

Malignant Catarrhal Fever



Informational Document

Saskatchewan
Sheep Development Board

SBA SASKATCHEWAN BISON ASSOCIATION

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UNIVERSITY OF SASKATCHEWAN
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Section A: Introduction

Malignant Catarrhal Fever (MCF) is caused by the ovine (sheep) herpes virus-2 (OvHV-2). This virus is carried by most sheep. The virus shows no clinical signs in sheep but can cause death in bison. Although there have been relatively few reported bison deaths in Saskatchewan due to MCF, expected growth in both sectors require that bison and sheep producers understand the disease and implement strategies to minimize the risk to bison from sheep carrying the virus.

There is no vaccine for the virus. The only effective strategy to mitigate the risk is to avoid direct contact between bison herds and sheep flocks. With only one observational study investigating the relationship between proximity to sheep farms and risk of contracting MCF, it is not possible to specify exactly what minimum distance must be kept between bison and sheep farms. Required distances vary depending on factors like temperature, relative humidity, wind direction and wind speed. The risk is also dependent on the concentration of animals, their age and their stress levels. It is clear that there is no "one-size-fits- all" strategy to manage the risk created by MCF.

With an understanding of the disease, bison and sheep producers can develop strategies that will go a long way to prevent bison losses due to MCF. This requires cooperation among bison and sheep producers and their industry associations to make the strategies most effective.

To address concerns voiced by industry about the potential risks of MCF, the Saskatchewan Minister of Agriculture created a task force to study MCF and develop recommendations for government and industry to effectively manage MCF (Section F). One of the recommendations was to complete a bison mortality study to compare the difference in occurrence in MCF in bison herds close to sheep operations and those farther away from sheep operations. The initial results from this study are presented in Section G. With the information assembled by the Malignant Catarrhal Fever Task Force and the results of the bison research, strategies to mitigate the risk of MCF are included in this document.

This document is intended to provide present and potential producers of sheep and bison, as well as governments and policy makers, with information and several strategies that will allow them to manage the risks created by MCF in order for both industries to prosper.

Section B: MCF Risk Mitigation for Sheep and Bison Producers

The risk of transmission of Malignant Catarrhal Fever (MCF) from a sheep farm to a bison farm is small; however, the potential impact on individual producers can be significant. Once clinical signs of the disease are present the affected bison almost always die. On the other hand, there is good evidence that not all bison exposed to MCF virus become sick. Bison can be exposed to MCF virus and not be affected. The outcome from exposure to MCF virus depends on factors such as the overall health and nutritional status of the bison herd, individual susceptibility to MCF virus and the current level of management stress in the herd.

Risk of virus spread is not constant or uniform

It is well understood that sheep flocks pose an MCF disease risk to bison herds, but the risk is not uniform across time. This means that there are periods during the production cycle of both species where they could conceivably occupy the same pasture without disease transmission. Sheep do not always shed virus and bison are more susceptible to disease at various times of the year. Studies have shown that lambs acquire the virus from the ewe and share it amongst themselves very soon after birth. However; the period where there is most virus being circulated in the flock occurs at weaning. The recently infected lambs are highly stressed at this time in the sheep production cycle. This favours the multiplication of the virus and greatly increases the likelihood of finding virus in saliva and respiratory droplets of the lambs. Therefore the lambs are more of a threat than adult sheep and the threat is most evident at weaning and other stressful times in the flock. An unstressed, adult sheep poses the least threat to bison.

Animal susceptibility to MCF is not constant or uniform

Bison by their nature may be more susceptible to stress which has the potential to compromise their immune system. Stress can come in the form of nutritional, environmental, social and physiological stress. It is easy to understand that an undernourished bison exposed to extremes of heat or cold might be susceptible to disease. We know from experience that mixing age groups or social groups, especially under crowded conditions can reduce immunity to disease in bison. Physiological states like pregnancy can affect the immunity of animals, bison included. Conversely it makes sense that an unstressed bison is relatively resistant to disease in general and this includes MCF. Un-crowded bison kept on good quality pasture with an adequate mineral supplement, in the absence of weather extremes and that have not been processed or handled recently are very disease resistant.

Section B: MCF Risk Mitigation continued...

There is reason to believe that some bison are resistant to MCF and have been exposed to the virus without ever developing the disease. Serological surveys of bison looking for antibodies in blood serum against MCF virus in the US have shown that as much as 18% of the farmed bison sampled have been exposed to the virus but have not become diseased. Apparently they were able to overcome their infection without becoming sick. Once clinical signs of MCF are observed mortality is inevitable but apparently not every bison that is exposed to the virus becomes sick.

In New Zealand Red deer, which are also very susceptible to MCF, cohabit farm environments with sheep throughout the country. Research in that species shows that individual animals within a herd are genetically more (or less) susceptible than their herd mates. NZ Red deer serosurveys also show that a significant proportion of farmed deer carry antibodies against MCF virus as yearlings, indicating that they were exposed but were not infected or did not remain infected. It is very possible that an examination of the appropriate gene(s) of bison would show a similar genetically based resistance to MCF virus.

Risks posed by the environment

It is true that MCF virus can apparently be carried by wind currents (but it is unknown how this works), in water, or on contaminated objects such as livestock shipping vehicles. It is likely that bison farms located where prevailing winds create a downwind situation, or are situated downstream from a shared water source with sheep have a higher risk of air or waterborne virus transmission. It is also likely that bison placed in a transport vehicle or a sale barn that has very recently held sheep are at risk from sheep associated MCF virus. However the magnitude of the risk is not constant or uniform.

The most often asked question about MCF is about how far apart sheep and bison must be kept in order to prevent the transmission of MCF. A widely cited published study of transmission capabilities demonstrated that bison housed 3 miles from a 20,000 lamb feedlot suffered losses from MCF (where actual "losses" were one MCF death out of 234 animals). This is obviously a far different magnitude of risk than that experienced when a neighbour decides to raise 50 or 100 lambs. Virus shed from relatively small flocks of sheep under most circumstances is very unlikely to travel 3 miles. There have been no experimental studies to determine the minimum distance that must be kept between bison and sheep farms but no doubt this distance would vary depending on factors like temperature, relative humidity, wind direction and wind speed. A recent observational study found that

there was a small but statistically significant risk of MCF (2 deaths per 1000 animals, over an 18 month period) in bison herds within 1.0 kilometers of sheep operations; therefore, it may be reasonable to assume that distances less than 1.0 km could pose a transmission risk under favourable environmental conditions.

The other frequently asked question is about the persistence of the virus on stock trailers and other shared equipment or facilities. No studies have been done to determine how long MCF virus might persist in contaminated environments like transport vehicles; however, the MCF virus needs an animal host to survive and does not live freely outside the host cell. Even in favourable moisture and temperature conditions the virus is unlikely to survive more than 24 – 48 hours. Therefore an arbitrary minimum period between shared occupancy of pens and trailers could be set at 48 hours so long as they are clean and dry.

Section C: Minimizing Risk of MCF in Bison Herds

Follow good stockmanship and best management practices for both sheep and bison at all times. The healthier and less stressed the animals are the smaller the risk of disease, including MCF. Bison and sheep should not be farmed in proximity to one another. Try to maintain the maximum distance possible between the herds and flocks closest to each other within the limitations of existing facilities and management systems.

Based on the observational study reported in Section G of this document, the Saskatchewan Bison Association and the Saskatchewan Sheep Development Board recommend that a minimum separation of 1 kilometer be maintained .

It must also be recognized that separation of species is more important during periods of increased risk such as during extreme weather or after processing and handling bison (or sheep).

Recognize that weaning lambs close to bison creates a risk to the bison. Consider indoor weaning or employ strategies that maximize the distance between the lambs and bison.

In situations where sheep and bison are being raised in relatively close proximity it is always a good management practice to communicate with your neighbor. Discussion needs to include co-existence strategies. Some of the suggested discussion topics would include:

- reducing animal stress
- grazing strategies
- fencing strategies
- weaning times
- increased production opportunities

Avoid using the same facilities or equipment, including water bowls; if required it is recommended that you allow a minimum of 48 hours between sheep and bison use. Always try to plan for bison to use first followed by sheep.

Transport vehicles should be thoroughly cleaned after sheep have been transported and before loading the vehicle with bison. Allow a minimum of 48 hours between loads of sheep and bison when shipping in the same transport vehicle.

Slaughter houses are dead-end facilities and hence there is no risk in using slaughter facilities for bison that also slaughter sheep.

Lamb feedlots probably constitute the greatest risk to bison as they typically contain large numbers of stressed, recently weaned, young animals that are actively developing OvHV-2 infections. This can result in a lot of virus production. Almost all major outbreaks of MCF in bison have involved contact with feedlot aged lambs. Special precautions will be necessary if bison are being raised in proximity to a lamb feedlot.

Section D: Common Questions and Answers

What is Malignant Catarrhal Fever (MCF)?

MCF is a fatal viral disease of bison. Other ruminant animals such as cattle, deer and moose are also susceptible to MCF. Bison are much more susceptible than cattle to the virus.

What causes MCF?

MCF is caused by the ovine (sheep) herpesvirus-2 (OvHV-2). OvHV-2 is often acquired by sheep when they are young. They remain carriers for life but only excrete the virus intermittently. Although many sheep are carriers of OvHV-2, the virus does not cause clinical disease in sheep.

How does the virus spread from sheep to bison?

The virus is shed in the nasal secretions of sheep with active infections. It can be spread to bison through direct contact with such sheep; however, the virus also becomes aerosolized (airborne) and can travel long distances in the air.

How far can the virus travel in the air?

This is unknown but varies with factors such as environmental conditions and number of sheep involved. Exceptional circumstances involving large numbers (thousands) of sheep has been reported to cause disease in bison pastured 5 kilometres from a sheep feedlot.

Are sheep the only carrier or cause of the spread of MCF?

Although it has been documented that outbreaks of MCF have a strong association with sheep it needs to be noted that there have been outbreaks of MCF were there have been no sheep in the immediate vicinity prior to the outbreak. There is no direct evidence that bison have become infected following contact with birds or insects but it can't be totally ruled out. Investigations are ongoing to identify other possible sources of the infection.

Is MCF passed from bison to bison?

No. Studies have shown that bison with MCF do not pass the virus on to other bison.

What are the Symptoms?

Bison may be found dead without symptoms, become ill and die in seven to 10

days, or develop a chronic form in which they are ill for months before they die. Symptoms in bison sometimes are very subtle and may be missed or misdiagnosed, as bovine virus diarrhea virus (BVDV), respiratory virus or a bacterial infection.

The following are some of the most common symptoms:

- Depression – head down, animal separates from herd, reduced or loss of appetite.
- Cloudy/ulcerated eye – slightly gray to totally white, may be in one or both eyes. In more extreme cases, the eye could bulge, or even rupture.
- Weeping eye – tearing from a slight bit to two to four inches of wet hair under the eye.
- Snotty nose – watery discharge to white (milky) mucus strands from one or both nostrils (more severe in cattle than in bison).
- Salivating – clear watery mucus dripping from the mouth.
- Erosions/ulcers – small sores or open lesions in the mouth which can extend into the throat and esophagus.
- Fever – up to 42.5 C, but the temperatures can vary over a wide range.
- Swollen joints – may be seen 10 to 12 days prior to onset of any other symptoms.
- Difficult urination – frequent, painful urination, or bloody urine.
- Other symptoms – coughing, aborted fetus, dehydration, diarrhea, tremors or circling.

Is there a treatment for MCF?

No, there is no effective treatment available for MCF in bison. Bison which become clinically ill, invariably die. However, research has shown that not all bison exposed to the virus become sick. Apparently some bison are more resistant than others to the MCF virus.

Does MCF occur in people?

No

Are there times during the year when MCF occurs more often?

MCF can occur any time throughout the year. It appears to be more prevalent during the winter months, which is when lambs come of age (between six to nine

months) and typically spread the virus to each other through active infections. This group of sheep may shed more virus than adult sheep. It is also possible that the virus survives better in the cold winter season. Bison are more susceptible to clinical disease during times of transportation, handling, birth and weaning or when stressed by environmental and nutritional factors present in the winter.

What risks are there at abattoirs/ slaughter facilities?

Slaughter houses are dead end facilities, there is no risk in using slaughter facilities for bison that also slaughter sheep.

Is MCF preventable?

In general, increasing the distance between sheep and bison reduces the risk. Information has changed over the years as to the distance that should be kept between bison and sheep. Currently, there is still no definitive science on what is considered a safe distance. This is because the risk of MCF varies depending on many factors besides distance, such as the age of the sheep; the size of the flock; climate; wind; and temperature. There are a number of reports of sheep and bison being kept in close proximity to each other with no ill effects.

What is the prevalence of OvHV-2 in the Canadian sheep flock?

The prevalence of OvHV-2 in the Canadian sheep population is unknown. Studies conducted in the USA suggest that OvHV-2 may be very prevalent in North America. Research specific to the Canadian situation is required.

Is there a vaccine for MCF?

There is no vaccine to prevent MCF in bison, nor is there a vaccine for the virus in sheep.

What do I do if I think an animal has MCF or has died of MCF?

If you suspect your animal has MCF, contact your local veterinarian. Tests can be done on live or dead animals to determine if they are infected with the virus. If the animal has been found dead without prior symptoms, it is important that other causes of sudden death, such as anthrax, are ruled out.

If MCF is found in your herd, your veterinarian can advise you on appropriate biosecurity measures you can take to minimize the potential for future incidents.

Section E: Contact Information

For more information contact:

- Dr. Wendy Wilkins, Disease Surveillance Veterinarian,
  Saskatchewan Ministry of Agriculture, Livestock Branch
  Phone: (306) 798-0253
  E-mail: wendy.wilkins@gov.sk.ca

- Saskatchewan Bison Association
  Phone: (306) 585-6304
  E-mail: sba001@sasktel.net

- Saskatchewan Sheep Development Board
  Phone: (306) 933-5200
  E-mail: sheepdb@sasktel.net

Informational videos can be viewed on either association website: Saskatchewan Sheep Development Board or Saskatchewan Bison Association.

Information and research regarding MCF is ongoing and results will be made available when they have been released.

Section F: Malignant Catarrhal Fever Task Force (2011)

The Saskatchewan Minister of Agriculture created this Task Force in 2011 in response to concerns voiced by industry members in Saskatchewan over the potential risk of MCF occurring in bison as a result of exposure to sheep. While MCF occurs infrequently in this province, both the bison and sheep industries are experiencing a period of growth. The expansion of these industries will undoubtedly put these two species in some degree of proximity more frequently in the future.

The members of the Task Force come from a variety of backgrounds and include members of industry, government and academia. While none are "MCF experts" per se, this Task Force includes experts in animal health and livestock disease in general and key representatives from industry organizations in Saskatchewan. Therefore, the Minister and the public can be confident that the recommendations from the MCF Task Force are based on science, fact, and the best interests of livestock industries and the Province of Saskatchewan.

Malignant Catarrhal Fever Task Force Members:

Ray Orb, chair – Vice-President, Saskatchewan Association of Rural Municipalities (SARM)
Donald Brooks, secretary – Secretary, Agricultural Operations Review Board, Saskatchewan Ministry of Agriculture
Chris Clark, VetMB, PhD – Associate Professor, Large Animal Medicine, Western College of Veterinary Medicine
Gordon Schroeder – Executive Director, Saskatchewan Sheep Development Board
Mark Silzer – Saskatchewan Bison Association
Brian Snell – Agricultural Producers Association of Saskatchewan (APAS)
Wendy Wilkins, DVM, PhD – Disease Surveillance Veterinarian, Livestock Branch, Saskatchewan Ministry of Agriculture

Mandate:

To study Malignant Catarrhal Fever and develop recommendations for government and industry to effectively manage the disease in Saskatchewan.

Executive Summary

The following executive summary is excerpted from the Saskatchewan MCF Task Force Report, 2011:

Malignant Catarrhal Fever (MCF) is a disease of livestock, primarily ruminants, caused by a herpes virus. In North America MCF is primarily caused by the ovine herpes virus-2 (OvHV-2), which is carried by sheep but does no harm to the sheep. In other susceptible species such as bison, however, the virus causes fatal disease for which there is no treatment and no vaccine.

Sheep are very susceptible to OvHV-2, and it is assumed that most sheep in North America are carriers. Once infected, sheep remain carriers of the virus for life. They shed the virus mainly through respiratory secretions. Adult sheep may shed the virus periodically, especially during times of stress; however, lambs aged 6-8 months of age shed large amounts of virus and are considered the main source of virus transmission. Bison are also very susceptible to the virus but are dead-end hosts; that is, although bison may develop MCF, they do not shed the virus and thus pose no risk to other animals.

Several large outbreaks of MCF in farmed bison have been reported in the literature, which demonstrate aerosol spread of virus from sheep to bison. Although these reports typically involved either close contact between the species or large numbers of animals in feedlot settings,

they are often touted as evidence for the need to create buffer zones to keep the species separated for MCF prevention. However, none of these reports contain information that justifies the need for kilometers-wide buffer zones between bison and sheep raised in non-intensive management systems.

Biosecurity in livestock production involves management practices designed to minimize disease transmission into, within, and out of groups of animals. For most modes of disease transmission, biosecurity practices can be put in place to minimize the risk of disease transmission. Aerosol transmission presents a unique challenge to livestock producers, since in most instances it is difficult, if not impossible, to control the airspace entering and exiting livestock premises. Many important livestock diseases, including MCF, can be spread over distances via aerosols. Producers of all livestock species need to be informed about relevant disease risks and become knowledgeable about management practices, which can minimize the risk of diseases such as MCF in their animals.

MCF is listed as a notifiable disease in the province of Alberta[1]; however, this is for monitoring and information purposes only, and does not involve disease control. There is currently no policy in place in Canada related to the control of MCF.

In the USA, MCF is designated as a reportable disease. This designation is not directly related to sheep-associated MCF. The wildebeest-associated form of MCF is considered a foreign animal disease (FAD) in that country; therefore, all cases of MCF are investigated to ensure they do not involve the wildebeest-associated virus. Also, the vesicular form of MCF closely resembles several other diseases such as Foot and Mouth Disease and Vesicular Stomatitis, which are also FADs. Once epidemiological investigations determine that MCF is caused by OvHV-2, no further action is taken. Following the Federal lead, many states have also designated MCF as reportable. From the available information, states also do not take further action once OvHV -2 is confirmed, though some states do take the opportunity to educate producers and provide recommendations for preventing further disease.

Fortunately, MCF is rarely confirmed in farmed bison in Saskatchewan. Typically, only one or two cases are diagnosed each year, if at all. Regrettably, concern over the *potential* for serious outbreaks, combined with a lack of understanding of this disease, can pit neighbor against neighbor, producer against producer. At issue is the transmission of virus over distances, which is poorly understood. Research into the risk of MCF in bison that are kept in varying degrees of proximity to sheep under normal production conditions is needed to address this knowledge gap[2].

Until such time as an effective vaccine is available, education and awareness will be key to MCF prevention. First and foremost, producers need to be aware of this disease; if they do not know the disease exists, they assuredly cannot take measures necessary for MCF prevention. It will take ongoing and collaborative efforts by the Province and by industry to ensure that bison and sheep producers in Saskatchewan remain cognizant of this disease and are provided with the knowledge and tools needed to minimize the risk of MCF in bison.

[1] As of February, 2015, MCF is also notifiable in Saskatchewan; as is the case in Alberta, this is for monitoring and information purposes only.

[2] A study underway in Saskatchewan is looking into this; preliminary results are presented in Section G of this document

Section G: Executive Summary- Bison Mortality Study 2013-2014

Investigators: Dr. Tasha Epp, Dr. Murray Woodbury, Dr. Cheryl Waldner; University of Saskatchewan

Purpose:

Malignant Catarrhal Fever (MCF) is a viral disease that is carried by sheep without harm to the sheep, but can be lethal when transmitted to bison. Over the last decade or so, several large outbreaks of MCF in bison have been attributed to exposure to sheep over large distances; one outbreak reported MCF in bison pastured up to 5 kilometers from a 20,000 lamb feedlot. The purpose of this project was to investigate causes of mortalities in bison which were exposed to commercial sheep operations at various distances under normal production settings. The study was specifically interested in comparing the difference in occurrence of MCF in bison herds close to sheep operations and those farther away from sheep operations.

Methodology:

This was the first study to follow farmed bison herds for a period of 18 months (December 2012 to May 31, 2014) and record the causes of death. There were 27 herds enrolled of which 26 herds completed the study (one herd dropped out after full herd dispersal in 2013). Herds were broadly categorized based on the distance of their boundary to the nearest sheep operation boundary for analysis; distances within 1.0 kilometer (km) were considered high exposure and distances at or greater than 1.0 km were classed as either low exposure (1 km to 5.6 km) or negligible exposure (greater than 5.6 km) based on distances.

Herds were requested to contact their local veterinarian each time a bison died on the farm during the study time period. The veterinarian performed a necropsy with all samples sent for analysis at Prairie Diagnostic Services (Saskatoon, Saskatchewan). For each death, the veterinarian and owner received a necropsy report which detailed the confirmed or suspected cause of death. All of the information was compiled and statistical analysis was done to answer the question of whether "distance from sheep is related to the development of MCF".

Findings:

Mortality rates and cause of death

Of the 26 herds to complete the study, 6 were within 1.0 km of sheep operation boundaries (high exposure group), 9 were within 1.0 to 5.6 km of sheep operation boundaries (low exposure group), and 11 were at distances greater than 5.6 km from sheep operation boundaries (negligible exposure group). Within the negligible exposure group, distances ranged from 8 km to 20 km away from sheep. Within the high exposure group, one bison herd had been co-mingled with sheep in the same pasture for 15 years with no identified occurrence of MCF

The average number of bison per herd ranged from 11 to 1300 (median: 168). Of the 4 herds with more than 500 bison, 3 were within 1.0 km of sheep operation boundaries. All herds were considered commercial bison operations where calves were produced and the majority were grazed or fed on pasture when available. The majority of sheep operations had less than 150

sheep; only one flock had more than 500 sheep.

Overall the mortality (death) rate based on the 76 necropsied deaths for all herds in the study was 1.1%; the top three causes of death were non-infectious causes (i.e. trauma, calving or malnutrition; proportion of necropsied deaths was 22%), copper deficiency (11%) and no confirmed diagnosis possible (18%). MCF deaths were recorded in 2 herds within 1.0 km of sheep operations within the study period; a total of 7 MCF deaths were recorded (2 in one herd; 5 in another; proportion of necropsied deaths was 9%). An additional 57 mortalities were reported by owners for which no necropsy was performed, for a total mortality rate of 1.9%. Of these, 38 (67%) were determined to be due to trauma, calving or nutritional issues by the owner themselves. Of the remaining 19 non-necropsied deaths for which there was no cause identified, 14 (74%) were from herds more than 5.6 km away from sheep operations while the remaining 5 mortalities were in herds more than 1.0 km from sheep operations; therefore, the chances of undiagnosed MCF in the non-necropsied deaths is unlikely.

Risk of MCF

Since MCF only occurred in the high exposure group, the low and negligible exposure groups were combined for analysis. Statistically, bison in herds less than 1.0 km from sheep operation boundaries were found to be at a higher risk of mortality from MCF than those at greater distances from sheep operation boundaries. However, the overall risk of death due to MCF in the herds within 1.0 km of sheep operations was 0.2%, or 2 MCF deaths per 1000 bison; the risk in herds at or greater than 1.0 km was 0% in this study.

Conclusion & Recommendations:

The primary aim of this study was to describe the risk of mortality from MCF in herds at varying distances from sheep operation boundaries. Of the 26 herds in the study, only 2 herds experienced any MCF deaths over the 18 month study time period. Despite the low overall risk of MCF occurrence, bison in herds less than 1.0 km of sheep operation boundaries were found to be at a higher risk of mortality from MCF than those at greater distances to sheep operation boundaries. While this study suggests caution for bison farms within 1.0 kilometre of sheep operation boundaries, 4 of the 6 herds within the high exposure group did not have any deaths due to MCF during the 18 month study period.

The commonly reported distance of 5 km separation between bison and sheep operations originates from the outbreak of MCF in a bison herd that was at varying distances from a 60,000 head sheep feedlot, which was occupied by 20,000 newly introduced lambs (Li et al 2008). In this paper, the reported mortality rates were 17.5%, 6.1%, and 0.43% at approximately 1.6, 4.2, and 5.1 km, respectively. All other outbreaks reported in the literature involved at least one or more of the following: bison within a feedlot or sale barn setting, large sheep operations (1,000 or more) or feedlots, and extremely close proximity to sheep (Berezowski et al 2005, Li et al 2008, Li et al 2006, O'Toole et al 2002, Schultheiss et al 2000).

In this study, the proportion of bison that died from MCF was 0.2% within 1.0 km of substantially smaller commercial sheep operations than in other outbreaks and only 2 out of 6 herds

that were within 1.0 km of sheep operation boundaries had any MCF deaths. There was no occurrence of MCF in herds with sheep operations further than 1 km away, suggesting that a 5 km separation distance is not required to decrease the risk of MCF in typical commercial bison herds in close proximity to commercial sheep operations. Given that the majority of herds in the high risk group, including the one that comingled sheep and bison, did not have any mortality due to MCF, this study further suggests that other, unmeasured factors may influence the development of MCF in bison, and cautions against relying solely on separation distances for the prevention of MCF. Bison producers should work closely with the neighbouring sheep operation to minimize the potential risks associated with MCF transmission.

Comparably, non-infectious causes of death in this study which included calving losses, trauma and nutritional issues as well as copper deficiencies were overall the most significant cause of bison death. Non-infectious causes occurred at least once in 17 of the 20 herds with deaths reported or necropsied. In 30 of 61 mortalities where mineral panels were done, copper was found to be marginally or seriously deficient; this deficiency may have been a primary cause of death in some cases, and likely a contributing factor to other causes of death. Bison are susceptible to the primary or secondary copper deficiencies; primary copper deficiencies have been reported to occur in varying soil types within Saskatchewan while secondary copper deficiency can result from water high in sulfates. This study did not define whether the copper deficiencies were primary or secondary. Overall, non-infectious issues remain an important cause of mortality on Saskatchewan bison farms.

In the end, the results of this study suggest that while MCF can be a devastating disease for individual bison producers, the overall incidence within commercial settings is very low. It also supports caution against proposing buffer zones based solely on the criteria of distance to sheep. Conditions from which bison died are likely to change on a year to year basis; particularly for environmentally-related diseases. There is opportunity to continue the bison mortality study and work is underway to formulate the study protocol and objectives. Hopefully, the information provided by this study can provide perspective and be used as a starting point for further discussion and collaboration between the bison and sheep industries as well as with researchers in academia.