

Hoback Elk Herd Unit (E104)
Brucellosis Management Action Plan Update
Wyoming Game & Fish Department
April 2011

A. Introduction and herd unit overview

Per recommendations presented by the Wyoming Governor's Brucellosis Coordination Team (BCT), this update to the Hoback elk herd unit (HEHU) Brucellosis Management Action Plan (BMAP) was prepared to evaluate brucellosis management recommendations developed and implemented during this plan's original development in 2006. Meetings among Wyoming Game and Fish Department (WGFD) personnel, interested livestock producers, federal land managers, and state and federal livestock health and regulatory officials were held to discuss progress on the plan's recommendations, review the various brucellosis management action options, and develop new brucellosis management recommendations based upon updated information. The WGFD has made substantial progress in the HEHU to better understand characteristics of elk-to-elk brucellosis transmission, refine elk parturition delineations, and to reduce the risk of both intra- and inter-specific brucellosis transmission. This update should be considered complementary to the original Hoback BMAP (WGFD 2007).

The HEHU covers the upper Hoback River water shed. The area is bound on the south by the Hoback Rim, and the east boundary is the hydrographic divide between the Hoback and Green River drainages. The northern boundary is the hydrographic divide between the Gros Ventre and Hoback River drainages. The western boundary is comprised of Dell Creek, Cliff Creek, and the hydrographic divide between the Greys and Hoback River drainages (Fig. 1). The HEHU encompasses 296 mi² (189,405 acres), lying almost entirely in Sublette County (95.8%). The remainder is in Lincoln (3.6%) and Teton Counties (0.6%). Only 9.5% of the land in this EHU is in private ownership. Most of the land is managed by the United States Forest Service (USFS, 89.5%); the remaining 1% is managed by the Bureau of Land Management (BLM). The major land uses in the area are domestic livestock grazing and year-round recreation. Summer uses include fishing, camping, horseback riding and motorized all-terrain vehicle use. In autumn, hunting is the predominant use. During winter, both private and outfitted snowmachine use is common.

Approximately 272 mi² are considered spring, summer, and fall range for elk (Fig. 2). There are 19 mi² designated crucial winter yearlong range, and 5 mi² are considered winter yearlong range. Only about 6 mi² are considered elk parturition range. There are two feedgrounds in the Hoback EHU, and two elk Hunt Areas (HA, Fig. 2). Dell Creek feedground (HA 87) is located at the mouth of Riling draw, north of Dell Creek, east of the Hoback River on US Forest Service (USFS) land. McNeel feedground (HA 86) is located about three miles south of US Highway 191 on the east side of the Hoback River on private land, which the Wyoming Game and Fish Department (WGFD) leases. Both Dell Creek and McNeel feedgrounds are intended to prevent damage, co-mingling, and winter starvation of elk. McNeel feedground additionally serves to keep elk away from US Highway 191, and prevents an excessive number of elk from otherwise attending the Franz feedground (Big Piney EHU- E106).

Hoback Elk Herd Unit (E104) Hunt Areas

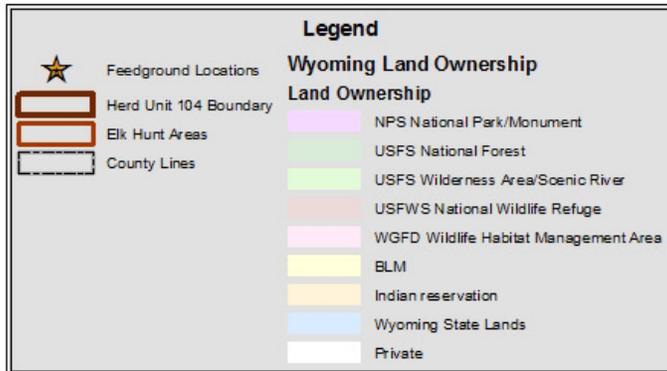
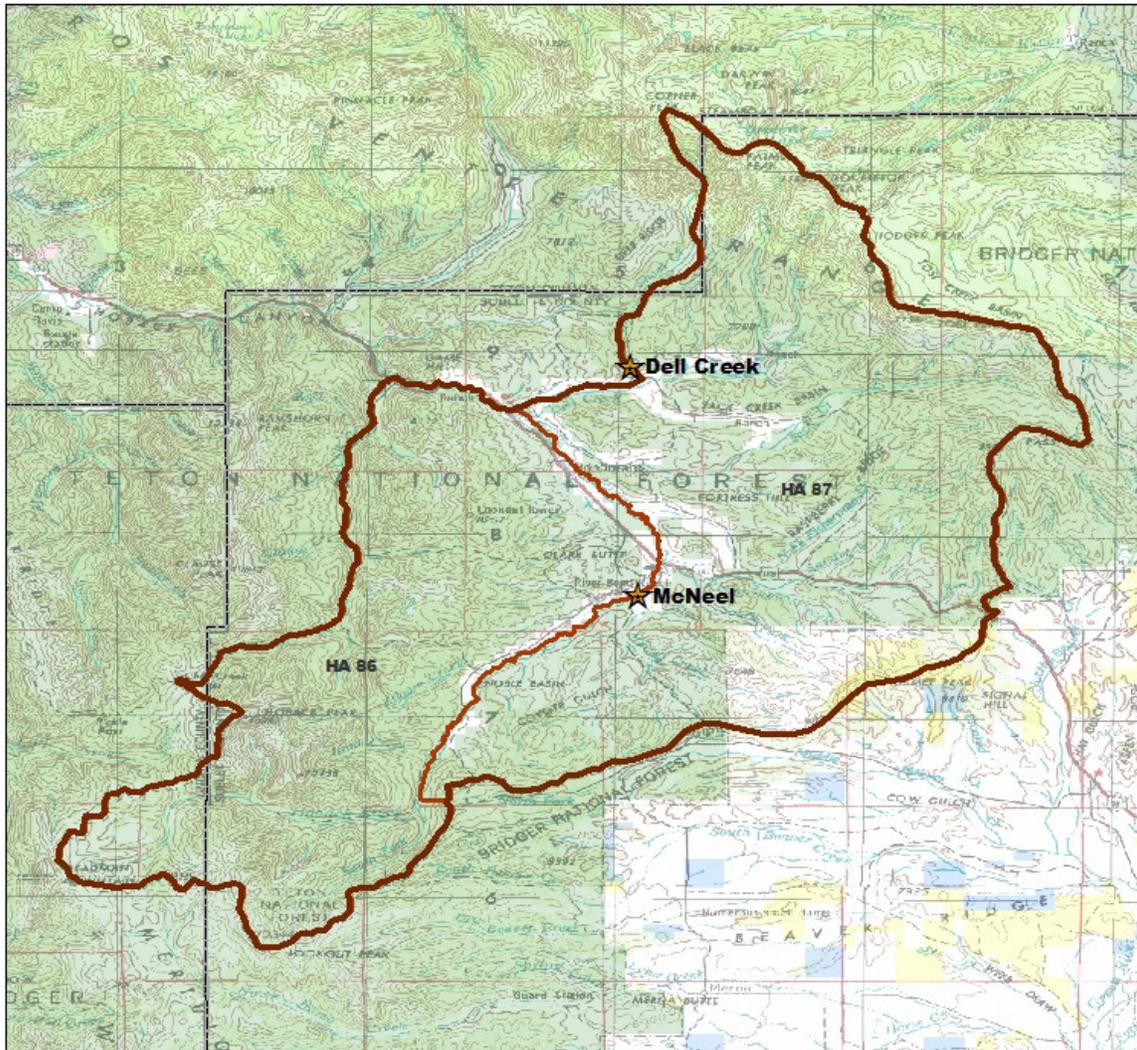


Figure 1. Land ownership, feedground locations, and Hunt Areas within the Hoback EHU.

Hoback Elk Herd Unit Seasonal Ranges

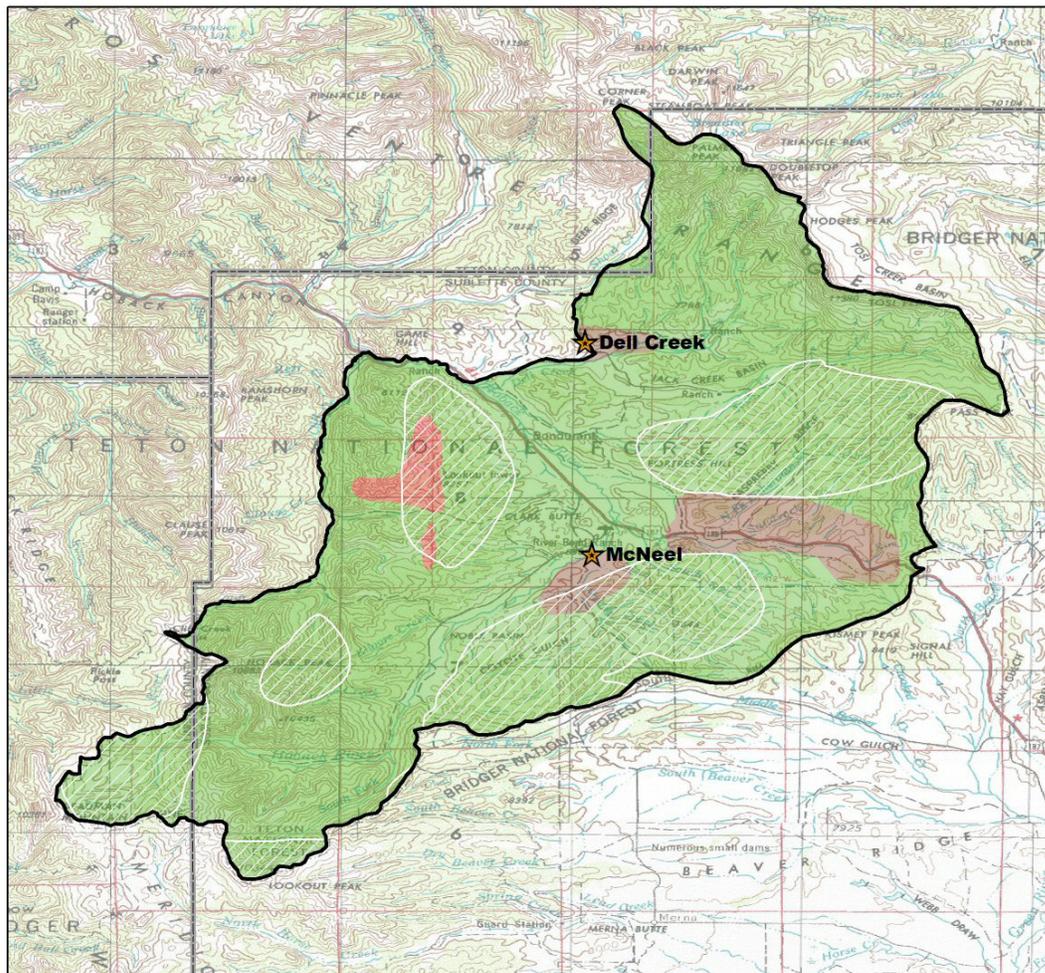


Figure 2. Seasonal elk ranges, elk feedgrounds, and Hunt Areas within the Hoback EHU.

B. Brucellosis Management Options

Listed below are nine potential options for managing brucellosis on the two feedgrounds in the HEHU. Short-term objectives of these options are to reduce prevalence of brucellosis in elk and prevent co-mingling of elk and cattle. Long term objectives include eliminating the reservoir of brucellosis in wildlife in the GYA if determined to be technically feasible, maintain livestock producer viability, reduce/eliminate dependence of elk on supplemental feed, maintain established elk herd unit objectives, improve range health, and maximize benefits to all wildlife. The Wyoming Game and Fish Commission (WGFC) will require support from various constituencies (agriculture, land management agencies, sportspersons, etc.) prior to pursuing these options, and several options will require decisions from entities other than the WGFC.

1. Relocating feedgrounds to lower elevation sites to maximize both geographic area for elk to disperse and distance from winter cattle operations.
2. Reduction/elimination of supplemental feeding.
3. Reducing numbers of elk on the feedgrounds through increased harvest.
4. Reducing numbers of susceptible cattle and stored crops in areas around feedgrounds during winter, or implementing changes in cattle operations by providing incentives to producers.
5. Elk-proof fencing of feedgrounds or private lands to prevent elk from drifting onto private land and reduce commingling.
6. Elimination of seropositive elk on feedgrounds through test and removal program.
7. Extensive habitat enhancement projects in suitable winter range areas near feedgrounds where the potential of commingling with livestock is minimal.
8. Acquisition of native winter range through fee-title purchase, conservation easements, or other methods.
9. Continuation of *Brucella* strain 19 elk vaccination.

C. Discussion of Options

1. Feedground Relocation

Feedground relocation options are limited in the HEHU. Changing feedground locations would likely disrupt established elk migration patterns, and habituating elk to new locations within the HEHU may require considerable effort. If more optimal locations for these feedgrounds existed (e.g., adjacent Herd Unit), relocation should be considered. Decision authority would lie with the WGFC.

Pros:

- may contribute to lower brucellosis prevalence
- elk would have increased area to disperse
- elk could be fed on larger areas and in more sanitary conditions
- elk numbers could be maintained at or near current levels

Cons:

- may increase damage and co-mingling situations
- brucellosis prevalence may persist

- would require funds for erection of new structures, fences, roads, etc.
- potential difficulty habituating elk to the new site
- localized damage to vegetation
- might increase competition of elk with other species

Land ownership of feedground sites in the Hoback EHU is USFS (Dell Creek) or private (Gil Ordway's River Bend Ranch- Bill and Tony Saunders, managers- under a 25-year lease). Nearby USFS lands do not provide sites with suitable space, slope, and other attributes that would make feedground relocation desirable. Relocating feedgrounds to other private lands would also be unlikely. Primary risk of comingling occurs during the winter and spring month, and many private landowners have cattle wintering on their private lands. Relocating feedgrounds to other private lands could put elk and cattle in closer proximity to each other, increasing risk of comingling. During the process of obtaining the McNeel feedground lease in 2006, WGFD found no suitable alternative locations within the HEHU for either McNeel or Dell Creek (WGFD 2007).

2. Reduction or Elimination of Supplemental Feeding

This Option (particularly Elimination) is probably unfeasible for feedgrounds in the HEHU given current conditions and herd objectives. Since 2000, typically 90+% of the elk in the HEHU have wintered on feedgrounds (WGFD 2010). However, if current conditions and herd objectives change, through implementation of one or more of Options 2 – 8, this option might become more realistic. The WGFC has the authority to make this decision.

Pros:

- reduced risk of intraspecific transmission of brucellosis and other diseases
- possibly facilitate efforts to eliminate brucellosis in elk
- reduced feedground and vaccination expenses incurred by WGFD

Cons:

- increased risk of property damage and interspecific transmission of brucellosis to livestock if implemented with current numbers of elk and /or prior to elimination of brucellosis in elk
- increased risk of property damage would entail increased fiscal and personnel resources from WGFD
- possibly increased elk winter mortality
- possibly lowered number of elk that could be wintered in the Hoback EHU
- possibly reduced hunter opportunity and long-term income to the WGFD due to reduced license sales
- may increase potential for vehicle-elk collisions
- eliminate the means for elk vaccination and test & removal program (offset by natural reduction in intraspecific brucellosis transmission)

As part of WGFD's Target Feedground Project (WGFD 2008), substantial reductions to feeding season length (particularly end date) have occurred since 2008 at various feedgrounds in the Pinedale and Big Piney EHUs. No increase in resource damage (private or public) or comingling, and no reduction in elk numbers have been observed. Minor reductions to length of

feeding season (early end date) may be possible within the HEHU depending on annual snow conditions.

3. Elk Reduction

Reducing elk numbers on feedgrounds in the HEHU through liberalized hunting seasons could allow more flexibility to pursue options 2 and 7, and could lead to more favorable conditions for options 8 and 9. The WGFC has the authority to make this decision.

Pros:

- would decrease elk densities on feedgrounds
- may contribute to lower brucellosis prevalence
- could increase hunting opportunities in the short term
- could increase license revenues in the short term
- potentially reduce some conflicts on private lands
- would reduce costs of supplemental feeding and vaccination

Cons:

- the response of seroprevalence of brucellosis in elk when populations are reduced is unknown, yet it is unlikely to reduce incidence to an acceptable level assuming the remaining elk are still fed
- the general public may be unwilling to accept large reductions in elk numbers
- will cause a loss of elk hunting opportunity in the long term
- may reduce license revenue in the long term (may be offset by reduced management costs)

The 2008 post-hunt population of elk on the HEHU was counted at 1,043 elk (WGFD 2010). This count has risen slowly since at least 2000 (767 elk), but has been relatively stable since 2003 (1,046 elk). Hunting seasons in recent years have been designed to maintain elk numbers throughout the HEHU at the WGFC quota of 1,100 elk.

4. Cattle Producer Change of Operation

This is an option that high-risk and other producers in the HEHU could implement to minimize/eliminate brucellosis risks to their herd. Brucellosis transmission potential within cattle and testing requirements associated with cow/calf operations would be eliminated if all cattle operations were yearlings, spayed heifers, and/or steers. Conversion to yearlings would also eliminate the need of storing most hay crops and winter feeding, reducing winter elk conflicts. Operations that feed through the winter can take small measures to avoid attracting elk such as feeding in the morning and feeding every day to keep feeding areas clean of hay. Implementing facets of this Option would require changes by the producer and possibly a favorable decision by the USFS to alter grazing permits.

Evaluation and implementation of alternatives in this option are totally under the jurisdiction of individual livestock operators, Wyoming Livestock Board, State Veterinarian, and the Animal and Plant Health Inspection Service (APHIS). Discussion and recommendations pertaining to this option should be contained in Individual Ranch Herd Plans for each livestock operation.

5. Fencing

This Option could be facilitated by Options 1 and 3, and may facilitate Options 6, 7, and 9 in the HEHU. Fencing of winter cattle feedlines could prevent elk from co-mingling with cattle. Elk-proof fencing around private stackyards can help in reducing an operation's attractiveness to elk, and when considered beneficial, WGFD provides fencing materials to landowners. New fencing would require favorable decisions by the landowner. Elk-proof fencing around elk feedgrounds can contain most elk within a given area. Fencing projects around feedgrounds would require favorable decisions by the landowner (private or federal).

Pros:

- may reduce damage problems and complaints
- may reduce risk of elk-cattle brucellosis transmission

Cons:

- cost and maintenance
- congregating all or most of the elk within the fence may be unfeasible
- large areas of fencing could impede migrations of other wildlife
- does not address seroprevalence of brucellosis in elk
- some producers may be unwilling to erect/maintain fencing
- could require cooperation and potential NEPA evaluation for federal lands

Large-scale, elk-proof fencing around feedgrounds can contain most elk within a given area, as evidenced by fences in Jackson Hole (surrounding National Elk Refuge), Star Valley (surrounding Grey's River feedground), and Pinedale (border of USFS land from New Fork Canyon to Fremont Ridge). Smaller-scale fences (e.g., adjacent west of Muddy Creek feedground, Pinedale EHU) may prevent elk from drifting onto localized areas, but likely do not contain most elk in the Herd Unit. Following a brucellosis outbreak in 2008, temporary electric fence has been implemented annually (post-feeding) just south of Franz feedground and has prevented cattle from drifting onto the feedground and comingling with resident elk. Currently, no permanent elk-proof fences exist in the HEHU for any purpose other than fencing of stackyards. Wide-scale fencing across a large geographic range in any part of the HEHU is likely not possible because of 1) conflicts with seasonal migration routes of other wildlife species (e.g., deer, moose, antelope) and 2) cost. Fencing (complete enclosure) of elk feedgrounds would likely reduce risk of interspecific disease transmission, but likely increase risk of intraspecific disease transmission. Fencing of cattle winter feeding pastures on private lands could eliminate most elk-cattle disease transmission risk, but would need cooperation from willing landowners, would be costly, would restrict movement of other wildlife species, and could considerably complicate cattle management.

6. Elk Test and Removal

This Option could eliminate a percentage of the seropositive animals on a feedground (Scurlock et al. 2010). The number of aborted fetuses and associated fetal fluids contaminated with *Brucella* bacteria may be decreased. The WGFC has the authority to make this decision.

Pros:

- would reduce brucellosis prevalence in elk

- could reduce elk numbers to more efficiently pursue options 1,2,6,7, and 8.
- may increase tolerance of elk on private lands if brucellosis prevalence is decreased
- may increase other State's acceptance of cattle from within the GYA

Cons:

- very expensive and requires substantial fiscal and personnel resources
- requires large traps on feedgrounds capable of working many animals with large holding pens
- must be implemented for several years to have appreciably decrease in brucellosis antibody prevalence
- general public may not support such an operation due to decreased elk numbers/hunting opportunity
- does not address other potential diseases on feedgrounds
- Data suggest only 54% of antibody-positive elk are actually infected
- *Brucella* antibody prevalence will likely rebound post implementation
- would require federal agency cooperation and potential NEPA evaluation for federal lands

The rates of both intra- and interspecific brucellosis transmission may decrease on all feedgrounds within the HEHU given implementation of this option.

7. Habitat Enhancement

Habitat projects create vegetative diversity, improve range conditions for other species, and have been utilized in areas adjacent to several feedgrounds throughout western Wyoming with some success at reducing feeding duration. The decision authority within the HEHU is with the USFS for most areas, and affected permittee consultation and cooperation is also necessary. This Option may be best used in conjunction with Options 2, 3, and 8 to achieve maximum success.

Pros:

- could reduce feeding duration and brucellosis prevalence
- would benefit many species of wildlife and, in some instances, cattle

Cons:

- may have limited effectiveness at reducing dependency on supplemental feed by the availability of forage in locations or years of high snow accumulation
- elk may not be tolerated on treatment areas when in close proximity to livestock
- requires changes in post-treatment wildlife and livestock management within the treatment area to ensure treatment effectiveness
- would require approval of federal agencies for federal land, private landowners for deeded land, and the State Land Board for state land projects
- may increase likelihood of invasive specie(s) establishment
- cost, coordination, and logistics of implementation

Historically, few elk wintered within the HEHU due to deep snow conditions (Anderson 1958, WGFD 1990), and this trend, influenced by recreational snowmobile activity, continues today (WGFD 2007, WGFD 2010). Little opportunity currently exists for developing significant acreages of winter range in the HEHU. However, the multi-year, landscape-scale Monument

Ridge project could enhance spring and fall range. To date, 1800 acres of aspen and sagebrush have been burned, vegetation response has been excellent, and an additional 900-1,200 acres are proposed for treatment. Increased forage quantity/quality in autumn may entice elk onto the feedgrounds and away from damage situations, without an earlier initiation of feeding. Increased forage quantity/quality in spring may entice elk off of feedgrounds, reducing risk of intraspecific brucellosis transmission.

8. Acquisition/Conservation Easements

Disease transmission risk on feedgrounds in the HEHU might be decreased by managing lands adjacent to, or connected with, areas used by wintering elk. With adequate intact, healthy, and accessible elk winter habitat available, elk feeding may be reduced. This Option also secures habitat for other wildlife species. The buying or long-term leasing of land to be managed commensurate with wildlife benefits is an option that can be used to maintain stability and health of all wildlife populations. Decision authority is with the private landowner.

Pros:

- secures habitat for all wildlife
- long-term solution
- helps secure future revenues for the WGFD
- may facilitate options 1, 2, and 7
- could reduce brucellosis prevalence in elk

Cons:

- cost and logistics
- limited availability of lands with high potential for wintering elk or connecting to existing or potential elk winter ranges
- requires landowner willingness

9. Continuation of Strain 19 Elk Vaccination Program

The WGFD initiated this program in 1985 on Grey's River feedground and has vaccinated about 80,000 elk to date on 21 state operated feedgrounds and the National Elk Refuge. Elk cows and calves were vaccinated the first two years on each feedground, then calves only thereafter assuming adequate coverage is maintained. Dell Creek feedground within the HEHU serves as a control population (i.e., no vaccination) to assess effectiveness of the vaccination program in reducing brucellosis seroprevalence in elk. Brucellosis seroprevalence data from Dell Creek and Grey's River feedground elk indicate no significant difference, no downward trend, and that seroprevalence may fluctuate cyclically over time throughout both populations (WGFD 2010, Fig. 3).

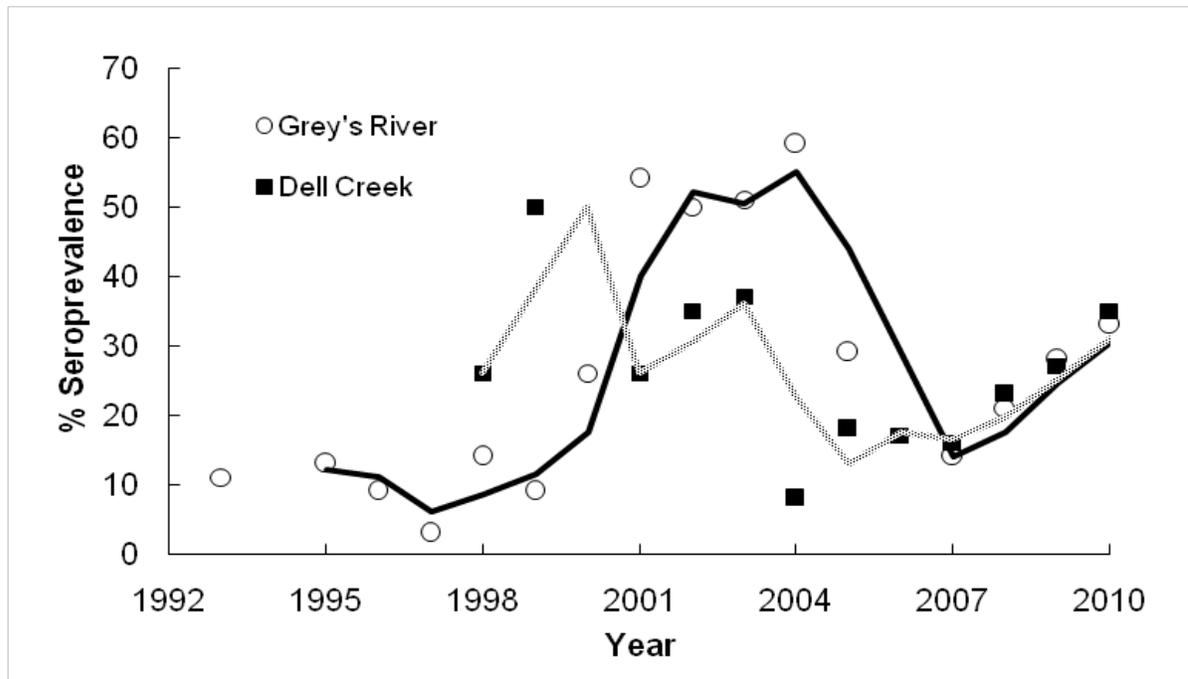


Figure 3. Seroprevalence levels in elk from Grey's River and Dell Creek feedgrounds, 1993-2010. Trendlines depict moving averages within individual feedground.

In captive studies, Strain 19 prevents abortion in 29% (Roffe et al. 2004) to 62% (Herriges Jr et al. 1989) of elk challenged with *B. abortus* strain 2308. Protection from *B. abortus* induced abortions afforded by Strain 19 vaccination may not be sufficient to effectively reduce seroprevalence in elk on feedgrounds. This may be due to the potential for numerous elk to come into contact with a single infected fetus aborted on a feedground (Maichak et al. 2009), and the potential that the infectious dose may overwhelm antibody protection (Cook 1999). The decision authority lies with the WGFC.

Pros:

- may be reducing total number of *B. abortus* induced and infected elk fetuses aborted on feedgrounds
- perceived by many as an effective disease management tool

Cons:

- cost and logistics
- not shown to reduce seroprevalence in elk on feedgrounds
- elk must be concentrated on feedgrounds to ensure delivery is feasible

This Option is currently employed on McNeel feedground in the HEHU. Disease transmission risk will likely not decrease significantly if this Option is continued, based on previous controlled studies and the program's evaluation to date between Grey's River and Dell Creek feedgrounds.

D. Coordination Meetings

1. Intra-Agency Meeting

Given the limited opportunity for substantial changes to feedground locations or management in the HEHU, no formal intra-agency meeting was held among WGFD personnel. However, informal conversations have occurred with most discussion concerning implementation of Target Feedground activities such as Low-Density feeding and early end date of feeding. With the use of delineator poles to mark irrigation ditches as suggested by the feeder, McNeel Feedground could be an ideal location for Low-Density feeding. Early termination of feeding may also be possible in the HEHU during years of low snow fall and/or early melt-off.

2. Producer Meeting

A meeting was held 27 December 2010 to discuss the nine options among livestock producers and associated land and resource management agencies (i.e., BLM, USFS, NRCS, WY Livestock Board, State Lands Board) within the HEHU. Four producers and several WGFD personnel attended the presentation, yet personnel from other organizations were not present. Several questions and comments were proposed by attending producers regarding Strain 19 vaccination, Test & Removal, as well as the Target Feedground Project and other research findings (e.g., early end-date, Low-Density Feeding, VIT and GPS collar data). However, no substantial changes were proposed or discussed in regards to feedgrounds within the HEHU.

3. Public Meeting

A meeting was held 24 March 2011 between WGFD and concerned members of the public to discuss the nine options as they pertained to the Hoback, Big Piney, Upper Green, and Pinedale Elk Herd Units. Three public individuals, one local media personnel, and four WGFD personnel attended the presentation which summarized WGFD brucellosis management and research strategies and their relation to the nine options. Several topics were discussed informally throughout the presentation including brucellosis in horses, environmental persistence of *B. abortus*, impacts of wolves on feedground elk populations and management, and strain 19 vaccination efficacy. No major changes were proposed for any Herd Unit, and members of the public found the presentation informative and useful.

E. Proposed Management Actions

1. Feedground Relocation

The WGFD will not pursue the relocation of any feedground or feedground elk population within the HEHU at this time.

2. Feeding Reduction/Elimination

The WGFD will not eliminate any feedgrounds in the HEHU at this time. As part of the Target Feedground Project, however, both feedgrounds within the HEHU could be candidates for early end-date of feeding in light snow years. WGFD will coordinate with feeders annually to select appropriate termination dates of feeding to minimize brucellosis transmission events on feedgrounds and the subsequent risk of intra- and interspecific transmission.

3. Elk Population Reduction

The WGFD manages for the current, WGFC established, elk herd unit population objective of 1,100 elk in the HEHU. Given the 2010 post-season number of elk observed in the HEHU (837) and likelihood that elk from the Big Piney HU (E106) will drift into the HEHU, efforts will continue to maintain current elk population numbers in the HEHU while focusing additional harvest efforts on the transient antlerless segment of this population.

4. Cattle Producer Change of Operation

The WGFD will work with cattle producers and other agencies (e.g., NRCS, BLM) in the HEHU to implement any changes to their operations that decrease the risk of interspecific disease transmission.

5. Fencing

The WGFD will encourage cattle producers in the HEHU to fence areas where hay is stored (stackyards) for winter feeding operations and continue delivery of materials for stackyard construction. WGFD will not pursue large-scale fencing of any lands on the HEHU at this time.

6. Elk Test and Removal

The WGFD implemented the pilot Test & Removal project in the Pinedale Elk Herd Unit from 2006 through 2010. The WGFD does not plan to implement this Option in the HEHU in the foreseeable future.

7. Habitat Enhancement

The WGFD will continue to coordinate with private landowners, federal land managers, livestock permittees, and NGO's (i.e., RMEF) to develop and implement habitat improvements that may reduce elk dependency on supplemental feed in the HEHU.

8. Acquisition/Conservation Easements

The WGFD will continue to identify and pursue all opportunities to implement this Option. Project proposals will be drafted and submitted to various funding agencies to facilitate implementation of this Option.

9. Vaccination of Elk Calves

The WGFD will continue the ballistic Strain 19 elk vaccination program until adequate data are collected to determine efficacy (or lack thereof) of the program at reducing brucellosis seroprevalence in elk attending feedgrounds. Dell Creek Feedground will continue to serve as the "control" population and will not receive vaccination.

F. Best Management Practices

In addition to the above options and commensurate with their short and long term goals, the following best management practices should be considered for elk feedgrounds in the HEHU. Some may be currently employed and should be maintained. Others may or may not be viable options for individual feedgrounds and livestock producers.

Feedground Management

1. Feed on clean snow whenever possible
2. Report abortions to WGFD

3. Minimize feeding season to the extent possible
4. Low Density feeding methods
5. No harassment/harvest of scavengers on feedground

G. Additional Actions

Brucellosis Surveillance

WGFD currently captures (via corral traps or chemical immobilization) and tests elk for exposure to brucellosis on 7 to 15 feedgrounds annually. This practice will continue annually on Dell Creek feedground to assess efficacy of the Strain 19 vaccination program and monitor prevalence trend of the disease. To assess efficacy of Target Feedground Project activities such as Low Density feeding and early end date (WGFD 2008), sufficient number of elk should be captured and tested for brucellosis prior to or during inception of those activities for comparison to elk tested eight to 10 years (Cross et al. 2007) following inception of those activities. Additionally, hunter-harvested elk brucellosis surveillance will occur annually in various areas throughout the State.

Information and Education

BFH and other WGFD personnel regularly inform and educate various public factions about wildlife diseases, including brucellosis. Educational outreach has included group presentations, news releases, interpretive signs at feedgrounds and crucial winter ranges, and various brochures and publications. The importance of quality wildlife habitat and the substantial role fire plays in natural ecosystems are also stressed during public forums. BFH and other WGFD field staff make numerous private landowner contacts regarding habitat improvement projects, wildlife-friendly management techniques, or ways to prevent commingling of elk and livestock. Additional efforts are focused on area school groups and events such as the WGFD's annual Hunting and Fishing EXPO to inform children and their parents on brucellosis.

These efforts should be continued to inform the public of the WGFD's role in brucellosis research and management and relay consequences of the disease to the State's economy. Additionally, should any of the aforementioned Options be officially adopted, I&E efforts should focus on why the Option(s) was (were) pursued and what benefits may be realized. The public should be made aware of any proactive management embarked upon by the WGFD, and their interests in the actions should be heard.

Research

Sound management of brucellosis in elk on feedgrounds and the risk of transmission from elk to cattle necessitate accurate and reliable data to facilitate decisions. Most research concerning brucellosis, feedground elk, and feedground management has focused on elk vaccination and its impacts to seroprevalence of the disease at the population level. More recently, the Brucellosis-Feedground-Habitat (BFH) Program of WGFD in cooperation with Iowa State University, Montana State University, and the University of Wyoming has conducted and published several epidemiological studies regarding transmission at the elk-to-fetus level on and off feedgrounds. Summaries of unique research projects and their findings are listed below.

1. Effects of management and climate on brucellosis seroprevalence of feedground elk

Cross et al (2007) compiled 16 years of seroprevalence data from feedground elk and 54 years of feeding and climate data from feedgrounds and local weather stations throughout the Greater Yellowstone Ecosystem. They found that brucellosis seroprevalence was positively

correlated to length of feeding season and end date of feeding, with feeding seasons lasting longer during years of increased snow. However, host (feedground) population size or density (animals per unit area of feedground) had little to no influence on seroprevalence. Therefore, they suggested management strategies to reduce length of feeding season (e.g., early end date) to reduce potential elk-to-fetus contacts (transmission events), and ultimately, seroprevalence of the disease on feedgrounds.

2. Effects of management, behavior, and scavenging on risk of brucellosis transmission

Maichak et al (2009) collected 48 culture-negative fetuses, fluids, and placentas (fetal units) from elk associated with the Test & Removal project and placed these on and adjacent to feedlines, as well as off feedgrounds and on native winter range (NWR) locations from 2005 through 2007. They found that elk density and elk-to-fetal unit contacts declined dramatically off feedlines (no contacts off feedgrounds), females were slightly predisposed to fetal unit investigations (greater time of investigation than males and juveniles), and that most elk did not investigate fetal units when $\geq 2\text{m}$ from their line of travel, particularly off feedlines. Additionally, they found that scavengers remove fetal units faster from feedground than NWR locations and reduce numbers of elk contacting fetal units. Therefore, they suggested that reduction of elk densities on feedgrounds, time spent on feedlines (e.g., altered feeding patterns), and protection of scavengers on and adjacent to feedgrounds could reduce intraspecific transmission of brucellosis.

3. Target Feedground Project and effects of low-density feeding

Based on the findings from the projects mentioned above, WGFD developed and implemented management actions pertaining to the Target Feedground Project (TFP) in 2008 (WGFD 2008). The two primary objectives of the TFP are to increase dispersion of hay throughout the feedground (termed Low-Density feeding) and actively end feeding three weeks prior to the current 10-year average. Creech et al. (In Review) compared Low-Density (LD) to traditional feedlines via data-logging radio collars and digital video cameras and found that LD feeding reduces elk-to-fetus contacts by 66%-75% and, based on an appropriate SIR disease model, may substantially reduce seroprevalence in elk if implemented over a decade or more. Active early termination of feeding is possible on some feedgrounds in light snow years, but the impacts of LD feeding and early termination of feeding on actual seroprevalence at the population level will require implementation of eight to 10 years (Cross et al. 2007).

4. Parturition/abortion ecology of feedground elk

From 2006 through 2010, the BFH program of WGFD in conjunction with Iowa St University, University of WY, Montana St University, and USGS deployed and recovered 301 vaginal implant transmitters (VITs) in 19 feedground and 3 NWR elk populations as part of a multi-faceted project to identify and characterize elk parturition (269/301) and abortion (17/301) sites, potential overlap with current elk parturition ranges, and potential overlap with public grazing allotments. Barbknecht et al. (2009) found that VITs were an effective tool for locating elk parturition sites. Furthermore, Barbknecht et al. (In Press) found that most elk tend to select parturition sites with substantial horizontal and overhead cover, often on gentle southern aspects in aspen or aspen/conifer stands, but that parturition sites range from low elevation willow/riparian to high-elevation alpine habitats. To date about 90% of parturition sites have occurred out of currently delineated parturition ranges, and several parturition events have

occurred on active grazing allotments. WGFD in conjunction with USGS is currently compiling and drafting various GIS models based on VITs to help refine elk parturition ranges. Of the abortions, 20% (13/65) were from seropositive females, 2% (4/227) were from seronegative females, and these occurred from 17 Feb to 6 July. About half of the abortions occurred on feedgrounds. Based on current funding, the BFH program will continue to deploy VITs through 2014 to further refine parturition ranges of specific feedground populations and increase sample size of abortions.

Furthermore, many aspects of feedground elk ecology, brucellosis transmission and pathology, and feedground management have not been investigated. Potential research topics that could assist in management decisions are listed below:

1. Influence of Target Feedground Project actions (active early end feeding date, Low-Density feeding, lower palatability feed) on seroprevalence in elk
2. Relationship of seropositive vs. culture positive, and strain of *Brucella*, in feedground elk.
3. Feedground elk parturition habitat site characteristics and proximity to cattle.
4. Effects of habitat improvement projects near feedgrounds on minimizing feedground dependence of elk (i.e. distribution, dispersal, length of feeding season, brucellosis seroprevalence).
5. Disease presence (other than brucellosis) and parasite loads in elk on feedgrounds.
6. Relationship of local scavenger densities vs. scavenging rates on feedgrounds.
7. Abortion and viable birth rates, and temporal and spatial distribution of abortions and births, in seropositive feedground elk.
8. Influence of snow-water equivalent (SWE) and habitat enhancement on elk use and distribution
9. Genetic comparison of seropositive elk that do or do not abort
10. Potential aerosol transmission of brucellosis and impacts to sero- and culture prevalence in elk and livestock
11. Potential for salt/mineral licks as sites of inter- and intraspecific brucellosis transmission

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