Big Piney Elk Herd Unit (E106)
Brucellosis Management Action Plan

WGFD
11 January 2007

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A. Introduction

1. BMAP Goal & Objectives

In February 2004, Wyoming lost its brucellosis class-free status when 31 reactor cattle were detected in a Sublette county herd (Wyoming BCT Report 2005). Infection of these cattle likely originated from elk on the nearby Muddy Creek feedground. Following this loss of class-free status, increased surveillance of Wyoming cattle revealed 2 individual herds with the disease in the Greater Yellowstone Ecosystem (GYE, Wyoming BCT Report 2005).

To develop management strategies regarding brucellosis in the GYE of western Wyoming and regain brucellosis class-free status, the Governor's Brucellosis Coordination Team identified the Brucellosis Management Action Plan (BMAP) process as their highest priority recommendation for reducing brucellosis transmission from elk to elk and from elk to cattle (Wyoming BCT Report 2005). Because of increased surveillance, research and BMAP development efforts, and lack of infection in cattle herds since 2005, Wyoming regained its brucellosis class-free status on 15 September 2006.

The objectives of this BMAP are to 1) document and analyze all available quantitative and qualitative data regarding brucellosis, 2) use available data to develop management options to reduce risk of brucellosis transmission among wildlife and from elk to cattle, and 3) select appropriate management options for implementation in the Big Piney Elk Herd Unit (BPEHU). This plan, combined with Appendices 1, 2, and 3, include data and information relevant to understanding, formulating, and implementing management actions. This document will receive periodic evaluation to incorporate new brucellosis and feedground research results, feedground management protocols, and agency (state, federal, private) recommendations.

2. Big Piney Elk Herd Unit Overview

The BPEHU is located on the east slope of the Wyoming Range in western Sublette and eastern Lincoln Counties, WY and includes elk Hunt Areas 92 and 94 (Fig. 1). The area is bound on the north by the Hoback Rim, on the northeast by Highway 189, on the east and southeast by the Green River, on the southwest by LaBarge Creek, and on the west by the hydrographic divide between the Green River and Grey's River drainages. The Bureau of Land Management (BLM) is responsible for management of 607 mi^2 (38%) of the surface area in this herd unit. The U. S. Forest Service (USFS) manages 380 mi^2 (24%) of the area. Private and state lands account for the remaining 587 mi^2 (38%) of the area along: North and South Horse Creek; North and South Cottonwood Creek; North, Middle, and South Piney Creek; and LaBarge Creek. Currently, five feedgrounds are located within the BPEHU: Franz, Jewett, Bench Corral, North Piney, and Finnegan. All feedgrounds in this Herd Unit (excluding Bench Corral) are located along the border of BLM or private lands and USFS lands and were established "uphill" from livestock operations primarily to prevent damage to stored hay (and later, prevent commingling).

Total area of the BPEHU is approximately 1,574 square miles (mi^2), of which 1,557 mi^2 (99%) have been delineated by the Wyoming Game and Fish Department (WGFD) as occupied elk habitat. Approximately 1,300 mi^2 (83%) are delineated as Spring/Summer/Fall range, 124 mi^2 (8%) as Crucial Winter Yearlong range, 8 mi^2 (<1%) as Crucial Winter range, 71mi^2 (5%) as Winter range, and 55 mi^2 (3%) as Winter Yearlong range (Fig. 2).

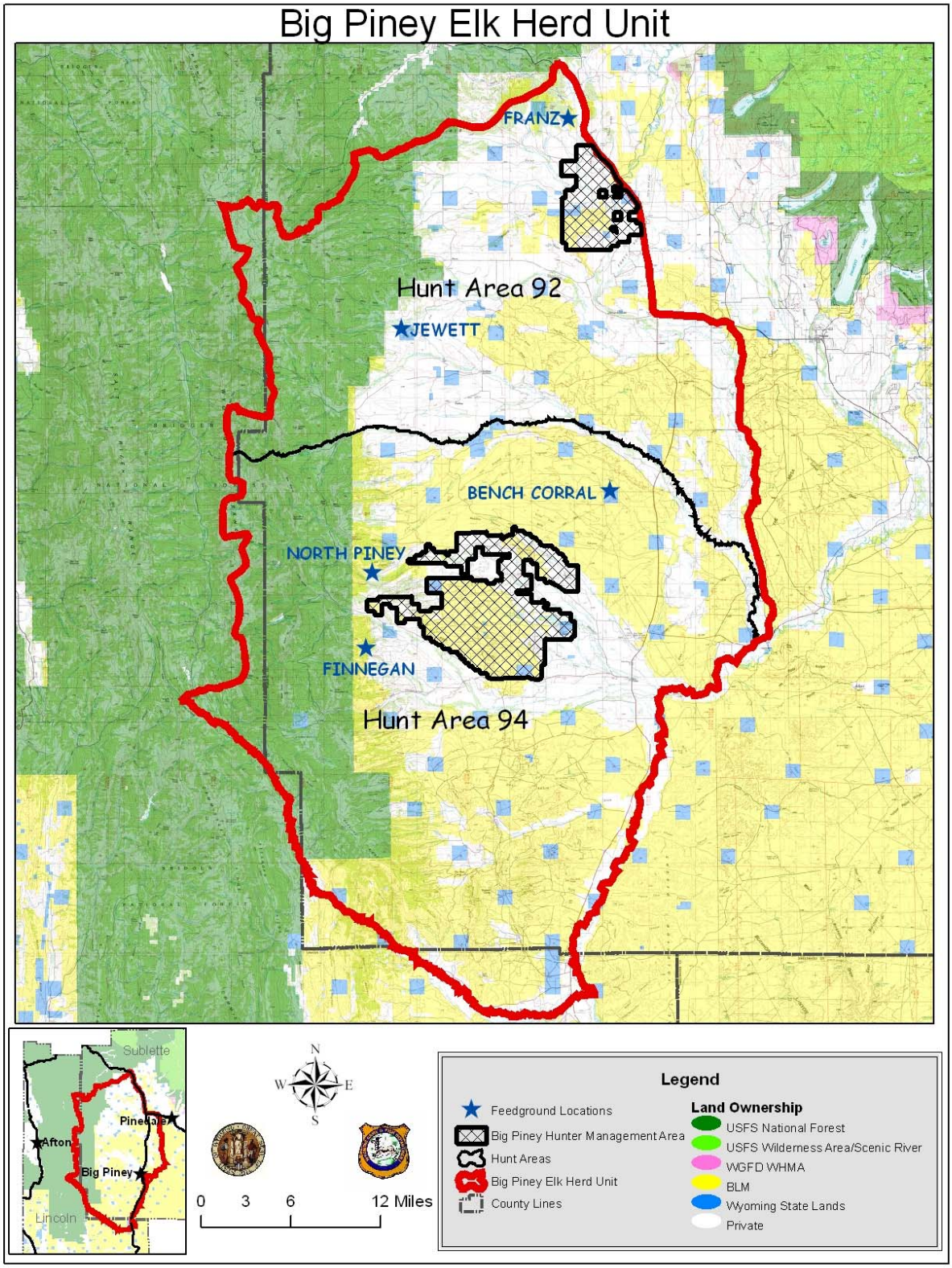

Figure 1. Herd Unit and Hunt Area boundaries for the BPEHU, Sublette and Lincoln Counties, WY. Includes state and federally owned lands, lands enrolled in the 2006 Big Piney Hunter Management Area, and locations of feedgrounds.

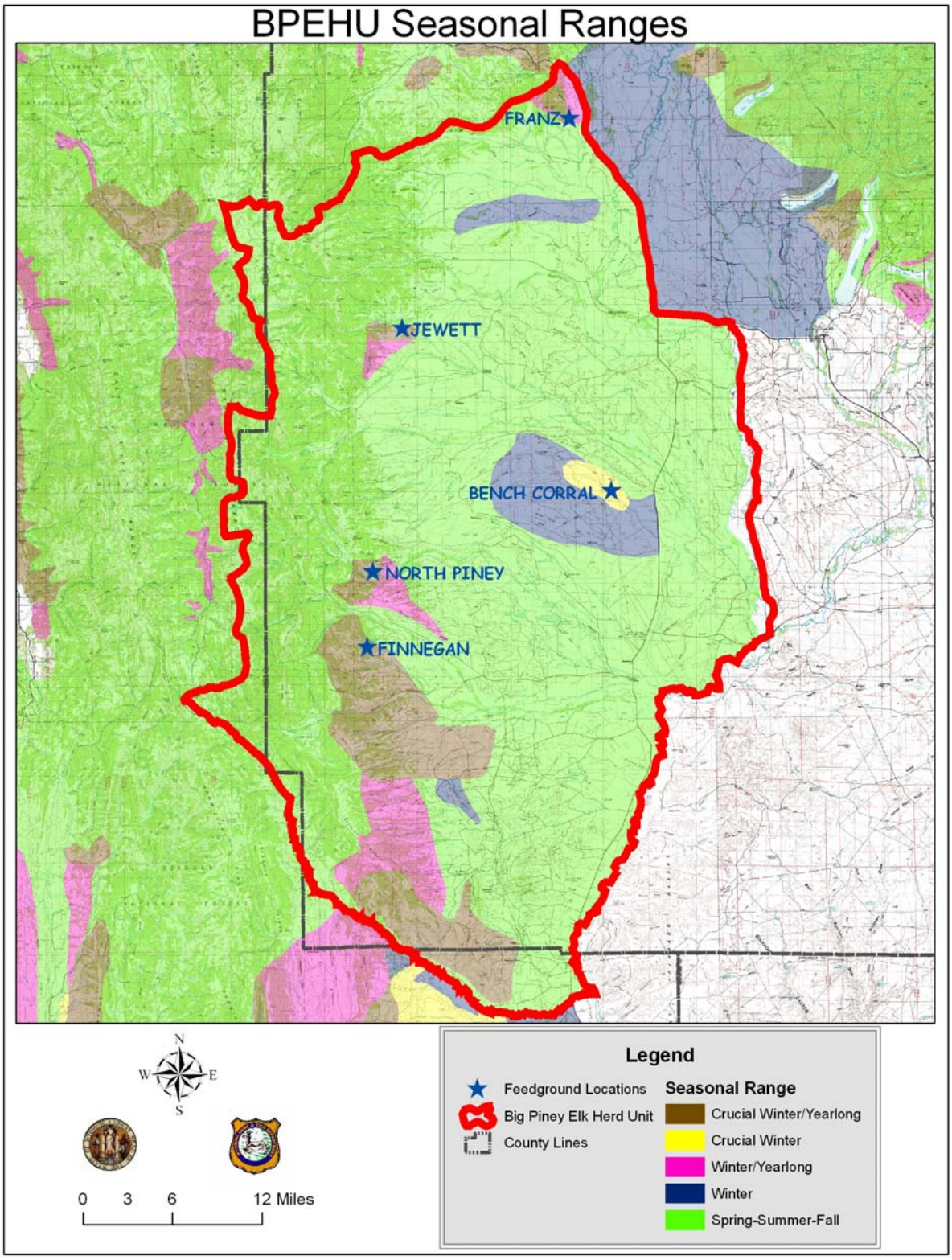

Figure 2. Areas delineated by WGFD as specific seasonal ranges of elk on the BPEHU, Sublette and Lincoln Counties, WY. Total area of the BPEHU is 1,574 mi^2.

3. Brucellosis Literature Review

Brucellosis, caused by infection with the bacterium *Brucella abortus*, has sparked controversy because of its persistence in elk (*Cervus elaphus*) and bison (*Bos bison*) of the Greater Yellowstone Ecosystem (GYE) of Wyoming, Montana, and Idaho (Thorne et al. 1978) and potential threat to domestic livestock (Kistner et al. 1982). Presumably, *B. abortus* was transmitted from domestic livestock to free-ranging bison and elk just prior to 1917 (Meagher and Meyer 1994) after repetitive commingling and subsequent contact with aborted fetuses contaminated with brucellosis. Subsequently, brucellosis was isolated from free-ranging bison (Mohler 1917) and elk (Rush 1932) of western Wyoming in 1917 and 1931, respectively.

Brucella transmission usually occurs via the oral route, with ingestion of bacteria that are shed by infected females in high numbers in aborted fetuses, fetal membranes and fluids, uterine discharges, and milk (Siello and Marys 1998). Although no study has attempted to determine if aerosol ingestion of *B. abortus* by elk is a viable means of transmission, previous studies (Thorne et al. 1978, Herriges, Jr. et al. 1989) have found that elk contracted brucellosis and subsequently aborted for unknown reasons. These elk could have aborted because of stress from handling (Herriges, Jr. et al. 1989) or contracted brucellosis via aerosol ingestion and aborted thereafter. Infection usually results in reproductive failure (abortion of the first pregnancy) and other clinical syndromes (Siello and Marys 1998).

Diagnosis of brucellosis in elk is complicated. Seroprevalence is determined by use of four tests as determined by the Animal & Plant Health Inspection Service (APHIS 1998). The following four tests are used to determine if an animal is seropositive: 1) Card test, 2) Standard plate agglutination (SPT) test, 3) Complement-fixation (CF) test, and 4) Rivanol test. An animal is considered "seropositive" if 1) either two or more tests react at certain dilution rates, or 2) if the CF test alone shows a reaction at a dilution rate of 2+ 1:20 or higher. The criteria used to determine what is called a positive reactor (positive) for the four serology tests is as follows: 1) Card – positive or negative (no dilution), 2) SPT – 1:100 dilution or greater, 3) CF – 2 + 1:20 dilution or greater, 4) Rivanol – 1:25 dilution or greater.

Once serostatus is determined using the four standard tests, another test called cELISA (competitive enzyme-linked immunosorbent assay) is conducted on seropositive animals to differentiate between Strain 19 vaccine and field strain *Brucella abortus*. Procedures for this test are described by Van Houten et al. (In Press). Determining if an animal is actually infected with *Brucella abortus* is accomplished only by removing select tissues (e.g., the reproductive tract and/or lymph nodes surrounding the reproductive tract) from the suspect animal and culturing the bacteria from these tissues. Based on data collected from the pilot Test and Removal project, the infection rate of elk identified as seropositive is about 36% (WGFD unpublished data).

Currently, 23 winter elk feedgrounds exist in western Wyoming. The National Elk Refuge (NER) is maintained by the US Fish and Wildlife Service near Jackson, Wyoming; the other 22 feedgrounds are scattered throughout western Wyoming and are maintained by WGFD. All feedgrounds in western Wyoming are used as substitutes for native winter range and to minimize depredation of private hay stores, winter mortality of elk, and elk-cattle commingling (Thorne et al. 1991). Feeding of about 13,000 elk on WGFD feedgrounds occurs typically from December to April (WGFD 2004). Although the Wyoming Livestock Board (2006) recently defined the "period of exposure" for cattle as 1 January to 1 May, *Brucella*-induced abortion events in captive and feedground elk have been documented from late February to June (Thorne et al. 1991, Roffe et al. 2004, WGFD unpublished data). The concentration of elk on feedgrounds

during most of this period likely increases the rate of intraspecific brucellosis transmission and prevalence (Thorne et al. 1979), either from density-dependent (Maichak unpublished data) and/or frequency-dependent effects (Cross et al. ACCEPTED PENDING REVISION). This likely explains why seroprevalence levels average 26%, 2%, and 0% in elk on, adjacent to, and completely independent of feedgrounds, respectively. Additionally, public grazing allotments where cattle and feedground elk are present during the latter stages (i.e., May and June; Roffe et al. 2004) of the transmission period may provide conditions for interspecific transmission. To date, commingling of elk and cattle has been documented on only 1 of 12 public grazing allotments that "turn-on" prior to 15 June and overlap with WGFD-delineated elk parturition areas within the brucellosis endemic area of western Wyoming (WGFD unpublished data). Elk from this allotment are assumed to be mostly independent of feedgrounds, ultimately posing little risk of interspecific transmission to livestock.

To control and eventually eliminate brucellosis from elk, a vaccination program was initiated in 1985 (Herriges et al. 1991). Almost all (>95%) calves are vaccinated annually using Strain 19 biobullets on every feedground except Dell Creek (WGFD unpublished data) which serves as a "control" site to assess efficacy of the program. In captive studies, Strain 19 prevents abortion in 29% (Roffe et al. 2004) to 62% (Herriges Jr et al. 1989) of elk challenged with *B abortus* strain 2308. Brucellosis seroprevalence levels average 26% among all feedgrounds; comparison of seroprevalence in vaccinated and non-vaccinated elk are not significantly different (WGFD unpublished data).

Enhancement of aspen, sagebrush, and conifer communities typically increases production of herbaceous species selected by elk. Habitat treatments (e.g., prescribed fire, mechanical, herbicide) implemented with the purpose of increasing forage production may reduce length of supplementary feeding season (WGFD unpublished data), reduce elk density on feedgrounds, reduce intra-specific disease transmission, and also influence spatial distributions (Gross et al. 1998). Prescribed burns and altered harvest strategies likely encouraged native forage utilization by the relatively large (mean during winter 2000-2004 = 924, range 729-1,187) "winter free-ranging" elk herd of Buffalo Valley in central Teton County, WY (WGFD, unpublished data). Additionally, elk from Buffalo Valley have historically had lower seroprevalence (2.7%, n = 75) than elk utilizing feedgrounds (26% for all feedgrounds, n = 1955; WGFD unpublished data). Habitat improvements have also been implemented near feedgrounds with some success of reducing the length of the supplemental feeding season (WGFD unpublished data). Brucellosis seroprevalence rates in elk attending feedgrounds with substantial habitat treatments and/or access to native winter range appear to be lower than those on feedgrounds with minimal to no access to additional feeding opportunities (WGFD unpublished data). Among the recommendations produced by the Brucellosis Coordination Team (BCT) was a call for further enhancement of winter elk habitat (Wyoming BCT Report 2005).

Scavengers will typically consume carrion opportunistically, and often focus foraging efforts on areas (e.g., roads, land-fills) where carrion are readily visible and accessible. Field studies have documented scavengers consuming pseudo-aborted bovine and elk fetuses faster on (33hr, 18.9hr) than off (57.5hr, 33hr) feedgrounds (Cook et al. 2004, Maichak unpublished data). Primary scavengers (based on total mass of fetus consumed and/or removed) include coyotes, foxes, and eagles, with magpies and ravens as secondary scavengers. Coyotes can be infected with brucellosis, presumably from ingestion of contaminated tissues and/or fluids (Davis et al. 1979). Transmission of brucellosis from scavengers (i.e., coyotes) to cattle has been documented under experimental conditions of close confinement (Davis et al. 1988), but no confirmed case of

natural interspecific transmission has been observed (Forbes 1990). Because consumption rates of fetuses are faster on than off feedgrounds, scavengers may act as a biological control of brucellosis, reducing intraspecific transmission of brucellosis. Seroprevalence rates in elk on feedgrounds with high vs. low scavenger densities has not been evaluated.

B. Brucellosis Management Options

WGFD currently employs several methods to minimize intraspecific transmission of brucellosis among elk (BMAP, Sections G, H). Elk feeders are encouraged to feed hay on clean snow when possible and recover aborted fetuses to reduce inadvertent ingestion of contaminated feed and exudates. To reduce abortion events and seroprevalence levels, elk are vaccinated ballistically with Strain 19 on 20 of 22 state feedgrounds, including 4 of 5 feedgrounds (excludes North Piney; Appendix 2, Section D-1, d) within this EHU, and currently on the NER. Attempts have been made to reduce the duration of the feeding season on each feedground. However, damage and elk/livestock co-mingling concerns typically determine the duration of supplemental feeding on most feedgrounds.

In most circumstances, elk are not tolerated consuming private crops or co-mingling with livestock. Strategies to hold elk on artificial feed longer and hazing elk to feedgrounds are often employed to minimize these conflicts. These practices increase the chance that an aborted fetus contaminated with *Brucella* will be contacted by elk wintering on feedgrounds, thus increasing exposure rates among elk.

Feedground management should continue to include the aforementioned methods currently utilized to minimize interspecific disease transmission. However, given current seroprevalence rates for feedground elk and the recent brucellosis occurrences in cattle, these methods alone are not sufficient to reduce incidence of the disease in elk to acceptable levels and prevent future interspecific transmissions. Alternative management options should be developed, implemented, and evaluated.

To reduce prevalence of brucellosis in elk on feedgrounds, given current technologies and efficacy of vaccines, feeding durations (and subsequent densities of elk and time spent on feedgrounds) would have to be decreased or ceased, if possible, during periods of high transmission risk. Reduced feeding durations would increase co-mingling if implemented abruptly, but substantial reductions in elk numbers through hunting prior to initiating the option could reduce these situations. Each feedground is unique and was established to address a site-specific management problem. Thus, each feedground will potentially require a different approach if reducing the duration of feeding and/or eliminating feeding are to be pursued as viable options. Some feedgrounds may have no alternative options to supplemental feeding and/or no option to reduce the feeding duration given current herd objectives and other conditions. To reduce the risk of interspecific transmission, cattle and elk need to be separated both temporally and spatially during the risk period. Livestock producers may have the potential to alter management to maintain this separation. As with feedgrounds, each producer and their operation are unique and what may work on one ranch may not work on another.

Based on current brucellosis research findings, WGFD personnel experience, and political and social realities, 8 potential Options for managing brucellosis on the 5 feedgrounds in the BPEHU have been developed and are listed below.

1. Relocating feedgrounds to sites with increased geographic area for elk to disperse and increased distance from winter cattle operations.
2. Elimination of feedgrounds.
3. Reducing numbers of elk on feedgrounds through increased harvest.
4. Reducing numbers of susceptible cattle and stored crops in areas where co-mingling/damage are likely to occur during winter, or implementing changes in cattle operations by providing incentives to producers.
5. Elk-proof fencing of feedgrounds or private lands to prevent elk from drifting onto private land and reduce co-mingling.
6. Extensive habitat enhancement projects in suitable winter range areas that will reduce co-mingling/damage and/or will reduce elk dependence on feedgrounds.
7. Acquisition of native winter range through fee-title purchase, conservation easements, or other methods.
8. Continuing Strain 19 elk vaccination.

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

C. Discussion of Options

1. Feedground Relocation

This Option would initially require a suitable area lower in elevation, in a lower precipitation zone, with no winter cattle operations in the vicinity. Current habitat conditions should be evaluated to determine production, health of vegetation, and approximate potential of the area. All lands within the BLM Pinedale Field Office are leased for grazing, so it is likely one or more permittees will need to be involved in the selection of a particular area. If purchase of AUMs is acceptable to a permittee, this could reserve forage for elk and other wildlife. Decision authority would lie with the permittee, BLM, and the WGFC. If more optimal locations for these feedgrounds existed, one should consider the following.

Pros:

- reduced elk density over geographic scale
- increased area for elk feeding (i.e., sanitary conditions)
- may reduce brucellosis prevalence
- maintain current elk herd objectives
- reduced browsing on local native woody vegetation

Cons:

- may maintain brucellosis prevalence
- requires funds for erection of new structures, fences, roads, etc.
- potential difficulty relocating and/or habituating elk to the new site
- may increase localized grazing of native herbaceous vegetation
- may increase dietary competition of elk with other animal species

Because of the high potential for damage and commingling risks, Franz, Jewett, Bench Corral, and Finnegan are currently not candidates for this Option.

In 1995, elk were relocated from North Piney feedground to Bench Corral feedground after WGFD personnel baited hay from North Piney to Bench Corral. Since that time (particularly 2001; Appedix 2, Section A-3, 4), elk have migrated to Bench Corral, decreasing 1) risk of intraspecific transmission by eliminating their concentration on the historically long duration, late season North Piney feedground, 2) risk of interspecific transmission, particularly to producers adjacent to North Piney feedground, and 3) monetary expenditures incurred by WGFD for maintaining North Piney feedground (Appendix 2, Section A-6). Direct competition for forage between elk and cattle in the Bench Corral area has been suggested by several producers. However AUMs permitted have not been reduced (Appendix 3, Section C-1) and herbaceous (i.e., grass) forage utilization data before and after relocating elk from North Piney to Bench Corral feedground are similar on allotments (Bench Corral Individual, Upper Bench Corral Common, Lower Bench Corral Common) surrounding Bench Corral feedground (Appendix 3, Section C-3). Additionally, damage claims paid by WGFD to landowners in HA 94 have not increased substantially following 1995-1996 (excluding winter 1996-1997; Appendix 1, Section A-3, a).

Because North Piney feedground typically "collects" elk and likely prevents damage to producers along North Piney Creek prior to their annual migration to Bench Corral feedground, WGFD has proposed to reclassify and manage North Piney feedground as a "Staging Area/Feedground" but will not consider the North Piney staging area/feedground for relocation at this time. Elk that leave North Piney will not be hazed back but allowed to migrate to Bench Corral feedground. Establishing a "cut-off" date for feeding and/or encouraging elk to leave North Piney with various methods (e.g., baiting to Bench Corral, reducing amount of hay fed per day, hazing) may be pursued following future re-evaluation of conditions at North Piney.

Future opportunities to implement this Option for feedgrounds in the BPEHU would be facilitated by combining with Options 3 through 7.

2. Feedground Elimination

This Option, given current conditions and herd objectives, is unfeasible for feedgrounds in the BPEHU. However, if current conditions and herd objectives change, through implementation of one or more of Options 3 through 8, this Option might become more realistic. The WGFC has the authority to make this decision.

Pros:

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

Cons:

- increased risk of property damage and interspecific transmission of brucellosis to livestock if implemented with current numbers of elk and /or prior to elimination of brucellosis in elk
- increased risk of property damage may increase financial and personnel resources from WGFD
- potential increase in elk winter mortality
- potential reduced number of elk that could be maintained in the Big Piney EHU
- potential long-term reduction in license sale revenue
- potential long-term reduction in hunter opportunity
- may increase potential for vehicle-elk collisions
- reduced feasibility of Strain 19 ballistic vaccination program

3. Elk Population Reduction

Reducing elk numbers on the feedgrounds in the BPEHU through liberalized hunting seasons could allow more flexibility to pursue Options 2, 5, 6 and 7. The WGFC has the authority to make this decision.

Pros:

- may reduce brucellosis prevalence
- increased short-term hunting opportunities and license revenues
- decreased elk densities and duration on feedgrounds
- potentially reduce conflicts on private lands
- reduced feedground and vaccination expenditures incurred by WGFD

Cons:

- the response of seroprevalence of brucellosis in elk when populations are reduced is unknown, yet it is unlikely to reduce incidence to an acceptable level assuming that the remaining elk continue to attend feedgrounds
- potentially continuing damage to private crops
- resistance from public, particularly outifitters and “sportsmen”
- success limited by skillfulness and efficiency of hunters
- loss of long-term hunting opportunities and license revenues

Hunting seasons in recent years have been designed to maintain elk numbers throughout the BPEHU (Appendix 1, Section B-4). The 2005 post-hunt population of elk on the BPEHU was estimated at 3,429 elk. The population is projected to decline to 3,064 elk following the 2006 hunting season. Following public process and review by WGFC during April 2006, the population objective for this Herd Unit was altered from 2,424 elk to 2,400 elk.

The 2006 hunting seasons have been designed to reduce the number of elk in the BPEHU; the emphasis to harvest adult females in both HA 92 and HA 94 will continue. The 2006 "General" (i.e., any antlered or antlerless elk) hunting season will extend into November (15 Oct – 5 Nov) and should attract hunters with general licenses to the BPEHU. Additional hunting opportunities are given in HA 94 with 100 limited-quota, Type 1 licenses valid for any elk from 15 Oct – 20 Oct, with those unused licenses valid for antlerless elk from 21 Oct – 5 Nov. Also, 300 limited quota Type 6 licenses will be valid for cow or calf elk in an attempt to increase harvest and reduce population growth of the herd. These Type 6 licenses are valid for the entire HA during the General season (15 Oct – 5 Nov) and the late season (16 Nov – 31 Jan) hunt on the Big Piney Hunter Management Area (Fig. 1). These management strategies are intended to bring the elk population closer to overall feedground and EHU objectives.

4. Cattle Producer Change of Operation

This is an Option that would be facilitated by Options 3 and 5 through 8. Producers in the BPEHU with chronic damage issues or otherwise defined as "high-risk" for commingling could implement this option to minimize/eliminate brucellosis risks to their herd. Brucellosis transmission potential within cattle and testing requirements associated with cow/calf operations would be eliminated if all cattle operations were switched to spayed heifers and/or steers. Conversion to yearlings would also eliminate the need of storing most hay crops and winter feeding, eliminating winter elk conflicts. Operations that feed through the winter can take small measures to avoid attracting elk such as feeding in the morning and feeding every day to keep feeding areas clean of hay. Ultimately, opportunity for disease transmission is reduced if cattle and elk do not co-mingle between early February and mid June (Thorne et al. 1991, Roffe et al. 2004). Implementing facets of this option would require changes by the producer and possibly a favorable decision by the BLM and/or USFS to alter grazing permits.

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

5. Fencing

This is an Option that would be facilitated by Options 1 through 4 and 6 through 8. Fencing of winter cattle feedlines could prevent elk from co-mingling with cattle. Elk-proof fencing around private stackyards reduces its "attractiveness" and likelihood for damage by elk. New fencing would require favorable decisions by the landowner. Where fencing stackyards is considered beneficial at reducing damage, WGFD provides fencing materials to landowners.

Large-scale, elk-proof fencing around feedgrounds can contain most elk within a given area, as evidenced by fences in Jackson Hole (surrounding National Elk Refuge), Star Valley (surrounding Grey's River feedground), and Pinedale (border of USFS land from New Fork

canyon to Fremont Ridge). Smaller-scale fences (e.g., adjacent west of Muddy Creek feedground) may prevent elk from drifting onto localized areas, but likely do not contain most elk in the Herd Unit. Currently, no fences exist in the BPEHU for any purpose other than fencing of stackyards. Wide-scale fencing across a large geographic range in any part of the BPEHU is likely not possible because of 1) conflicts with seasonal migration routes of other wildlife species (e.g., deer, moose, antelope) and 2) cost. Fencing projects around feedgrounds would require favorable decisions by the landowner (state and/or federal).

Pros:

- may be successful in fencing off stored hay and small-scale livestock operations
- may reduce damage problems and complaints
- may reduce interspecific risk of brucellosis transmission
- reduced attractiveness of particular operations to elk may reduce damage in a broad geographic area

Cons:

- costs may be prohibitive for construction, maintenance and monitoring
- congregating all or most elk within the fence would be unfeasible
- long lengths of fencing could impede movements of other wildlife, livestock and humans
- increased wildlife and/or livestock mortalities associated with entanglement
- does not completely address persistence of brucellosis in elk
- increased disease risks for elk or livestock in enclosure
- landowners (private, state, and or federal) may be unwilling to erect fences
- will likely require National Environmental Policy Act (NEPA) compliance
- reduces wildlife viewing opportunities

6. Habitat Enhancement

This Option would be facilitated by implementation of Options 2, 3, 4, and 7. Habitat enhancement projects can reduce the time elk spend on feedgrounds (Rogerson, unpublished data). If habitat improvements are completed near feedgrounds or between summer range and feedgrounds, the enhanced forage produced will decrease the dependence of elk on artificial feed, snow conditions permitting. Reduced feeding durations and lower elk concentrations on feedgrounds, especially during the high transmission risk period, may decrease the probability of intraspecific brucellosis transmission events (Appendix 3, Section B-1). Habitat enhancement projects also create vegetative diversity and improve range conditions for other floral and faunal species (including livestock).

Opportunities for habitat enhancement aimed at reducing elk dependency on feedgrounds in the BPEHU are located primarily around Bench Corral feedground. Other areas on the BPEHU exist, but may have less of an effect at reducing length of feeding season because of variable snow conditions. Increased forage quantity/quality in autumn may entice elk onto the feedgrounds and away from damage situations, without an earlier initiation of feeding. Increased forage quantity/quality in spring may entice elk off of feedgrounds, reducing risk of intraspecific brucellosis transmission.

Pros:

- reduced feeding duration and possibly brucellosis seroprevalence
- reduced risk of intraspecific brucellosis transmission
- benefit many species of vegetation, wildlife, and cattle
- funding available through government and non-government agencies

Cons:

- limited effectiveness in reducing dependency on supplemental feed in years of average or greater snow accumulations that make forage unavailable
- may increase commingling and/or damage situations
- may require short-term changes (i.e., rest) in livestock management for treatment area
- may increase likelihood of invasive species establishment

7. Acquisition/Conservation Easements

This Option would be facilitated by Options 1 through 6. Risk of intraspecific brucellosis transmission on all feedgrounds in the BPEHU might be decreased by managing lands adjacent to, or connected with, areas used by wintering elk. With adequate intact, healthy, and accessible elk winter habitat available, elk feeding may be reduced in this EHU. This Option could be used also to facilitate purchase of a forage reserve, securing habitat for other wildlife species. The buying or long-term leasing of land to be managed commensurate with wildlife benefits is an option that can be used to maintain stability and health of all floral and faunal populations. Decision authority is with the private landowner.

Pros:

- secures areas for all vegetation and wildlife
- long-term solution
- could reduce brucellosis seroprevalence in elk
- can be used as forage reserve – strongly facilitates Option 6
- helps secure future revenues for the WGFD

Cons:

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

8. Continuation of Strain 19 Elk Vaccination Program

The WGFD initiated this program in 1985 on Grey's River feedground, and has vaccinated approximately 66,000 elk to date on 22 state operated feedgrounds and the NER. Female and juvenile elk were vaccinated during the first two years of the program on all feedgrounds, then juveniles only thereafter assuming adequate coverage is maintained. Dell Creek feedground serves as a control population (i.e., no elk are vaccinated) to assess effectiveness of the vaccination program in reducing brucellosis seroprevalence in elk (Appendix 2, Section D-1, a-e).

Brucellosis seroprevalence data from elk on Dell Creek and Grey's River feedgrounds indicate no significant difference (WGFD unpublished data). In captive studies, Strain 19 prevents abortion in 29% (Roffe et al. 2004) to 62% (Herriges Jr et al. 1989) of elk challenged with *B. abortus* strain 2308. Protection from *Brucella*-induced abortions afforded by Strain 19 vaccination may not be sufficient to effectively reduce seroprevalence in elk on feedgrounds. This may be due to the potential for numerous elk to come into contact with a single infected fetus aborted on a feedground (Maichak unpublished data; Appendix 3, Section B-1) or because the infectious dose may overwhelm antibody protection (Cook 1999). The decision authority lies with the WGFC.

Pros:

- effective delivery system
- may reduce total number of *Brucella* induced, infected elk fetuses aborted on feedgrounds
- perceived by the public to be an active disease management tool

Cons:

- financially and logistically expensive
- has not shown to reduce seroprevalence in elk on feedgrounds
- elk must be concentrated on feedgrounds to ensure delivery is feasible; maintains brucellosis in elk
- development of effective vaccine has not yet occurred

D. Coordination Meetings

1. WGFD Intra-Agency Meeting

On 25 October 2006, a WGFD intra-agency meeting was held at the Pinedale Library to provide an overview of the current BPEHU BMAP draft and discuss alternative management options to elk feedgrounds and brucellosis management in this Herd Unit. All Options were discussed individually, with most discussion pertaining to Option 2 (Feedground Elimination) with respect to North Piney feedground. WGFD personnel recommended maintaining the current management strategy regarding North Piney feedground, classifying it as a "Staging Area" rather than a season-long feedground.

On 11 December 2006, a WGFD intra-agency meeting was held at the Pinedale Field Office to discuss and affirm proposed management actions regarding North Piney and Bench Corral feedgrounds. WGFD personnel proposed to reclassify and manage North Piney feedground as a "Staging Area/Feedground" but will not consider North Piney feedground for relocation or elimination at this time. Elk that leave North Piney staging area/feedground will not be hazed back but allowed to migrate to Bench Corral feedground. Establishing a "cut-off" date for feeding and/or encouraging elk to leave North Piney with various methods (e.g., baiting to Bench Corral, reducing amount of hay fed per day, hazing) may be pursued following future re-evaluation of conditions at North Piney.

2. Inter-Agency Meeting

On 27 October 2006, an inter-agency meeting was held at the Pinedale Library to provide an overview of the current BPEHU BMAP draft and discuss alternative management options to elk feedgrounds and brucellosis management in the BPEHU. Agencies attending were WGFD, BLM, NRCS, and APHIS. All Options were discussed individually, with most conversation related to Options 4 (Incentives for Producer Change of Operation), 5 (Fencing), 6 (Habitat Enhancement), and 7 (Acquisition/Conservation Easements). NRCS personnel were supportive of and willing to participate in Option 4 and could possibly assist with labor costs associated with Option 5 (on private lands). All agencies agreed that opportunities for Option 6 should be pursued when feasible, but that securing a forage reserve to assist implementation of this Option would be facilitated most by working with local land-trust agencies to implement Option 7 (specifically through conservation easement).

3. Producer Meetings

On 30 October 2006, a livestock producer meeting was held at the Big Piney Library to provide an overview of brucellosis ecology/etiology, a summary of the current draft BPEHU BMAP, and discuss alternative management Options to elk feedgrounds and brucellosis management in the BPEHU. WGFD, NRCS, and APHIS personnel along with 4 livestock producers were in attendance. All Options were discussed individually, and no significant recommendations were made. Because attendance by producers at this meeting was low, it was decided to hold a second meeting on 16 November 2006.

On 16 November 2006, a second livestock producer meeting was held at the Big Piney Library to provide a summary and hard copy of the current draft BPEHU BMAP, discuss alternative management Options to elk feedgrounds and brucellosis management in the BPEHU, and discuss WGFD proposed management actions with respect to individual Options in the BPEHU. WGFD, BLM, and APHIS personnel along with 4 livestock producers were in attendance. All Options and WGFD proposed management actions were discussed individually, and no significant recommendations were made.

E. Producer Survey Questionnaire

1. Goals/Objectives of Producer Questionnaire

The overall goal of the Questionnaire was to collect unbiased, quantifiable data regarding 1) the opinions of livestock producers regarding the 8 Options currently listed in the BMAPs, and 2) risk of damage from and/or commingling with elk.

The first objective of the Questionnaire was to quantify the percentage of livestock producers within the BPEHU comprising defined opinions (Strongly Opposed, Moderately Opposed, Indifferent, Moderately Support, Strongly Support) regarding individual BMAP management options (reported below). The second objective was to quantify various aspects of livestock operations in the BPEHU, particularly those that are related directly (Damage, Y/N) and indirectly [Hay Production (Y/N), Amount of Hay produced (acres), Stackyards Present (Y/N), Total Stackyards, Winter Feeding (Y/N), Distance to Nearest and Next Nearest

Feedgrounds] to damage from, and potentially commingling with, elk (Appendix 1, Section A-3, b).

The percentages of the various opinions and results of livestock producer operations were compared to qualitative data (i.e., written responses to management options from Questionnaire; verbal responses from meetings) to determine feasibility of implementing various Options. Data collected from this Questionnaire were not used for purposes other than the development of the BPEHU BMAP. Specific information on livestock operations, elk damage, and commingling will be kept confidential.

2. Quantitative Responses to Questionnaire

Of approximately 81 producers identified in the BPEHU, 28 have responded to and provided opinions to the Options within the Questionnaire. Quantitatively, responses (i.e., Opinions) regarding individual Options are variable, but some trends are apparent (Table 1).

Table 1. Percentages of responses (Opinions) regarding individual BMAP Options in the BPEHU.

	Opinion				
Option	Strong Opp.	Mod Opp.	Indifferent	Mod Sup.	Strong Sup.
1	17	13	13	44	13
2	82	11	7	0	0
3	15	15	42	19	8
4	29	8	29	29	4
5	27	0	8	35	31
6	19	23	12	23	23
7	26	30	15	15	15
8	4	4	11	21	61

The majority of producers appear supportive of: relocating feedgrounds (Option 1); fencing stackyards, feedgrounds or other areas (Option 5); and continuation of Strain 19 vaccination (Option 8). Most producers were very opposed to feedground elimination (Option 2), and modestly opposed to acquisition of native winter range (Option 7). Opinions with respect to reducing current elk herd numbers (Option 3), incentives to livestock producers for change of operations (Option 4), and implementing habitat enhancement projects to reduce elk dependence on feedgrounds (Option 6) were mixed and/or indifferent.

3. Qualitative Responses to Questionnaire

Qualitative, written responses were usually consistent with qualitative results but were occasionally mixed or even contradictory. Approximately 50% of all producers who provided quantitative answers provided qualitative answers.

For Option 1, written responses were contrary to quantitative results, suggesting that feedground relocation might not be feasible because of snow conditions or commingling and damage issues. Some responses to Option 1 suggested that feedground relocation (or possibly decommissioning) could be helpful. Responses to Option 2 mirrored quantitative results, suggesting that feedground elimination is not a viable option particularly because of damage and

commingling concerns, but cost/benefit analysis of feedground operations should be considered. Responses to Option 3 were mixed and somewhat dissimilar from quantitative results; some stated that elk herd reduction has worked or could facilitate vaccination while others stated that it has not helped or changed dispersal patterns. Responses to Option 4 (producer incentives/change of operation) were similar to quantitative data, with some responses inquisitive as to what kind of incentives were available, but many responses said that this program would not work because of financial costs. Responses to Option 5 were similar to quantitative results: positive with respect to fencing of stackyards and negative (cost prohibitive, elk dispersal too great) with respect to fencing large public and/or private areas. Responses to Option 6 were somewhat similar to quantitative data, suggesting that habitat enhancement may work, but many suggested that they would not work because of deep snow conditions, financial costs, access to private land, and competition with livestock. Responses to Option 7 appeared to be more supportive of land acquisitions and/or easements than quantitative results, but some suggested that it would be cost prohibitive and that feedgrounds would need to be maintained because of continued insufficient availability of native forage. Responses to Option 8 were very similar to quantitative results; generally in favor of the vaccination program, but suggesting need for a better vaccine in both elk and cattle.

Individual qualitative responses (edited for grammar and punctuation) to the Questionnaire are listed below.

Option 1.

1. N. Piney should be removed
2. Jewett, Bench Stay
3. Good Idea
4. These feedgrounds were established years ago in areas to intercept the elk as they tried to do their annual migration to the desert. The increase in elk numbers and the increase in hay production caused the elk to help themselves to the available hay. The feedgrounds are in areas above cattle concentrations in the winter months. They have worked well for over 40yrs till the wolves became a problem
5. Where do you go?
6. My land in the Big Piney Elk Herd Unit is summer grazing.
7. May help in some cases. If elk are fed too high they may be dispersed below feedgrounds before feeding starts, which could worsen problem.
8. Maintain existing feedgrounds would help
9. I don't see how you can accomplish both. For an increase in elk dispersal, you have to move to a lower elevation resulting in contact and conflict with domestic cattle herds.
10. Without a detailed description of what this implies, it doesn't mean anything
11. Too much snow normally. Not a viable option in my opinion.
12. Where is there a large enough area to relocate?
13. This really depends on how far from the (relocated) feedground are now – these elk are used to these established feedgrounds.
14. The North Piney feedground is a great place for an elk feedground. But because of the wolf problem, they won't stay, therefore putting too many elk on the Bench Corral feedground.
15. There is a probability that some feedgrounds could be relocated but keep in mind that our feedgrounds were established through a process of trial & error. Relocating or

eliminating any of them over a period of many years has the potential to harm any ranch anywhere in the Herd Unit.

16. These feedgrounds were established because they were and still are necessary.

Option 2.

1. Stupidest thing to do – will have commingling.
2. Elk populations fed too long - will go to hell.
3. Good idea for quick fix, but not good for long term.
4. The feedgrounds in my area have worked well for over 40 years – for the above reasons.
5. I think we all agree that feeding of elk is not natural, but what are the other choices? Starvation or grazing on private land. I don't think either of those would be acceptable. Their natural winter range is taken up by people. The people that want to eliminate feedgrounds have never come up with a workable solution.
6. These feedgrounds were established to support a larger elk herd than the area will naturally support in the winter, without elk getting onto the private property and into the rancher's hay stack.
7. Recipe for disaster.
8. The environmentalist's dream. One step closer to turning every ranch into a subdivision. There is a reason feedgrounds were established to begin with.
9. Common sense says no.
10. – We know that concentration is unnatural and enhances disease.
    - We know that feedgrounds create the perfect wolf buffet.
    - We know that feedgrounds have mainly been responsible for herd size enhancement over the years.
    - It's a tough balance to maintain. If the costs make sense, maybe as is – is ok – If not, adjustments should be considered.
11. In deep snow country, you cannot eliminate feedgrounds. It is unreasonable to even consider doing away with the feedgrounds along the Wyoming front.
12. No.
13. These feedgrounds came about through the efforts of wildlife managers who spent their entire careers dedicated to that wildlife and providing the public greater opportunity to enjoy that wildlife for whatever purpose. The elimination of elk feedgrounds is not a reasonable option for ranchers or elk.
14. To eliminate these feedgrounds is not good for the ranchers, sportsmen, or the elk.

Option 3.

1. Leave seasons open long as possible.
2. Hasn't worked – elk numbers haven't changed.
3. This area – Finnegan, N. Piney and later Bench Corral? Have proven successful in the past.
4. I trust that you know the numbers of elk we should have for a viable population.
5. I personally like to hunt elk, and reduced elk numbers mean less opportunity to get an elk. However, I believe that most of the area is over the herd objective size. Bring the numbers in the elk herds that are over objective would be the prudent thing to do.
6. I doubt if there would be any change in elk dispersal problems.
7. Less animals obviously simplifies a vaccination program.

8. This option dependent on management determined by Game & Fish. Doesn't appear to me that numbers would be dramatically affected.
9. I feel elk numbers could be reduced some; the wolves will take care of that.
10. Be real careful you don't get an over-harvest and reduce numbers to a point where adjacent land can't be obtained and maintained.
11. Longer hunting season.
12. In reality, increased harvest is occurring. Predators are harvesting elk in some areas at an alarming rate. If we follow the theory of reducing numbers to take care of the problem, uncontrolled predators will soon have the job done. This is an option and a question that should only be answered on a site-specific or case-by-case basis through consultation and cooperation between WGFD and the ranchers being affected.
13. On individual feedgrounds this might be an option, but only on a feedground-by-feedground basis. It couldn't be applied statewide.

Option 4.

1. Can't eliminate all cows in herd unit.
2. Probably won't happen.
3. This doesn't seem a problem – maybe for Pete and Tim Thompson and Dan Budd the only operators close to the feedgrounds where commingling could occur.
4. This move will in the long run fail because it will come to be called a welfare program for ranchers.
5. Might be some options here and I would support them. I don't think my place could change much. You could buy me a new snow machine to chase elk with!
6. Need clarification on what is meant by incentives? What if one doesn't want to participate?
7. An incentive to implement what kind of change? I seem to donate a lot of "standing hay" to these herds as well.
8. Significant changes would require large expenditures. If individual producers want to make changes, so be it.
9. What kind of changes?
10. I am not sure how this could be implemented. Are there some ideas out there that I am not aware of?
11. When money or the like is the incentive, the programs are sometimes abused. Incentives used like an iron fist such as the Endangered Species Act create a lot of hardship, hard feelings, and end up hurting much more than helping.
12. What would the incentive be?

Option 5.

1. Fence (drift) along west edge of property to prevent commingling.
2. This is a common practice in this area.
3. You already provide fencing materials to ranchers for stackyards. As for fencing of feedgrounds, I would think that would be almost impossible to do and to work
4. This will be expensive and likely not solve the problems. A large part of its problem will be maintenance of the fencing. Cattle operators will come and go, and operators will change modes of operation.
5. Might be helpful where geographically feasible, to help hold elk higher near feedgrounds

6. Fencing stackyards maybe, private land or feedground would not be desirable
7. Elk disburse over such large areas this might not be cost effective
8. Fencing of haystacks proves effective. Fencing feedgrounds and private lands seems to me to be an unreachable solution.
9. Does not seem cost effective.
10. Support: Fencing of stackyards. Not a feasible option to fence feedgrounds and private lands.
11. Fence elk into a feedground and the wolves will have a hay-day. Our hay stacks are already fenced.
12. This sounds like an impossible act to use.
13. Fencing of haystacks will take care of damage problems. I am not familiar as to how the private lands lay in relation to the feedgrounds. Fencing of feedgrounds – are we thinking in terms of the Soda Lake feedgrounds (fencing large areas)? If so, we are talking big money.
14. Fence off private lands.
15. In most instances, this is not viable management. These are intelligent animals. They will move on to easier foraging opportunities and create a more congested situation. In general, good fences make good neighbors but care must be taken not to stop the movement of all animals that must migrate to survive. Providing game fence to land owners for small areas such as haystacks is on type of incentive that is beneficial to elk and landowners alike.
16. Wildlife must move to survive. Giving landowners game fence for haystacks is a good example of how fencing could be of benefit.

Option 6.

1. Good idea.
2. Not enough winter range to support many elk except lower elevation BLM lands.
3. Elk wintering on BLM lands will conflict with cattle grazing like at Bench Corral.
4. I still feel the feedgrounds have served their purpose and would continue to do so.
5. Quality winter habitat is the only real answer to trying to spread the elk out and reduce feeding. But most of that is on private land. So do you work out agreements with landowners to use private land?
6. I think some habitat enhancement will be useful. However, doubt that extensive enhancement will be practical or worthwhile. For example, a hard winter could make enhanced habitat unavailable and send elk onto private property to commingle with cattle. Other things such as drought, fire, or human encroachment could render such projects mostly useless. Again, the cost to do and maintain the projects would be prohibitive.
7. When snow gets deep elk will still need feedgrounds. If start of feeding in fall is too much delayed, elk may be dispersed down country making it difficult to get back to feedground.
8. Simple translation – get rid of cows.
9. Habitat enhancement implies increased feed. That would require water which we don't seem to have much of anymore.
10. Here again, snow in the higher country will prohibit using a lot of the enhanced range but may shorten the feeding season by providing more forage late in the fall.

11. – I support this if cattle are properly used as the tool to do it.
12. Elk are going to feedgrounds regardless of feed available on winter range.
13. What extensive habitat enhancement project can you do in the area? Where?
14. In winter, it doesn't matter how much habitat is available, the snow is deep and the elk need to be fed.
15. First step to get cattle off Federal ground. It wouldn't stop the elk from coming to feed lines. They have had hay for years and winter range areas aren't going to satisfy them.
16. Habitat enhancement is a waste of time and money if the WGFD doesn't wake up and recognize what large predators are doing to our big game herds. The wolves have been running big game off the winter ranges and feedgrounds for several years and the problem is only getting worse. Habitat enhancement would be totally ineffective without providing safe harbor.
17. Providing habitat enhancement won't work if predators keep wildlife run off of these areas. These animals must feel secure to stay in an area.

Option 7.

1. Might be possible.
2. This may help, but the feedgrounds are still needed – on an average winter (I have been here for 70 of them), there is not sufficient feed (natural) available before the elk reach the desert areas, where the wind clears areas of feed for them.
3. I guess I answered this in question #6.
4. Some of this may be practical, but large acquisitions that will have a significant impact will be expensive and probably rare.
5. When snow gets deep, elk will still need feedgrounds. If start of feeding in fall is too much delayed, elk may be dispersed down country making it difficult to get back to feedground.
6. Would support if there were no public access limitations.
7. Same thing – get rid of cows.
8. I would support this if it recognized a rancher's ability to leave forage for winter range.
9. Not a strong supporter of the State acquiring more land. Easements and "other methods" may be options.
10. I'm basically opposed, unless the G&F wants to become serious about land management, along with game management and law enforcement.
11. This is good.
12. Conservation easements are just another method used to limit a landowner's use of of the land and in the long haul bring on the demise of true agricultural land use. When you drive legitimate ranching operations off the land you will lose wildlife habitat and public access to the wildlife due to "No Trespassing" signs. When fee title purchase occurs for wildlife, you have lost it as a viable part of agriculture, often adversely affecting neighboring ranchers.
13. Private lands already provide winter range for wildlife habitat. When ranchers sell for wildlife use, they are no longer agricultural lands in the traditional sense. The agricultural community loses something.

Option 8.

1. Good idea.
2. Find a vaccine that works.
3. My favorite option.
4. This seems to work? Expensive – yes, time consuming yes, but where do we draw the line?
5. I am not educated enough on this to answer.
6. I know you aren't getting all the elk and no vaccine is 100%, but it is probably helping some.
7. Worth a try.
8. Since elk are already more of a managed, virtually domesticated animal than actual wildlife, manage them accordingly.
9. Strain 19 or improved vaccines could make a difference in the seroprevalence but all elk will be difficult to capture and vaccinate.
10. If you're comfortable it's working.
11. Good vaccine – will not let ranchers use anymore.
12. Continue the program. Not perfect, but we would be in more trouble if a vaccination program had not been implemented years ago.
13. This can only help.
14. The development of new and better vaccines should also be pursued, both in elk and cattle because those who believe that brucellosis is an eradicatable disease are a bigger problem than brucellosis. Brucellosis is very wide spread across many species, but with research and diligence it can be managed. It is highly improbable that it will ever be eradicated!
15. Eventually, newer, more effective vaccines could be on the market for our cattle and the elk. This would benefit everyone. Vaccinating the elk now can greatly help in the management of the disease.

4. Proposed Additional Options

In addition to the 8 Options presented in this BMAP, producers were provided the opportunity to list additional options on the Questionnaire. Most additional options were related to elimination of wolves, however, some responses included combinations of certain Options or need to increase vaccine efficacy for both livestock and elk. One option suggested investigating an increased number of feedgrounds while maintaining current herd sizes in the BPEHU to reduce intra-specific contact rates among elk. Individual additional options provided by producers responding to the Questionnaire are listed below (edited for grammar and punctuation).

1. Elimination of wolves.
2. Combinations of #1, #5, and #8 – all could help.
3. They will have to go all the way and micro-manage the herds as do the producers of livestock, including culling by other than hunting, vaccination, and other practices used by livestock producers.
4. Increase number of elk feedgrounds and make them smaller. This will spread the elk out more, reduce vegetation damage at the feedground, and increase access to natural forage. It should also reduce the transmission of disease within the herd, simply because the

contact probability will decrease, most likely more than a one-to-one ratio in the reduction of elk on the feedground. I would strongly suggest that this concept be carefully explored and if possible tried out. To a fair degree, this will simulate a reduction of elk on a feedground without a large reduction in the total elk herd size, and it will provide diversification in the herd in case of a disease outbreak. The cost will increase because there are more areas to manage, but within limits, the benefits will probably out weigh the cost.

5. Eliminate wolves on all feedgrounds and the elk will stay where you feed them! Instead of running the elk back to the feedgrounds after the wolves have run them onto private ground, try running the wolves about 10 miles a day instead. The elk will stay on feedgrounds, and be a lot healthier without the stress of being run back and forth. It wouldn't cost any more, you are already paying someone to run the elk everyday, let them run the damn wolves instead!
6. Reduce wolf numbers. I know, that's not in your options but would probably help most.
7. Reduction of feedground operations and wolf introduction have pushed elk onto private lands, in my opinion. Restoration of feedground operation is important as well as keeping wolves away from the feedgrounds.
8. Step up the vaccination program for elk – it's the only way.
9. The two things I believe would help more than anything would be:
    a. Develop a vaccine for livestock that would be virtually 100% effective.
    b. Work with Game & Fish to move elk whenever the chances of co-mingling occur during the time of highest exposure to brucellosis.
10. Common sense used & promoted by all involved.
11. Better quality hay on feedgrounds and longer feeding season.
12. Better management of elk in spring and summer to keep off private lands.
13. Issue landowner tags to remove elk on private lands with extended seasons.

F. Proposed Management Actions

1. Option 1

Because North Piney feedground typically "collects" elk and likely prevents damage to producers along North Piney Creek prior to their annual migration to Bench Corral feedground, WGFD has proposed to reclassify and manage North Piney feedground as a "Staging Area/Feedground" but will not consider the North Piney feedground for relocation or elimination at this time. Elk that leave North Piney will not be hazed back but allowed to migrate to Bench Corral feedground. Establishing a "cut-off" date for feeding and/or encouraging elk to leave North Piney with various methods (e.g., baiting to Bench Corral, reducing amount of hay fed per day, hazing) may be pursued following future re-evaluation of conditions at North Piney. WGFD will work with producers and land management agencies to determine opportunities for relocating North Piney staging area/feedground (and other feedgrounds) and pursue this Option as opportunities are identified.

2. Option 2

WGFD will not pursue this option in the immediate future given existing elk brucellosis seroprevalence rates, risk of damage/commingling, and public expectations for current elk numbers. North Piney staging area/feedground has the highest potential for implementation of

this option. WGFD will work with producers and land management agencies to determine opportunities for eliminating North Piney feedground and pursue this option throughout the BPEHU as opportunities are identified.

3. Option 3
WGFD manages for current, Commission established, elk herd unit population objectives. Elk herd unit reviews occur every 5 years. Elk herd unit management, including population objectives for the BPEHU were reviewed and discussed by the public WGFC in early winter 2006. Following meetings, public input, and recommendations from Jackson/Pinedale WGFD personnel, the WGFC elected to reduce the previous BPEHU objective from 2,424 to 2,400 elk. The WGFD will continue to design and implement harvest strategies to ensure elk populations are maintained at established Herd Unit objectives.

4. Option 4
WGFD will work with cattle producers and other agencies (e.g., NRCS, BLM) in the BPEHU to implement any changes to their operations that decrease the risk of interspecific disease transmission.

5. Option 5
WGFD will encourage cattle producers in the BPEHU to fence areas where hay is stored (stackyards) for winter feeding operations and continue delivery of materials for stackyard construction. WGFD will not pursue large-scale fencing of any lands on the BPEHU at this time.

6. Option 6
WGFD will continue to coordinate with private landowners, federal land managers, and livestock permittees to develop and implement habitat improvements that may reduce elk dependency on supplemental feed in the BPEHU.

Several areas on the BPEHU are suitable for enhancement, primarily adjacent to Bench Corral feedground. Other areas suitable for enhancement exist adjacent to Finnegan and North Piney feedgrounds. The Maki Creek Aspen Enhancement project (adjacent to Jewett feedground) is underway and scheduled for completion of treatments in Spring 2008.

7. Option 7
WGFD will continue to identify and pursue all opportunities to implement this Option. Project proposals will be drafted and submitted to various funding agencies to facilitate implementation of this Option.

8. Option 8
WGFD will continue the ballistic Strain 19 elk vaccination program until adequate data are collected to determine efficacy of the program in reducing brucellosis seroprevalence in elk on feedgrounds.

G. Best Management Practices

In addition to the 8 Options (BMAP, Section C) and commensurate with their short- and long-term goals, the following best management practices should be considered for elk feedgrounds. Some may be currently employed and should be maintained. Others may not be viable options for individual feedgrounds.

Feedground Management

1. Encourage feeders to feed on clean snow.
2. Insist feeders recover any aborted fetus encountered and immediately submit to a regional WGFD office for testing.
3. Minimize feeding duration to maximum extent possible.
4. Where possible, implement large-scale habitat treatments at strategic locations near feedgrounds.
5. Maintain the Strain 19 ballistic vaccination program in elk.
6. Prevent elk/cattle co-mingling.
7. Eliminate predator/scavenger control on and adjacent to feedgrounds by WGFD employees or any other personnel associated with feedground operations.

H. Additional Actions

1. Brucellosis Surveillance

The WGFD currently traps and tests elk for exposure to brucellosis on 4 to 6 feedgrounds annually. Given current funding and status of the disease, this practice should continue annually to monitor prevalence of the disease. Surveillance enables assessments of the efficacy of the Strain 19 vaccination program and other strategies in use. Additionally, hunter-harvested elk brucellosis surveillance will occur annually in an effort to survey the entire state over a 4-year period. During the 2005-2006 hunting season, WGFD attempted to collect blood samples from hunter-killed elk on HAs 92 and 94; only 2 samples (1 positive, 1 negative) were returned from both HAs combined. During 2005-2006 winter trapping season, WGFD collected serology data from 32 elk (4 positive, 28 negative) chemically immobilized at Bench Corral feedground. WGFD is planning to collect (via portable corral trap) additional serology data from elk at Bench Corral in the 2006-2007 winter trapping season.

Increased surveillance efforts have contributed to an improved evaluation of brucellosis management strategies in the BPEHU (Appendix 2, Section D-2) through a better understanding of the disease's distribution, particularly following the relocation of elk from North Piney feedground to Bench Corral feedground in winter 1995-1996. Further surveillance will enhance current understanding of brucellosis ecology in the BPEHU. Although surveillance opportunities are prevalent in the BPEHU, these opportunities may be reduced because of logistical constraints during the Pinedale Elk Herd Unit test and removal pilot project.

2. Information and Education

WGFD personnel regularly inform and educate various public factions about wildlife diseases, including brucellosis. Outreach, particularly from the Information & Education (I&E) branch, has included group presentations, regular news releases, interpretive signs at feedgrounds and crucial winter ranges, Game and Fish brucellosis website (http://gf.state.wy.us/wildlife/Brucellosis/), and various brochures and publications. Participation in the Greater Yellowstone Interagency Brucellosis Committee (GYIBC) and the Wyoming Brucellosis Education Team (WBET) has increased I&E brucellosis efforts on statewide and regional levels.

The importance of quality wildlife habitat, habitat enhancement, disease research, as well as the role of feedgrounds and elk damage management activities are presented to the public by WGFD personnel at various meetings and conferences. WGFD personnel make numerous private landowner contacts regarding habitat improvement projects, wildlife-friendly management techniques, or ways to prevent co-mingling of elk and livestock. Additionally, efforts are focused on area school groups and educational exhibits at events such as the Wildlife Heritage Foundation of Wyoming's annual Hunting and Fishing EXPO and the annual elk antler auction in Jackson to inform children and their parents of the Brucellosis-Feedground-Habitat (BFH) program and brucellosis management.

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

3. Progress Reporting

Efforts associated with this plan and/or the Wyoming Governor's Brucellosis Coordination Team will be summarized and reported annually.

4. Research

Sound management of brucellosis in elk on feedgrounds and the risk of transmission from elk to cattle necessitates accurate and reliable data to facilitate decisions. Much of the research concerning brucellosis, feedground elk, and feedground management has focused on elk vaccination. Many aspects of feedground elk ecology, brucellosis transmission and pathology, and feedground management have not been investigated or sufficiently evaluated. Potential research topics that could assist in management decisions are listed below.

1. Relationship of seropositive vs. culture positive, and strain of *Brucella*, in feedground elk.
2. Characteristics of scavenging of aborted fetuses on feedgrounds; relationship of coyote densities and scavenging rates on feedgrounds.
3. Feedground elk parturition habitat site characteristics and proximity to cattle.

4. Effects of habitat improvement projects near feedgrounds on minimizing feedground dependence of elk (i.e., distribution, dispersal, length of feeding season, brucellosis seroprevalence).
5. Disease presence (other than brucellosis) and parasite loads in elk on feedgrounds.
6. Abortion and viable birth rates, and temporal and spatial distribution of abortions and births, in seropositive feedground elk.
7. Relationship of brucellosis seroprevalence and feeding duration of elk.
8. Impacts of wolves on distribution of elk using feedgrounds.
9. Snow-water equivalency measurements in areas of habitat enhancement projects, both past and future, and explore relationships with elk use and distribution.
10. Comparison of serology in feedground elk known to be vaccinated and unvaccinated.
11. Alteration of feeding patterns on feedgrounds and effect on contact rates of elk with aborted fetuses.

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APPENDIX 1
ELK HERD MANAGEMENT

A. Historic Elk Herd Management

1. Feedground History

There are currently five elk feedgrounds in the BPEHU. In addition to the five that are currently operating, two Department-operated feedgrounds have been discontinued: Reardon Canyon and Deer Hills (Fig. 3).

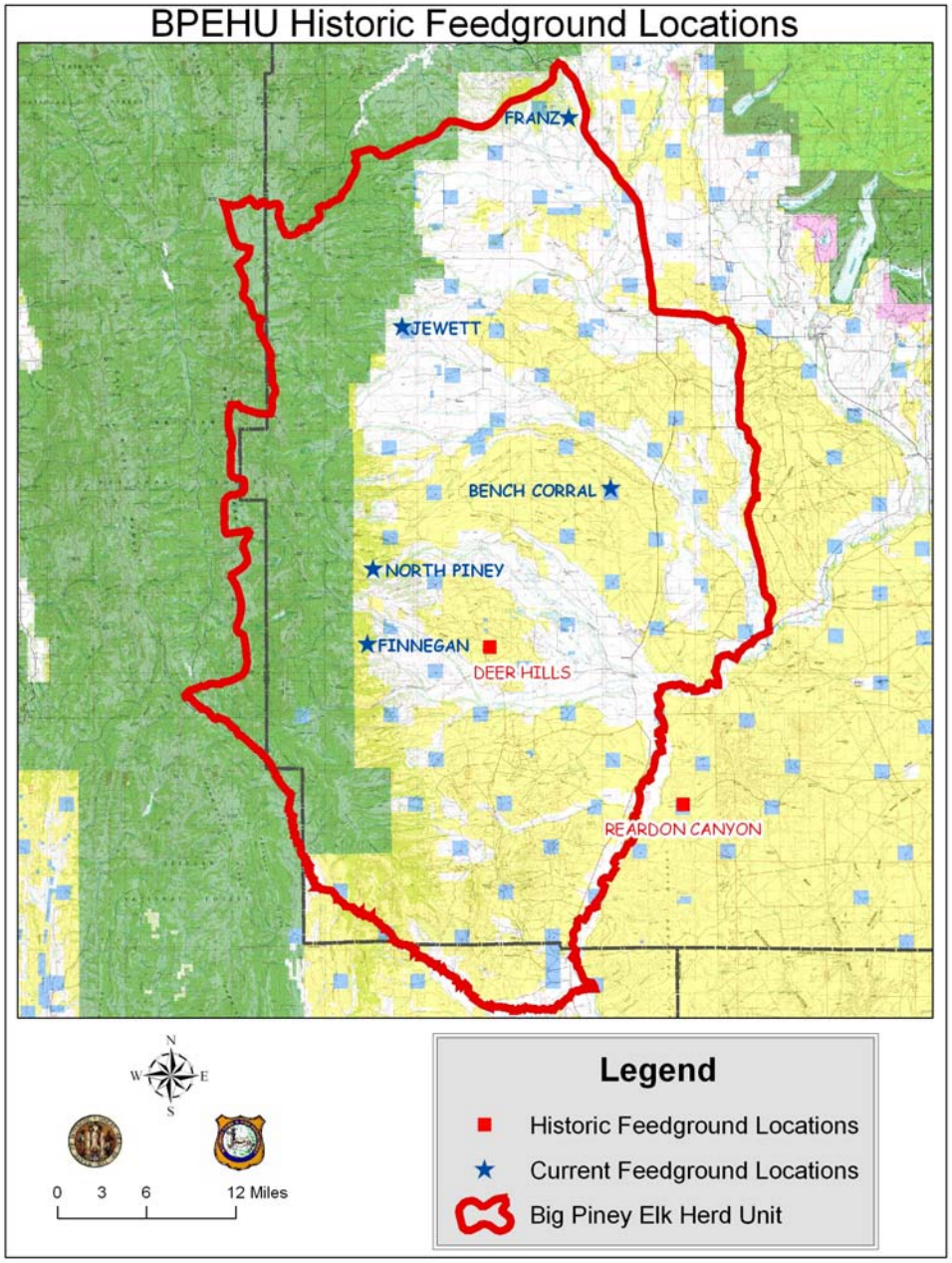

Figure 3. Locations of current and historic (decommissioned) feedgrounds on the BPEHU.

The following section regarding historic management of the Big Piney elk herd is excerpted from the *Brucellosis/Feedground/Habitat Management Action Plan* for the BPEHU (edited for grammar, punctuation, content; WGFD 1989). It is intended to be a history of the management of the Big Piney elk herd, but the current management of elk in western Wyoming is inextricably linked to feedgrounds over the last half-century. Thus, the background information it provides is relevant for understanding, formulating, and implementing any future management actions relating to brucellosis.

> "During the 1940s, Boyd Charter was the first Deputy Game Warden to be stationed in Big Piney. As winter cattle feeding operations increased along the Green River and its tributaries, elk migrations to winter ranges were short stopped by stored hay. As a result, it became difficult for elk to migrate to historic winter range on the Little Colorado Desert between Big Piney and Farson. Prevention of elk damage to stored hay became a primary duty for game wardens during the winter. Charter attempted to move elk across the Green River and out onto the Little Colorado desert. One route historically used by elk to cross the river was near the Five-Mile Bridge and into Reardon Canyon (David Thomas, personal communication).
>
> "In 1949, John J. Barton replaced Boyd Charter as the Big Piney Deputy Game Warden, and the earliest record of elk feeding was in 1950. An average of 127 elk were fed hay and concentrates for 43 days in Reardon Canyon. A filed report estimated the costs for feeding at $13.53 per elk, and "a great deal of the expense on the Reardon Canyon feedground was from moving elk out of damage areas onto the desert. Large numbers were moved through the feedground, and it was used as a stop to keep them from going back to the hay stacks". In 1951, elk were again fed at the Reardon Canyon feedground. An average of 210 elk were fed 54 tons of hay and 15 tons of concentrate over a period of 115 days.
>
> "Evidently, damage problems increased, or at least elk feeding became recognized as a primary method of damage control. In addition to the Reardon Canyon feedground, elk feedgrounds were started on the George Franz ranch near the Hoback Rim and in the Deer Hills west of Big Piney in 1952. Over 300 elk were fed that year. Reardon Canyon, Franz and Deer Hills elk feedgrounds continued to operate through the 1955-56 winter. Orville A. "Red" Wilkerson replaced Barton in 1954. In 1956, a fourth feedground, Jewett, was started by Wilkerson. During the winter of 1956-57, over 900 elk were fed. The Reardon Canyon feedground continued to operate through 1958, but was discontinued in 1959 because elk became increasingly difficult to move across the river. Also, the new feedgrounds located closer to elk summer range prevented elk from using historic migration routes.
>
> "Dave Thomas replaced Red Wilkerson as the Big Piney Deputy Game Warden in 1959. Finnegan and North Piney elk feedgrounds were started in 1960; and, by 1961, an estimated 1600 elk were fed on the five feedgrounds. Each of these were near the forest boundary, which is roughly the boundary between summer and transitional range. On Christmas morning, 1962, elk left the Franz feedground and made it all the way down to the New Fork River near Boulder, Wyoming (Dave Thomas, personal communication). Thomas presumed they would have stopped in the area of Muddy Creek on the southern end of the Wind River Mountains. Area wardens spent several days herding those elk back to the Franz feedground with an airplane and snowplanes. Approximately 200 head were lost from mortality and scattering (Dave Thomas, personal communication).
>
> "During the 1960s, feedground counts of elk ranged from 209 to 461 on Franz, 15 to 650 on Deer Hills, 278 to 418 on Jewett, 61 to 238 on Finnegan and 118 to 286 on North Piney. Finnegan and North Piney feedgrounds were added because the Deer Hills feedground was not effective. Elk left Deer Hills and continued to cause damage to stored hay on Mickelson's "Guthrie" place. In addition, the willows on North Piney Creek caused difficulty in moving those elk. Thus, establishing a feedground further up country was chosen as a solution to the problem.

Elk south of the creek were herded to Finnegan, and elk north of the creek were herded to North Piney. In 1969, Deer Hills feedground was discontinued.

"From 1970 to 1975, the feedground records are incomplete. In 1971, Charles Thornton replaced Big Piney Deputy Game Warden Dave Thomas; and, in 1973, Damage Control Warden Dallas Jenkins moved to the Big Piney area. Responsibility for feedgrounds shifted from the Deputy Game Warden to the Damage Control Warden in 1975. In 1977, feedground responsibility shifted to feedground manager, Scott Norelius.

"In 1975, the Department implemented strategic planning as the foundation management system. This system, still used today, recognizes distinct wildlife populations or herds. Management strategies for each herd is [*sic*] based upon a predetermined objective. Some wildlife management responsibility was taken from the wardens and delegated to wildlife biologists, who were required to report annually on each population in Job Completion Reports (JCR). Emphasis began to shift from individual feedground management to herd management. From 1975 to 1977, JCRs for the Big Piney elk herd (hunt areas 92, 93, and 94) were compiled by Biologist Jim Straley. During those years, the elk poplulation was estimated to be stable near the objective of 2000. In 1976-77, feedground elk were not counted, due to a mild winter and the elk's ability to winter without supplemental feed.

"Biologist Dave Lockman assumed responsibility for the Big Piney elk herd in 1978 and noted several interesting observations in the JCR: feeding on most of the feedgrounds had begun by early December, and elk that wintered on Deadline Ridge (elk hunt area 94) began raiding haystacks on LaBarge Creek. Lockman speculated that recreational snow vehicle travel was redistributing elk away from natural wintering areas. The weather remained extremely cold through December and January; and, by early February, an emergency feeding operation was initiated on the Chrisman Ranch to prevent elk damage to stored hay. Sixty-seven elk from Deadline Ridge and 150 elk from Miller Mountain (area 102) were fed until late February, when they moved back onto the ridges above the emergency feedground. Lockman also became concerned with the impacts of seismic exploration on winter elk range, as this activity was displacing elk off native winter range. Limits on numbers of elk per feedground were established by Commission Policy, and were based on elk counts made over several years. Lockman recognized that up to 250 elk were wintering out in area 94, and that there was little potential for elk to winter out in area 92 because of snow patterns. He also recognized that there was a 'high degree of interchange... between feedground elk segments'. Elk from any one feedground could appear on any other feedground in subsequent years.

"In 1980, Bruce Johnson became the biologist responsible for the Big Piney elk herd and estimated the population at about 2,600. Of these, about 300 wintered out in area 92 on Deadline and Riley Ridges. He described that winter (1980-1981) as being the warmest and driest on record. District personnel recommended changes in feedground quotas and decided that feedground counts would be done by district personnel and not by temporary feedground personnel. These numbers would be reported in the JCR as official feedground counts. In 1981, elk were trapped at Finnegan feedground to assess distribution changes. Blood samples were taken from 37 elk and none tested positive for brucellosis reactors. Major oil and gas field development on Deadline and Riley Ridges caused concern over loss of crucial elk winter range. A separate regulation had been in effect in elk hunt area 93 to distribute elk onto Bench Corral feedground. The regulation had not worked as intended, and area 93 was discontinued and absorbed within the boundaries of areas 92 and 94.

"In 1982, elk were trapped at Finnegan and Franz feedgrounds. Of the 29 blood samples taken at Finnegan, one tested positive for brucellosis. Of the 46 blood samples taken at Franz, 10 tested positive for brucellosis. Miller Land and Livestock controlled much of the private land surrounding Franz feedground and began to limit hunter access in area 92. Johnson correctly predicted an increase in elk use of Franz feedground because of reduced hunting pressure.

Johnson observed new wintering areas in hunt area 94 where he documented elk migrating across Coal Creek and around the south end of Darby Mountain to North Mountain.

"Rich Anderson replaced Scott Norelius as feedground manager in 1983. Johnson observed that the Big Piney elk herd was not a distinct population, as tag and collar returns indicated migration rates were far in excess of 10 percent. During the heavy winter of 1983-1984, elk were moved from Aspen Ridge (elk area 93[*sic*]) to Franz feedground to eliminate a damage problem. Elk were also moved from a damage area on LaBarge Creek to native winter range on Graphite Hollow. Oil and gas field development continued to impact crucial winter range on Deadline Ridge and winter range between North Piney Creek and South Cottonwood Creek.

"In 1984, the Commission, led by Edward Moriarty of Jackson, adopted a new feedground quota that increased elk numbers on BPEHU feedgrounds. Limited interchange (i.e., < 10% among Herd Units) of elk was documented between Big Piney, Afton, Hoback and Fall Creek elk herds. Johnson opined that late season hunts were disruptive to feedground operations and preferred to open the hunting season for cow elk earlier. From 1985 to 1991, the only major changes were in biologists responsible for the BPEHU. Johnson was succeeded by Lee Wollrab who was succeeded by Dave Lockman, Scott Smith, and finally Joe Bohne. Bernard Holz replaced Chuck Thornton as Game Warden in 1989.

"In 1988, the new feedground quotas were adopted into the Commission policy manual. During these years the BPEHU population objective increased from 2,150 to 2,424 with most of this increase realized on feedgrounds. Numbers of elk wintering out declined sharply in 1990-1991. Only 271 elk were observed on native winter range during the February survey, compared to 472 in 1988 and 299 in 1989 (Table 2).

Table 2. Number of elk on native winter range in the BPEHU from 1988-1991.

		1988-89	1990-91
Area 92-	Between Cottonwood and Horse Creek	50-75	29
Area 94-	Red Canyon	--	18
	Billy Canyon	30	19
	Deer Hills	50-75	27
	North Mountain	50-75	--
	Riley Ridge	75	5
	Graphite Ridge/Rock Creek/Long Hollow	200	169
	Fish Creek/Indian Creek	--	27
	TOTAL	342-530	294

"The majority of the Big Piney elk herd historically wintered out on native winter range in the Little Colorado Desert area between Big Piney and Farson during normal to severe winters. As previously mentioned, elk ceased using this winter range with the advent of feedgrounds which short stop elk prior to reaching native winter range. Currently, no habitat inventory work relative to elk winter range has been conducted in the Little Colorado Desert area.

"Lockman proposed that Cretaceous Mountain, Hogsback, the southern exposures of Lake Ridge, Pine Grove Ridge, Black Canyon and the canyons east of the Green River between Piney Creek and LaBarge be evaluated as potential wintering out areas for elk. These areas were historically used as winter range by elk (Dave Thomas, personal communication). Other areas for consideration may include Rock Creek, Graphite Hollow, and Long Hollow. These areas offer minimized human impact and Rock Creek has been identified as a wilderness study area and an Area of Critical Environmental Concern (ACEC) by the Bureau of Land Management. Resolution of the following problems would be necessary before elk could re-occupy former winter ranges: 1) conflicts with livestock operators and grazing allotments on public lands, 2) damage control on private lands, and 3) high levels of human activity in oil/gas fields."

2. Recent Management History

In 1989 and 1990, WGFD drafted statewide and Herd Unit action plans for the Brucellosis-Feedground-Habitat (BFH) project (Appendix 2, Section D). The first Big Piney BFH project biologist was hired in the summer of 1992. In the 1992 Job Completion Report (JCR) prepared by Joe Bohne, it was reported that in association with the Big Piney BFH project, stackyard fencing materials were distributed to six landowners on the BPEHU from mid-1992 to mid-1993 (WGFD 1993). More than 550 blood kits were hand-distributed to hunters by opening day of the 1992 season. About fifty usable samples were collected, but the rate of seropositives from that sample was not reported. Bohne also opined that it was important to maintain an adequate number of elk on native winter range. If the five feedgrounds were at their Commission quotas, just 274 elk would be on native winter range, but the available winter range complexes in the Big Piney EHU could probably support many more elk than this.

The number of elk counted on native winter range increased from about 300 after the 1992 hunting season to 443 in the postseason 1993 counts (WGFD 1994). Gary Fralick (Bohne's replacement) attributed this to minimal snow accumulations and increased availability of native forage. In fact, feeding never took place at Bench Corral in the winter of 1993-94 because of the mild winter conditions. About 150 elk were documented wintering in the Graphite Hollow, Rock Creek, and Pine Hollow areas of HA 94. Blood kits were once again handed out to hunters. Of 1,200 kits handed out, 94 were returned that were testable. Of those 94, twelve were seropositive (12.7%).

Blood kits were handed out again for brucellosis surveillance in the 1994 hunting season. From the hunter surveillance effort spanning 1992-1994, the proportion of seropositive adult females in the BPEHU was 10% (WGFD 1995).

The winter of 1994-1995 was again characterized by light snow and warm temperatures (WGFD 1996). Feeding started much later than usual at Franz, and feeding at Bench Corral lasted for only ten days. The amount of hay fed per elk was much lower at each of the five feedgrounds than in most previous winters. Because of the mild winter, the five-person feedground management team (warden, wildlife biologist, habitat biologist, BFH biologist, and feedground manager) considered jumping a year ahead on the plan to move the North Piney elk to Bench Corral. In fact, early in January of 1995, about 200 elk left the North Piney feedground on their own, eventually ending up in the Bench Corral area.

By mid-1995, the Piney BFH project had delivered materials for 32 stackyards to 16 landowners (WGFD 1996).

In the winter of 1995-1996, about 30 elk crossed the Green River and spent the winter in Reardon, Chapel, and Figure Four Canyons (WGFD 1997). Also during the 1995-1996 winter, Department personnel attempted to move elk from North Piney feedground to the Bench Corral feedground in order to winter elk at a lower elevation site in native winter range (WGFD 1997). The Bench Corral feedground was originally put in place to hold elk away form livestock operations, where elk could utilize surrounding winter range for much of the winter but were fed during periods of deep, persistent snow and cold temperatures. The North Piney feedground is located at a higher elevation and elk were always fed November through April to keep elk from moving down North Piney Creek to cattle ranches.

The original operation that moved elk went fairly well. The elk utilized native range adjacent to the Bench Corral feedground for most of the winter, and only one incident of damage to private haystacks was attributed to the North Piney elk during the move (WGFD 1997).

However, the effort was controversial since concurrence had not resolved by all affected parties. The BLM was preparing a planning document to address the consolidation of the feedgrounds, and allow baiting on BLM land to facilitate moving the elk. Concerns from adjacent landowner and grazing permittees holding leases from the BLM also needed to be addressed. Before the 1996-1997 winter, however, the BLM withdrew its support of the project, and area ranchers demanded that the North Piney feedground continue to operate as in the past.

The WGFD agreed to try to hold elk at the North Piney feedground during the winter of 1996-97 (WGFD 1998). An early winter blizzard and equipment problems resulted in the elk not being fed for 2 days at North Piney, and most elk left for the Bench Corral feedground. Feeding operations were enhanced at the lower feedground and some elk were successfully moved out of damage situations. Overall, the increased number of elk was effectively maintained at Bench Corral, and the elk continued to use native winter range when the weather moderated. Despite most of the North Piney elk spending the winter around Bench Corral, the North Piney feedground was operated through early May. This was because about 300 elk, thought to previously have wintered out on and around Johnson Ridge, were in damage-causing situations in North Piney and South Cottonwood drainages. In December and January, Department personnel were successful in moving about 140 elk to the North Piney feedground.

Also in the winter of 1996-1997, approximately 150 elk were observed in Figure Four Canyon and an additional 100 were documented in Buckhorn Draw, east of the Green River during annual wildlife distribution and trend surveys (WGFD 1998). During the 1998-1999 winter, for the first time at least the previous seven years, about 140 elk wintered out on the areas treated by or immediately adjacent to the Cretaceous Mountain prescribed burn (WGFD 1999). That same group of elk was also observed using native winter ranges in the Lackey Draw and Dry Basin areas east of the Calpet Highway.

During the 1997-98 and 1998-99 winters, elk left North Piney early in the winter and moved to Bench Corral on their own despite full feeding efforts at the higher elevation feedground (WGFD 1998, 1999). Assisted by mild temperatures and below normal snowfall, many elk were able to use the native winter range around Bench Corral for much of both of those winters. It was also reported that no significant damage problems resulted from changes in winter elk distribution in those two winters.

The advantages and disadvantages of the North Piney/Bench Corral arrangement were discussed in the 1998 JCR. The advantages were that it: 1) allowed elk to use native winter range for most of the winter, 2) reduced feedground costs and, 3) reduced intraspecific transmission risk of *Brucella.* The disadvantages were that: 1) North Piney feedground was still maintained as transitional feeding site where a very small number (50-100) elk still needed to be fed all winter, 2) opportunities for elk to move into damage situations may be greater as they move down country to Bench Corral and, 3) uncertainty in elk distribution made administration of the two feedgrounds complicated (i.e., feeder work loads and amount of hay to store).

It was reported that, in 2000, elk had recolonized some of the suitable winter range found on Cretaceous Mountain, the west slope of the Hogsback, and Riley Ridge after being displaced by extensive oil and gas development in the early- to mid-1980s (WGFD 2001). During mild, relatively snow-free winters elk would readily make use of the Graphite Hollow and Hogsback winter range complex. This was especially evident during the 1999-2000 winter when approximately 100-120 elk used the eastern portion of the Hogsback and the sagebrush foothills near Sali Mine for most of the winter. And, as was typical in preceding years, elk left the North Piney feedground in late December in the direction of the Bench Corral feedground. The mild

and relatively snow-free conditions allowed them to remain in the sagebrush basins of Muddy Creek for most of the winter. In mid-February, snow conditions forced them to Bench Corral, where they stayed the rest of the winter.

The Big Piney Hunter Management Program was implemented for the first time during the 2000 elk hunting season (WGFD 2001). It was designed to displace elk from damage and co-mingling situations on private property. In 2000 postseason trend counts, only 251 elk were recorded away from feedgrounds in the BPEHU. Over the previous four years an average of 657 elk were counted on native winter ranges. Some of this decline was attributed to the Hunter Management Program's success in displacing 110-120 elk out of damage and co-mingling situations in North Piney Creek and onto the Finnegan and Bench Corral feedgrounds. Also in 2000-2001, elk use declined significantly on the Hogsback for unknown reasons; no more than 100 elk were observed there in November and December. By February 2001 there were no more than 76 elk counted on the west slope of the Hogsback.

As part of the Big Piney Elk GIS Study, thirty elk were captured and radio-collared in the Piney and West Green River EHUs in February of 2000 (WGFD 2001). Fifteen of the elk captured were tested for antibodies to *Brucella*; none were positive. The objectives of the study were to develop elk winter range suitability models, and to compare habitat selection between an area of high gas and oil development (HA 94) and an area with little to no gas and oil development (HA 102). To date, the results of this project have not been compiled, summarized, or published.

About 350 elk were observed on native winter range during the 2001 postseason classification counts (WGFD 2002). Once again, most of the North Piney feedground elk left partway through the 2001-2002 winter for native ranges or the Bench Corral feedground, despite the Department's efforts to keep elk at their respective feedgrounds. The Big Piney Hunter Management Area was again successful in moving elk off of private property in North Piney Creek and parts of Cottonwood Creek.

Trend counts following the 2002 and 2003 hunting seasons each documented 300-350 elk on native winter range (WGFD 2004). In the winter of 2002-2003, most of the wintering out elk could be found on Riley Ridge/South Piney Creek (n = 113), and the Hogsback (n = 100). In the winter of 2003-2004, most of the wintering out elk could be found on the Hogsback (n = 235).

North Piney elk, numbering about 380, moved to Bench Corral feedground in January of both 2003 and 2004, reportedly following wolf depredation (WGFD 2004). High elk numbers and a long feeding season over the winter of 2003-2004 resulted in hay shortages at Bench Corral and Jewett. Additional hay was hauled into both of those feedgrounds during the late winter months.

Only 53 elk were counted on native winter range during the 2004 postseason trend surveys, but the decline from previous years was attributed to the Hogsback/Graphite Hollow elk (typically 250-300 elk) abandoning that winter range and moving south across LaBarge Creek into HA 102 (WGFD 2005). It was believed that heavy snow accumulations between December and February forced them out of the area they had typically been wintering in. The number of elk counted on Bench Corral feedground declined to 680 in the winter of 2004-2005 compared to the >800 elk counted there the previous two years (WGFD 2005). This was a direct result of the increased harvest that took place in late October when deep persistent snows pushed elk into the sagebrush habitat around Bench Corral.

3. Damage History

a. Damage Claims

Techniques for preventing elk damage in the BPEHU have included fencing haystacks, hazing animals away from the damage source with pickup trucks, snowmobiles, WGFD personnel on snowshoes, and/or noise-making devices, and institution of hunting seasons on lands (primarily privately owned) located on areas of chronic damage. In some years, not all damage has been preventable and some landowners have received monetary compensation (Fig. 4). Since 1989, WGFD has paid landowners in HA 92 $6,446.00 for 6 damage claims (WGFD unpublished data). In that same time, WGFD has paid landowners in HA 94 $17,619.10 for 9 damage claims. In both HAs, nearly all claims were for damage to stored hay.

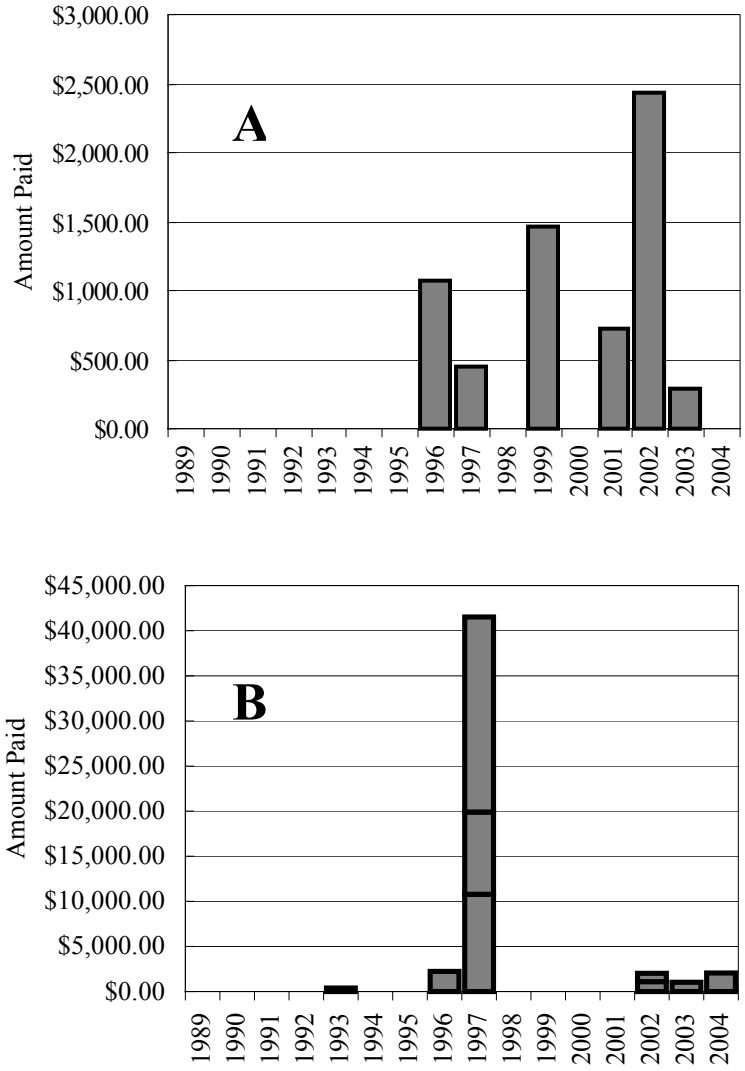

Figure 4. Monetary claims paid to landowners in HA 92 (A) and HA 94 (B) by WGFD for elk-specific damage from 1989 through 2004 on the BPEHU. Claims do not reflect expenses incurred by WGFD for damage prevention activities.

b. Analyses of Producer Survey Questionnaire

Of the 28 producers in the BPEHU that responded to the Questionnaire (BMAP, Section E-1-4), 52% reported damage to some portion of their operation at one time or another; type of operation appears to be unrelated to damage (Table 3). Overall, 61%, 77%, and 69% of producers in the BPEHU produce hay, have 1 or more stackyards, and feed livestock throughout winter, respectively. Damage appears unrelated to stackyard ownership and winter feeding of livestock (Table 4). Although damage appears unrelated to hay production (yes/no; Table 4) and amount (acres) of hay produced (Fig. 5), producers reporting damage vs. those not reporting damage had an average production of 2000 acres and 975 acres, respectively, suggesting that risk of damage increases with increasing acres of hay produced.

Table 3. Occurrence of damage to various livestock operations on the BPEHU.

	Damage	
Operation	Yes	No
Cow-Calf	5	5
Steer	1	1
Spayed Heifer	0	0
Yearling	0	1
Multiple Types	6	4
Total	12	11
% of Total	52	48

Table 4. Occurrence of damage to livestock operations with hay production, functional stackyards, and winter feeding on the BPEHU.

	Damage		
Factor	Yes	No	%Total
Hay Production Yes	6	8	61
Hay Production No	6	3	39
Stackyard(s) Yes	12	8	77
Stackyard(s) No	2	4	23
Winter Feeding Yes	11	7	69
Winter Feeding No	3	5	31

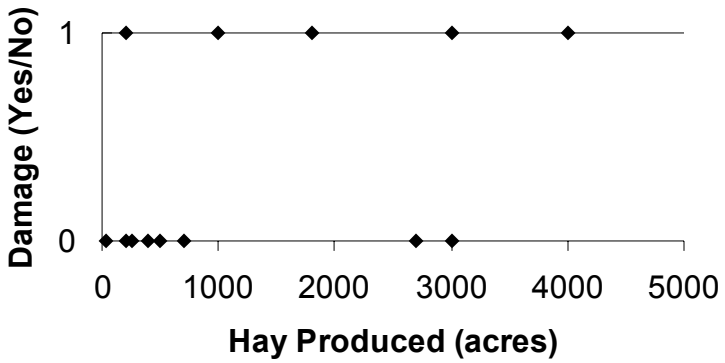

Figure 5. Occurrence of damage (yes = 1, no = 0) with respect to amount (acres) of hay produced for individual producers on the BPEHU.

Throughout the BPEHU (and all Elk Herd Units within the brucellosis endemic area of western Wyoming), WGFD personnel (and other agencies) have assumed that risk of damage and/or commingling increases as distance of livestock production operation decreases with respect to individual feedground(s); producers within 5 miles of any feedground are presumed to

be at "high" risk of incurring damage and/or commingling situations. Based on results of the Questionnaire, livestock producers incurring damage are slightly farther from nearest and next-nearest feedgrounds than producers not incurring damage (Table 5). Average distance for all producers reporting damage is 11.38 miles and is over 2 times greater than the assumed "high" risk distance of 5 miles. Distance to nearest and next-nearest feedgrounds do not appear to be associated with occurrence of damage (Fig. 6 A, B). Ultimately, risk of damage (regardless of type of operation, production of hay, and proximity to feedground) and/or commingling appears ubiquitous among all producers within the BPEHU, and may be more accurately predicted by proximity to migration routes, elk home-range sizes, or some combination therein.

Table 5. Average distance to nearest and next-nearest feedgrounds for producers reporting damage/no damage on the BPEHU.

	Distance to Feedground (miles)		
Damage	Nearest	Next-Nearest	Mean
Yes	9.13	13.83	11.38
No	7.91	13.41	10.35
Mean	8.56	14.79	

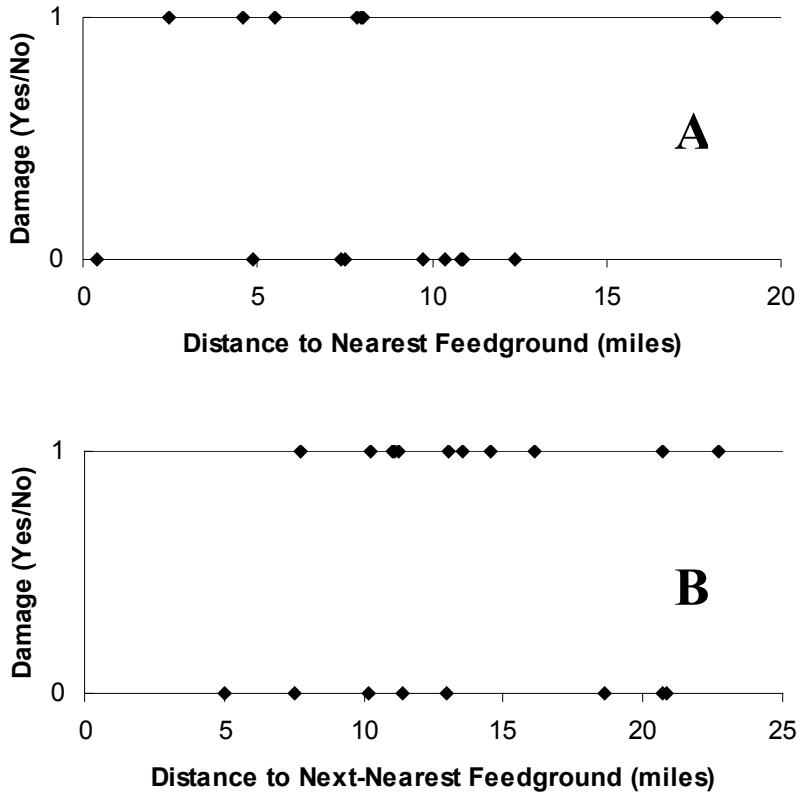

Figure 6. Occurrence of damage (yes = 1, no = 0) on livestock operations with respect to nearest (A) and next-nearest (B) feedgrounds in the BPEHU.

B. Current Elk Herd Management

1. Population Estimate

The 2005 post-hunt population of elk on the BPEHU was estimated at 3,429 elk (WGFD 2006). The population is projected to decline to 3,064 elk following the 2006 hunting season. The population objective for this herd unit is 2,400 elk.

2. Trend Counts and Demography

A total of 3,108 elk were observed during postseason surveys (2005 post-hunt) on the BPEHU. This is a significant increase from the 2,630 and 2,220 elk observed in 2003 and 2004, respectively (WGFD 2006). The number of elk counted increased on both the Franz and Bench Corral feedgrounds (Figure 7). The greatest increase in feedground elk numbers was at Bench Corral; 1,010 elk were counted post-hunt 2005 compared to 680 post-hunt the previous year. The number of elk counted on native winter ranges was also up. The number of elk counted on native ranges in HA 94 increased from 336 elk and 53 elk in 2003 and 2004, respectively, to 494 elk post-hunt 2005.

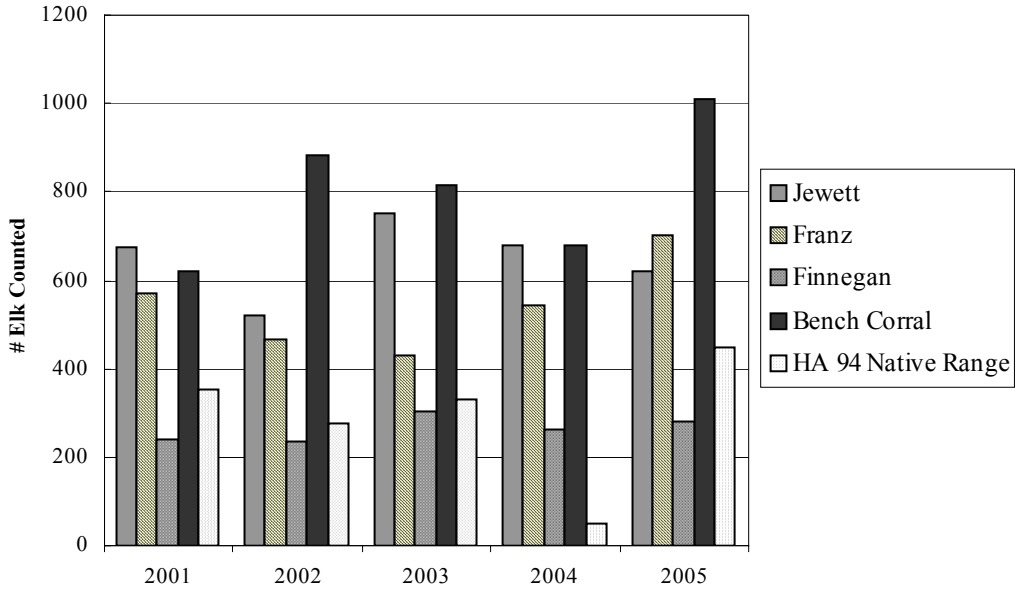

Figure 7. Number of elk counted on Jewett, Franz, Finnegan, and Bench Corral feedgrounds and native winter range (HA 94) during annual post-hunt trend counts. North Piney feedground is not included because most elk move off the feedground before counts take place. Native range in HA 92 is not included because counts have averaged < 20 elk in this time span.

Forty-five percent (n = 1367) of the 2005 trend count was observed in HA 92 (WGFD 2006). All but 45 of these elk were counted on the Franz and Jewett feedgrounds. In HA 94, a total of 1,459 elk were counted. Across the BPEHU, 85% of the elk counted during the 2005 trend count were on feedgrounds (Figs. 7, 8).

In 2005, the observed bull:cow ratio was 31:100 (Fig. 9; WGFD 2006). A total of 499 antlered elk were counted. This is the second highest number of bulls counted in the BPEHU; 521 bulls were counted in 1998. Since 2000, the number of antlered elk counted in HAs 92 and 94 averaged 223 and 153, respectively.

The observed calf:cow ratio in post-hunt 2005 trend counts was 42:100 (Fig. 9; WGFD 2006). This is virtually unchanged from the 41 calves:100 cows observed in 2004, but substantially higher than the ratio of 33:100 in 2003. A total of 689 calves were counted in 2005, the highest number ever observed in the BPEHU. The 5-year (2000-2004) average calf:cow ratio is 36:100; an average of 482 calves were counted during this period.

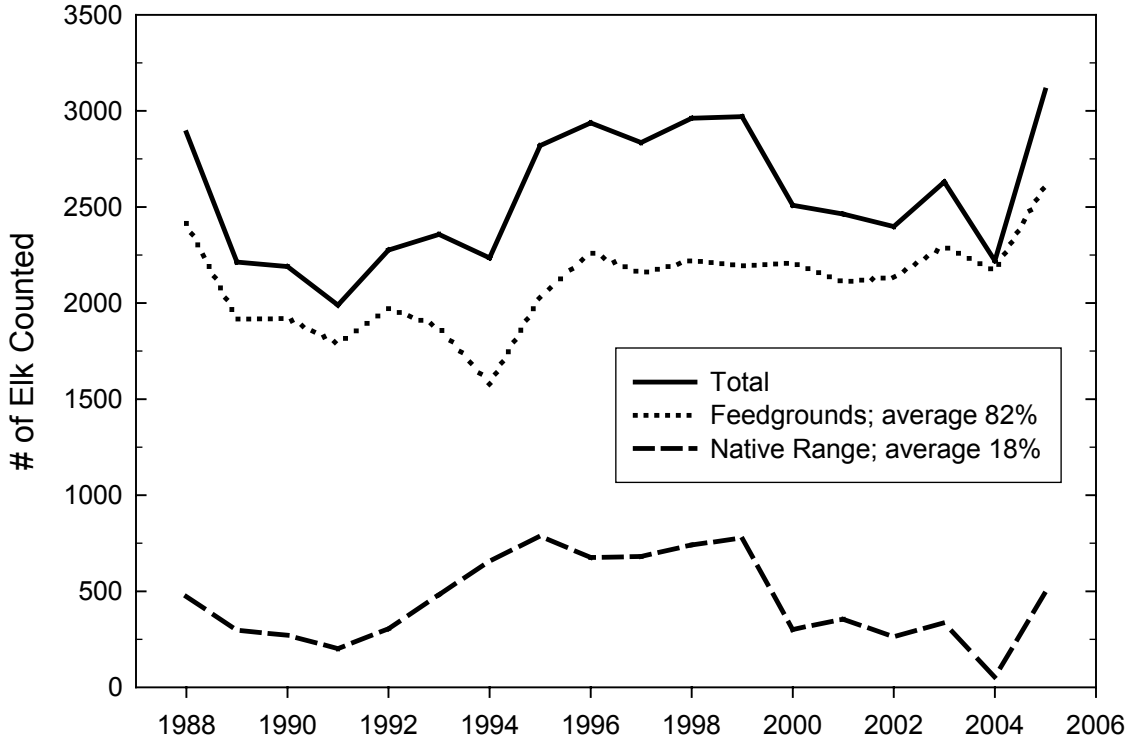

Figure 8. Number of elk counted in the BPEHU on all feedgrounds (combined) and on native range during annual post-hunt trend counts, 1988-2005. The herd objective is 2,400 elk.

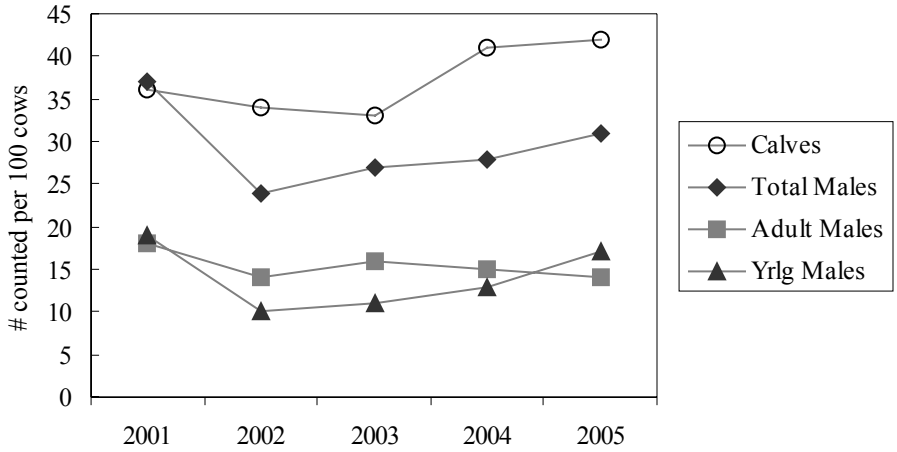

Figure 9. Ratio of calves, bulls, and spikes per 100 cows counted during annual post-hunt trend counts in the BPEHU, 2001-2005.

3. Harvest & Hunter Success

In 2005, an estimated 513 elk were harvested from the BPEHU; 895 elk were harvested in the 2004 hunting season (WGFD 2006). A total of 318 antlered elk (62% of total harvest), and 195 cows and calves (38% of harvest) were taken in 2005. The 164 cow elk harvested in 2005 is the lowest number recorded for that segment of the population since 2000. From 2000-2004, an average of 336 cow elk were harvested annually.

In 2005, hunters harvested 220 elk from HA 92 and 293 from HA 94 (WGFD 2006). In HA 92, hunter success was estimated to be 25% for the 2005 season. This was a decline from the success level of 29% in 2004. However, days per harvest declined from 28 days in 2004 to 24 days in 2005. In HA 94, hunter success was estimated to be 38% for 2005; days per harvest increased from 15 in 2004 to 33 days in 2005.

4. Hunting Seasons and Population Management

The 2006 hunting seasons have been designed to reduce the number of elk in the BPEHU; the emphasis to harvest adult females in both HA 92 and HA 94 will continue (WGFD 2006). The 2006 "General" (i.e., any antlered or antlerless elk) hunting season will extend into November (15 October – 5 November) and should attract general license hunters to the BPEHU. Additional hunting opportunities are given in HA 94 with 100 limited-quota, Type 1 licenses valid for any elk from 15 Oct – 20 Oct, with those unused licenses valid for antlerless elk from 21 October – 5 November. Also, 300 limited quota Type 6 licenses will be valid for cow or calf elk in an attempt to increase harvest and reduce population growth of the herd. These Type 6 licenses are valid for the entire HA during the General season (15 October – 5 November) and the late season (16 November – 31 January) hunt on the Big Piney Hunter Management Area (Fig. 1, BMAP). These management strategies are intended to bring the elk population closer to overall feedground and EHU objectives.

To prevent elk from damaging private lands/hay stores and/or commingling with cattle along North Piney Creek, and facilitate movement of elk to North Piney and Bench Corral feedgrounds, a hunting season was initially implemented in 2000 under the Private Lands Public

Wildlife Program in HA 94 (WGFD 2001, 2006). Landowner attitudes toward this hunting season were positive, and several landowners enrolled their lands for this program. As a result, the Big Piney Hunter Management Program will be once again implemented in 2006 in HA 94, with additional lands in HA 92 being enrolled to address damage/commingling concerns regarding elk from Franz feedground. The lands enrolled will be private property in the west 40 Rod and Warren Bridge areas of HA 92 and North Piney Creek watershed in HA 94 (Fig. 1, BMAP). All unused HA 94 Type 1 and Type 6 licenses will be valid on the lands enrolled in this program. This hunting season will take place from 16 November – 31 January and allow for harvest of antlerless elk.

5. Ear Tag Returns

A tagging program has been conducted occasionally since 1966 in an effort to increase knowledge of elk movements in and out of the BPEHU (WGFD 1985). Brucellosis surveillance has been the focus of trapping efforts since the early 1980s. Elk were tagged most recently in the BPEHU at the Bench Corral feedground in the winter of 2006. Elk have been ear-tagged during at least one capture effort at each of the five feedgrounds in the BPEHU (Table 6). A total of 124 elk were trapped at the North Piney feedground in the winters of 1990 and 1991. Franz was trapped in 1983-1985, and again in 2003 and 2005. Elk were trapped on Finnegan feedground in 1982-1984, and again in 1989 and 2001. The longest period of time has passed since elk were trapped on the Jewett feedground; a total of 87 elk were trapped there from 1966 through 1968.

Tag return data has been compiled through the 2003 hunting season. An evaluation of all known-location tag returns (n = 172) from elk tagged within the BPEHU (1966-2003) indicates that 27% (n = 45) of recovered tags were from elk killed outside the herd unit boundaries (Tables 6, 7). Thus, tag returns indicate a high level of interchange with surrounding elk herd units. Franz feedground has been documented to have especially high levels of interchange with surrounding EHUs; over half of the Franz ear tags are recovered outside the BPEHU, most of them in the adjacent Hoback EHU immediately north.

Table 6. Harvest locations of elk trapped and tagged at BPEHU feedgrounds. No ear tags have been recovered yet from elk tagged at Franz feedground in 2005. Compiled from WGFD JCRs (1985, 1988-2006) and unpublished data.

			# Tags Returned	
Feedground	**Years Trapped**	**# Tagged**	**In Piney EHU**	**Other EHUs**
Jewett	1966-1968	**87**	**19 (79%)***	**5 (21%)**
Finnegan	1982-1984	116	41	4
	1989	32	3	1
	2001	82	13	1
	Finnegan Total	**230**	**57 (90%)**	**6 (10%)**
Franz	1983, 1984	119	16	11
	1985	47	8	18
	2003	35	3	0
	2005	133		
	Franz Total	**334**	**27 (48%)**	**29 (52%)**
North Piney	1990	62	9	1
	1991	62	12	4
	No. Piney Total	**124**	**21 (81%)**	**5 (19%)**
Bench Corral	2006	33	0	1
	Bench C. Total	**33**	**0 (0%)**	**1 (3%)**
	BPEHU Total	**808**	**124 (73%)**	**46 (27%)**

*Total and (mean relative percent) of ear tags returned.

Tag-return data compiled from 1966-1987 indicated much greater interchange than compared to data since 1990. The proportion of elk tagged inside the BPEHU, then subsequently harvested outside the BPEHU, was over 33% (Table 7). Data since 1990 indicate the proportion is closer to 15%. With the large number of elk trapped and tagged at the Franz feedground in 2003 and 2005 (n = 168), the proportion of tag returns coming from outside the BPEHU boundaries is once again likely to rise in the coming years.

Interchange among herd units is believed to affect the population composition and herd size estimates to some degree between individual years. However, population models appear sufficiently operative for developing harvest strategies to achieve objectives.

Table 7. Known harvest locations of elk trapped and tagged in the BPEHU, 1966-2003. From 1966-2003, 808 elk were trapped and tagged on feedgrounds. Additional elk were tagged during radio-collar studies; because of incomplete data those are not included here. Compiled from WGFD JCRs (1985, 1988-2006) and unpublished data.

Time Period of Trapping	Location of Harvest	# of Tagged Elk Harvested	% of Tag Returns
1966-1987	Big Piney EHU	74	67.3
	Other EHUs	36	33.7
	Total	**110**	
1990-2003*	Big Piney EHU	50	84.7
	Afton EHU	3	5.1
	Fall Creek EHU	2	3.4
	West Green River EHU	2	3.4
	Hoback EHU	1	1.7
	South Wind River EHU	1	1.7
	Total	**59**	
1966-2003	Big Piney EHU	124	73.4
	Other EHUs	45	26.6
	Total	**169**	

*No tag returns were reported during 1988 and 1989.

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APPENDIX 2
FEEDGROUND & BRUCELLOSIS MANAGEMENT

A. Feedground Management – Populations, Seasons, and Expenditures

In 2005-2006, the BPEHU had the longest feeding season of any EHU in the Jackson/Pinedale region (Fig. 10; WGFD unpublished data). Some feedgrounds in this EHU start very early (e.g., 1 November) and run until late in the spring. Elk move to feedgrounds gradually and also leave for native ranges gradually in the spring. In the winter of 2005-2006, most of the elk on these feedgrounds were fed from early January through late March. The average length of the feeding season for feedgrounds in the BPEHU (mean = 132 days) was ten days longer than the overall feedground average (mean = 122 days). However, without including the North Piney feedground, which operated for just 59 days last winter, the average length of the feeding season was 151 days for feedgrounds on the BPEHU.

Counts indicated that 2,614 elk were fed in the BPEHU in 2005-2006. This number does not include North Piney feedground, and still was almost 500 elk over feedground quotas set by the Commission (2,150 for the five feedgrounds, Table 8).

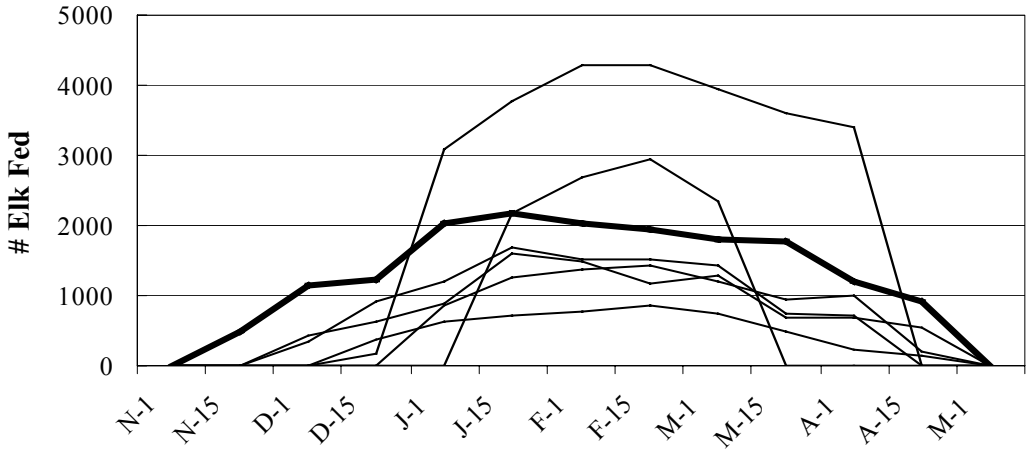

Figure 10. Estimated number of elk being fed on feedgrounds over the length of the 2005-2006 feeding season, grouped by EHU. The five feedgrounds of the BPEHU are designated by the bold line.

Table 8. BPEHU feedground quotas established by the Wyoming Game & Fish Commission.

	Feedground Quota (# of Elk)	
Feedground	**1975**	**1984**
Franz	350	450
Jewett	550	650
Bench Corral	226	250
North Piney	267	400
Finnegan	333	400
BPEHU Total	1,726	2,150

The cost to feed elk in the BPEHU last winter ($78 per elk) was above the overall feedground average ($65 per elk; WGFD unpublished data). Also in the winter of 2005-2006, about 15% of all elk fed and about 20% of the total cost are associated with feedgrounds in this EHU, making it one of the less cost-efficient for the feedground program.

1. Franz

In 2005, feeding was initiated on 28 November and continued until 26 April 2006, resulting in a 149-day feeding season, which is shorter than in recent years (Table 9, Fig. 11; WGFD unpublished data). During the official feedground count, 700 elk were tallied (Table 9; WGFD 2006); the Commission quota for Franz is 450 elk (Table 8). The number of elk on the Franz feedground has been over quota each of the last two years, but the long-term average is under quota (WGFD 2006).

Elk were fed a maximum estimated average of 0.65 tons of hay per elk (i.e., 457 tons ÷700 elk) over the course of the winter (Fig. 12; WGFD 2006). This matches the long-term average for Franz, and was about 0.1 tons greater than the average for all feedgrounds combined.

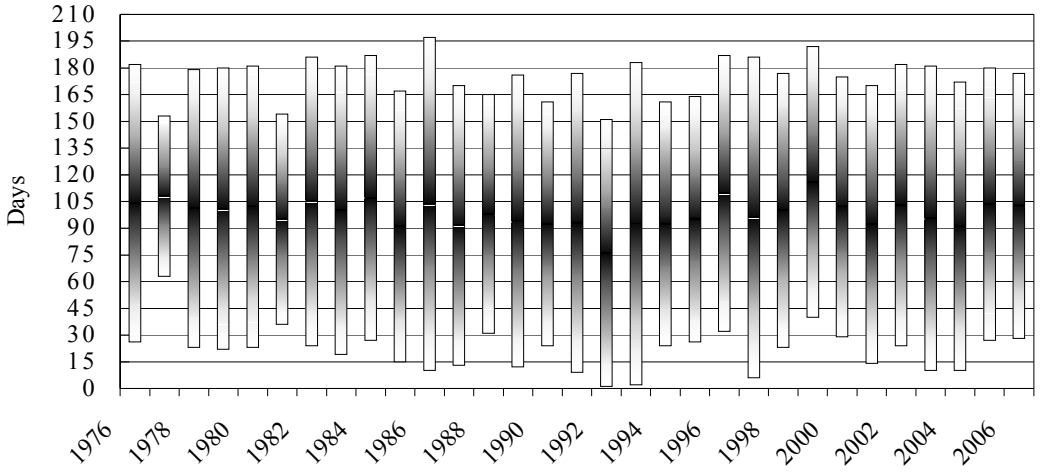

Figure 11. Beginning date, ending date, and days fed at Franz feedground since 1975-76 (0 on y axis = 1 November).

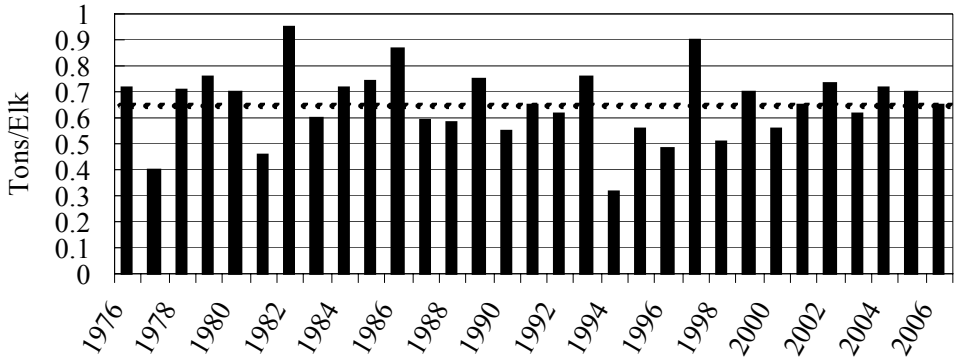

Figure 12. Maximum estimated tons of feed per elk per year at Franz feedground since 1975-76. The dashed line indicates the long-term average for this feedground.

Table 9. Summary data from the Franz feedground since 1975-76.

Year	# Elk	Tons Fed	Days	# Dead	Cost/Elk ($)	Tons/Elk
1975-76	309	221	165	3	48	0.72
1976-77	80	32	92	0	39	0.40
1977-78	384	272	160	2	55	0.71
1978-79	256	194	166	1	56	0.76
1979-80	250	175	161	1	57	0.70
1980-81	63	29	127	0	38	0.46
1981-82	234	222	163	1	81	0.95
1982-83	280	167	164	0	62	0.60
1983-84	402	290	162	0	60	0.72
1984-85	420	312	158	0	66	0.74
1985-86	421	368	188	2	85	0.87
1986-87	524	310	151	5	53	0.59
1987-88	571	329	147	2	54	0.58
1988-89	575	432	160	2	70	0.75
1989-90	450	249	138	1	69	0.55
1990-91	502	324	167	4	73	0.65
1991-92	375	234	152	4	74	0.62
1992-93	368	281	186	2	97	0.76
1993-94	480	152	137	0	41	0.32
1994-95	354	197	139	1	68	0.56
1995-96	300	145	157	0	64	0.48
1996-97	370	333	181	0	118	0.90
1997-98	625	320	155	0	71	0.51
1998-99	461	325	183	0	82	0.70
1999-00	467	262	148	0	72	0.56
2000-01	550	358	157	0	80	0.65
2001-02	571	420	160	0	123	0.73
2002-03	466	288	171	0	89	0.62
2003-04	428	310	164	1	89	0.72
2004-05	545	384	154	1	85	0.70
2005-06	700	457	149	5	83	0.65
Average	412	271	160	1.2	71	0.65

2. Jewett

In the winter of 2005-2006, feeding began on 13 November and continued until 24 April, resulting in a 162-day feeding season (Fig. 13; WGFD unpublished data). Both the beginning and ending dates were near long-term average for Jewett. Jewett feedground tends to have one of the longer feeding seasons among all feedgrounds. The long-term average for Jewett is 153 days (Table 10), the average for all feedgrounds over the last thirty years is about 127 days.

The Commission quota for Jewett is 650 elk; 622 elk were counted here in the winter of 2006 (Table 10; WGFD 2006). The amount of hay fed per elk has been on a consistent upward trend over the last thirty years (Table 10, Fig. 14; WGFD 2006). The long-term average for Jewett is 0.64 tons per elk. Last year, each elk received a maximum estimated average of 0.79 tons over the course of the winter.

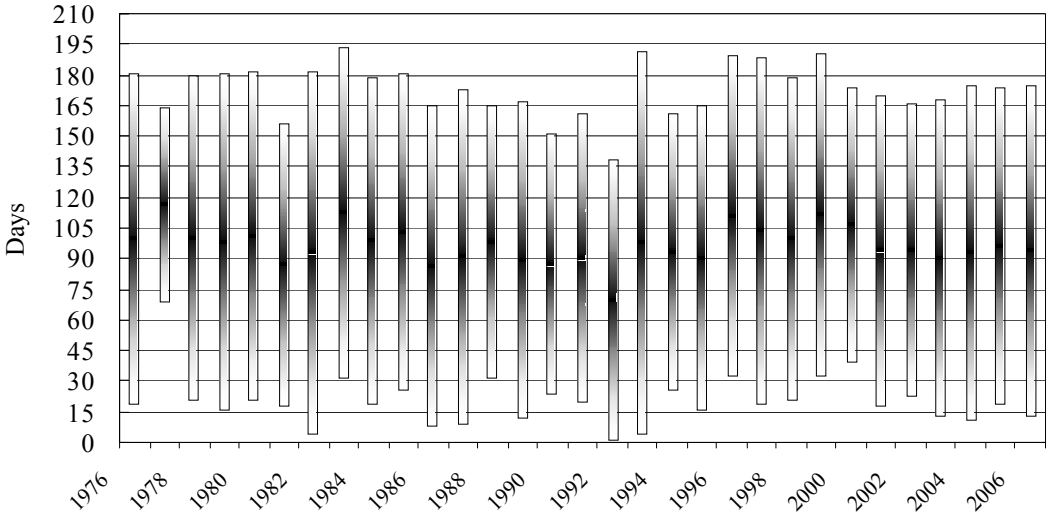

Figure 13. Beginning date, ending date, and days fed at Jewett feedground since 1975-76 (0 on y axis = 1 November).

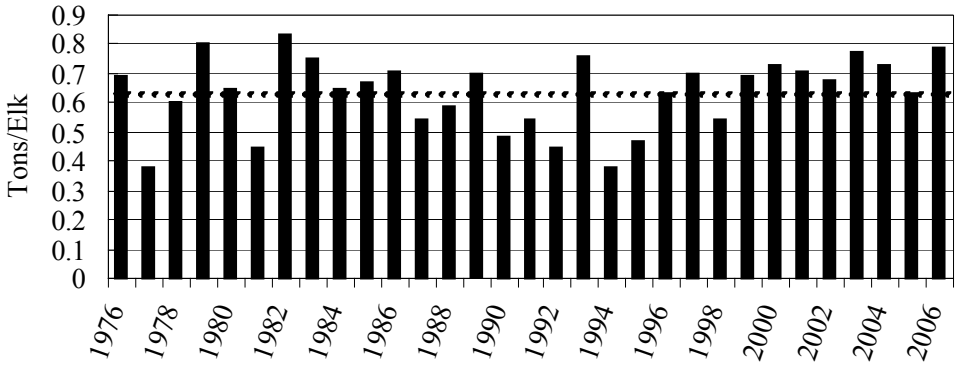

Figure 14. Maximum estimated tons of feed per elk per year at the Jewett feedground since 1975-76. The dashed line indicates the long-term average for this feedground.

Table10. Summary data from the Jewett feedground since 1975-76.

Year	# Elk	Tons Fed	Days	# Dead	Cost/Elk ($)	Tons/Elk
1975-76	533	369	160	11	46	0.69
1976-77	217	83	95	0	30	0.38
1977-78	650	390	156	4	42	0.60
1978-79	480	385	167	4	53	0.80
1979-80	601	392	153	0	45	0.65
1980-81	551	246	145	2	36	0.45
1981-82	680	567	179	1	58	0.83
1982-83	611	460	163	4	57	0.75
1983-84	620	400	157	5	51	0.65
1984-85	652	440	160	3	55	0.67
1985-86	666	472	166	2	54	0.71
1986-87	693	378	156	0	44	0.54
1987-88	672	395	136	4	51	0.59
1988-89	628	437	160	3	65	0.70
1989-90	617	296	128	0	56	0.48
1990-91	500	268	145	1	60	0.54
1991-92	547	248	139	1	50	0.45
1992-93	580	441	188	6	87	0.76
1993-94	636	241	136	0	42	0.38
1994-95	618	289	139	3	55	0.47
1995-96	597	379	159	0	73	0.63
1996-97	602	420	170	4	89	0.70
1997-98	607	327	159	5	69	0.54
1998-99	553	380	160	1	78	0.69
1999-00	530	389	136	0	84	0.73
2000-01	670	475	154	1	73	0.71
2001-02	675	464	145	5	114	0.68
2002-03	523	401	156	8	97	0.77
2003-04	750	541	166	9	83	0.73
2004-05	678	423	157	17	74	0.63
2005-06	622	491	162	2	91	0.79
Average	599	383	153	3.4	63	0.64

3. Bench Corral

The location of this feedground is such that it allows the Department to keep elk in the area that have moved east and south, past the other feedgrounds in the BPEHU. Bench Corral feedground thus prevents elk from crossing Highway 189 and moving onto private property. In the winter of 2005-2006, 1,010 elk were here during the classification count (WGFD 2006); the Commission quota is 250 elk. Feeding began on 6 December, and continued for 110 days, through 31 March (WGFD unpublished data). While the long-term average for season length at Bench Corral is under 100 days ($\bar{x} = 93$), each of the last five winters has been over 100 days ($\bar{x} = 112$; Fig. 15, Table 14; WGFD unpublished data). Over the same five-year span, the average season length for all feedgrounds has been over 123 days (WGFD unpublished data).

The elk on Bench Corral were fed a maximum estimated average of 0.48 tons of hay per elk over the course of the 2005-2006 winter (Table 11, Fig. 16; WGFD 2006), which was below the

average for all feedgrounds combined ($\bar{x}$ = 0.55 tons/elk; WGFD unpublished data). However, the amount of hay fed per elk is on an upward trend over the last several years. From 1975-76 through the winter of 1994-95, Bench Corral elk received an average of 0.29 tons/elk (WGFD 2006). But since winter 1995-96, Bench Corral elk have been receiving an average of 0.35 tons/elk. The increased cost/elk to operate the Bench Corral feedground over the same time spans reflects this increase in hay fed (Table 10).

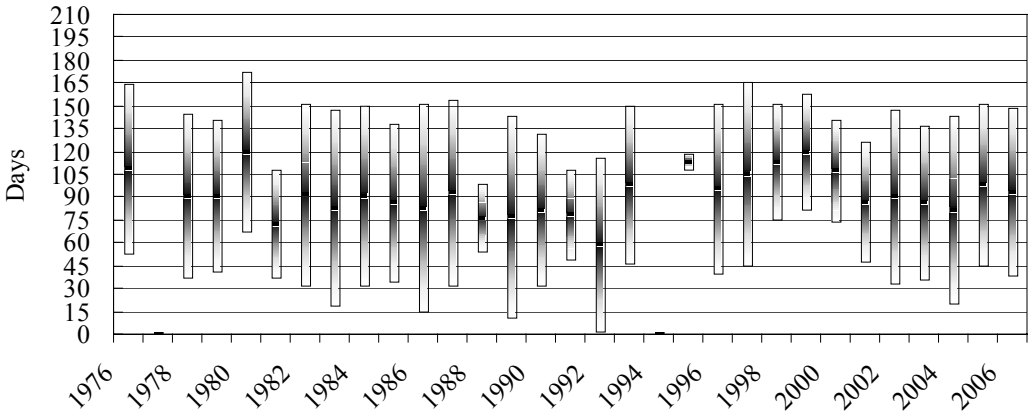

Figure 15. Beginning date, ending date, and days fed at Bench Corral feedground since 1975-76 (0 on y axis = 1 November).

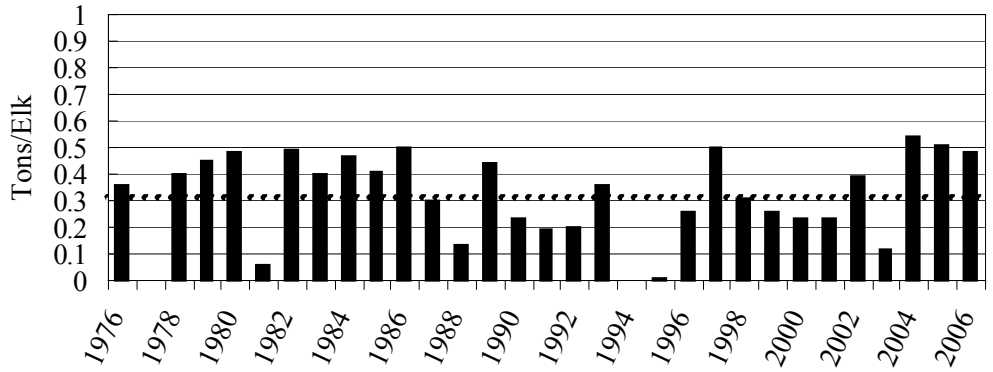

Figure 16. Maximum estimated tons of feed per elk per year at Bench Corral feedground since 1975-76. The dashed line indicates the long-term average for this feedground.

Table 11. Summary data from the Bench Corral feedground since 1975-76.

Year	# Elk*	Tons Fed	Days	# Dead	Cost/Elk ($)	Tons/Elk
1975-76	240	86	103	5	27	0.36
1976-77	0	0	0	0	0	0
1977-78	258	103	115	0	69	0.40
1978-79	298	133	99	0	31	0.45
1979-80	372	180	105	4	33	0.48
1980-81	65	4	67	0	4	0.06
1981-82	325	160	128	0	44	0.49
1982-83	281	113	131	2	39	0.40
1983-84	285	134	120	2	41	0.47
1984-85	170	69	105	0	46	0.41
1985-86	273	136	137	0	44	0.50
1986-87	339	102	123	0	28	0.30
1987-88	280	37	46	0	15	0.13
1988-89	439	193	132	0	50	0.44
1989-90	322	73	101	0	37	0.23
1990-91	250	47	59	0	23	0.19
1991-92	275	56	117	0	32	0.20
1992-93	258	92	104	6	47	0.36
1993-94	0	0	0	0	0	0
1994-95	250	2	10	0	1	0.01
1995-96	803	212	111	2	34	0.26
1996-97	650	322	121	3	67	0.50
1997-98	559	175	76	0	42	0.31
1998-99	841	215	76	1	28	0.26
1999-00	837	189	67	1	25	0.23
2000-01	700	159	80	0	27	0.23
2001-02	671	263	114	4	60	0.39
2002-03	882	110	102	0	18	0.12
2003-04	813	443	125	5	63	0.54
2004-05	680	344	108	1	59	0.51
2005-06	1010	481	110	4	55	0.48
Average	433	149	93	1.3	35	0.31

*Total elk counts since 1995-96 include elk that began the winter at North Piney FG and moved to this feedground after feeding had begun.

4. North Piney

Feeding was started on 1 November 2005 in an effort to hold elk at this site. Damage and co-mingling possibilities exist if elk leave this feedground. Additionally, the ranching community has pressured the Department in the past to hold these elk at North Piney rather than having them migrate to Bench Corral. In 2005, the last day of feeding was 30 December. The elk were fed at North Piney for a total of 60 days (Fig. 17; WGFD unpublished data).

An estimated 570 elk were present on the feedground before they left for Bench Corral (Table 12; WGFD 2006). This is the most elk to attend this site in recent years. The elk were fed a maximum estimated average of 0.14 ton/elk (i.e., 79 tons ÷ 579 elk) while they attended the feedground (Fig. 18). This amount is similar to the amount offered to the elk since they have been moving to Bench Corral (beginning winter of 1995-96). Across the twenty years prior

(1975-76 through 1994-95), North Piney elk were fed over half a ton ($\bar{x}$ = 0.52 tons/elk), were fed for about 150 days ($\bar{x}$ = 149.8), and costs averaged over $20,000 ($\bar{x}$ = $20,005; WGFD 2004, WGFD unpublished data). The small amount of hay fed and the short feeding season of 2005-2006 resulted in a total cost of about $11,300 ($19.82 per elk) to the WGFD (WGFD unpublished data).

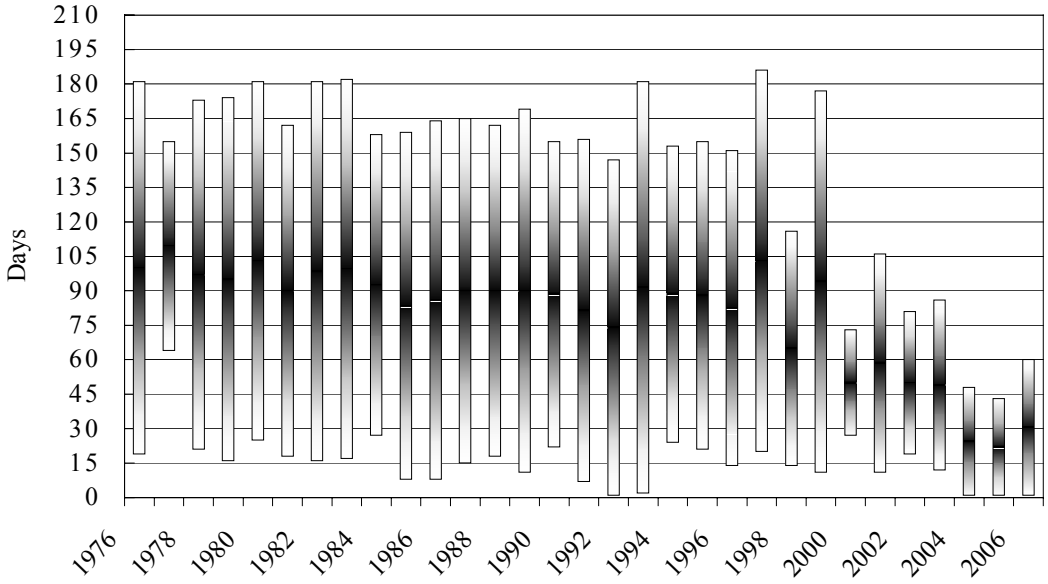

Figure 17. Beginning date, ending date, and days fed at North Piney feedground since 1975-76 (0 on y axis = 1 November).

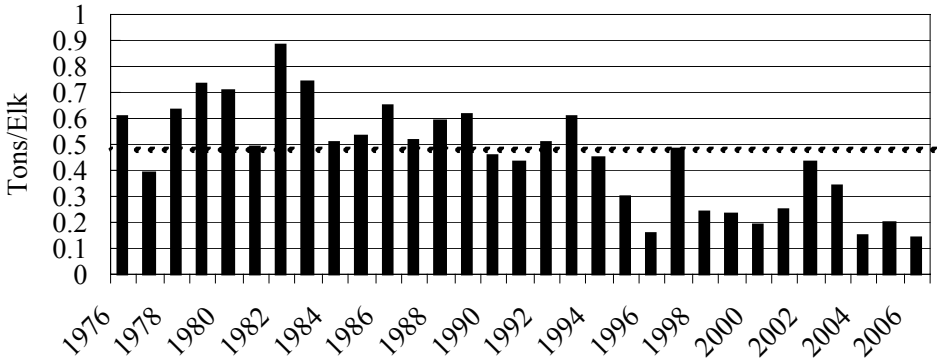

Figure 18. Maximum estimated tons of feed per elk per year at North Piney feedground since 1975-76. The dashed line indicates the long-term average for this feedground.

Table 12. Summary data from the North Piney feedground since 1975-76.

Year	# Elk	Tons Fed	Days	# Dead	Cost/Elk ($)	Tons/Elk
1975-76	420	256	156	1	42	0.61
1976-77	106	41	91	0	37	0.39
1977-78	400	250	156	2	44	0.63
1978-79	400	293	160	1	49	0.73
1979-80	394	279	167	1	50	0.71
1980-81	350	171	144	0	41	0.49
1981-82	332	252	156	2	74	0.88
1982-83	337	251	165	1	68	0.74
1983-84	374	192	136	4	48	0.51
1984-85	238	125	155	1	56	0.53
1985-86	288	187	164	1	62	0.65
1986-87	324	169	153	2	53	0.52
1987-88	397	233	147	1	64	0.59
1988-89	396	246	160	4	67	0.62
1989-90	468	216	134	2	57	0.46
1990-91	374	162	152	2	53	0.43
1991-92	396	203	148	0	61	0.51
1992-93	450	276	180	1	76	0.61
1993-94	534	241	136	0	42	0.45
1994-95	386	115	136	0	37	0.30
1995-96	*350 (0)	56	139	0	30	0.16
1996-97	*300 (215)	168	167	3	118	0.48
1997-98	*373 (22)	91	103	0	38	0.24
1998-99	*475 (86)	108	167	1	30	0.23
1999-00	*396 (0)	74	46	0	23	0.19
2000-01	*311 (22)	79	96	1	26	0.25
2001-02	*200 (0)	85	64	0	74	0.43
2002-03	*388 (0)	133	75	0	50	0.34
2003-04	*410 (0)	62	48	1	21	0.15
2004-05	*450 (0)	72	43	0	22	0.20
2005-06	*570 (0)	79	59	1	20	0.14
Average	374 (257) $^{\Psi}$	167	129	1.1	49	0.46

*Total elk counts since 1995-96 show the maximum elk present at North Piney before most of the herd moved to Bench Corral. The ( ) indicate the number of elk that remained after the herd left.

$^{\Psi}$The larger number indicates the number of elk that came to the feedground in autumn; the average number that remained throughout the winter are in parentheses.

5. Finnegan

Feeding was initiated on 1 November 2005 and continued until 1 May 2006, lasting for 183 days (Table 13, Fig. 19; WGFD unpublished data). Elk were fed at Finnegan for 184 days the previous winter (WGFD 2006). The long-term average is just 154 days at this feedground. WGFD personnel tallied 282 elk during the classification count; the long-term average is 329. The feedground quota is 400.

Finnegan feedground elk have received a maximum estimated average of 0.90 (2005-2006) and 0.99 (2004-2005) tons of hay per elk over the last two winters (Table 13, Figure 20; WGFD

2006). Each of these amounts was the most among feedgrounds for that year. The 0.99 tons per elk in 2004-2005 was the most ever fed to elk at a feedground over the course of a feeding season. The cost of feeding at Finnegan, per elk, in each of these years was correspondingly high. The $156 per elk incurred in 2004-2005 was the greatest amount ever recorded for the feedground program. The cost per elk in 2005-2006 at Finnegan was $141, while the overall feedground average was $68 (WGFD unpublished data).

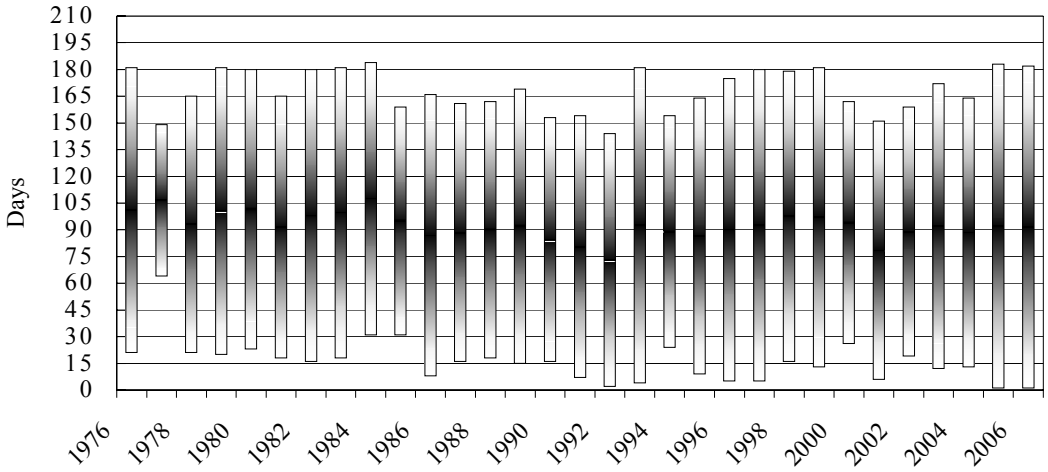

Figure 19. Beginning date, ending date, and days fed at Finnegan feedground since 1975-76 (0 on y axis = 1 November).

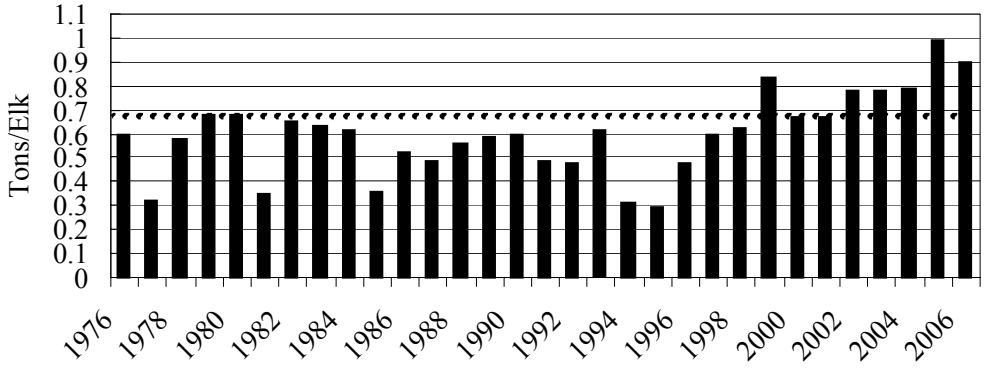

Figure 20. Maximum estimated tons of feed per elk per year at the Finnegan feedground since 1975-76. The dashed line indicates the long-term average for this feedground.

Table 13. Summary data from the Finnegan feedground since 1975-76.

Year	# Elk	Tons Fed	Days	# Dead	Cost/Elk ($)	Tons/Elk
1975-76	273	165	153	0	42	0.60
1976-77	81	26	85	0	47	0.32
1977-78	385	225	145	0	43	0.58
1978-79	425	287	166	0	46	0.68
1979-80	440	290	158	13	49	0.68
1980-81	356	126	146	2	32	0.35
1981-82	389	252	156	0	56	0.65
1982-83	285	180	164	0	61	0.63
1983-84	355	217	155	2	57	0.61
1984-85	274	98	129	2	36	0.36
1985-86	293	152	164	1	52	0.52
1986-87	287	142	148	0	52	0.49
1987-88	357	201	146	1	59	0.56
1988-89	404	237	160	3	59	0.59
1989-90	355	213	139	0	75	0.60
1990-91	327	161	150	1	60	0.49
1991-92	375	181	144	0	57	0.48
1992-93	386	243	178	2	77	0.61
1993-94	376	115	131	0	42	0.31
1994-95	389	111	156	0	38	0.29
1995-96	394	188	172	0	78	0.48
1996-97	450	271	177	0	87	0.60
1997-98	323	201	164	4	89	0.62
1998-99	281	234	169	1	106	0.83
1999-00	311	207	137	2	84	0.67
2000-01	290	194	147	0	94	0.67
2001-02	242	189	142	2	129	0.78
2002-03	234	170	160	0	109	0.73
2003-04	305	242	162	1	115	0.79
2004-05	264	261	184	4	156	0.99
2005-06	282	255	182	2	141	0.90
Average	329	195	154	1.4	72	0.60

6. Bench Corral/North Piney Cost Analysis

There are several presumed financial and disease-reduction benefits to shortening the feeding season at North Piney. Fully understanding the disease-reduction benefits of the shortened feeding season will require disease surveillance over a period of several years. One concern arising from the North Piney/Bench Corral situation, from a disease transmission standpoint, is that adding North Piney elk to the Bench Corral feedground would lengthen the collective feeding season of both feedgrounds. When combining data from both feedgrounds, however, the average length of the feeding season has been shortened since 1995-1996 (before: 148 days, since: 138 days; WGFD 2006). Most of the reduction has occurred during the end of the season. Since winter 1995-1996, the average end date (both feedgrounds combined) has been 31 March; prior to 1995-1996, the average end date was 15 April (WGFD 2004, WGFD unpublished data). For example, in the winter of 2005-06, feeding was initiated at North Piney on 1 November (much earlier than at Bench Corral), but feeding at Bench Corral was terminated on 28 March

(later than in previous years). Thus, we know that the length of time elk spend on these feedgrounds has been reduced. Through future surveillance efforts we will discover whether an associated decline in seroprevalence has resulted.

Financial benefits to the WGFD have already occurred. Using data from the feedground program, costs per elk at Bench Corral and North Piney feedgrounds have been reduced since 1995-96 (Fig. 21; WGFD 2004, WGFD unpublished data). The average cost/elk prior to 1995-96 is $46.04 while the average cost per elk since then has been $41.73. The lower expense per elk can be attributed to the shortened feeding season as well as a reduction in tonnage of hay fed per elk. The amount of hay fed per elk has actually been on a downward trend over the last thirty years (Fig. 22; WGFD 2006). This applies to all feedgrounds combined, as well as when North Piney and Bench Corral are treated as one unit.

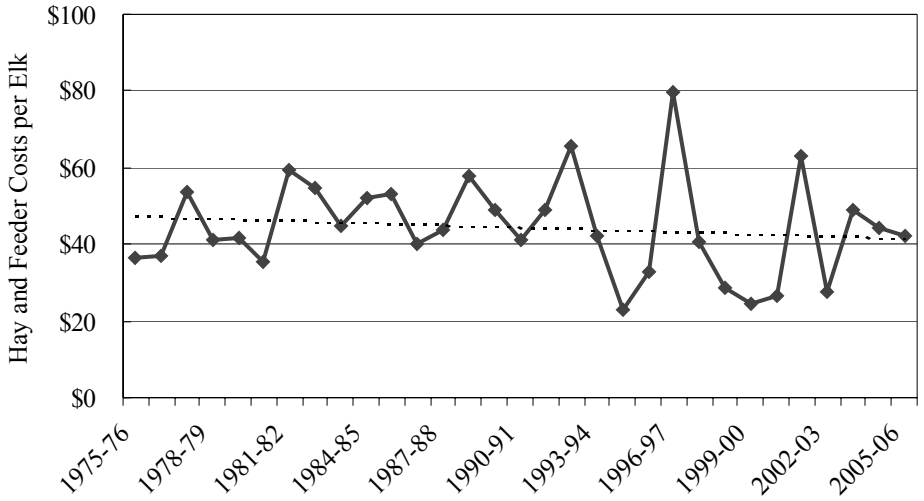

Figure 21. Costs per elk, since 1975-76, for the North Piney and Bench Corral feedgrounds combined. Costs include feeder compensation and hay, but do not include administration, management, or maintenance.

The actual amount of hay fed on these two feedgrounds has increased over time (WGFD 2006). Combining North Piney and Bench Corral feedgrounds, the average tonnage of hay consumed over all years has been 316 tons. Prior to 1995-1996, this value was 294 tons. Since 1995-1996 the average tonnage of hay fed has been 356. Thus, less hay has been fed per elk (Fig. 22) with a concomitant increase in the number of elk being fed.

The greater number of elk being fed has lead to an increase in actual annual cost of operating Bench Corral feedground (Fig. 23; WGFD 2004, WGFD unpublished data). Bench Corral costs (i.e., feeder and hay expenses) have increased from about $8,000 to $32,000 (Fig. 23). The average total cost of one winter of feeding at North Piney, meanwhile, has dropped from about $20,000 to $13,000 (Fig. 23).

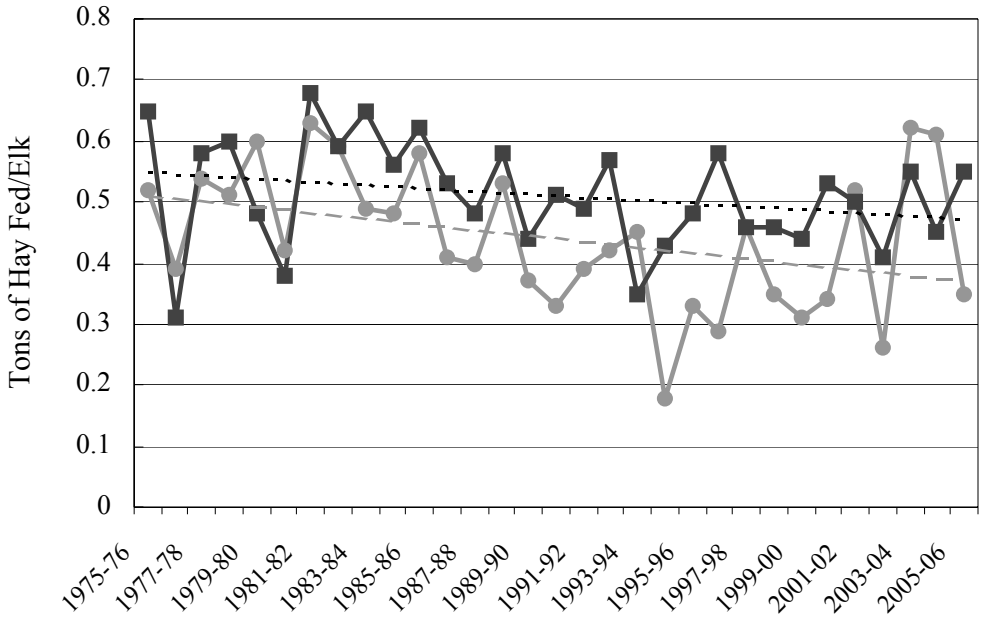

Figure 22. Maximum estimated tons of hay per elk for North Piney and Bench Corral feedgrounds combined (—) and for all feedgrounds combined (—).

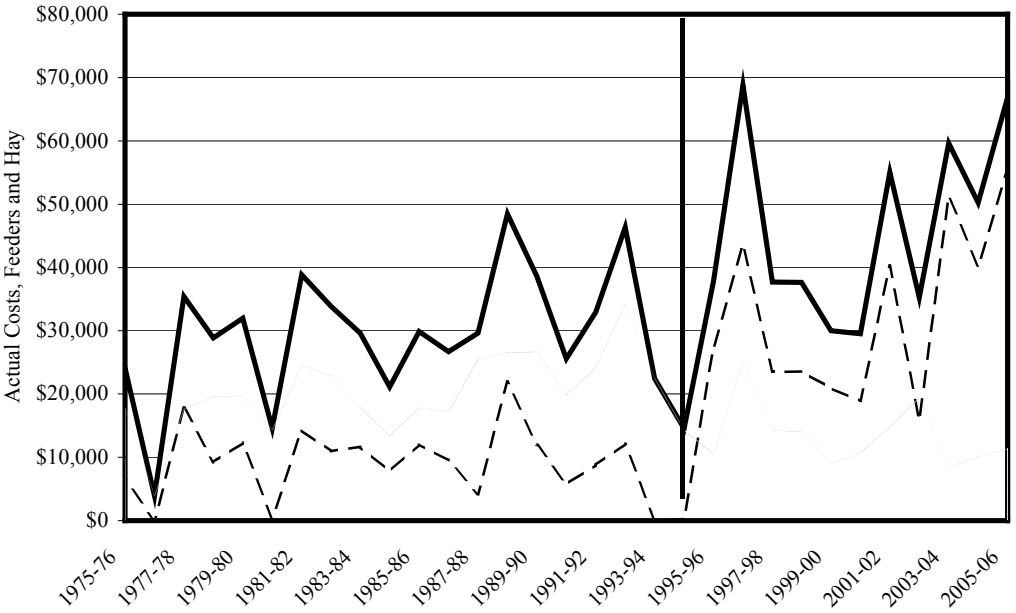

Figure 23. Actual costs (feeder compensation and hay combined) at Bench Corral (---), North Piney (…), and the two feedgrounds combined (—), since 1975-76. Costs do not include administration, management, or maintenance. The vertical line marks 1995-96; since that time most of the elk at North Piney have left for Bench Corral part way through the winter.

The reduction in costs, on a per elk basis, has occurred despite continued rising expenses for hay and feeder compensation (WGFD 2004, WGFD unpublished data). Actual costs incurred by WGFD for hay, hay delivery, and feeder's wages are well documented (Fig. 24). The expense to the winter feeding program of hay and its delivery has essentially doubled since the mid-1970s (Fig. 24). Natural inflation acting on the actual cost of operating the feedgrounds disguises the fact that costs per elk have been reduced for North Piney/Bench Corral.

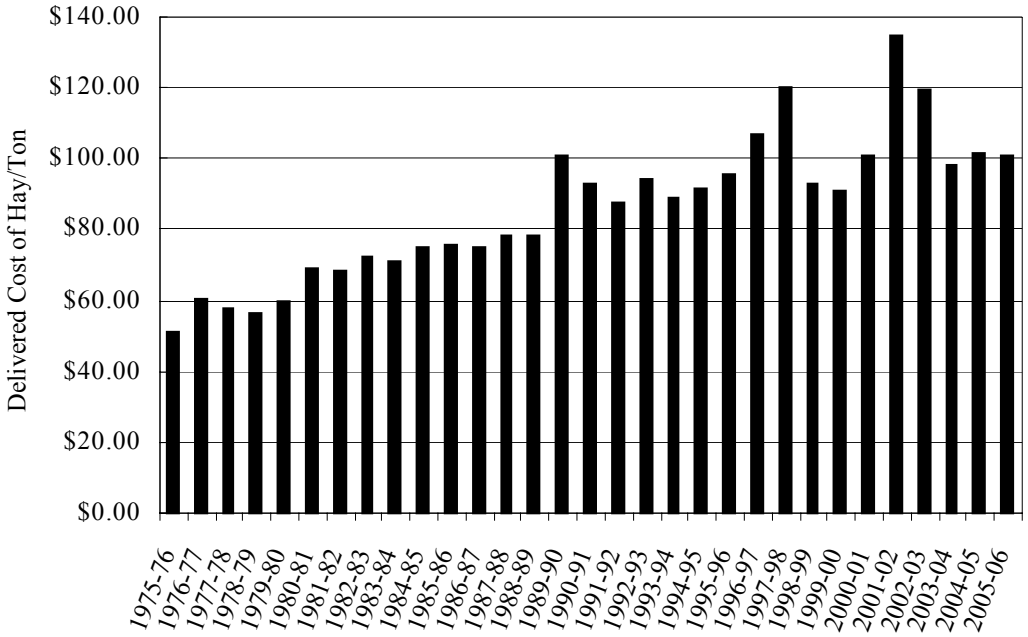

Figure 24. Average amount ($) WGFD has paid for hay and delivery since 1975-76 for the elk feedground program.

B. Feedground Operational Goals

On April 2, 1997, the Director of the WGFD issued a statement identifying feedground management goals:

1. Provide nutritional supplement to wintering elk that frequent elk feedgrounds
2. Prevent where possible, the co-mingling of elk on cattle and horse feedlines
3. Control brucellosis within elk on feedgrounds by vaccination
4. Minimize other damage conflicts on private lands

These directives do not differ from the Jackson/Pinedale Region's existing long-term objectives. Those objectives are to supplement the winter diet of elk in a manner that prevents excessive starvation, reduces risk of disease transmission to domestic livestock, and/or helps prevent damage to private property. Concurrently while accomplishing these objectives, opportunities to minimize the dependency of elk on supplemental feed have been taken.

Several management decisions must be made annually on each feedground. Depending on the situation, some decisions may be implemented and others may not. Some are in direct contrast with others; those given preference depend upon individual situations. The following are issues that should be considered at each feedground.

1. Can the dependency of elk on supplemental feed be reduced? Even though other issues may be given preference, reducing the dependency on feedgrounds should be considered when making all decisions regarding the operation of the feedgrounds. Reducing the length of the feeding season may reduce the spread of disease and will reduce feeding costs.
2. Does the feedground assist in preventing damage/co-mingling? Feeding elk is an effective method of keeping elk off of private property.
3. What can be done to keep feedground operating costs as low as possible? The amount of hay fed (influenced primarily by amount fed daily and the length of the feeding season) represents most of the cost to the feedground program. Any reduction in the amount of hay fed decreases the cost of the program.
4. How to feed in a manner that provides the most sanitary conditions? This usually involves keeping the feedgrounds as large as possible and feeding on fresh snow as much as possible.
5. Attempt to feed just enough to keep the elk in good body condition, but not low enough to compromise damage concerns. This level of feeding is less than what the elk can and will consume if offered more. Feeding should not be adjusted to attempt to keep old and/or crippled elk alive. A good rule of thumb is to feed enough to keep calves healthy for the first part of the winter, and then feed enough to keep pregnant cows in good nutritional condition during the later part of the winter. It is these two age groups (calves on the feedground and those that will be born in the spring) that are most susceptible to reduced nutrient intake.
6. Attempt to feed at rate that will satiate elk when the potential damage problems exist. This feeding rate is basically feeding "all they will eat" and is in excess of the physiological need of the animals, but the additional feed will keep the elk from wandering in search of more food (thus reducing the possibility of causing damage).

C. Feedground Operational Plans

Feedgrounds in the BPEHU serve primarily in damage/disease prevention. These feedgrounds are generally situated between summer ranges and the private holdings, which are located at lower elevations. Generally, as elk migrate from summer ranges (higher elevations) toward transitional and winter range (lower elevations) with the onset of winter, they can be enticed to stay on the feedgrounds by feeding them and, therefore, reducing conflicts with private concerns.

A considerable amount of area suitable for sustaining wintering wildlife exists in the herd unit. A large portion of the elk fed on these feedgrounds could perhaps free range during the winter months on the native ranges in Sublette and Sweetwater Counties. However, the high potential for damage and disease transmission to livestock in these areas precludes allowing elk to free range without close monitoring of their activities and location. When conflicts with private interests are likely, feedground management needs to be conducted in a manner that gathers and holds elk rather than allowing them to disperse.

1. Franz

This feedground is located on the Hoback Rim and prevents damage problems in the area. It has been used to hold elk over the winter that appear to have left/missed the Black Butte Feedground, elk that appear in the "40 Rod" area, as well as elk on nearby ranches. In recent years, elk from the McNeel feedground have moved into this area during the early winter months. Commission quotas allow for 450 elk.

a. Primary Management Issues

1. Begin the feeding operation early enough to hold elk in the area before they move onto private property and/or the desert, where they will eventually cause damage problems.

b. Secondary Management Issues

1. Some concern exists that this herd may grow in numbers because of the amount of private property in the surrounding areas where hunting is not allowed (especially to the general public). This situation is being monitored and addressed by incorporation of private lands into the Big Piney Hunter Management Area.

2. Jewett

Jewett feedground is located on a State section that is land-locked by private property. Existing livestock operations are several miles from the feedground. Commission quota is 650 elk.

a. Primary Management Issues

1. Feed in a manner that entices the elk to stay in the immediate area around the feedground and discourages them from moving onto private property.

b. Secondary Management Issues

1. None.

c. Management Suggestions/criteria

1. This area seems to offer an opportunity to allow elk to free range prior to feeding. However, experience has shown that allowing elk to free range can result in some leaving the area and ultimately causing damage. While it is enticing to promote free ranging elk at this feedground, it comes at the risk of elk leaving the area. The best way to eliminate much of the potential for having elk co-mingle with livestock or cause damage is to feed them as soon as the arrive following the hunting season.
2. Feeding can be terminated as soon as elk begin wandering from the feedground and adequate residual/new growth is available.

3. Bench Corral

This feedground is located on a State section surrounded by BLM administered lands. The area is dominated by sagebrush habitat that offers considerable native forage during the winter months. Also, snowfall in this area is relatively low. As a result, this feedground typically has the shortest feeding season of all feedgrounds, which also results in the lowest cost of feeding elk. The opportunity to encourage free ranging elk exists at this feedground, although the elk activity and location must be closely monitored. These elk could move great distances in a relatively short time and could easily and quickly cause significant damage problems if allowed to leave the area. Commission quota is 250 elk.

a. Primary Management Issues

1. The location of this feedground is such that it allows the Department keep elk in this area that have moved past other feedgrounds and/or onto the desert (keep them from moving east and crossing HWY 189). Feeding the elk here keeps them from moving on to private property.
2. Keep enough hay on hand to feed the North Piney elk, should they move onto this feedground.
3. Feed the elk before they move east of the feedground and/or north of Muddy Creek.

b. Secondary Management Issues

1. Opportunities to encourage free ranging elk exist on this feedground. Monitor elk activities closely and capitalize on these when possible.

c. Management Suggestions/criteria

1. Feeding should begin when elk move onto the feedground and immediate area and native forage availability/elk behavior indicates that they may leave the area.
2. When elk begin wandering from the feeding area in the spring signals the time to reduce the amount fed and indicates that termination of feeding is near. Elk from this feedground generally stay above the snowline as they migrate west.

4. North Piney

The reasoning that drives the feeding operation at North Piney has changed several times in the past few years and will be changed with development of this BPEHU BMAP. The elk that typically wintered on this feedground were baited to the Bench Corral Feedground during the winter of 1995-96 in an effort to eliminate the North Piney feedground. The elk have voluntarily moved to Bench Corral most years since then which has reduced feeding costs and increased the days that the elk free range. However, because of concerns of overgrazing and pressures by environmental groups to reduce livestock grazing in the area, the livestock industry originally asked that both feedgrounds be operated as they were prior to 1995-96. As a result, the emphasis on feeding at North Piney was done in a manner to prevent elk from migrating to Bench Corral.

Following input from WGFD personnel, livestock permittees, land management agencies, responses from the Producer Questionnaire, and analyses of forage utilization data from the Bench Corral public grazing allotments, WGFD personnel have proposed to reclassify North Piney as a "staging area/feedground" and allow elk to voluntarily migrate from North Piney to Bench Corral. Elk that leave North Piney will not be hazed back but allowed to migrate to Bench Corral feedground. Establishing a "cut-off" date for feeding and/or encouraging elk to leave North Piney with various methods (e.g., baiting to Bench Corral, reducing amount of hay fed per day, hazing) may be pursued following future re-evaluation of conditions at North Piney. Commission quotas allow for 400 elk.

This feedground sets adjacent to private property, and several working cattle ranches exist in the area. Elk that move to private property can be very difficult to either chase or bait to a feedground because of the nature of the vegetation and topography in the area.

a. Primary Management Issues

1. Feed in a manner that prevents elk from migrating on to private property when initiating feeding in the early winter.
2. If the elk leave the feedground during the winter, Department will not attempt to herd them back to the feedground.
3. The elk feeder must be informed prior to hiring that the duration of the job is dependent on elk being present at the feedground in large enough numbers to justify feeding them. If the elk leave, the job will probably be terminated.

b. Secondary Management Issues

1. Continue to work with all concerned interests to allow these elk to migrate onto Bench Corral feedground.

c. Management Suggestions/Criteria

1. Monitoring bales of good quality alfalfa should be placed on the feedground as soon as the hunting season ends (usually mid-November) in an attempt to hold elk from migrating on to private property.
2. Should the elk leave North Piney and move toward Bench Corral, they should not be herded back to North Piney.
3. If the elk leave, the draft horses should be walked out promptly or they might get snowed in at the feedground until spring.
4. If the elk do not leave North Piney, the feeder(s) must ensure that adequate amounts of good quality feed are fed each day and properly distributed so that all elk can receive enough to eat to satisfy their appetites.
5. If the elk do not leave the feedground, feeding in the spring should cease as soon as enough native forage (new growth and/or residual) is available to hold the elk from moving to private property.

5. Finnegan

This feedground sets on BLM administered lands, and WGFD has an easement to this feedground through private property. This same landowner has no tolerance for elk on his private property. Elk that migrate beyond this feedground may cause damage problems. Commission quota is 400 elk.

a. Primary Management Issues

1. Feed the elk in a manner that keeps them on the feedground and off the adjacent ranch. This usually means starting feeding early in the season and continuing it until enough new growth exist to entice the elk to move away from the private property.

b. Secondary Management Issues

1. None.

c. Management Suggestions/criteria

1. Monitoring bales should put out at this location near the end of the hunting season (around mid-November).
2. Feeding should continue in the spring until the elk quit eating the hay and move to higher elevations.

D. Brucellosis Management Summary

1. Vaccination

a. Franz

Vaccination was completed at this feedground for the ninth consecutive year. In the winter of 2006, 160 calves of 165 classified (97%) were successfully vaccinated (Table 14). A total of 979 juveniles and 545 adult females have been vaccinated on this feedground since the program was initiated in 1996.

b. Jewett Feedground

Strain 19 vaccination was completed for the ninth consecutive winter at this feedground with excellent results. In 2006, 100% calf coverage was achieved, with 166 calves receiving a dose (Table 14). The nine-year total for this feedground is 1,426 juveniles and 304 adult females.

c. Bench Corral Feedground

The strain 19 vaccination program was implemented at this feedground in 1997. Due to mild winter conditions, no vaccinations took place in 2000 or 2001, and both adult female and juvenile elk were vaccinated in 2002 (Table 14). Calf vaccination only resumed in 2003 with a coverage of 63%, attributed to mild winter conditions and adjacent native winter range which decreases dependence on artificial feed and reduces crowding. In 2004, 100% of calves were successfully vaccinated. This winter, 166 of 244 calves were successfully inoculated (68% of classified). A portion of the wintering population arrives at this feedground each year from the North Piney feedground after the classification counts are completed. Thus, the total number of elk on the feedground at the time of vaccination is a rough estimate. The total number of vaccine doses administered to elk at this feedground since 1997 is 2,090.

d. North Piney

Because elk normally leave this feedground for Bench Corral (Table 14) prior to the initiation of vaccination activities on most other feedgrounds (i.e., mid-late January), elk have not been vaccinated on the this feedground and are presumed to be vaccinated at Bench Corral.

e. Finnegan Feedground

A total of 78 of 53 classified (>100%) juveniles were vaccinated during a three-day period in mid February 2006 (Table 14). This was the tenth consecutive winter for vaccination at this feedground. Since 1996, a total of 882 juveniles and 172 adult females have been vaccinated.

Table 14. Summary of vaccination (2000-2006) for feedgrounds on the BPEHU.

		Classification			Calves Vaccinated	
Year	Feedground	Calves	Females	Total Elk	Number	% of Classified*
2000	Finnegan	77	205	300	77	100%
2000	Franz	86	269	467	83	97%
2000	Jewett	110	271	530	139	>100%
2000	North Piney**	0	0	0	n/a	
2000	Bench Corral[φ]			837	1	
2001	Finnegan	75	197	290	76	>100%
2001	Franz	105	281	550	105	100%
2001	Jewett	167	421	670	179	>100%
2001	North Piney**	0	0	0	n/a	
2001	Bench Corral	162	442	700	0	
2002	Finnegan	46	171	242	57	>100%
2002	Franz	96	298	571	99	>100%
2002	Jewett	162	428	675	163	>100%
2002	North Piney**	0	0	0	n/a	
2002	Bench Corral[ψ]	150	400	550	150	78%
2003	Finnegan	50	167	234	55	>100%
2003	Franz	81	279	466	63	78%
2003	Jewett	119	328	523	120	>100%
2003	North Piney	0	0	388	n/a	
2003	Bench Corral	198	564	882	124	63%
2004	Finnegan[$]	28	156	303	61	>100%
2004	Franz	100	233	428	97	97%
2004	Jewett	177	470	750	179	>100%
2004	North Piney**	0	0	0	n/a	
2004	Bench Corral	150	520	813	158	>100%
2005	Finnegan	72	163	264	73	>100%
2005	Franz	136	306	545	136	100%
2005	Jewett	170	404	678	170	100%
2005	North Piney**	0	0	0	n/a	
2005	Bench Corral	153	431	680	156	>100%
2006	Finnegan	53	199	282	78	>100%
2006	Franz	165	372	700	160	97%
2006	Jewett	142	369	622	166	>100%
2006	North Piney**	0	0	0	n/a	
2006	Bench Corral	244	525	1010	166	68%

* >100% coverage suggests some yearlings may have received S19 dose.

** Elk left North Piney for Bench Corral.

[φ] Elk not classified.

[ψ] Classification is estimated; about 200 elk arrived after counts were completed.

[$] 98 animals not classified.

2. Serology

The WGFD initiated brucellosis surveillance of elk on the Greys River feedground and National Elk Refuge in 1971 to monitor the distribution and prevalence of the disease. Currently, BFH and other WGFD personnel trap, bleed, and test elk on 4 to 6 feedgrounds annually. Several thousand (4,272) yearling and adult female elk trapped on 21 different feedgrounds have been tested to date (post-winter 2005-06).

Seroprevalence is determined by use of four tests as determined by the Animal & Plant Health Inspection Service (APHIS 1998). The following four tests are used to determine if an animal is seropositive: 1) Card test, 2) Standard plate agglutination (SPT) test, 3) Complement-fixation (CF) test, and 4) Rivanol test. An animal is considered "seropositive" if 1) either two or more tests react at certain dilution rates, or 2) if the CF test alone shows a reaction at a dilution rate of 2+ 1:20 or higher. The criteria used to determine what is called a positive reactor (positive) for the four serology tests is as follows: 1) Card – positive or negative (no dilution), 2) SPT - 1:100 dilution or greater, 3) CF - 2+ 1:20 dilution or greater, 4) Rivanol - 1:25 dilution or greater.

Once serostatus is determined using the four standard tests, another test called cELISA (competitive enzyme-linked immunosorbent assay) is conducted on seropositive animals to differentiate between Strain 19 vaccine and field strain *Brucella abortus*. Procedures for this test are described by Van Houten et al. (In Press). Based on cELISA, seroprevalence levels range from 13% to 37% (Table 15). Determining if an animal is actually infected with *Brucella abortus* is accomplished only by removing select tissues (e.g., the reproductive tract and/or lymph nodes surrounding the reproductive tract) from the suspect animal and culturing the bacteria from these tissues.

Dell Creek feedground is the only state-operated feedground where elk vaccination is not conducted. Distribution data of elk from this feedground suggest little interchange with surrounding feedgrounds, thus providing a suitable control to compare elk vaccination efficacy with other feedgrounds. Brucellosis surveillance was initiated on Dell Creek in 1989, and has since been conducted from 1998-2006. Serology data using cELISA (Table 16) indicate *Brucella* seroprevalence averages 29% (+/- 13.8) on Dell Creek, and has fluctuated from 8% in 2004 to 50% in 1999. More data are needed on all feedgrounds within the BPEHU to more accurately assess efficacy of the Strain 19 vaccination program.

Table 15. Number of yearling, adult, total female, and % seroprevalence of elk tested on the BPEHU feedgrounds as determined by 4 standard tests and cELISA.

		# Tested			% Seroprevalence	
Feedground	**Year**	**Yearling**	**Adult**	**Total**	**4 Standard**	**cELISA**
Finnegan	1982	5	9	14	0%	*
	1983	4	10	14	0%	*
	1984	2	1	3	33%	*
	1989	2	11	13	0%	*
	2001	13	20	33	30%	18%
	Sum	**26**	**51**	**77**	**14%**	**N/A**
Franz	1983	2	24	26	54**%**	*
	1984	6	9	15	20**%**	*
	1985	5	13	18	17**%**	*
	2003	10	41	51	41**%**	37%
	2005	13	22	35	34**%**	34%
	Sum	**36**	**109**	**145**	**37%**	**36%**
North Piney	1990	2	19	21	29%	*
	1991	10	11	21	10%	*
	Sum	**12**	**30**	**42**	**19%**	**N/A**
Bench Corral	2006	0	32	32	19%	13%

* cELISA test not conducted

Table 16. Yearly % seroprevalence (number of elk sampled) as determined by the cELISA test on Dell Creek, Finnegan, Franz, and Bench Corral feedgrounds. Total seroprevalence is included for feedgrounds that have been tested multiple years.

Year	Dell Creek*	Finnegan	Franz	Bench Corral
1998	26 (34)			
1999	50 (36)			
2000	45 (22)			
2001	26 (35)	18 (33)		
2002	35 (34)			
2003	37 (30)		37 (51)	
2004	8 (36)			
2005	18 (34)		34 (35)	
2006	17 (30)			13 (32)
Total	**29% (291)**		**36% (86)**	

*Elk have never been vaccinated at this feedground; this feedground is used as the "control" for assessing efficacy of vaccination (i.e., treatment) on seroprevalence.

3. Prevention of Elk/Cattle Commingling

Annually, WGFD personnel employ a variety of damage control techniques to maintain spatial and temporal separation of elk and cattle. The WGFD has a long-standing practice of providing game-proof stackyard fencing to private producers to prevent elk from depredating privately owned stored hay crops and to discourage elk from frequenting cattle feeding areas. By preventing elk from establishing feeding patterns in cattle wintering areas, the potential for interspecific brucellosis transmission may be diminished.

a. Stackyards

Since 1992, elk-proof fencing materials for 176 haystacks (as of May 2006) have been provided by WGFD personnel to cattle producers in Lincoln, Sublette, and Teton counties in western Wyoming. Since 2005, WGFD personnel have distributed materials for at least 3 permanent stackyards in BPEHU.

b. Hazing/Hunting

In some instances, elk are hazed from cattle feeding sites. These animals are removed from areas of conflict via snowmobiles or aircraft to WGFD feedgrounds. In other cases, when the aforementioned management actions fail to achieve desired results, special depredation hunting seasons or kill permits are employed to remove problem animals (Appendix 1, Section A-2). In the BPEHU, WGFD personnel have worked with private landowners and producers to establish the Big Piney Hunter Management Area (HMA; BMAP, Fig. 1). Since its inception in 2000, the Big Piney HMA has likely reduced the amount of damage complaints and expenditures incurred by WGFD while increasing hunting opportunities.

c. Elk Parturition Area Overlap with Public Grazing Allotments

Since 1999, BFH personnel have monitored areas where elk parturition areas overlap with public grazing allotments that "turn on" prior to 15 Jun (Fig. 25). During the elk calving period from late May to mid June, a potential risk of brucellosis transmission to cattle on overlapping ranges exists. Twelve public land grazing allotments in 3 counties have been identified as potential risk areas. Eleven of 12 risk areas showed no elk/cattle interaction from 1999-2006. To date, no commingling situations have been documented on any of the 6 allotments overlapping with WGFD delineated parturition areas on the BPEHU. Coordination and education efforts with land managers and grazing operators will be initiated to resolve elk/cattle interaction if and when conflict areas are identified.

Additionally, 29 elk from Bench Corral feedground were implanted with vaginal radio transmitters (VITs) in winter of 2005-2006 to document abortion/parturition locations. One abortion from a seronegative female was documented on the feedground on 17 February 2006. Only 4 of the remaining 25 relocated VITs were located on areas delineated by WGFD personnel as parturition habitat (Fig. 25). No VITs were located on areas currently inhabited by cattle.

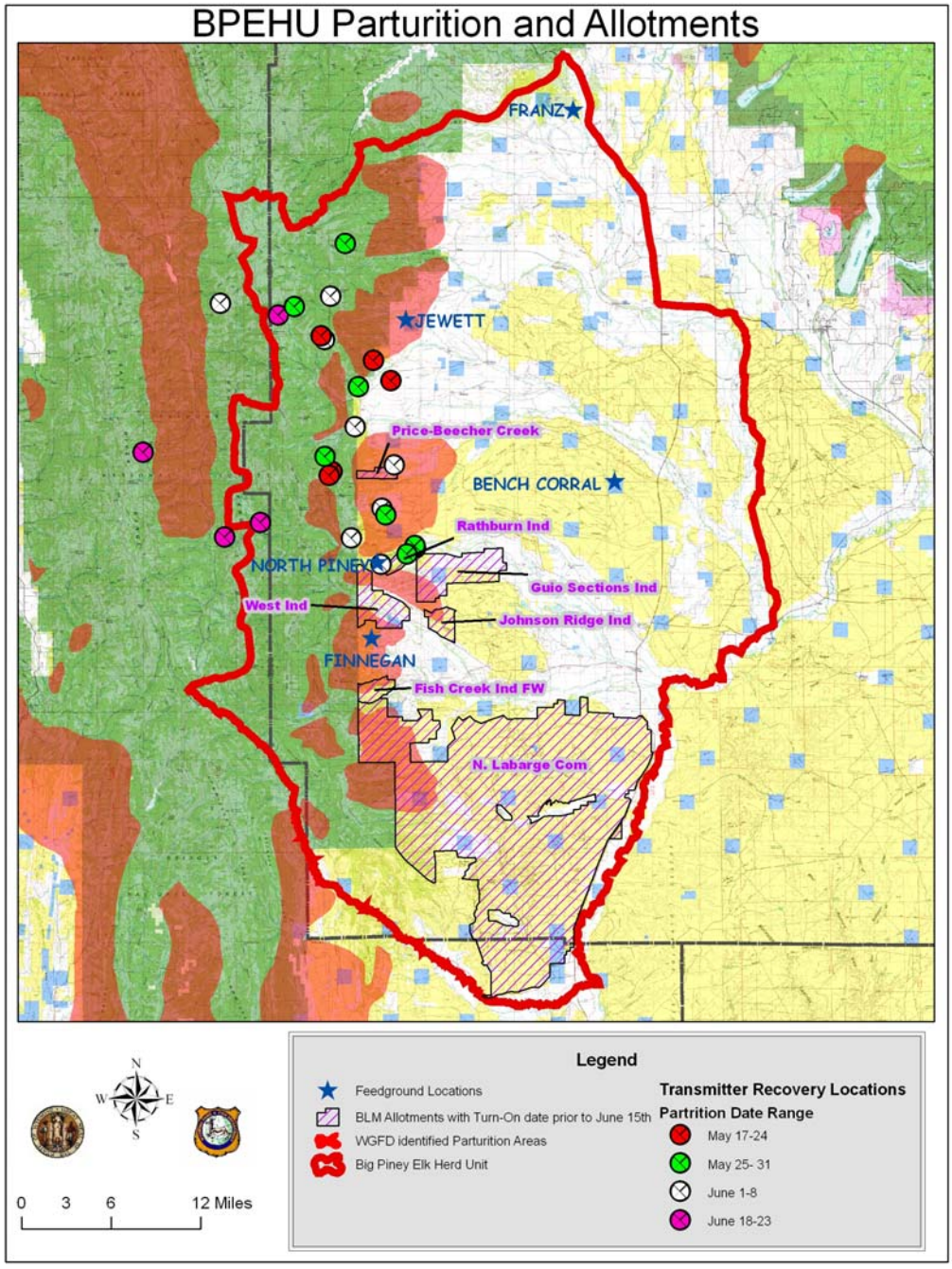

Figure 25. WGFD-delineated parturition areas, locations of parturition sites of 25 female elk implanted with vaginal radio transmitters, and overlap with public grazing allotments with turn-on dates prior to 15 June on the BPEHU.

4. Biological Control - Scavenging

Several WGFD personnel working with feedgrounds have suggested that retaining viable populations of scavengers on and adjacent to feedgrounds may increase the scavenging rate of aborted fetuses. Ultimately, this "biological control" likely reduces the risk of intra-specific transmission of brucellosis. In March 2005, 6 pseudo-aborted fetuses and respective placentas (hereafter termed fetal unit) were placed on Franz feedground to determine how quickly fetal units were removed from the feedground. During this study, fetal units were removed from 3.33hr to 24hr (mean = 14.9hr) after placement on the feedground; coyotes and eagles were considered the primary scavengers. In March and April 2006, 29 fetal units were distributed among and placed on Franz, Soda Lake, Muddy Creek, and Alpine feedgrounds, and 4 fetal units were place in Buffalo Valley (non-feedground), northeast of Jackson, WY. Mean scavenging rate on the feedgrounds was 18.99hr vs. 33.37hr in Buffalo Valley, suggesting that scavengers are actively selecting feedgrounds as feeding sites and likely reducing risk of intra-specific transmission of brucellosis. Coyotes and eagles were identified again as primary scavengers with the addition of foxes. Based on the results of these two studies, scavengers are likely a viable form of biological control for brucellosis. Control of scavengers on and adjacent to feedgrounds should be prevented.

E. Literature Cited

Animal & Plant Health Inspection Service. 1998. Brucellosis in *Cervidae*: Uniform Methods and Rules, Effective September 30, 1998. APHIS 91-45-12.

WGFD. 2006. Annual Big Game Herd Unit Job Completion Report (2005) for the Piney Elk Herd Unit (E106), Jackson/Pinedale Region. Cheyenne, WY. 29 pp.

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APPENDIX 3
HABITAT MANAGEMENT

A. Feedground Habitat Assessment

1. Factors Affecting Vegetative Change on Feedgrounds (excerpt, WGFD 2006)

WGFD feeds between 14,000 and 17,000 elk at 22 different locations each winter. Concentrating large numbers of elk on relatively small areas for 70 to 180 days each winter causes vegetative changes to those areas receiving heavy use. The effect that feedground elk have on vegetation (e.g., browse use, species richness/diversity) is dependent on several factors (listed below).

a. Vegetation type present prior to the establishment of the feedground.
Feedgrounds established on land under cultivation (e.g., hay meadows) have little, if any, vegetation changes occurring on the feedground proper, although changes typically occur to adjacent areas. Feeding sites in areas dominated by woody plant species show the greatest change.

b. Snow depths.
Snow depths at some feedgrounds affect vegetation change. Deep snow can restrict elk movements, limiting the size of the area used/inhabited by elk during the winter. Vegetation that is accessible to elk during winter feeding can receive heavy utilization. However, deep snow may protect low growth forms of native shrubs and herbaceous plant species on and near feeding sites.

c. Density of elk on the feedground.
Feedgrounds concentrate populations of elk (250 to ≥ 1000 animals) on feeding areas varying from 15 acres (Muddy Creek) to 145 acres (South Park) during a substantial portion (90 days to 160 days) of the winter. High numbers and/or densities of elk typically impact vegetation change on the feedground proper more than areas surrounding the feedground.

d. Productivity of the site.
This is related to vegetation present at the site. Again, feedgrounds established on land under cultivation (e.g., hay meadows) have little, if any, vegetation changes occurring on the feedground proper, although changes typically occur to adjacent areas. Feeding and loafing areas on shallow soils and/or dry south slopes are more susceptible to loss of native shrubs and invasion of weeds than are those on more productive sites.

e. Length of the feeding season.
Promoting elk to free range by delaying feeding in the early winter and/or terminating feeding early in the spring increases the use on areas near the feedgrounds. Implementation of broad-scale habitat enhancement projects adjacent to feedgrounds can reduce this impact.

f. Total years a site has been used as a feedground.
Vegetation change occurs with each successive year that a site is used. The vegetation that is present (e.g., grasses, forbs) may not be affected by the additional use, or may be overutilized (e.g., shrubs), resulting in plant death. Palatable tree species such as aspen and cottonwood often survive if established in larger (≥ 10ft) growth forms. Young sprouts (i.e., suckers) of these species often receive heavy utilization and either do not survive or form stunted, "hedged" growth forms.

2. General Assessment of Vegetative Change Associated with Feedgrounds (excerpt, WGFD 2006)

Feedground elk foraging/behavior patterns and subsequent vegetative changes can be grouped into general categories (listed below).

a. Feeding area.

This is the area where hay is spread and varies from 15 acres at Muddy Creek to 145 acres at South Park. A total of 1,258 acres are used for this purpose, or an average of 57 acres per feedground. Commonly, most native herbaceous and woody species are replaced by introduced perennial grass species. Plant species diversity may be limited to a single grass species. Some feedgrounds, particularly those with deep snow conditions and/or large feeding areas, may retain many native species.

Grass production in these areas is generally much greater than was present before the establishment of the feedground and provides large quantities of forage. Some of these sites (South Park, Camp Creek, Grey's River) are productive enough that the WGFD has harvested hay in previous years. Production of 2,000 to 6,000 lbs of forage per acre (1-3 ton per acre) is common on areas where elk have been fed and the vegetation converted into a grass type. The large amount of grass production commonly serves as an attractant to cattle grazing.

b. Waste areas.

These are areas where large amounts of manure collect and/or vehicle travel has disturbed the area to the point that no vegetation or only weedy species are present. The depth of manure can increase to the point that precludes plant life or provides conditions only for specially adapted plants (normally weeds). Also, areas can be disturbed (tractor activity during normal feeding operations) to the point that native species are killed and replaced by invading plants (annual weeds). Waste areas are not present on all feedgrounds. When present, these areas tend to be less than one acre, although feedgrounds with small feeding areas (Muddy Creek, Scab Creek) supporting large numbers of elk have larger waste areas. Waste areas can be found on the feeding area and/or loafing areas.

c. Loafing areas.

Elk tend to select a site where they "loaf" or spend "idle" time when not eating hay. Elk spend much of their time on these areas, and vegetation use can be substantial. These areas vary in size (estimated 1 to 40 acres), location (may or may not be on the feedground proper), and appear to be related to snow depths and the location of cover (if present). When loafing areas are off the feeding area, they are immediately adjacent to the feeding area. Shrubs may be killed or severely hedged. Bark on trees may be eaten or rubbed off, which may kill some trees. Areas receiving this type of use are also seen on some native ranges caused by elk not associated with feedgrounds.

Conifers are invading aspen stands at some locations. Reproduction of woody species in these areas is nearly non-existent, unless it is a low growth form that is protected by snow. The amount of herbaceous plant production present depends largely on the productivity of the site. Most areas having deep soils produce large quantities of herbaceous forage, commonly grasses.

d. Transitional areas.

Transitional areas are commonly within 1/2 mile of the feedground. These areas provide native forage to elk as they migrate into the area before feeding is initiated in the early winter and as they search for native forage as the snow leaves in the spring. There may be a reduction in the

frequency and production of some plant species that are native to the area (*e.g.*, shrubs, suckers), and an increase in the frequency and production of some other native plant species (e.g., native and non-native herbaceous species).

Determining the size of these areas and the effects of feedground elk are often complicated because of use by other wild ungulates. These areas tend to be highly irregular in shape, complicating boundary delineations and acreage calculations. The areas most affected are those along migration routes. Areas adjacent to feedgrounds, but not in migration paths, commonly show some vegetation change associated with feedground elk.

Delaying feeding in the early winter and/or terminating feeding early in spring may increase forage utilization on transitional areas. Most heavy to severe browse utilization by feedground elk is believed to occur within ¼ to ½ mile of feedgrounds.

3. Wyoming Range Feedground Habitat Assessment (excerpt, WGFD 2006)

Per Director Cleveland's request of a qualitative assessment of habitat conditions on and adjacent to elk feedgrounds in western Wyoming, all feedgrounds (Franz, Jewett, Bench Corral, North Piney, Finnegan) along the east slope of the Wyoming Range were visited on 17 and/or 19 June 2006. At each feedground, BFH personnel spent approximately 1 hr visually assessing the conditions (presence/absence, age category, browse use) of all habitat on and up to 1.25 mi from the feeding area (i.e*.,* feedline). Habitat conditions beyond 1.25 mi were not assessed because of logistic constraints.

Feedlines of all feedgrounds are generally on large, relatively flat (0 – 5% slope) areas. Land ownership of these areas ranges from State (Jewett, Bench Corral) to BLM (Franz, North Piney, Finnegan). On feedlines, mountain big (*Artemesia tridentata* var. vaseyana), Wyoming big (*Artemesia tridentata* var. wyomingensis), and/or silver (*Artemesia canescens*) sagebrush were not present likely from trampling and compacting by tractors, feed sleighs, wagons, horses, and/or elk. Trees such as aspen (*Populus tremuloides*) and chokecherry (*Prunus virginiana*) and other shrubs such as antelope bitterbrush (*Purshia tridentata*), buffaloberry (*Sheperdia* spp), snowberry (*Symphoricarpos occidentallis*), Wood's rose (*Rosa woodsii*), sticky currant (*Ribes viscosissmum*), serviceberry (*Amelancher alnifolia*), shrubby cinquefoil (*Potentilla fruticosa*), and willow (*Salix* spp.) were not present likely because of soil and precipitation constraints. Grass and forb production in these areas ranged from good to excellent depending on precipitation zone (i.e*.,* lowest at Bench Corral, assumed native winter range; highest at Franz).

In areas immediately adjacent (0 – 0.25 mi) to feedlines, sagebrush was present, typically in mature to decadent age classes with little/no browse use. Snowberry, buffaloberry, and shrubby cinquefoil were often present, typically in mature and decadent age classes with browse use ranging from none to moderate/heavy, usually for snowberry and buffaloberry. Antelope bitterbrush was present only on rocky, south-facing slopes in mature age class with no to low browse use. Wood's rose and sticky currant were often present in mature and decadent age classes with browse use ranging from low to moderate/heavy. Serviceberry and willows were often present, usually in mature and decadent age classes and browse use ranging from moderate to severe. Chokecherry was typically heavily to severely browsed (estimated >75% terminal leaders). Aspen taller than 10 ft were severely "barked", and most stands exhibited poor suckering (estimated 250 – 500 stems/ac). Of all suckers present, most (estimated > 90%) were browsed and had a "hedged" or "medusa" body form. All aspen stands on north-facing exposures were encroached severely by subalpine fir (*Abies lasiocarpa*). At Franz feedground,

subalpine fir within this area were browsed heavily to severely. Grass and forb production for all feedgrounds in this area (0 – 0.25 mi) again ranged from good to excellent (except in dense conifer or conifer/aspen stands) depending on precipitation zone.

From 0.25 mi to 0.75 mi from feedlines, sagebrush was present, typically in mature to decadent age classes with little/no browsing. Browsing of all shrubs, particularly snowberry, buffaloberry, Wood's rose, sticky currant, and willows decreased to low or moderate levels. Use of serviceberry and chokecherry remained heavy to severe with many serviceberry plants appearing hedged. Barking of aspen taller than 10 ft decreased to moderate/heavy, and suckering ranged from an estimated 200 to 3000 stems/ac. Browsing appeared to decrease slightly, ranging from 30% to greater than 90%, likely dependent on whether the stand was in or out of a "loafing" or "security" area adjacent to the feedground. Again, all aspen stands on north-facing slopes were encroached severely by conifers. Grass and forb production in this area again ranged from good to excellent (except in dense conifer or conifer/aspen stands) depending on precipitation zone.

From 0.75 mi to 1.25 mi from feedlines, sagebrush was present, typically in mature to decadent age classes with little/no browsing. Browsing of snowberry, buffaloberry, Wood's rose, sticky currant, decreased and ranged from no to low/moderate levels. Browsing of serviceberry and chokecherry remained heavy to severe with many plants appearing hedged. Use of willows was not visibly apparent. Barking of aspen taller than 10 ft decreased and ranged from low to moderate, and suckering ranged from an estimated 500 to 3000 stems/ac. Browsing of aspen again decreased and ranged from an estimated 40% to 60%. Again, all aspen stands on north-facing slopes were encroached severely by conifers. Similar to those areas closer to feedgrounds, grass and forb production in this proximity ranged from good to excellent (except in dense conifer or conifer/aspen stands) depending on precipitation zone.

Noxious weeds were not apparent at most feedgrounds. At North Piney, however, a small (estimated < 0.25 ac) patch of cheatgrass (*Bromus tectorum*) was found about 0.25 mi NNW of the feedline.

B. Habitat Enhancements & Monitoring Data

1. Justification & Overview of Habitat Enhancement Projects

Wildlife habitats in western Wyoming have been modified through fire suppression, urban expansion, oil and gas development, and other anthropogenic practices during the past century (WGFD 2001). Historically, disturbances (primarily wildfire) maintained health and diversity of vegetation communities. Many communities, such as aspen and sagebrush, are dependant upon fire for regeneration (Wright and Bailey 1982). Fire frequency has been suggested to occur on 32 to 70-year intervals for sagebrush (Houston 1973), and 80 to 100-yr intervals for aspen (Schier 1974).

Habitat enhancement projects can be employed to mimic natural disturbances, create a mosaic of multi-aged plant communities, and restore habitat to a more properly functioning condition across the landscape (Stroud 1990). WGFD personnel cooperate with other agencies to implement habitat enhancement projects that restore or create vegetative diversity, increase forage (herbaceous and browse) production, and improve range conditions for myriad species (WGFD 2001). These projects involve identification of treatment areas, approval of land

management agencies and/or livestock permittees, acquisition of funding, habitat inventory, implementation, and pre- and post-treatment monitoring.

The primary goal of the "Habitat" approach of the BFH program is to enhance transitional and winter elk habitat to minimize the transmission and prevalence of brucellosis in elk associated with feedgrounds (Clause et al. 2002). Although the Wyoming Livestock Board (2006) recently defined the "period of exposure" for cattle as 1 January to 1 May, *Brucella*-induced abortion events in captive and feedground elk have been documented from late February to June (Thorne et al. 1991, Roffe et al. 2004, WGFD unpublished data). The concentration of elk on feedgrounds during most of this period likely increases the risk of intraspecific brucellosis transmission and/or prevalence (Thorne et al. 1979), either through density-dependent (Figs. 26, 27; WGFD unpublished data) and/or frequency-dependent effects (i.e., increased length of feeding season, Fig. 28; Cross et al. ACCEPTED PENDING REVISION).

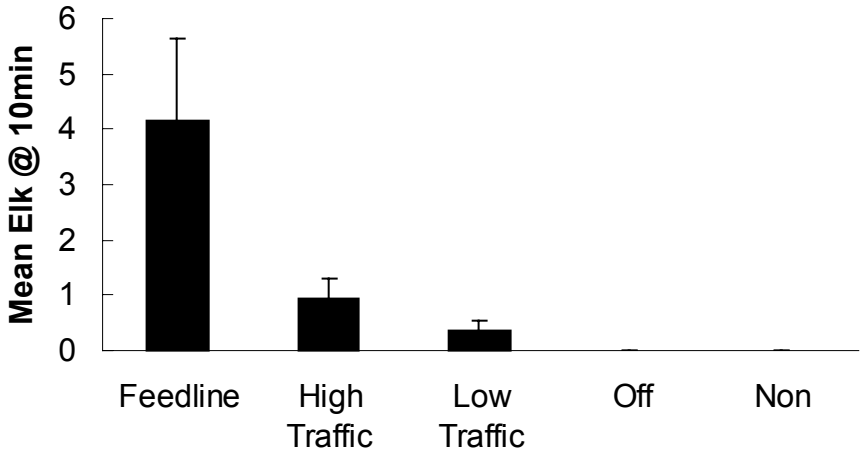

Figure 26. Mean number of elk counted every 10 min during 4-hr sampling period within 5m of pseudo-aborted elk fetuses and membranes (i.e., fetal unit). Fetal units were placed on Buffalo Valley (non-feedground) and within 3m of areas defined as feedline, high traffic, low traffic, and off the feedground on Grey's River, Franz, Soda Lake, and Muddy Creek feedgrounds.

Manipulating decadent vegetation in areas near feedgrounds can increase the production and palatability of grasses while promoting new forb and shrub growth (WGFD unpublished data). Near some feedgrounds, habitat treatments may be less effective for brucellosis management due to heavy snow conditions (even during relatively mild winters), damage/commingling risks, or post-treatment management regimes of the habitat enhancement area (e.g., livestock grazing). When desirable forages are available, the dependence of elk on artificial feed will decrease, as demonstrated annually during the green-up (WGFD unpublished data). Shorter feeding durations and lower elk concentrations on feedgrounds, especially during the high transmission risk period, may decrease the probability of intraspecific brucellosis transmission events. Any reduction in length of feeding season, regardless of cause, will also reduce cost of feedground operation.

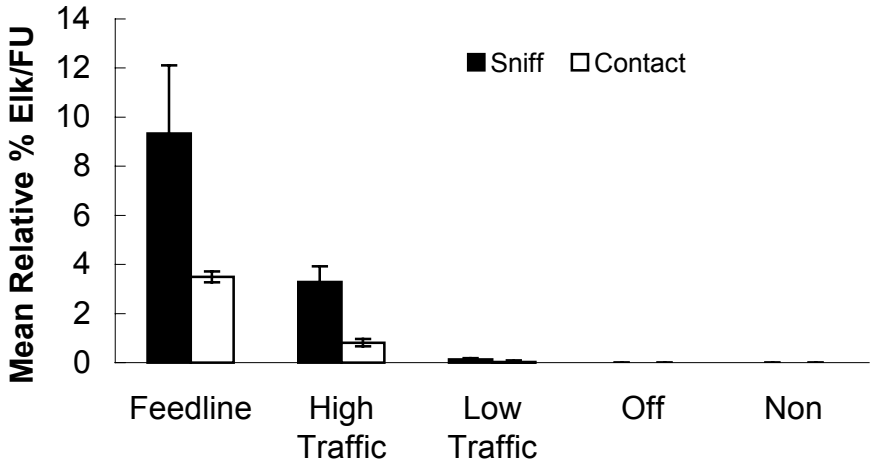

Figure 27. Mean relative % of elk on (Grey's River, Franz, Soda Lake, Muddy Creek) and off (Buffalo Valley) feedgrounds observed sniffing and contacting pseudo-aborted fetal units (i.e., fetus and membranes).

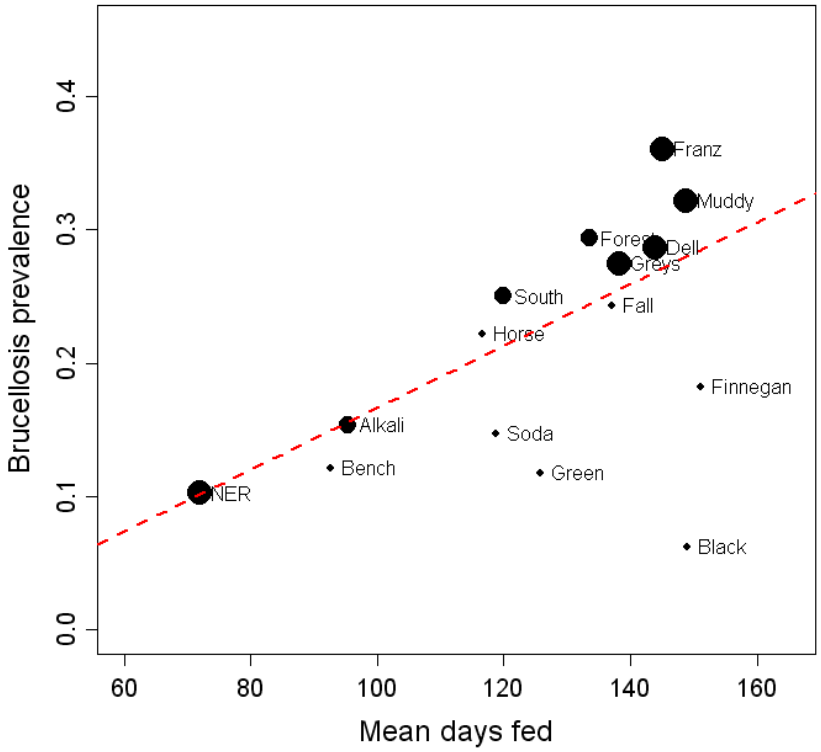

Figure 28. Seroprevalence of brucellosis in elk increases with the length of feeding season ($P < 0.0004$). Sites were weighted according to the reciprocal of their estimated variance, reflected by the size of each point in the plot. Brucellosis status was determined using four standard serological tests and confirmed using a cELISA test, which differentiates between vaccinated and naturally infected animals. Data included all feedgrounds with over 30 tests (2064 total tests) and feeding season lengths were based upon all data from 1955 to 2006.

Prescribed, or human-controlled fire, works to mimic the natural occurrence of fire on the landscape and enhances habitat. Fire encourages growth of early successional plant communities preferred by elk and other wildlife. It is also typically the most cost efficient treatment type per acre. To provide adequate fine-fuels for fire growth and spread, all areas to be treated with prescribed fire require 1 season of rest from livestock grazing. To encourage reestablishment and growth of herbaceous vegetation species and prevent colonization of weeds and less desirable species, areas treated with prescribed fire require 2 seasons of rest (often, 1 season rest, 1 season deferment) from livestock grazing (Stroud 1990).

Mechanical treatments involve the use of some form of machine to manipulate vegetation. These devices usually involve some type of modified farm equipment such as a disc, half-round drum, ripper, or mower (Stroud 1990). Thinning and harvesting using chainsaws or a forward harvester (vehicle used to cut and move trees) may also be used. Mechanical habitat treatments promote herbaceous production, species diversity, stand rejuvenation, and elimination of select species. Often, these treatments (particularly via chainsaws) are used prior to conducting prescribed burns to 1) provide adequate fuel for fire spread, and 2) provide greater control over fire behavior (e.g., near edge of areas to be burned or structures). These treatments usually do not require pre-treatment rest from grazing. Post-treatment grazing management is based on site-by-site objectives. Treated aspen may need to be rested or fenced to prevent overbrowsing by domestic stock; sagebrush treated with mechanical methods usually does not require rest.

Herbicide application may be used to reduce a particular life form (e.g., shrub) in order to increase the quantity and quality of another life form (e.g., grasses and forbs), subsequently diversifying plant communities (Stroud 1990). Herbicide treatments are sometimes employed in areas where prescribed fire is not an option or mechanical treatments are not as cost effective. Historically, 2,4-D was used to remove 100% of sagebrush, maximizing herbaceous production for livestock within treated areas. Because 2,4-D usually eliminates forbs (preferred and depended upon by many wildlife species), its use has been discontinued. Recently, "Spike" (a.k.a., 20P, *Tebuthiron*) has been used to reduce sagebrush density to 40% to 60% of its original density and increase herbaceous production while maintaining forbs. Livestock grazing management is usually not necessary in areas to be treated with herbicides; post-treatment grazing management depends on site objectives.

Rest and/or deferment from livestock grazing is another type of habitat treatment (Stroud 1990). Because of the need for public and private grazing allotments to maintain viability of livestock operations and the relative uncertainty and distrust of conservation easements necessary to purchase AUMs, this treatment type has received little attention in western Wyoming (and the western US). However, this treatment type may provide a greater abundance of native forage for elk than in treated areas in exchange for payment to a willing permittee or landowner.

2. Constraints on Implementation and Success of Habitat Enhancement Projects

Successful implementation of any habitat enhancement project involves several steps. Identification of an area in need of enhancement (e.g., sagebrush stand or aspen clone unaltered by wildfire in last 50 to 150 years) is primary, and numerous areas in both sagebrush and aspen habitats on the BPEHU have been delineated. Support of landowner agency(ies) and/or public grazing permittee(s) are key to successful implementation of enhancement projects. Support of both landowner agencies and grazing permittees in the BPEHU has been mixed, particularly

because of livestock management issues (i.e., rest, fence maintenance). Acquisition of funding to implement projects is paramount, and there are currently numerous funding sources (e.g., WGFD Habitat Trust Fund, Mule Deer Foundation, RMEF, Wyoming Wildlife & Natural Resource Trust, JIO) willing to support both landscape-scale and smaller projects. In the BPEHU, two major constraints limit implementation and/or success of habitat enhancement projects: grazing management (i.e., rest) and oil and gas development.

a. Grazing Management

Throughout the BPEHU, numerous areas on public grazing allotments with both sagebrush and aspen/conifer habitats have been identified as potential areas for habitat enhancement projects. Numerous enhancement projects have occurred throughout the BPEHU (Appendix 3, Section B, 3); those areas where prescribed fire was used as the primary treatment method could not have occurred without rest (1 yr pre-treatment, 2 yr post-treatment) from livestock grazing. For previous treatments on public grazing allotments in the BPEHU, locations where livestock producers transferred livestock to are unknown. Livestock from these allotments were likely transferred either to private grazing pastures or were sold. Because of the uncertainty of where to move cattle displaced by these treatments and to maximize opportunities to enhance habitats of all types, forage reserves for livestock must be secured on the BPEHU.

Areas suitable for forage reserves can be privately owned land and/or part of public grazing allotments on USFS and/or BLM lands. Forage reserves provide benefits to myriad wildlife and vegetation species, but acquisition requires willing seller(s) and, typically, substantial monetary funding. Forage reserves on public grazing allotments provide benefits to myriad wildlife and vegetation species but require cooperation from land management agencies, livestock permittees, and also monetary funding (typically for purchase of allotted AUMs).

b. Oil & Gas Development

Throughout the BPEHU, oil and gas development and extraction operations were initiated in the 1940s. Currently, most operations are confined to the southern end of the BPEHU, with others scattered along the boundaries of BLM and USFS lands. Additionally, several areas have been leased and many more are proposed for lease (Fig. 29).

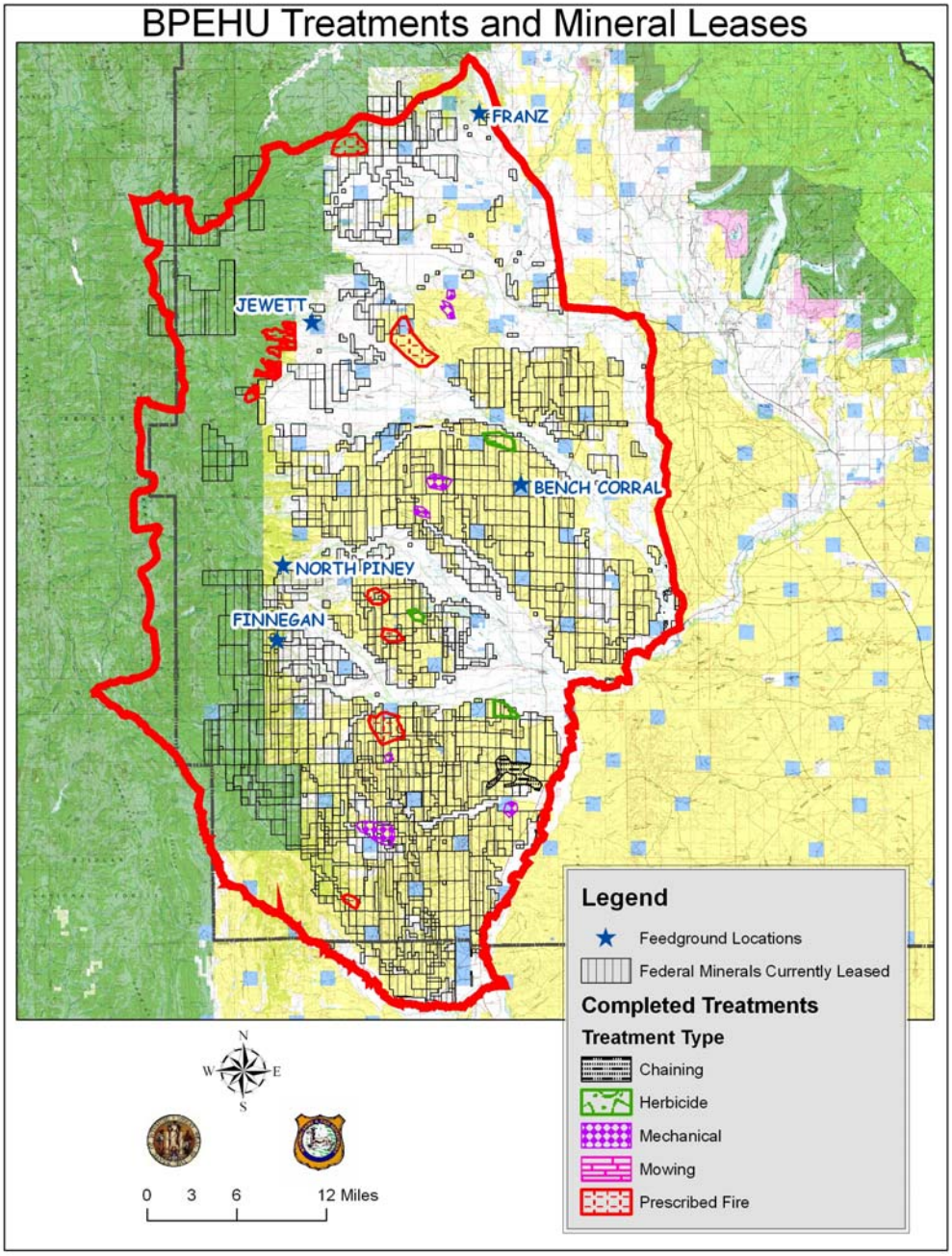

Figure 29. Feedground locations, previous habitat enhancement projects, and overlap with oil/gas leases on the BPEHU.

It is well known that oil and gas operations typically degrade native habitat on and adjacent to the site of activity (e.g., roads, well pads, tank batteries, transfer stations). For small-scale operations, alteration of native habitat (particularly those dominated by sagebrush) typically results in displacement of native wildlife and may promote establishment of non-native vegetation. For large-scale operations, alteration of native habitat is much greater (i.e., greater loss of habitat, increased opportunity for establishment of non-native vegetation), resulting in

displacement and/or mortality of species dependent on that habitat (e.g., sage grouse and sagebrush habitats on the Pinedale Anticline and Jonah Field).

It is unknown how oil and gas operations affect success (e.g., vegetation re-establishment, use of area by wildlife) of implemented habitat enhancement projects. However, based on data collected from the Pinedale anticline and Jonah Field, success of habitat projects is likely limited on areas where oil and gas operations overlap with previously implemented habitat enhancement projects. Opportunities for off-site mitigation may exist, but success of these "enhancement" projects may be less than areas where habitat enhancement projects have occurred previously. Additionally, implementation of off-site mitigation enhancement projects is constrained by grazing management issues. Ultimately, oil and gas exploration in the BPEHU should be mandated to occur at a controlled, predictable rate on areas previously treated and those areas proposed for enhancement. The BLM has the authority to make this decision.

3. Analyses of Habitat Enhancement Projects on the BPEHU

At least 29 habitat enhancement projects (totaling 20,899 acres treated) have occurred within the BPEHU on elk winter and transitional ranges (Table 17). In addition, approximately 5,863 acres of wildfires have occurred on public lands within the BPEHU since 1951 (Fig. 30). Most habitat enhancement projects in the BPEHU have occurred on BLM lands with sagebrush habitats and are not associated with an elk feedground (Fig. 31) with the exception of treatments occurring in the Bench Corral area and the Maki Aspen Enhancement project 1.25 to 5 miles west and south west of Jewett feedground. These projects and respective goals and vegetation monitoring data are explained in Section B, 3, a - c.

Table 17. Treatment types, names, land ownership, year(s) treated, and acreages treated for habitat enhancement projects on the BPEHU.

Treatment Type	Treatment Name*	Land Owner	Year	Habitat	Acres
Herbicide: 2,4 – D					
	Beaver Ck. Ind.	BLM	1966	Sagebrush	980
	Beaver Ck. Ind.	BLM	1967	Sagebrush	470
	Bench Corral Ind.	BLM	1965	Sagebrush	4,123
	Dead Indian Dome Ind.	BLM	1963	Sagebrush	480
	Fox-Jose C.	BLM	1970	Sagebrush	320
	LaBarge Ind.	BLM	1967	Sagebrush	1,590
	Lower Bench Corral C.	BLM	1967	Sagebrush	1,550
	Piney Ind.	BLM	1963	Sagebrush	200
	Upper Bench Corral C.	BLM	1966	Sagebrush	1,756
	Upper Bench Corral C.	BLM	1969	Sagebrush	500
	Upper N. LaBarge Ind.	BLM	1970	Sagebrush	410
				Total Acres Treated:	12,379
Herbicide: Spike 20P					
	Bench Corral	BLM	1994	Sagebrush	384
	Bench Corral	BLM	1994	Sagebrush	148
	McNinch-Deer Hills	BLM	1994	Sagebrush	600
	O'Neil Ind.	BLM	1994	Sagebrush	222
				Total Acres Treated:	1,354
Mechanical: Chaining					
	Chimney Butte	BLM	1990	Sagebrush	1700
Mechanical: Mowing					
	Mobil Mowing	BLM	1996	Sagebrush	800
	Mobil Mowing	BLM	1997	Sagebrush	550
	Mobil Mowing	BLM	1998	Sagebrush	550
	Ryegrass Ind.	BLM	2005	Sagebrush	200
	James Ryegrass Ind.	BLM	2005	Sagebrush	200
				Total Acres Treated:	2,300
Mechanical: Pitting					
	Upper Bench Corral C.	BLM	1994	Sagebrush	256
Mechanical: Ripping					
	Upper Bench Corral C.	BLM	1994	Sagebrush	320
Prescribed Fire					
	Beaver Ridge	USFS	1996	Aspen/Con	140
	Brodie Draw	BLM	1999	Sagebrush	800
	Cretaceous Mt.	BLM	1993	Sagebrush	500
	Deer Hills	BLM	1991	Sagebrush	400
	Gentle Annie	BLM	1998	Aspen/Con	600
	Maki **	USFS	2005	Aspen/Con	150
				Total Acres Treated:	2,590
				Grand Total Acres Treated:	**20,899**

* Treatments have occurred on allotments designated as Individual (Ind.) or Common (C.) allotments.
** Treatment involves mechanical falling of conifers prior to prescribed fire; prescribed fire has not yet occurred.

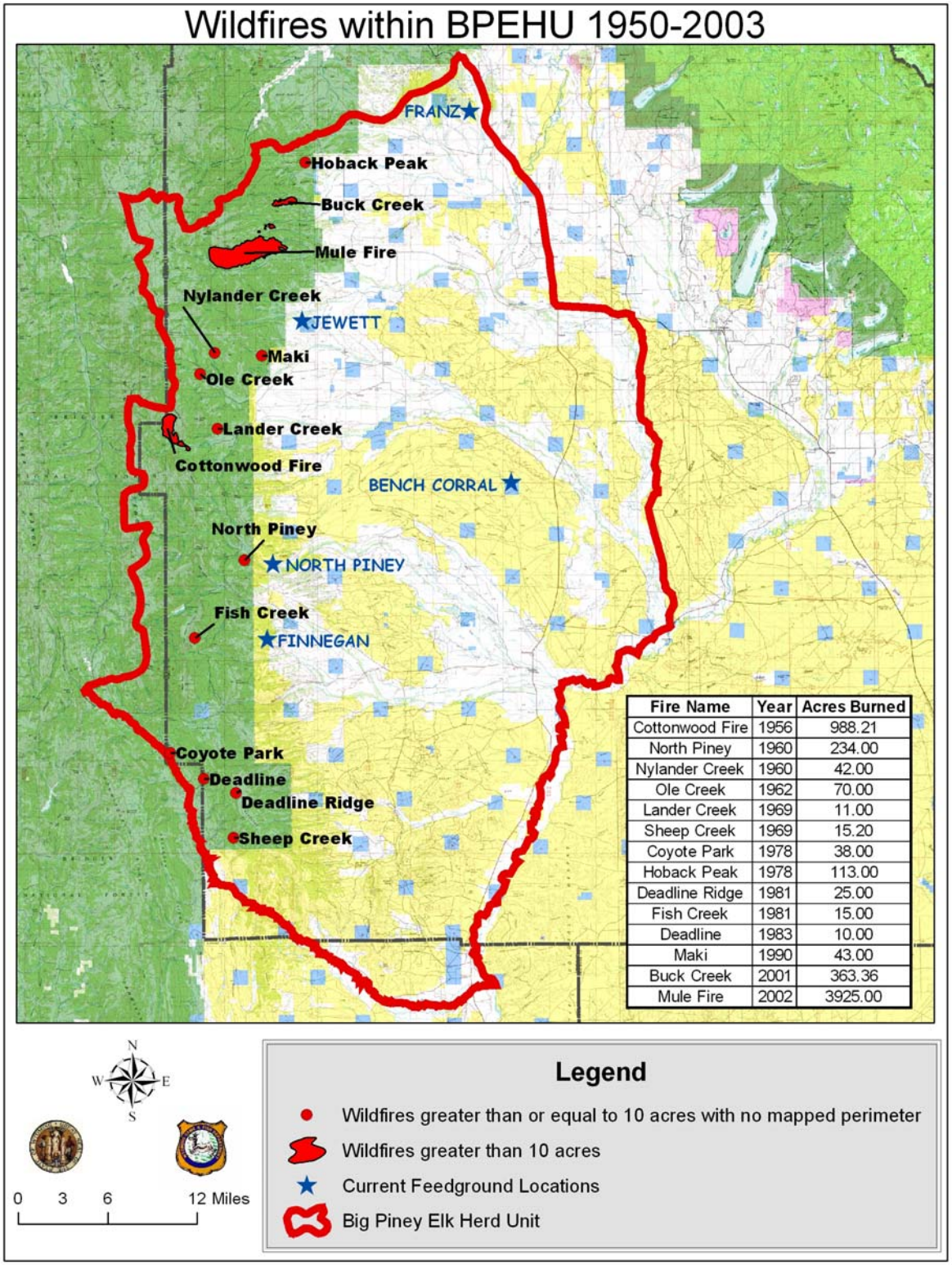

Figure 30. Locations and acreages of wildfires occurring on the BPEHU since 1951.

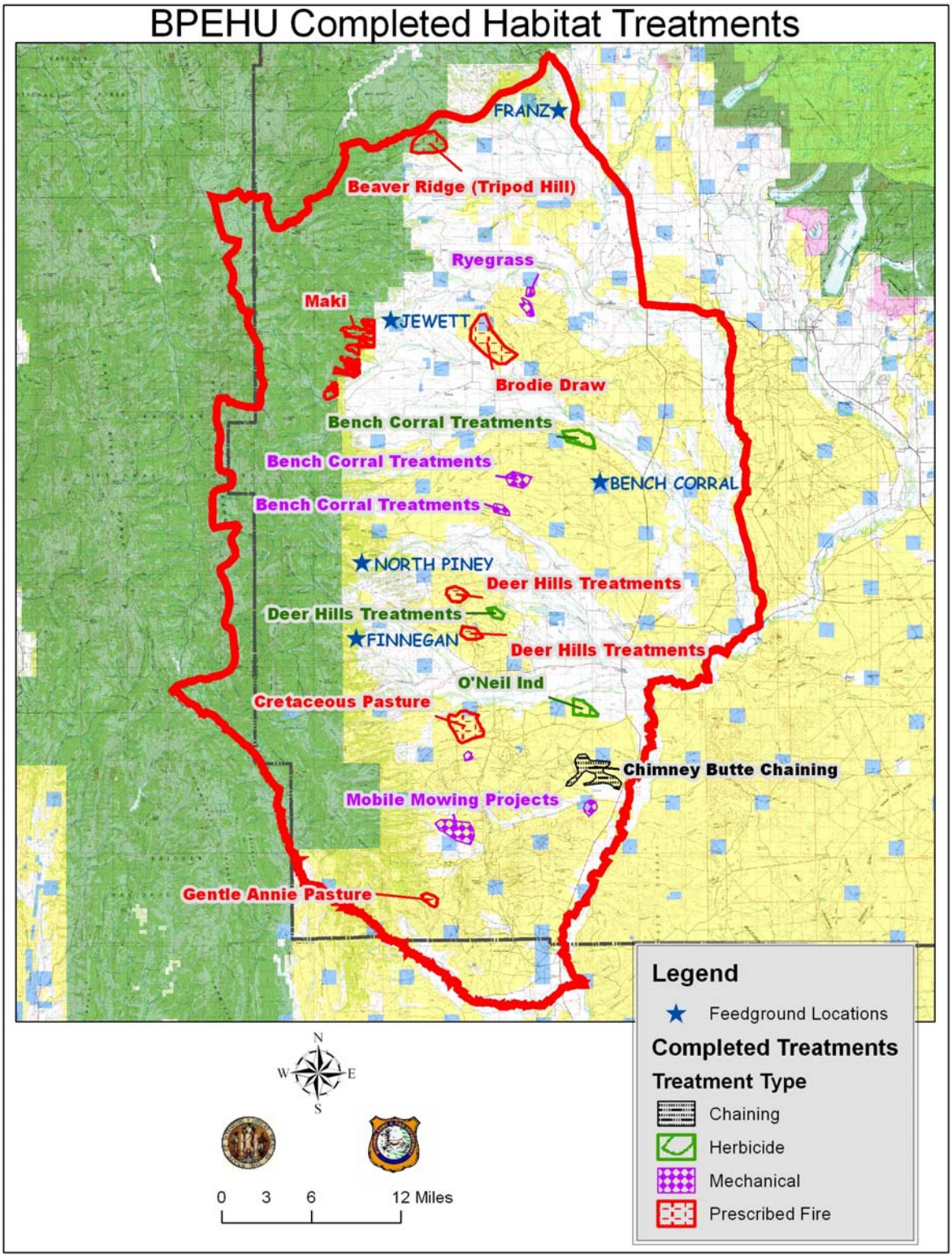

Figure 31. Locations of habitat enhancement projects and feedgrounds on the BPEHU.

a. Herbicides

Since 1963, at least 13,733 acres of sagebrush habitat on public lands in the BPEHU have been treated by herbicides, with the majority of those occurring in the 1960s (Table 20). From 1963 to 1970, all treatments are assumed to have used 2,4-D. The overall goal of these projects was livestock range improvement with the primary objective of 100% sagebrush control. Cooperators for these projects are assumed to have been BLM and livestock permittees. Vegetation monitoring data for these treatments either do not exist or were lost (WGFD unpublished data).

Since 1994, 2 separate sites in the Bench Corral area, one site on the McNinch-Deer Hills area, and one site on the O'Neil Individual allotment received aerial applications of Spike (20P). The goals of these enhancement projects were to reduce the successional stages of sagebrush-dominated habitats and increase vegetation species diversity and cover and production of herbaceous forage on areas of potential elk winter range. Cooperators for these projects included WGFD, BLM, livestock permittees, and/or RMEF and Mobil, Enron, and Chevron Oil and Gas Companies. Pre-treatment data do not exist; however grass and forb production appear to be higher and lower, respectively, on treated vs. untreated sites (Fig. 32).

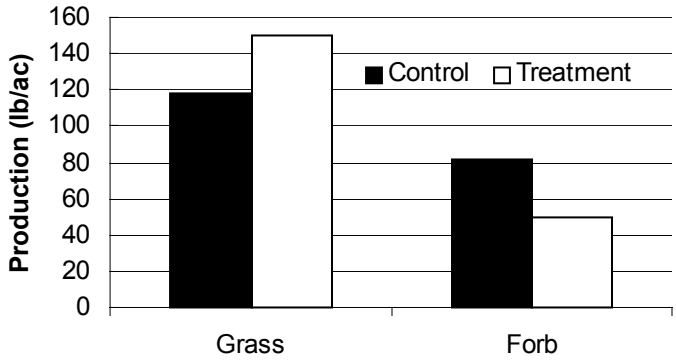

Figure 32. Grass and forb production (lb/ac) estimates from sites previously treated with Spike on the BPEHU.

b. Mechanical

Since 1990, at least 4,576 acres of sagebrush habitat on public lands in the BPEHU have been treated by various mechanical methods, including chaining, mowing, pitting, and ripping (Table 20). The goals of these enhancement projects were to reduce the successional stages of sagebrush-dominated habitats and increase vegetation species diversity and cover and production of herbaceous forage on areas of potential elk winter range. Cooperators for these projects included WGFD, BLM, livestock permittees, and/or RMEF, and Mobil, Enron, and Chevron Oil and Gas Companies.

Pre-treatment data are too sporadic for accurate comparisons. However, grass and forb production are slightly higher and much lower, respectively, on treated vs. untreated sites (Fig. 33).

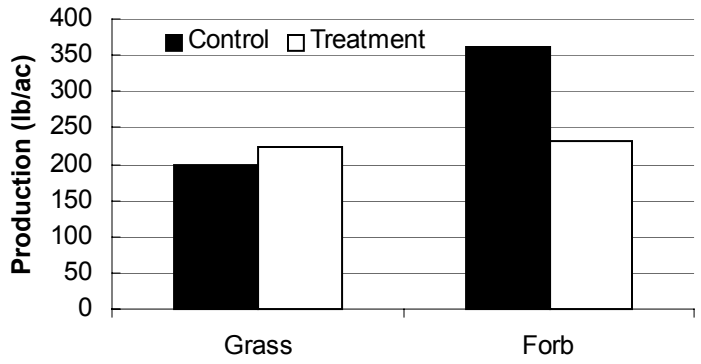

Figure 33. Grass and forb production (lb/ac) estimates from sites previously treated with mechanical methods on the BPEHU.

c. Prescribed Fire

Since 1991, about 2,590 acres of public lands on the BPEHU have been treated with prescribed fire. Approximately 1,700 acres of sagebrush and/or mountain mahogany habitats have been treated, and goals of these enhancement projects were to reduce the successional stages of shrub-dominated habitats and increase vegetation species diversity and cover and production of herbaceous forage on areas of potential elk winter range. Approximately 890 acres of aspen/conifer habitat have been treated, and goals of these projects were to increase aspen vigor and reproduction (i.e., suckering), thereby increasing the browse production on elk transitional range. Cooperators for these projects have included WGFD, livestock permittees, and/or BLM, USFS, and/or RMEF and Mobil Oil & Gas.

Pre-treatment data either do not exist or are too sporadic for accurate comparisons. Grass and forb production in sagebrush and mountain mahogany habitats were higher on treated vs. untreated sites (Fig. 34).

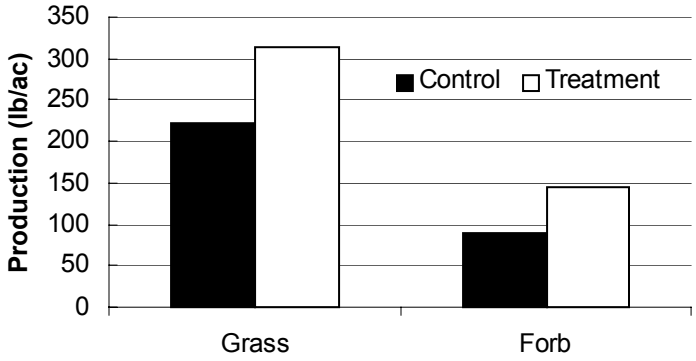

Figure 34. Grass and forb production (lb/ac) estimates from sites previously treated with prescribed fire on the BPEHU.

Data regarding herbaceous production and suckering response following treatment from sites dominated by aspen habitat do not exist for projects in the BPEHU. However, pre-treatment data related to aspen do exist. On the Cottonwood Creek drainage within USFS lands, 84% and 16% of aspen communities were classified in 2000 and 2001 as "conifer-climax" and "stable aspen climax", respectively. Of the 84% classified as conifer-climax, 74%, 24%, and 2% fall within high, moderate, and low treatment prioritization categories, respectively. The average age of aspen in this drainage was 74 years.

Within the Maki aspen enhancement area of the North Cottonwood Creek drainage, the majority of the 978 aspen suckers monitored occur within the 1 to 3 ft height class. Very low percentages of these aspen suckers that were classified occur in the 3 to 6, 6 to 10, and >10-ft height classes (Fig. 35), further suggesting that aspen regeneration is limited. Browsing of aspen suckers appears to decrease slightly as distance from the feedground increases; overall, browse use does not appear excessive (Fig. 36).

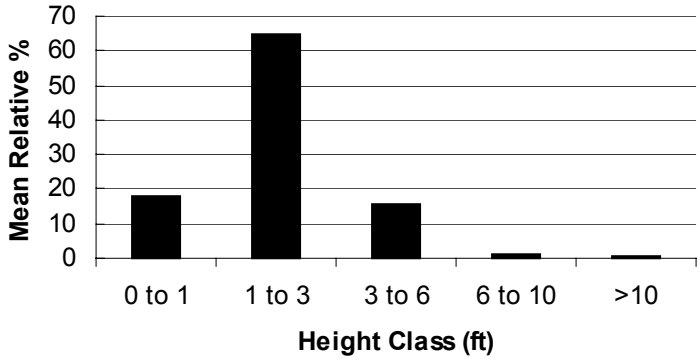

Figure 35. Mean relative percent of aspen suckers classified in various age classes on the Maki aspen enhancement project area in the BPEHU.

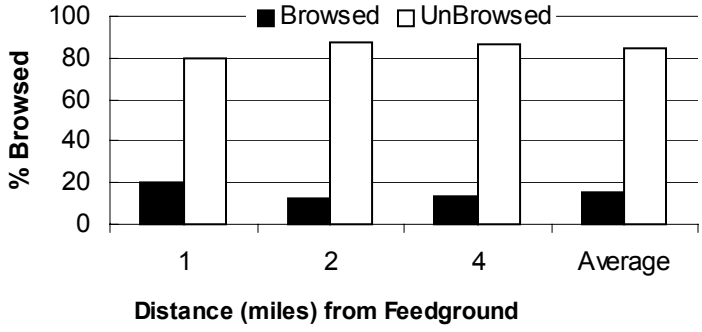

Figure 36. Mean relative % of browsed and unbrowsed aspen suckers on the Maki aspen enhancement project area in the BPEHU.

It is likely that most aspen stands within the BPEHU are similar to those monitored within the North and South Cottonwood drainages, emphasizing the need for treatment to rejuvenate and increase suckering response within those stands. Increasing aspen browse to reduce elk dependency on feedgrounds in the BPEHU should be investigated. Projects with this intent should be landscape-scale (e.g., greater than 1000 acres per year) to prevent overbrowsing by elk and other ungulates.

C. Additional Habitat Monitoring Data

1. Bench Corral Allotment Summary

In 1995, WGFD proposed to establish a migration route for elk from North Piney feedground to Bench Corral feedground. Livestock grazing interests were strongly opposed this proposal, stating that increased numbers of elk would reduce available forage for livestock, possibly resulting in BLM-mandated reductions of AUMs allotted on Bench Corral Individual and Upper and Lower Bench Corral Common allotments (Fig. 37). During the winter of 1995-1996, WGFD personnel lured elk from North Piney by trailing hay to Bench Corral. Since about 2001, the majority of elk from North Piney have migrated to Bench Corral (Appendix 2, Section A-4).

AUMs allotted to Bench Corral Individual (3,284) and Upper (2,063) and Lower (2,774) Bench Corral Common allotments (and all other allotments on BLM lands between North Piney and Bench Corral feedgrounds) were established in 1964 following the estimation of livestock nutritional carrying capacity for all allotments in the Pinedale region. Since 1964, AUMs permitted on all allotments in the Pinedale region have not changed. Additionally, AUMs permitted on all allotments represent approximately 50% of total AUMs available. The remaining 50% of AUMs available on all allotments in the BPEHU (and throughout the Pinedale region) are designated by the BLM specifically for wildlife use and to maintain ecological health of the allotment(s).

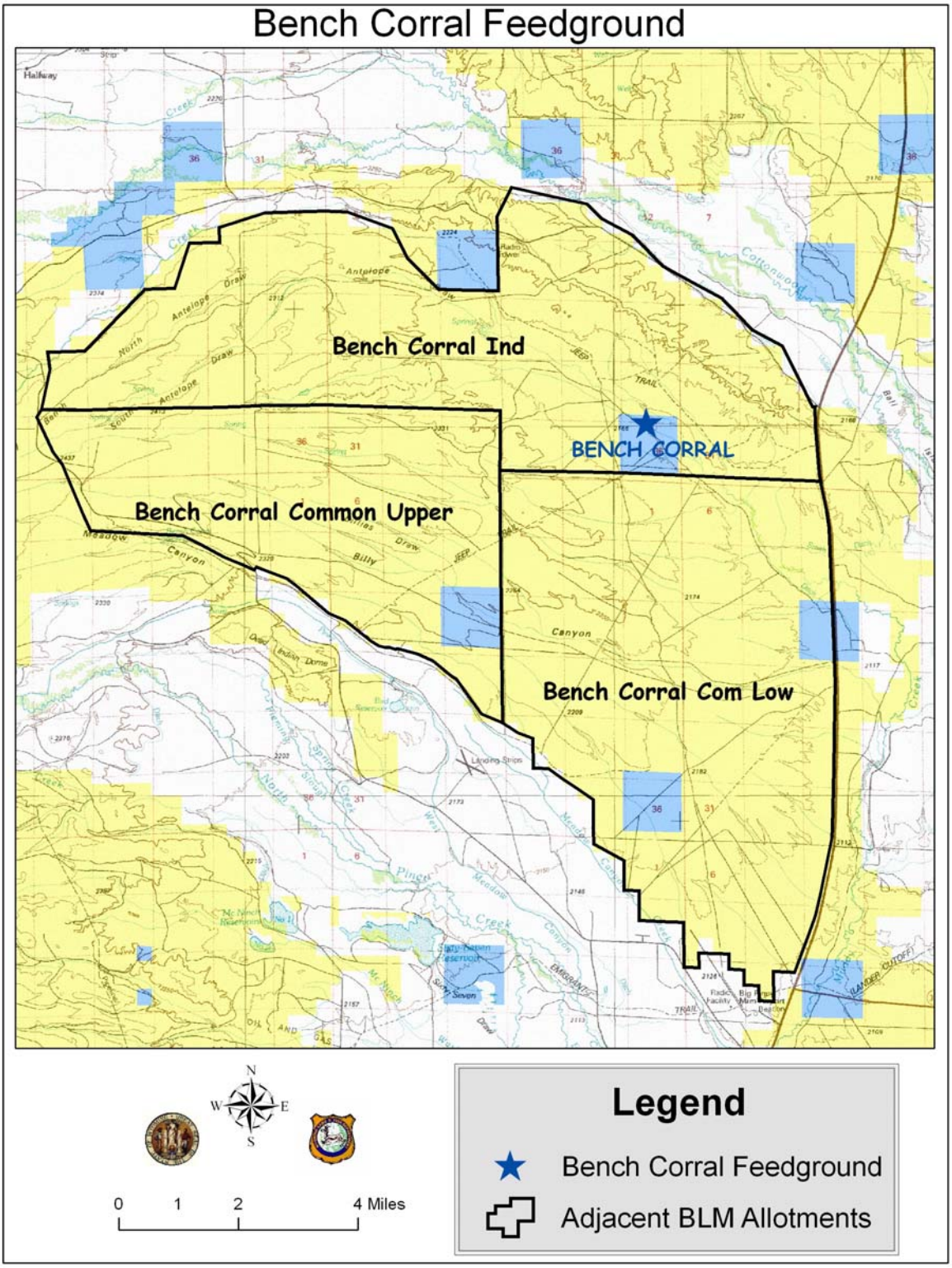

Figure 37. Public grazing allotments associated with Bench Corral feedground on the BPEHU.

2. Bench Corral Forage Production

In 1995 and 2000, estimates of the amount of forage (lb/ac) required to sustain an elk through a worst-case scenario winter without supplemental feeding were determined for the area surrounding Bench Corral, including the Bench Corral Individual and Upper and Lower Bench Corral Common allotments. Clippings of grass and forb production (following livestock grazing) were collected in September and October (following grazing season) at 11 sites and 29 sites in 1995 and 2000, respectively. In 1995, it was estimated that 6,199,642 lb of forage remained throughout 33,120 acres of winter range on the Bench Corral area following livestock grazing. The estimate for forage consumed by 973 elk (based on maximum counts at North Piney, 534 elk in 1994, and Bench Corral, 439 elk in 1989) at 12.5 lb forage consumed/elk/day during a 180-day feeding season (Equation 1) results in:

973 elk x 12.5 lb/elk/day x 180 days = 2,189,250 lb forage consumed (1)

These results suggest that a population of 973 elk could be maintained solely on forage produced in 1995 on native winter range in the Bench Corral area.

In 2000, it was estimated that 2,980,457 lb of forage remained throughout 33,120 acres of winter range on the Bench Corral area following livestock grazing. Based on Equation 1, sufficient forage remained to support a population of 973 elk on native winter range.

In winter of 2005-2006, 1,010 elk were counted at the height of the feeding season on Bench Corral feedground. Substituting 1,010 elk into Equation 1 results in:

1,010 elk x 12.5 lb/elk/day x 180 days = 2,272,500 lb forage consumed (2)

Again, these results (Equation 2) suggest that a population of 1,010 elk could be maintained solely on native forage produced, as recorded in 2000.

3. Bench Corral Forage Utilization

Annually, the BLM assesses livestock forage utilization on permanently established monitoring transects throughout many allotments within the BPEHU. On allotments surrounding Bench Corral (i.e., Bench Corral Individual, Upper Bench Corral Common, Lower Bench Corral Common), monitoring of livestock forage utilization has occurred almost annually since 1988 on upland and riparian sites. These data provide an accurate assessment of the available forage utilized by livestock for the time periods before (1988 to 1995) and after (1996 to 2002) the elk migration from North Piney to Bench Corral was initiated.

Utilization data derived from permanently established transects on upland sites from each allotment and all allotments combined suggest no differences before or after elk were relocated from North Piney to Bench Corral (Table 18). Additionally, utilization data derived from permanently established utilization cages on riparian areas suggest no differences before or after elk were relocated from North Piney to Bench Corral (Table 18). The substantial increase in elk density on and around Bench Corral feedground since 1995 has not increased the percentages of plants observed to be utilized in any category (particularly Moderate to Severe). Ultimately, direct dietary competition between elk and cattle is unobservable and likely insignificant for all allotments on and around Bench Corral feedground.

Table 18. Mean relative percent of all grasses utilized by category from 1988 to 2002 for Bench Corral Individual, Upper Bench Corral Common, Lower Bench Corral Common allotments, and all allotments combined on the Bench Corral area of the BPEHU.

	Allotment Name							
	Bench Corral Ind		Upper Bench Com.		Lower Bench Com.		Total	
Time Period	1988-1995	1996-2002	1989-1995	1996-2002	1988-1993	2000-2002	1988-1995	1996-2002
Utilization Category*								
Slight	40.65	47.18	52.43	46.23	42.99	64.06	45.36	52.49
Light	31.05	32.76	31.15	33.99	29.24	23.85	30.48	30.2
Moderate	18.79	17.22	13.87	16.33	19.81	11.34	17.49	14.96
Heavy	8.02	2.84	2.49	3.3	6.31	0.74	5.61	2.29
Severe	1.49	0	0.07	0.14	4.58	0	2.05	0.05
N**	8	7	7	7	4	3	19	17
Paired[ψ]	57.75	52.96	49.53	43.79	NA	49.5	53.64	48.75
N**	6	7	6	6	0	3	12	16

* Slight = 0 – 20%, Light = 21% - 40%, Moderate = 41% - 60%, Heavy = 61% - 80%, Severe = 81% - 100%; transects on upland sites

** N = sample size, i.e., total years sampled within time period

[ψ] Utilization based on paired (i.e., grazed vs. ungrazed) plots in riparian areas

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