SRunning head: BRUCELLOSIS IN THE GREATER YELLOWSTONE ECOSYSTEM

Brucellosis in the Greater Yellowstone Ecosystem and New Management Strategies Focused on Elk

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**Introduction**

 From the time European cattle introduced brucellosis to the United States in 1917, it has presented many different management issues causing much discussion amongst multiple government organizations (Scurlock & Edwards, 2010). Since the 1930’s, the US has made a great effort to eradicate brucellosis, and all 50 states were finally declared brucellosis free in 2008. However, later that year, an infected herd of cattle was found in Montana causing the state to lose its Class Free status (Cross et al., 2010). Following this discovery, 27 herds in Wyoming, Idaho, and Montana have been infected, marking the re-emergence of brucellosis in the US. All other states remained Class Free, indicating the Greater Yellowstone Ecosystem is the last brucellosis reservoir in the US (National Academies of Sciences, Engineering, and Medicine, 2017).

For many years, brucellosis eradication has been focused on the Yellowstone bison population; however, recent research suggests efforts should be shifted to focus on elk (National Academies of Sciences, Engineering, and Medicine, 2017). This transition to elk based management is very controversial as it brings the 23 elk feedgrounds into question. These 23 feedgrounds feed about 19,000 elk each season, so they are the first place researchers have looked to start ridding of the disease (Colligan, 2017). The feedgrounds are intended to prevent the transmission of brucellosis from elk to cattle and increase elk population sizes to satisfy hunters and outfitters. However, the high concentration of elk has made them a hot bed for brucellosis (National Academies of Sciences, Engineering, and Medicine, 2017). Because much of the elk population is artificially fed through feedgrounds that are funded by state and federal government, brucellosis has become a political disease that is highly debated among stakeholders. These stakeholders include but are not limited to: state and federal wildlife officials, hunters, ranchers, outfitters, conservationists, and landowners (Colligan, 2017). As the focus has shifted from bison to elk, there are many different management options available to be pursued to treat the elk population. This document will present findings from recent research and discuss four of the most viable management options. These options have been chosen by looking at statistical data of their effectiveness in multiple case studies in order to propose a solution to end brucellosis in the elk population. The four management options presented are population reduction, feedground intervention, incremental closure of feedgrounds, and vaccination.

**Brucellosis: The Main Issue**

 The presence of brucellosis in the elk population and the transmission of brucellosis from elk to cattle is an increasingly important issue as stakeholders are losing millions of dollars a year due to the disease. In the most recent report published by the National Academies of Science, Engineering, and Medicine, (2017) findings refute past positions that management efforts should be focused on bison. They encouraged managers to focus their efforts on elk as they have recently caused multiple brucellosis outbreaks. (Bozeman Daily Chronicle, 2017).

**What is Brucellosis?**

 Brucellosis is a bacterial disease caused by Brucella Abortus that is very common among wildlife and livestock populations (Cross, Edwards, Scurlock, Maichak, & Rogerson, 2007). Brucella Abortus causes late-gestation abortions, decreased milk production, and loss of fertility in both wildlife and livestock (Outbreak News Today, 2017). The most common method of transmission is through contact with infected fetuses or placenta from abortion events (Cross et al., 2007). It can also be spread to calves through nursing if the mother is infected (Outbreak News Today, 2017).

**The Role of Feedgrounds in Transmission** Across the Greater Yellowstone Ecosystem, the Wyoming Fish and Game Department and the US Fish and Wildlife Service have established 23 elk feedgrounds. These feedgrounds have been under fire in recent brucellosis investigations because they concentrate elk into a small roaming area between November and April and typically infected elk will abort their fetuses between February and June. Therefore, there is a three-month time span where elk are at increased risk to come into contact with an abortion event. Research has shown that seroprevalence of brucellosis on the feedgrounds is approximately 26%, while it is only about 2-3% in other areas of the Greater Yellowstone Ecosystem. Thus, showing that there is a connection between the feedgrounds and the prevalence of brucellosis in the population (Cross et al., 2007). Due to the abundance of brucellosis on the feedgrounds, current research is being focused on how to control the disease on the grounds and the closing of feedgrounds has been proposed (National Academies of Sciences, Engineering, and Medicine, 2017).

**Brucellosis Policy**

 Efforts to eradicate brucellosis began in 1934 as a part of an economic recovery program during the Great Depression. In 1954, brucellosis was once again spreading rapidly through wildlife and livestock, so Congress appropriated funds to establish The State-Federal Brucellosis Eradication Program. The program focused its eradication efforts on active surveillance of domestic cattle and bison herds and wildlife. If a herd or group of wildlife were infected, they would be removed, sometimes causing huge financial losses, but slowly reducing the seroprevalence of brucellosis. These efforts were successful, as the country was declared Class Free in 2008, until an infected cattle herd was discovered in Montana (Animal and Plant Health Inspection Service, 2008).

 Along with the surveillance strategies, the State-Federal Brucellosis Eradication Program established a policy system to classify states based on the amount of brucellosis present in the state. The classifications are Class Free, Class A, Class B, and Class C, with Class C meaning that all animals in the state must be quarantined, trade is restricted, and all animals must be strictly monitored. In Class A or Class B states, areas that are heavily infected can be sectioned off and marked as a Designated Surveillance Area (DSA), while all other areas remain open for free trade (9 CFR 78.40-Designation of States/areas, 2010). This policy has fallen short in many ways; the most important of which is the spread of brucellosis outside of the DSA. Often times, the DSAs are not expanded in a time-efficient manner to capture the roaming patterns of wildlife, so populations outside of the DSA are infected (Outbreak News Today, 2017). Therefore, researchers are trying to create new policies to stop brucellosis at the source rather than simply containing it.

**Management Options**

 With the focus of brucellosis management shifting from bison to elk, there are multiple management options being researched to best control the disease. State and federal agencies will need to collaborate to form consistent policies and practices to meet their goal of eradicating brucellosis (Outbreak News Today, 2017). Four of the most prominent options to be looked into further are: population reduction, intervention on the feedgrounds, incremental closing of feedgrounds, and vaccination.

**Population Reduction**

 Population reduction presents an opportunity to stop the spread of brucellosis to cattle by decreasing the chance for contact between wildlife and livestock. In elk, brucellosis transmission is influenced by population density, so decreasing the population could decrease seroprevalence, thus decreasing transmission. One way to reduce population size could be to increase elk hunting by allowing states to sell more elk tags each year. Not only could this be manipulated to focus on heavily infected areas, but hunting can be very profitable for the states. In fact, one study done by Kauffman and colleagues (2012), showed that if there is a 50% reduction in the elk population, it would increase demand for elk hunting licenses, possibly increasing revenues by more than $500,000 per year.

Another possibility for population control could be the utilization of contraception. GonaCon™is an immunocontraceptive that has previously been successful in reducing brucellosis in bison. A field trial conducted with bison in Corwin Springs showed that GonaCon™ is significantly effective in reducing abortion and birthing of infected calves. It has been predicted that GonaCon™ would be similarly effective in the elk population, but this is only estimation. A final option that could be utilized to reduce the elk population is the test and removal process where brucellosis positive elk would be removed. In order to determine the effectiveness of this method, a 5-year field study was done at Muddy Creek feedground. The results of this study showed the test and removal technique could reduce the seroprevalence of brucellosis, as it showed a 37% reduction throughout the 5-year study. Although it proved to be successful, the test and removal method is very expensive and difficult to carry out on a large scale, so it would most likely be confined to the elk populations that utilize the feedgrounds (National Academies of Sciences, Engineering, and Medicine, 2017).

**Feedground Intervention**

 Molecular characterization of brucellosis in feedground elk suggests that the feedgrounds maintain the greatest diversity of Brucella Abortus lineages and are the source of infection for many elk populations. One important factor in feedground intervention would be balancing the timing and use of feedgrounds to encourage dispersal earlier in the season. This would allow for birthing to occur in less densely populated areas to reduce transmission. In addition, changes in the feeding patterns from lines of feed to checkerboard patterns could reduce transmission by lessening elk to elk contact. Finally, the removal of aborted fetuses on the feedgrounds could be beneficial because aborted placentae provide the highest risk of transmission due to the high concentration of bacteria. Upon removal, disinfectant can be used to clear the area of bacteria to prevent transmission. Though research has not been sufficient to fully support this method, models predict it would be highly effective. Although feedgrounds provide a great way to intervene in the elk population due to the high concentration of elk and small land area, treating only feedground elk would not be sufficient in completely eradicating the disease because it would still be present in free roaming elk. Additionally, the feedgrounds are very expensive to maintain for the long term and are highly contentious among stakeholders (National Academies of Sciences, Engineering, and Medicine, 2017).

**Incremental Closure of Feedgrounds**

 Although very unpopular among outfitters and ranchers, one management option is to slowly close the 23 elk feeding grounds surrounding Yellowstone (French, 2017). In the 2017 report published by the National Academies Press, the panel suggested that, “The weight of evidence nonetheless suggests that reduced use or incremental closure of feedgrounds could benefit elk health in the long-term, and could reduce the overall prevalence of brucellosis in elk on a broad population basis” (National Academies of Sciences, Engineering, and Medicine, 2017). Closure of feedgrounds could potentially prevent “seeding” of new reservoirs, highly concentrated infected areas that were not already there. While feedgrounds may increase short-term risk due to increased contact between elk and cattle, in the long term, it would reduce the seroprevalence in elk leading to a reduction in the disease.

 Brucellosis is not the only disease highly concentrated on the feedgrounds; Chronic Wasting Disease and Bovine Tuberculosis are also present on the feedgrounds in high numbers. In 2011, a court case was brought against the US Fish and Wildlife Service for failing to promote “healthy” wildlife due to the increased presence of disease on the feedgrounds. Additionally, a 2012 study showed that feedground elk had significantly higher numbers of stress related hormones, which suppress the immune system making the elk more susceptible to disease. This increased susceptibility to disease coupled with a high concentration of infection rates is predicted to have detrimental effects on the elk population in the next 20-40 years. Therefore, efforts to reduce or eliminate feedgrounds are crucial for long-term health of the elk population (National Academies of Sciences, Engineering, and Medicine, 2017).

**Vaccination**

 Vaccination is one of the most popular options among stakeholders, but it is a very difficult task to achieve, as previous vaccination efforts have been ineffective. In 1985, the Brucella Abortus strain 19 ballistic vaccination program was started in hopes to reduce the amount of reproductive failures and limit contact with infected tissues. In a study conducted by the Wildlife Society (2017), results showed the difference in seroprevalence between pre- (24.22% ) and post- (27.72%) vaccination was not significant enough to prove a correlation between the vaccination and a decrease in seroprevalence. As presented in the graphic below, the s19 Brucella abortus ballistic vaccination program was not successful in significantly reducing seroprevalence in the feedground populations (Maichak et al., 2017).

(Maichak et al., 2017)

 Due to a lack of understanding of the elk’s immune system, an effective vaccine has yet to be established. However, with new genome sequencing technology, there is hope to learn more about elk’s unique immune response to Brucella Abortus. With more research on the IFN-γ gene sequence, antibody responses have been detected and CD4T lymphocytes were seen in an immune response to Brucella Abortus. Therefore, research is being done to create a vaccine that would artificially increase the amount of CD4T lymphocytes to heighten resistance against the bacteria. If a proper vaccination is produced, this would be a viable option because administration of the vaccine can be done easily with a modified version of the biobullet or through oral vaccination on the feedgrounds. This method is advantageous because it is much safer for the wildlife and does not involve population reduction (National Academies of Sciences, Engineering, and Medicine, 2017).

**Conclusion and Recommendations**

 As brucellosis seroprevalence rates are rising, and recent research has supported the shift in brucellosis management from bison to elk, efforts must be made to eradicate the disease. With the Greater Yellowstone Ecosystem being the last known reservoir of brucellosis in the US, federal and state agencies must work together to take action against Brucella Abortus in the elk population. Due to its detrimental effects on livestock, federal and state wildlife managers are not the only stakeholders in the issue; cattle ranchers are also heavily involved in lobbying for and influencing brucellosis policy. Additionally, elk hunters and outfitters hold a big part in the issue because many of them depend on a healthy elk population to survive (National Academies of Sciences, Engineering, and Medicine, 2017).

 Of the management options presented, population reduction would be the most successful and least controversial as it is already practiced and would bring economic benefit. Many elk are already hunted each year and according to Druska Kinkie, a rancher in Montana, ranchers have been killing elk on their land for years to prevent the spread of brucellosis (French, 2017). Through hunting, the state could take the elk population into administrative hands by determining the amount of elk to be hunted each year through the issuing of hunting licenses. Additionally, hunters and outfitters would profit because they would be allowed to hunt more elk than in the past (National Academies of Sciences, Engineering, and Medicine, 2017).

 Contraception is another method that could be used to reduce the population and recent research has shown GonaCon™ is effective in reducing the amount of abortion events, which could reduce transmission rates. Also, contraceptive methods would please conservationists because it would reduce the number of elk killed in population reduction efforts. The test and removal process, which was used when all 50 states were declared Class Free in 2008, is another option that has shown to significantly reduce the seroprevalence of brucellosis (National Academies of Sciences, Engineering, and Medicine, 2017).

 In order to proceed with population reduction, there would need to be collaboration between federal and state agencies, especially in funding. States would need to increase research on population predictions in order to accurately set the number of hunting licenses sold to produce a lower population. Additionally, feedgrounds would need to be utilized to begin administering contraception to the elk visiting the area. Finally, surveillance efforts would need to be increased in the Greater Yellowstone Ecosystem in order to identify infected animals and remove them from the population. The combination of these three methods to reduce the population would greatly reduce population density, thus lessening transmission rates and seroprevalence of brucellosis.

Bibliography

 Animal and Plant Health Inspection Service. (2008). *United States Animal Health Report*.

Bozeman Daily Chronicle. (2017). Brucellosis control must focus on elk. Retrieved from <http://www.bozemandailychronicle.com/opinions/editorials/brucellosis-control-must-focus-on-elk/article_9c22ce72-094d-53a7-8b58-9e219611b4f5.html>

Colligan, C. (2017). *Beating Brucellosis*. Retrieved 11 June 2017, from <http://www.wyomingbrucellosis.com/_pdfs/beating_brucellosis3.pdf>

Cross, P., Cole, E., Dobson, A., Edwards, W., Hamlin, K., & Luikart, G. et al. (2010). Probable causes of increasing brucellosis in free-ranging elk of the Greater Yellowstone Ecosystem. *Ecological Applications*, *20*(1), 278-288. <http://dx.doi.org/10.1890/08-2062.1>

Cross, P., Edwards, W., Scurlock, B., Maichak, E., & Rogerson, J. (2007). EFFECTS OF MANAGEMENT AND CLIMATE ON ELK BRUCELLOSIS IN THE GREATER YELLOWSTONE ECOSYSTEM. *Ecological Applications*, *17*(4), 957-964. <http://dx.doi.org/10.1890/06-1603>

French, B. (2017). The most effective way to reduce brucellosis spread is to decrease elk populations, panel says. *Billings Gazette*. Retrieved from <http://billingsgazette.com/montana-untamed/the-most-effective-way-to-reduce-brucellosis-spread-is-to/article_1f70b000-6bec-5bcc-8d11-3e7f14563c50.html>

Maichak, E., Scurlock, B., Cross, P., Rogerson, J., Edwards, W., & Wise, B. et al. (2017). Assessment of a strain 19 brucellosis vaccination program in elk. *Wildlife Society Bulletin*, *41*(1), 70-79. http://dx.doi.org/10.1002/wsb.734

National Academies of Sciences, Engineering, and Medicine. (2017). *REVISITING BRUCELLOSIS IN THE GREATER YELLOWSTONE AREA* (1st ed.). WASHINGTON: NATIONAL ACADEMIES PRESS.

Outbreak News Today. (2017). *Yellowstone brucellosis: Control efforts should focus on elk*. Retrieved from http://outbreaknewstoday.com/yellowstone-brucellosis-control-efforts-focus-elk-58848/

Scurlock, B., & Edwards, W. (2010). STATUS OF BRUCELLOSIS IN FREE-RANGING ELK AND BISON IN WYOMING. *Journal Of Wildlife Diseases*, *46*(2), 442-449. <http://dx.doi.org/10.7589/0090-3558-46.2.442>

*9 CFR 78.40 - Designation of States/areas.*. (2010). *LII / Legal Information Institute*. Retrieved 11 June 2017, from https://www.law.cornell.edu/cfr/text/9/78.40