



# **Cody Elk Herd Unit (E216)**

## **Brucellosis Management Action Plan Update**

### **Wyoming Game and Fish Department**

#### **July 11, 2019**

#### A. Introduction and Herd Unit Overview

This update to the Cody elk herd unit (CEH) Brucellosis Management Action Plan (BMAP) evaluates brucellosis management recommendations included in the original 2012 BMAP. This revision is based on meetings coordinated by Wyoming Game and Fish Department (WGFD) and Wyoming State Livestock Board (WLSB) personnel. The ecology and current status of brucellosis, results of options implemented in the 2012 BMAP, and feasibility of new options were reviewed during these meetings. WGFD will update this plan as needed.

The CEH is located along the eastern border of Yellowstone National Park (YNP) in Park, Big Horn, Hot Springs, and Washakie Counties Wyoming and includes the Wyoming Brucellosis Designated Surveillance Area (DSA) along the Park and Big Horn county line, and Elk Hunt Areas (HA) 55, 56, 58-61, and 66 (Fig. 1). A majority of land ownership is public, split between the U. S. Forest Service (USFS; 1,567 mi<sup>2</sup>, 39%) and Bureau of Land Management (BLM; 1,491 mi<sup>2</sup>, 37%). Private (773 mi<sup>2</sup>), state (171 mi<sup>2</sup>), and Bureau of Reclamation (1 mi<sup>2</sup>) lands account for the remaining 24% of the area. From west to east, habitat consists of forested mountains, sagebrush/grassland foothills, and badlands interspersed with riparian and agricultural ecotones along the North and South Forks of the Shoshone River, Greybull River, and Bighorn River. Climate consists of cold winters and ephemeral snowpack in foothills and badlands, and hot summers with limited precipitation.

Total area of the CEH is approximately 4,005 mi<sup>2</sup>, of which 2,163 mi<sup>2</sup> (54%) have been delineated by the WGFD as occupied elk habitat. Of 2,163 mi<sup>2</sup> of occupied elk habitat, approximately 1,138 mi<sup>2</sup> (60 %) are delineated as Spring/Summer/Fall range, 565 mi<sup>2</sup> (30%) as Crucial Winter Yearlong range, 83 mi<sup>2</sup> (4%) as Yearlong range, 76 mi<sup>2</sup> (4%) as Winter-Yearlong range, and 32 mi<sup>2</sup> (2%) as Winter range. About 526 mi<sup>2</sup> (24%) are designated as Parturition range (Fig. 1B).

From 1991 to 2017, the 5-yr average seroprevalence estimates of elk increased from about 2% to 15% (WGFD 2018). Elk in the CEH are currently defined as migratory and non-migratory (i.e., resident), with more resident elk now than the early 1980s in HA 58, 61, and 66 (Rudd 1982; Hurley 1996; Middleton et al. 2013; Middleton unpublished data; WGFD unpublished data). Potential causes of recent increase in seroprevalence include large, dense groups on winter range, similar to conditions on feedgrounds in western Wyoming (Cross et al. 2010, Brennan et al. 2017). Persistent concentration of elk on specific winter ranges and an increase in resident (i.e., non-migratory) elk is likely promoted by effects of wolves, land use, availability of suitable habitat, and climatic changes (Middleton et al. 2013, Proffitt et al. 2011, Proffitt et al. 2015). Since 1990, multiple livestock herds in HAs 58 and 61 were quarantined (Brennan et al. 2017).

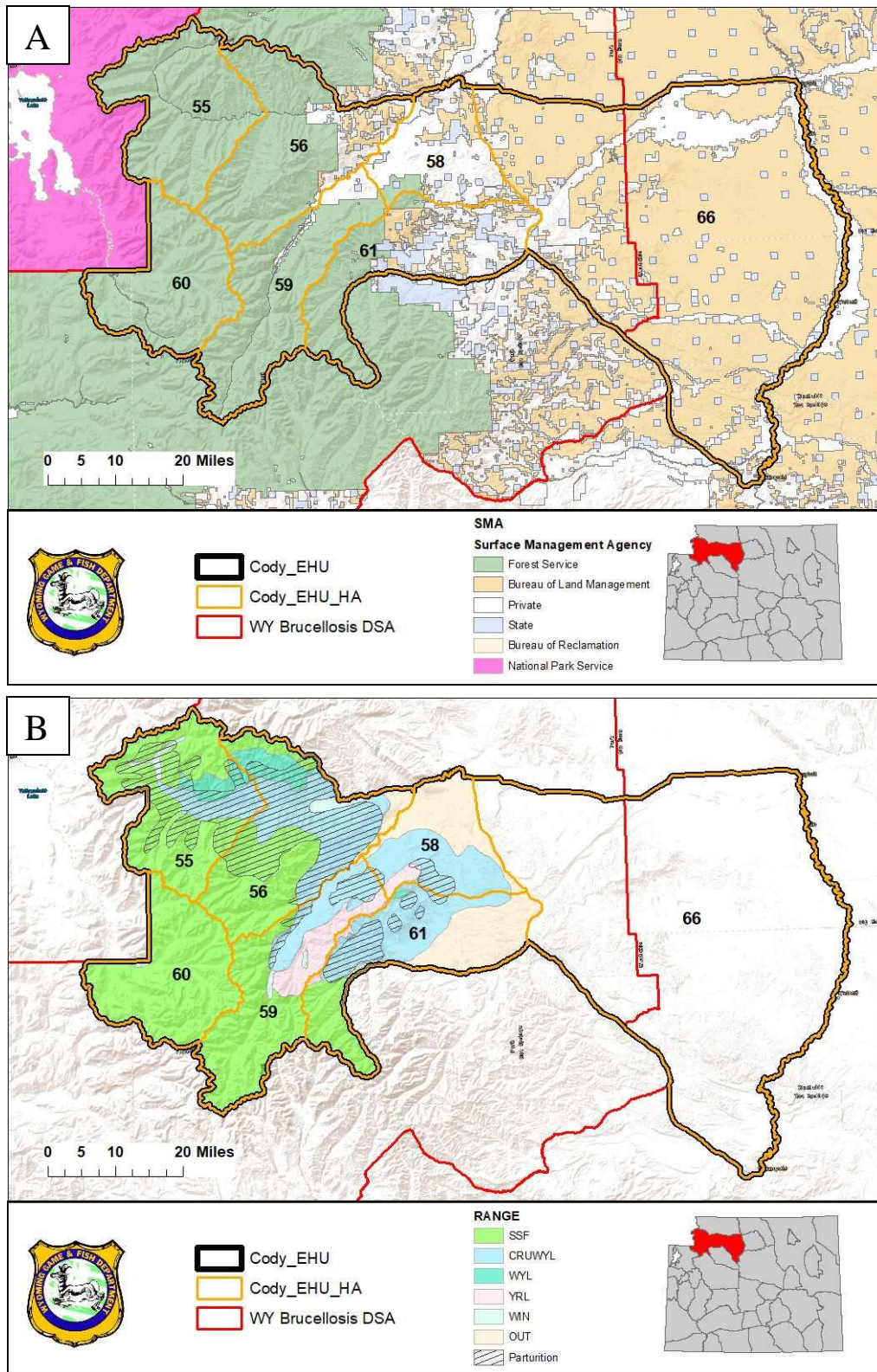


Figure 1. Cody elk herd unit, elk hunt areas, and land ownership (A); seasonal and parturition ranges (B); and the WY brucellosis designated surveillance area boundary.

## B. Brucellosis Management Options

Listed below are potential options for managing brucellosis in the CEH. Short-term objectives of these options are to reduce comingling of elk and cattle and the prevalence of brucellosis in elk. Long term objectives include eliminating the reservoir of brucellosis in elk in the Greater Yellowstone Ecosystem (GYE) if feasible; maintain livestock producer viability, established elk herd unit and range health objectives; and maximize benefits to all wildlife. Implementation of several options together will likely be more effective than instituting any option alone. 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. Hazing elk away from livestock during the abortion risk period.
2. Implementing extensive habitat enhancement projects to disperse elk and entice them away from livestock.
3. Game-proof fencing to prevent elk from comingling with domestic livestock and damaging stored crops.
4. Reducing numbers of elk through increased harvest.
5. Reporting and removing aborted elk fetal materials by WGFD personnel.
6. Sampling harvested elk for brucellosis exposure or infection.
7. Delineating areas of brucellosis risk by mapping elk use areas with GPS collar data.
8. Adapting land use or policy to minimize risk of brucellosis transmission.

## C. Discussion of Options

### 1. *Hazing*

Hazing (e.g., negative reinforcement of elk via pursuit on foot or others means and discharge of cracker-shells) is often used to prevent comingling of elk and livestock during the abortion period and reduce risk of brucellosis transmission from elk to livestock. Hazing operations require coordination among affected producer, WGFD, and occasionally, land management agency(ies). Frequency and number of hazing operations typically increases with decreased tolerance of affected producer for elk, often determined by prevalence of brucellosis, number, and residence time of elk.

Pros:

- Separates elk from livestock
- Can be implemented by affected landowner with WGFD approval

Cons:

- Temporary; elk often return to areas where previously hazed from
- Concentrates elk during abortion period and promotes elk-to-elk brucellosis transmission
- May require additional measures (lethal removal) for sustained effectiveness

Hazing operations in the CEH typically occur frequently near the southern boundary at ranches along the Greybull River with diminishing frequency northward along foothills and into the South Fork of the Shoshone River. Hazing operations are often conducted solely by WGFD personnel, yet depending on discretion of district warden, producers are permitted to conduct hazing

operations without direct oversight of WGFD personnel. This option may be best used in conjunction with options 2, 3, and 4 to achieve maximum success

## 2. *Habitat Enhancement*

Habitat projects have been implemented to manipulate distribution of elk (WGFD 2016). Projects should be designed to reduce group size and density of free-range elk during the brucellosis transmission period in areas away from cattle. Consultation and cooperation with the private landowner(s)/permittee(s) and land management agency(ies) is necessary. This option may be best used in conjunction with options 1, 3, 4, and 8 to achieve maximum success.

### Pros:

- Provides long-term benefits to many wildlife species and cattle
- Can help distribute elk
- Funding available through government and non-government agencies

### Cons:

- Potential unavailability of treatable areas given climate, terrain and land use
- Pre- and post-treatment logistics (sensitive species considerations, rest period)
- Use of treated areas dependent upon weather, disturbance, proximity to areas of elk use
- Increased likelihood of invasive species establishment

Since 1960, about 95,471 acres of non-agricultural (i.e., sagebrush/grassland and forest) habitats in the CEH have been treated with fire (71,721 acres), mechanical (22,052 acres), and herbicide (1,698 acres) treatments (Fig. 2). Opportunities exist in the CEH for habitat enhancement aimed at increasing the quality and quantity of forage, and subsequently reducing elk density, during the abortion period on winter ranges in the sagebrush/grassland foothills of Carter Mountain, particularly from the Greybull River to the Meeteetse Rim, and to the South Fork of the Shoshone River. Other opportunities for habitat enhancement in the CEH exist on transitional and summer ranges.

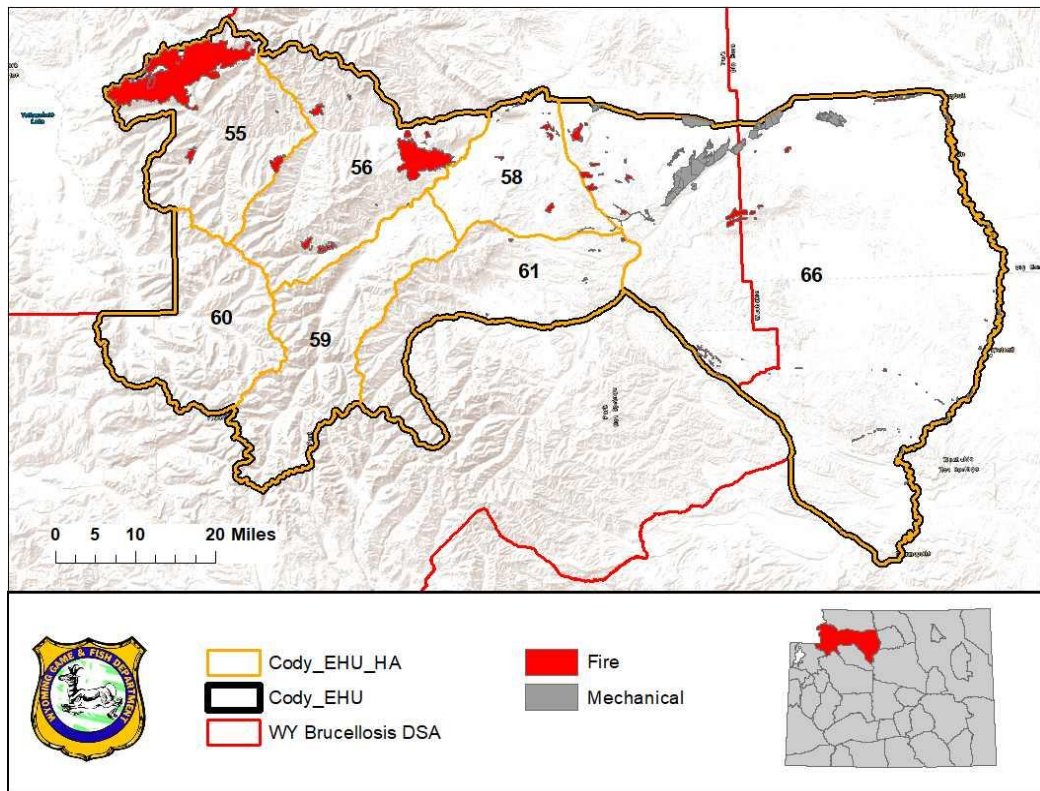


Figure 2. Habitat Treatments in the Cody elk herd unit, 1960-2017.

### 3. Fencing

Game-proof fencing of haystacks reduces risk of damage and commingling by eliminating food attractants. For pasture fences, switching from five or six strand barbed wire or woven wire fences to wildlife-friendly fences will likely contain most cattle and facilitate movement of elk during hazing operations. Fencing large areas of winter range and roadways (e.g., National Elk Refuge) reduces commingling of elk and cattle and vehicle-elk collisions. Fencing of winter cattle feed lines or ranches can prevent elk from commingling with cattle. This option may be best used in conjunction with options 1, 2, 4, 7, and 8 to achieve maximum success.

#### Pros:

- Reduced elk damage
- Funding available through government and non-government agencies
- Reduced commingling and vehicle collisions
- Likely facilitates hazing of elk

#### Cons:

- Expensive
- Congregating all or most of the elk or cattle within a fence may be unfeasible
- Extensive fencing could impede migrations of non-target wildlife
- Does not address elk-elk brucellosis transmission
- Requires landowner cooperation and potential NEPA review for federal lands

Where fencing stack yards is considered beneficial (e.g., prevent damage to stored crop), and landowners provide appreciable hunting access, WGFD provides fencing materials and suggested schematics to landowners in the CEH. Switching to wildlife-friendly fence to contain cattle and facilitate hazing shows promise yet remains untested. Wide-scale elk-proof fencing across a large geographic range in any part of the CEH is likely not possible because of conflicts with seasonal migration routes of other wildlife species (e.g., sage grouse, deer, moose, pronghorn), high costs, and lack of public support.

#### 4. *Increased Harvest*

Reduction of elk numbers simplifies type, number, and complexity of management actions (e.g., hazing, fence repair, hunting season structure). If numbers of elk are reduced appreciably, brucellosis prevalence may also be reduced (Proffitt et al. 2015; National Academy of Sciences, Engineering, and Medicine 2017). Reducing elk numbers on winter ranges in the CEH through liberalized hunting seasons could allow more flexibility to pursue options 1-3 and could lead to more favorable conditions for option 8. The WGFC has the authority to approve elk harvest strategies.

##### Pros:

- Decreased elk densities and lower brucellosis prevalence
- Prevent movement of elk and brucellosis to new areas
- Increase hunting opportunities and license revenues in the short term
- Reduced agricultural conflicts on private lands

##### Cons:

- Brucellosis will persist
- Public generally unwilling to accept large reductions in elk numbers
- Success limited by access to private or privately land-locked public lands
- Loss of some hunting opportunity in the long term

The 2017 post-hunt elk population trend count for the CEH was 5,586 elk. The 3-year average (2015-2017) trend count was 4,898 elk. The WGFC population objective is 4,400 elk ( $\pm 20\%$ , i.e.,  $\pm 880$ ). From 2008-2017, hunting seasons were designed to reduce elk numbers throughout the CEH to the population objective of 4,400 elk, particularly in HAs 61 and 66. In HA 61, season length, number of limited quota cow/calf licenses issued and harvest peaked in 2013. The peak corresponded with the implementation of a successful Hunter Management Assistance Program. In HA 66, season length, limited quota cow/calf licenses issued and harvest continue to increase.

#### 5. *Reporting Abortions*

Abortions and associated materials (fetus, placenta, and fluids) are the primary source of contagious *Brucella abortus* bacteria in elk, bison, and livestock. Direct contact with these materials and uptake of bacteria are the primary mode of transmission of brucellosis (Thorne et al. 1978; Nicoletti 1980). Observing abortions and aborted materials is rare (Cross et al. 2015), yet when found, maintaining separation of materials and animals, and ultimately reporting the event to WGFD allows personnel to remove aborted materials and clean the site to prevent transmission (WGFD 2016). This option is best used in conjunction with options 1, 7, and 8.

Pros:

- Aborted materials can be secured and removed, and site cleaned to greatly reduce likelihood of brucellosis transmission
- Livestock in vicinity not predisposed to quarantine
- Provides materials for testing and understanding brucellosis spread

Cons:

- Suggests potential exposure to nearby livestock and wildlife
- Risk of elk-to-human transmission of brucellosis during removal/cleaning

Implementing a practice in the CEH wherein public and/or private individuals notify WGFD personnel who remove aborted materials and clean-up site (e.g., remove contaminated vegetation, sterilize with 50:50 bleach:water) would reduce likelihood of transmission of brucellosis to wildlife and livestock. Verbal assurance from WLSB personnel that producers with livestock near aborted materials are not predisposed to herd quarantine should further encourage individuals to report abortions.

### 6. *Harvest Sampling*

Understanding trends, spread, and management of brucellosis through seroprevalence (i.e., proportion of elk with serum antibodies suggesting exposure to the bacteria out of all sera samples tested) and genetic typing of *B. abortus* in affected free-ranging elk populations can be achieved through collection and testing of samples from hunter-harvested elk. This requires substantial coordination among WGFD field and Wildlife Health Laboratory (Lab) personnel, and participating landowners, outfitters/guides, and other entities. Collection of samples by hunters is voluntary, and return of samples is likely related to hunter understanding of need for samples, vested interest of landowners, financial incentives, or availability of WGFD field personnel (WGFD 2018). Options 4 and 7 would facilitate this option.

Pros:

- Facilitates public engagement and participation
- Can cover broad or targeted geographical areas
- Can detect trends or differences with sufficient sample sizes
- May provide additional revenue to participating businesses (e.g., convenience stores)

Cons:

- Cost
- Low return of elk blood samples from hunters relative to the number of elk blood sample kits (kits) distributed to hunters
- Seroprevalence estimates from hunter-harvested elk are lower than seroprevalence from elk tested in the winter and/or spring
- Substantial coordination required by WGFD and participating entities

Since the 1990s, WGFD has sampled elk in various areas of the state through distribution and return (primarily via mail) of kits provided to hunters. The average return of samples from hunters receiving kits is about 10%, and seroprevalence estimates are generally about 5% lower in sera collected during hunting season vs. winter/spring. In the CEH via random distribution of kits to hunters from the WGFD Lab, HA 61 is sampled almost annually; all other HAs are sampled at

varying time scales. Hunter management programs targeting specific populations around Meeteetse have provided copious sera and lymphatic tissue samples. Participating landowners and outfitters trained in collection techniques have provided additional sera, and to lesser extent, iliac and supramammary lymphatic tissue samples.

Seroprevalence in the CEH has risen substantially since 1990, averaging near 13% from 2012-2017 (WGFD 2018). Genotyping of *B. abortus* cultured from elk throughout the GYE and specifically in the CEH near Meeteetse suggests origination near Jackson, WY (Kamath et al. 2016). Genetic samples of *B. abortus* north and east of Meeteetse Creek are lacking in the CEH.

### 7. *Risk-Mapping*

Brucellosis-induced abortions in seropositive elk are known to occur from early February to late June, peaking from early March to mid-May (Cross et al. 2015). Areas where seropositive elk occur during the full or peak abortion period can be considered brucellosis risk areas within the elk herd unit. Based on data from marked animals, maps can be developed identifying brucellosis risk areas. Utilizing risk maps, producers and land managers can make informed decisions to implement strategies that minimize risk of brucellosis transmission among elk and from elk to cattle herds (WGFD 2016).

#### Pros:

- Illustrates areas where brucellosis management actions could be focused
- Repeatable to determine if elk management strategies were effective
- Data required to identify brucellosis risk areas are available

#### Cons:

- Reduced vigilance in areas of lower brucellosis risk
- Risk areas dependent upon sample size
- Confidentiality concerns

In the CEH, fine-scale GPS data exist from numerous elk collared over several years and are available for use in generating elk movement maps (Middleton unpublished data; WGFD unpublished data). These data suggest the establishment and increase of non-migratory “resident” elk populations may pose greater risk of transmission to livestock than migratory elk. Deployment of additional GPS radio collars and vaginal implant transmitters in the CEH would benefit livestock, land, and wildlife managers in the CEH by not only confirming current risk but also evaluating results of potential brucellosis mitigation actions (e.g., fence modification to facilitate hazing elk away from livestock) and delineated seasonal ranges.

### 8. *Land Use/Policy*

Alterations in land use and/or policy can reduce potential for transmission of brucellosis among elk and from elk to livestock while providing additional short- and long-term resource benefits. Examples employed in areas with high brucellosis seroprevalence in elk include seasonal human presence closures to prevent displacement of elk into livestock, preventing harvest or harassment of scavengers to expedite removal of aborted materials, and voluntary livestock producer change of operation (WGFD 2016). Changes to land use and/or policy are often controversial; require



substantial time, coordination, and approval among stakeholders; and may require WGFC approval, NEPA, or other processes to be implemented on state or federal lands.

Pros:

- Potential to substantially reduce transmission risk among elk and between elk and livestock
- Short- and long-term solution
- Can have multiple or synergistic resource benefits

Cons:

- May be controversial
- Requires substantial time, coordination, and approval among stakeholders
- May require NEPA

To reduce likelihood of brucellosis transmission from elk to elk, and elk to livestock in the CEH, changes to land use and policy have included land management agency changes to livestock allotment turn-out dates, seasonal stipulations to mineral extraction, or voluntary changes implemented by livestock producers following consultation with WLSB.

D. Coordination Meetings

1. *Producer, Interagency, and Non-Government Organization Meetings*

From July 2017 to March 2018, 22 meetings were held one-on-one and in group settings to discuss brucellosis and elk ecology, past brucellosis management, and feasibility of the eight options presented as well as other possible options for the CEH, Gooseberry elk herd unit and Absaroka bison management area. Among the 81 individuals attending meetings were livestock producers, land-managers (BLM, USFS), and non-government representatives (Rocky Mountain Elk Foundation Thermopolis and Cody, Wyoming Outdoorsmen, Greater Yellowstone Coalition, Cody Country Outfitters and Guides). Group livestock producer meetings were held in Cody, Thermopolis, Burlington, and Meeteetse where WGFD and WLSB personnel attended to provide information and address specific questions. Opinions of individuals or groups for feasibility of specific options were categorized as “positive” (supported), “neutral” (indifferent), or “negative” (no support) based on responses and comments.

Among stakeholders at meetings, most have lived in the CEH for over 20 years and heard of brucellosis, yet many were unaware of basic epidemiology, particularly the abortion period in elk and timing of transmission. After being asked to respond yes or no, most individuals and groups said there were more elk now (88% yes) and in new places (80% yes) than 20 years ago, particularly from west to east in the CEH; 91% said there were resident (non-migratory) elk in the CEH, especially at lower elevations in the upper South Fork River and Greybull River, between Meeteetse and Cody (Flat Top and Wyoming Highway 120), Meeteetse Rim, and Lower Greybull River.

Overall, public response to possible management options were positive (Table 1). Conventional brucellosis management actions of preventing commingling via hazing and fencing haystacks were supported, yet hazing was considered temporary. Elk population management (harvest and/or redistribution) through a variety of strategies (outfitter/guide, hunt coordinator, trespass admission,

and/or WGFD Hunter Management Program) continues to be supported, yet was considered ineffective in some areas because of refugia provided by some landowners allowing little or no hunting, or insufficient season length or license issuance (e.g., lower Greybull River). Harvest sampling, including ongoing WGFD efforts to incentivize the return of brucellosis test kits through a raffle for prizes, was supported to help continue to understand seroprevalence trends, possible effects from management, and especially risk to livestock. Several individuals and groups (including many landowners) offered to assist sample collection efforts.

Table 1. Responses of individuals and groups of livestock producers, sportspersons, and non-government and government personnel (2017-2018) to possible options to manage brucellosis in the Cody elk herd unit.

<u>Option</u>	<u>% Response</u>		
	<u>Positive</u>	<u>Neutral</u>	<u>Negative</u>
Hazing	54	23	23
Habitat Enhancement	50	43	7
Fencing	62	15	23
Increased Harvest	85	5	10
Remove Abortions	75	25	0
Harvest Sampling	84	8	8
Risk Mapping	75	25	0
Land Use/Policy	31	54	15
Average Response	64	25	11

Concepts adapted from the WGFD Brucellosis-Feedground-Habitat program and associated BMAPs were generally supported after providing explanation and specific examples of use around supplemental elk winter feedgrounds. Use of wildlife friendly fence (to facilitate hazing) was supported by many individuals, agencies, and some producers. Habitat enhancement options such as fire in mountain areas and seeding forage species at lower elevations were supported by landowners and agencies with larger tracts of land and active treatment programs. Most individuals and groups said they had not seen an abortion, yet agreed to report abortions after reassurance from WLSB personnel they would not be quarantined if they reported them. Efforts to understand brucellosis transmission risk thru modeling of GPS collar data was supported, particularly from WLSB personnel, and other suggestions included use of flights and camera traps.

Past changes to land use and policy included USFS and BLM alteration of livestock turn-out dates to minimize temporal overlap with the abortion period in elk with no support for further changes. Despite USFS seasonal vehicle travel restrictions west of Meeteetse to prevent displacement of elk into livestock on private lands, these were deemed ineffective given the recent boom in shed antler collection and sales. Therefore, seasonal human presence closures during the brucellosis transmission period and/or antler hunting seasons were discussed with particular emphasis on foothill areas west of Meeteetse. Seasonal human presence closures and to lesser extent antler hunting seasons were supported.

Additional options proposed and discussed included: educate landowners of brucellosis risk who allow little or no hunting; manage wolves to manage elk distribution and transmission risk; develop

an effective vaccine (elk or livestock); identify migratory and resident herds, target resident herds; implement immunocontraception where over objective and no or minimal hunting is allowed; and coordinate with WSLB to develop a livestock herd plan.

### 2. *Intra-Agency Meetings*

From July 2017 to January 2018, several informal conversations occurred between the Cody disease biologist and various WGFD personnel including administrators, wardens, and biologists regarding brucellosis and the eight options proposed in this plan. Following explanation of individual options, personnel agreed that all had merit, would likely not result in backlash from publics, and could be pursued at varying scales and locations in the CEH.

### 3. *Public Meetings*

From 11 April to 16 April 2018, three meetings were held in Burlington, Meeteetse, and Cody to allow the general public opportunity review proposed options and comment on the CEH, Gooseberry Elk Herd, and Absaroka Wild Bison Management Area BMAPs. Attendees (21) were primarily livestock producers and farmers. Also attending were WGFD, USFS, and WSLB personnel as well as local media.

Among all meetings and options for elk, average responses of attendees were primarily positive (Table 2). Increased number of licenses, expanded season length, and harvest of elk in HA 66 was especially supported. There was substantial interest in elk population, harvest, seroprevalence, and GPS data, with much discussion of population sampling methods. Several attendees (including producers) were verbally committed to allowing more public access and obtaining more blood and tissue samples, particularly along the lower Greybull River. Additional suggestions included refining elk counts with camera traps, phasing out elk feedgrounds over 50 years, and assessing the feasibility of fencing cattle feeding areas to prevent commingling.

Table 2. Responses of individuals and groups of livestock producers, farmers, media, and government personnel (2018) to proposed options to manage brucellosis in the Cody elk herd unit.

<u>Option</u>	<u>% Response</u>		
	<u>Positive</u>	<u>Neutral</u>	<u>Negative</u>
Hazing	50	25	25
Habitat Enhancement	33	67	0
Fencing	33	67	0
Increased Harvest	100	0	0
Remove Abortions	0	100	0
Harvest Sampling	67	33	0
Risk Mapping	67	33	0
Land Use/Policy	67	33	0
Average Response	52	45	3

## E. Proposed Management Actions

### *1. Hazing*

WGFD will continue to coordinate with livestock producers and land management agencies to haze elk away from livestock during the abortion period. In instances where repeated hazing becomes ineffective at maintaining separation of elk and livestock, WGFD may lethally remove elk.

### *2. Habitat Enhancement*

In coordination with USFS, BLM, and private land owners, WGFD will investigate potential treatment options in transitional and summer range to promote migration, and investigate potential treatment options in foothill areas of winter range along Carter Mountain, upper South Fork of the Shoshone River, and around Tatman Mountain in the CEH.

### *3. Fencing*

WGFD will continue to provide elk-proof stack yards to producers in the CEH who provide substantial public access for elk hunting. WGFD will continue to coordinate with interested land management agencies and private land owners to implement wildlife-friendly fences to facilitate hazing of elk away from livestock and migration of other big game animals.

### *4. Increased Harvest*

WGFD will continue to coordinate with stakeholders to help manage elk populations at objective, or reduce specific populations or segments of the population, by one or more of the following: promoting and sustaining adequate hunter access; maintaining or expanding season length; and increasing license numbers (particularly cow/calf licenses). To help prevent potential spread of brucellosis, WGFD will continue to manage elk in HA 66 for the objective of zero elk through hunter harvest.

### *5. Reporting Abortions*

WGFD will encourage stakeholders to report and provide detailed location (e.g., UTM, Lat/Long) of aborted materials (fetus, placenta, fluids) from elk. WGFD personnel will remove aborted materials, including contaminated vegetation, and soak the contaminated area with a 50:50 bleach:water solution. Fresh aborted materials will be submitted and tested for *B. abortus* and incinerated at the WGFD WHL. All aborted materials not submitted for testing will be disposed in a sanitary landfill.

### *6. Harvest Sampling*

WGFD will coordinate with stakeholders to collect blood throughout the CEH through continued mailing and distribution in the field of kits to hunters, outfitters, guides, livestock producers, license agents and other interested parties. To increase return of useable samples from hunters, WGFD will continue to coordinate with sponsors to implement a raffle for prizes during the 2018, 2019, and 2020 elk hunting seasons. WGFD will continue to collect lymphatic tissue when available, particularly in HAs 55, 56, 58, 61 and 66.

### 7. *Risk Mapping*

WGFD will continue to coordinate with interested partners (e.g., academics, land management agencies, and WLSB) to develop, fund, and implement projects aimed at mapping areas of brucellosis transmission risk. Maps will be provided to participating and interested stakeholders.

### 8. *Land Use/Policy*

WGFD will continue to coordinate with interested stakeholders and land management agencies regarding potential development and implementation of actions such as seasonal area closures. Other potential actions (e.g., conservation easement, land swap) will be addressed as needed or as the opportunities arise.

## F. Additional Actions

### 1. *Education*

Despite the relative familiarity of stakeholders in the CEH regarding fundamental brucellosis ecology and management, many individuals are presumed unfamiliar with the disease and the potential negative impacts resulting from spillover from elk to livestock. Based on suggestions from stakeholder meetings, a coordinated effort to educate landowners who are either absentee (e.g., non-resident) or do not allow elk hunting could help address localized brucellosis concerns within specific elk HAs by displacing elk off of refugia. WGFD is committed to helping educate these stakeholders through direct contact.

### 2. *Scavenging Aborted Materials*

Because of physiological differences between scavengers (e.g., coyotes, eagles) and elk, bison, or livestock, *B. abortus* does not cause abortion in scavengers, and scavengers are considered a “dead-end” host of *B. abortus* (National Academy of Sciences, Engineering, and Medicine 2017; H. Edwards, WGFD, personal communication). In natural settings, scavengers have not been linked to transmission of brucellosis to livestock (Davis et al. 1988), elk, or bison. Scavengers removed pseudo-aborted materials from the landscape faster in areas of high than low host species density, and reduced the number of elk contacting these materials (Maichak et al. 2009, Aune et al. 2012). To help prevent transmission of brucellosis among elk, a best management practice of preventing harvest or harassment of scavengers on feedgrounds in western Wyoming offers a no-cost, biological control of aborted materials (WGFD 2016).

In the CEH, implementing a similar practice of preventing harvest or harassment of scavengers during the abortion period may facilitate removal of aborted materials. Targeting specific areas to promote scavenging, such as large geographic areas with many wintering elk, limited human presence, and few livestock would minimize risk of livestock depredation. During meetings to discuss and develop the CEH BMAP, responses of individuals and groups were 35%, 50%, and 12% positive, neutral, and negative respectively to allow scavengers to consume aborted materials.

### 3. *Research*

To continue understanding brucellosis, its management in wildlife, and prevention of transmission to livestock in and beyond the CEH, pertinent questions concerning various actions that have (or have not) been implemented need to be answered. Based on options in this plan and discussions

pertaining to its development, below is a list of possible questions to facilitate management-oriented research:

- A. Does consistent hazing of elk away from livestock prevent transmission to cattle?
- B. Do wildlife-friendly fence designs facilitate hazing of elk away from livestock?
- C. Do habitat treatments reduce elk group size during the abortion period?
- D. Is brucellosis prevalence in elk associated with hunting season structure, access or both?
- E. Does control of predators and large carnivores control brucellosis prevalence in elk and/or spillover to cattle?
- F. Do scavengers move pseudo-aborted materials away from or toward elk and livestock?
- G. Does offering prizes increase return of useable blood samples by hunters?
- H. Do risk maps generated from elk GPS locations prevent spillover transmission to cattle?
- I. Do antler hunters displace elk into livestock?
- J. Do seasonal human presence closures affect brucellosis prevalence in elk and spillover to cattle?
- K. Does immunocontraception control seroprevalence and population size in elk?

#### G. Literature Cited

- Aune, K., J. C. Rhyan, R. Russell, T. J. Roffe, and B Corso. 2012. Environmental persistence of *Brucella abortus* in the Greater Yellowstone Area. *Journal of Wildlife Management*, 76:253-261.
- Brennan, A., P. C. Cross, K. Portacci, B. M. Scurlock, and W. H. Edwards. 2017. Shifting brucellosis risk in livestock coincides with spreading seroprevalence in elk. *PLoS ONE* 12:e0178780.
- Brennan, A., P. C. Cross, M. Higgs, W. H. Edwards, B. M. Scurlock, and S. Creel. 2014. A multi-scale assessment of animal aggregation patterns to understand increasing pathogen seroprevalence. *Ecosphere* 5:1-16.
- Cross, P.C., E.K. Cole, A.P. Dobson, W.H. Edwards, K.L. Hamlin, G. Luikart, A.D. Middleton, B.M. Scurlock, and P.J. White. 2010. Probable causes of increasing brucellosis in free-ranging elk of the Greater Yellowstone Ecosystem. *Ecological Applications* 20: 278-288.
- Cross, P. C., E. J. Maichak, J. D. Rogerson, K. M. Irvine, J. D. Jones, D. M. Heisey, W. H. Edwards, and B. M. Scurlock. 2015. Estimating the phenology of elk brucellosis transmission with hierarchical models of cause-specific and baseline hazards. *Journal of Wildlife Management* 79:739-748.
- Davis, D. S., F. S. HECK, J. D. WILLIAMS, T. R. SIMPSON, and L. G. Adams. 1988. Interspecific transmission of *Brucella abortus* from experimentally infected coyotes (*Canis latrans*) to parturient cattle. *Journal of Wildlife Diseases* 24: 533-537.

- Hurley, K. P. 1996. Carter mountain elk migration study. Final Report. Wyoming Game and Fish Department, Cheyenne, WY.
- Kamath, P. L., J. T. Foster, K. P. Drees, G. Luikart, C. Quance, N. J. Anderson, P. R. Clarke, E. C. Cole, M. L. Drew, W. H. Edwards, J. C. Rhyan, J. J. Treanor, R. L. Wallen, P. J. White, S. L. Robbe-Austerman, and P. C. Cross. 2016. Genomics reveals historic and contemporary transmission dynamics of a bacterial disease among wildlife and livestock. *Nature Communications* 7:1-10.
- Maichak, E. J., B. M. Scurlock, J. D. Rogerson, L. L. Meadows, A. E. Barbknecht, W. H. Edwards, and P. C. Cross. 2009. Effects of management, behavior, and scavenging on risk of brucellosis transmission in elk of western Wyoming. *Journal of Wildlife Diseases* 45:398-410.
- Middleton, A. D., M. J. Kauffman, D. E. McWhirter, J. G. Cook, R. C. Cook, A. A. Nelson, M. D. Jimenez, and R. W. Klaver. 2013. Animal migration amid shifting patterns of phenology and predation: Lessons from a Yellowstone elk herd. *Ecology* 94:1245-1256.
- National Academy of Sciences, Engineering, and Medicine. 2017. Revisiting brucellosis in the Greater Yellowstone Area. The National Academies Press, Washington, DC.
- Nicoletti, P. 1980. The epidemiology of bovine brucellosis. *Advances in Veterinary Science and Comparative Medicine* 24:69-98.
- Proffitt, K. M., J. A. Gude, J. Shammart, and F. King. 2011. Variations in elk aggregation patterns across a range of elk population sizes at Wall Creek, Montana. *Journal of Wildlife Management* 76:847-856.
- Proffitt, K. M., N. Anderson, P. Lukacs, M. M. Riordan, J. A. Gude, and J. Shamhart. 2015. Effects of elk density on elk aggregation patterns and exposure to brucellosis. *Journal of Wildlife Management* 79:373-383.
- Rudd, W. J. 1982. Elk migrations and movements in relation to weather and hunting in the Absaroka Mountains, Wyoming. M.S. thesis. University of Wyoming, Laramie, Wyoming.
- Thorne, E. T., J. K. Morton, F. M. Blunt, and H. A. Dawson. 1978. Brucellosis in elk II. Clinical effects and means of transmission as determined through artificial infections. *Journal of Wildlife Diseases* 14:280-291.
- Wyoming Brucellosis Coordination Team. 2005. Wyoming Brucellosis Coordination Team. Report and recommendations. January 11, 2005.
- Wyoming Game and Fish Department. 2006. Big Piney Elk Herd Unit (E106) Brucellosis Management Action Plan. Wyoming Game and Fish Department, Cheyenne, WY.

Wyoming Game and Fish Department. 2016. Big Piney Elk Herd Unit (E106) Brucellosis Management Action Plan. Wyoming Game and Fish Department, Cheyenne, WY.

Wyoming Game and Fish Department. 2018. 2017 brucellosis surveillance in non-feedground elk herds, March 2018. Wyoming Game and Fish Department, Cheyenne, WY.