Gooseberry Elk Herd Unit (E214)
Brucellosis Management Action Plan Update
Wyoming Game and Fish Department
July 11, 2019

A. Introduction and Herd Unit Overview

The Gooseberry elk herd unit (GEH) Brucellosis Management Action Plan (BMAP) evaluates potential brucellosis management recommendations. Meetings were held among Wyoming Game and Fish Department (WGFD) and Wyoming Livestock Board (WLSB) personnel, interested livestock producers, federal land managers, and non-government organizations to review the ecology and current status of brucellosis in the GEH and feasibility and potential success of BMAP options. WGFD will update this plan as needed.

The GEH is located in the southwest corner of the Bighorn River Basin in Park and Hot Springs Counties Wyoming and includes Elk Hunt Areas (HA) 62, 63, and 64. Much of the GEH is encompassed by the Wyoming Brucellosis Designated Surveillance Area (DSA) running along the West Cottonwood Road and South Fork of Owl Creek in Hot Springs County (Fig. 1A). Private land accounts for 429 mi^2 (27%) of the area in the GEH. The Wind River Reservation (363 mi^2, 23%), Bureau of Land Management (BLM; 361 mi^2, 23%), U. S. Forest Service (USFS; 318 mi^2, 20%), and State of Wyoming (120 mi^2, 8%) are responsible for management of the remaining land surface area. From west to east, habitat consists of forested mountains and sagebrush/grassland canyons and foothills interspersed with riparian and agricultural ecotones along Gooseberry Creek, Cottonwood Creek, and Owl Creek. Climate consists of cold winters and ephemeral snowpack in foothills, and hot summers with limited precipitation.

Total area of the GEH is approximately 1,272 mi^2, of which 725 mi^2 (57%) are currently delineated by the WGFD as occupied elk habitat. Of 725 mi^2 of occupied elk habitat, approximately 296 mi^2 (41%) are delineated as Crucial Winter range, 234 mi^2 (32%) as Winter range, and 195 mi^2 (27 %) as Spring-Summer-Fall range. About 120 mi^2 (8%) are designated as Parturition range (Fig. 1B).

From 1991 to 2017, 5-yr average seroprevalence estimates of hunter-harvested elk increased from about 2% to 23% (WGFD 2018). From 2017 hunter-harvested elk, seroprevalence was 17%, 14%, and 10% in HA 62, 63, and 64, respectively. The trend of diminishing seroprevalence from HA 62 to 64 (north to south) is consistent among years (WGFD unpublished data). Observations suggest elk in the GEH were historically migratory with more non-migratory (i.e., resident) elk now than 20 years ago (WGFD unpublished data). Potential causes of recent increase in seroprevalence include large, dense elk groups on winter ranges, 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 the increase in resident elk is likely promoted by effects of wolves, land use, availability of suitable habitat, and climatic changes (Middleton 2013, Proffitt et al. 2011, Proffitt et al. 2015). Since 1990, one livestock herd within HA 63 was quarantined (Brennan et al. 2017).

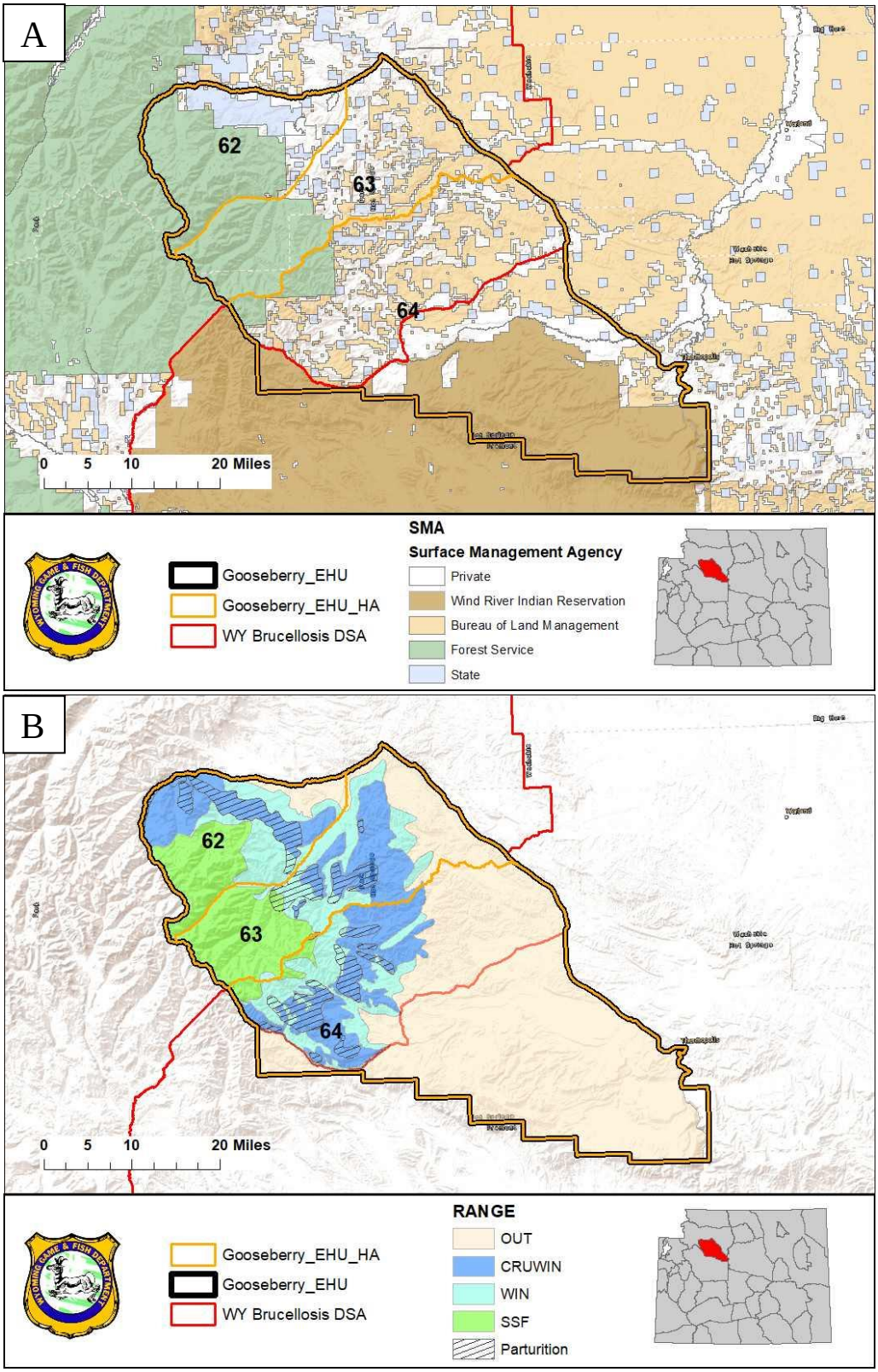

Figure 1. Gooseberry elk herd unit, elk hunt areas, and land ownership (A); seasonal and parturition ranges (B); and the WY brucellosis designated surveillance area boundary.

B. Brucellosis Management Options

Listed below are potential options for managing brucellosis in the GEH. 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 wildlife in the Greater Yellowstone Ecosystem (GYE) if feasible; maintain livestock producer viability, established elk herd unit objectives, range health; 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 commingling with domestic livestock and damaging stored crops.
4. Reducing numbers of elk through increased harvest.
5. Reporting to 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 other means and discharge of cracker-shells) is often used to prevent commingling 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 total 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 occur occasionally throughout the GEH, particularly along the Greybull River with diminishing frequency away from foothills. Hazing operations are often conducted solely by WGFD personnel, yet depending on discretion of the 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 maximize reduction of group size and density of free-range elk during the brucellosis transmission period in areas away from cattle. Consultation and cooperation among private landowner(s)/permittee(s) and land management agency(ies) is likely 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 influence elk distribution
- 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 1968, about 220,000 acres of sagebrush/grassland and conifer forests in the GEH have been treated with fire (193,119 acres), herbicide (23,598 acres), and mechanical (3,036 acres) treatments (Fig 2). Opportunities exist in the GEH for habitat enhancement aimed at increasing the quality and quantity of forage. This has the potential to reduce elk density during the abortion period on winter ranges in the sagebrush/grassland foothills, particularly in HA 62, and on transitional and summer ranges.

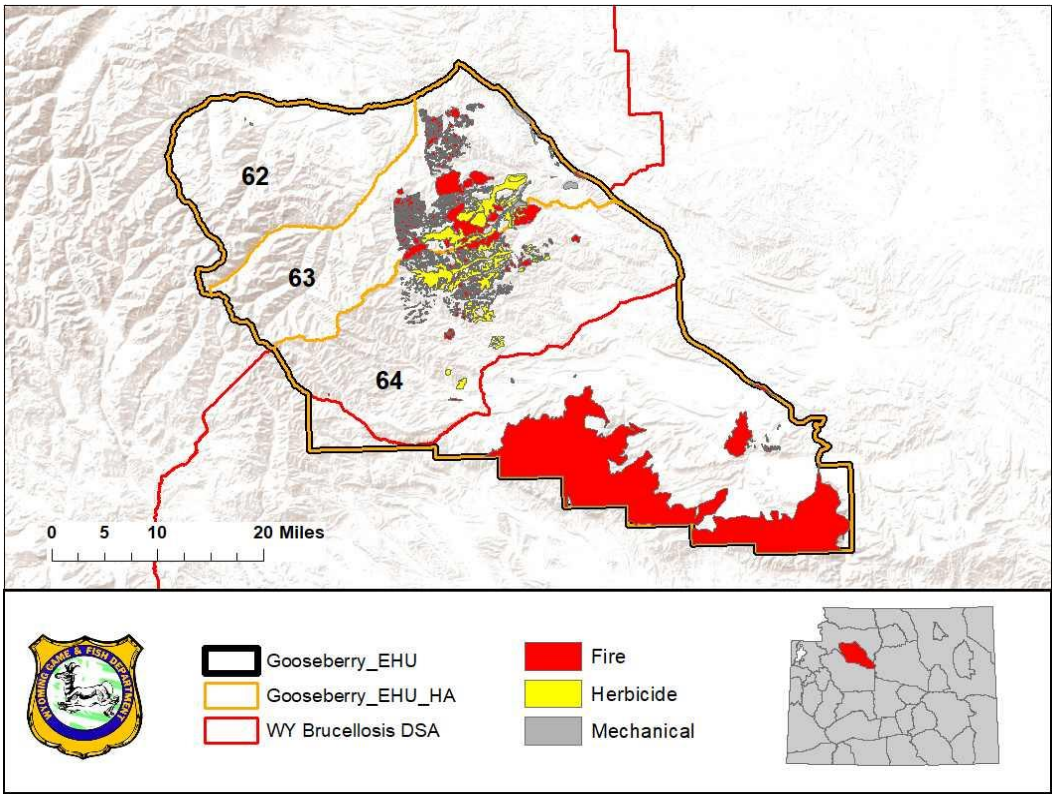

Figure 2. Habitat Treatments in the Gooseberry elk herd unit, 1960-2017.

3. *Fencing*

Game-proof fencing of haystacks reduces risk of damage and commingling by eliminating food attractants. For pasture fences, switching from 5- or 6-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 collisions. Fencing of winter cattle feedlines 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 GEH. 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 GEH is likely not possible because of conflicts with seasonal migrations 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 GEH 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 to Bighorn Mountains
- Increase hunting opportunities and license revenues in the short-term
- Reduced 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 land
- Loss of some hunting opportunity in the long-term

The 2017 post-hunt population trend count for the GEH was 2,597 elk. The 3-year average (2015-2017) trend count was 2,472 elk. The WGFC population objective is 2,000 (± 20%; i.e., ± 400) elk. From 2008-2017, hunting seasons were designed to reduce elk numbers throughout the GEH to the population objective of 2,000 elk. In HAs 62-64, days available to hunt, number of limited quota cow/calf licenses issued, and harvest peaked in 2013 and 2014 and was coupled with a successful Hunter Management Access Program.

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 finding 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 brucellosis transmission during removal/cleaning

Implementing a practice in the GEH wherein public and/or private individuals notify WGFD personnel who remove materials and clean-up site (e.g., remove contaminated vegetation, sterilize with 50:50 bleach:water) would reduce likelihood of transmission 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 to collect blood samples (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 sampling 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 GEH via random distribution of kits to

hunters from the WGFD Lab, HAs 62 and 63 have been sampled almost annually. Hunter management programs targeting specific populations around Meeteetse have provided copious sera and lymphatic tissue samples. Participating landowners have provided additional sera.

Seroprevalence in the GEH has risen substantially since 1990, averaging near 23% from 2012-2017 (WGFD 2018). Genotyping of *B. abortus* cultured from elk throughout the GYE and specifically in the GEH suggests origination near Jackson, Wyoming (Kamath et al. 2016).

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 GEH, fine-scale GPS data are currently being collected from 14 elk captured in February 2018 (Middleton unpublished data, WGFD unpublished data). These data will help identify migratory and resident elk populations, and coupled with corresponding seroprevalence data, could provide a foundation for development of risk maps. Deployment of additional GPS radio collars and vaginal implant transmitters in the GEH would benefit livestock, land, and wildlife managers in the GEH by not only helping confirm current risk, but 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 GEH, changes to land use and policy have included land management agency changes to livestock allotment turn-out dates, 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 GEH, Cody 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 GEH 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 in the GEH; 91% said there were resident (non-migratory) elk in the GEH, especially at lower elevations such as Cottonwood Creek and Putney Flats.

Among all options, responses were primarily 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., HA 63). Harvest sampling, including ongoing WGFD efforts to incentivize return of kits via 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 with 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 Gooseberry elk herd unit.

	% Response		
Option	Positive	Neutral	Negative
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 prescribed fire on foothill and mountain habitats 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 that 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. 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 who allow little or no hunting of brucellosis risk; 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 hunting allowed; and coordinate with WSLB to develop a livestock herd plan.

2. *Intra-Agency Meetings*
From July 2017 to April 2018, several informal conversations occurred between the Cody wildlife disease biologist and various WGFD 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 GEH.

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 GEH, Cody 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 brucellosis management options for elk, responses of attendees were generally positive (Table 2). Increased number of licenses, season length, and harvest of elk in HA 63 was especially supported. There was substantial interest in elk population, harvest, seroprevalence, and GPS data, with much discussion of population sampling methods. Additional suggestions included refining elk counts with flights, 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 Gooseberry elk herd unit.

	% Response		
Option	Positive	Neutral	Negative
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 and winter range areas of the GEH.

3. *Fencing*
WGFD will continue to provide elk-proof stack yards to producers in the GEH 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 maintain elk populations at objective, or reduce specific populations or segments of the population where undesired, by one or more of the following: promoting and sustaining adequate hunter access to populations; maintaining or expanding season length; and increasing license numbers (particularly cow/calf licenses).

5. *Reporting Abortions*
WGFD will encourage stakeholders to report and provide detailed location (e.g., UTM, Lat/Long) of aborted materials (fetus, placenta, and 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 Lab. 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 GEH through continued mailing and distribution of kits to hunters, outfitters, guides, livestock producers, license agents, and other interested parties. To increase return of useable blood 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 and sample lymphatic tissue when available.

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 trades) will be addressed as needed or as the opportunities arise.

F. Additional Actions

1. *Education*

Despite the relative familiarity of stakeholders in the GEH regarding fundamental brucellosis ecology and management, many individuals are presumed unfamiliar with the disease and the potential negative impacts resulting from the transmission 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 HA 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 WY offers a no-cost, biological control of aborted materials (WGFD 2016).

In the GEH, 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 limited human presence, many wintering elk, and few livestock would minimize risk of livestock depredation. During meetings to discuss and develop the GEH 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 GEH, 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, both?
E. Does lethal removal (or lack thereof) 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 maps generated from elk GPS locations prevent spillover transmission to cattle?

I. Do antler hunters displace elk into livestock?
J. Do seasonal area closures affect brucellosis prevalence in elk and spillover to cattle?
K. Does immunocontraception control seroprevalence and population size in elk?

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