Wyoming Elk Feedgrounds Management Plan

Wyoming Game and Fish Department

Cheyenne, Wyoming

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Commission President

Signed: Richard A. Ladwig

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The Elk Feedgrounds Public Collaborative was facilitated by Tara Kuipers of Tara Kuipers Consulting LLC based in Cody, Wyoming.

The internal Wyoming Game and Fish Department's Elk Feedgrounds Steering Committee developed and provided technical information and oversight to the Elk Feedgrounds Public Collaborative and drafted the Wyoming Elk Feedgrounds Plan. Members include Dr. Samantha Allen (State Wildlife Veterinarian); Raymond Bredehoft (Habitat and Access Branch Supervisor); Hank Edwards (Wildlife Health Laboratory Supervisor-retired); Scott Edberg (Wildlife Division

Deputy Chief-retired); Mark Gocke (Jackson-Pinedale Region Public Information Specialist); Gary Hornberger (Elk Feedgrounds Supervisor); Brad Hovinga (Jackson Region Wildlife Supervisor); Dave Hyde (Elk Feedgrounds Manager); Jordan Kraft (South Pinedale Game Warden); John Lund (Pinedale Region Wildlife Supervisor); Janet Milek (Casper Region Public Information Specialist); Jared Rogerson (Pinedale Region Wildlife Disease Biologist); Brandon Scurlock (Pinedale Region Wildlife Management Coordinator); Cheyenne Stewart (Jackson Region Wildlife Management Coordinator); and Ben Wise (Jackson Region Wildlife Disease Biologist).

The Wyoming Game and Fish Department Elk Feedgrounds Steering Team consulted with local representatives from partnering Federal agencies that have an interest in elk management and elk feedgrounds. Those representatives included Frank Durbian (Refuge Manager, National Elk Refuge, U.S. Fish and Wildlife Service); Eric Cole (Senior Wildlife Biologist, National Elk Refuge, U.S. Fish and Wildlife Service); Douglas "Gus" Smith (Division Lead Science and Resource Management, Grand Teton National Park, National Park Service); James Wilder (Forest Wildlife Biologist, Bridger-Teton National Forest, U.S. Forest Service); Mark Thonoff (Wildlife Biologist, Pinedale Field Office, Bureau of Land Management).

Special assistance in the Wildlife Disease Shared Learning session was provided by Dr. Jennifer Malmberg, previously Assistant Professor at the University of Wyoming and Disease Pathologist at the Wyoming State Veterinary Laboratory, currently Supervisory Research Biologist and CWD Project Leader with USDA APHIS Wildlife Services.

Message from the Director

Wyoming is blessed with incredible wildlife resources, vast landscapes and some of the healthiest big game herds in the world. The same species that existed 1,000 years ago still roam their historic home ranges. For well over a century, Wyomingites have dedicated their lives to conserving wildlife and protecting natural resources. This dedication served as the catapult to initiate the first elk feedground. Severe winters from 1909-11 took a toll on elk and resulted in severe mortality. Leaders at that time, with the best tools and technology available, established the first elk feedground to address the needs of starving elk and prevent damage to haystacks. Today, we continue to live with the positive and negative consequences of their decisions. As is the case with many wildlife management challenges, natural systems and human interaction with wildlife evolve over time creating needs for on-the-ground management to adapt.

The complexities of elk feedground management in western Wyoming create a situation where our challenges today are much more difficult than they were in the early 1900s. Wildlife and domestic animal diseases, land ownership patterns and jurisdictions, actions by courts, differing values among stakeholders as well as habitat fragmentation are issues bearing on the growingly difficult challenges of elk and elk feedground management.

Our current policies and the current state of the ecosystem evolved for more than 100 years. When supplemental elk feeding began in the early 1900s in Jackson Hole, Grand Teton National Park did not exist. The National Elk Refuge was in its infancy. Federal statutes like the National Environmental Policy Act and the Endangered Species Act did not exist. Brucellosis was new to the country and chronic wasting disease was not known to exist. Agriculture was an important land use as it is today, but the manner in which domestic livestock was produced was different. It is important for all to note the fact that the actions and decisions that resulted in our current state are measured in decades rather than years. As we evolve this system for the future, it is not reasonable or responsible to force quick, large-scale policy changes. Historic timeframes and transitions will continue to define the course.

The Plan is intended to chart a long-range path for feedground management. It is not a feedground closure plan. It is a road map to identify a responsible set of actions that will guide the manner in which all involved make decisions to deal with current and emerging challenges and conflicts. The Plan creates a process and venue to discuss and analyze ways to reduce our reliance on supplemental feeding in places where it's feasible, and in a way that protects the values and objectives feedgrounds achieve today. This isn’t a novel or new idea. Throughout the history of feedground management, the Department has made necessary changes to add feedgrounds, eliminate feedgrounds, reduce feeding season length and conduct emergency feeding.

We all have a goal to protect domestic livestock from diseases that are transmitted from wildlife, protect private property, provide elk hunting and viewing opportunities and mitigate interspecies competition. The Sideboards identified throughout the plan are based on these guiding objectives. These goals are important today and will be in the future. The Plan was developed with significant input by stakeholders and takes a responsible and reasonable approach to feedground management by using the best and newest science.

The Plan is broad and offers an all-encompassing approach for all areas of western Wyoming where supplemental feeding occurs. It was developed to be intentionally broad. The actions that will occur as a result of the Plan are meant to be localized and include input from local stakeholders. It will require a more targeted, in-depth and site-specific analysis. The Plan is intended to create the framework for future analyses, discussions and decisions.

I am hopeful interested parties and stakeholders will continue to provide input and perspective as we work together to solve the challenges that are before us today. The Wyoming Game and Fish Department is acting in good faith to carry out its mission and statutory mandates to meet the expectations of Wyoming's citizens. It would be irresponsible for us to do otherwise or to ignore the facts we have before us. Wyoming has a long-standing, successful track record of handling complex problems in an inclusive manner informed by science. The Wyoming way worked before and it can work again as we attempt to make good decisions for the future of feedground management.

Brian Nesvik

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Executive Summary

The Wyoming Elk Feedgrounds Management Plan (Plan) provides direction for the Wyoming Game and Fish Department (Department) on elk management in herds that encompass the current 21 Department operated elk feedgrounds (feedgrounds). The Plan is applicable over both the near and long term. Plan implementation is adaptable by each individual feedground, management Strategy, and over time.

The Plan stemmed from the Department's 2020 Wyoming Chronic Wasting Disease (CWD) Management Plan's (CWD Plan) development process (WGFD 2020). During that process, it became apparent that the feedground system was overly complicated to incorporate into the CWD Plan. As a result, the "*Elk Feedgrounds: A Challenge We Can Take On*" public collaborative process was initiated. While CWD is a significant factor in feedground management, the ultimate goal was to consider all biological, social, economic, and political issues, along with wildlife diseases, to achieve a durable long-term Plan informed by a public process.

The Plan provides a summary of the initial Plan development process (Phase 1 and 2 - Section 1) and important background context to feedgrounds in Wyoming (Section 2). Using that background information, the Plan establishes management Direction, Sideboards, and Goals (Section 3). The Direction notes that "given everything we know about CWD, this disease changes the dynamics of the feedground system due to both disease impacts itself and management actions intended to mitigate those impacts. Given the Department's responsibility to manage for healthy and sustainable cervid (deer, elk, and moose) populations over the long-term, CWD cannot be disregarded." Because changes in feedground management could have negative consequences, Sideboards were developed to provide assurances to the public and affected stakeholders and must be adhered to as the Department works to accomplish the Goals of 1) promote elk health by limiting disease transmission while providing supplemental feed and 2) reduce reliance of elk on supplemental feed while adhering to the Sideboards. The Sideboards are to 1) adhere to standard Department process for elk herd unit population objective review with public process and Wyoming Game and Fish Commission (Commission) approval for any proposed changes, 2) prioritize hunting opportunities as the primary tool to manage elk populations toward the Commission-approved herd unit objectives, 3) minimize elk damage to private property, disease transmission to livestock, and negative economic impacts to livestock producers, and 4) minimize competition with other wintering wildlife species. In order to accomplish the Goals, a suite of Management Strategies (Strategies) are presented (Section 3).

Each feedground presents a unique situation that necessitates a tailored management approach. Thus, the Plan outlines the process for developing Feedground Management Action Plans (FMAPs) for each elk herd with feedgrounds (Section 4). FMAPs will use the best available science, expertise, and local knowledge on how to uniquely implement the Management Strategies as appropriate on each feedground. FMAPs will consider both immediate and long-term obstacles, outstanding questions, and solutions in collaboration with stakeholders. Progress will be reported annually in the Job Completion Report (JCR) for each respective elk herd for both Department and public tracking and accountability. The Plan will only be successful over the long-term if Management Strategies are implemented as soon as they become viable in relation to each feedground. The Plan and the forthcoming FMAPs provide the necessary framework for that success.

SECTION 1- Summary of Phases I and II

1.1 Background

In 2018, the Commission directed the Department to develop a statewide CWD Plan, which was approved by the Commission in 2020 (Wyoming Game and Fish Department (WGFD) 2020). During that process, it became apparent that the elk feedground system was unique and overly complicated to incorporate into the CWD Plan. To move forward with the CWD Plan for implementation outside of the feedground herd units, the Commission directed the Department to develop a CWD plan specific to feedgrounds, which was the inception of a new Department initiative called "*Elk Feedgrounds: A Challenge We Can Take On*." The initiative was a collaborative process consisting of an internal Department steering team and a large-scale public and stakeholder engagement process facilitated by a third-party facilitator.

While CWD is a significant factor in feedgrounds management, the ultimate goal of the feedgrounds collaborative process was to consider all biological, social, economic, and political issues, along with wildlife diseases, to achieve a durable long-term feedgrounds management plan informed by a public process for Department-operated feedgrounds.

1.2 Phase I: Public Meetings, Shared Learning, and Stakeholder Meetings

Phase I of the feedgrounds collaborative process was launched in December 2020 with four public meetings that were held virtually due to the COVID-19 pandemic. Phase I was designed to share information on feedground history, current operations, and related disease concerns. Phase I was also designed to gather feedback on key feedground-related issues and inform how these issues were to be addressed in Phase II. Major Phase I themes are summarized in the "*Elk Feedgrounds: A Challenge We Can Take On*; Phase I Collaborative Process," February 2021 report (Kuipers 2021).

1.3 Phase II: Elk Feedground Management Plan

Phase II began in July of 2021, with six public meetings being held across the state (Laramie, Rock Springs, Casper, Afton, Pinedale, Jackson) to explain the public collaborative process moving forward and invite those interested to become a Phase II stakeholder. A total of 60 members of the public volunteered to be stakeholders representing six distinct interest groups: government/elected officials, landowners, NGOs, outfitters, sportspersons, and the general public. Stakeholders were assigned to the interest group they most identified with. While they were not invited to author the Plan or reach a consensus on management directions, stakeholders were invited to provide meaningful input beyond the binary "open vs. closed" perspectives of feedground management, to offer more creative and long-term solutions to be considered for the Department's Plan.

Feedback from the stakeholder groups was used to generate a comprehensive list of topics for a shared learning process. Subject-matter experts presented information on these topics weekly beginning in November 2021 and concluding in February 2022. Following the shared learning process, stakeholder groups met individually to provide feedback to the Department on their concerns and suggestions for developing the Plan. Directly relevant to the Plan, five common

themes emerged from stakeholder input: 1) solutions to complex issues surrounding feedgrounds require a long-term approach, 2) the Plan must take a multi-pronged approach, 3) the Plan must remain adaptable, 4) decision-making should remain at the local and state levels, and 5) plans need to be feedground-specific. All feedback from the stakeholder interest groups was analyzed and summarized by the independent facilitator.

Work on a draft Plan began in late spring 2022 and was released to the public and reviewed with the stakeholders on June 30, 2023. Four public meetings, three in-person and one virtual, were held in late July 2023 to publicly discuss the draft Plan. A final in-person stakeholder meeting was held on August 30, 2023, to answer any remaining questions and gather final input from the stakeholder interest groups. Feedback received was assessed and either incorporated into the Plan or archived for incorporation into the forthcoming Phase III FMAP process, as appropriate.

Valuable comments from both stakeholders and the general public were received, and extensive changes were made to the draft Plan. Revision to the draft Plan focused on clarifying Sideboards to accomplishing the Goals, clearly addressing brucellosis management, adherence to Department processes (new and existing), defining metrics of success, addressing conflicting language, ensuring utilization of public processes, providing adaptive CWD management implementation, incorporating stakeholder input, developing funding mechanisms, and defining the Phase III FMAP process.

SECTION 2- Historical and Current Context

This Section describes and quantifies the historical and current context of the feedground system. It is critical to understand the evolution of feedground management to best plan for the future.

2.1 Elk Feedgrounds

2.1.1 History

Wyoming began feeding elk in the Jackson area in the winter of 1909-1910 (the Department did not yet exist). The federal government became involved in 1912 with the creation of the National Elk Refuge (NER). While efforts to reduce elk starvation were the initial driving force, using feedgrounds to reduce damage to private property later became a management tool and was a major factor in the expansion of feedgrounds throughout the Jackson and Pinedale areas of western Wyoming. In 1929, the Wyoming legislature passed legislation making the Commission financially liable for elk damage to hay and private property. While maintaining elk numbers and damage prevention was the basis for implementing supplemental feeding, the value of providing separation between cattle and elk for disease prevention (namely brucellosis) became recognized in later years.

In 1929, storage sheds were built in the Gros Ventre River drainage, in the Upper Green River drainage near the mouth of Roaring Fork, and at the forks of Big and Little Greys rivers. Hay and cottonseed cake were stored in these sheds and fed if necessary to prevent elk starvation (Dean 2016). Starting in the late 1940s and increasingly in the 1950s and 1960s, the number of

feedgrounds in Sublette County increased. A total of 14 feedgrounds were created during this period, two of which, Reardon Canyon and Deer Hills, were later terminated. Elk were also fed at several locations in the Blackrock/Moran area in Teton County from the early 1930s through 1972 when feeding was terminated. From 1973 through 2020, elk were regularly fed in Buffalo Valley on an 'emergency' basis to facilitate elk/cattle separation for disease and damage concerns. Elk have also been periodically fed on an 'emergency' basis in Star Valley and various locations throughout Teton, Lincoln, and Sublette Counties.

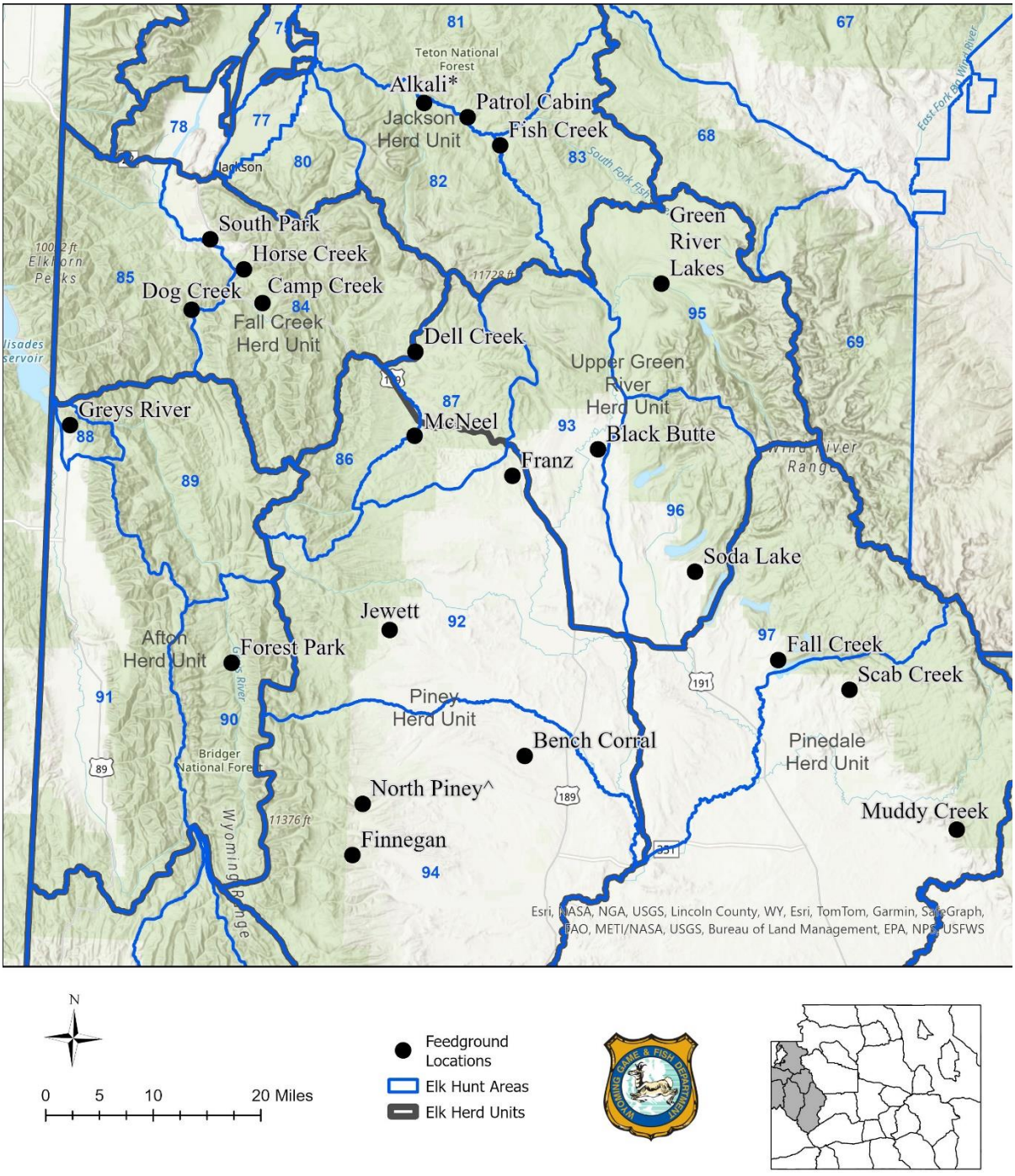
Management of feedgrounds has evolved as changes in equipment, personnel, public awareness, disease, and damage issues have occurred. The feeding frequency, length of the feeding season, and the amount fed per elk have all changed over time. In the early years of feedgrounds, elk were not fed daily, feeding seasons consisted of a few days, and the amount of hay fed per elk was inadequate to provide for the caloric needs of the number of elk being fed to survive winter. There were gradual adjustments until feeding was conducted daily and the feeding season length was increased. Elk were held in certain areas to control their distribution for conflict reduction, and feed was provided based on the nutritional needs of elk.

2.1.2 Current Operations

The Department currently operates 21 winter feedgrounds in Teton, Lincoln, and Sublette counties on state, federal, and private lands (Figure 1). The United States Fish and Wildlife Service (USFWS) operates the NER in Teton County. The goals of providing supplemental feed to elk during winter remain similar to when feedgrounds were initially established; feedgrounds reduce the potential for the starvation of elk (especially calves), elevate elk numbers beyond what available native winter ranges could support and help control elk distribution during winter to reduce damage to stored crops and elk/cattle commingling. Another by-product of some feedgrounds is that they may reduce elk-vehicle collisions. The most recently established feedground was Forest Park (1980). The most recently terminated feedground was Alkali, as decided in the United States Forest Service (USDA FS) 2019 Alkali Creek Feedground Five Year Permit memo, which stemmed from a September 2018 court decision (USDA FS 2019, D. Wyo. 2018). The 2019 permit allowed for emergency feeding given specific parameters for the 2019-2024 seasons, followed by permit expiration and termination. Elk that were formerly fed at the Alkali feedground are now fed at the nearby Patrol Cabin and Fish Creek feedgrounds, as well as the NER. The North Piney feedground has only been used in recent years as a staging area to gather elk in December; these elk then migrate to Bench Corral feedground where feeding seasons are relatively shorter.

Department personnel collate feedground metrics (i.e., season length, elk numbers, tons of hay distributed) and annually report relevant management information in the JCR for the respective herd units. The feeding season is defined as Nov 1 through April 30 of the following year. A herd unit (herd) is an established geographic area that encompasses the entire lifecycle of a species, ideally with less than 10% interchange between herds. From 2001 to 2021, an average of 14,928 elk were fed an average of 6,333 tons of hay each feeding season. The long-term average feeding season is 122 days.

Figure 1. Feedground locations and names (black) with corresponding elk herd units (dark gray) and hunt areas (blue).



*The Alkali feedground permit allows emergency feeding for the 2019-2024 seasons, followed by termination.

^The North Piney feedground is used as a staging area for elk that move to Bench Corral.

Pasture grass and alfalfa hay have been the primary feeds since the inception of feedgrounds, although concentrates, primarily in the form of pellets, have been used periodically. Before the development of baling machines in the 1930s, hay was harvested and fed in loose form. The feeding of baled hay prevails today. The NER fed loose or baled hay from 1912 until 1972, when the NER switched to pelleted alfalfa due largely to the ease of feeding with large machinery and reductions in feeding times and disease transmission rates (Dean 2016).

The source of hay has gradually changed over time. In the early years, due to limitations with transportation, hay was secured from producers who lived near individual feedgrounds. Local hay production declined beginning in the 1990s, necessitating hay being purchased out of state (Idaho). The Department has also produced limited quantities of hay on Wildlife Habitat Management Areas (WHMA) for feeding elk. In 1975, the Department acquired the rights from the National Wildlife Refuge System near Fontenelle Reservoir to farm the Seedskadee Wildlife Unit. However, the price of hay from the private sector was generally lower than production costs at Seedskadee, and operations were terminated in 1988 (Dean 2016). Since 2015, the Department has been producing hay for feedground use at South Park, Horse Creek, Spence Moriarity, and Whiskey Basin WHMA.

Small square bales of hay are preferred for feeding on Department feedgrounds because they can be manually loaded on a sleigh and pulled by a team of draft horses. However, small bales have become less available and more expensive over time, and large hay bales are now utilized more frequently. The large size of these bales requires a tractor for loading, creating maintenance and operation challenges in the remote settings of many feedgrounds.

Draft horse teams remain the primary method used to distribute hay on feedgrounds because the majority of feedgrounds are in remote locations without utilities. Feeders with horse teams distributing small hay bales remain an efficient method to feed elk daily. One person can operate draft horses pulling a sleigh and manage deep snow better than a wheeled tractor. However, with reduced production and increased costs of small bales, heavy equipment is becoming necessary to handle and load large bales on the sleighs. Tractors must be stored in a heated garage or utilize diesel-powered engine block heaters to start daily. Hay bale processors, which mechanically break up a hay bale and distribute the hay on the ground, have been used for several years with success. In 2021, a tracked tractor with a 3-point attached hay bale processor was purchased and has demonstrated the ability to negotiate deep snow, allowing for expanded hay distribution across the feedground and more efficient and safe hay handling/loading.

Feedgrounds have always been controversial, and their management options are complex. The response by the public and government agencies in the early 1900s ultimately set the stage for feedgrounds to be part of elk management in the Jackson and Pinedale areas. Criticisms of the practice followed and generally contended that elk numbers should not exceed the capacities of native ranges to support them. While few wildlife managers prefer feedgrounds over native elk winter range, feedgrounds have historically become an integral part of elk management in western Wyoming and have been effective in achieving their intended goals.

2.1.3 Feeding Alterations

To improve animal husbandry techniques, the Department has experimented with alterations to feeding methodologies. Early in the 1950s, it was reported that most of the elk that died on feedgrounds were calves. In response, the Department experimentally constructed a creep feeder at the South Park feedground to provide a physical barrier that only allowed access for calves (Anderson 1951). Hay bunks were used once during the spring of 1989 near and on the Fish Creek feedground (Dean 2016). Ultimately, the Department found creep feeders and hay bunks to be ineffective in improving animal husbandry.

The Department currently uses square bale spinners, which are bale processors that mount on the three-point hitch of a tractor. These processors are currently being used on four feedgrounds, where they efficiently allow for spreading the hay over a more significant portion of the feedground on a daily basis. Bale processors are cost-effective and require very little maintenance, but some feeding situations require that the tractor has tracks rather than tires, which are much more expensive, to negotiate deep snow and variable terrain.

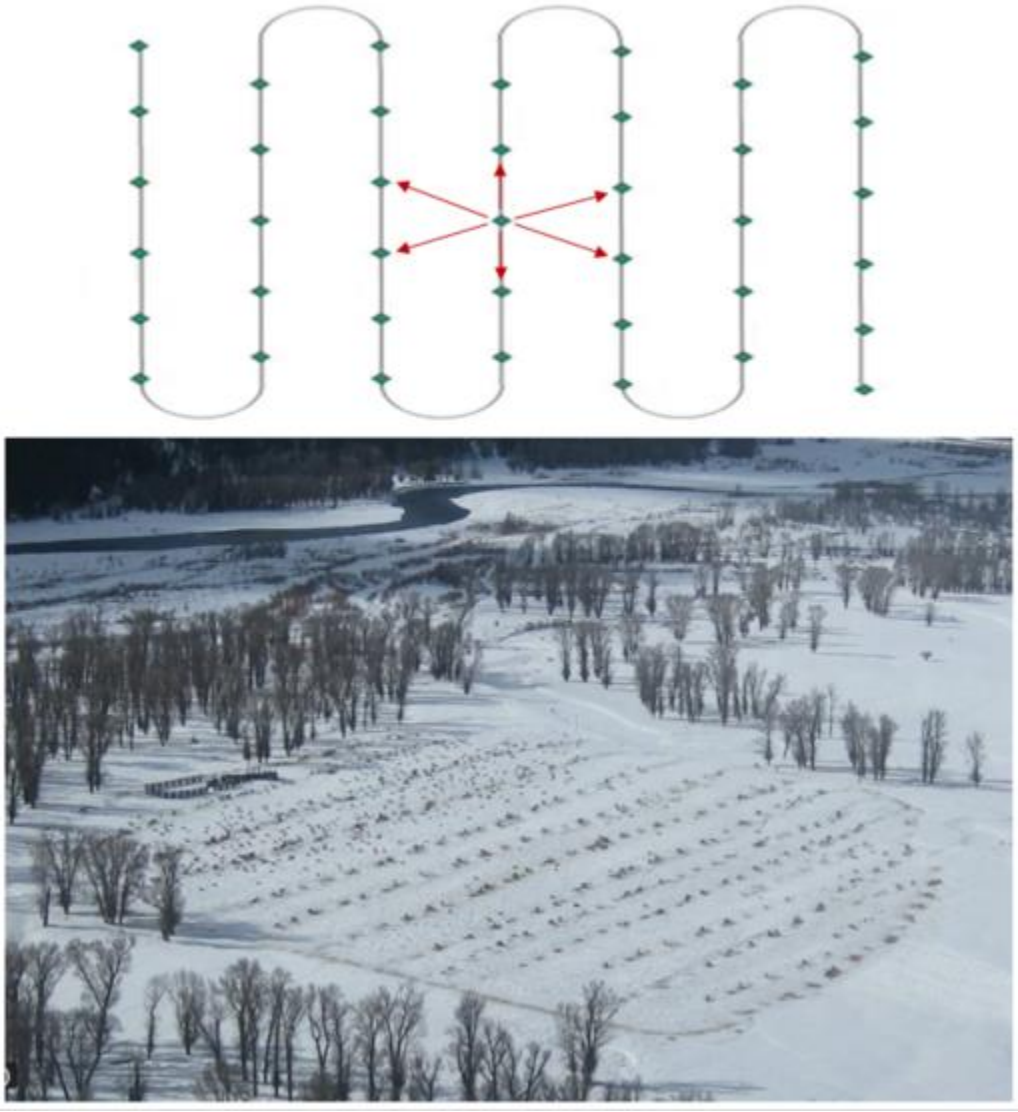
There are currently three feeding methodologies that can reduce elk densities while on feed: 1) low-density (LD) feeding, 2) early feeding end dates, and 3) delayed start dates. In 2008, the Department introduced LD feeding and early end dates as two new research-based feedground management strategies. These techniques have been found to be a cost-effective way to significantly and sustainably lower brucellosis prevalence among feedground elk.

LD feeding works by reducing elk contact with brucellosis-induced abortions. Traditional feedlines consist of a linear distribution of hay piles spaced close together, and research has shown that the most significant transmission of brucellosis via elk-fetus contact occurs while elk are congregated on feedlines (Maichak et al. 2009). This is likely due to the high density of elk during feeding time and because it encourages elk to walk along the same path. LD feeding is designed to diminish the significance of the disease ‘hotspot’ by reducing elk density during feeding and encouraging travel along many paths, thereby mimicking a free-ranging behavior. LD feeding is accomplished by spacing hay in larger piles but at wider intervals along numerous rows in a grid pattern. When viewed from above, the distribution of hay resembles a “checkerboard” (Figure 2). When administered consistently throughout the season and across years, significant reductions in brucellosis seroprevalence are expected while also reducing transmission of some other diseases (e.g., necrobacillosis). LD feeding is currently possible on all but four feedgrounds where there is either an inability to negotiate difficult terrain, extreme annual snow levels, or the available feeding area is not large enough for the current elk population. LD feeding has been implemented with varying degrees of success, largely inconsistently, since 2008 due to a variety of factors. As a result, LD feeding has only been adequately and consistently employed across 3 to 4 feedgrounds over the last several years.

Figure 2. Depiction of traditional feedline operations (a) and low-density feeding (b), with green diamonds representing hay piles, gray lines showing the feeding route, and red arrows depicting elk movement while being supplementally fed under the different methods.

(a)

(b)

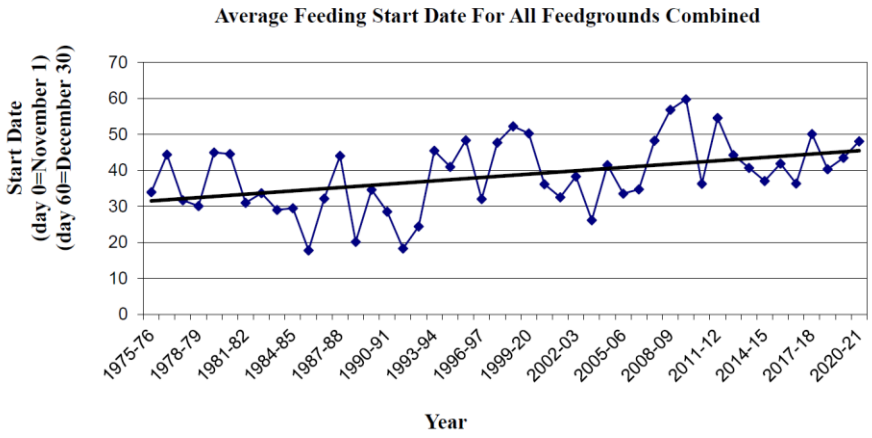


Traditional feeding operations typically initiate from mid-November thru January, depending on the feedground location, typical early snow levels, availability of native habitat, and level of risk of commingling with cattle and or private property damage. Traditional management of feeding termination has relied upon the presence of elk. Scenarios vary, but typically, elk attendance at a given feedground declines in spring as the snow recedes and native forage becomes accessible. Feeding continues until few or no elk return. The brucellosis transmission period is February through June but peaks in March through May (Cross et al. 2015). Though supplemental feeding initiates prior to the brucellosis transmission period, feeding end dates can range from late February to early May, overlapping to varying degrees with the peak period of transmission. While snowpack is the most influential component driving end-feeding dates, other management factors can impact when elk leave feedgrounds, including hay type (i.e., alfalfa, grass, or mix), hay quantity/quantity, quantity/quality of available native forage and level of disturbance. Most variation in brucellosis seroprevalence among elk attending feedgrounds can be explained by the end feeding date (Cross et al. 2007).

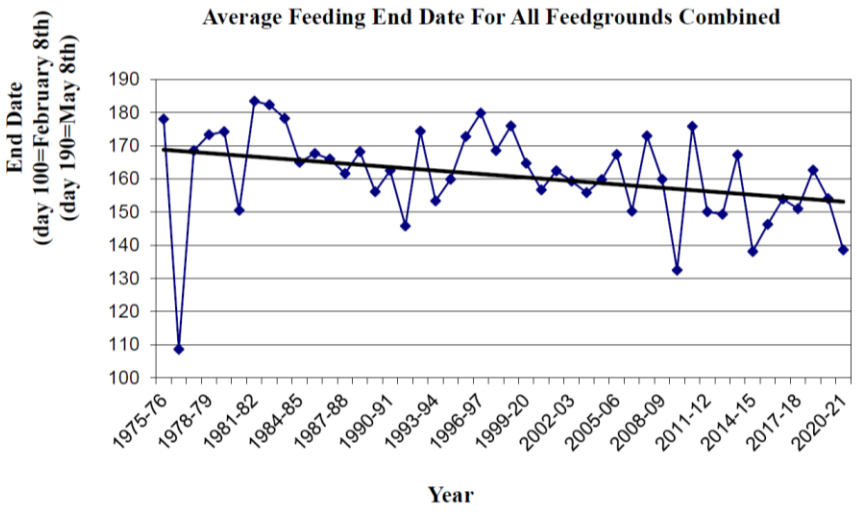
The tool of early end-date management was first introduced in 2008. Ending seasonal supplemental feeding as early as possible in late winter/early spring aims to narrow the overlap of the feeding season with the brucellosis transmission period. This is accomplished by systematically reducing hay rations as adjacent native forage becomes accessible in the receding snow. It is difficult to quantify how much earlier supplemental feeding ended in a given year, as it is unknown when elk would have voluntarily abandoned the feed when offered (Section 2.5.2). However, a change in the average feeding end date over many years can be quantified (Figure 3b). Other benefits have been observed from early end dates, such as the reduction of necrobacillosis incidents because elk are not being fed on dry ground, ice or water, and/or mud mixed with urine and feces. Early end-date management has been applied to as many as nine feedgrounds since 2008. Those feedgrounds were selected because they were associated with a relatively high availability of late-winter/early-spring native forage coupled with a low risk of commingling with cattle. Regional managers continue to end feeding as early as possible, given the annual and feedground-specific concerns and opportunities. Though early end-date management has been a tool implemented due to the existing disease, delayed feeding start dates may have additional benefits for incoming diseases such as CWD (Figure 3a).

Figure 3. Average feeding start (a) and end (b) dates for all feedgrounds combined from 1975 to 2021.

(a)



(b)



2.1.4 Legislation, Statutes, and Policy

The Department is statutorily charged with managing and protecting all Wyoming wildlife (Wyoming Statute (W.S.) § 23-1-103), and the Commission is directed and empowered to make suitable provisions for the feeding of elk as may be deemed necessary (W.S. § 23-1-302(a)(ix)). While the Commission has the statutory authority to feed elk, the Department is directed not to develop and operate any additional feedgrounds without approval. The supplemental feeding of elk and wild bison is outlined in Commission Policy (VII D - Supplemental Feeding of Elk/Wild Bison, July 13, 2006). Temporary feeding is also addressed in policy and may occur when Department managers identify an emergency and agreement is reached by the Department Director and Commissioner for the area(s) where the emergency exists.

W.S. § 23-1-305 states that feedgrounds can only permanently cease operations upon order of the Governor. To close a feedground, the Commission is statutorily required to concurrently provide its recommendation to the Governor and Wyoming Livestock Board (WLB). The statute requires WLB to provide its opinion to the Governor on whether they believe the closure of the feedground is appropriate. A minimum of one public meeting would be held in a location that fosters the most public participation by the people directly impacted by the proposed closure. Public comments would then be provided for the Governor's consideration on whether to issue a feedground closure order.

Commission Policy VII D (July 13, 2006) provides Department direction on feedground management.

> *Under most conditions the Commission discourages the private, intentional feeding of big and trophy game animals. In order to maintain established elk herd population objectives in the Jackson/Pinedale region, the Commission directs the Department to provide supplemental feed for elk as provided in this policy... The Commission recognizes the importance of supplying supplemental feed to elk [at existing Department feedgrounds]. The Commission also recognizes that without such feeding, the elk populations would have to be decreased significantly to levels that could be supported by the limited native range forage… It is recognized that the Commission approved herd unit population objectives exceed established*

total feedground quotas for each herd unit due to the presence of some elk wintering on native range. Recognizing that elk population objectives for each herd unit exceed the number of elk to be maintained on feedgrounds and the unpredictability of elk distribution considering habitat conditions, weather, and other factors that may influence the distribution of elk on Department operated feedgrounds, the Commission directs the Department to strive to manage feedgrounds for the total feedground elk quotas for each elk herd unit as listed in Table 1.

The number of elk on the NER is to be maintained in accordance with a mutually agreed upon number established cooperatively by the Commission through the Department and the USFWS. In 2007, the NER Bison Elk Management Plan and Environmental Impact Statement Record of Decision selected the Preferred Alternative to manage elk numbers to approximately 5,000 on the refuge (USFWS 2007).

The Department manages elk based on herd population objectives and public process (Section 2.2.2) and reports annually in the respective herd JCR. Due to variability in elk distributions at feedgrounds over time, the quotas established are not currently biologically relevant. They are primarily used to estimate budget needs and provide additional guidance to inform management decisions. The Plan recommends removing feedground quotas from Commission policy and incorporating them into herd objectives (Section 4.3.2). This would provide more clarity and continuity to managers when developing management proposals. This would also provide fewer administrative hurdles when quotas need updating but still require Commission approval through the herd objective review process.

2.1.5 Budget and Personnel

The Department's feedgrounds program is comprised of two full-time employees charged with operating 21 feedgrounds in Teton, Sublette, and Lincoln counties. Currently, 16 private contractors are hired annually to feed elk, with some contractors feeding elk on more than one feedground. Several private contractors are hired annually to produce, haul, and stack hay on each feedground during the summer. During 2022, the annual Commission budget for the feedgrounds program was $2.7 million, with the majority of that total spent on hay. Hayshed and other facility and road access maintenance are budgeted and managed by the Department's Habitat and Access Section with an approximate Commission budget of $400,000. The cumulative Commission feedground budget in 2022 was $3.1 million.

2.1.6 Research

Extensive research has been undertaken concerning feedgrounds, primarily instigated by the implementation of the Brucellosis Management Action Plans (BMAPs) as mandated by the Wyoming Brucellosis Coordination Team (BCT). The inception of this research dates back to 2006, with the initial publications emerging in 2007. The studies have predominantly centered on brucellosis, often incorporating comparative analyses with diverse attributes of elk biology in relation to native free-ranging herds (Appendix 3).

Table 1. Elk feedground quotas and counts over the previous three winter feeding seasons. Table adapted from Commission Policy VII D (July 13, 2006) table.

Herd Unit	Feedground	Feedground Quota	Feedground Quota Sum	2020/21-2022/23 Winter Count Average (Range)
Afton (E105)	Greys River	1,000	1,750	533 (471 - 583)
	Forest Park	750		584 (399 - 703)
Piney (E106)	Bench Corral	250	2,150	1,083 (600 – 1,407)
	Finnegan	400		457 (407 – 524)
	Franz	450		389 (89 – 622)
	Jewett	650		440 (345 – 505)
	North Piney*****	400		No elk counted
	McNeel*	600		940 (779 – 1,050)
Fall Creek (E103)	Camp Creek	900	3,950	1,050 (948 – 1,249)
	Horse Creek	1,250		1,570 (1,043 - 1,934)
	Dog Creek	800		803 (518 - 1,014)
	South Park	1,000		866 (786 - 949)
Green River (E107)	Black Butte	500	1,975	1,039 (918 – 1,263)
	Green River	675		734 (698 – 774)
	Soda Lake	800		929 (0 – 944)******
	Dell Creek*	400		571 (529 – 596)
Jackson (E101)	Alkali**	800	2,450	No elk counted
	Fish Creek***	1,000		1,544 (1,228 – 1,859)
	Patrol Cabin***	650		
	National Elk Refuge****	5,000		7,712 (7,229 – 8,500)
Pinedale (E108)	Fall Creek	700	1,800	614 (0 – 708)******
	Muddy Creek	600		450 (368 – 515)
	Scab Creek	500		800 (745 – 862)

*The Dell Creek and McNeel feedgrounds were part of the Hoback elk herd unit, which was dissolved in 2022. Feedground quotas were added to the herd unit objectives in the Green River and Piney elk herd units, respectively.

**The Alkali feedground permit allows for emergency feeding for the 2019-2024 seasons, followed by termination.

***The Fish Creek and Patrol Cabin feedground counts are combined due to the elk moving between them and being classified at whichever one they occupy when classifications occur.

****The National Elk Refuge is not a Department managed feedground.

*****Elk at North Piney feedground migrate to Bench Corral feedground during January and are classified on the Bench Corral feedground.

******A “0” count indicates a year when elk were not fed at the feedground, and that year was not included in the average calculation.

2.2 Elk Population Ecology and Management

This Section describes the impacts of feedgrounds on elk population ecology and management, which are summarized in Table 2.

Table 2. Summary of feedground effects on elk population ecology and management.

Ecology or Management Issue	Effect	Description
Use of Native Winter Range	Reduced	Feedgrounds attract elk off of native winter range (Smith 2001).
Migration	Reduced	Feedgrounds have short-stopped historic migration routes, and fed elk spend less time on summer range (Jones et al. 2014).
Calf Ratios	Reduced and/or Increased	Feedgrounds can reduce calf winterkill on native winter range. Conversely, feedgrounds can increase calf mortality due to disease transmission on feedgrounds (Foley et al. 2015).
Elk Population	Increased	Feedgrounds allow for higher elk populations than would be sustainable without feedgrounds (Smith 2001).
Brucellosis Prevalence	Increased	Feedgrounds perpetuate brucellosis in elk by increasing prevalence rates among elk (Cotterill et al. 2018, Cross et al. 2007, Scurlock and Edwards 2010).
Elk/Cattle Commingling	Reduced and/or Increased	Feedgrounds help maintain separation between elk and cattle and consequently, brucellosis transmission from elk to cattle. Conversely, higher elk populations can increase elk/cattle commingling away from feedgrounds and outside the feeding season (Schumaker et al. 2012).
Damage to Private Property	Reduced and/or Increased	By attracting elk to feedgrounds, they cause less damage to private property, such as stacked hay consumption, forage consumption, and fence/infrastructure damage. Conversely, increased elk populations can increase the risk of damage (Schumaker et al. 2012).

2.2.1 Historical Winter Range and Elk Migrations

Numerous sources indicate that before the settlement of western Wyoming, some elk likely wintered at low elevations in the Snake, Gros Ventre, Hoback, Greys, and Green River valleys. Elk also likely migrated south to portions of the Red Desert, similar to present-day migrations of mule deer and pronghorn (Preble 1911, Allred 1950, Cromley 2000). Upon settlement and associated human development, conversions of native habitats to crops and the importation of

domestic livestock all likely contributed to the cessation of long-distance migrations of elk in western Wyoming by the early 1900s.

Presently, during years of low snow accumulations, habitats around Fall Creek, Scab Creek, Muddy Creek, Bench Corral, Green River Lakes, Patrol Cabin, Fish Creek, Forest Park, Horse Creek, Camp Creek, Dog Creek, and Soda Lake feedgrounds can support elk wintering on native ranges. Most elk migrations today are movements from high-elevation summer ranges to lower-elevation winter ranges, and elk attending feedgrounds spend approximately one month less time on summer ranges than elk utilizing native winter ranges (Jones et al. 2014). Elk are a highly adaptable species, and feedgrounds have changed their behavior.

2.2.2 Herd Unit Population Objectives

All elk herds in the Jackson and Pinedale regions with feedgrounds are managed toward Commission approved winter trend count population objectives. These trend-based objectives use a three-year average (+/- 20%) to account for variable winter conditions and elk distributions. Trend counts include classification counts from the ground at feedgrounds, usually during February, when elk attendance is presumed greatest and concurrent aerial surveys to document elk on native winter ranges. The feedgrounds were managed in seven herds until 2022 when the Hoback herd was dissolved and incorporated into the Green River and Piney herds. In 2022, five of the six elk herds containing feedgrounds in the Jackson and Pinedale regions were within 20 percent of the management objectives (WGFD 2022). Herd objectives are reviewed every five years, and if a change is proposed public meetings are held in the region, and Commission approval is sought.

Feedgrounds create a unique duality whereby their use reduces elk/cattle commingling and damage to private property while facilitating elevated populations and corresponding herd objectives. The historical precedence of feedground management maintaining elevated elk numbers, despite commingling and damage concerns, has led to some stakeholders preferring to maintain current herd objectives.

2.2.3 Elk Harvest

Wildlife managers are responsible for setting and maintaining elk herd objectives, and hunting has been the primary management tool used to meet those objectives. During the annual season-setting process, managers employ various methods to achieve the desired harvest, such as determining license quotas, offering additional antlerless and reduced-price cow/calf licenses, and altering season dates. In some herds, maintaining objectives as opposed to being over-objective can be difficult due to various challenges, such as the public desire to manage toward the upper limit of the herd objective, poor hunter access, and mild weather. Large ranches with limited hunter access can become refuge areas for elk, resulting in poor hunter harvest on accessible adjacent public and private lands. Elk harvest is directly correlated with snowfall, and warm, dry fall conditions can result in difficult hunting conditions and poor harvests. Currently, landowners who allow access are eligible to receive payments via landowner coupons ($16) for each antelope, deer, and elk harvested on their deeded land. The Department's Access Yes program provides monetary payments for landowners who enroll their property for public hunting access.

2.2.4 Large Carnivores

Since the reintroduction of gray wolves into the Greater Yellowstone Ecosystem (GYE) in 1994 and 1995, their interaction with and impacts on elk populations have been of considerable interest to wildlife managers and the public throughout Wyoming.

Predator-prey dynamics in the feedground system are still not completely understood. Gray wolves frequent feedgrounds during winter months, and variable levels of predation occur annually on or near feedgrounds. The Department does not conduct cause-specific mortality assessments on most elk winter mortalities, so it is difficult to quantify annual predation rates on feedgrounds. Woodruff and Jimenez (2019) studied wolf-elk interactions from 2000-2007 in the Gros Ventre drainage and found that 37% of wolf kills occurred on, and 63% occurred off of feedgrounds, and each gray wolf killed an average of 13 elk per winter (min=4, max=31). During the winter, when the most elk were killed on feedgrounds in this study (31 elk in 2002), there were a total of 4,398 elk classified on the Gros Ventre feedgrounds; therefore, wolves killed 0.7% (Woodruff and Jimenez 2019). Aside from direct mortality, gray wolves can affect elk behavior and can displace elk. Both elk and gray wolves are very adaptable and will change their behavior and movement based on external factors, such as supplemental feed, human disturbance, snow depth, topography, and predator-prey risk/availability dynamics (Barker et al. *in review*, Barker et al. 2023, Woodruff and Jimenez 2019). For elk, these behavior changes can be temporary and short-term (e.g., moving between feedgrounds) or long-term and generational (e.g., learned behavior by calves/yearlings perpetuating into future generations). For example, Barker et al. (*in review*) found that elk in the Jackson herd did not consistently alter their behavior in response to nearby gray wolves but exhibited a more nuanced approach to predation risk by altering their behavior only in areas where wolves were particularly likely to make kills (i.e., risky places based on topography (terrain traps), deeper snow, more canopy cover and in close proximity to snowmobile trails where wolves can travel more easily). The authors conclude that once elk have habituated to predation risk, they are less likely to leave areas of increased predation risk, as long as nutrition is not limited.

There is concern that if elk spend more time on private lands, wolves will follow suit. If that results in livestock depredations, the Department is statutorily (W.S. § 23-1-901) required to respond to reports of gray wolf and trophy game damage and compensate for verified livestock depredations. This includes depredations by gray wolves in the gray wolf trophy game and seasonal trophy game management areas. Increased wolf depredation creates negative impacts to livestock operations. Elk and gray wolf movement to lower elevations may also result in increased gray wolf harvest by hunters if it occurs during open hunting seasons.

The Department's Gray Wolf Management regulation (Chapter 21) permits the lethal removal of gray wolves when the Department determines that gray wolf-wild ungulate conflict has occurred at any state-operated elk feedground. Gray wolf-wild ungulate conflict is defined as when a gray wolf or wolves displace elk from a feedground, and it results in one of three conflicts: 1) damage to privately stored crops by displaced elk, 2) elk commingling with domestic livestock, or 3) displacement of elk from a feedground onto a highway right of way causes human safety concerns. The provisions in this regulation do not apply if the lethal removal of gray wolves may prevent the Department from achieving the management objectives.

Predators play both beneficial and complicating roles with respect to diseases present on feedgrounds. Gray wolves can create an additional feedground management dynamic by disrupting feeding operations, displacing elk to adjacent feedgrounds, and increasing the potential for elk damage and commingling with cattle by displacing elk from feedgrounds (Dean et al. 2004). Predators can also improve management by moving elk away from feedgrounds to spring transitional ranges and keeping elk from lingering in the feeding areas once the feed has been consumed. Additionally, predators can play an important role in reducing disease transmission by scavenging aborted fetuses and removing a source of brucellosis transmission (Maichak et al. 2009). In recognition of this, the removal of predators such as coyotes and foxes is not permitted on Department feedgrounds. Mountain lions have been observed on feedgrounds, but impacts have been minimal. Bear hibernation coincides with the feeding season, so they have had little to no impact on feedground management.

2.3 Federal, State, and Private Land Management

The 22 current feedgrounds are operated on a mixture of land ownerships. Some feedgrounds are operated over multiple jurisdictions (Fall Creek, Franz, and Dog Creek). Eight feedgrounds are operated on Commission-owned lands.

2.3.1 Bureau of Land Management (BLM)

Five of the Department's 21 feedgrounds are permitted on BLM lands through a Memorandum of Understanding, including Fall Creek (also on USDA FS and Commission land), Finnegan, Franz, North Piney, and Scab Creek feedgrounds. The BLM's mission is to sustain the health, diversity, and productivity of public lands for the use and enjoyment of present and future generations. The BLM manages habitat within land-use capabilities and is consistent with BLM's Planning System. The BLM places special management emphasis on public lands mutually established as being of unique importance to winter elk feeding programs. These public lands are used to meet the Department's elk population objectives through winter feeding to provide sustained harvest at levels compatible with habitat capabilities. The Pinedale BLM Resource Management Plan guides management in and adjacent to feedgrounds to maintain and improve habitat quality and ensure the continued viability of the feedgrounds

2.3.2 United States Forest Service (USDA FS)

There are eight Department-operated feedgrounds permitted on USDA FS lands on the Bridger-Teton National Forest (BTNF) through Special Use Permits (SUP), including Alkali (currently only available for emergency feeding and will be eliminated after 2024 based on a court decision), Dell Creek, Dog Creek (also on private land), Fall Creek (also on BLM and Commission land), Fish Creek, Forest Park, Green River Lakes, and Muddy Creek feedgrounds. The primary USDA FS considerations for these permits are the potential effects on USDA FS lands and any potential conflicts the operation may have with other public uses and USDA FS programs. The 1990 Bridger-Teton Land and Resource Management Plan (Forest Plan) guides management direction and decision-making on the BTNF and provides multiple uses and sustained yield. The Forest Plan ensures that feedground operations are consistent with relevant goals, objectives, and standards.

In 2022, the BTNF initiated an Environmental Impact Statement on the long-term special use permits for Dell Creek and Forest Park feedgrounds. The five other USDA FS SUPs expire in 2028. In 2023, the BTNF initiated public scoping for a Forest Plan Revision. No decisions on either of these projects have been made as of November 2023.

2.3.3 United States Fish and Wildlife Service (USFWS)

The USFWS operates a winter elk feeding program on the NER. The NER was established in 1912 as a winter game reserve for elk. Over time, the NER purpose has been legislatively broadened to include refuge and breeding grounds for birds and other big game animals, the conservation of fish and wildlife, and the protection of natural resources and conservation of threatened and endangered species. The NER winter elk feeding program is currently guided by the 2019 Bison and Elk Management Step-Down Plan (Step Down Plan), which is a structured framework for reducing the reliance of elk and bison on supplemental feeding over a five-year period. The Step Down Plan involves joint management and coordination with Grand Teton National Park (GTNP) and the Department because elk that winter on the NER includes the Yellowstone, GTNP, Teton Wilderness, and Gros Ventre segments of the Jackson elk herd. The specific management goal of the 2019 Step-Down Plan for elk is to work towards reducing the average number of elk on feed to 5,000 while maintaining the Department's Jackson elk herd objective of 11,000 (USFWS 2019). A lawsuit filed by Defenders of Wildlife in 2020 challenged the USFWS plan to reduce reliance on supplemental feed on the NER through a "Step Down" plan. The lawsuit challenged the timeline of the plan and the "inadequate response" due to the urgent threat of CWD among elk on the NER (Case# 1:19-cv-00746-TSC). In 2023, the NER announced a Notice of Intent to develop an update to the 2007 Bison and Elk Management Plan (BEMP) and associated environmental impact statement. The process is ongoing at the time of publishing this Plan.

2.3.4 National Park Service (NPS)

GTNP actively assists in managing the Jackson elk herd through their elk reduction program (ERP). The laws, regulations, and policies guiding GTNP on wildlife management have the purpose of conserving the scenery, the natural and historical objects, and the wildlife therein, to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. The GTNP enabling legislation in 1950 authorized the ERP, a joint effort between the Department and GTNP utilizing hunters licensed by the State of Wyoming and deputized as rangers by the Secretary of the Interior for the proper management and protection of the elk. The annual ERP season structure and quotas are determined jointly by the Department and GTNP; the annual need to conduct the ERP is based on managing toward objectives. The GTNP has four policy goals related to elk management listed within the 2007 BEMP as a co-lead agency on the EIS: 1) restore and perpetuate natural ecosystem functioning in the park, restore and maintain native habitats, 2) perpetuate natural processes and interactions of bison and elk with natural environmental fluctuations influenced by fire, vegetation succession, weather, predation, and competition, 3) contribute to Department objectives for the Jackson elk and bison herds to the extent compatible with Goals one and two, and 4) work with the Department to reduce the prevalence of brucellosis in bison and elk populations in order to protect the economic interest and viability of the livestock industry and reduce the risk of adverse effects of or from other non-endemic diseases not currently found in the Jackson bison and elk

herds. The GTNP desired summer bull-to-cow ratio is 35 bulls per 100 cows and a summer count of 1,600 elk in GTNP to be more reflective of non-hunted populations. GTNP defines bulls as branch-antlered bulls and excludes yearlings. The Department manages the Jackson elk herd under a recreational management strategy, including a mid-winter bull-to-cow ratio sub-objective of 15-29. The 2007 BEMP also recommends GTNP work in close cooperation with the Department to understand existing conditions, trends, new research findings, and other changing circumstances to provide the basis for developing and implementing a dynamic framework for decreasing the need for supplemental food on the refuge. GTNP is a cooperating agency on the 2023 NER BEMP environmental impact statement process.

2.3.5 Office of State Lands and Investment (OSLI)

Two of the Department operated feedgrounds are permitted on OSLI lands. These include Bench Corral and Jewett feedgrounds. These are managed through a 25-year Special Use Permit. The current permit expires in 2032.

2.3.6 Private

Three of the Department operated feedgrounds are conducted on private lands. These include Dog Creek (also on USDA FS land), Franz (also on BLM land), and McNeel feedgrounds. Each feedground on private land is managed uniquely based on individual agreements between the Department and the landowners.

2.4 Current Social and Economic Values

Elk populations in western Wyoming are managed using feedgrounds and recreational hunting to support current population objectives. The current social and economic benefits of feedgrounds are of high value to some stakeholders. However, other stakeholders express real concern that disease impacts on elk populations have the potential to negatively affect wildlife in the GYE, specifically relating to elk health, numbers, and age class diversity. Weighing the social and economic values that the feedgrounds provide against the biological concerns of maintaining current elk population levels on feedgrounds with the knowledge of an emergent deadly disease is extremely complicated. These complexities necessitate the Department to understand and consider these social and economic values in the context of future management of western Wyoming elk.

2.4.1 Hunting

Hunting is one of the most popular outdoor recreational activities in Wyoming. The USFWS (2011) estimated that 140,000 individual hunters pursued big game species throughout Wyoming that year. During 2021, 56,691 hunters pursued elk in Wyoming and tallied 465,236 total recreation days (WGFD 2021). In Sublette County alone, elk hunting generated 55,862 hunter days in 2015, while Teton County generated an additional 28,719 hunter days (Taylor and Foulke 2016). Within the Pinedale and Jackson elk herds during 2021, there were 9,450 resident elk hunters and 2,495 nonresident elk hunters, generating 87,857 total hunter days (WGFD 2021).

Hunting and fishing are important components and drivers of the recreation-based economy in Wyoming. Past investigations into this contribution have estimated the total positive impact on the Wyoming economy from big game hunters alone generated $303,588,073 in 2015 (Southwick and Associates 2017). Their activities also supported 3,100 jobs, $85.6 million in personal income, and $28.2 million in state and local taxes (Southwick and Associates 2017). Individually, resident big game hunters were estimated to spend from $91 - $148 per day, while non-residents spend $551 - $580 per day while hunting (Taylor and Foulke 2016, Southwick and Associates 2017). Big game hunters generated a total of $8.4 million in Teton County and $15.5 million in Sublette County in 2015 (Taylor and Foulke 2016). When extrapolated to hunter data in the Pinedale and Jackson regions in 2021, both resident and non-resident hunters generated $12.6 to $25.2 million in expenditures (Table 3).

Table 3. Hunter expenditures per elk hunter per day for the Pinedale and Jackson elk herd units (102 to 103 and 105 to 108) in 2021. Averaged total expenditures for 2021 were extrapolated from Department license sales in the corresponding elk hunt areas from that year and applied the per-elk hunter estimates from the associated report.

Source	Resident Expenditures		Nonresident Expenditures	
	Per Elk Hunter	Averaged Total	Per Elk Hunter	Averaged Total
USFWS 2011	$1,254	$11,850,300.00	$5,367.61	$13,392,186.95
Taylor and Foulke 2016 and USFWS 2011	$90.91/day	$1,093,283.66	$396.93/day	$1,769,117.01
Taylor 2018 and Southwick Associates 2017	$148.38/day	$1,784,417.88	$579.82/day	$2,584,257.74
Total	$12,636,747.75 to $25,242,486.95			

2.4.2 Outfitters and Guides

A total of 31 licensed outfitters are authorized to hunt elk in the Jackson and Pinedale regions. Individual outfitters served from one to 38 elk hunters annually, and the average number of clients per outfitter ranged from five to 18 hunters. The average cost of a public-land, professionally outfitted elk hunt was approximately $5,000 in 2021, generating between $930,000 and $1,235,000 in gross revenue annually for these 31 outfitters (McWhirter et al. 2022).

Management towards herd objectives provides clear and consistent expectations for hunting season regulation proposals developed by the Department. Hunting season regulation proposals are also informed by public comment and require Commission approval. In feedground herds, hunter and outfitter sentiment often desires management for maximum elk numbers. Hunting outfitters and guides make a substantial proportion of their annual income based on license allocations and season durations. Per the Department's statutory authority to manage and protect all Wyoming wildlife (W.S.§ 23-1-103) and mission of "Conserving Wildlife, Serving People," elk management decisions are made for the benefit of wildlife health and conservation while accounting for public engagement and commenting.

2.4.3 Elk Damage

W.S. § 23-1-901 and Commission Regulation Wildlife Damage Claims (Chapter 28) require that the Department investigate and consider the damage to land, growing agricultural crops, stored crops, seed crops, extraordinary damage to grass and/or improvements such as fences and windbreaks caused by big game animals, and to monetarily compensate landowners for verified damage claims. Wyoming statute defines elk as a big game animal (W.S. § 23-1-101).

Brucellosis transmission concerns related to elk/cattle commingling are precisely addressed and strictly prohibited during winter months in local producers' United States Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) Veterinary Services livestock herd management plans and thus require immediate Department mitigation. This is a greater concern than traditional crop damage within the Brucellosis Designated Surveillance Area (DSA; Section 2.5.2).

Significant resources are dedicated to preventing and managing elk damage and elk/cattle commingling, including manpower, equipment, and associated costs. Methods include designing hunting seasons to target population segments responsible for damage, hazing elk away from damage and commingling situations (sometimes to a nearby feedground), emergency feeding to move elk away from damage and commingling situations, providing fencing material for hay stackyards, lethal removal of offending elk, and working with landowners to find additional solutions to minimize damage risk based on each unique situation.

Some feedgrounds have adjacent, eight-foot tall, woven wire, elk-proof perimeter fencing to facilitate favorable elk distributions or are strategically located in areas to control elk distribution away from private property. A total of 44.25 miles of elk-proof fencing occurs adjacent to the Greys River (13 miles), Soda Lake (25.5 miles), Horse Creek (1.6 miles), Camp Creek (0.4 miles), South Park (2.5 miles), and Muddy Creek (1.25 miles) feedgrounds. Elk exclusionary fences are used to discourage elk occupancy on private lands and commingling with cattle on adjacent private lands. The fences also reduce the number of elk-vehicle collisions on the highway.

Elk damage claims in the Jackson and Pinedale regions are relatively uncommon due to the presence of feedgrounds. From 2011 to 2021, only six damage claims totaling $4,600.63 and averaging $418.24/year were claimed in the Jackson Region. Within the Pinedale Region, damage claims associated with elk were submitted in 7 of the last 11 years (2011-2022), totaling $28,285.10 (range $0 to $18,311.35) and averaging $2,571.37/year. Maintaining the number and extent of elk damage claims to a minimum requires substantial personnel time, equipment, and, in the case of emergency feeding, substantial financial costs. From 2018 to 2022, a total of 2,967 Department hours were spent on the prevention and management of elk damage and elk/cattle commingling in the Jackson and Pinedale regions, ranging from 458 to 710 hours in any given year. The costs of operating feedgrounds are somewhat offset by a reduction in the number and total costs of elk damage claims.

2.4.4 Cattle Production

Wyoming's 1.3 million cattle inventory had a value of $1.75 billion in 2018 (WDA 2021). The three counties where feedgrounds are located (Lincoln, Sublette, and Teton) were home to a cattle inventory of 104,000 in 2021 (WASS 2021). Traditional cattle operations in these areas primarily

involve parcels of private land where hay is grown and stored during summer when the cattle utilize grazing allotments on state and federal lands. Cattle herds are moved back to lower elevation deeded lands where they are fed the stored crops during winter. These interconnected large parcels of private land and leased grazing allotments are vital components of local, traditional cattle operations. These private working lands also provide critically important habitats and migratory connectivity for elk and other wildlife in western Wyoming by maintaining open space. As these local communities deal with increasing human population, development, and land use change, the importance of these private working lands is increasingly important to maintaining wildlife habitat and habitat connectivity (Gigliotti et al 2022).

Local cattle producers and the Department have a long history of developing working relationships with each other. These relationships are the backbone by which common ground is identified and positive outcomes for both cattle and wildlife management are accomplished. The Department recognizes that actions resulting in the reduction or elimination of cattle grazing may impact a ranch's ability to be economically sustainable and may harm the agricultural infrastructure of a local community. Some ranchlands may be subdivided for residential use, while others may be kept intact or enlarged to increase amenity or commercial values rather than habitat management for livestock production (Gosnell 2006). This can result in negative outcomes for traditional agricultural communities and for wildlife.

Cattle producers in western Wyoming are inextricably connected to state, national, and international brucellosis rules and regulations. As such, decisions relative to feedground management are of considerable interest to wildlife and cattle managers as well as regulatory livestock health officials. According to the USDA APHIS National Bovine Brucellosis Surveillance Plan, brucellosis can have considerable animal health and trade consequences. As a result, USDA APHIS has cooperated with the U.S. cattle industry and State animal health authorities to eradicate brucellosis from the U.S. to achieve and maintain national brucellosis disease-free status. Due to the known wildlife reservoirs of brucellosis in the GYE, including elk, elevated and continued surveillance efforts are required within the cattle DSA to detect and manage brucellosis in cattle (NAS 2020). The ability to maintain brucellosis-free cattle herds within Wyoming's portion of the DSA is largely attributed to the use of feedgrounds to maintain spatiotemporal separation between cattle and elk during the brucellosis transmission period (February through June); however, there have been periodic brucellosis spillover (when a disease moves from one species to another) events from elk to cattle over the recent decades (Cross et al, 2015 and Rhyan et al. 2013).

Cattle producers implement a variety of brucellosis prevention and management practices, including fencing haystacks, delaying grazing on high-risk pastures or allotments, allowing Department personnel to haze elk off private property to maintain elk and cattle separation, and vaccinating and testing cattle for brucellosis. The cost of individual ranch-level brucellosis management practices ranges from $200 to $18,000 per unit or year (Roberts 2011). The WLB reported livestock producers filed 170 brucellosis risk assessments and 160 brucellosis herd management plans to mitigate the risk of brucellosis in the fiscal year 2022, with 75,000 cattle tested for brucellosis and no cattle testing positive in that year. Expenditures from federal and state animal health budgets for brucellosis testing and vaccination of cattle in western Wyoming totaled $467,119 in fiscal year 2022 (WLB 2022).

According to the WLB, when a brucellosis reactor is identified in a cattle herd, the herd of origin is quarantined, and the reactor bovine is humanely disposed of per state and federal regulations. The herd remains under quarantine until three negative whole herd tests have been completed, with each test a minimum of 60 days apart and one test occurring within 60 days post-calving. The quarantine includes all sexually intact cattle and usually lasts approximately one year. Close contact herds also typically require 1-2 negative whole herd tests for confirmation of brucellosis-free status, remaining under quarantine throughout the testing period. Brucellosis non-negative cattle are eligible for indemnity using both state and/or federal funding. Indirect expenses due to quarantine may result in significant financial losses due to loss of marketing opportunities, grazing restrictions, and other unforeseen situations and have been reported to range from $2,000 to $200,000 (Schumaker, Peck, and Kauffman 2012). Quarantined herds are eligible for brucellosis mitigation expense reimbursement of up to $25,000 per quarantine through state funds

Given the financial and logistical consequences of brucellosis exposure in a cattle herd, management changes to feedgrounds have the potential to impact the economic sustainability of individual cattle producers and the local agricultural lands and economy. Therefore, decisions must consider, understand, and mitigate impacts to local cattle operations, which could precipitate further impacts on local communities and wildlife populations (Gigliotti et al. 2022, Gosnell 2006, and Maher et al. 2023).

2.4.5 Department Revenue

Hunting license sales are the primary revenue generator for the Department, with big game license sales comprising nearly 48% ($29+ million) of annual license revenue in 2020, contributing over 30% of all revenue sources for the Department (WGFD 2021). Elk license sales alone generated $11,470,177 statewide in 2021 (WGFD 2021). During 2021, residents purchased 1,179 full-price limited quota elk licenses and 2,194 reduced-price limited quota cow/calf elk licenses, and nonresidents purchased 366 full-price limited quota elk licenses and 606 reduced price limited quota cow/calf elk licenses in all elk herds containing feedgrounds in the Jackson and Pinedale regions (Table 4). License fees for these licenses generated a total of $624,654 in 2021. Full-price general elk licenses are also valid in most of the feedground elk herds, yet revenue from full-price general elk licenses is difficult to track due to the ability of hunters to pursue elk anywhere in Wyoming with a general season. However, general license hunter numbers can be estimated by querying the number of general license holders who also purchased an Elk Special Management Permit. The grand total for 2021 license sales for all Pinedale and Jackson Region elk herds, including elk special management permits, was approximately $2,110,122 (Table 4). For comparison, the total cost to manage and maintain the feedground program in 2022 was approximately $3,100,000 (Section 2.1.5).

Table 4. Elk license revenue for the Pinedale and Jackson elk herd units 2021.

	Resident Elk Licenses			Nonresident Elk Licenses			All
	Full Price Limited Quota (Types 1-5)	Reduced Price Cow/Calf (Types 6-8)	Full Price General	Full Price Limited Quota (Types 1-5)	Reduced Price Cow/Calf (Types 6-8)	Full Price General	Elk Special Management Permit
Total Licenses	1,179	2,194	6,597	366	606	1,362	10,770
License Fee	$57	$43	$57	$692	$288	$692	$15.50
Youth License Fee	$25	$20	-	$275	$100	-	-
Special License Fee	-	-	-	$1,268	-	$1,268	-
License Sales Total	$88,628	$62,359	$376,029	$303,087	$170,580	$942,504	$166,935
	Sum = $2,110,112						

2.4.6 Wildlife-Related Tourism

Tourism is an important financial resource in Wyoming, and wildlife-related tourism is no exception, especially in western Wyoming. Wildlife-related tourism, including wildlife touring, watching, and other non-consumptive uses, brings substantial funding and jobs to Wyoming (Taylor 2017). When combined with hunting and fishing, wildlife-related tourism contributes an estimated 9,600 jobs, $788 million in expenditures, and a total economic benefit of up to $1 billion in business activity (Taylor and Foulke 2016). Wildlife-related tourism accounts for about half of the aforementioned revenue and jobs added to the state's economy. According to the 2021 Economic Impact of Travel report completed by the Wyoming Office of Tourism, the travel industry's Gross Domestic Product (GDP) was estimated to be $1.6 billion in that year, representing 3.7% of Wyoming's GDP (Dean Runyan Associates 2021). It is important to note that the big game populations within the GYE hold local, national, and international value and importance that is not possible to quantify. Wildlife-related tourism accounts for substantial employment and revenue in western Wyoming.

2.4.7 Jobs

Local communities have come to rely on feedgrounds for dependable revenue streams. Given the quantity of hay the Department purchases annually, this has become a main source of income for some regional hay producers. The Department also contracts about 16 people to feed elk annually, providing important seasonal income for those contractors.

2.5 Elk Feedground Disease Management

2.5.1 Overview of Pathogens, Environment, and Animal Health

Biologically, the primary benefit of artificial feeding of free-ranging elk is reducing winter mortality due to malnutrition, especially in areas without adequate available native winter range. Research has shown prolonged congregation of wildlife, repeated over time, increases the likelihood and risk of infectious disease transmission and potentially increases animal stress (TWS 2020, AFWA; Gillin and Mawdsley 2018, WAFWA 2017, WAFWA 2021). The Plan focuses on "infectious" diseases (illnesses caused by harmful agents or pathogens), particularly those of current concern (brucellosis, CWD, necrobacillosis, psoroptic mange) and one that is not currently found in Wyoming's elk populations but has potential risk (bovine tuberculosis, or 'bTB').

Disease is defined as "any impairment that interferes with or modifies the performance of normal functions" and is a relative state, the middle between absolute health and death (Wobeser 2006). Typically, every disease process will have an energetic cost on an individual. There is only a finite amount of energy available, and infectious disease processes can incur large expenditures of energy. While a disease may not outright kill an animal, it can leave them susceptible to malnutrition, predation, and other maladies.

Several factors can play a role in the transmission and occurrence of disease. The three main areas are the host (e.g., elk), agent/pathogen (e.g., brucellosis, CWD, necrobacillosis, mange, bTB), and the environment (e.g., feedground, native winter range, captive; Figure 4). These areas are not equal across time and space and can all interact to contribute to the prevention or development of disease. Conditions encountered on feedgrounds are different from those found in native winter range settings or those found in ranching/captive settings; fully understanding factors that can play a role in disease occurrence and transmission is critical for effective management. For example, some pathogens may be very infectious depending on the time of year (e.g., brucellosis), and others are heavily dependent on environmental factors (e.g., necrobacillosis).

While the relationship between host and agent/pathogen is critically important to understanding and managing disease, the impact of the environment is a critical factor regarding disease management in the feedground system and will continue to be so, especially in the future. Environmental change can create stress in an individual and population, and the speed by which change occurs will determine the level and type of stress produced. Acute stress can be adaptive and helpful (e.g., a winter storm pushing animals to a new area), whereas chronic or repeated stress is typically harmful (e.g., fed elk have 31% higher levels of stress hormones; Wobeser 2006, Forristal et al. 2012). This is important because any changes that are made on feedgrounds need to be done in a thoughtful and consistent manner, factoring in other large-scale environmental changes.

This very brief introduction on how the complex interactions of agent/pathogen, host, and environment all work together is important to understanding how diseases can (or cannot) be managed on feedgrounds. Managers may be able to influence some of these factors (i.e., environmental alterations like drainage, reducing density, etc.), but other factors may be uncontrollable (i.e., climate, pathogen, strain type, etc.). Feedgrounds present a unique and daunting disease control challenge given the current logistical design (i.e., high animal densities).

Infectious diseases are the most common cause of mortality on feedgrounds. This Section describes current disease impacts and management on feedgrounds, which are summarized in Table 5.

Figure 4. Interactions among host, agent, and environment. Conceptualization adapted from Fraser and Parmley 2009.

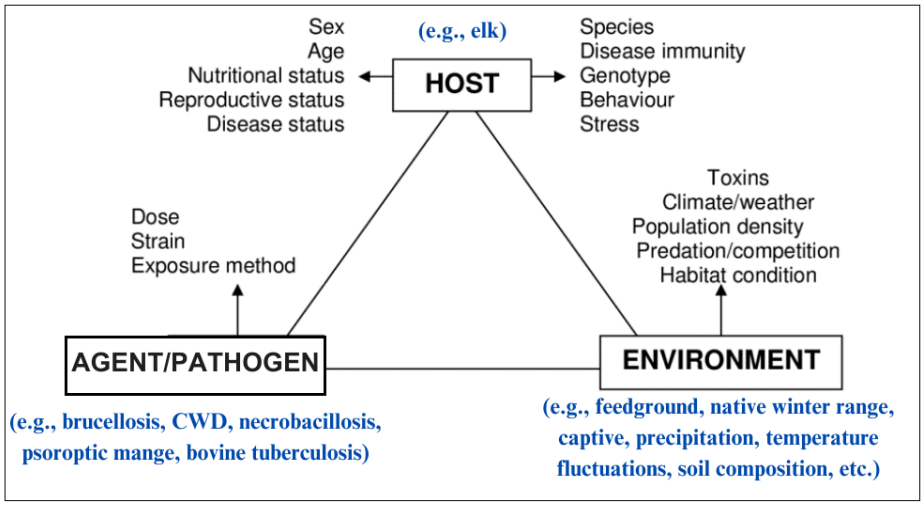


Table 5. Summary of diseases on feedgrounds as of November 15, 2023, with additional detail provided in Sections 2.5.2 through 2.5.6.

Disease	Detected in elk on Feedgrounds?	Location	Comments
Brucellosis	Yes	All feedgrounds	Long-term seroprevalence average is 22% for yearling and older female elk. Reduces reproductive output of exposed females
CWD	No	Adjacent to two feedgrounds	Detected in Pinedale (*n*=2) and Jackson (*n*=1) elk herd units. Always fatal once infected, can have negative population level impacts at higher population prevalence rates.
Necrobacillosis	Yes	All feedgrounds	All feedgrounds have outbreak potential, given the host and environment conditions. Can cause significant calf mortality.
Psoroptic Mange	Yes	All Feedgrounds	All feedgrounds have outbreak potential, given the host and environment conditions. Mange induced hair loss can increase mature bull mortality.
Tuberculosis	No	N/A	-

2.5.2 Brucellosis

Background and Transmission

Brucellosis is a highly contagious bacterial disease first isolated in cattle in the United States in 1910. Although there are several *Brucella* bacteria species, *B. abortus* is one that commonly infects elk, bison, and cattle in the GYE and is zoonotic (capable of infecting humans). Brucellosis was likely introduced to wildlife in the GYE from infected bison that were transplanted into Yellowstone National Park from a brucellosis-infected cattle ranch. Elk may have contracted brucellosis via the infected bison in Yellowstone and when they commingled with diseased cattle in the early 1900s when an estimated 12% of cattle herds in the United States had brucellosis (Ragan, 2002).

Infection of the female reproductive tract results in the abortion typically of the first calf following infection. Fetuses delivered near term often are stillborn or fail to thrive due to an overwhelming brucellosis infection. The male reproductive tract (testes, seminal vesicles, prostate) can also be infected. Infection of the bone or joint membranes results in lameness that may make the animal more susceptible to predation. Brucellosis results from ingestion or inhalation of *B. abortus* bacteria associated with abortions (Cheville et al. 1998). Under cool, moist conditions, Aune et al. (2011) found that *Brucella* bacteria can persist on fetal tissues, soil, or vegetation for up to 81 days during experiments in the GYE, and transmission may occur to animals grazing on contaminated pasture or consuming other feedstuffs contaminated by discharges or fetal membranes. Treatment of brucellosis in animals is generally not practical, as it requires multiple drugs administered daily for several weeks.

Brucellosis has been found to impact elk. Cross et al. (2015) documented that 16% of seropositive and pregnant elk abort their fetuses per year. Cotterill et al. (2018) estimated that the combination of reduced mid-winter pregnancy and abortion due to brucellosis following mid-winter lowered the reproductive output of exposed female elk by 24%. While reproductive output declines with brucella exposed female elk, the Department's ability to manage to population objectives has not been shown to be impacted by the presence of brucellosis.

Distribution and Prevalence

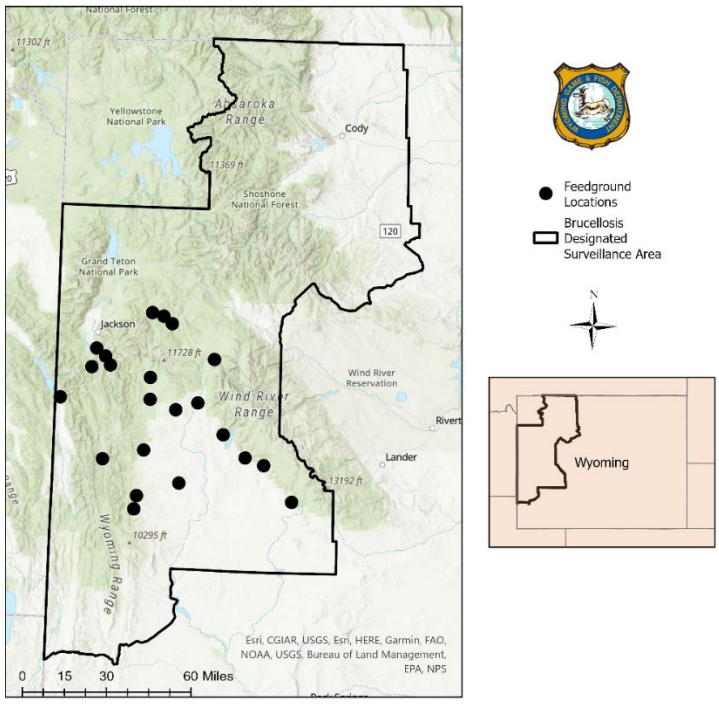
Due to the widespread occurrence of bovine brucellosis in the United States and its importance as a disease of humans, the Cooperative State-Federal Brucellosis Eradication Program was initiated in 1934. This program has nearly eliminated brucellosis in domestic cattle, but the disease continues to be of large economic and management concern in the GYE, where wildlife serves as the last remaining reservoir of brucellosis in the country.

The Department tests elk for exposure to brucellosis (*B. abortus*) at approximately four feedgrounds annually and gathers blood samples from hunter-harvested elk outside of the domestic cattle DSA in herds that do not utilize feedgrounds on a statewide, rotating basis (Figure 5). While mean brucellosis exposure rates (i.e., seroprevalence) vary among feedgrounds, the long-term average is 22% for yearling and older female elk (Scurlock and Edwards 2010). For non-fed elk, seroprevalence in the western portion of the state varies between 0-5% in elk herds south of the GYE (e.g., South Wind River and West Green River) and between 8-22% in herds east of the GYE (e.g., Clarks Fork, Gooseberry, Cody and Wiggins Fork). An increasing trend in brucellosis

seroprevalence in non-fed elk herds east of the Continental Divide in the GYE has been observed since the mid-2000s and may be due to increased elk densities created by burgeoning elk populations and management practices on private lands coupled with elevated exposure risk from feedground elk (Cross et al. 2010).

From 1992 to 2021, 6,727 biological samples from the non-endemic brucellosis areas have also been analyzed. In 2012, brucellosis was documented outside the GYE when it was discovered in elk in the Bighorn Mountains. Since the initial discovery, this disease was sporadically detected in several elk hunt areas (39-41, 45, 49) along the western slope of the Bighorn Mountains. Intensive sampling efforts of elk in the Bighorns Mountains continued via hunter-harvest and opportunistically during elk captures for several years following, and the disease was not documented from 2017 through 2021; however, it was confirmed again in 2022 and 2023.

Figure 5. Brucellosis Designated Surveillance Area in Wyoming.



Surveillance and Management

The Department has long recognized the challenges presented by brucellosis and the operation of feedgrounds, and in 1989 developed a multi-faceted approach to control the disease (Clause et al. 2002). This integrated approach, called the Brucellosis-Feedground-Habitat (BFH) Program, combined ongoing Department programs (feedground elk vaccination, feedground management, habitat enhancement, elk/cattle separation, and education) with the goal of eliminating brucellosis in elk and separation of elk and cattle during potential brucellosis transmission periods. The BFH program was disbanded in 2017 in recognition of the potential larger influence CWD and other diseases could have on future feedground management. Disease biologists in Pinedale and Jackson continued, but re-tooled their focus to all diseases affecting wildlife in their respective areas of responsibility. Many of the management strategies employed under the BFH program remain.

The Department periodically estimates the prevalence of brucellosis at a given feedground by capturing elk in corral traps to gather a statistically significant number of blood samples to test for exposure to brucellosis and determine seroprevalence. Several permanent (non-portable) corral traps were constructed in the 1970s and 1980s. While some are still in use, these traps have become outdated in terms of animal care and safety and are now in a state of disrepair. The Department also operates a set of portable traps built in the mid to late 2000s that were built specifically to facilitate the elk test and slaughter pilot project in the Pinedale Elk Herd. The updated design reduces elk stress and handling times, ultimately enhancing the safety of both elk and humans involved in the process. There are currently six feedgrounds lacking permanent or portable traps. In these situations, seroprevalence estimates are derived from the mean feeding end date over the past eight years, which is strongly correlated with current brucellosis seroprevalence (Cross et al. 2007). Changes to feedground management could potentially necessitate adjustments in surveillance techniques if trapping is no longer viable. Sampling through hunter harvest remains an option, although sample sizes vary, and it's not always clear which feedground elk may have attended.

Feedgrounds remain the primary tool for maintaining elk/cattle separation and reducing the risk of disease spillover. Because feedgrounds are not a fail-safe management tool, elk/cattle segregation must periodically be re-established, requiring substantial personnel hours and the use of trucks, snowmobiles, tracked vehicles, and helicopters to haze elk away from damage and elk/cattle commingling situations. In 2021, aerial drones were introduced for brucellosis management activities and have proven to be an effective and efficient tool for re-distributing elk away from cattle commingling situations. The Department also regularly provides game-proof fencing to cattle producers to protect privately-owned stored crops while eliminating a potential food reward to wintering elk, thereby reducing the risk of disease spillover. The Department typically distributes fencing materials for around 20 stack yards to local cattle producers annually.

The Department has focused brucellosis management efforts on habitat improvements and vaccination of elk in the past. Assisting land management agencies with the implementation of habitat enhancements to improve the quantity and quality of native forage to reduce elk dependence on supplemental feed in late winter/early spring has shown utility in re-distributing elk and reducing the duration of high elk densities. A 30-year-long vaccination program (1985 to 2015) was discontinued following the winter of 2015-16 because the vaccine neither demonstrated a measurable reduction in seroprevalence in elk herds nor reduced the abortion rate in seropositive elk (Boroff 2013, Maichak et al. 2017). Additionally, the bio-bullets used to administer the vaccine were no longer available for purchase.

A pilot "test and slaughter" program was implemented from 2006 to 2010 on Fall Creek, Scab Creek, and Muddy Creek feedgrounds in the Pinedale elk herd. Though the project significantly reduced brucellosis seroprevalence, it did not prevent brucellosis transmission events. Less than half of the available yearling and older female elk were captured and sampled and seroprevalence rebounded immediately after cessation of the pilot project (Boroff 2013, Scurlock et al. 2010).

LD feeding and managing for earlier feeding end dates are two research-based strategies initiated in 2008 (Section 2.1.3). While these strategies have been demonstrated to be effective for brucellosis management, they can be difficult to implement. Creech et al. (2012) reported up to a 75% reduction in elk-fetus contacts during LD feeding compared to traditional line feeding.

Ending seasonal feeding as early as possible in late winter/early spring aims to narrow the overlap of the feeding season with the peak abortion period, which relies heavily on numerous habitat enhancement projects that have occurred on native ranges in close proximity to several feedgrounds. Although mean brucellosis seroprevalence varies among feedgrounds, most of that variation can be explained by the end feeding date (Cross et al. 2007). Supplemental feeding initiates prior to the brucellosis transmission period, but end feeding dates can range from late February to early May, overlapping to varying degrees with the peak brucellosis transmission period of March-May (Cross et al. 2015). Traditional management of feeding termination relied upon elk presence. Scenarios vary, but typically elk attendance at a given feedground declines in spring as the snow recedes and native forage becomes accessible. Feeding continues until few or no elk return. Feedgrounds with a higher perceived risk of elk/cattle commingling are fed an average of 10.5 days later than other feedgrounds (Cross et al. 2007). While snowpack is the most influential component driving end-feeding dates, other management factors can impact when elk leave feedgrounds, including hay type (i.e., alfalfa, grass, or mix), hay quality, the amount of hay fed per elk per day, quantity/quality of available native forage and the type or amount of disturbance at the feedground. Managers have some flexibility to alter these factors to shorten the feeding season. With consistent annual feeding truncation over time, a significant reduction in brucellosis seroprevalence is expected, ultimately decreasing the risk to cattle (Cross et al. 2007).

Despite the numerous brucellosis management efforts described above, occurrences of brucellosis in cattle herds of Sublette and Teton counties were linked to elk from nearby feedgrounds in 2003, 2004, 2008 (Rhyan et al. 2013), and 2015, resulting in increased testing requirements, movement restrictions, reduced marketability and economic losses for cattle producers. Debate continues among stakeholders over appropriate management for both species (Galey et al. 2005, Roberts et al. 2012).

Brucellosis Coordination Team and Brucellosis Management Action Plans

In response to brucellosis outbreaks in cattle herds and the loss of Wyoming's brucellosis-free status in 2004, Wyoming Governor Freudenthal established the BCT in 2005. Charged with developing best management practices and making specific recommendations, the BCT proposed the development of BMAPs for each of the seven elk herds with feedgrounds at the time as their top recommendation. BMAPs were developed in consultation with local cattle producers, land management agencies, and state and federal veterinarians and were completed in 2006-2007. The BMAPs identified nine management options, many of which the Department had long used as management strategies, that could be considered tools to manage brucellosis on the feedgrounds within each elk herd. Those options included feedground relocation, feedground phase-out, elk population reduction, providing incentives for changes in private cattle operations, game-proof fencing, elk test and slaughter, habitat enhancement, habitat acquisition, and elk vaccination.

Most options were not widely pursued as action items. Habitat enhancement projects and distributing elk-proof fencing materials to private landowners have continued. A one-mile drift fence was also installed on federal and private land near the Muddy Creek feedground. The pilot test and slaughter program implemented during 2006-2010 in the Pinedale elk herd was a direct result of the BCT recommendations, but as described above, did not provide a long-term solution for brucellosis reduction in the absence of other strategies that could reduce elk density and maintain a low prevalence once achieved. Additionally, costs and personnel requirements to

conduct the project on three feedgrounds were high. Cost analysis of conducting test removal at the ecosystem scale on 22 feedgrounds were exorbitant. For these reasons the project was not implemented elsewhere. As previously mentioned, elk vaccination was discontinued following the winter of 2015-16. The BMAPs were updated every five years, with the final update occurring in 2016. Essentially, little change in elk brucellosis management occurred as a result of BMAP development due to a lack of BMAPs being incorporated into standard Department processes for prioritization and implementation, such as herd objectives, JCRs, and Department inter-program staff coordination.

2.5.3 Chronic Wasting Disease (CWD)

Background and Transmission

Chronic wasting disease is a chronic, 100% fatal disease affecting the central nervous system of members of the deer family, including mule deer, elk, moose, and white-tailed deer (*Cervidae*, commonly referred to as cervids). At the time of this publication, CWD has been detected in 31 states, four Canadian provinces, Finland, Norway, South Korea, and Sweden. This disease belongs to the group called transmissible spongiform encephalopathies, which includes bovine spongiform encephalopathy in cattle, scrapie in sheep, and Creutzfeldt-Jakob disease in humans. These diseases are caused by abnormally shaped proteins called "prions," that cause a conformational change in the normal cellular protein structure. As prions accumulate, they cause cell death in the nervous system (Forloni et al. 1993). The disease progresses as more nervous system cells are lost, ultimately ending in the death of the animal. There is currently no cure or treatment for CWD or other prion diseases, partly because the immune system of an infected animal does not recognize prions as a source of infection. Therefore, there is no immune response, making the development of a vaccine or other treatments very difficult.

Early in the course of CWD, animals show no apparent clinical signs. As the disease advances, with the accumulation of prion protein, affected animals show weight loss, reluctance to move, lethargy, excessive salivation, droopy ears, and increased drinking and urinating. No immunity, recovery, or absolute resistance to CWD has been documented. Deer typically die from the disease within 2.5 years of infection, and elk will succumb to the disease in three to four years (Miller et al. 2008, Miller et al. 2012). However, natural genetic variation in some deer and elk can impact the length of the incubation period of infected animals. Clinical signs in animals with CWD do not appear until late in the course of the disease, resulting in the majority of hunter-harvested animals that test positive for CWD appearing to be in normal body condition. Infection can be detected in carcasses as well as in live animals, and diagnostic tests have become increasingly reliable as CWD research has progressed (Miller and Fischer 2016). CWD is infectious, and prions are shed from several routes during most of the disease course, exposing other cervids either directly or through environmental contamination. Prions can persist for years in the environment, and their binding to soil elements (e.g., clay) enhances persistence and infectivity (Johnson et al. 2007). Infectious prions can persist in the environment for years, which complicates disease management and control, especially once prevalence is high (Georgsson et al. 2006, Miller et al. 2004, Miller and Fischer 2016, and Seidel et al. 2007).

All potential modes of transmission of CWD, or their relative likelihood, have not been identified. Evidence suggests the disease can pass directly from an infected animal to an uninfected animal or indirectly by contact with soil, plants, or feed contaminated with prions. To date, there is no evidence of CWD transmission to humans or domestic animals, but some studies have shown there could be a risk to non-human primates (Waddell et al. 2018, Pritzkow 2022).

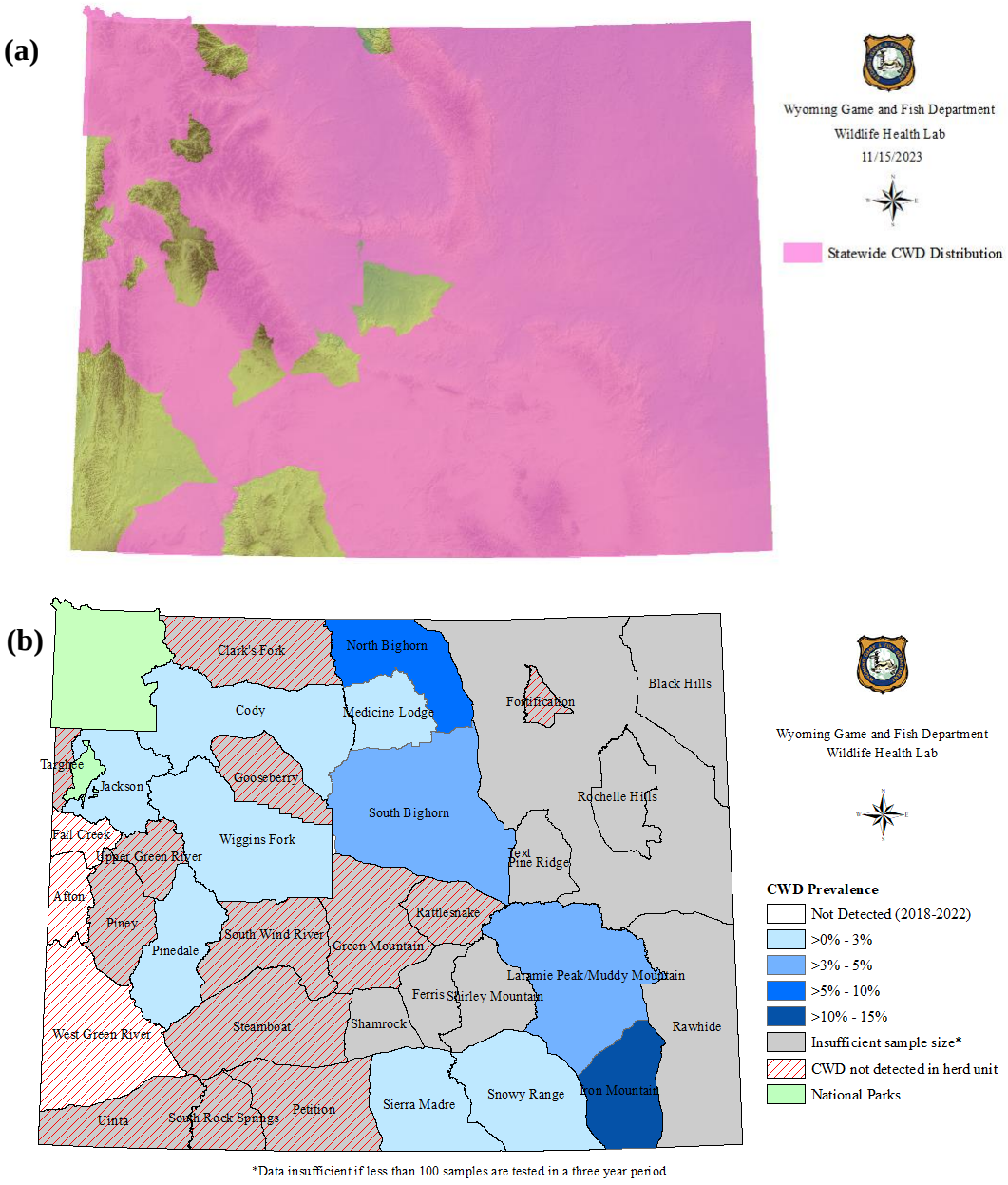
Recent projections suggest CWD may have significant population-level impacts in Rocky Mountain National Park elk (Monello et al. 2013, Monello et al. 2014), Wyoming white-tailed deer (Edmunds et al. 2016), Wyoming mule deer (DeVivo et al. 2017), and in the Jackson elk herd (Galloway et al. 2021). Other research suggests certain populations may be able to survive, bolstered by genetic selection and some level of hunting season restrictions (Robinson et al. 2012, Williams et al. 2014). Regardless, when CWD becomes well established in an area ('endemic'), published literature and anecdotal observations agree that it will likely depress cervid populations at an unknown but potentially significant level, especially if adult female survival rates become depressed. As such, management efforts designed to reduce the spread and prevalence of CWD are imperative.

Distribution and Prevalence

Since the discovery of CWD in southeast Wyoming in a free-ranging mule deer (*Odocoileus hemionus*) in 1985, elk (*Elaphus canadensis*) in 1986 (also southeast), white-tailed deer (*Odocoileus virginianus*) in 1990 (also southeast), and moose (*Alces alces*) in 2008 in western Wyoming, this disease has now been documented throughout most of the state (Figure 6a). As of November 15, 2023, CWD had been identified in 34 of 37 (92%) of the state's mule deer herds, in 17 of 35 (49%) of the state's elk herds, and generally wherever white-tailed deer occur in Wyoming. Surprisingly, CWD has not been documented in another moose since the initial discovery in 2008 in Star Valley in western Wyoming.

Prevalence estimates vary among herds, although deer herds generally exhibit significantly higher prevalence than sympatric elk herds. The overall Wyoming CWD prevalence of mule deer is 15.8% (range: 0%-65.8%), whereas the prevalence for elk is 2% (range: 0-13.7%). In the majority of mule deer herds where statistically significant sample sizes have been obtained, prevalence has steadily increased since its initial discovery within the herd. However, in some southeastern Wyoming mule deer herds where the disease has long been established, CWD prevalence has either somewhat declined from peak levels and/or has remained relatively static, albeit at levels high enough to likely impact population performance (Figure 6b).

Figure 6. Wyoming CWD statewide distribution for all species as of November 15, 2023 (a) and prevalence in hunter-harvested adult elk by herd unit from 2018-2022 (b).



Surveillance and Management

The Department has conducted surveillance for CWD since 1997. Surveillance to detect CWD in new areas and monitor prevalence is conducted utilizing three primary sources for testing: hunter-harvested cervids, targeted cervids (animals exhibiting clinical signs of CWD), and road-killed cervids. Targeted and road-killed cervids have a greater likelihood of testing positive for CWD (Krumm et al. 2005) and are therefore valuable in detecting the disease in new areas but are not used to estimate prevalence.

To adequately monitor cervid populations for CWD while balancing the testing capacity of the Department's Wildlife Health Laboratory, the Department has deployed a rotating, 5-year program that focuses surveillance on one or two deer and elk herds in each Department region annually. Surveillance efforts for each deer and elk herd are geared toward collecting a minimum of 200 samples from adult male mule deer or any adult elk within one to three years. Adult males are targeted for mule deer surveillance because very little female harvest occurs in Wyoming. For elk, sampling adults of both sexes is used because both sexes are harvested throughout the state.

The Department conducts additional CWD surveillance work related to feedgrounds in the Pinedale and Jackson regions. In western Wyoming, considerable effort is put into monitoring for CWD. Road-kill, targeted, and hunter-harvested cervids are all tested, in addition to animals that perish on and near feedgrounds during the feeding season. Grand Teton National Park and the NER have implemented mandatory CWD sampling requirements for hunter-harvested elk. This mandatory sample submission in the Jackson elk herd provides sufficient samples to be able to detect CWD as low as 1% prevalence with 95% confidence. In the six herds with feedgrounds, an average of 740 CWD samples have been tested annually from 2020-2022. Over that three-year period, three of the six herds reached the 200 sample size target specified in the CWD Plan (Jackson n=1,319, Fall Creek n=299, Afton n=212, Pinedale n=175, Upper Green n=114, Piney n=101). The Commission General Hunting Regulation (Chapter 2) allows the Department to mandate CWD sample submission from harvested deer, elk, and moose from designated hunt areas. To date, this option has not been pursued for elk in feedground-related hunt areas. Potential changes in feedground management are not expected to affect CWD surveillance.

In 2018, the Western Association of Fish and Wildlife Agencies (WAFWA) published "Recommendations for Adaptive Management of Chronic Wasting Disease in the West." That document outlines three primary CWD suppression strategies: 1) reduction of artificial points of host concentration, 2) hunter-harvest management, and 3) harvest targeted at disease 'hot-spots' (Western Association of Fish and Wildlife Agencies 2017). In Wyoming, CWD management is guided by the Commission's 2020 CWD Plan. Disease management strategies are outlined in that plan, to be assessed and implemented at the hunt area, herd unit, and regional scales based on place-based biological and social needs. Management strategies include reducing artificial sources of cervid concentrations, using hunter-harvest strategies to reduce CWD prevalence, proper carcass disposal, restrictions on translocations, targeted removal, and interagency coordination. The CWD Plan outlines general best management practices for feedgrounds, which have been addressed throughout the Plan.

Research regarding hunter participation has indicated that cervid management could be complicated due to the presence of CWD, with hunter participation decreasing (Bishop 2004, Heberlein 2004, and Meeks et al. 2022). It is important to note that this trend may not be universal (Holland et al. 2022), and depending on when the surveys/studies occur (immediately after the initial identification of CWD in an area vs. years after CWD has already been identified), could be a factor in hunter participation.

Predicting How CWD Will Affect Elk Attending Feedgrounds

While the specific impacts of CWD on feedground elk herds are unknown (how quickly prevalence will increase and what measurable population impacts will occur at various prevalence rates), based on our understanding of CWD epidemiology, it is nearly certain that CWD prevalence among feedground elk will exceed that of unfed elk. For example, the prevalence of CWD in captive elk and deer has been found to be much higher (59-100%) than for free-ranging animals (0->50% in Wyoming), likely due to the increased opportunity for animal-to-animal transmission and exposure to an increasingly contaminated environment from living in a confined space. Feedground elk differ from free-ranging elk in density and behavior. Wyoming free-ranging elk winter densities in the GYE from 2011 to 2020 averaged 4.79/km^2, whereas the feedground densities averaged 6.21/km^2 (Cook et al. 2023). Feedground elk behavior differs from that of free-ranging elk, even when free-ranging elk densities are high. Fed elk use the same feeding, loafing, and bedding sites daily for multiple months every year. Free-ranging herds use similar areas within their winter ranges, but they are constantly moving in search of food.

Conversely, there is a concern that CWD in elk on feedgrounds may mimic CWD in captive elk, resulting in an elevated CWD prevalence and potentially leading to greater population declines over time. The understanding of CWD disease ecology in elk is less developed than that of mule and white-tailed deer, and predictions come with uncertainty. In general, disease transmission can be correlated to the density of animals in a given area and the frequency of contact between animals. It is safe to assume that when the disease becomes established, artificially concentrating elk on feedgrounds will likely result in a more rapid spread of CWD and contribute to increased prevalence of prions in the soil and possibly uptake by vegetation (Pritzkow et al. 2015). Captive elk densities are determined by the property managers as compared to feedground densities, which are affected by many variables such as elk behavior, herd population numbers, hunting seasons, winter range disturbance, weather, and, in some instances, the presence of gray wolves. While captive elk are confined in perpetuity via fencing, feedground elk become behaviorally confined to feedgrounds, feedground areas, and feedground complexes. However, feedground elk do move away from feedgrounds seasonally.

Since it is unknown how CWD will affect elk populations once it becomes established in the feedground system, models can be useful in providing predictions based on what we do know. Several feedground-specific models have been developed to date that incorporate demographic data from feedground elk herds and integrate those data with the current knowledge of disease ecology of elk and CWD. Modeling studies, and the models themselves, will always have limitations due to the inability to predict all factors and influences, especially over a long timeframe; however, they provide a statistical framework to predict what will happen in the future based on what we know now. Similar to predicting the weather, models provide ‘best guesses,’ and multiple different models can be effective at showing trends and patterns for likely future scenarios.

There are currently four published models and one unpublished technical memorandum that forecast how CWD may affect elk populations attending feedgrounds. Although there are many differences among the models, they all predict that hunting and mortality from CWD will be additive and, therefore, result in higher mortality than in the absence of one or the other.

1. *Supporting adaptive management with ecological forecasting: chronic wasting disease in the Jackson Elk Herd (Galloway et al. 2021):*
   This model incorporates an earlier unpublished model (Galloway et al. 2017) developed using disease ecology data from elk in Rocky Mountain National Park, a population that has been exposed to CWD for 30 to 50 years. These data were then combined with the demographic data from the Jackson elk herd to construct the model that could be used as a tool to inform managers how differing levels of CWD will interact with the population performance.

   This model forecasts that CWD prevalence may reach a mean prevalence of 12% in the herd within six years. Given the uncertainty in this prediction, the authors could not rule out a prevalence as high as 20%. Using recruitment rates observed during the last two decades in the Jackson herd, the model predicted that a CWD prevalence of 7% in females would cause a decline in the population, even in the absence of female harvest. The authors also could not rule out prevalence as high as 23% before population declines.

2. *CWD model of genetic selection favoring prolonged survival in elk (Williams et al. 2014):*
   The researchers based this model on elk genotypes and the knowledge that CWD-infected elk with the ML or LL genotype at codon 132 tend to have prolonged incubation periods (O'Rourke et al. 1999, O'Rourke et al. 2007) and, therefore, would have an extended reproductive life in a herd where CWD is endemic.

   The model uses "life table" data from 39 elk brought into a research facility heavily contaminated with CWD, where their survival time was tracked until nearly all elk had died from CWD. Using the survival time for elk with the MM genotype (1,568 days) and the ML genotype (2,882 days), along with demographic data from the Pinedale elk herd, the model predicted that populations would decrease by ~62% but stabilize in approximately 90 years, assuming antlered harvest only. The model predicted the frequency of the MM genotype to decrease by 91%, and the LL genotypes would increase 20 times by year 100. However, genetic sampling of elk captured on feedgrounds indicates the LL genotype currently comprises only about 2-3% of feedground elk (Monello et al. 2017); potential fitness tradeoffs associated with this genotype are unknown.

3. *CWD undermines efforts to control the spread of brucellosis in the Greater Yellowstone Ecosystem (Maloney et al. 2020):*
   This bio-economic model considers both brucellosis and CWD with a cost/benefit analysis of closing feedgrounds or continuing to feed. The authors used GPS data from collared elk to predict migratory behavior and population densities with and without feeding using the demographic data from the Pinedale elk herd. Incorporated into the model are hunting benefits, brucellosis, damage, elk depredation costs, brucellosis prevention costs to cattle producers, and supplemental feeding costs.

   While this model considers many different scenarios and outcomes, the most economical and effective disease management strategy (for brucellosis and CWD) was to reduce the Pinedale herd to 950 animals (from 2,904) if feedgrounds remain or a reduction to 2,150 animals if feedgrounds are discontinued.

In these populations, CWD prevalence was expected to reach 4.1% and 2.7%, respectively. The model predicted that continuation of feeding, with the current elk herd management, could see prevalence exceed 75% and would cost the Pinedale area $19 million over 20 years once CWD is detected in the study area.

4. *Forecasts of elk abundance under CWD transmission scenarios at Dell Creek and Forest Park feedgrounds and Predicted winter habitat for elk in Afton, Fall Creek, Hoback, Piney, and Upper Green River herd units (Technical Memorandums, Western EcoSystems Technology, Inc., 2021):*

The Department contracted Western EcoSystems Technology, Inc. (WEST) to develop disease and resource selection models to forecast elk abundance and potential distributions under various CWD transmission scenarios within herds associated with the Dell Creek and Forest Park feedgrounds (i.e., Afton and Upper Green River herds) in an effort to help inform the USDA FS on a decision to continue to permit these feedgrounds on USDA FS lands. The matrix population model of Galloway et al. (2017, 2021) was fit to observed data from 1988 to 2020 (including count, age/sex composition, hunter harvest and CWD testing data), then Bayesian forecasting was used to predict population sizes out to the year 2040 under the four management alternatives (permit to allow continued feeding, five year phase-out, emergency feeding every five years, and cessation of feeding). The disease model used a constant probability of transmission, which was estimated to be 0.052 for the Afton herd and 0.049 for the Upper Green River herd, meaning that approximately 5% of susceptible elk are estimated to become infected with CWD each year that CWD is present. These estimated transmission probabilities were lower than the 8% probability of transmission estimated by Monello et al. (2014) for Rocky Mountain National Park (RMNP) and include both direct and indirect transmission pathways. WEST concluded that closing feedgrounds would decrease CWD transmission by limiting animal-to-animal contact and reducing hotspots of environmental contamination. However, because it is not known how much CWD transmission would be reduced by closing feedgrounds, they reported scenarios that assumed various amounts of reduction (10% - 90%) in CWD transmission probability by closing feedgrounds. Model forecasts for the year 2040 suggested that the continued feeding alternative would result in the smallest elk populations, and cessation of feeding resulted in the largest elk populations. Relative changes in population sizes were the largest among management alternatives when CWD transmission probability was assumed to be reduced by 50% or more by feedground closure.

The WEST analysis had two primary limitations: 1) the analysis assumed a constant probability of infection per individual per year, which it estimated from the currently low prevalence measured in the Afton and Green River elk herds and some prior information from RMNP. The model structure assumed that transmission would be constant over time and intermediate between the current conditions around the feedground system and the previously reported transmission rates for elk in RMNP. This model structure is useful for short-term predictions. For longer-term predictions, disease models typically assume that the probability of infection per susceptible individual increases with increasing prevalence of disease or the number of infected animals. However, that relationship is not known for the elk feedground area and cannot be estimated from currently available data. 2) The

analysis assumed that CWD and hunter harvest were the only sources of mortality. Feedground closure may result in elk mortalities due to other sources (e.g., starvation, removal to reduce comingling with livestock or mitigate crop damage, and emigration to other herds where feeding still occurs).

5. *Evaluating management alternatives for Wyoming elk feedgrounds in consideration of chronic wasting disease (Cook et al. 2023):*
   The authors developed disease and habitat selection models to help inform the USDA FS on a decision to continue to permit two supplemental feedgrounds on USDA FS lands. The model quantified the effects of four management alternatives (permit to allow continued feeding, three year phase-out, emergency feeding, and cessation of feeding) on select elk performance metrics. Elk herds in Wyoming without supplemental feedgrounds were found to have 23% lower elk densities on winter ranges; thus feedground closures were assumed to result in reduced elk carrying capacity. Because CWD transmission rates among elk attending feedgrounds is unknown, a panel of experts was used to derive direct and indirect CWD transmission rates of 1.9 and 4 times higher, respectively, than elk on native winter range, resulting in average CWD prevalence rates of 42% for fed elk versus 13% for unfed elk in year 20 given a starting prevalence of 1.6%. Analyses were conducted both at the scale of the two feedgrounds requiring permits and at the scale of all five elk herd units containing feedgrounds in western Wyoming. The closure of all elk feedgrounds was projected to result in the largest elk populations and the largest cumulative elk harvest at year 20, yet costs to producers associated with increased brucellosis transmission from elk to cattle were increased with the cessation of all feeding.

   The authors concluded three key uncertainties for model forecasts, including: 1) the magnitude of elk population declines associated with cessation of feeding is unknown, 2) while the CWD transmission rates of fed and unfed elk were derived using published data, empirical estimates, and expert opinion- actual rates are unknown, and 3) the behavior and movements of elk in response to feedground closures is unknown. Additionally, common to both the WEST (2021) and Cook et al. (2023) efforts, analyses did not include consideration of genetic selection towards CWD-resistant phenotypes.

Impacts on Other Cervids

Feedground management could have impacts on other cervids that frequent or live in the feedground system. As CWD increases in prevalence in elk that reside or frequent the feedgrounds, it increases the risk of CWD transmission to non-elk cervids, like mule deer and moose. This increase could occur from direct contact with a prion-shedding elk or indirectly from a contaminated environmental component (Almberg et al. 2011). CWD has been detected in mule deer in both the Wyoming Range and Sublette herds and 11 of the 18 deer hunt areas overlapping feedground herds. Mule deer seasonal ranges overlap 95% of feedgrounds, and seven of the feedground boundaries are within the designated Sublette mule deer migration corridor. Similar to mule deer, moose seasonal habitats overlap with 95% of the feedgrounds, so CWD exposure risk is assumed.

2.5.4 Necrobacillosis

Background and Transmission

The anaerobic bacterium *Fusobacterium necrophorum* (cause of necrobacillosis) typically infects animals through the feet or mouth. After initial infection, the bacteria can then infect the rest of the body, particularly targeting the liver, and toxins produced by the bacteria cause tissue necrosis that can lead to death. This disease typically occurs sporadically in individual animals and is known to cause major outbreaks in large groups of congregated animals (Allred et al. 1944, Murie 1930, Rosen et al. 1951, Wobeser et al. 1975, Leader-Williams 1982). The stress of crowding, inadequate nutrition, heavy contamination of local environments with feces, presence of domestic ruminants, and highly abrasive food material that traumatizes the oral mucosa increase the risk of disease for individual animals and populations.

Ungulates (hoofed mammals) with infected feet can show signs of lameness (one or more than one limb affected) or spend a large amount of time in sternal recumbency (i.e., laying down on the chest and stomach). Additionally, animals will show hesitancy or difficulty in rising. If the infection is in the mouth, the animal will have a large amount of drool, drop food, or have difficulty manipulating/swallowing feed. Overall, animals spend less time eating, resulting in poor body condition. If the bacteria spread to the rest of the body, the animal will deteriorate rapidly. In some cases, the only sign of disease is sudden death.

Fusobacterium necrophorum is a normal inhabitant of the intestinal flora and is excreted in feces. Environments heavily contaminated with feces will also be heavily contaminated with *F. necrophorum*. This bacterium then takes advantage of susceptible individuals by invading compromised skin or mucosa. Outbreaks in wild ruminants have been associated with the concentration of animals around water holes under drought conditions or around food sources at times of food shortage. Outbreaks often end when the cause of abnormal concentrations of animals is relieved. The risk of disease occurrence increases in situations where animals occur in high density (typically due to artificial congregation of animals), muddy soil, extensive manure accumulation, and standing water (Nagaraja et al. 2005), and while the bacterium is often found in feces, their presence alone does not cause disease.

Distribution and Prevalence

Necrobacillosis is found worldwide in domestic livestock production, but cases in free-ranging wildlife are extremely rare. It is presently found on feedgrounds in Wyoming, where necrobacillosis outbreaks are often associated with high densities of elk, late feeding season snow melt/ice/mud conditions, and feeding coarse forage (e.g., alfalfa) as opposed to grass hay. Smaller outbreaks with minimal mortalities may go undetected. The most recent outbreak occurred in March 2023 at the Horse Creek feedground when over 155 elk calves were euthanized or succumbed to the disease. In the last ten years (2013-2023), necrobacillosis outbreaks were identified on at least two feedgrounds (Horse Creek and Soda Lake).

Surveillance and Management

Surveillance includes monitoring feedgrounds for symptomatic elk and humanly euthanizing symptomatic elk. Elk euthanized or found dead are tested to confirm necrobacillosis, and carcasses are removed.

2.5.5 Psoroptic Mange

Background and Transmission

Different species of *Psoroptes* mites are common parasites of the skin and are highly transmissible. In elk, evidence of disease typically includes itchiness or biting at lesions and various sizes of patchy areas of alopecia and skin crusting. These lesions are typically found on the neck, trunk, and upper legs. Males tend to become infected in the middle or late winter (associated with poor nutritional condition and other factors associated with the post-rut period). If infected animals survive until the spring, the disease can become self-limiting, and clinical signs can resolve by early summer. This parasite is directly transmitted (animal to animal) and from contaminated environments (environment to animal). Mites can survive as long as two weeks in the environment outside of the host. There is no suitable treatment for large populations of animals dispersed across the landscape. However, management should revolve around prevention, limiting transmission, and minimizing stress.

Distribution and Prevalence

Psoroptic mange has a worldwide distribution and is presently found in Wyoming (Ziccardi et al. 1996). It has been detected at all feedgrounds, but there is no routine monitoring of the parasite or symptoms. Anecdotally, it is exacerbated when feedground elk densities (especially bull densities) are high. On the NER, 40-60 mature bulls die from complications due to psoroptic mange each feeding season.

Surveillance and Management

The Department does not actively conduct psoroptic mange surveillance.

2.5.6 Bovine Tuberculosis

Background and Transmission

Bovine tuberculosis (bTB or Bovine TB) is caused by the bacterium *Mycobacterium bovis*, and while primarily a disease of domestic cattle, it does spillover and infect wildlife (primarily white-tailed deer, bison, and elk), but there have been cases in other free-ranging mammals. Bovine TB is spread through inhalation; high-density or artificial concentration of animals is thought to exacerbate the spread. This bacterium tends to cause pulmonary lesions but can spread to other organs, resulting in emaciation and, eventually, death. Similar to CWD, bTB can be difficult to spot, especially early in the disease process. There is no proven vaccine for wildlife, and treatment would be almost impossible in a wildlife setting due to the requirement of long-term antibiotic administration. Testing is also difficult in a living, free-ranging animal setting since it requires

holding animals for at least three days. This pathogen is zoonotic, and individuals should be cautious when handling infected tissues.

Bovine TB was detected in at least six game farms in Montana in the early 1990s. Infected farmed fallow deer were found positive in Sheridan and Richland counties, and infected farmed elk were found in Granite, Park, Big Horn, and Carter counties. In 1993, after the disease was confirmed in captive elk on the Big Horn County game farm, an effort was made to survey free-ranging wildlife in the area for the disease. Forty-one mule deer and three white-tailed deer were collected from an adjacent cattle ranch from November 1993 through January 1994, and samples were submitted for bTB testing. Two mule deer had suspicious lesions consistent with bTB infection. M. bovis was isolated from the lymph nodes of one of those deer. M. bovis has also been detected in a few coyotes in that area. In August 1994, additional wildlife surveillance efforts were carried out, and 130 mule deer, 15 white-tailed deer, 15 coyotes, one pronghorn antelope, one elk, three porcupines, and one rabbit were collected. Bovine TB was detected in just one of the 15 coyotes sampled during this effort. In 1995, seven coyotes were collected for testing, and bTB was detected in one of those coyotes. Little wildlife surveillance was conducted around the other game farms, in part due to low wildlife densities in those areas.

Distribution and Prevalence

As of the date of this Plan, bTB has not been established in Wyoming or the GYE. However, domestic cattle cases have been identified in Montana (found in a beef herd in 2021) and Colorado (found in a dairy in 2010). Regarding free-ranging species, cases have been identified across Canada and the United States, particularly in Michigan, where white-tailed deer continue to be identified with bTB, and in Canada, bTB has been identified in national parks in bison (Alberta) and in elk (Manitoba) (Wobeser 2009, VerCauteren et al. 2018).

Surveillance and Management

In response to an outbreak of bTB in Montana cattle from 1996-2002, field personnel collected over 1,100 samples from hunter-harvested elk on the NER and GTNP. The disease was not detected. Passive surveillance was utilized from 2003 to 2021, where tissues were submitted for diagnostic evaluation from any animal demonstrating bTB-specific lesions, including hunter-harvested and feedground mortalities. Active surveillance was initiated in 2021 by utilizing lymph nodes collected for CWD surveillance, where any identified abscesses within lymph nodes are further evaluated using established NVSL protocols. Unfortunately, surveillance is limited to only those animals sampled for CWD and demonstrating abscesses, which is unlikely to detect the disease at low prevalence. Early detection of bTB can be accomplished by increasing surveillance/monitoring programs from hunter-harvested elk from the GYE and surrounding hunt areas and increasing the Department's Wildlife Health Laboratory's abilities to process the increased diagnostic load. Additionally, continuing to support the livestock industry in its surveillance/monitoring and eradication programs will decrease the risk of spillover from livestock into a free-ranging wildlife population. Reducing and/or eliminating feedgrounds would not reduce the risk of introduction of bTB into western Wyoming however, once presenton a specific feedground it increased transmission (on and off the feedgrounds) is expected.

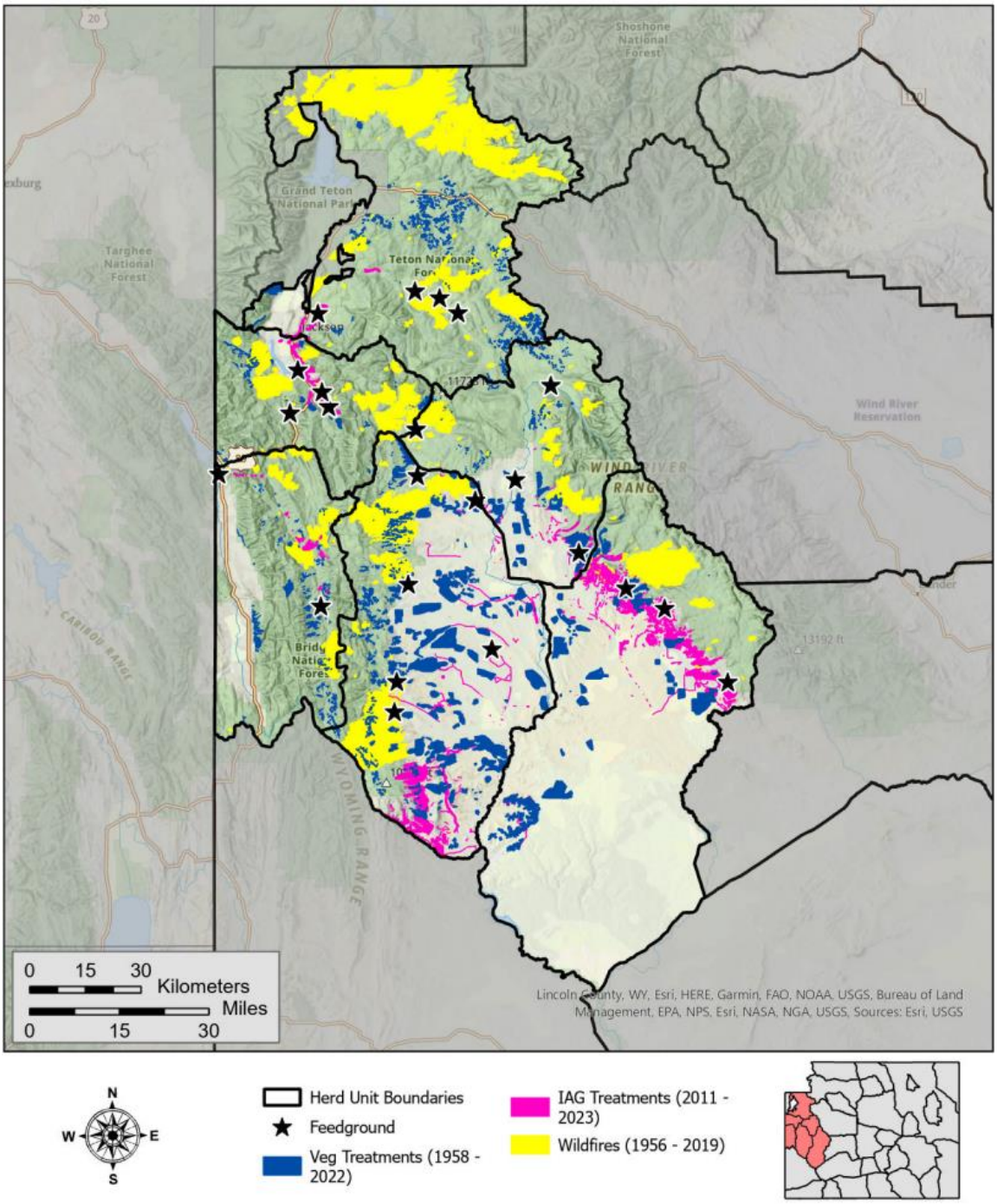
2.5.7 Habitat Enhancement

Elk are primarily herbaceous grazers and can consume an average of 20 pounds of forage per day during summer. During winter, elk on native range shift their diets to include a greater percentage of woody browse such as willows or aspen (Kauffman et al. 2018). Areas directly adjacent to feedgrounds can be impacted by intense browsing pressure throughout the winter, resulting in a noticeable lack of woody vegetation and a highline appearance to trees with branches removed within the browse zone. Elk that utilize native winter range typically prefer to use south-facing windswept slopes with relatively easier foraging opportunities, lower elevation rangelands with less snow accumulation, or agricultural pastures.

Enhancements of native habitats associated with feedgrounds have been pursued as a disease mitigation tool to reduce elk dependence on feedgrounds and feedground densities as snow conditions permit, with some documented successes (Henry 2009, Zaffarano et al. 2018). This vegetation modification can increase the quantity and quality of forage available for elk. Reduced feeding duration and lower elk concentration on feedgrounds may decrease disease transmission (Cross et al. 2007, Creech et al. 2012). Habitat enhancement projects also promote vegetative age class and species diversity and can improve forest and range conditions for myriad species.

From 1956 to 2022, the Department has been a partner or lead agency in the efforts to enhance habitats. These projects include active management such as vegetation treatments, prescribed fire and mechanical treatments of aspen communities, shrub treatments, prescribed logging efforts encompassing 360,000 acres, and annual invasive grass treatments totaling 90,000 acres. The Department has also worked collaboratively with public and private land managers on methods to capitalize on naturally occurring wildfires for forest and wildlife benefit. From 1956 through 2019, natural wildfires totaled over 610,000 acres (Figure 7).

Figure 7. Vegetation treatments and disturbance in feedground elk herds, 1956 to 2022.



SECTION 3- Elk and Feedground Management Direction

3.1 Direction

The Plan is designed to provide overarching direction to Department employees to ensure unified Goals with regard to elk management as it pertains to the Department's state-operated feedgrounds. Feedgrounds have been utilized in the management of elk populations in western Wyoming for over a century. Feedgrounds have enabled the Department to manage elk populations to maximize hunting opportunities by limiting winter mortality, minimizing elk damage to private property, reducing disease transmission to cattle, and limiting interspecies winter competition with other wild ungulates. However, feedgrounds present significant concerns when considering intra-species disease transmission, habitat management, and the long-term health of these elk populations. Based on the best science and information available, this disease changes the dynamics of the feedground system due to both disease impacts itself and management actions intended to mitigate those impacts. Given the Department's responsibility to manage for healthy and sustainable cervid (deer, elk, and moose) populations over the long-term, CWD cannot be disregarded. Management direction is necessary to provide a long-term path forward and a suite of options for Department employees to consider and employ on a site specific basis. No Strategies can be implemented to accomplish the Goals without adhering to the Sideboards. The Plan will be reviewed and approved by the Commission every five years.

3.2 Sideboards

The Department must strive to achieve the Plan's Goals while adhering to the Sideboards. Given the historical and current context provided in Section 2, the Sideboards are designed to provide assurances to the public and affected stakeholders. The Department recognizes that any management changes associated with feedgrounds could have consequences to the current social and economic values identified in Section 2.4, which the Department is committed to understanding in order to mitigate through the public process. In unforeseen situations or circumstances that may cause the Sideboards to conflict with each other, engagement with affected stakeholders will determine the appropriate course of action.

As such, the Department will continue to:

1. Adhere to standard Department process for elk herd unit population objective review with public process and Commission approval for any proposed changes.
2. Prioritize hunting opportunities as the primary tool to manage elk populations toward the Commission-approved herd unit objectives.
3. Minimize elk damage to private property, disease transmission to livestock, and negative economic impacts to livestock producers.
4. Minimize competition with other wintering wildlife species.

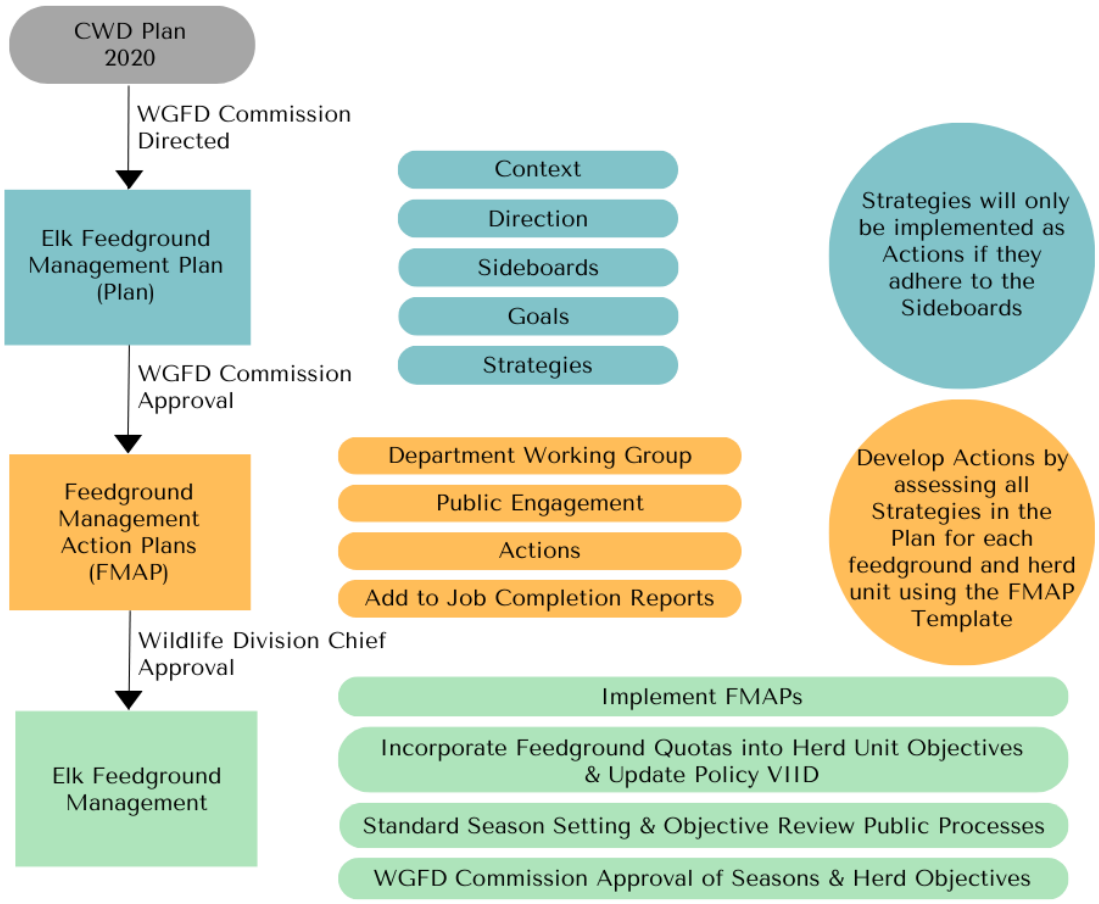
3.3 Goals

The overall Goals of the Plan are to 1) Promote elk health by limiting disease transmission while providing supplemental feed and 2) reduce reliance of elk on supplemental feed while adhering to the Sideboards. Limiting disease transmission between wildlife and cattle, protecting private property, providing elk hunting and viewing opportunities, and mitigating interspecies competition remain Department priorities, which is why management actions aimed at accomplishing the Goals must adhere to the Sideboards in Section 3.2.

3.4 Feedground Management Action Plan Introduction

This Plan provides the context, Direction, and Strategies for elk management in the feedground system moving forward. The FMAPs provide the mechanism to implement the Plan adaptively by uniquely assessing and implementing the Strategies (Section 3.5) as appropriate for each feedground. While the FMAPs will address each feedground, they will be conducted at the herd unit level. The FMAPs will turn the appropriate Strategies into Actions for each herd unit and feedground as well as measure successful adherence to the Sideboards (Section 4, Figure 8).

Figure 8. Schematic outlining the process for the elk and feedground management Direction. Chronic Wasting Disease (CWD), Wyoming Game and Fish Department (WGFD), Feedground Management Action Plans (FMAP), Job Completion Reports (JCR), and Commission policy on supplemental feeding (Policy VIID) are further defined in the Plan.



3.5 Feedground Management Strategies

This Section includes all of the management Strategies currently identified as options to address each management topic. Each management topic identified in this Section has a unique objective, followed by Strategies that could be implemented to achieve the objective.

Given the Sideboards, not all Strategies will be applicable, appropriate, or achievable for every feedground. Strategies listed here will be assessed for each feedground, implemented as appropriate, and reviewed annually through the FMAP development and review processes (Section 4). These plans must remain adaptable by updating options in response to evolving science, public sentiment, new data, landscapes/habitats, laws, regulations, legal actions, etc.

The Department has the authority to implement many of the Strategies identified in this Section and has already been implementing some for many years. This Section emphasizes the need to prioritize and employ management Strategies through the standard procedures and job duties at the Department's regional level. Conversely, some of the Strategies are new and may require additional levels of Department and public engagement. Each Strategy will be evaluated toward the Plan Goals and Sideboards and be assessed within each FMAP. While this is primarily a long-

term plan, change over the long-term will only occur if opportunities for implementing management options are pursued as they become available.

3.5.1 Elk Population Management

Objective: Develop and propose management options to sustain healthy elk populations.

Per standard Department procedure, elk populations are managed toward herd population objectives, which are reviewed on a minimum 5-year basis, using hunting as the primary management strategy. Herd population objectives will be reviewed following FMAP approval for each elk herd and will, therefore, be informed by the FMAPs (Section 4). Subsequent FMAP updates could trigger objective reviews as well as the converse. All publics interested in feedground management are invited to participate in the herd objective public review process and the annual hunting season setting public process. Alternative management options should be considered to increase harvest opportunities and to manage elk populations when traditional hunting season strategies have not been effective.

Strategies

- **Herd Objectives:** Encourage managers to review elk herd population objectives in consideration of available native winter range and LD feeding capacity on feedgrounds. Given the challenges of obtaining reliable trend count data on native winter range, consider alternative herd objectives. Proposed changes to herd objectives would follow Department standard procedures and the associated public process.
- **Commission Policy Feedground Quotas:** Remove feedground quotas from Commission policy and incorporate them into herd objectives. Define how to determine and manage feedground quotas. For example, herd objectives or sub-objectives could identify feedground maximum capacity based on how many elk can be fed with sustainable LD feeding.
- **Hunting Seasons:** While working to manage toward herd objectives, utilize hunting seasons to manage herd segments as appropriate as possible based on the unique conditions of each hunt area.
- **Auxiliary Management:** Implement Commission Regulations Auxiliary Management Hunting Seasons (Chapter 34) and Lethal Taking of Wildlife (Chapter 56) to respond to damage or potential elk/cattle commingling situations. Consider non-traditional hunting seasons in areas where herds are over-objective, emergency feeding is being considered, and/or hunting season strategies have been ineffective.
- **Access:** Wildlife managers will continue to explore incentives for hunter access to or across private lands to achieve harvest goals, particularly for antlerless elk in areas above herd objectives.
- **Migration:** Maintain and encourage seasonal movements of migratory elk
- **Monitoring:** Monitor elk distribution, movements, herd segment numbers, and elk availability to adapt hunting season structures as necessary.

3.5.2 Disease Management

Objective: Prevent and mitigate outbreaks of endemic and novel diseases from occurring and spreading, both on and off feedgrounds. Implement surveillance, prevention measures, and control measures as appropriate for the disease and the stage of the disease progression on the feedground or in the herd.

3.5.2.1 Brucellosis

Brucellosis is endemic in the GYE elk population, so management should focus on reducing commingling between elk and domestic cattle and reducing the prevalence of brucellosis where possible. Strategies in the Plan are consistent with the BMAPs, which were most recently updated in 2016 in a process approved by the BCT. The risk of brucellosis transmission to domestic cattle is a primary management concern.

Surveillance and Management Strategies

The Department will continue brucellosis surveillance in known infected elk herds.

- **Surveillance:** Continue surveillance on feedgrounds in accordance with the annual brucellosis surveillance efforts (Section 2.5.2). Consider integrating the sampling protocol into the statewide rotational surveillance program using hunters to collect blood samples as needed or appropriate.
- **Operate Feedgrounds:** Controlling elk distribution with feeding is the Department's primary management strategy to maintain spatial separation between elk and cattle.
- **Cattle Commingling Conflict Mitigation:** Haze elk away from elk/cattle commingling conflicts onto feedgrounds or other areas suitable for wintering elk and spatially separate from cattle as soon as possible with appropriate equipment (snow machines, snowcats, drones, and aircraft). If hazing is not possible or successful, utilize Chapter 34 and Chapter 56 to lethally remove elk commingling or causing conflict.
- **Reduce Feeding Season Length:** Consistent annual feeding truncation over time is expected to result in a considerable reduction of brucellosis seroprevalence over time, ultimately reducing spillover risk to cattle (Section 2.5.2).
- **Low-Density Feeding:** LD feeding is a research-based method to reduce brucellosis transmission via the reduction in elk-fetus contact rates (Section 2.5.2). Develop techniques to maximize LD feeding on each feedground, implement for the feeding season duration, and monitor progress.
- **Habitat Enhancements:** Conduct habitat enhancements in suitable winter ranges near feedgrounds where the potential of commingling with cattle is minimal.
- **Fencing:** Utilize elk-proof fencing to discourage elk from moving onto private land to reduce commingling and damage on private lands or to facilitate elk migration. Provide elk-proof fencing materials to producers to protect livestock operations from elk damage and to prevent attracting elk to conflict situations. Fence placement should consider and minimize impacts to important migration areas and habitat accessibility for other wildlife species.
- **Feedground Relocation:** Relocate a feedground to a site with an increased area for elk to disperse and further from winter cattle operations.

- **Increase Winter Range:** Acquisition of native or potential winter ranges through fee-title purchase, conservation easements, or voluntary elk occupancy agreements on private lands.
- **Elk Population Management:** Reducing elk densities is one of the most effective strategies for managing brucellosis. Manage elk herds towards population objectives through hunting.
- **Test and Slaughter:** Elimination of seropositive elk on a feedground through test and slaughter.
- **Vaccination:** Feedground vaccination program should an efficacious vaccine be developed.
- **Carcass Removal:** Develop a carcass removal and disposal plan for each feedground.

3.5.2.2 CWD

Objectives: Find and utilize opportunities to increase native winter range habitat and reduce elk reliance on supplemental feed to prevent the introduction of CWD into the feedgrounds; or, when found on feedgrounds, minimize the impacts of CWD by reducing animal-animal and environment-animal transmission.

Based on peer-reviewed literature and the ecological dynamics within feedgrounds, we can infer that without effective management intervention, CWD prevalence among elk will continue to increase over time (Table 7). To date, there are no tools available to eradicate the CWD prion, so management should focus on "slowing the spread" and prevention. Preventative actions may include habitat alterations or acquisitions to reduce areas where prions can accumulate via dense host concentrations (i.e., "hotspots") and reducing elk populations, where possible, to reduce/slow the transmission of CWD among elk and other cervids. Some concern has been expressed that population management actions aimed at slowing the spread of CWD would have irreversible negative consequences for elk populations over the long-term. Contrarily, elk populations have demonstrated significant growth potential in Wyoming, particularly when harvest is limited. Population management aimed at slowing the spread of CWD now will increase the management options in the future if conditions or CWD management options change. In addition, the population growth potential will be higher if CWD prevalence is lower (Gillin and Mawdsley 2018, The Wildlife Society 2020, Western Association of Fish and Wildlife Agencies (WAFWA) 2017, WAFWA 2021). Finally, the Department's management Strategies will continue to be adaptive if future conditions or our understanding of CWD dynamics in elk improves. To recognize the unique management challenges of CWD and the genesis of this Plan (Section 1), this Section has additional objectives.

Table 7. Inferences of population and associated hunting opportunity trajectories based on research that has predicted that elk populations will begin declining due to CWD somewhere between 7% (Galloway et al. 2021) and 13% prevalence (Monello et al. 2014). This table summarizes inferences from published literature and does not describe management actions or non-CWD dynamics (e.g., mortality from winterkill and/or harvest, weather, disturbances, etc.).

Feedground Management	CWD	CWD prevalence	Elk Population	Future Hunting Opportunity
With feedgrounds	Absent	N/A	Same as current (high), stable	Same as current (high), stable
In the absence of feedgrounds	Absent	N/A	Initially reduced primarily via harvest, then stable	Lower than current, stable
With feedgrounds	Present	Continue to increase over time, faster; higher CWD prevalence	Declining: CWD prevalence increases, reaches >7-13% rapidly, and population decline occurs.	Declining: fewer elk due to CWD results in fewer elk available for harvest. Higher proportion of harvested elk being CWD positive.
In the absence of feedgrounds	Present	Continue to increase over time, slower; lower CWD prevalence	Initially reduced via harvest, then declining; CWD prevalence increases, reaches >7-13% over longer period of time, and population declines occur more slowly	Declining: over a longer period as compared to the "With feedgrounds/CWD Present" scenario. Slower increase in proportion of harvested elk being CWD positive.

Surveillance Strategies

The Department will continue to conduct CWD surveillance on feedgrounds.

- **Statewide CWD Surveillance Plan:** Continue the surveillance regime identified in the CWD Management Plan. This means Department personnel actively collect samples from harvested elk, and hunters voluntarily submit samples from harvested elk with the Department goal of obtaining a sample size of 200 every one-to-three years.
- **Monitoring:** After CWD is detected in an elk herd containing a feedground, the Department will continue to monitor prevalence over the long-term. Statistically valid sample sizes and logistics for obtaining samples over a specified time period will be assessed with assistance from the Department's Veterinary Services Unit. The monitoring plan should be adhered to for consistency over the long-term.
- **Scale:** The Department manages elk at the herd level. However, in the feedground scenario, it may be appropriate to conduct CWD surveillance at the feedground or elk hunt area scale or within a specified radius of a feedground. Consideration should be given to whether the surveillance scale is appropriate when assessing surveillance methods.
- **Mandatory Sampling:** In situations where voluntary sampling is inadequate to obtain a desired sample size, mandatory sampling should be considered.
- **Feedground Mortalities:** Department personnel will perform post-mortem CWD testing for any cervid found sick or dead on or in close proximity to feedgrounds.
- **Environmental Testing:** Environmental or fomite testing if available or the situation for testing is appropriate.

Prevention and Management Strategies

Management needs to be adaptive based on the unique and varying situation of each feedground. Through the FMAP process, managers will select the most prudent and scientifically supported options appropriate for each feedground while adhering to the established Sideboards in Section 3.2, given the understanding that the status quo may be the only option for some feedgrounds unless conditions change in the future. The Target Feedground Management Plan (WGFD 2016) should be used as a resource as it includes published research to determine feedgrounds where larger management changes would have the highest ability for implementation while having the least negative impacts. The tiered approach provided here is adaptive both in time and by feedground. This approach also provides a unique research design whereby CWD impacts at the feedground level can be assessed given different management approaches.

- **Elk Population Management:** The Department recognizes that current public sentiment is mixed regarding population management as a CWD management tool. However, preventative management designed to reduce elk densities and contact rates (Section 3.5.1) has the potential to slow the spread of CWD and buffer the negative population-level impacts observed at higher CWD prevalence rates (Section 2.5.3 and Table 7). Therefore, elk population management will be assessed in the same manner as the other Strategies through the FMAP process and with considerable public process. Through the FMAP process, managers will assess, select, and implement the appropriate elk population management Strategies under different CWD scenarios (Table 6). Public notification will also be required when a herd's CWD prevalence status changes (Section 3.5.11). Elk

population management Strategy options with increasing intensity are listed here. These options will be used to populate Table 6 as appropriate for each feedground during the FMAP development process. The most progressive management Strategies will be implemented as appropriate while adhering to the Plan Sideboards. It is worth noting that the most prudent and scientifically supported option identified here (native winter range objectives) is consistent with elk management in Wyoming elk herds without feedgrounds.

Following approval of this Plan and the subsequent FMAPs, feedground quotas will be removed from Commission policy and incorporated into herd objectives (Section 4.3.2). The mechanism by which feedground quotas are incorporated into herd objectives will be determined through the FMAP process. The Low Density Feedground Quotas Strategy is the only Strategy listed here that specifies how to determine feedground quotas when incorporating into herd objectives.

1. **Status Quo:** Manage toward Commission-approved herd objectives. Update objectives per standard Department 5-year review timeline and process, including proposing changes as appropriate. Employ disease mitigation practices as possible.
2. **Low Density Feedground Quotas:** Update herd feedground quotas based on how many elk can be fed with sustainable LD feeding. Determine how to manage for LD feedground quotas during the FMAP process. For example, herd objectives or sub-objectives could identify feedground maximum capacity..
3. **Elk Density Reductions**: Reduce the number of elk on an identified feedground by a minimum of 10% via harvest as the primary tool within one year. If the harvest is insufficient, Auxiliary Management (Section 3.5.1) will be considered to supplement hunter harvest.
4. **Native Winter Range Objectives:** Adjust herd objectives to what can be sustained in the absence of feedground(s) following the Department herd objective review process. Reduce densities of elk via harvest to achieve new objectives over a determined time frame to maintain harvest as the primary management tool and prevent large winter-kill events. If harvest is insufficient, Auxiliary Management (Sections 3.4.1) will be considered to supplement hunter harvest. This Strategy would be more aligned with elk management in non-feedground herds in the rest of Wyoming.

Table 6. FMAP template for adaptive elk population management based on four CWD scenarios. The most prudent and scientifically supported management Strategies will be implemented as appropriate while adhering to the Plan Sideboards. This table does not address other CWD management tools. The 5% and 10% thresholds are intended to be below values where elk populations decline. Researchers have predicted that elk populations will begin declining due to CWD somewhere between 7% (Galloway et al. 2021) and 13% prevalence (Monello et al. 2014).

Prevention (immediate) *Animal-to-Animal Prevention*	**CWD first detected in elk in the elk Herd Unit** *Animal-to-Animal Mitigation*	**5% Prevalence (<7%)** *Environmental Contamination Prevention*	**10% Prevalence (<13%)** *Environmental Contamination Mitigation*
Select the appropriate option (1-4) from Section 3.5.2.2 (Elk Population Management) that adheres to the Sideboards.	Select the appropriate option (1-4) from Section 3.5.2.2 (Elk Population Management) that adheres to the Sideboards.	Select the appropriate option (1-4) from Section 3.5.2.2 (Elk Population Management) that adheres to the Sideboards.	Select the appropriate option (1-4) from Section 3.5.2.2 (Elk Population Management) that adheres to the Sideboards.

- **Feedground Alterations:** Strategies outlined under Feedground Alterations (Section 3.5.7), particularly regarding feeding timing and duration (reduced feeding length), will be assessed with the intention to prevent and minimize the impact of CWD. Limiting exposure to prions on feedgrounds can be accomplished by ensuring that feedgrounds are operated in a way that limits elk exposure to potentially contaminated soil and fecal material. This could be achieved through the large-scale implementation of late start-date, early end-date, and low-density feeding, ensuring adequate snow cover is present for the feeding season duration. These techniques will reduce the need for manure removal and soil manipulation if there is adequate snow cover to prevent elk from feeding on prion and feces-contaminated soil. Feeding area expansion, moving feeding areas, and additional feedgrounds have the potential to slow the initial spread of CWD but may increase the area of environmental contamination hotspots (Sections 2.5.3 and 3.4.7).
- **Habitat Accessibility:** Strategies outlined under Habitat Accessibility (Section 3.5.4) will be assessed with the intention of preventing and minimizing the impact of CWD.
- **Elk Population Management:** Strategies outlined under Elk Population Management (Section 3.5.1) will be assessed with the intention of preventing and minimizing the impact of CWD. Reduce elk densities where possible and acceptable to reduce congregation.
- **Carcass Removal:** Carcass removal and disposal plans should be developed for each feedground. Additionally, an economic evaluation of establishing a Department-operated prion denaturing facility, such as an industrial incinerator or biochar pyrolysis equipment,

should be completed to assess the capacity to responsibly dispose of CWD-infected (or suspected) carcasses.

- **Substrate Conversion:** Prions are known to bind to many soil types (Smith et al. 2011), and when bound to bentonite clay, infectivity is increased (Johnson et al. 2007). To limit the bioavailability of prions in the environment to cervids, substrate conversions of feeding areas should be considered. Suitable substrates may include gravel or other aggregates (without sharp edges) that would limit the availability of fecal material on the surface when snow cover is absent. While an aggregate substrate would not prevent prion transmission, if designed correctly, it may reduce indirect prion transmission. Maintenance of the substrate would be required once the aggregate substrate is no longer porous (filled with sediment or manure).
- **Fencing:** In consideration of prions, soil types, and the ability of plants to uptake, bind, and transport prions from the soil (Pritzkow et al. 2015), feedgrounds may serve as an indirect source of CWD transmission to cervids during the spring, summer, and fall months (Zabel and Ortega 2017). Fencing feedground areas should be considered to restrict cervid access, thereby limiting CWD transmission from these areas. Where fencing is considered a viable option, special consideration must be given to how wildlife migration and habitat permeability may be hampered, the initial cost of construction, and long-term maintenance costs.
- **Hay Acquisition:** The knowledge of a plant's ability to uptake, bind, and transport prions from the soil (Pritzow et al. 2015), coupled with the potential for fecal/urine/saliva contamination of hay/alfalfa in agricultural fields by CWD-positive cervids, warrants considering sourcing hay/alfalfa utilized on feedgrounds only from areas in the state where CWD has not been identified, if possible.
- **Manure:** An additional option for limiting prion contamination of the environment includes the removal of manure from feeding areas at the end of the feeding season. Where possible, manure may be removed mechanically and properly disposed of through alkaline hydrolysis (Murphy et al. 2009), incineration, or in an approved landfill.
- **Research**: Investigate methods to reduce the risk of environmental CWD transmission.

3.5.2.3 Necrobacillosis

Surveillance Strategies

Continue necrobacillosis surveillance on feedgrounds and require sampling/testing from elk when clinical signs dictate.

Prevention and Management Strategies

- **Hay Type:** Prevent injury to the oral mucosa by feeding grass hay and eliminate feeding coarse forage such as alfalfa when possible.
- **Reduced Feeding Length:** Feeding on clean snow may reduce bacterial exposure while feeding. Truncation of the feeding season limits the amount of time dense elk aggregations are exposed to increasing accumulations of feces, especially during spring when freeze/thaw cycles occur and it becomes more difficult to feed on clean snow.

- **Reduce Elk Densities:** Reduce elk densities where possible and acceptable to reduce congregation.
- **Feedground Drainage:** Adequate drainage of feeding and loafing areas to prevent water/mud accumulation and the formation of ice. Broken ice can damage the interdigital area of the hoof, providing entry sites for bacterial infections.
- **Manure Management:** Feed on clean snow. In some cases, manure may need to be manually removed (e.g., tractor with blade or bucket) and properly disposed of. LD feeding is another way to promote a cleaner feedground throughout the season as compared to traditional feedlines.
- **Feedground Cleanliness:** Remove any sharp objects that could cause hoof injuries (e.g., wire, scrap metal).
- **Move Feeding Areas:** Move feeding locations to prevent excessive manure accumulation with the understanding that prion accumulation would be exacerbated over a larger area and would also reduce the potential of feedground fencing as an option. Funding to acquire proper equipment would be necessary.
- **Targeted Removal:** Due to welfare concerns, the Department will target and remove elk that appear sick, debilitated (unable to rise), or are otherwise visibly incapacitated on feedgrounds and test for the disease.
- **Carcass Removal:** Develop a carcass removal and disposal plan for feedgrounds.

3.5.2.4 Psoroptic Mange

Surveillance, Prevention, and Management Strategies

- **Surveillance:** Consider conducting psoroptic mange surveillance on feedgrounds or opportunistically sampling and testing elk when clinical signs dictate.
- **Reduce Elk Densities:** Reduce elk densities where possible and acceptable to reduce congregation

3.5.2.5 Bovine Tuberculosis

Surveillance Strategies

The Department will continue bTB surveillance on feedgrounds, including testing lymph nodes collected for CWD surveillance. In an attempt to manage disease risk effectively and quickly, the Department will sample/test elk on feedgrounds when clinical signs dictate. Sampling will depend on clinical signs and tissues available. For safety precautions, department personnel involved with feedground management will review the "Guidelines for Surveillance of Bovine Tuberculosis in Wildlife" (2021) developed and provided by the USDA.

Prevention and Management Strategies

Given the seriousness of this disease and the difficulty of eradication once established in wildlife populations, immediate actions are required to limit this disease to the full extent possible.

- **Increased Surveillance:** If detected, the Department will increase bTB sampling and testing on the feedground and around the feedground (e.g., within a 10-mile radius, within a radius determined by the Department, or within the elk hunt area containing the affected feedground). Require mandatory sampling and testing of all hunter-harvested elk samples from the determined radius during hunting seasons. If an appropriate number of elk cannot be sampled to delineate the extent of bTB on the landscape, the Department will attempt to sample coyotes that are found around the feedground (at least a radius of 10 miles from the feedground).
- **Targeted Removal:** Lethally remove and test all elk and other cervids in the determined surveillance radius in coordination with APHIS and the Wyoming State Veterinarian.
- **Documentation:** The Department's Wildlife Health Laboratory will provide increased diagnostic and mapping support to track the extent of the outbreak.
- **Reduce Elk Densities:** Reduce transmission by reducing elk density.
    - Cease feeding as soon as possible; this disease has been shown to spread quickly in populations at high densities, especially those that are supplementary fed (Schmitt et al. 2002). When feeding is stopped, animals must be monitored to ensure no contact with domestic livestock. Lethally remove and test any elk that comes into contact or close proximity to domestic livestock. If supplemental feeding must continue for an extended period of time, or if contact with domestic livestock is a concern, LD feeding will be employed at the lowest densities possible, given the usable feedground area.
    - Reduce animal density on the feedground by population reduction with a target elk density of 1-2 animals per km^2 (Shury 2015). Alternatively, a 50% reduction should be considered (Schmitt et al. 2002, Ramsey et al. 2014, and VerCauteren et al. 2018). This could potentially occur through increased hunter opportunity.
- **Public Outreach:** Due to the seriousness of this disease, if bTB is detected, the Department will notify the public and hold public meeting(s) to share current findings, plans, and potential management solutions for the eradication of bTB on feedground(s). The Department will, at a minimum, notify individuals from the WLB, public health agency, sportspersons, and nearby livestock producers and landowners.

3.5.3 Habitat Enhancements

<u>Objective:</u> Implement habitat treatments that increase forage production on native elk winter ranges distant from cattle operations.

Habitat projects have been utilized historically in areas adjacent to feedgrounds with some positive impact on elk distribution and feeding duration, but rarely have habitat enhancement projects been focused on native elk winter ranges distant from feedgrounds if elk are the only species of concern (Henry 2009 and Zaffarano et al. 2018). Many aspen and other habitat enhancements have been completed across mid and high-elevation areas with objectives focused on mule deer or other ecological health goals. Projects should continue to be designed in areas that provide the opportunity for elk to free range during the brucellosis transmission period in areas distant from cattle. The decision authority to implement enhancement projects is typically with the appropriate land management agency or private landowner. In some instances where the Commission owns

the land, that decision would be handled per Commission Policy. Although not a planned action, wildfires may substantially improve foraging opportunities for elk if the post-fire land management decisions prioritize wildlife habitat. All habitat enhancement Strategies need to include vegetation monitoring to ensure objectives are met, typically including livestock rest or deferment with cooperating producers and proper weed management protocols.

Strategies

- **Prescribed Fire:** Prescribed fire has been used as one of the more common habitat enhancement techniques, specifically with elk habitat in mind. Aspen habitat has been successfully improved through the use of prescribed fire throughout the Intermountain West and continues to be a common strategy to reduce succession and increase herbaceous forage. Other habitats are also suitable for prescribed fire, including mountain shrubs, mesic sagebrush communities, and mixed conifer stands, given proper prescription windows are realized.
- **Mechanical Treatments:** Many different implements have been used to reduce shrub or mat-forming forb cover, set back succession, and increase herbaceous forage. Tractor-pulled mowers, Lawson aerators, pitters, and harrow implements have been used throughout western Wyoming for over 50 years with mostly successful effects.
- **Herbicide:** Several formulations of herbicide have been applied to improve elk habitat. Perhaps the most widely used application is an aerial application of the herbicides Plateau or, more recently, Rejuvra, for the control of cheatgrass. By reducing invasive annual grasses, increases in native grass production can be achieved, which are preferred by elk for foraging over invasive annual species. Also, by managing cheatgrass, the threat of unplanned wildfires is greatly reduced. Another type of herbicide application is a sagebrush thinning herbicide application of tebuthiuron, or Spike, though sagebrush cover-reducing treatments must carefully consider the needs of other wintering ungulates and sagebrush obligates that rely on diverse, healthy sagebrush communities.
- **Irrigation:** Irrigating hay meadows with the intent of providing standing forage for elk can be a successful enhancement strategy when livestock management leaves residual forage for elk.
- **Reseeding:** In places where less desirable, non-native, or weedy vegetation has been allowed to dominate, reseeding or planting higher quality forage species can improve the quality and quantity of forage for elk. Previous disturbances or lands formerly used as pasture land can be prime candidates for these efforts.
- **Wildfire:** Post-wildfire habitat management has occurred throughout western Wyoming for decades. Through a collaborative approach with federal, state, and county agencies, private landowners, livestock permittees, county weed and pest districts, NGOs, and elected officials, wildlife objectives can be achieved by developing solutions unique to each set of circumstances. These solutions typically include weed management, sediment and erosion control, livestock deferment for a period of time, and other site-specific components. The Department follows the outline provided in the Department Wildfire Response Guide (WGFD 2019).

3.5.4 Habitat Accessibility

Objectives: Increase opportunities for elk to winter away from feedgrounds and conserve elk habitat permeability on the landscape

It is the Department's responsibility to promote best management practices for the long-term management of elk in a way that includes the agricultural community, accounts for interspecies competition, and emphasizes the reciprocal benefits to elk and the public. As an arbiter of change in the future of elk management, the Department's long-term perspective is essential in guiding short-term goals and actions. Increasing native winter range availability and use will take considerable time, funding, and support from both public land managers and private landowners. To manage disease issues in western Wyoming elk, new and innovative paths need to be explored to allow elk to winter away from feedgrounds where opportunities allow while continuing to minimize conflict with livestock operations and limiting competition with other wintering wildlife.

In the case of Teton and northern Lincoln counties, this will require looking outside of traditional agricultural use properties. Land ownership in western Wyoming has changed in recent decades, and there are now far fewer traditional agricultural operations. The long-term focus of the Plan must consider those lands with non-traditional ownership and potential opportunities associated with those lands. This Plan calls for the Department to seek opportunities to cooperatively increase access to these lands for wintering elk.

Strategies

- **Purchase or Lease:** Seek opportunities to acquire, through purchase or lease, lands that could be used as winter range for elk as an alternative to feedgrounds.
- **Elk Occupancy:** Identify properties that could serve as elk winter range or serve to connect migrations to native winter ranges, and develop a long-term plan to pursue elk occupancy agreements with interested landowners. To date, elk occupancy agreements have been implemented, administered, and paid for through contractual agreements between willing landowners and NGOs. Each agreement is uniquely designed to accommodate the needs of the landowner. Any elk occupancy agreements using Department funds should concurrently consider hunting accessibility.
- **Conservation Easements:** Seek opportunities to utilize conservation easements with interested landowners that will allow increased elk occupancy on private lands.
- **Winter Closures:** Work with land management agencies and private landowners to reduce human disturbances on native winter ranges to encourage elk occupancy of native winter ranges. Engage with the outdoor recreation community to communicate the importance of winter closures for wildlife conservation.
- **Funding:** Land purchases, leases, and easements will require substantial investment by the Commission and other entities. Department personnel will bring potential opportunities to the Department's Regional Leadership Teams to forward to the Department's Property Rights Team and external partners as they arise.
- **Public Engagement:** Considerable public support would be required to increase elk occupancy on lands currently not utilized by elk. Funding for increasing elk native winter ranges will not become available to the Department without broad public support, including support from the agricultural community and lawmakers (Sections 3.4.8 and 3.4.11).

- **Engagement with Elected Officials**: Provide expert knowledge in testimony to elected officials and their representatives at the city, county, state, and national levels. Examples of topics related to the Plan include but are not limited to elk damage prevention versus payment to landowners (i.e., proactive versus reactive management and funding mechanisms) and methods to incentivize increased elk occupancy away from feedgrounds.

3.5.5 Emergency Feeding

Objective: Use emergency feeding to mitigate elk damage and elk/cattle commingling conflicts, which cannot be addressed with traditional conflict resolution methods and existing feedground management. Emergency feeding should be the last option implemented after all other options have been exhausted or cannot be accomplished.

While emergency feeding should be the last option, it is an important management tool. Aside from debriefing emergency feeding operations and providing guidance, most Strategies are designed to prevent the need for emergency feeding. The Plan provides reference and background information that would be useful reference materials for other areas considering emergency feeding.

Strategies

- **Debrief:** Emergency feeding can affect elk behavior and create perpetual feeding situations. Following an emergency feeding scenario, local managers shall analyze the causal factors that led to the need and future strategies to avoid recurrence of emergency feeding operations.
- **Emergency Feeding Guidance:** Consider statewide Department or Commission guidance on standard practices or considerations for deciding to implement, how to conduct, debriefing, and future prevention of emergency feeding operations.
- **Access:** Wildlife managers will continue to explore incentives for hunter access to and across private lands to achieve harvest goals, especially for antlerless elk in areas above herd objectives.
- **Auxiliary Management:** Implement Commission Regulation Chapter 34 and Chapter 56 to respond to damage or potential elk/cattle commingling situations. Consider non-traditional hunting seasons in areas where herds are over-objective, emergency feeding is being considered, and/or hunting season strategies have been ineffective.
- **Herd Unit Objectives:** Encourage managers to review elk herd population objectives in consideration of available native winter range and LD feeding capacity on feedgrounds. Given the challenges of obtaining reliable trend count data on native winter range, consider alternative herd objectives. Proposed changes to herd objectives would follow Department standard procedures and the associated public process.
- **Hunting Seasons:** While working to manage toward herd objectives, utilize hunting seasons to manage herd segments as appropriate as possible based on the unique conditions of each hunt area.

3.5.6 Feedground Phase-outs

Objective: Implement a long-term combination of management Strategies that reduce elk reliance on supplemental feed while adhering to the Plan's Sideboards. If those actions are successful enough that phase-out becomes a viable option given the Plan's Sideboards, pursue the planning, effort, coordination, and approval required to phase out that feedground in accordance with W.S. § 23-1-305.

Pursuant to W.S. § 23-1-305, the Department does not have the authority to independently close any feedground. The long-term implementation of the Plan may allow the opportunity for the Department to pursue feedground phase-outs in the future. The advantage of implementing feedground phase-outs, in addition to reducing feedground operational costs (Section 2.1.5), is that the dense aggregations of elk associated with feeding would cease, reducing the incidence of brucellosis, CWD, necrobacillosis, and other diseases in elk and thereby reducing potential disease spillover to other domestic or wildlife species. The predicted negative population impacts from high CWD prevalence on elk and mule deer populations would be reduced, which could result in more stable hunting opportunities over the long term (Section 2.5.3, Table 7). As was noted in the historical background in this Plan, the Department has successfully phased out feedgrounds in the past without negative long-term impacts.

Disadvantages of feedground phase-out may include increased risk of elk damage to private lands and elk-to-cattle brucellosis transmission in the near term (if test slaughter is not implemented immediately prior to phase-out), increased damage control costs, elevated elk winter mortality, reduced elk populations, and associated hunter opportunity, increased potential for vehicle-elk collisions, increased elk presence in residential areas, and a potential increase in competition on native winter range with other wildlife species, if not implemented in accordance with the Plan.

Strategies

- **Combine Management Strategies:** Depending on the particular feedground to be phased out, successful implementation would likely require a combination of several management actions and considerable effort toward outreach and education. Ultimately, elk reliance on supplemental feed would be eliminated over the long term while adhering to the Plan Sideboards.
- **Outreach and Coordination:** The Department will not pursue feedground phase-out or closure without significant outreach and coordination efforts with affected stakeholders and the general public.
- **Monitoring:** During and after the completion of feedground phase-out, increased elk monitoring would be required to minimize damage to private property and respond to elk/cattle commingling conflicts. Outfitting an adequate proportion of the elk population with GPS collars would provide an efficient way to monitor distribution in near real-time.
- **Elk Redistribution:** When traditional hunting seasons are not sufficient to affect elk distribution, use aerial drones and auxiliary hunting seasons (Commission Regulation Ch. 34) and directed lethal removal (Commission Regulation Ch. 56) as tools for moving elk to desirable native ranges.

3.5.7 Feedground Alterations

Objective: Manage feedgrounds to decrease disease transmission on feedgrounds and improve animal welfare and health. Continue to identify funding needs and pursue funding opportunities as needed.

Strategies

- **Feeding Area Expansion:** Expanding feeding areas can reduce elk densities while on a feedground; however, CWD prion contamination would occur in a broader area. Some constraints for implementation include terrain, obstacles, special use permit restrictions, land status, equipment, funding, personnel, and hay storage.
- **Move Feeding Areas:** A moving or migrating feedground scenario could better mimic native-range elk behavior. This would potentially allow for feeding on clean snow daily, decrease elk concentration while on feed (as long as LD feeding is employed), and decrease intraspecific disease transmission. There is concern that depending on how this was implemented, it could increase interspecies disease transmission in some areas and increase CWD prion deposition on the landscape. This would require access to large, continuous tracts of land, purchasing heavy equipment, federal permitting, additional personnel, and strategic planning to implement.
- **Additional Feedgrounds:** While additional feedgrounds would likely not reduce the transmission/occurrence of CWD, the transmission of some diseases may be reduced by allowing for smaller elk concentrations across the landscape while being more manageable for feedground personnel. Creating new feedgrounds would require land acquisitions, additional federal and/or state land permits and/or private land leases/easements, additional facilities, feeding personnel, and feeding equipment. This would also require updating Commission policy VII D if remains in effect.
- **Feedground Relocation:** Many feedgrounds occur on federal public land and are operated under a permit with the associated land management agency. Litigation with public land management agencies has resulted in the elimination of some feedgrounds. Feedgrounds could be moved from public to private, state, and/or Commission-owned lands. Moving feedgrounds to Commission-owned lands would place more management emphasis on the Department, which is responsible for the management and health of the state's wildlife and is responsible and liable for damage.
- **Non-Annual Feeding:** The original purpose for winter feeding of elk was to prevent mass mortality during extreme winter conditions. As the Department works towards reducing reliance of elk on feed, there may be situations where it would be appropriate to forego feeding during mild and average winters and feed during severe winters to protect elk and human health and safety. This has been conducted successfully at several feedgrounds and the National Elk Refuge in the past. When considering this Strategy, clear metrics need to be used to determine scenarios by which feeding would or would not be implemented in any given year.
- **Heavy Equipment Acquisition:** Available hay bale size and shape have significant impacts on the cost and equipment needed to distribute on a feedground. In some cases, purchasing heavy equipment can substantially improve feeding operations, albeit heavy equipment operation and maintenance brings its own set of challenges.

- **Hay Acquisition:** Finding hay to purchase in close proximity to feedgrounds has become more difficult. Given these circumstances, land acquisition that includes hay production properties (such as those found in Farson and Star Valley) should be considered to provide hay to the feedgrounds. The Department will explore options to reduce contract processing times in order to expedite the hay purchasing process.
- **Carcass Disposal:** Lethal removal of symptomatic elk and proper disposal of carcasses are essential to reducing the spread of disease on feedgrounds. Lethal removal of sick or dead elk from feedgrounds, especially in the actual feeding areas, reduces disease transmission risk (Miller et al. 2004), reduces the risk of injury/damage to the feeding equipment/horses, and is essential for maximizing the area in which elk can be fed. Elk that are exhibiting signs of serious illness or neurologic disease are to be euthanized immediately by Department personnel, sampled for diseases, removed from the feedground, and transported to an approved disposal location. Currently, some carcasses suspected of CWD are taken to an approved landfill, but with changing municipal waste disposal regulations and increasing volume and cost, other disposal options may become less cost-prohibitive. These options include but are not limited to, incineration, composting, alkaline hydrolysis (Murphy et al. 2009), and biochar (Wang and Wang 2019). The Department does not have the personnel or budgetary resources to employ these techniques at this time. However, these options may become more economical in the future, and Department capacity may increase if this issue is a statewide priority. The Department will consider an alternative disposal option that denatures the CWD prion (pilot biochar facility).

3.5.8 Agricultural Producers and Landowners

<u>Objective:</u> Work cooperatively with agricultural producers and landowners on voluntary management Strategies designed to accomplish the Goals outlined in the Plan while understanding and minimizing impacts to those producers and landowners. Through this process, continue to learn how to best adhere to the established Sideboards.

Some FMAP actions will likely require substantial coordination between all affected parties and considerable funding to be successful. Evaluation and implementation of the livestock management alternatives in this Section are under the jurisdiction of individual livestock operators. In addition, the WLB, the Wyoming State Veterinarian, and the U.S. Department of Agriculture APHIS Veterinary Services all have a vested interest in impacts on regional livestock operations.

The Department will continue to work with producers and landowners to prevent elk/cattle commingling, reduce the risk of brucellosis transmission to cattle, and minimize elk damage. The Department's role in facilitating the Strategies below is to provide information, support, and assistance for interested producers and landowners. The Strategies below come from examples of actions that have already occurred with or been considered by willing partners. The diversity of land uses and private land management in western Wyoming is incredible. It is therefore important to remember that the Strategies listed may or may not be applicable, or even palatable, based on any given individual landowner and their personal interests and goals.

Strategies that have been or could be implemented in cooperation with interested landowners

- **Engage:** Continue to engage with producers and landowners and work to understand their perspectives and needs. Provide information about and contained within the Plan as well as support and assistance for Plan implementation.
- **Shipping Cattle:** Securing financial incentives for willing landowners to ship cattle to areas of low brucellosis risk could facilitate reducing the reliance of elk on feedgrounds and increase tolerance for elk wintering on private lands.
- **Fencing:** Provide elk-proof fencing for stored crops and winter livestock feeding pastures to reduce the risk of elk commingling with cattle and damage. Fencing can prevent elk from receiving a food reward. Reducing the risk of disease transmission and private property damage may result in greater tolerance of elk on currently unavailable native winter ranges and private lands. Work cooperatively with landowners to customize fencing that achieves the purpose without creating additional barriers to the desired movements of livestock and other wildlife species.
- **Conflict-Reduction Management Actions:** Other changes in operations, such as developing a water source enabling the producer to calve in lower brucellosis transmission risk areas, could be appealing if financial incentives were provided.
- **Strategic Grazing Rotations:** Continued utilization of elk movement data to develop maps depicting areas of high risk of brucellosis transmission on both private and public land to provide area producers helpful information they may choose to use as they make grazing management plans to reduce the risk of brucellosis transmission, particularly during the latter portion of the transmission period (May 1 – June 15).
- **Elk Occupancy:** Compensating private landowners for voluntarily allowing elk to utilize private lands during winter could reduce the reliance of elk on supplemental feed by providing an alternative winter range while supporting the agricultural community by providing alternative income.
- **Brucellosis Compensation:** Investigate the feasibility of providing financial compensation for costs and income loss associated with cattle brucellosis infection. The Property and Environment Research Center (PERC) established a brucellosis compensation fund pilot program in Montana in 2022 to support ranchers who provide elk habitat. Consider working to facilitate program expansion into Wyoming if the program can provide stopgaps to alleviate concerns that the program could disincentivize proactive brucellosis management practices.

3.5.9 Public Land Management

Objective: Work cooperatively with the USDA FS, BLM, NPS, USFWS, and OSLI to accomplish the Goals outlined in the Plan.

The Department regularly provides management recommendations to federal partners through established inter-Department relationships and public land management planning processes. Coordination with public land management agencies and private landowners is critical in increasing opportunities for elk on native winter ranges.

Strategies

- **Planning Processes:** Continue to actively participate in public land management planning processes by identifying and recommending protections for crucial native elk winter ranges.
- **Winter Closures:** Identify key elk native winter ranges and coordinate with land managers and public land users to determine if closures to human recreation (winter range closures) can reduce elk dependence on feedgrounds.
- **Migration:** Investigate opportunities to cooperatively re-establish and protect migration routes.
- **Special Use Authorizations and Interagency Agreements:** Continue to Pursue Special Use Authorizations and/or Interagency Agreements as appropriate and necessary to cooperatively develop and implement habitat enhancement projects.

3.5.10 Funding

Objective: Acquire traditional and non-traditional funding to implement the Plan and FMAPs.

Funding constraints present a significant hurdle to accomplishing the Goals and adhering to the Sideboards in the Plan. The Plan provides Department Direction but does not provide authority to make budgetary commitments. While it is important to recognize the expectation that funding needs have been identified in the Plan, additional funding will be identified in the FMAPs, and regional Department personnel will work toward acquiring the funds needed to implement the Strategies identified in the Plan and subsequent FMAPs.

Strategies

- **Needs:** Identify funding needs and priorities through the FMAP process.
- **Traditional Sources:** Submit Commission budget requests through the annual Department budget planning cycle for prioritized funding needs.
- **Non-Traditional Sources:** Identify and pursue non-traditional sources of funding to implement FMAPs. Some examples include NGOs, market-based solutions, federal and state government funding, and grants. Work with partners to identify new and innovative funding sources.

3.5.11 Coordination, Collaboration, and Communication

Objective: Communicate the complexities and challenges surrounding feedgrounds both internally and externally. Maintain a high level of coordination, collaboration, and communication regarding the management of feedgrounds.

It is paramount that the Department works in coordination with partners, collaborates with stakeholders, and communicates effectively with all interested and affected individuals, decision-makers, and the public. This will require substantial public outreach, education, and engagement efforts.

Strategies

- **Season Setting:** Continue to actively communicate with and engage the public in the management of feedgrounds during annual season-setting public meetings. Because season setting is one mechanism by which feedground management occurs, continue to encourage stakeholders interested in feedground management to participate in the season setting process.
- **Herd Objective Reviews:** Provide the public with an update on population dynamics, disease prevalence, and an overview of herd objectives and feedground quotas as a part of a feedground update within the five-year herd objective review. Because herd objective reviews are one mechanism by which feedground management occurs, continue to encourage stakeholders interested in feedground management to participate in the herd objective review process.
- **Feedground Management:** Increase the outreach of ongoing and emerging issues regarding feedground management, including how those issues are being addressed and how the public and other stakeholders can further engage and participate.
- **CWD Status:** Notify the public when the herd changes CWD scenario/status.
- **FMAPs:** Actively communicate with and engage the public, stakeholders, and landowners in the FMAP process. Incorporate communication efforts and plans into the FMAP process.
- **Management Strategies:** Continue to provide educational information regarding current and new management Strategies, how and where they can be implemented, and how they are expected to benefit elk management.
- **Human Dimensions:** Consider conducting human dimensions and public attitude surveys to guide management decisions based on hunter and public attitudes regarding CWD management options and changes in elk herd objectives.
- **Personnel:** Dedicating personnel to this work will ensure long-term accountability, continuity, and effectiveness. While the FMAP process will identify specific personnel and resource needs, the Department should consider dedicating personnel to implementing this Plan. This could include additional personnel and/or adjusting existing position responsibilities.
- **Internal Communications:** The Communications and Education Division will assist regional and statewide Department staff and Commission to disseminate updated information and current talking points within the Department as needed.
- **External Communications:** The Communications and Education Division will assist regional and statewide Department staff to disseminate updated information to the public as needed. This includes continued communication with the public regarding feedground management planning, FMAP development and implementation, and information related to the latest science related to disease management and herd health. This also includes continued engagement with major stakeholders identified in Phase II (including but not limited to government/elected officials, landowners, NGOs, outfitters, sportspersons, and the general public) as well as other interested/affected stakeholders.

3.5.12 Research

Objective: To better understand the complex nature of feedgrounds, disease, and the associated economics to make science-based management recommendations and decisions. Actively engage in research opportunities and pursue research funding.

Research on the benefits and consequences of maintaining feedgrounds in the presence of CWD could facilitate management decisions. The implications of retaining or closing feedgrounds and the long-term impacts of those actions on elk herds should continue to be explored. Research must address how the existence of feedgrounds affects individual livelihoods and local economies and how various resources may be affected by reduced elk populations, either from feedground closure or from CWD mortality. The Department will promote and actively engage in research opportunities and partner with appropriate entities to pursue research funding.

Strategies

- **Research:** The Department will continue to collaborate with external governmental entities, academic institutions, and the private sector on research priorities, projects, and funding to facilitate the expansion of knowledge to inform management. The Department is committed to a long-term investment in research on adaptive feedground and disease management.
- **Funding:** Pursue traditional and non-traditional funding to conduct relevant research (Section 3.5.10).
- **Engagement:** The Department will continue to monitor published research and contribute to the body of knowledge through relevant conferences, symposiums, written documents, and other collaborative forums to ensure it remains current on the newest scientific information that applies to feedground and disease management.
- **Priorities:** Continue to assess, pursue, and update the research priorities that were identified during the Plan's development process (Appendix 3).

3.5.13 Wildlife-Vehicle Collision Reductions

Objective: Work cooperatively with the Wyoming Department of Transportation (WYDOT) and other interested partners to limit elk-vehicle collisions.

The risk of wildlife-vehicle collisions (WVCs) with elk present on roadways is a major factor in the decision-making of the initiation and duration of supplemental feeding of elk at some feedgrounds. Elk distribution to lower-elevation native winter ranges can result in increased WVCs, resulting in increased wildlife mortality and human safety concerns. Allowing elk to safely cross roadways and utilize native winter ranges adjacent to roadways would increase winter foraging opportunities and potentially reduce the duration of supplemental feeding. The construction of wildlife crossing structures has demonstrated they are an effective measure to reduce WVCs, allow for permeability of roadways, and improve motorist safety in areas that have high densities of wildlife seasonally (Huijser et al. 2017). Wildlife crossings is a broad term that includes actual wildlife crossing structures (overpasses and underpasses), associated fencing to direct wildlife to crossing locations, and other infrastructure required to facilitate the safe passage of wildlife across roadways. Variable message signs and permanent wildlife crossing signs are

currently in use seasonally to alert motorists of increased wildlife movements in relation to roadways. This technique works well in certain situations but, over time, loses effectiveness unless signs are moved or changed frequently (Huijser et al. 2015).

Strategies

- **Wildlife Crossings:** Continue to work with WYDOT in highway development planning, design, and implementation. Ensure that wildlife crossings and reductions in WVCs continue to be investigated and incorporated into roadway development and replacement projects with an emphasis on areas adjacent to native elk winter range and migration paths.
- **Education and Outreach:** Continue to help educate the public on the importance of WVC mitigation projects to ensure the support and success of wildlife crossing projects.
- **Chapter 21:** The Department has the authority to lethally remove gray wolves if they displace elk from a feedground onto a highway right of way, causing human safety concerns,

SECTION 4- Feedground Management Action Plans (FMAPs)

4.1 Overview

Upon adoption of the Plan by the Commission, the Department will develop FMAPs for each individual elk herd and associated feedgrounds. Each FMAP will use the best available science, expertise, and local knowledge on how to uniquely implement the Strategies identified in the Plan as appropriate at each feedground. FMAPs will consider both immediate and long-term obstacles, outstanding questions, and solutions. While the FMAPs will assess each feedground, they will be conducted at the herd level to maintain consistency in Department standard processes for management and reporting. Once developed, each FMAP will be reviewed annually for evaluation, reporting, and minor updating. Major updates will be incorporated into the herd objective review process. Each FMAP will:

- Adhere to the Plan's Direction, Sideboards, and Goals.
- Provide specific and detailed methods to implement the appropriate Strategies identified in the Plan under current and future feedground management.
- Be adaptive in time, approach, and location.
- Consider and assess the best available science and social and economic issues.
- Utilize workshop(s) with potentially-impacted stakeholders and the public to develop immediate and long-term solutions.

4.2 Constraints

To achieve the desired outcomes of the FMAPs, certain constraints must be acknowledged. To overcome constraints, the Department must work to garner additional funding, increase internal and external education, engage all stakeholder groups to achieve support for management Actions, and focus on Department personnel to help achieve milestones toward its overarching Goals.

4.2.1 Funding

Current feedground management utilizes substantial funds to maintain current operations. Any future monitoring or modifications proposed in FMAPs will require considerable funding increases to incorporate many of the Strategies. The Jackson and Pinedale regions will continue to identify and articulate funding needs to statewide Wildlife Division administration, the Directors Office, and the Commission for their prioritization at the statewide level. The Department should also explore non-traditional funding sources to support the future of elk management (Section 3.5.10).

4.2.2 Public Engagement

The Plan Goals can only be accomplished at the pace at which affected stakeholders and public sentiment align. This is why Department personnel must stay vigilant over the long-term and why Strategies were developed to address Coordination, Collaboration, and Communication (Section 3.5.11).

4.2.3 Personnel

Department personnel will develop and implement FMAPs, potentially necessitating changes to existing personnel duties or the creation of new positions. Adherence to the Plan will require considerable long-term coordination and monitoring to achieve intended outcomes. Dedicating personnel to this work will ensure long-term accountability, continuity, and effectiveness. While specific personnel and resource needs will be identified through the FMAP process, the most immediate needs may be addressed by increasing FMAP implementation capacity through additional personnel and/or adjusting existing position responsibilities. The Jackson and Pinedale regions will continue to identify and articulate personnel needs to Wildlife Division administration, the Directors Office, and the Commission for their prioritization at the statewide level (Section 3.5.10)

4.3 Process

4.3.1 FMAP Development

Department Working Groups

Two regional internal feedground working groups (one each) in the Jackson and Pinedale regions will develop FMAPs for the six elk herds containing feedgrounds. Each herd will have individualized FMAPs, with an overall three-year completion objective for all six elk herds upon adoption of the Plan by the Commission. The Pinedale and Jackson regions will each complete one target herd FMAP each year. Each working group will be composed of the following, at a minimum:

- *Working Group Organizer*: Regional Wildlife Disease Biologist (Jackson and Pinedale - three herds each).

- *Core Members*: Feedground Managers, regional Wildlife Biologists, Game Wardens, Terrestrial Habitat Biologists, and the Public Information Specialist with feedgrounds within their district, and a representative from Habitat and Access Branch staff.
- *Technical and Advisory Support:* Representative from Veterinary Services and Science, Research, and Analytical Support units.
- *Regional Wildlife Supervisor and Wildlife Management Coordinator*: Act as project managers and facilitators. Ensure the process moves forward with active participation from all members. Provides specific direction and intervention as needed to ensure the group is following the process to achieve the Goals.

Order

The order of each FMAP development will be determined after the approval of the Plan based on the highest priority. The Department will consider the status of federal land management agency decision-making processes, herd CWD status/risk, and other factors when making those decisions.

Template

The Department will incorporate knowledge garnered from stakeholders during the development of the Plan and the institutional knowledge surrounding feedground management to develop each FMAP, following the FMAP assessment checklist template (Appendix 1). Each Strategy identified in the Plan will be reviewed for each feedground as it relates to the Plan's Direction, Goals, and Sideboards. The checklist includes an Assessment (immediate and long-term opportunities, constraints, accomplishments, metrics for success, and needs) and an Implementation Plan (turning Strategies into Actions). The implementation plan for some Strategies may not be applicable at any given time. The template can be customized as appropriate to increase efficiency and effectiveness during the FMAP development process.

Public Involvement

The Department recognizes that public involvement is necessary to accomplish the Plan's Goals while adhering to the Sideboards. After the Department working groups complete the initial FMAP assessment checklist, the Department will host a minimum of one workshop for each FMAP herd. The Department may hold multiple workshops to meet with different stakeholders separately or if the Department determines that one workshop is insufficient. The Department will identify and collaborate with potentially-impacted stakeholders, including local elected government officials. The intent of the workshops and any follow-up meetings/conversations are to:

- Share the Department's progress in FMAP development, including the initial assessments and implementation plans.
- Get feedback on the Department's FMAP progress. Solicit input on immediate and long-term items in the assessment and implementation plans that may not have been addressed.
- Seek input from affected stakeholders on how best to alleviate their specific concerns and minimize impacts on their goals within the context of the Plan.
- Get public feedback on creative ways to address constraints and needs.

- Assure a balanced approach; determine if the scale of the mitigation measures designed to adhere to the Sideboards is appropriate to the scale of the Strategies identified to reach the Goals.

Product

Written plans will be finalized using input from the public process (Section 4.3.1). The FMAP assessment checklist could serve as the final plan if all the necessary components are incorporated. Final FMAPs will include a prioritized list of Actions that can be pursued immediately so Department managers and partners can begin working without delay. FMAPs are intended to be a concise, straightforward playbook that specifically identifies obstacles and solutions to implement Actions to accomplish the Plan Goals. Final FMAPs will be approved by the Wildlife Division Chief before implementation and incorporated into the JCR for each elk herd.

4.3.2 FMAP Implementation

Implementation

Once the Plan is approved, FMAPs will be implemented immediately. FMAP implementation includes the process of removing feedground quotas from Commission policy and incorporating them into herd objectives. FMAP implementation also includes incorporating FMAPs into future herd objective reviews, which will be initiated upon approval of each FMAP. Annual JCR reports will incorporate a brief summary of FMAP progress.

Review and Update

Annual debriefs, coordination, and minor updates will be needed to incorporate FMAP progress into herd JCR reporting. Major FMAP updates will occur as needed and will follow the FMAP Development process (4.3.1). FMAP updates could trigger objective reviews as well as vise-versa. The Plan will be updated as necessitated by major changes in science, management direction, or other.

SECTION 5- Conclusion

This Plan provides an opportunity to take a step back, examine the status quo, and chart a path forward, together. The Direction outlines the need for the Department to have a unified goal and approach for elk and feedground management, particularly in the face of CWD, which has never previously been articulated. The Goals and Sideboards provide clarity and specificity to the overarching Direction. It will take tremendous team work and determination to find the best Strategies to implement at the right time for each feedground through the FMAP development process. It will take both patience and persistence to effectively implement those Strategies. It is easy to see what we have in common; an instinctive and serious obligation to make certain that healthy, sustainable wildlife populations endure. It is difficult, however, to come to agreement on how to accomplish that monumental task. With this Plan, the Direction and Goals make clear that some changes are needed. This is why it cannot be overstated that the successful implementation of this plan hinges on internal and external partnership, collaboration, trust, and creativity.

In the face of existing and threatening diseases, it is incumbent upon wildlife managers to explore all options for managing elk, now and into the future. As the Department looks toward its long-term objectives, it must continue looking for opportunities to incorporate new ideas and science into elk management in a way that will allow for the conservation of healthy elk populations. Securing opportunities for elk to winter away from feedgrounds is a priority for wildlife managers in collaboration with affected and interested stakeholders. Incremental change will lead to more sustainable elk population health, conservation, and management over the long term.

The internal steering committee and Department would like to extend our gratitude to those who participated in this process and provided meaningful comments. We appreciate the time and input you invested in tackling this challenging wildlife management issue. We look forward to working with you more. Thank you.

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APPENDIX 1: FMAP Assessment Checklist Template

Elk Feedground Management Plan (Plan) Feedground Management Action Plan (FMAP) Checklist Template.

Plan Goals: 1) Promote elk health by limiting disease transmission while providing supplemental feed and 2) reduce reliance of elk on supplemental feed while adhering to the Sideboards.

Plan Sideboards:

1. Adhere to standard Department process for elk herd unit population objective review with public process and Commission approval for any proposed changes.
2. Prioritize hunting opportunities as the primary tool to manage elk populations toward the Commission-approved herd unit objectives.
3. Minimize elk damage to private property, disease transmission to livestock, and negative economic impacts to livestock producers.
4. Minimize competition with other wintering wildlife species.

Instructions: Use this template to assess each Strategy identified in the Plan as it relates to the Direction, Goals, and Sideboards. Identify new Strategies as appropriate. First, provide a current Assessment related to each Strategy at each feedground, including immediate and long-term opportunities, constraints, accomplishments, metrics for success, needs, costs, or any other relevant information and data. Next, develop an Implementation Plan for each Strategy at each feedground. Consider immediate, short-term, and long-term management. Finally, prioritize immediate actions to be pursued and how to implement those actions.

Metric(s) of Success

Determine appropriate feedground or herd unit metrics of success for the Goals and Sideboards.

Feedground:	Herd Unit:	Meeting date(s):
Department Members Present:		
Identify Potentially Impacted Stakeholders:		

Elk Population Management

Strategy	**Assessment:** immediate and long-term opportunities, constraints, accomplishments, metrics for success, needs, costs	**Implementation Plan**
Herd Objectives		
Commission Policy Feedground Quotas		
Hunting Seasons		
Auxiliary Management		
Access		
Migration		
Monitoring		

Disease Management- Annual Reporting

Disease	**Detected this feeding season?**	**Location**	**Summarize known sampling, mortality, and prevalence metrics**
Brucellosis	Yes / No		
CWD	Yes / No		
Necrobacillosis	Yes / No		
Psoroptic Mange	Yes / No		
Tuberculosis	Yes / No		
Other	Yes / No		

Disease Management- Brucellosis

Strategy	**Assessment**	**Implementation Plan**
Surveillance		
Operate Feedgrounds		
Cattle Commingling Conflict Mitigation		
Reduce Feeding Season Length		
Low-Density Feeding		
Habitat Enhancements		

Fencing		
Feedground Relocation		
Increase Winter Range		
Elk Population Management		
Test and Slaughter		
Vaccination		
Carcass Removal		

Disease Surveillance- CWD

Strategy	Assessment	Implementation Plan
Statewide CWD Surveillance Plan		
Monitoring		
Scale		
Mandatory Sampling		
Feedground Mortalities		
Environmental Testing		

Disease Management- CWD

Strategy	Assessment	Implementation Plan
Elk Population Management 1) Status Quo 2) Low Density Feedground Quota 3) Elk Density Reductions 4) Native Winter Range Objectives		

Prevention (immediate) *Animal-to-Animal Prevention*	**CWD first detected in elk in the elk Herd Unit** *Animal-to-Animal Mitigation*	**5% Prevalence (<7%)** *Environmental Contamination Prevention*	**10% Prevalence (<13%)** *Environmental Contamination Mitigation*
Select the appropriate option (1-4) from Section 3.5.2.2	Select the appropriate option (1-4) from Section 3.5.2.2	Select the appropriate option (1-4) from Section 3.5.2.2	Select the appropriate option (1-4) from Section 3.5.2.2

Strategy	Assessment	Implementation Plan
Feedground Alterations		
Habitat Accessibility		
Elk Populations Management		
Carcass Removal		
Substrate Conversion		
Fencing		
Hay Acquisition		
Manure		
Research		

Disease Management- Necrobacillosis

Strategy	Assessment	Implementation Plan
Surveillance		
Hay Type		
Reduced Feeding Length		
Reduce Elk Densities		
Feedground Drainage		
Manure Management		
Feedground Cleanliness		
Moving Feeding Area		
Targeted removal		
Carcass removal		

Disease Management- Psoroptic Mange

Strategy	Assessment	Implementation Plan
Surveillance		
Reduce Elk Densities		

Disease Management- Tuberculosis

Strategy	Assessment	Implementation Plan
Increased Surveillance		
Targeted Removal		
Documentation		
Reduce Elk Densities		
Public Outreach		

Habitat Enhancements

Strategy	**Assessment**	**Implementation Plan**
Prescribed Fire		
Mechanical Treatment		
Herbicide Treatment		
Irrigation		
Reseeding		
Wildfire		

Habitat Accessibility

Strategy	**Assessment**	**Implementation Plan**
Purchase or Lease		
Elk Occupancy		
Conservation Easements		
Winter Closures		
Funding		
Public Engagement		
Engagement with Elected Officials		

Emergency Feeding

Strategy	**Assessment**	**Implementation Plan**
Debrief		
Emergency Feeding Guidance		
Access		
Auxiliary Management		
Herd Unit Objectives		
Hunting Seasons		

Feedground Phase-outs

Strategy	**Assessment**	**Implementation Plan**
Combine Management Strategies		
Outreach and Coordination		
Monitoring		
Elk Redistribution		

Feedground Alterations

Strategy	Assessment	Implementation Plan
Feeding Area Expansion		
Move Feeding Areas		
Additional Feedgrounds		
Feedground Relocation		
Non-Annual Feeding		
Heavy Equipment Acquisition		
Hay Acquisition		
Carcass Disposal		

Agricultural Producers and Landowners

Strategy	Assessment	Implementation Plan
Engage		
Shipping Cattle		
Fencing		
Conflict-Reduction Management Actions		
Strategic Grazing Rotations		
Elk Occupancy		
Brucellosis Compensation		

Public Land Management

Strategy	Assessment	Implementation Plan
Planning Processes		
Winter Closures		
Migration		
Special Use Authorizations and Interagency Agreements		

Funding

Strategy	Assessment	Implementation Plan
Needs		
Traditional Sources		
Non-Traditional Sources		

Coordination, Collaboration, and Communication

Strategy	Assessment	Implementation Plan
Season Setting		
Herd Objective Reviews		
Feedground Management		
CWD Status		
FMAPs		
Management Strategies		
Human Dimensions		
Personnel		
Internal Communications		
External Communications		

Research

Strategy	Assessment	Implementation Plan
Research		
Funding		
Engagement		
Priorities		

Wildlife-Vehicle Collision Reductions

Strategy	Assessment	Implementation Plan
Wildlife Crossings		
Education and Outreach		
Chapter 21		

Prioritizing: Final plans shall include a prioritized list of actions that can be pursued immediately so Department managers and partners can begin working on them without delay. Include cost estimates and potential methods to acquire the necessary funding.

Priority Number or Tier	Action	Who is primarily responsible	Budget needs and methods to acquire

APPENDIX 2: Feedground Research

Chronological list of peer-reviewed publications for research conducted on or associated with elk feedgrounds from 2007 to present.

Cross, P. C., W. H. Edwards, B. M. Scurlock, E. J. Maichak, and J. D. Rogerson. **2007**. Effects of management and climate on elk brucellosis in the Greater Yellowstone Ecosystem. Ecological Applications 17:957-964.

Hines, A. M., V. O. Ezenwa, P. C., and J. D. Rogerson. **2007**. Effects of supplemental feeding on gastrointestinal parasite infection in elk (*Cervus elaphus*): Preliminary observations. Veterinary Parasitology 148:350-355.

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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.

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.

Scurlock, B. M and W. H. Edwards. **2010**. Status of brucellosis in free-ranging elk and bison of Wyoming. Journal of Wildlife Diseases 46:442-449.

Babnknecht, A. E., W. S. Fairbanks, J. D. Rogerson, E. J. Maichak, B. M. Scurlock, and L. L. Meadows. **2011**. Elk parturition site selection at local and landscape scales. Journal of Wildlife Management. 75:646-654.

Creech, T.G., P. C. Cross, B. M. Scurlock, E. J. Maichak, J. D. Rogerson, J. C. Henningsen, and S. Creel. **2012**. Effects of low-density feeding on elk-fetus contact rates on Wyoming feedgrounds. Journal of Wildlife Management. 76:877-886.

Forristal, V. E., S. Creel, M. L. Taper, B. M. Scurlock, and P. C. Cross. **2012**. Effects of supplemental feeding and aggregation on fecal glucocorticoid metabolite concentrations in elk. Journal of Wildlife Management 76:694-702.

Brennan, A., P. C. Cross, M. Higgs, J. P. Beckmann, R. W. Klaver, B. M. Scurlock, and S. Creel. **2013**. Inferential consequences of modeling rather than measuring snow accumulation in studies of animal ecology. Ecological Applications 23:643-653.

Cross, P.C., E. J. Maichak, A. Brennan, B. M Scurlock, J. Henningsen, and G. Luikart. **2013**. An ecological perspective on *Brucella abortus* in the western United States. Rev. Sci. Tech. 32:79-87.

Cross, P. C., T.G. Creech, M. R. Ebinger, K. Manlove, K. Irvine, J. Henningsen, J. D. Rogerson, B. M. Scurlock, S. Creel. **2013**. Female elk contacts are neither frequency nor density dependent. Ecology. 94:2076-2086.

Brennan, A., P.C. Cross, M. D. 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 5:1-25.

Hand, B. K., S. Chen, N. Anderson, A. Beja-Pereira, P. C. Cross, M. Ebinger, H. Edwards, R. A. Garrott, M. D. Kardos, M. Kauffman, E. L. Landguth, A. Middleton, B. Scurlock, P. J. White, P. Zager, M. K. Schwartz, and G. Luikart. **2014**. Sex-biased gene flow among elk in the Greater Yellowstone Ecosystem. Journal of Fish and Wildlife Management 5:124-132.

Jones, J. D., M. J. Kauffman, K. L. Monteith, B. M. Scurlock, S. E. Albeke, and P. C. Cross. **2014**. Supplemental feeding alters migration of a temperate ungulate. Ecological Applications 24:1769-1779.

Cross, P. C., E. J. Maichak, J. D. Rogerson, K. M. Irvine, J. D. Jones, D. M. Heisey, W. H. Edwards, 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.

Foley, A.M., P.C. Cross, D.A. Christianson, B.M. Scurlock and S. Creel. **2015**. "Influences of Supplemental feeding on winter elk calf:cow ratios in the southern greater Yellowstone ecosystem." J. Wild Management. 10:1002/jwmg.908.

Maichak , E. J., B.M. Scurlock, P.C. Cross, J.D. Rogerson, W.H. Edwards, B. Wise, S.G. Smith, T.J. Kreeger. **2016**. "Assessment of the *Brucella abortus* Strain 19 Ballistic vaccination program in elk on winter feedgrounds of Wyoming, USA." Wildlife Society Bulletin. 10.1002./wsb.734.

Kauffman, M., D. Peck, B. Scurlock, J. Logan, T. Robinson, W. Cook, K. Boroff, and B. Schumaker. **2016**. "Risk assessment and management of brucellosis in the southern greater Yellowstone area: A citizen-science based risk model for bovine brucellosis transmission from elk to cattle." J. Prev. Vet. Med. 132: 88-97.

Boroff, K., M. Kauffman, D. Peck, E. Maichak, B. Scurlock and B. Schumaker. **2016**. "Risk assessment and management of brucellosis in the southern greater Yellowstone area (II): Cost-benefit analysis of reducing elk brucellosis prevalence." J. Prev. Vet. Med. 134: 39-48.

Merkle, J.A., K.L. Monteith, E.O. Aikens, M.M. Hayes, K.R. Hershey, A.D. Middleton, B.A. Oates, H. Sawyer, B.M. Scurlock, and M.J. Kauffman. **2016**. "Large herbivores surf waves of green up during spring." Proc. R. Soc. B. 283: 20160456.

Kamath, P.L., J.T. Foster, K.P. Drees, G. Luikart, C. Quance, N.J. Anderson, P.R. Clarke, E.K. Cole, M.L. Drew, W.H. Edwards, J.C. Rhyan, J.J. Treanor, R.L. Wallen, P.J. White, S. Robbe-Austerman and P.C. Cross. **2016**. "Genomics reveals historic and contemporary

transmission dynamics of a bacterial disease among wildlife and livestock." Nature Communications. 10:1038.

Merkle, J. A., P. C. Cross, B. M. Scurlock, E. K. Cole, A. B. Courtemanch, S. R. Dewey and M. J. Kauffman. **2017**. "Linking spring phenology with mechanistic models of host movement to predict disease transmission risk." Journal of Applied Ecology 00:1-10.

Cotterill, G. G., P. C. Cross, A. D. Middleton, J. D. Rogerson, B. M. Scurlock and J. T. du Toit. **2018**. Hidden cost of disease in a free-ranging ungulate: brucellosis reduces mid-winter pregnancy in elk" Ecology and Evolution.

Cotterill G. G., P. C. Cross, E. K. Cole, R. K. Fuda, J. D. Rogerson, B. M. Scurlock and J. T. du Toit. **2018**. Winter feeding of elk in the Greater Yellowstone Ecosystem and its effects on disease dynamics. Phil. Trans. R. Soc. B 373:20170093.

Cotterill, G., P. Cross, J. Merkle, J. Rogerson, B. Scurlock and J. du Toit. **2020**. Parsing the effects of demography, climate, and management on recurrent brucellosis outbreaks in elk. Journal of Applied Ecology 57:379-389.

Bidder, O. R., T. Connor, J. M. Morales, G. J. M. Rickbeil, J. A. Merkle, R. K. Fuda, J. D. Rogerson, B. M. Scurlock, W. H. Edwards, E. K. Cole, D. E. McWhirter, A. B. Courtemanch, S. Dewey, M. J. Kauffman, D. R. MacNulty, J. T. du Toit, D. R. Stahler and A. D. Middleton. ***In press***: Forage senescence and disease influence elk pregnancy across the Greater Yellowstone Ecosystem. Ecosphere.

APPENDIX 3: Research Priorities

Research priorities that were developed during the Elk Feedground Management Plan development process. Items are not ranked or listed in any order of priority.

- Role of environmental transmission in CWD maintenance and expansion.
- Reduction of any/all disease transmission on feedgrounds.
- Economic analysis of how feedgrounds currently contribute to local economies and how that would change given either future CWD population-level impacts or population reductions and reduced reliance on supplemental feed via management.
- Economic assessment of feedground management on cattle producers.
- Predator effects on cervid disease ecology and elk distribution.
- Feedground soil/substrate and prion binding.
- Improved disease detection methods in elk (e.g., live-animal, chute side diagnostics for CWD, brucellosis, bTB, etc.)
- Environmentally friendly methods of prion deactivation.
- Effective brucellosis vaccine for elk, cattle, and bison.
- Necrobacillosis research on the effects of feed type, animal density, and influence of climate on incidence.
- How feeding influences CWD prevalence over time.
- CWD transmission dynamics between elk, mule deer, white-tailed deer, and moose, including juxtaposition of migratory habitat and feedgrounds and species-specific movement behavior.
- Economic analysis of carcass disposal/prion deactivating methods (e.g., thermochemical conversion gasification, alkaline digestion, incineration, biochar).
- How feedground closure may influence competition with other big game species and sage-grouse.
- Evaluate the influence of habitat treatments (including variables such as vegetation type, slope, proximity to feedgrounds, seasonal range, etc.) on reducing the duration of feeding or dependency on feed.
- Pilot project for feedground phase-out. Assess North Piney and Alkali feedgrounds as pilot studies for feedground phase-out.
- New innovations to reduce disease transmission risk between elk and livestock.
- Market-based incentives to increase tolerance of elk on private lands and elk harvest on private lands.
- Assess forage availability in potential elk winter range off of feedgrounds.
- Assess how elk respond to changes in feedground management, including research/monitoring elk movements, migration, habitat modeling, interspecies competition, herd segment numbers and demographics, calf survival, and changes to predator distribution and numbers.
- Improved population survey techniques when elk are off feedgrounds.