed using 'DescTools' (Signorell *et al.* 2019); data tables were created using 'data.table' (Dowle & Srinivasan 2019) and 'flextable' (Hijmans 2019a); bearing and distance between origin and destination of permit movements was calculated using 'geosphere' (Hijmans 2019b); spatial analysis was performed using 'pgirmess' (Giraudoux 2018); mean ranks were analysed using 'PMCMRplus' (Thorsten 2018); the manipulation of Microsoft Word was performed with 'officer' (Gohel 2019); graphics were illustrated using 'ggplot2' (Wickham 2016); reports were generated using 'knitr' (Xie 2014; Xie 2015; Xie 2019); and wrappers for common string operations came from 'stringr' (Wickham 2019).

Means (μ) were reported with standard deviations (σ) in round brackets. For example: (μ ± σ).

When medians (Med) were reported, square brackets were used to denote the inter-quartile range (IQR). For example: Med [Q1; Q3]. A confidence interval of 95% was used as standard. Significance was assessed at $p < 0.05$.

3.5.2 Comparing years and seasons

As the study period started in May of 2016 and ended in April of 2019, comparing years and seasons had to be done in specific ways to eliminate bias. When comparing the four, twelve-month cycles within the study period, months from May to April were used and periods were denoted as 2015/16, 2016/17 *etc*. In analyses performed based on calendar years, median ranks of the data were used to compare values between years and compensated for the non-normal distribution of the data. When seasonal data were grouped per year, it required five categories (denoted as Year 1 to Year 5) to account for the fractional recording of 'cool dry' seasons in 2015 and 2019 within the time frame of the study.

3.5.3 Estimating 'loss of trade' during the FMD outbreak movement standstill of 2017

The precise dates of the outbreak (3 March to 7 December 2017) defined the date range within which the mean number of animals/products moved per type of movement over 2015, 2016, 2018 and 2019 were calculated in Microsoft Excel. Values were rounded up to the nearest animal/product. From these means, the total number of animals/products moved per type of movement during the relaxation periods was subtracted to get the actual 'loss of trade'.

CHAPTER IV: RESULTS

4.1 Movement activity

4.1.1 Overview of cattle ownership and movement activity

For the period May 2015 to April 2019, 3127 bovine red cross movement permits and 48 monthly FMD inspection summaries could be verified. Records, as summarised in Table 3 below, indicated that the cattle population of Bushbuckridge fluctuated around 77 166 (± 2260.92) cattle, distributed between 9739 (± 161.85) cattle owners (Fig. 3). The mean herd size of eight animals (7.93 ± 0.20) varied little between years. Live movement sizes ranged from 1 to 83 animals and product movement sizes ranged from 1 to 12 units.

Table 3: Movement data summary

Year	Cattle population	Number of Cattle owners	Average herd size	Permits	Animals	Products	Proportion of population moved
2015/16	79590	9848	8,09	887	5700	53	0,072
2016/17	78431	9819	7,99	640	2337	59	0,031
2017/18	76046	9499	8,01	739	2534	43	0,034
2018/19	74596	9791	7,63	861	2697	109	0,038

During the study period, 2949 permits were issued for the movement of live cattle and 178 permits for products of bovine origin, averaging a sum of 782 permits per year. 98% of all movements were live cattle (13268) and 2% were products (264). Animals and products moved as a proportion of the cattle population is showed in Fig. 4. Between 3.1% and 7.2% (0.04 ± 0.02) of the total population were moved per twelve-month cycle.

The information represented in Fig. 3 shows that there exists a general decline in the Bushbuckridge cattle population over time and erraticism in the number of cattle owners registered at any one time. The peak of cattle numbers was in May 2015 (82026) and the nadirs were observed in October 2017 (74352) and September 2018 (73815). Owners numbers peaked in November 2016 (10441), then reached an all-time low in September 2017 (9108) and rose again to peak at 10453 in December 2018.

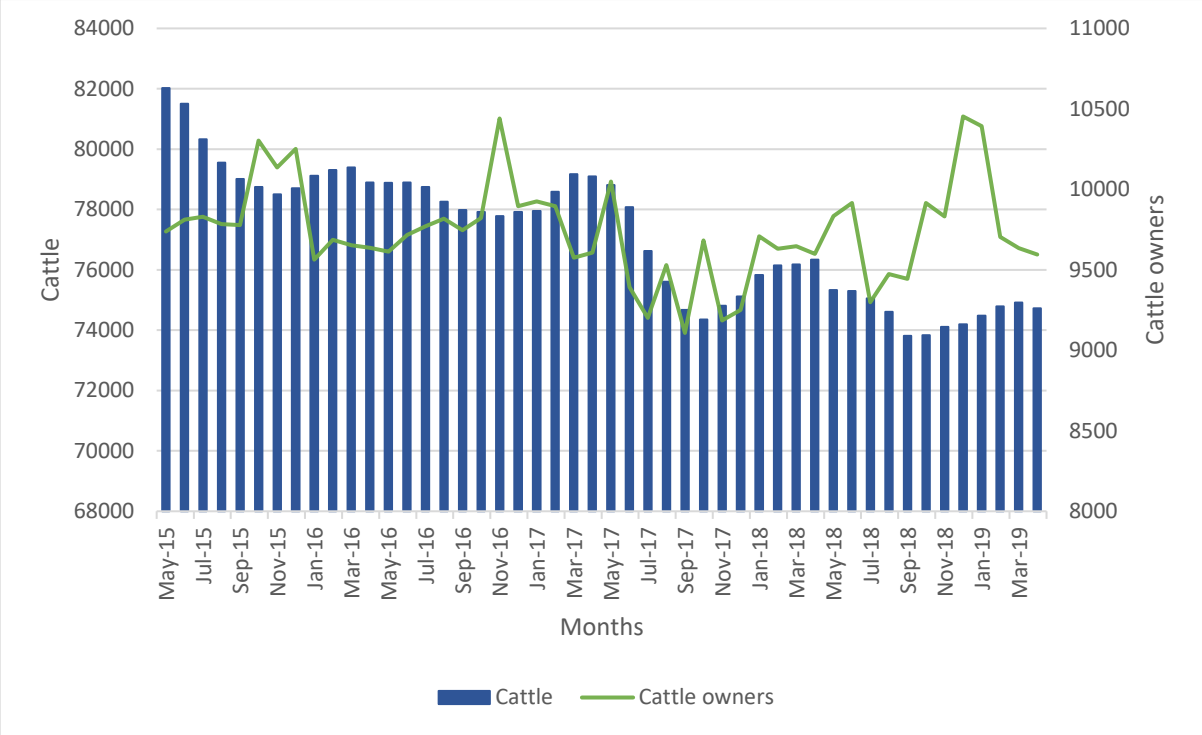

Figure 3: Bushbuckridge cattle numbers and owners over time

Figure 4: Animals, products and population proportions moved per year

4.1.2 Temporal trends in movement

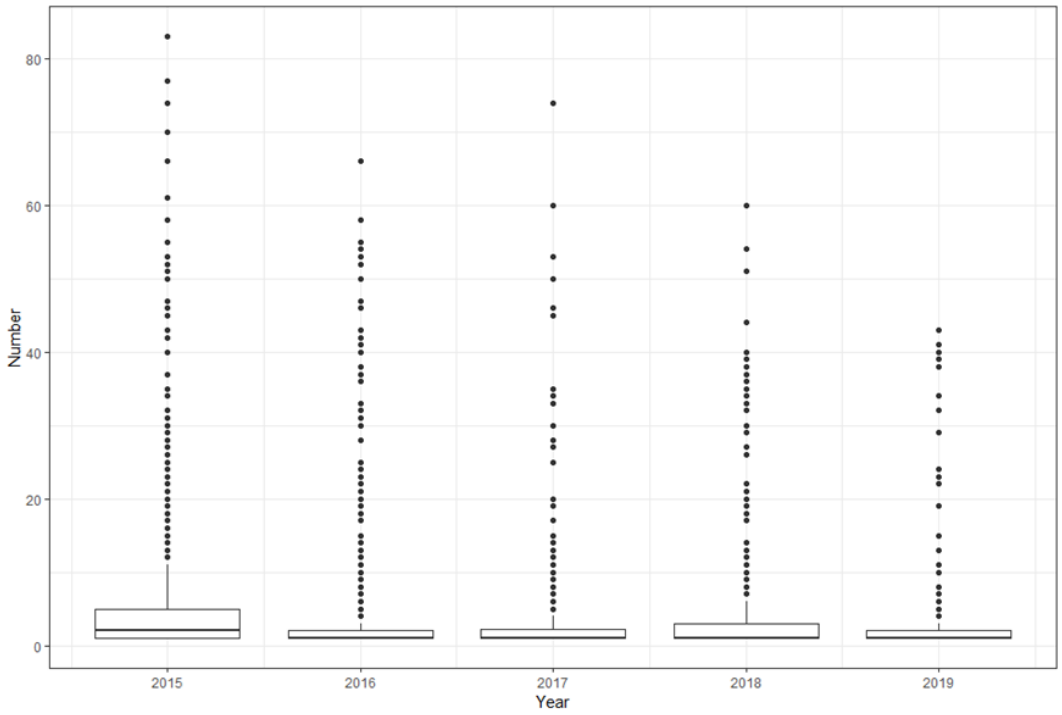

Figure 5: Animals/products moved per permit per year

The median ranks of the number of animals/products moved per permit were significantly different (Kruskal-Wallis test: H = 36.45, 4 d.f., p = 2.34 x 10^{-7}) amongst the five years (Fig. 5). Conover's all-pairs rank comparison tests were carried out for the five pairs of groups. There was very strong evidence (p-value < 0.001) that 2015 differed significantly from all other years but none of the other years differed from one other.

Individually, the respective median number of animals or products moved per permit in 2015 were 2 [1; 6] and 1 [1; 1]; compared to 1 [1; 3] and 1 [1; 1] in 2016; 1 [1; 3] and 2 [1; 2] in 2017; 1 [1; 3] and 1 [1; 2] in 2018 and 1 [1; 2] and 1 [1; 1] in 2019.

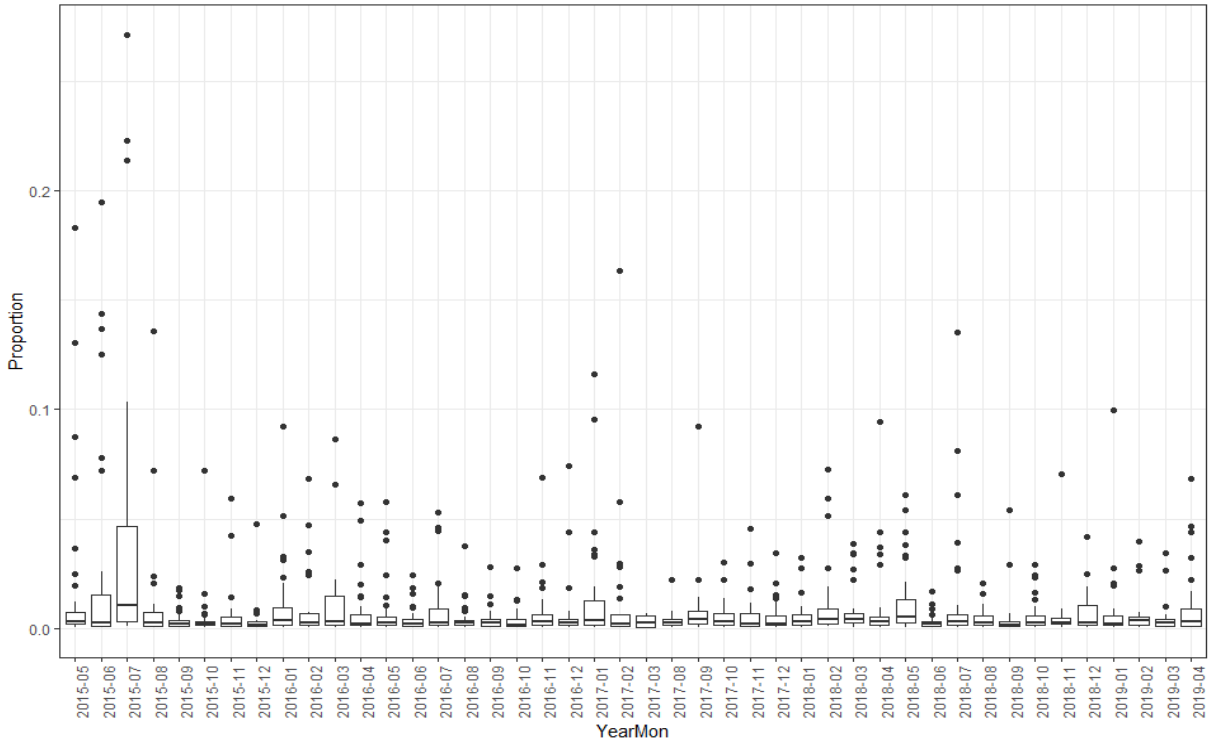

Figure 6: Proportion of the cattle population moved per IP (aggregated) per month

Figure 6 provides an overview of the proportion of the total cattle population moved over the study period. As no movements occurred during the core FMD movement standstill period from 3 March to 7 August 2017, this period was not included in the figure. The mean ranks of the proportion of animals/products moved per IP per month were significantly different (Kruskal-Wallis test: H = 78.98, 43 d.f., p = 6.77 x 10^{-4}).

4.1.3 Seasonal trends in movement

Table 4 groups the total number of animals/products moved for each of the defined seasons over the four years of the study period.

Table 4: Seasonality of live cattle/products moved May 2015 to April 2019

SEASON	*MOVEMENT*						
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Subtotal**	Proportion
COOL DRY	3492	1015	0	1551	326	6384	0,47
HOT DRY	805	746	790	633	-	2974	0,22
HOT WET	1201	890	1293	790	-	4174	0,31

Despite no movements being allowed during the 'cool dry' period of the 2017 FMD movement standstill in the third year of the study, 47% of all movements took place during this season.

Figures 7 and 8 below, illustrate the seasonality of live and product movements respectively.

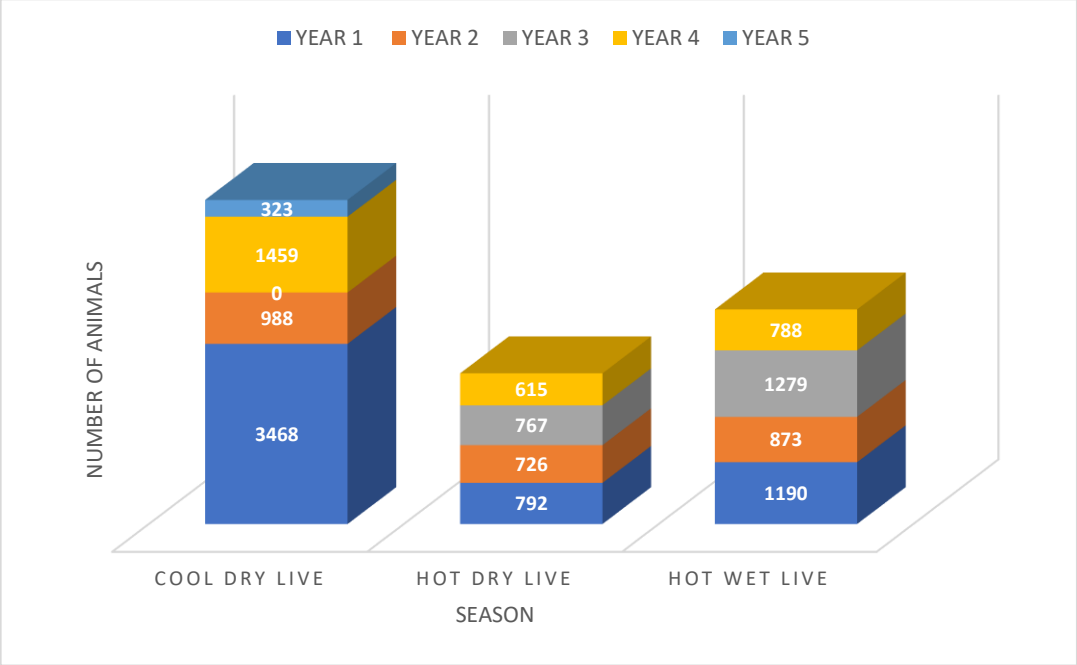

Figure 7: Number of live cattle moved per season during the study period

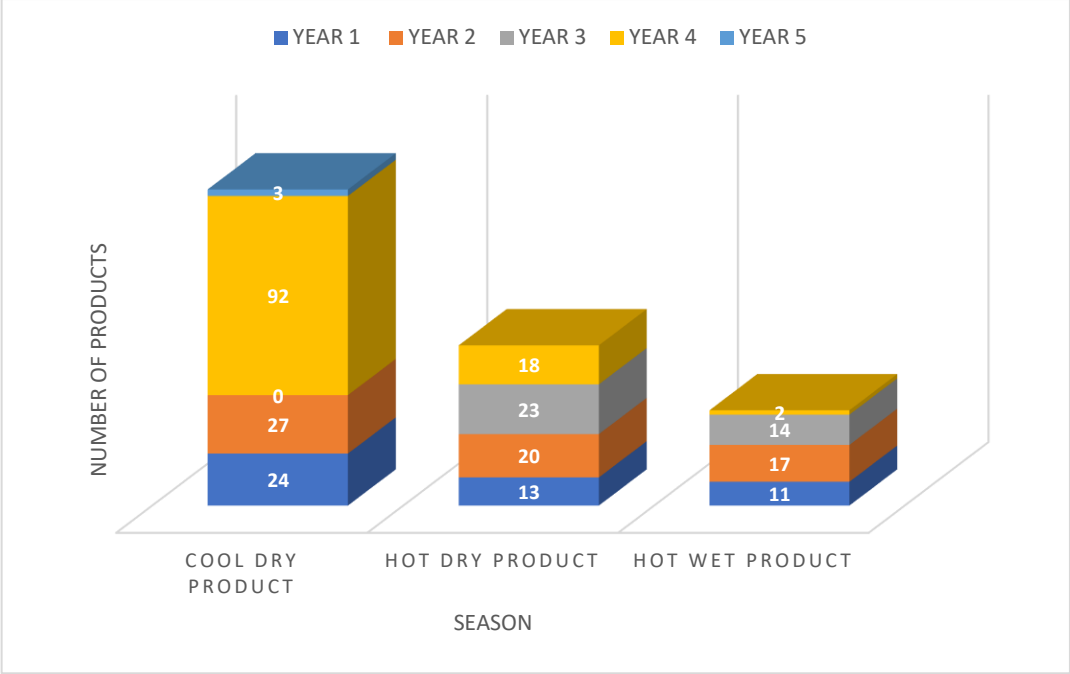

Figure 8: Number of products moved per season during the study period

The most live cattle and products were moved during the 'cool dry' season. The least popular season for moving live cattle was shown to be the 'hot dry' season; whilst the least popular season for moving products of bovine origin was clearly the 'hot wet' season.

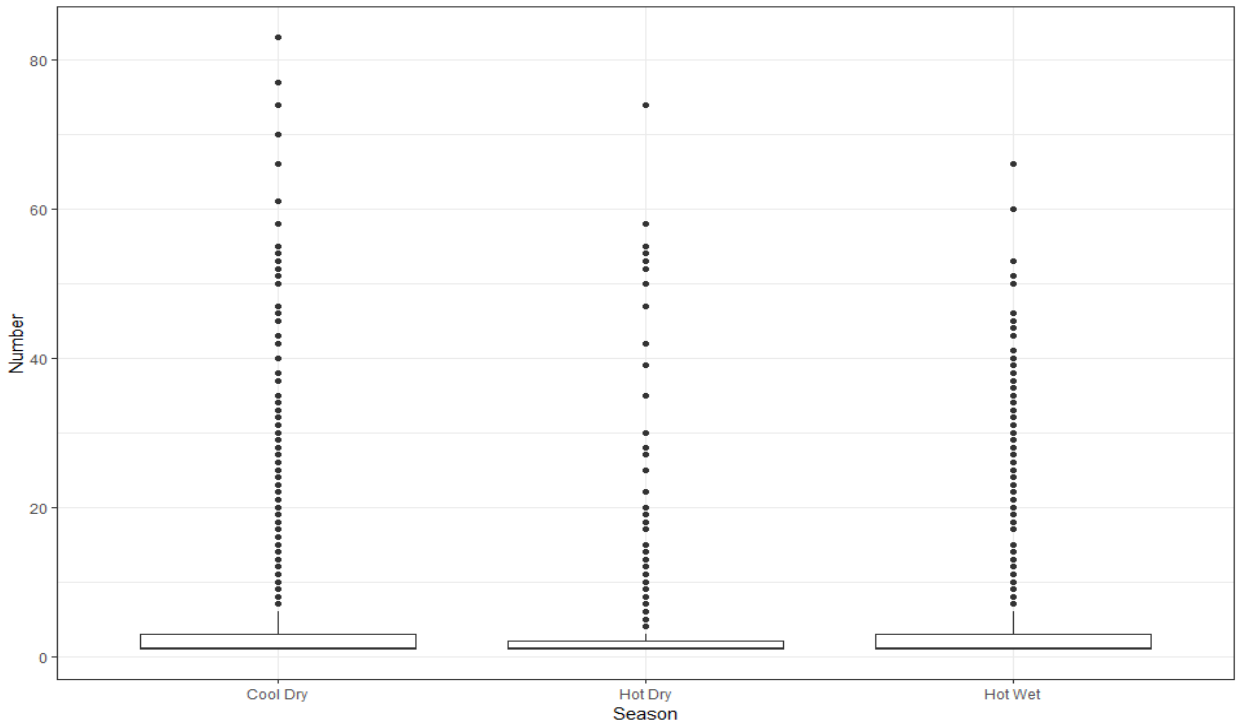

Figure 9: Number animals/products moved per permit per season

Overall, the median ranks of animals/products moved per permit were significantly different among the three seasons (Kruskal-Wallis test: H = 19.165, 2 d.f., p = 6.89 x 10^{-5}). Conover's all-pairs rank comparison tests were carried out for the three pairs of groups. There was very strong evidence ($p < 0.001$) that the 'cool dry' season differed significantly from the 'hot dry' season but not from the hot-wet season.

The median number of animals/products moved respectively per permit in the 'cool dry' season were 2 [1; 4] and 1 [1; 1]; compared to 1 [1; 2] and 1 [1; 1] in the 'hot dry' season; 2 [1; 3] and 1 [1; 1] in the 'hot wet' season (Fig. 9).

Upon investigation, neither the median ranks of number of permits issued per inspection point per season, nor number of animals/products moved per inspection point per season showed any significant differences between groups. Likewise, the differing mean ranks of the proportion of animals/products moved per inspection point per season were statistically insignificant.

4.1.4 Movements leaving Bushbuckridge

A Wilcoxon signed rank sum test revealed a significant difference (p = 0.0079) between the number of animals and products moved within Bushbuckridge and those leaving Bushbuckridge. The amount moved within Bushbuckridge is 24 times more than those moved out of the BLM (Z = 24). The difference of location measure was calculated as 2237 [708; Inf], which estimates the median of the difference between a sample from movements within BBR and a sample from movements to outside.

4.1.5 Distances moved and transport types

The minimum and maximum distances over which animals were moved were zero (0) and 172 kilometres respectively. The minimum and maximum distances over which products were moved were zero (0) and 470 kilometres respectively.

The mode of transport utilised was indicated for 66% of live animal or product movements and 54% of permits. Of the records available, 33% made use of vehicles and the majority (67%) of animals were herded to their destinations (Tab. 5).

Table 5: Transport methods recorded for live animal and product movements

	Live	**Product**
Herded	5978	-
Vehicle	2793	162
Unknown	4497	102

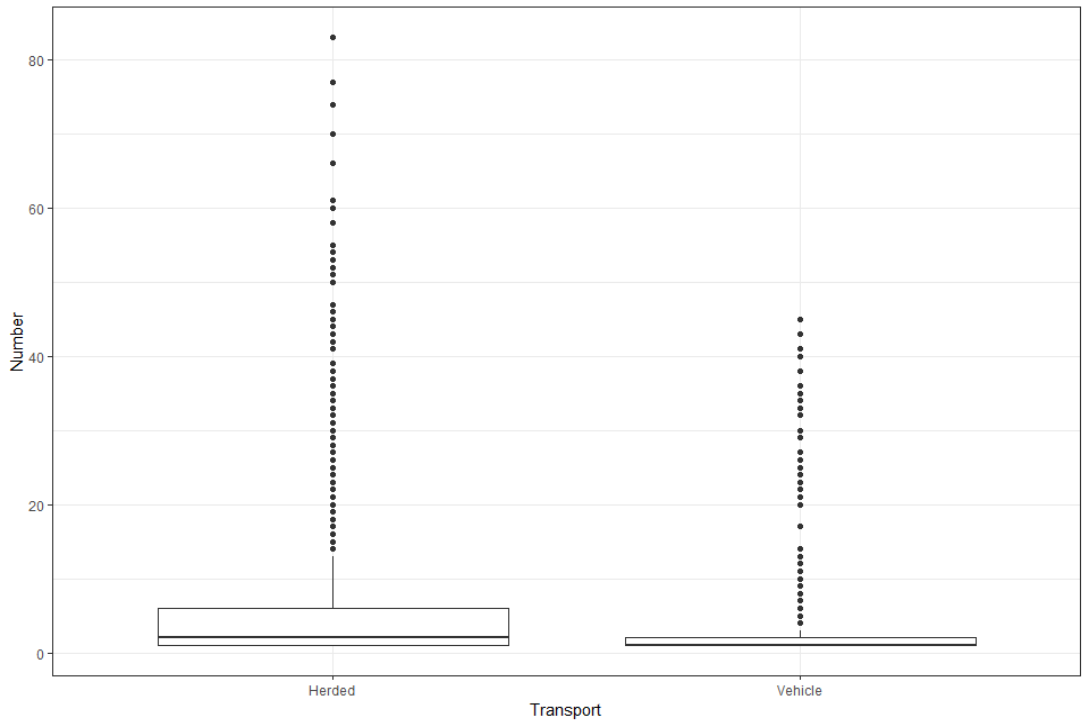

Figure 10: Number of animals/products moved per permit by transport type

The median ranks of animals or products moved per permit herded and transported per vehicle were significantly different ($H = 157.22$, 60 d.f., $p = 1.19 \times 10^{-10}$). The median number of animals or products per permit herded was 2 [1; 6] versus vehicle transport, 1 [1; 2] (Fig. 10).

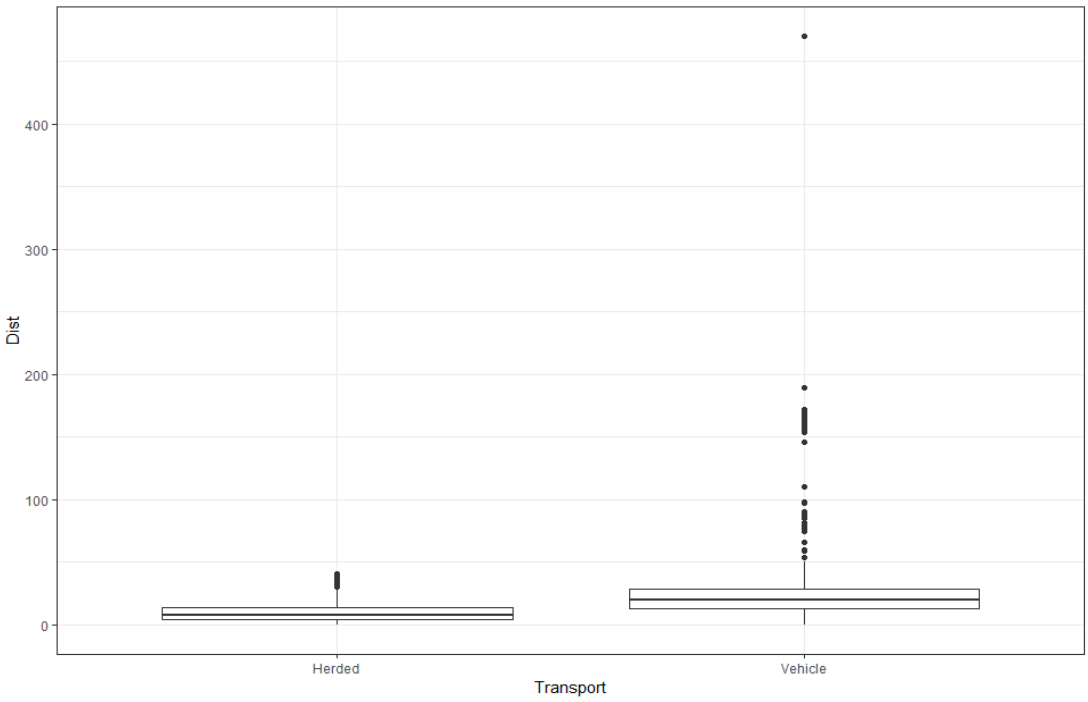

Figure 11: Mean ranked distance (in km) moved by transport type

The results of a Kruskal-Wallis test were highly significant (H = 491.75, 81 d.f., $p < 2.2 \times 10^{-16}$); the median ranks of the distance animals or products moved per permit were meaningfully different between the two groups. The median distance animals/products moved per permit in the herded category was 8 [4; 14] and 20 [13; 29] in the vehicle category.

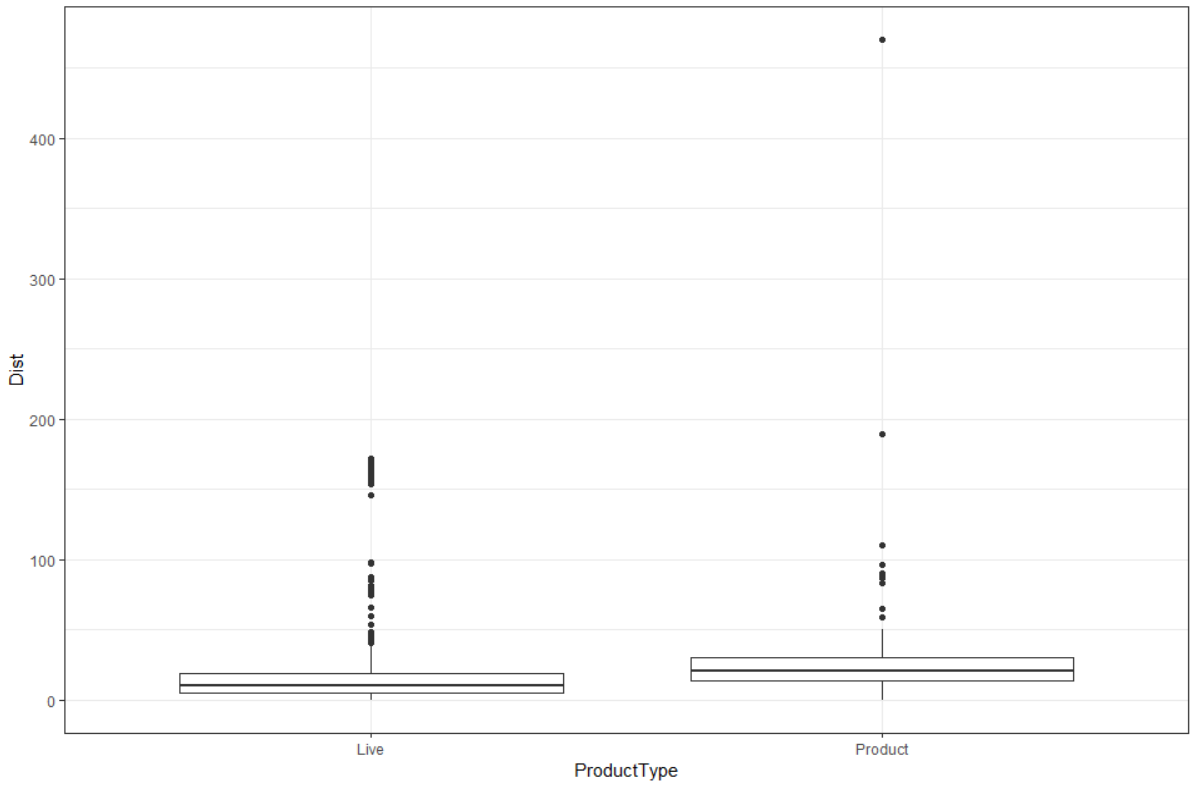

Figure 12: Mean ranks of distance (in km) moved by different product types

According to the outcome of the Kruskal-Wallis rank sum test, the mean ranks of distance moved between live cattle, 10 km [5; 19] and products, 21 km [14; 30.75], differed very significantly (H = 88.76, 1 d.f., $p < 2.2 \times 10^{-16}$).

4.1.6 Reasons for movement

A reason for movement was supplied for 50.8% of animals/products moved and 47.6% of permits (Tab. 6). The majority of movements were for husbandry reasons, followed by feedlot. The actual offtake (Own consumption, Commercial slaughter and Feedlot) mean, as a percentage of the population was determined as 0.57% over the study period.

Table 6: Movement reason summary for animals/products and permits

Reason	Animals/ Products	Permits
Husbandry	5122	1298
Own consumption	147	90
Commercial slaughter	97	45
Feedlot	1512	56

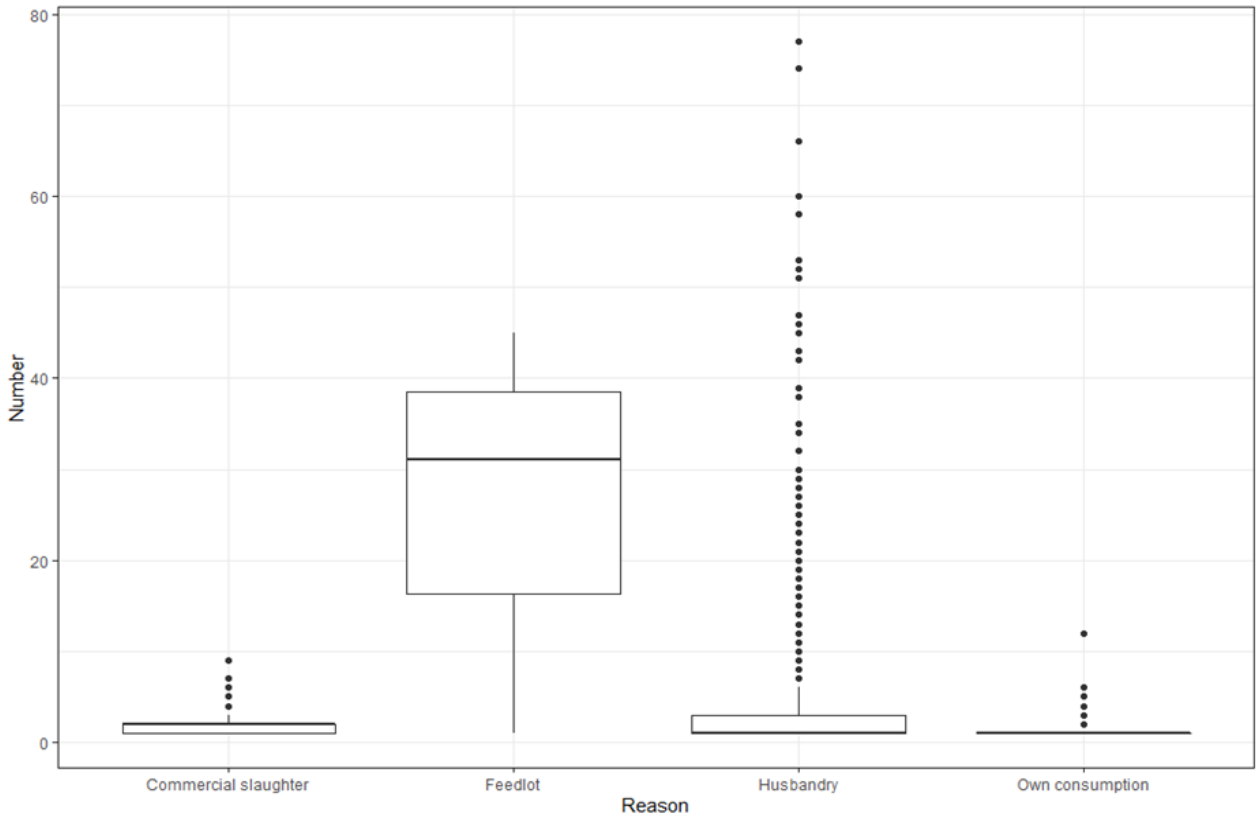

Figure 13: Number of animals/products per permit by movement reason

The results of a Kruskal-Wallis test were significant ($H = 173.14$, 3 d.f., $p < 2.2 \times 10^{-16}$); the mean ranks of animals/products moved per permit were significantly different among the four reasons for movement. Conover's all-pairs rank comparison tests were carried out for the four pairs of groups. All category pairs except 'husbandry'- 'commercial slaughter', and 'own consumption'- 'commercial slaughter' differed significantly ($p < 0.001$) from one another.

The median number of animals/products moved per permit for 'commercial slaughter' were 2 [1;2], compared to 31 [16.25;38.5] for 'feedlot', 1 [1; 3] for 'husbandry' and 1 [1; 1] for 'own consumption'.

4.2. Formal and informal cattle trade

4.2.1 Overview of trade data

As shown in Table 7, formal trade comprised only 7% of permits and 23% of animals/products moved. Both the number of permits written for moving products and the number of products moved are nearly divided equally between informal and formal trade types.

Table 7: Trade type summary for permits and animals/products

Trade type	Animals/ Product		Permits	
	Live	Product	Live	Product
Formal	1526	83	59	42
Informal	5185	84	1341	47

Table 8: The number of animals/products moved per year per trade type

Year	Formal trade	Informal trade
2015	269	2116
2016	178	1011
2017	27	623
2018	879	1092
2019	256	427

Table 8 demonstrates the difference in the numbers of animals/products traded on a formal and informal basis per calendar year. Using a Wilcoxon rank sum test to analyse the number of animals/products moved annually for formal and informal trade revealed a significant difference ($W = 104900$, $n = 6878$, $p < 2.2 \times 10^{-16}$). The number of animals moved for informal trade purposes is 2 times more than those traded formally ($Z = 2$). The difference of location

measure was calculated as -742 [95% C.I., -Inf; -171], which estimates the median of the difference between a sample from informal movements and a sample from formal movements.

Formal trade in 2018 was composed of 52 animals/products slaughtered commercially and 827 animals/products moved to feedlots. 826 out of the 827 feedlot animals were moved to the Gaza Beef feedlot and 23 carcasses out of the 52 slaughtered commercially were moved to the Skukuza Abattoir for processing as part of the University of Pretoria's Herding for Health: Mnisi Mobile Abattoir pilot project (2017).

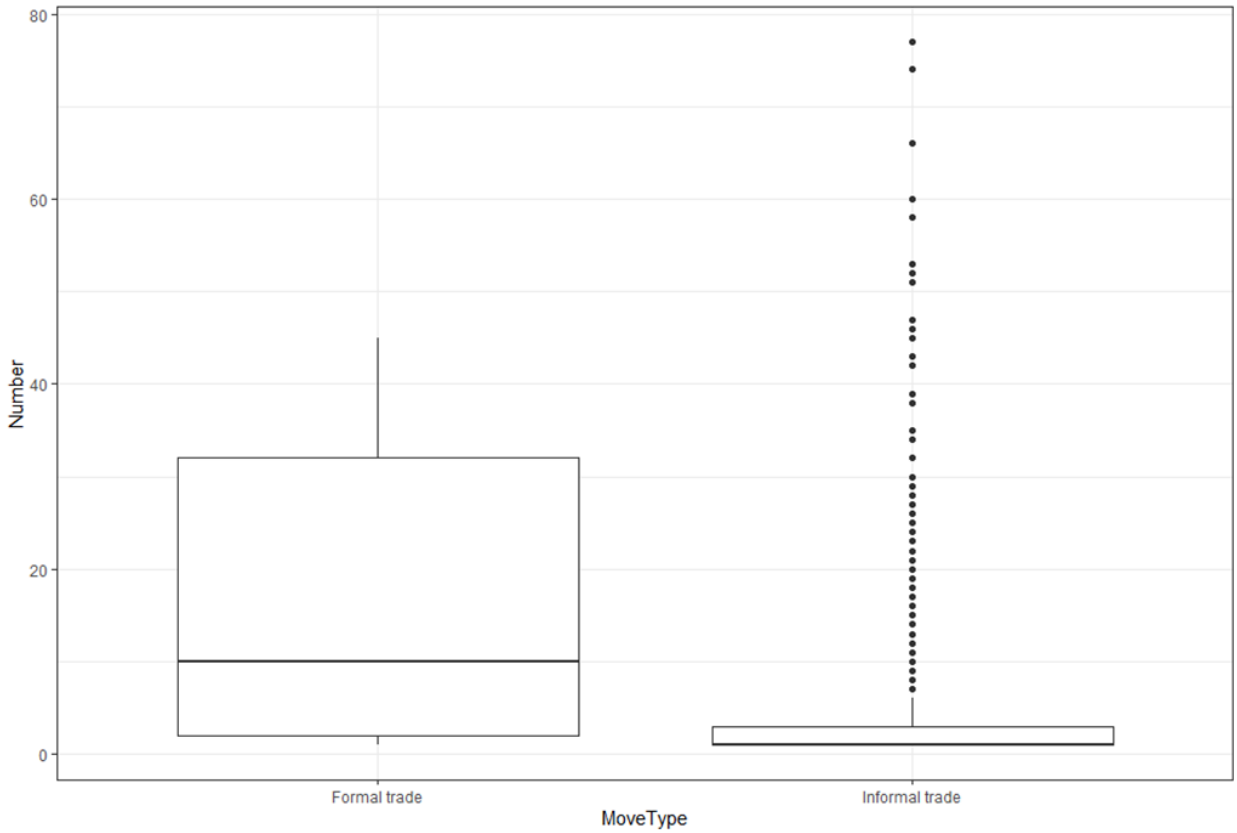

Figure 14: Number of animals/products moved per permit per trade type

The median number of animals/products moved per permit varied significantly (Kruskal-Wallis rank sum test: H = 406.91, 51 d.f., $p < 2.2 \times 10^{-16}$). The median number of animals/products moved for formal trade purposes is 10 [2; 32] compared to 1 [1 ;3] for informal trade (Fig. 14).

4.2.2 Distances moved and transport methods

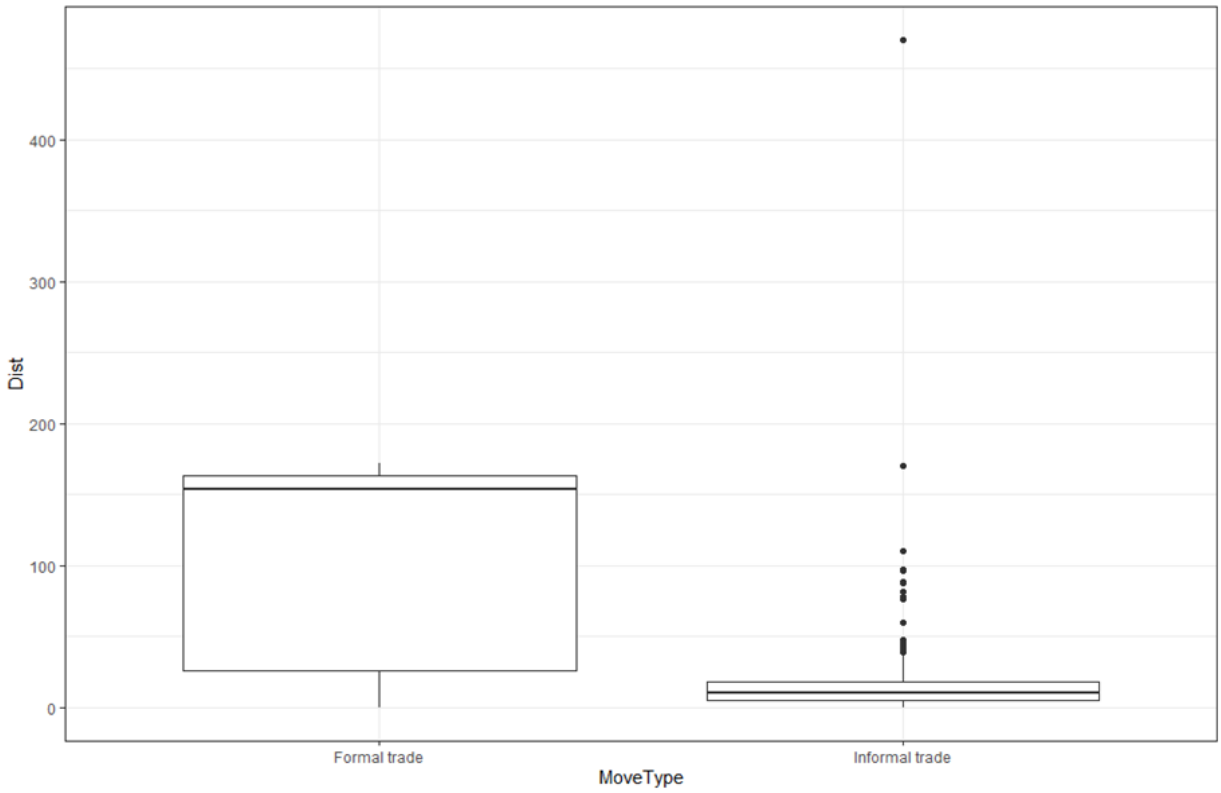

Figure 15: Distance (in km) moved per trade type

The median distance moved for formal trade was 154 km [26; 163] while for informal trade the median distance was only 10 km [5; 18] (Fig. 15). Utilising a Wilcoxon rank sum test with continuity correction, a significant difference was highlighted in the distance travelled between the two trade types, n = 1489, W = 125260, $p < 2.2 \times 10^{-16}$.

The method of transport which was used to move animals/products over distance was also investigated. The median number of animals/products herded and moved using a vehicle for formal trade purposes were 2.5 [1.75; 3.25] and 12 [2; 34] respectively. By contrast, the median number of animals/products herded and moved using a vehicle for informal trade purposes were only 2 [1; 5] and 1 [1; 2] respectively.

When comparing the transport methods of formal and informal trade sets with a Kruskal-Wallis test, the differences were strongly significant (H = 76.71, 1 d.f., $p < 2.2 \times 10^{-16}$); the median ranks of animals/products moved per permit by trade type were significantly different between the "herded" and "vehicle" transport types. Very strong evidence ($p < 2.2 \times 10^{-16}$) from Conover's

all-pairs rank comparison test indicated that the number of animals/products transported for formal and informal trade reasons differed significantly.

4.2.3 Formal and informal trade leaving Bushbuckridge

The sum of animals/products moved within and exiting Bushbuckridge can be further subdivided by trade type, as shown in Table 9. Formal trade numbers leaving BBR are consistently the highest over the study period, while informal trade clearly dominates over formal commerce in the local marketplace. Formal trade movements out of BBR were the lowest during 2017 and peaked in 2018.

Table 9: The number of animals/products moved per year, by trade type, within and out of Bushbuckridge

		2015	2016	2017	2018	2019
Movements within Bushbuckridge	Formal trade	7	10	13	21	3
	Informal trade	2110	1008	622	1039	427
	Unspecified	2067	1737	1056	1459	295
Movements out of Bushbuckridge	Formal trade	262	168	14	858	253
	Informal trade	6	3	1	53	0
	Unspecified	14	20	2	4	0

4.3 Effects of an FMD outbreak on the local cattle industry

4.3.1 Movement standstill effects

The effects of the movement standstill imposed on the BLM as a result of the 2017 FMD outbreak, are illustrated in Figures 16 and 17, below.

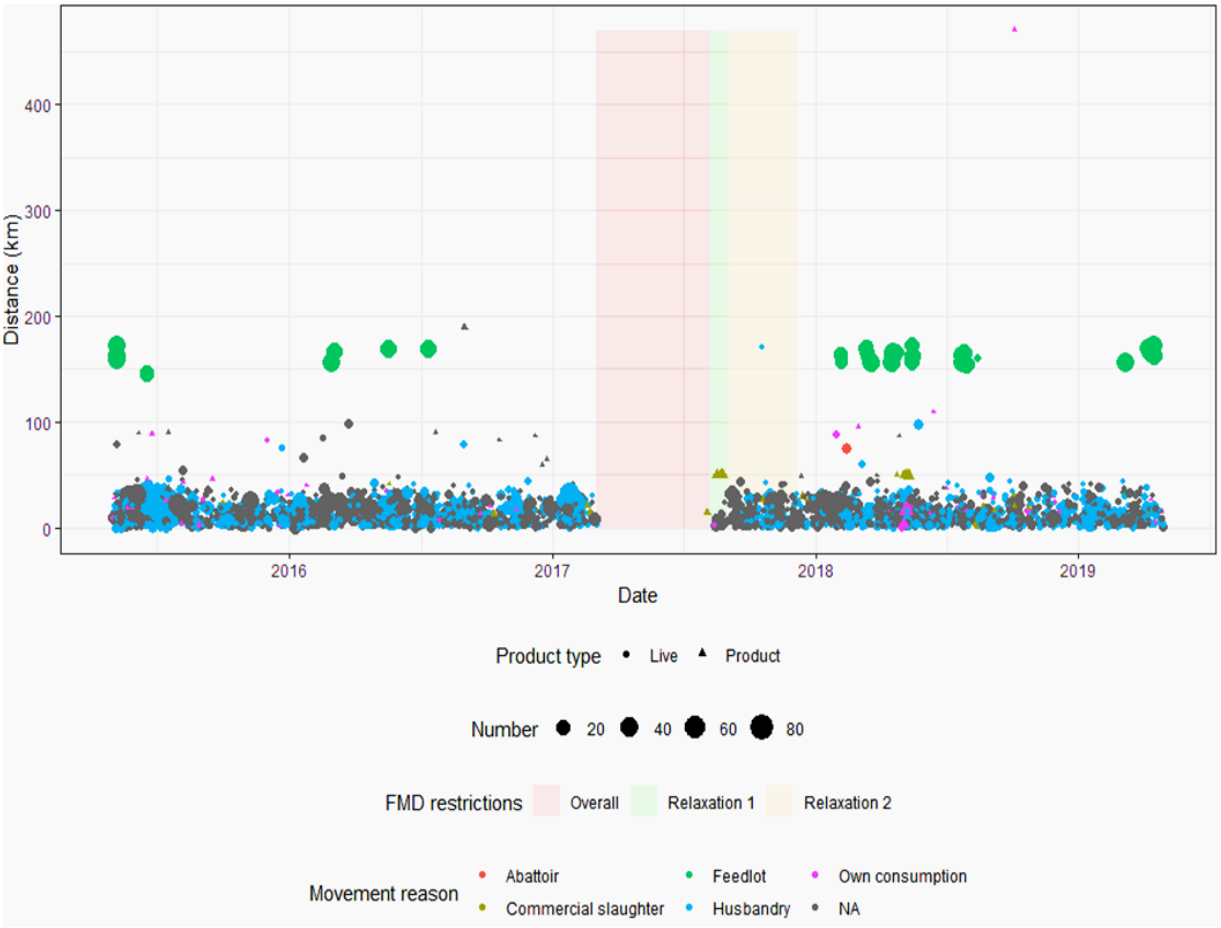

Figure 16: Summary of the distance animals/products moved, by number, product type, and movement reason

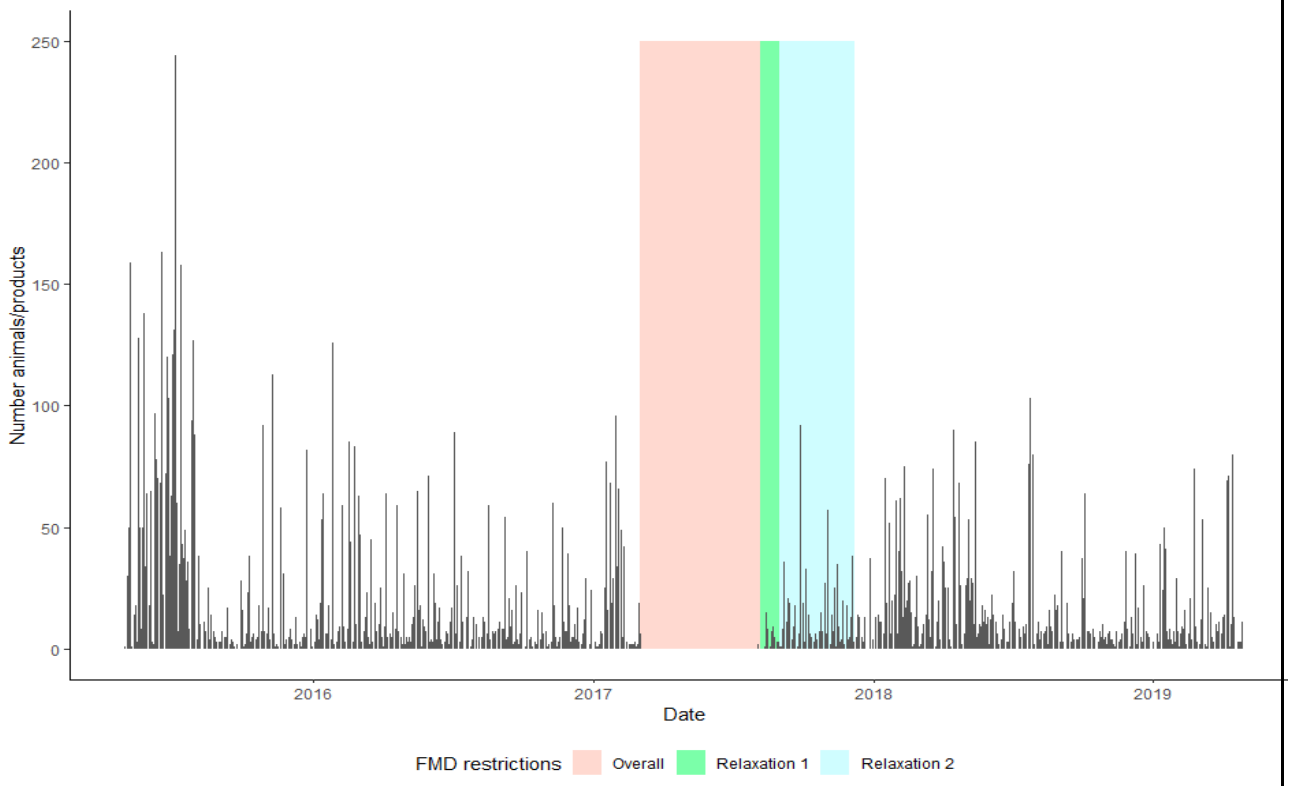

Figure 17: Summary of the total number animals/products moved by date

The overall effect of the standstill was evaluated using a Wilcoxon rank sum test to compare the median number of animals/products moved before and after the FMD movement standstill. The test showed a significant difference (W = 111, p = 0.024). The number of animals/products moved before the standstill was 1.7 [0.26; 3.46] times more than those moved after the movement restrictions were lifted (Z = 1.72).

The median number of cattle owners per IP decreased dramatically from March to September 2017 (Fig. 18), concurrently the median herd size per cattle owner increased between March and August 2017 (Fig. 19).

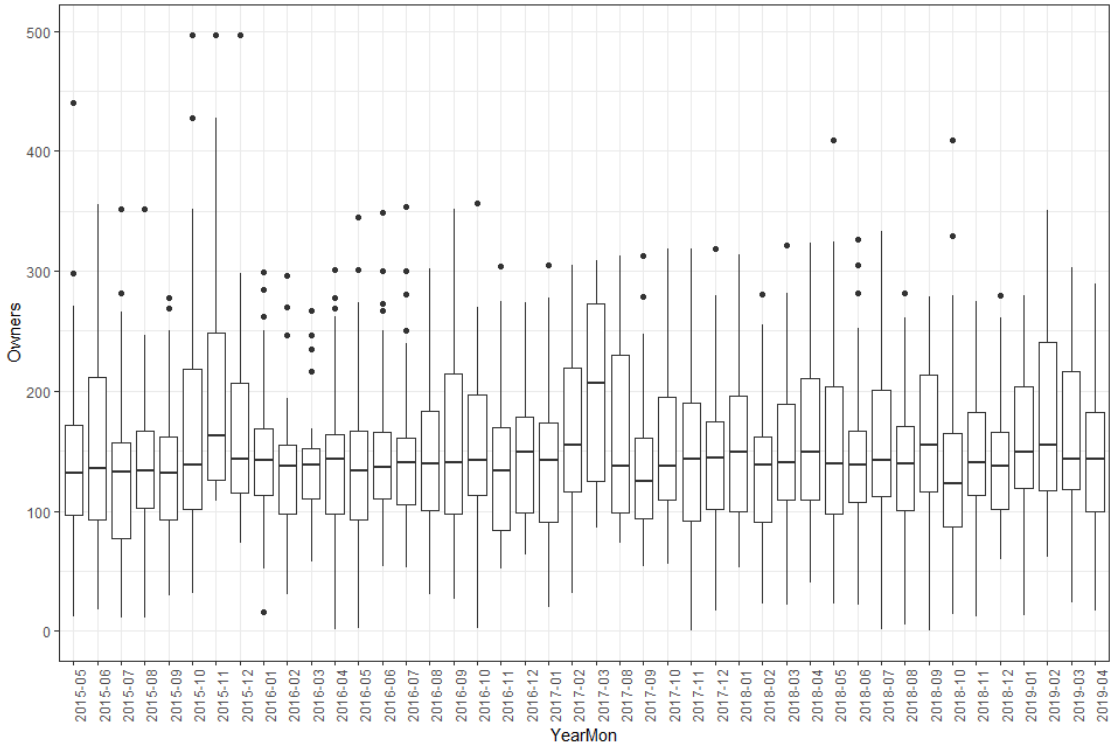

Figure 18: Median number of cattle owners per IP (aggregated) over time (excl. overall FMD standstill period)

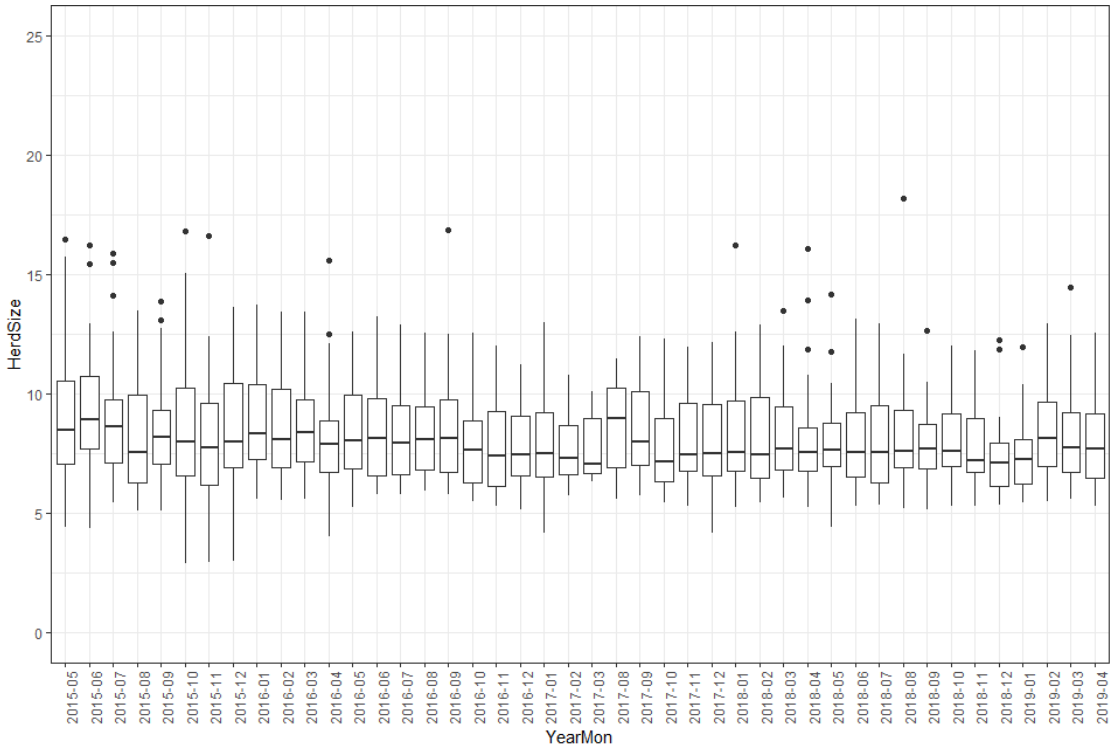

Figure 19: Median herd size per IP (aggregated) (excl. overall FMD standstill period)

4.3.2 Potential trade loss

Using the average number of animals/products moved in the three, year periods over which there were movement data available for the 3 March to 7 December period, overall mean trade was calculated by comparing years. From this mean, the number of animals/products that were allowed to move during the FMD relaxation periods, from 7 August 2017, were subtracted and it was possible to approximate the potential 'loss of trade' incurred by the cattle farmers of BBR due to the 2017 FMD outbreak movement standstill (Tab. 10).

Table 10: Estimated loss of animals/products moved due to FMD outbreak standstill, 3 March to 7 December 2017

	Mean number Animals/products moved during standstill period (excl. 2017)	-	Number Animals/products moved during FMD standstill relaxation periods	=	**Estimated loss of animals/products moved**
Commercial slaughter	20		20		**0**
Feedlot	467		0		**467**
Husbandry	1171		185		**986**
Own consumption	42		3		**39**
Not recorded	1416		646		**770**

CHAPTER V: DISCUSSION

The objectives of this study were as follows:

i. To describe the movement activity of cattle
ii. To estimate the level of the informal and formal cattle trade
iii. To determine the impact of an FMD outbreak-induced movement standstill on the local cattle industry.

5.1 BBR cattle population demographics

The BBR cattle population shows a distinct downward trend. The initial cattle population of 82026 in May 2015 was the highest during the course of the study period. It would be interesting to have had records prior to this period to evaluate whether it was a peak or part of the downward trend.

Owner numbers were decidedly variable but remained high overall (Fig. 3). Over the period 2001 to 2016, the population of Mpumalanga increased from 785 000 to 1.2 million (Stats SA 2016), showing a distinctly positive growth rate. Despite the increase in population, household size in Mpumalanga decreased from 4.3 to 3.5 from 2001 to 2016. A mounting number of households and population leads invariably to an increased requirement for land, resources and municipal services by communities. A simultaneous trend of urbanisation and demand for modernisation quickly leads to a reduction in communal grazing land and water available to livestock. The cattle population decline after 2016 coincides with severe environmental pressures, experienced by farmers and cattle alike during the 2015-2016 drought period, after which the population has yet to recover. Studies have shown (Coppock 1993, Elllis *et al*. 1993, Scoones 1993) that mortalities in communal livestock occupying rangelands are frequently between 25 and 75 percent during drought conditions. Considering this information, it is remarkable that the BBR cattle population over this time-frame decreased by only 2 percent. Perhaps this could be ascribed to the optimally adapted Nguni and Afrikaner breeds which make up the majority of the local cattle population, capable of withstanding water and food depravation in high temperatures without succumbing to climatic adversity.

Annually the cattle population begins to increase from October, peaking in March/April and dipping to the lowest numbers around September. The BBR calving season shows a clear peak in November, coinciding with the beginning of the summer rains, dropping to its lowest in

March (Gaudex 2014). Annual population minimums in September can be explained by a combination of offtakes during the 'cool dry' season, poor veld condition at the end of the dry season, and low calving rates at this time.

Mean herd size per owner was relatively constant at eight animals, which is in line with previous findings that in southern Africa, typically 68% of communal cattle farmers own fewer than ten animals (Casey & Maree 1993). This is lower than the average herd size of 25.8 cattle reported in a demographic study performed in the B2 ward of Bushbuckridge East by Gaudex (2014), but closer to the median herd sizes of 11 animals reported by van Rooyen (2016) following a study wards B1 to B4.

Owner peaks almost always occurred during cattle population dips and vice versa, most notably at the end of the calendar year. One explanation could be that at year end, when community members are traditionally awarded financial bonuses, they use the money to purchase cattle and become transient owners. Animals are purchased with an intent to slaughter over the festive season, after which these new owners are removed from cattle registers.

On occasion, surprising increases or decreases in owner numbers were observed between one month and the next at particular IPs or wards. It should be noted that poor record-keeping or delays in removing transient owners from cattle registers could have influenced these totals. Local jumps in owner totals likely coincided not with mass owner demographic changes, but simply with AHTs only sporadically removing moribund owners from cattle registers.

5.2 Movement activity

While there are many movements happening in the BLM (Tab. 2), the proportion of the total population moved is on average 4 percent. The overwhelming majority of movements is of live cattle. Reasons for proportionally low numbers of products moved could include logistical constraints such as lack of processing facilities, transport and refrigeration equipment. With limited resources available, it is practically much easier to move live animals on foot and then slaughter them at destination. Considering home slaughter is the preferred slaughter method, it is also more hygienic to utilise meat at destination immediately after slaughter rather than to slaughter at origin IP and then having to transport the meat on the back of an open vehicle. A marked increase of product movements in 2018/19 could speak to an increase in the number of vehicles or facilities available locally for slaughter.

The mean proportion of animals/products moved per year was 4%. The proportion of the cattle population moved was comparatively high in the first year of the study but then halved and remained roughly constant (0.31-0.38) during the subsequent 3 years (Fig. 4).

There is a temporal and seasonal trend to the movement of animals and products. On an annual basis, the median number of animals/products moved per permit per year ranged between one (2016, 2017, 2018, 2019) and two (2015). This shows a significant decrease after 2015 in movement unit size, which correlates directly with the proportion of the population moved per year. The proportion of the cattle population moved per IP (aggregated) showed a significant difference between months, but overall the proportion remained constant, only peaking briefly in July 2015.

A distinct seasonality was observed for live and product movements, annually and overall. The majority of all movements occur in the 'cool dry' season. The most animals/products moved in one season was the 'cool dry' period of 2015. This was the second year of the local drought which precipitated a substantial decrease in the cattle population and likely prompted movements to alternate grazing areas or de-stocking in resource depleted areas.

Live animals moved are the most numerous in the 'cool dry' season when the cattle population is at its peak. This is followed by the 'hot wet' season when owner numbers peak and festive season trade is in full swing. Lastly, in the 'hot dry' season the least number of animals are moved. This overlaps directly with the period when cattle are in their poorest body condition, cows are in the last trimester of gestation, and the cattle population is at its annual low. It is the worst time of the year to attempt to drive cattle over even short distances. Body condition scores of cattle are so low during the end of the dry season that they develop often irreversible protein energy malnutrition and walking becomes too much for animals (personal observation), lending affected individuals to get stuck in the crush during inspection or even drown in the plunge dips.

Bovine products are also moved primarily in the 'cool dry' season when cattle numbers are high and owners might be inclined to cull surplus animals before the oncoming 'hot dry' season. Due to lack of refrigerators and chilling facilities, it makes sense that consumers would feel most confident about purchasing, transporting and storing freshly slaughtered carcasses in this, the mildest season. The 'hot dry' season comes in second, likely due to the stimulation of late season off-takes of cattle in poor condition, unlikely to survive until the rains. The hot-wet season, when grazing is at its best and the majority of cows have calved and are in milk is understandably the least likely time owners would move products.

Despite the fact that testing of the seasonal median ranks of number of animals/products per IP were not statistically significant, the presence of many large outliers indicates that this result may not be a good representation of the data. The median ranks of number of permits per IP also showed no significant differences between seasons, with few outliers, indicating a good fit with the model. It makes sense that, although the number of permits issued per season are roughly equal, in peak movement seasons such as the 'cool dry', the movement unit size would be increased.

That the differing mean ranks of the proportion of animals/products moved per IP per season were statistically insignificant signifies that the quantity of animals/products moved remain consistently proportional to the cattle population in each season.

Seasonality of movements would have been even more marked if prohibition of movement during the FMD outbreak of 2017, mainly in the 'cool dry' season, had not artificially decreased the numbers.

5.3 Transport methods and distances travelled

The data clearly illustrate that the overriding majority of movements take place within BBR and that cattle are mainly transported by herding animals to their destinations. Local cattle movements outnumber movements out of the BLM by 24 to one.

Live animals were moved a maximum of 172 km to the Gaza Beef feedlot. The furthest a bovine carcass was moved was to Estcourt in the KwaZulu-Natal province. This case was very interesting because despite the FMD regulations requiring the owner to debone all the meat prior to transport and the additional paperwork, not to mention the distance the meat had to be transported, he still chose to slaughter his own animal for a funeral in Estcourt rather than to buy and slaughter an animal at the destination (personal observation).This further illustrates the socio-cultural value placed on cattle by rural African communities (Musemwa *et al.* 2008)

Of the records which indicated a transport method, two-thirds of live animals were herded to their destinations (a median distance of 8 km) by farmers rather than driven with a vehicle (a median distance of 20 km). This could be due to a lack of access to larger vehicles. Usually light delivery vehicles (bakkies) are used or alternately, light duty trailers. Neither are designed to

secure animals for safe travel on the local roads which are generally untarred and of poor quality. In order to secure one animal to the back of a light delivery vehicle, common practice is for farmers will hog-tie it and transport it lying down and secured with ropes which carries a risk of bloat but less risk of other injuries. Thus, if an owner wants their cattle to arrive at destination without serious injuries such as broken legs, it is definitely safer, if more time-consuming, to herd the animals there. This is corroborated by the data: the median ranked number of animals/products per movement using a vehicle was one versus two when herded.

Local movements of larger groups of animals necessitate herding. The exception to this is the large-scale movement of animals to the Gaza Beef feedlot following cattle sales. In this instance, the buyer brings their own trucks and trailers, each capable of transporting 35-40 head of cattle, with which to collect the animals.

Live cattle are moved a median ranked distance of 10 km compared to 21 km for products. Products are easier to transport than live cattle and there is usually an economic incentive for moving product but not always for live cattle. When cattle owners need to access processing facilities or markets, they may require a vehicle to travel further, but the financial returns would need to make the investment in transport worthwhile.

Owners are more likely to use a vehicle if they only need to move few animals [1; 2] over greater distances [13 km; 29 km]. This also speaks to the lack of resources of the local emerging farmers. It is simply too expensive for most to rent a trailer for moving more than two animals at a time.

5.4 The Bushbuckridge cattle trade

Animal husbandry is the foremost reason disclosed for movement. This indicates that farmers are actively moving and trading cattle within the community, albeit mainly for agricultural purposes. Common husbandry reasons for moving animals include the desire to increase or decrease herd size, alter herd genetics and herd transfers to alternate grazing areas.

Mean offtakes of animals constituted only 0.57% of the population which is extremely low compared to a mean offtake percentage of 6.16 reported by van Rooyen (2016), for a communal system with similar FMD-linked movement restrictions in rural Namibia. In light of such low offtakes it would be reasonable to postulate that the consistent decline in the cattle population over the study period was due to lower calf recruitment or consistently higher mortalities than recruitment. This is commonly observed in production systems which are natural resource driven (van Rooyen 2016).

Animals destined for the feedlot from cattle sales or auctions were the second most numerous movement reason category. More units are moved to feedlots per permit, than for any other movement reason. As such, the overall finding that more animals/products are moved per permit for formal trade reasons than for informal trade reasons is not surprising.

Trade in BBR is predominantly informal in nature. So much so, that less than a quarter of the movements can be classified as formal trade. The number of animals/products traded informally are twice that of those traded formally. Conversely, the number of animals/products traded per permit are ten times higher in formal transactions than in informal ones.

Comparing formal and informal market access, a few key findings were noted:

- The distances travelled to access formal markets are far greater than those travelled to access informal markets (Fig. 15).
- The numbers of animals/products per movement destined for the formal market were much larger when being transported by a vehicle than those herded; while the opposite proved true of informal trade. This is most likely due to the types of vehicle available to informal and formal traders respectively.
- Formal trade numbers leaving BBR are consistently the highest over the study period, while informal trade clearly dominates over formal commerce in the local marketplace.

All of these findings speak to sufficient informal marketing options locally, and concurrently, insufficient financial incentives offered by the formal marketplace regionally. Without the cultivation of both to yield significant market returns, small-scale cattle farmers are unlikely to be motivated to develop the local marketplace further or become active participants in forging a stronger relationship with regional formal markets.

5.5 The effects of an FMD outbreak on the local cattle industry

The FMD outbreak of 2017 which led to the movement standstill appears not to have resulted in a detrimental effect on the local cattle industry in the medium term going forward despite distinct changes to the overall BBR herd dynamics.

The steepest decline in cattle numbers was observed from March to November 2017 which coincides exactly with the FMD outbreak. The lowest recorded number of owners was also reported in September 2017 (9108) and a corresponding increase in herd size. Small-scale farmers are consistently found to be the most severely affected by losses incurred through FMD outbreaks (Baluka 2016). It is understandable that smaller-scale farmers felt the need to

abandon their livestock investment as movement restrictions continued, but the marked decline in the cattle population during this time is confounding. Only three reasons for such a sudden decline in cattle numbers make sense given the movement restrictions in place: firstly, a dramatic increase in slaughters for personal consumption, which do not require movement permits and are thus not recorded; secondly, mass mortalities during the outbreak from other diseases or adverse environmental conditions; and thirdly, illegal movements out of the area reported as either personal slaughters or mortalities to local AHTs. This should be investigated further by MVS to rule out illegal movement activities.

During the movement standstill itself, a significant amount of trade loss was incurred. The extreme decline in formal trade leaving BBR in 2017 can be directly attributed to the FMD outbreak movement restrictions. 96% of formal trade, 85% of informal trade and 54% of unknown trade was lost by the local cattle farmers of BBR. According to the calculation of estimated loss of animals/products moved during the FMD standstill phases (Tab. 11), the largest losses in the formal market were to the feedlot (467) and in informal trade, to husbandry (986) and own consumption (39). Potentially, 770 animals/products without reason for movement were also 'lost' during this period. Animals/products moved for commercial slaughter purposes were made up for completely in the movement relaxation periods.

Comparing the number of animals/products moved before and after the outbreak, during the entire study period, it was observed that 1.72 times more units were moved prior to the standstill than after. This being said, the data are skewed due to the high number of animals moved in 2015/16 and a general decrease in cattle numbers over the study period (Fig. 17). In fact, the proportion of the population moved in 2017/18 and 2018/19 was higher than in 2016/17 (Tab.2).

In 2018 more animals were traded formally and more animals/products were moved out of BBR than any of the other years (Fig. 16). This marked increase in formal trade was unexpected. It begs the question of whether farmers were more motivated to sell larger numbers of animals to the formal market out of desperation to downsize their herds and whether this was in response to the FMD outbreak, due to environmental pressures or a novel stressor. It is also possible that improved market access opportunities provided increased impetus for farmers to sell their cattle.

Negative environmental influences could have also been a strong motivator for reducing population size. Rainfall in Bushbuckridge from July 2017 to June 2018 was only 182.5 mm (World Weather Online n.d.) of the average annual 860 mm (SA Explorer 2000-2017), however,

it should be noted that rainfall had been consistently poor from the 2014/15 hot-wet season up until the improved rainfall of the summer of 2018/19. This does not explain why only from 2018 so many more animals were sold or auctioned to feedlots.

It is possible that some emerging farmers became wary of owning cattle after the outbreak and were motivated to downsize or sell all their animals as an adaptive strategy. The inability to move animals during the standstill would have put pressure on the few more commercially-oriented farmers to access markets after the outbreak to compensate for the months of trade 'lost' due to the movement standstill. However, the majority of cattle owners in BBR practice subsistence farming and only trade when it becomes financially necessary. These farmers have no use for compensating by trading more cattle after an outbreak if the need for an influx of capital has passed. This is consistent with the findings in the data which show no marked peak in trade immediately following the end of the movement standstill. In fact, trade only picked up a few months after the end of the movement restrictions, which does not support the theory that the increase in animal trade observed in 2018 was in any way related to the FMD outbreak of 2017.

Could a shift in the formal market have occurred? National FMD movement restrictions had not changed, and owners still could not trade to any new areas outside the FMD protection zones. No new abattoir facilities had been registered in Bushbuckridge. Permit data indicated that in 2018, all but one of the animals sold to feedlots were sold to Gaza Beef. It seems that either cattle owners were more motivated to sell, or Gaza Beef was more motivated to buy from Bushbuckridge.

In early 2017, Gaza Beef was paying well under the national average price for C grade feedlot cattle (Appendix F) and once the FMD outbreak was declared, farmers had even fewer marketing options. Communal farmers, already marginalized by FMD control regulations and outraged by the further restrictions imposed on them as a result of the outbreak began putting an increasing amount of pressure on DARDLEA to provide new avenues of market access. In response, the acting District Director of DARDLEA chaired a meeting to discuss the pilot Mnisi Mobile Abattoir Project (MMAP) proposed by Herding for Health (DARDLEA 2017a), the outcome of which was for MVS to facilitate the project provided all veterinary disease control and public health regulations were met.

Once the MMAP was rolled out in August 2017, BBR farmers were offered sale prices much closer to those of the national market (CSA 2019). Then, for the first time, in May 2018, a sale

price even exceeding the national market price was offered and subsequently the farmers found themselves with something of a competitive formal market.

A marked increase in feedlot sales to Gaza Beef was observed in the dataset for 2018. Movement data for 2019 up to April suggests that the inclination to increased feedlot movements is being maintained, as is the improved cattle price from Gaza Beef (Appendix F). Ongoing outbreaks of FMD in the Vhembe (May 2018) and Giyani (August 2018) areas of Limpopo Province (DAFF 2019) and their subsequent movement restrictions continue to place pressure on Gaza Beef to source cattle from BBR instead. Whether this trend will continue once the cattle movement restrictions in Limpopo are lifted remains to be seen.

5.6 Improving marketing opportunities for local cattle farmers

While limited by current geographic trade systems, only two directions for improving local market opportunities exist: either to improve and expand current market frameworks or to build new ones. A third option would be to do away with geographic based trade completely and investigate new possibilities such as CBT.

5.6.1 Expanding and improving existing frameworks

The simplest means of improving market access for local cattle farmers would be to build on current systems of marketing and expand and improve these to make them more widely available. Scoones *et al.* (2010) emphasize how important growing local urban markets is to rural communities. This is a low-cost option which is under-exploited.

Established facilities and their associated butcheries could be developed further by exploring value-chain options. Investment by the state or non-government organisations for business expansion and technical support would be critical but could yield huge dividends without requiring the purchase of expensive mobile abattoir equipment. As transport appears to be a largely limiting factor in BBR, providing farmers with transport with which to mobilise their cattle to local rural abattoirs could make a significant difference. Marketability of this meat which could not leave the PZV in large quantities would need to be evaluated however.

Transporting live animals to the Skukuza GPP is another option which could be investigated. Constraints include re-registering the abattoir for the slaughter of cattle and as an FMD-designated facility. Considerable financial investment would also be required to meet FMD-

designated requirements as well as to build lairages and a stunning box required for the processing of live cattle. If re-registered as an FMD-designated abattoir, meat could be legally marketed in the FZ. If not, meat could only be marketed within the IZ.

Mobile abattoirs as an option for local slaughters have shown potential. The MMAP may not have slaughtered many animals during its pilot project, but it did have a visible impact on the economics of the cattle trade in BBR. Positive outcomes of the project included R117 430 of income to participating farmers in the 2017 trial (Meat Naturally PTY 2018) and overall stimulation of the formal cattle trade through the boosting of cattle sale prices as noted in Figure 16 and Table 11 (CSA 2019).

This novel approach to providing market access for marginalised rural communities did face many challenges during the trial period. The logistics associated with the pilot project were immensely complicated and substantial capital inputs were required to buy and modify a mobile game abattoir for use. Reliance on the Skukuza GPP for processing meant that the MMAP only had access to limited slaughter windows as the GPP was only available assist with processing cattle in periods when not processing wildlife or storing game meat. The project operated at a substantial loss overall and the meat quality was considered poor by consumers (Meat Naturally PTY 2018), however, the business model did indicate that profitability could be attained within a relatively short period of time should the mobile abattoir operate on a continuous basis.

Despite these numerous challenges, the Herding for Health programme and their associated partners have indicated that they would be interested in expanding the mobile abattoir project to the entire BBR should registration of the facility be approved by the relevant VPH bodies (Dr J. van Rooyen [Director: Herding for Health Programme, Conservation International] pers. comm., 30 October 2019). Without innovative projects such as these to test the waters, valuable marketing pathways may never be explored.

Gaza Beef PTY's monopoly of the regional cattle market is largely due to ownership of a registered quarantine facility for cattle from both the FMD protection zones (Dr K.B. Mohlabe [SV Giyani, Limpopo Veterinary Services] pers. comm., 18 October 2019), without which they could not source animals from the PZV. Historically, cattle sales have only been organised in the BBR E area, but should farmers be made aware of such opportunities in BBR N and BBR S, they too could benefit from this marketing avenue. More farmers will likely want the opportunity of making use of this option, now that beef prices have improved.

It must be mentioned that an overall concern for participants and consumers along the production chain has been product quality. Meat originating from the rangelands of BBR appears to be of consistently poor quality; the majority of animals produce only C grade carcasses. Animals purchased by Gaza Beef are almost all graded a C class prior to entering their feedlot system; C-grade carcasses are generally observed by Veterinary Public Health officials at the local rural abattoirs (Dr K. Singh [Mpumalanga Veterinary Public Health] pers. comm., 10 October 2019) and Meat Naturally PTY (2018) reported only C-grade carcasses as the output of their mobile abattoir pilot. Feedback from KNP staff following the sale of the MMAP meat at the Skukuza GPP was that the meat was too expensive, took too long to cook and was very tough (Meat Naturally PTY 2018).

Low carcass quality seen at slaughter (Mr L. Pieterse [Buyer for Gaza Beef] pers. comm., 10 October 2019, Dr K. Singh [Mpumalanga Veterinary Public Health] pers. comm., 10 October 2019) can be attributed to poor animal condition and poor handling of animals during the slaughter process. A small improvement in the meat quality could be made by decreasing stress prior to slaughter by allowing animals to rest at the abattoir overnight or even for a few hours prior to processing, should the facility allow. Improving general handling practices of live animals and products can be achieved through augmented training of abattoir personnel.

Animal body condition varies through the year and is also age dependent. Seasonal slaughter of animals in prime body condition following the bountiful 'hot wet' season would produce the best annual carcass quality. Rotational grazing systems would also go a long way to improving body condition scores in seasons when veld condition is otherwise poor. Grazing schemes such as those of the Herding for Health programme in BBR E (van Rooyen 2016; UP DVTD 2017) are a key tool for sustainable rangeland management and the education of farmers on land-use. Implementation of these programmes becomes a real challenge in the rapidly developing areas on the western side of the BLM, where population expansion prohibits the establishment of such initiatives and limit management tools with which to improve feed availability and condition of cattle.

Another reason for poor beef quality is the strong preference of farmers to cull only old animals that are no longer productive. Younger animals, especially cows are considered too valuable to sell without sufficient market incentives. Maintaining a younger herd is also a risk reduction strategy by farmers (van Rooyen 2016) who feel more secure that younger, stronger animals will survive environmental and disease stressors better.

A means with which to improve local meat products in the short term would be to focus on the development of value-added products. These products, such as processed or cured meats which do not require high quality beef, could satisfy local consumers and provide a valuable source of protein to impoverished communities. Such processes do require greater skills development but could also create job opportunities and increased product diversity (AHEAD 2019).

Evaluation of longer-term solutions would need to focus on analysing interactions between limiting factors such as conformation, animal body condition, the seasonality of offtakes and the marketing cycle in relation to FMD control restrictions. For example, the impetus for animal improvement in terms of genetics and body condition or carcass quality are market driven. Thus, while formal market access remains limited to BBR farmers due to movement control restrictions, they are unlikely to strive for improved production without incentive.

5.6.2 Provision of new facilities: a red meat abattoir for Bushbuckridge

The establishment of a government funded local red meat abattoir would afford the community of the BLM the facility to slaughter an increased number of cattle locally. If successful, the benefits reaped could be numerous. These include job creation, local skills development, sustainable resource management, food security, development of local infrastructure, improved animal health management and community upliftment through poverty reduction. However, the prerequisite for such a facility would be substantial financial input by the State for the initial construction and equipment.

Currently, the two rural abattoirs registered in BBR are limited to slaughtering a maximum of two livestock units per day (RSA Government Gazette 2004). They should thus, in theory, be able to slaughter a minimum of ten cattle per five-day work week, yet, these abattoirs only achieve on half of that (Dr K. Singh [Mpumalanga Veterinary Public Health] pers. comm., 10 October 2019). According to Dr Singh of VPH (pers. comm 30 October 2019), limitations on throughput at both abattoirs are not due to lack of chiller capacity, but due to low levels of consumer demand at the associated butcheries.

Thus, prior to the establishment of a higher throughput red meat abattoir, a thorough market feasibility study would be required to accurately assess local demand for products from such a facility.

5.6.3 Options for commodity-based trade

Despite the OIE now accepting certain CBT approaches to FMD, as outlined in the TAHC: Chapter 8, (OIE 2019), very few countries are adopting policies supporting this approach (Scoones *et al.* 2010, van Rooyen 2016). South Africa itself is yet to become an active practitioner notwithstanding evidence promoting soundness of principles, despite the idea of FMD designated abattoirs being built on CBT theory.

Since the inception of the CBT approach, various researchers have attempted to evaluate the cost-benefit ratio of adopting such a system. Cassidy, Tomson & Barnes (2013) illustrated through their 'multi-criteria decision analysis for a CBT approach to beef exports from the east Caprivi Region of Namibia' that implementing CBT based on the OIE TAHC or development of a *sous vide* (low temperature, long time cooking) processing facility would provide a more favourable investment scenario over creating FMD-free compartments or maintenance of multispecies land use and adjacent conservancies as is the *status quo*. Naziri *et al.* (2015) however, considered the additional market access costs to far outweigh costs incurred to satisfy SPS prescribed measures for FMD risk-mitigation.

The AHEAD programme 'GAP analysis of the implementation of CBT of beef in Ngamiland, Botswana' performed most recently (September 2019) indicated that financial inputs need not be a limiting factor, but rather that co-ordination, synergy and partnerships as well as stake-holder consultations and participation were key. The list of recommendations developed was substantial, yet the researchers stressed that not all actions should be the responsibility of Veterinary Services, but rather spread amongst stakeholders such as farmers, NGOs, development partners, academic institutions and the private sector, in addition to government. This is a critical point, considering that the costs of implementing CBT cannot be carried by government alone and, as evidenced by the supreme lack of FMD designated abattoirs nation-wide, it has yet to become an attractive private business investment. Only through diversifying roles and responsibilities in this way could a profitable and sustainable CBT model for beef production adjacent to wildlife areas be developed with the greatest chance for success.

5.6.4 The way forward

The cattle farmers of Bushbuckridge need to be centrally involved in deciding the way forward. Well managed public-participation is required to adequately evaluate stakeholder inputs before

decisions are made regarding the future of marketing beef from BBR. A distinct dichotomy can be observed between the attempts of BBR farmers to amass as many cattle as possible, whilst concurrently demanding improved market access. While this appears counter-intuitive, the ability to transact is in fact essential for the continued economic well-being of these farmers in times of financial stress. It is then, when farmers are driven to sell and urgently require the capital that they are most reliant on their cattle for survival.

Growing the agricultural knowledge base of the community with the assistance of the various extension and training services available (Herding for Health Ecorangers, UP, MVS, DARDLEA Animal Production), is the first step towards improved productivity. Through a combination of one-on-one and group extension sessions, such as farmer's days, stakeholders can be given the tools for improved decision-making.

Markets are principally demand-driven. If the quality of beef derived from BBR cattle cannot be improved, the expansion of marketing options would be curbed substantially. Good quality meat could be channelled into the lucrative tourism industry, a market for which already exists in the GKNP. Upmarket safari lodges in the region would not doubt extoll the virtues of locally produced, grass-fed, organic beef which supported their community initiatives to their guests. Yet none could get away with serving their high-paying customers tough, C-grade meat that needed to be cooked indefinitely.

Opportunities to unlock new pathways for formal market access are available to local cattle farmers, should they choose to pursue them. It is the responsibility of government support services to equip rural farmers to make the best possible decisions for their specific situations. Holistic and integrated programmes should be prioritised by all departments involved in environmental management, agriculture, water, wildlife and forestry (Shackleton *et al.* 2000) so that extension services can provide information and training to communal farmers beyond the scope of agriculture. Partnerships with non-governmental agencies as well as private enterprises are also becoming increasingly important for sustainable rural development (Vetter 2013).

Only by applying context-specific solutions to local problems can policy be developed to engage with the specific and complex livelihood circumstances which define rural communities in Africa today (Scoones *et al.* 2005). Some tough choices will need to be made on how best, or even whether, to promote formal cattle trade avenues in the BLM. What is truly important, however, is that the decision should ultimately remain that of the local people of Bushbuckridge.

While this study has explored several technical solutions for market access, it lacks information on the social capacity and will of BBR farmers to formalise the cattle trade. For all we know, these farmers may believe formal market access to be out of their reach or have no interest in developing commercial agricultural enterprises at all.

Attempts made by public and private institutions to support cattle farmers and provide for their needs would be much more effective and sustainable if concrete information was available on the true requirements and knowledge gaps of the people. For example, if social science research indicated that BBR farmers knew practically nothing about the principles of capitalism, the choice of whether farmers should or should not pursue formalised cattle trade in Bushbuckridge could be facilitated by teaching cattle owners how to accurately evaluate the costs and benefits thereof. Then, should they decide to adopt a novel livelihood strategy, they could be equipped with the capacity to become active stakeholders in the outcome of these new ventures. Only by improving the decision-making capabilities of the people of BBR will they ever stand a chance at finding a pathway out of poverty for themselves.

5.7 Recommendations for further research

A key question remaining is what the level of market saturation would be. This is a very difficult question to answer with the general paucity of data available on the largely informal cattle trade throughout Africa. One hopes that these baseline data could be used in the near future to further examine the economic value of the cattle trade in the BLM and analyse the vast trade networks which exist in the BLM.

Furthermore, from the comparatively vast impact of the 2015/16 drought on cattle movements in BBR it is clear that cattle herd dynamics here are based much more heavily on nature than on commerce. As a chiefly nature-based system, the BBR cattle industry is highly sensitive to environmental factors such as changes in climate, disease outbreaks and natural disasters. It would be valuable to investigate the relationships between the BBR herd dynamics, climate data, disease ecology and the adaptive response strategies employed by local cattle farmers to deal with these natural threats to their livelihoods over the long term.

Social science studies could help decision makers understand exactly how best public and private organisations might assist the cattle farmers of BBR. This could be achieved by accurately determining the current knowledge level of farmers on a range of topics from primary animal healthcare to economics in order to assess what training is desired and/or required to equip the community for effective decision-making.

Shortcomings of this study include the absence of stakeholder participation in the research, such as through surveys, and lack of formal economic evaluation of the local and regional cattle market for the formal and informal cattle trade.

CHAPTER VI: CONCLUSION

While large numbers of movements took place in BBR, the proportion of animals/products moved were consistently very low. Overall, the number of movements which took place were proportional to the size of cattle population at the time.

The movement of cattle in the BLM was heavily influenced by the environment, and, cultural and socio-economic benefits of the cattle themselves. For example, the decline of the cattle population was closely associated with periods of extreme environmental pressures, namely drought. The movements of animals/products were also markedly seasonal. Environmental conditions and financial demands on farmers determined when they chose to move or sell cattle.

The lack of access to motorised transport and refrigeration facilities by the community was found to have significant implications for when and how owners decided to move their animals/products. For instance, products were generally moved in the 'cool dry' season when ambient temperatures were lower and meat would not spoil so quickly.

Most movements were of live animals; predominantly by herding them to their destination. The overwhelming majority of movements were local (within BBR). This is both due to FMD-based movement restrictions and lack of means with which to transport groups of animals over significant distances. Financial means to transport animals/products beyond the boundaries of the BLM were limited and/or considered an unnecessary expense when local markets were available.

Despite the perceptions of local policy makers, the information provided by this study indicates that farmers in BBR are actively moving and trading cattle within the BLM for agricultural reasons and out of BBR to access formal markets in the adjacent PZ. Overall, the cattle trade is predominantly informal in nature, with a very low offtake rate compared to similar rural areas in southern Africa.

Farmers moved animals/products much greater distances in order to access formal markets over informal markets, and generally required use of motorised transport to do so. This is because the majority of formal markets options available to the cattle farmers of BBR are currently situated outside of the local municipality.

The findings of this study speak to a sufficient range of informal marketing options locally, and concurrently, of insufficient financial incentives offered to cattle farmers by the formal

marketplace regionally. Without nurturing both, to yield significant market returns, small-scale cattle farmers are unlikely to be motivated to develop the local marketplace further or become active participants in forging a stronger relationship with regional formal markets.

The FMD outbreak of 2017 which led to an enforced movement standstill for all BBR cattle farmers within the BLM did not prove detrimental to the local cattle industry in the medium term. Distinct changes to the overall BBR herd dynamics such as a decrease in total number of cattle owners and corresponding increase in average herd size were, however, noted. Small scale farmers were found to be the most severely affected by the FMD outbreak, which is consistent with the findings of other studies.

During the movement standstill itself, a significant amount of trade loss was incurred. Formal trade was affected the most directly by the outbreak as the majority of formal trade avenues are located outside the district. However, loss of commercial slaughter movements was made up completely during the movement relaxation periods. In 2018, following the outbreak, an improvement in cattle prices stimulated farmers to access the formal marketplace, and an increase in the proportion of the cattle population moved was observed.

A marked decline in the cattle population was detected over the course of the FMD outbreak. It is possible that the cattle may have succumbed to environmental pressures during this time or the number of home slaughters may have increased, but mortalities as a result of FMD are highly improbable. Further investigation by MVS is necessary to determine whether illegal movements were the cause of the population decline.

The key constraints to marketability of animals/products originating in BBR were identified as absence of a competitive market system and associated infrastructure such as FMD designated abattoirs, disease control regulations, poor carcass quality, seasonality of offtakes and potentially lack of willingness by owners to sell.

Farmers currently pursue formal marketing options when incentivised financially or pressurised by adverse conditions such as environmental factors or disease outbreaks, still, an increasing demand for opportunities to access formal markets proactively, rather than waiting for a sale to take place has been noted (Dr B.O. Rikhotso [Deputy Director Animal Health: Bohlabela] pers. comm., 4 November 2019). Resource limitations were the main constraint to improved production of the cattle farming system, specifically, the restricted availability of grazing in communal rangeland systems and inability of the impoverished cattle owners to source supplementary feed.

Growing established local markets is likely the best way to assist the local population with market access, development and poverty reduction. Local, low-cost marketing options are very important for the LED of rural communities. The large population size of the BLM necessitates a large requirement for animal-based protein. As such, the people of BBR should be cultivated as the principle consumers in the local beef market chain. Community members should be encouraged to source more of their meat locally, not just for special occasions. This approach makes the most sense, logistically and for disease control.

Various alternative options of improving formal market access both within and external to BBR were evaluated. As transport appears to be a largely limiting factor in BBR, providing farmers with transport with which to mobilise their cattle to local rural abattoirs could make a significant difference. In order to extend the opportunity of accessing Gaza Beef's feedlot market to more of the community, cattle sales could be organised more regularly and expanded to other areas of BBR.

CBT options should be evaluated for future expansion of the BBR beef trade, provided a multi-stakeholder approach is utilised to share risks and responsibilities. This would in turn promote the sustainability of such an undertaking.

The potential future establishment of a red meat abattoir in BBR by the local government should not be viewed as a definitive solution to all local market-related issues. Investment in such a project should be very carefully evaluated through market research, cost-benefit analyses and public participation prior to committing.

The cattle trade in Bushbuckridge is not a commercially-driven production system. Rather, it is based on natural population dynamics and environmental factors such as disease outbreaks, climate change and natural disasters. This will need to be taken into account when policy decisions are made. Context-specific solutions should be generated to address local needs, effectively support development of a sustainable cattle trade, and unlock new markets going forward.

Key role players such as DAFF and DARDLEA should prioritise the development of holistic and integrated programmes to expand the repertoire of extension staff beyond the realm of agriculture. In this way, decision-making ability of farmers can be advanced.

Opportunities for further research include economic valuation of the cattle trade in the BLM and analysis of the vast trade networks within, in addition to various social science studies. Investigation of the relationships between BBR herd dynamics, climate data, disease ecology

and the adaptive response strategies employed by local cattle farmers to deal with these natural threats to their livelihoods over the long term would also be incredibly valuable.

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APPENDICES

Appendix A: SAFAIS colour-coded FMD zone ear-tags for cattle.

Protection zones with vaccination – green eartags	
Protection zones without vaccination – pink eartags.	
High surveillance area (north KZN): yellow eartags. (The same yellow colour eartag will be rolled out for the entire free zone at a later stage).	

(DAFF 2014a)

Appendix B: BLM FMD Inspection Points

Name of inspection point	State Vet Area	Ward	Geographical location	
			Latitude	Longitude
CLARE B	BBR E	B1	-24,647222	31,331111
CLARE A	BBR E	B1	-24,628889	31,305556
WELVERDIEND A	BBR E	B1	-24,583333	31,325556
WELVERDIEND B	BBR E	B1	-24,578333	31,359444
THLAVEKISA	BBR E	B1	-24,627500	31,380278
EGLINGTON	BBR E	B2	-24,653611	31,342222
SHARE	BBR E	B2	-24,681667	31,315833
UTLHA B	BBR E	B2	-24,710833	31,401667
SHORTY	BBR E	B2	-24,675556	31,374722
ATHOL	BBR E	B2	-24,713611	31,352222
GOTTENBURG	BBR E	B3	-24,638333	31,415833
UTLHA A	BBR E	B3	-24,699722	31,445556
DIXIE	BBR E	B3	-24,700503	31,485609
SEVILLE B	BBR E	B3	-24,674167	31,441389
UTLHA A SCHEME	BBR E	B3	-24,699722	31,445556
SEVILLE A	BBR E	B3	-24,679444	31,404444
HLALAKAHLE	BBR E	B3	-24,617222	31,433889
ALLANDALE B	BBR E	B4	-24,715278	31,295862
LUDLOW A	BBR E	B4	-24,653611	31,281111
ALLANDALE A	BBR E	B4	-24,707913	31,281678
LUDLOW B	BBR E	B4	-24,653611	31,281111
DUMFRIES C	BBR E	B4	-24,742500	31,306667
SONGENI	BBR N	B5	-24,711389	31,183889
EDINBURGH A	BBR N	B5	-24,706667	31,223889
ISLINGTON	BBR N	B5	-24,622778	31,259167
BURLINGTON A	BBR N	B5	-24,644167	31,213889
ROLLE C	BBR N	B5	-24,730278	31,249444
EDINBURGH B	BBR N	B5	-24,706667	31,223889
ROOIBOKLAAGTE B	BBR N	B14	-24,655556	31,069444
BUFFELSHOEK B	BBR N	B14	-24,636944	31,148611
BUFFELSHOEK A	BBR N	B14	-24,645278	31,128889
BAROMENG	BBR N	B14	-24,620556	31,099444
ROOIBOKLAAGTE A	BBR N	B14	-24,650000	31,082222
NEWLINE	BBR N	B15	-24,631389	31,006389
CRAIGIEBURN C	BBR N	B15	-24,641667	30,973333
ARTHURSEAT B	BBR N	B15	-24,610556	31,065278
ARTHURSEAT A	BBR N	B15	-24,663056	31,015833
CRAIGIEBURN A	BBR N	B15	-24,664444	31,001667
CRAIGIEBURN B	BBR N	B15	-24,680833	30,982500
KASTEEL A	BBR N	B16	-24,713333	31,046111

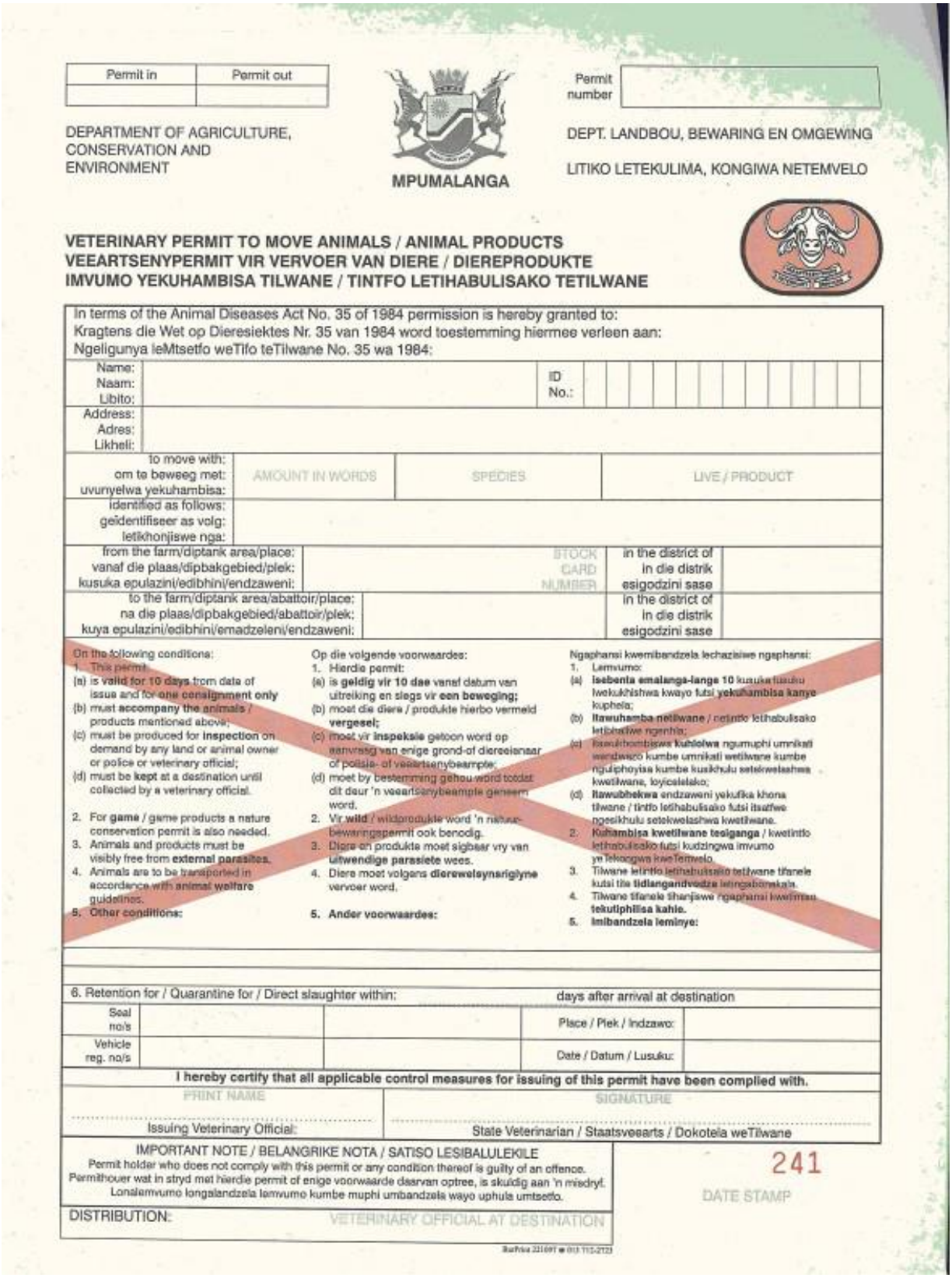
Name of inspection point	State Vet Area	Ward	Geographical location	
			Latitude	Longitude
KASTEEL B	BBR N	B16	-24,708611	31,014722
KASTEEL C	BBR N	B16	-24,709167	31,013056
ZOEKNOG A	BBR N	B16	-24,758333	31,000556
ZOEKNOG NGUNI	BBR N	B16	0,000000	0,000000
WALES	BBR N	B16	-24,707500	30,953056
ZOEKNOG B	BBR N	B16	-24,764444	30,973056
LONDON	BBR N	B17	-24,805278	31,035556
GA-RELANE	BBR N	B17	-24,789444	31,073611
DWARSLOOP B	BBR N	B17	-24,791667	31,114444
VIOLETBANK A	BBR N	B17	-24,747500	31,035278
VIOLETBANK B	BBR N	B17	-24,775278	31,010000
VIOLETBANK C	BBR N	B17	-24,771664	31,032598
ACORNHOEK B	BBR N	B18	-24,610556	31,065278
MBONDOYENI A	BBR N	B18	-24,598056	31,158056
MBONDOYENI B	BBR N	B18	-24,568889	31,135833
OKKERNOOTBOOM	BBR N	B18	-24,602778	31,116111
TIMBAVATI	BBR N	B18	-24,594444	31,100556
BURLINGTON B	BBR N	B18	-24,644167	31,213889
ACORNHOEK A	BBR N	B18	-24,578611	31,078056
DINGLEYDALE A	BBR N	B19	-24,680278	31,150000
HLAMALANI	BBR N	B19	-24,748333	31,068889
DINGLEYDALE B	BBR N	B19	-24,704444	31,111667
ORINOCO B	BBR N	B19	-24,746667	31,110278
ORINOCO A	BBR N	B19	-24,732222	31,076111
TSAKANI	BBR N	B20	-24,612500	31,049444
MALEBE PROJECT	BBR N	B20	-24,612500	31,049444
BROOKLYN A	BBR N	B20	-24,594167	30,986111
BROOKLYN B	BBR N	B20	-24,594167	30,986111
BROOKLYN C	BBR N	B20	-24,594167	30,986111
GREENVALLEY A	BBR N	B20	-24,606944	31,032222
GREENVALLEY B	BBR N	B20	-24,606944	31,032222
DUMFRIES A	BBR S	B6	-24,771111	31,298889
NEWINGTON A	BBR S	B6	-24,802500	31,320000
AGINCOURT B	BBR S	B6	-24,818056	31,247222
MERRY PEBBLE STREAM C	BBR S	B6	-24,795556	31,256667
AGINCOURT A	BBR S	B6	-24,820278	31,221389
MERRY PEBBLE STREAM A	BBR S	B6	-24,762778	31,243333
DUMFRIES B	BBR S	B6	-24,768464	31,319208
MERRY PEBBLE STREAM B	BBR S	B7	-24,776389	31,212778
ROLLE B	BBR S	B7	-24,738889	31,230556
NEWFOREST	BBR S	B7	-24,737500	31,160000
NEWFOREST DAIRY	BBR S	B7	-24,724444	31,159722

Name of inspection point	State Vet Area	Ward	Geographical location	
			Latitude	Longitude
ROLLE A	BBR S	B7	-24,743333	31,210000
ARTHURSTONE	BBR S	B7	-24,789722	31,137500
IREAGH A	BBR S	B8	-24,838889	31,312500
IREAGH B	BBR S	B8	-24,841389	31,342778
NEWINGTON B	BBR S	B8	-24,823333	31,280556
CUNNINGMOOR B	BBR S	B8	-24,895556	31,290278
CROQUETLAWN	BBR S	B8	-24,854444	31,275833
LILLYDALE	BBR S	B9	-24,858056	31,373333
BELFAST	BBR S	B9	-24,952222	31,378056
HUNTINGDON	BBR S	B9	-24,929167	31,408056
JUSTICIA	BBR S	B9	-24,885833	31,404722
SOMERSET	BBR S	B9	-24,905833	31,368611
MADRAS A	BBR S	B10	-24,987778	31,146667
CALCUTTA A	BBR S	B10	-24,985000	31,210000
CALCUTTA E	BBR S	B10	-24,970278	31,281111
OAKLEY B	BBR S	B10	-24,921667	31,242500
MADRAS B	BBR S	B10	-25,018611	31,168333
MARITE	BBR S	B11	-24,962222	31,108056
WATERVAL	BBR S	B11	-24,913500	31,118200
OAKLEY A	BBR S	B11	-24,951944	31,215556
JIM BROWN	BBR S	B11	-24,977222	31,094722
SAND FORT	BBR S	B11	-24,981944	31,122222
MARONGWANE	BBR S	B11	-24,928333	31,159167
ALEXANDRIA	BBR S	B11	-24,955278	31,155278
MAVILJAN A	BBR S	B12	-24,853611	31,080556
XANTHIA	BBR S	B12	-24,828889	31,145833
MAVILJAN B	BBR S	B12	-24,833333	31,024444
DWARSLOOP A	BBR S	B12	-24,791667	31,114444
MAVILJAN C	BBR S	B12	-24,814722	31,106667
INYAKA	BBR S	B12	-24,554200	31,093300
CUNNINGMOOR A	BBR S	B13	-24,886111	31,207778
CALCUTTA C	BBR S	B13	-24,962500	31,242222
CORK	BBR S	B13	-24,955000	31,304444
RONALDSEY	BBR S	B13	-24,926111	31,305556
KILDARE	BBR S	B13	-24,888056	31,318333

Appendix C: FMD inspection summary

7A (part ... of ...)	WARD		MONTH	CATTLE FMD INSPECTION and MOUTHING (FMD CONTROLLED AREA)																											
				WEEK 1 .....to..... "			WEEK 2 .....to..... "			WEEK 3 .....to..... "			WEEK 4 .....to..... "			WEEK 5 .....to..... "			MONTH TOTAL			INCREASES/DECREASES									
																						INCREASES			DECREASES						
FARM / DIPTANK NAME	FARM REG NO.	FMD ZONE	OWNER NAME / STOCK CARD NUMBER	DATE	INSPECTED	MOUTHED	DATE	INSPECTED	MOUTHED	DATE	INSPECTED	MOUTHED	DATE	INSPECTED	MOUTHED	DATE	INSPECTED	MOUTHED	INSPECTED	MOUTHED	Total Cattle (beginning of month)	Calf born	Permit In	From	To	Permit Out	Died	Slaughtered	Total Cattle (end of month)	Total cattle owners		
SIGNATURE OF REPORTING OFFICIAL			MONTH TOTAL																												
			QUARTER: previous total																											FMD = FOOT AND MOUTH DISEASE	
			QUARTER: total to date																												
			YEAR: previous total																												
			YEAR: total to date																												
			YEAR: TARGET																												

Appendix D: Red cross movement permit



Permit in	Permit out

DEPARTMENT OF AGRICULTURE, CONSERVATION AND ENVIRONMENT

MPUMALANGA

Permit number

DEPT. LANDBOU, BEWARING EN OMGEWING

LITIKO LETEKULIMA, KONGIWA NETEMVELO

VETERINARY PERMIT TO MOVE ANIMALS / ANIMAL PRODUCTS
VEEARTSENYPERMIT VIR VERVOER VAN DIERE / DIEREPRODUKTE
IMVUMO YEKUHAMBISA TILWANE / TINTFO LETIHABULISAKO TETILWANE

In terms of the Animal Diseases Act No. 35 of 1984 permission is hereby granted to:
Kragtens die Wet op Dieresiektes Nr. 35 van 1984 word toestemming hiermee verleen aan:
Ngeligunya leMtsetfo weTifo teTilwane No. 35 wa 1984:

Name: Naam: Libito: | ID No.:

Address: Adres: Likheli:

to move with: om te beweeg met: uvunyelwa yekuhambisa: | AMOUNT IN WORDS | SPECIES | LIVE / PRODUCT

identified as follows: geïdentifiseer as volg: letikhonjiswe nga:

from the farm/diptank area/place: vanaf die plaas/dipbakgebied/plek: kusuka epulazini/edibhini/endzaweni: | STOCK CARD NUMBER | in the district of in die distrik esigodzini sase

to the farm/diptank area/abattoir/place: na die plaas/dipbakgebied/abattoir/plek: kuya epulazini/edibhini/emadzeleni/endzaweni: | in the district of in die distrik esigodzini sase

On the following conditions:
1. This permit
(a) is **valid** for **10 days** from date of issue and for **one consignment only**
(b) must **accompany the animals** / products mentioned above;
(c) must be produced for **inspection** on demand by any land or animal owner or police or veterinary official;
(d) must be **kept** at a destination until collected by a veterinary official.

2. For **game** / game products a nature conservation permit is also needed.
3. Animals and products must be visibly free from **external parasites.**
4. Animals are to be transported in accordance with **animal welfare** guidelines.
5. **Other conditions:**

Op die volgende voorwaardes:
1. Hierdie permit:
(a) is **geldig vir 10 dae** vanaf datum van uitreiking en slegs vir **een beweging;**
(b) moet die diere / produkte hierbo vermeld **vergesel;**
(c) moet vir **inspeksie** getoon word op aanvraag van enige grond-of dieresiesaar of polisie- of veeartsenybeampte;
(d) moet by bestemming gehou word totdat dit deur 'n veeartsenybeampte geneem word.
2. Vir **wild** / wildprodukte word 'n natuur-bewaringspermit ook benodig.
3. Diere en produkte moet sigbaar vry van **uitwendige parasiete** wees.
4. Diere moet volgens **dierewelsynsriglyne** vervoer word.

5. **Ander voorwaardes:**

Ngaphansi kwemibandzela lechaziswe ngaphansi:
1. Lemvumo:
(a) **isebenta emalanga-langa 10** kusuka lusuku lwekukhishwa kwayo futsi **yekuhambisa kanye** kuphela;
(b) **itawuhamba netilwane** / netintfo letihabulisako letibhaliwe ngenhla;
(c) **kwekuhombisiwa kuhdolwa** ngumuphi umnikati wendzawo kumbe umnikati wetilwane kumbe ngulophoyisa kumbe kusikhulu setekwelashwa kwetilwane, loyicelelako;
(d) **itawubhekwa** endzaweni yekufika khona tilwane / tintfo letihabulisako futsi itsatfwe ngesikhulu setekwelashwa kwetilwane.
2. **Kuhambisa kwetilwane tesiganga** / kwetintfo letihabulisako futsi kudzingwa imvumo ye lekoqwa kweTemvelo.
3. Tilwane letintfo letihabulisako tetilwane tifanele kutsi tibe **tidlangandvodza** letingabonakala.
4. Tilwane tifanele tihanjiswe ngaphansi kwemiso **tekutiphilisa kahle.**
5. **Imibandzela leminye:**

6. Retention for / Quarantine for / Direct slaughter within: days after arrival at destination

Seal no/s			Place / Plek / Indzawo:	
Vehicle reg. no/s			Date / Datum / Lusuku:	

I hereby certify that all applicable control measures for issuing of this permit have been complied with.

PRINT NAME ..... Issuing Veterinary Official:

SIGNATURE ..... State Veterinarian / Staatsveearts / Dokotela weTilwane

IMPORTANT NOTE / BELANGRIKE NOTA / SATISO LESIBALULEKILE
Permit holder who does not comply with this permit or any condition thereof is guilty of an offence.
Permithouer wat in stryd met hierdie permit of enige voorwaarde daarvan optree, is skuldig aan 'n misdryf.
Lonalemvumo longalandzela lemvumo kumbe muphi umbandzela wayo uphula umtsetfo.

241
DATE STAMP

DISTRIBUTION: VETERINARY OFFICIAL AT DESTINATION

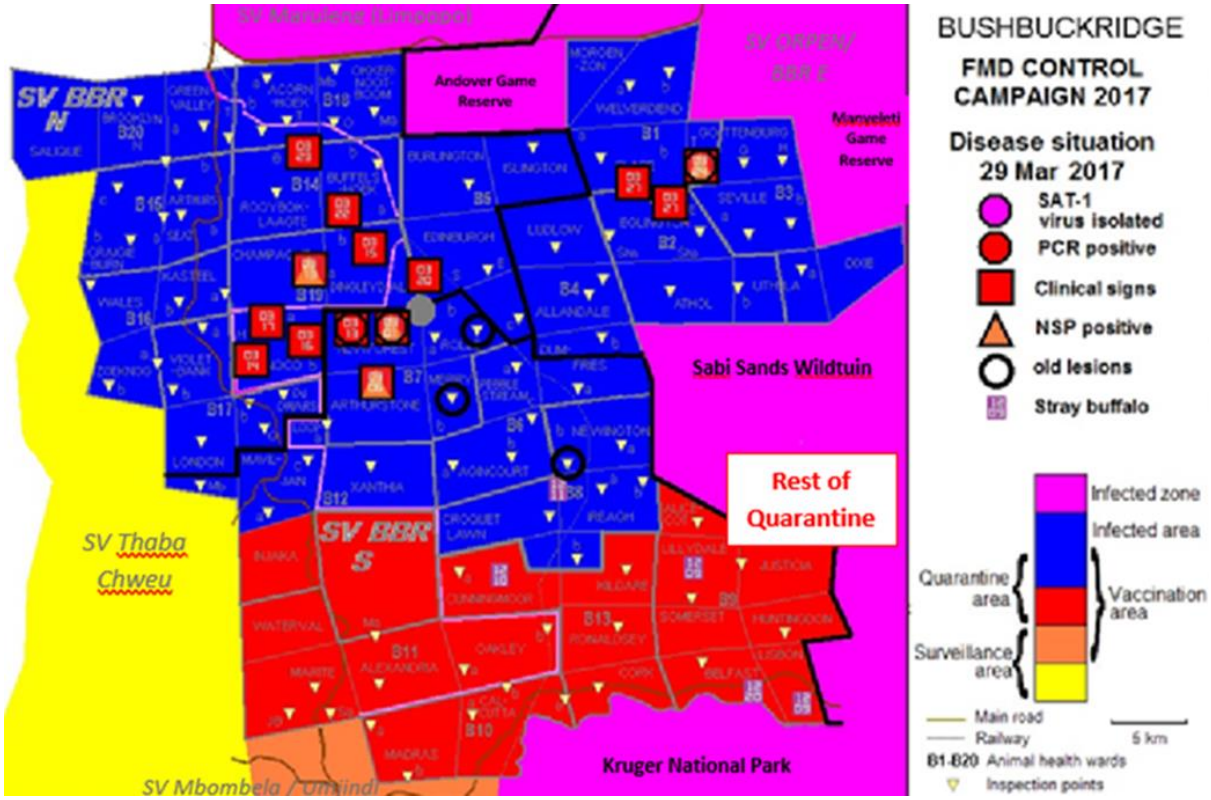
Appendix E: Movement permit monthly register

agriculture, rural development, land & environmental affairs
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

Permit register

DATE OF PERMIT	PERMIT NUMBER	PERMIT TYPE	OFFICIAL	OWNER	SPECIES	LIVE / PRODUCT TYPE	NUMBER	FROM FARM / DIPTANK	FROM DISTRICT	FROM SV AREA	FROM ZONE	TO FARM / DIPTANK	TO DISTRICT	TO SV AREA	TO ZONE	Comment

Appendix F: Map of the Bushbuckridge study area indicating the geographical extent of the 2017 foot and mouth disease outbreak as of 29 March 2017 and the demarcation of the quarantine areas (DARDLEA 2017a).



Appendix G: Bushbuckridge cattle sale prices February 2017 to March 2019

	February 2017		August 2017			May 2018			March 2019	
Top C – feedlot average	National average	Gaza Beef	National average	Gaza Beef	MMAP	National average	Gaza Beef	MMAP	National average	Gaza Beef
Cow R/kg (% of national avg.)	16.12	12.50 (78%)	20.07	12.50 (62%)	17.50 (87%)	18.88	16.50 (87%)	20.00 (106%)	17.18	15.00 (87%)
Bull R/kg (% of national avg.)	16.12	12.00 (74%)	20.07	12.00 (60%)	17.50 (87%)	18.88	15.50 (82%)	20.00 (106%)	17.18	15.00 (87%)

(Conservation South Africa 2019)

Appendix H: Animal Ethics Protocol Approval

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Veterinary Science
Animal Ethics Committee

Ref: V096-17

27 September 2017

Dr J van Rooyen
Department of Veterinary Tropical Diseases
Faculty of Veterinary Science
(jacques.vanrooyen@up.ac.za)

Dear Dr van Rooyen

Project V096-17 : The quantification of the cattle trade in the Bushbuck-ridge (BBR) Local Municipality, Mpumalanga, and its implication for disease control as well as local economic development policies (O Pretorius)

The following protocol was evaluated at the September 2017 meeting of the Animal Ethics Committee of the University of Pretoria.

The application does not need animal ethics approval as no animals or animal samples are involved

If you have any question, please feel free to contact the committee.

Yours sincerely

Prof V Naidoo
CHAIRMAN: UP-Animal Ethics Committee

Room 6-13, Arnold Theiler Building, Onderstepoort
Private Bag X04, Onderstepoort 0110, South Africa
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Fakulteit Veeartsenykunde
Lefapha la Disaense tša Bongakadiruiwa

Appendix I: Additional research outputs

Abstract of presentation to be delivered at the 2019 Mpumalanga Veterinary Services Scientific Days (28-29 November 2019, Nelspruit)

The quantification of cattle movement in the Bushbuckridge Local Municipality, Mpumalanga, and implications for trade and disease control

In the Bushbuckridge Local Municipality (BLM), Mpumalanga, the size and economic importance of the local, mostly informal, cattle trade has been considered negligible to date by local policy makers. Opportunities for the local cattle farmers to access formal live or product markets remain severely limited, mainly as a result of movement restrictions associated with foot-and-mouth disease (FMD) control. Data, in the form of movement permits and monthly cattle registers were used to analyse movement and trade activity in the area over a four-year period (May 2015 - April 2019). The population fluctuated around 77 166 head of cattle, distributed between 9739 emerging livestock farmers. The proportion of animals/products moved were consistently very low (0.04 ± 0.02). Movements were found to be highly seasonal ($p < 0.001$) with the 'cool dry' season (April-July) being the most active. Most movements were of live animals herded to their destinations. The vast majority of trade did not leave Bushbuckridge and was informal in nature. Farmers moved animals/products much further to access formal markets ($p < 0.001$), and generally required use of motorised transport to do so.

The FMD outbreak of 2017 did not prove detrimental to the local cattle industry in the medium term. However, distinct changes to the overall Bushbuckridge herd dynamics were noted, with small scale farmers most severely affected. As a direct result of the heightened movement restrictions in this period, an estimated 96% of formal trade; 85% of informal trade, and 54% of local trade were lost. In 2018, an improvement in cattle prices stimulated farmers to access the formal marketplace, and an increase in the proportion of the cattle population moved was observed.

It was concluded that farmers pursue formal marketing options only when financially incentivised or pressurised by adverse conditions such as environmental factors or disease outbreaks. Growing established local markets is likely the best way to assist the local population with market access, development and poverty reduction. The key constraints to marketability of animals/products originating in the BLM were identified as the absence of a competitive market system and associated infrastructure such as FMD designated abattoirs, disease control regulations, poor carcass quality, and seasonality of offtakes. These limitations will need to be considered when policy decisions are made. Context-specific solutions should be generated to address local needs and effectively support development of a sustainable cattle trade going forward.