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Tables

IMPACTS ON THE JACKSON ELK HERD

This section describes the effects of the alternatives on elk numbers, distribution, movements, calf production, mortality, and the health of elk inhabiting the National Elk Refuge and Grand Teton National Park, as well as the entire Jackson elk herd. It also identifies and explains the factors that would influence the population and that would lead to the population effects described below.

METHODOLOGY USED TO ANALYZE EFFECTS

Sources of information used to assess the level of impact on wildlife included: (1) scientific literature on species' life histories, distributions, habitat selection, and responses to human activities; (2) site-specific information on wildlife species in the park, the refuge, state and national forest lands, including complete and ongoing studies (when available); and (3) the professional judgment of park, refuge, state, and forest biologists and managers familiar with management concerns related to individual species.

In addition, analytical specialists were contracted to perform computer-modeling of forage allocation model and the elk population using elk population data and a variety of bison population sizes. The models predicted changes in population parameters under the various alternatives and assisted in explaining factors behind historical trends. The results were used as a tool to help predict the number of elk and bison that could exist under each alternative and to assess the effects of climatic variation and forage enhancement on elk and bison numbers and other population parameters such as distribution, mortality, and sustainability. As previously described, when winters are referred to as average, above-average, or severe in the text, snow accumulations would be similar to those used in modeling for the impact analysis (Hobbs et al. 2003). These rankings were based on 50 years of measuring inches of snow-water equivalent (the amount of water stored as snowpack) at the Hunter-Talbot hayfields in Grand Teton National Park (Farnes et al.1999). Snow-water equivalent was considered the best measure for predicting how ungulates would respond to winter conditions. The winter of 1996 was designated as average, 1982 as above average, and 1997 as severe.

The threshold for the effect of snow-water equivalents on forage availability can be difficult to measure in the field. Some of the assumptions in the model relied on professional judgment and observations of elk behavior. Snow conditions can affect this threshold and are not represented in the model. For example, if crusting of snow makes forage less available at lower snow-water equivalents, then model predictions for an average winter could tend to be more like those for a severe winter, and predictions for a mild winter could more closely resemble those for an average winter.

Identifying variables that are measurable early in the winter to determine winter severity and, under some of the alternatives, whether supplemental feeding should occur in a given year would be critical. Refuge and WGFD personnel would continue to jointly evaluate forage availability. Preliminary analyses indicate that the index of winter severity calculations for the Blacktail/Gros Ventre area for January 1 were strongly correlated with the supplemental feeding start date on the refuge and could be a useful tool for early winter evaluations (Cole 2005). When calculating the index of winter severity for elk, snow, temperature, and forage variables are weighted at 45%, 35%, and 20%, respectively (Farnes et al. 1999).

Elk numbers were estimated using a variety of methods, including the PopII model (Fossil Creek Software 1999) and data from ground and aerial (helicopter) censuses. These censuses are conducted in a single day in February of most years to count and classify elk by age and sex to help ground-truth modeling results. Overall, modeled projections varied from total herd counts by about 10%–15%, primarily due to sightability problems on native winter range. Native winter range counts were adjusted for sightability bias to provide a more accurate idea of actual elk numbers on native winter range. When feedground counts were subtracted from WGFD modeled total herd estimates, it was determined that, on average, about 66% of elk on native winter range were counted during censuses. This percentage agreed with the estimate by Lubow and Smith (2004) of 66.3% sightability. Because native winter range counts represented two-thirds of the total elk estimated on native winter range, these counts were increased by half to approximate actual numbers on winter range.

It is understood that in all alternatives except Alternative 2 the Fish and Wildlife Service and the National Park Service would work cooperatively with the Wyoming Game and Fish Department to achieve population objectives, including herd ratios and elk herd segment sizes; to establish hunting seasons; and to evaluate hunting / elk reduction areas. The state would formally establish objectives and strategies after public review and approval by the Wyoming Game and Fish Commission.

The analysis of disease-related impacts is based on synthesis of information from three primary sources: (1) disease experts from the U.S. Fish and Wildlife Service, the National Park Service, the U.S. Geological Survey, the Animal Plant and Health Inspection Service, the Wyoming Game and Fish Department, and the Wyoming Livestock Board; (2) published scientific literature; and (3) unpublished data and reports from the refuge and the park. A three-day meeting of disease experts from the agencies listed above was held November 12–14, 2002. The session was interactive, with experts discussing disease impacts to elk and bison that could result from implementation of each of the six management alternatives. Impact topics associated with each disease that were discussed included: prevalence in the herd; production and recruitment; mortality; demographics and distribution; and transmission of the disease to elk, bison, livestock, humans, other ungulates (mule deer, moose, pronghorn, bighorn sheep), predators and scavengers (black bears, coyotes, ravens, crows), and threatened and endangered species and sensitive species (wolves, grizzly bears, bald eagles, trumpeter swans). Some diseases were discussed in more detail than others, due to higher potential for impacts to wildlife, livestock, or humans (e.g., brucellosis).

The primary factors considered by disease experts that differ among alternatives were numbers of animals (elk and bison), animal density, intensity and duration of supplemental feeding, animal distribution on the landscape, elk and bison migrations, habitat improvements, and potential for contact between elk/bison and livestock or humans. All of these factors, individually or in combination, can influence the impacts of diseases in wildlife populations.

In cases where major differences in opinion existed between disease experts both viewpoints are documented. For this planning process a thorough literature review was conducted for additional information on the diseases of concern (Peterson 2003). This review summarized what is known regarding infectious agents that currently affect, or could in the future affect, Jackson elk and/or bison, places this information in an ecological context for use in management decision-making, and points to areas where, from an ecological perspective, more information is needed.

The analyses were quantitative wherever data allowed. Where sufficient numeric information was not available, qualitative or relative assessments were made. During the disease expert meeting, the following impact levels were defined; these impact levels are applied throughout the disease portions of the environmental consequences section where sufficient information to determine the degree of impact exists:

- *Negligible* — The impact would be at the lower levels of detection (5%–10% change).
- *Minor* — The impact would be slight, but detectable (11%–25% change).
- *Moderate* — The impact would be readily apparent and would have the potential to become major (26%–79% change).
- *Major* — The impact would be severely detrimental, or if beneficial, would have exceptional beneficial effects (80% or greater change).

Discussion of direct, indirect, secondary, short-term (less than 5 years), long-term (15–20 years or longer), and cumulative impacts are included as appropriate. The effects of Alternative 1, and all other alternatives relative to Alternative 1, are documented. Potential mitigation measures that could be implemented to reduce impacts are included where appropriate. Throughout the disease impact analysis, the focus is on elk that winter on the refuge, although impacts on the entire herd are also discussed.

For some diseases, such as chronic wasting disease, little is known regarding the epidemiology of the disease, and disease experts were unable to predict impacts precisely enough to fit into the threshold levels identified above. In such cases, relative impacts under the alternatives were ranked that could result based on what is known about the disease.

When comparing impacts of Alternatives 2–6 to Alternative 1, it was assumed that the increasing bison population under Alternative 1 would remain on the refuge during winter because the supplemental feeding program would encourage bison to stay there.

The diseases of concern, listed below, include the primary diseases that consulted experts believed could have impacts on the Jackson elk and bison herds. Wildlife in the project area could be susceptible or exposed to many other diseases, but the biological significance of these other diseases in the project area is minimal; therefore, these diseases were not included. The diseases of concern that are analyzed in depth include the following (for a discussion of diseases that would not be affected by elk and bison management, and therefore are not analyzed in depth, see pages 149 and 132):

- *Macroparasites (parasitic arthropods and helminths) documented in the Jackson elk or bison herds* — psoroptic scabies, helminths and lungworms
- *Bacterial microparasites documented in the Jackson elk or bison herd* — necrotic stomatitis, septicemic pasteurellosis, bovine brucellosis.
- *Bacterial microparasites not documented in the Jackson elk or bison herd* — bovine tuberculosis and paratuberculosis (Johne's disease). There are no impacts at present from bovine tuberculosis or paratuberculosis. The discussion of potential impacts is addressed in the context of the effects each alternative would have on transmission and prevalence if either of these disease was introduced.
- *Viral microparasites not documented in the Jackson elk or bison herd* — malignant catarrhal fever
- *Prion microparasites not documented in the Jackson elk or bison herd* — chronic wasting disease. There are no impacts at present from chronic wasting disease. The impact analysis focuses on the effects that each alternative would have on transmission and prevalence if this disease became established.

To avoid redundancy, some of the disease discussion in the following impact analysis covers effects on both bison and elk. Effects are treated separately when greater detail is needed.

IMPACTS OF THE ALTERNATIVES

IMPACTS COMMON TO ALL ALTERNATIVES

Although the prevalence of brucellosis would vary among alternatives, brucellosis would not likely be eradicated from the portion of the Jackson elk herd utilizing the refuge under any alternative, even using Strain 19 vaccine (Gross, Miller, and Kreeger 1998; Kreeger and Olsen 2002; Roffe et al. 2002). Therefore, brucellosis-induced abortions would likely continue to occur at some level under all alternatives. Some potential for brucellosis transmission between elk and bison would thus remain under all alternatives.

Brucellosis has the potential to cause cow elk to abort or elk calves to become sick and may currently be reducing calf production by up to 5% on the refuge (Oldemeyer, Robbins, and Smith 1993, as adjusted for lower seroprevalence in recent years). This translates to a small loss in elk numbers overall, as adults do not generally die from brucellosis (Dobson and Meagher 1996), and the herd itself has a high intrinsic potential to increase (Lubow and Smith 2004). As an example of the small loss current levels of brucellosis on the refuge could cause, if the calf-to-cow ratio was 25 calves to 100 cows, a 5% reduction in calf production would result in a ratio of 23.75 calves to 100 cows. Unless prevalence rose on the refuge, this loss would only slightly change the demographics of the Jackson elk herd. Because brucellosis would have only negligible impacts on the Jackson elk herd demographics, no impacts on the distribution of elk on the refuge or the park are expected as a result of brucellosis under any alternative.

Brucellosis can cause lameness in chronically infected adult elk and may increase winter deaths of a small percentage of infected elk through predation or starvation (Thorne et al. 1982). Few, if any, adult elk deaths related to brucellosis would be expected, and impacts on adult mortality would be negligible at most.

Brucellosis may be transmitted to other ungulates, predators, scavengers, and other wildlife species (including threatened, endangered, and sensitive species), but aside from bison, these species are most likely dead-end hosts (Davis 1990; Thorne 2001). Brucellosis is not expected to directly adversely impact populations of any of these species (Thorne et al. 1982; Disease Expert Meeting 2002), and these species are not expected to transmit the disease to other species or conspecifics. Therefore, under all alternatives, no direct impacts to these species would occur resulting from transmission of brucellosis from the Jackson elk herd.

No direct impacts on elk mortality, production, and recruitment are expected under any alternative as a result of lungworm infection.

Necrotic stomatitis is not a transmissible disease. Thus, transmission between elk would not occur under any of the management alternatives.

If chronic wasting disease was found in an elk from the Jackson elk herd, 50 elk would be removed within 50 miles of the index case. If another infected elk was found, another 50 would be removed, and so on. This disease management strategy, as well as potentially decreasing densities through hunting or other means, would increase elk mortality under all of the alternatives.

ALTERNATIVE 1

Analysis

In the following sections, short- and long-term effects are discussed together unless otherwise noted.

Under Alternative 1 the refuge would continue to provide both standing forage and pelleted hay to as many as 7,500 elk. Annual fluctuations in numbers would continue to occur but on average 5,000–7,500 elk would be supplementally fed for an average of 70 days during 9 of every 10 years. In 2003 approximately 7,000 elk wintered on the refuge. The 20-year average has been about 8,000 although numbers have ranged from approximately 5,000 to 11,000. For the purposes of this analysis, it is assumed that the 1974 Memorandum of Understanding with the Wyoming Game and Fish Department, which sets an upper limit of 7,500 elk on the refuge, would be met. In addition, if the Jackson elk herd objective was met and maintained, the average number of elk on the refuge would be approximately 5,600. This number is the average of elk counted during five of the last six winters (a partial count was not included), adjusted for a Jackson elk herd size of 11,000, and it is considered the baseline in these analyses for the number of elk wintering on the refuge.

TABLE 4-5: ESTIMATED NUMBER OF ELK ON THE NATIONAL ELK REFUGE, IN THE GRAND TETON NATIONAL PARK SEGMENT, AND TOTAL IN THE JACKSON HERD UNIT

	Wintering on the National Elk Refuge	Grand Teton National Park Segment	Total in Herd
Existing (1997–2001)	7,056	3,238	14,641
Alternative 1	5,574	2,676	11,000
Alternative 2	1,200–6,000	576–2,880	8,100–11,000
Alternative 3	1,000–2,000	500–1,000	7,900–11,000
Alternative 4	4,000–5,000	1,300–1,600	10,900–11,000
Alternative 5	5,574[1] 5,000–7,500[2]	<2,500 <2,500	11,000 13,000–15,000
Alternative 6[3]	2,400–3,200	1,200–1,600	9,300–11,000

1. Assuming that the herd is maintained at the herd objective. When the herd is at objective, it is estimated that elk numbers on the National Elk Refuge would average approximately 5,574.
2. Assuming that the herd is allowed to exceed the herd objective; i.e., 7,500–8,500 elk on the National Elk Refuge would require that the herd objective be exceeded by a moderate to major amount.
3. After a series of above-average or severe winters, numbers could drop to the low number shown for Alternative 2.

Other numbers of elk in the region would also remain the same under Alternative 1. These are detailed in the Chapter 3 and summarized here. The number of elk on native winter range currently averages about 4,400 to 7,800, and the objective for this segment of the herd (i.e., when the entire herd numbers 11,000) is 3,700. Elk on winter range in the park number about 535, and range between 200 and 1,300 (WGFD 1989–2002a). The objective for elk on native winter range in the park (i.e., when the herd is at 11,000) would be 356, with an estimated range of 137 to 857. Elk numbers in the entire Jackson herd are currently estimated at 13,356 (winter 2003–4) and ranged from 13,200 to 19,657 during the period 1989 to 2003.

Under Alternative 1 the number of elk on native winter range would be expected to remain similar to baseline conditions (2,900 to 5,200 elk), and averaging approximately 3,700.

Alternative 1 also assumes that approximately 2,500 elk would continue to be fed annually on three feedgrounds in the Gros Ventre River drainage. Using counts for the refuge (5,876) and Gros Ventre feedgrounds (2,839) and the WGFD PopII estimate for total herd size, 65% of the total Jackson elk herd was fed in the winter of 2003–4.

Distribution and Movements of Elk

About half of the total Jackson elk herd would continue to winter on the refuge under Alternative 1, of which between 19% (Anderson et al. 1998; GTNP unpubl. data) and 48% would come from the park segment, 12% from the Gros Ventre segment, 12% from the Teton Wilderness segment, and 28% from Yellowstone National Park segment (Smith and Robbins 1994).

Existing management of the refuge (feeding, cultivation of standing forage, and prescribed fire to improve quality of forage), protection of elk inside park boundaries, and environmental conditions (shallower snow depth) would continue to attract elk to these lands. As a result, elk density on the refuge would continue to be increased by supplemental feeding, from an average of 0.5 elk/acre if elk were distributed equally on the southern areas of the refuge to 500 elk/acre at the feedgrounds during two-hour feeding periods.

Fall elk distribution and use of native transitional and winter ranges on and near the refuge and the park would continue to be influenced by hunting. Elk would attempt to move from open hunt areas to non-hunted portions of the park and the refuge.

Elk Behavior, Social Interactions, and Nutrition

A maximum of 7,500 elk currently occupy the refuge and are fed at four sites or through standing forage in most (9 of 10) years. This would continue under Alternative 1.

Elk would continue to habituate to the start of supplemental feeding operations within several days, and once habituated, they would not react adversely to feed trucks or the dispensing of pellets (B. Smith, pers. comm. 2002). Elk would continue to temporarily leave feedlines for various reasons, mostly associated with interactions between animals, but also if feeding operations did not progress in a familiar manner (B. Smith, pers. comm. 2002). Elk behavior would continue to vary from day to day. On most mornings elk would be close to where they were fed the day before, which would result in less movement and fewer interactions among elk. On Poverty Flats the supplemental feeding location would continue to vary daily, and over the course of several days feeding sites could be distributed over a large area. This would continue to require elk to move longer distances to feeding sites and could result in slightly higher levels of interaction as they converged on feedlines (Cole, pers. comm. 2002). It is expected that gorings by bull elk on feedlines would be rare, as the program has been fine-tuned over the last 30 years to reduce competition. Under baseline conditions, an estimated three to four gorings per year occur that result in substantial injury or death (B. Smith, pers. comm. 2002).

During periods of supplemental feeding, elk would continue to be concentrated along lines of alfalfa pellets. After eating at the feedlines, the elk would continue to disperse to nearby areas, rest during a large part of the day (Smith and Robbins 1984), and feed on native forage as they have in the past.

As the bison population grows, progressive displacement of elk from preferred forage on the refuge is considered likely (Telfer and Cairns 1979; Helprin 1992). Bison impacts on elk would be greatest during periods when high quality forage is in critical demand, such as during drought years and during especially cold or snowy winters. However, even during fall, bison may browse woody plants preferred by elk (Smith, Cole, and Dobkin 2004a). Large numbers of bison could remove much of the forage elk would use in addition to contribution to plant degradation through overuse. These impacts would become significant at some unknown bison population level.

Smaller amounts of standing forage would be available for elk on their wintering grounds, which could necessitate changes in the supplemental feeding program. To maintain up to 7,500 elk on the refuge, the amount of food provided might need to be increased repeatedly over time, and feeding might need to be initiated earlier each year in the long term.

Disease Prevalence and Transmission

Some of the disease discussion covers effects on both bison and elk to avoid redundancy.

Bovine Brucellosis

Under Alternative 1 brucellosis prevalence in the refuge portion of the Jackson elk herd, and the entire Jackson elk herd, would vary over time as it has in the past and would remain fairly high (seroprevalence rate since 1980 averaged approximately 28%; NER unpubl. data) in the short term. In the long term the Jackson bison herd would continue to increase in numbers. As bison numbers continued to increase, the chance for contact between elk and bison would increase, particularly on the feedgrounds. Although the degree of risk for transmission from bison to elk would continue to increase, this risk might be negligible in the long term.

Septicemic Pasteurellosis

Because the epidemiology of this disease in elk is poorly understood (B. Smith 2001; see Chapter 3, page 129), impacts from the alternatives are discussed only in relative terms. Potential impacts on prevalence, and production/recruitment, and mortality from septicemic pasteurellosis would be highest under Alternatives 1 and 5 because of high numbers of elk on the refuge.

Winter Supplemental Feeding for Elk

Under Alternative 1 supplemental feeding would continue to affect various population parameters. In Jackson elk, feeding increases herd size, beyond numbers that would be present without supplemental feeding, by providing supplemental nutrition and limiting winter mortality to 1%–2%. It does not appear to alter pregnancy rates or calf production, as these rates are similar in fed and unfed elk populations (B. Smith 2001).

The feeding program would continue to enhance elk survival and maintain a larger population.

Necrotic Stomatitis

As described in Chapter 3 (see page 130), necrotic stomatitis occurs in elk when coarse woody vegetation or grasses with large awns and seeds puncture the soft tissue of the mouth or throat and become infected with *F. necrophorum* (Leighton 2001). Most of the management alternatives are designed to balance elk and bison numbers with habitat and forage availability. When sufficient winter forage (either standing forage or supplemental feed) was available for elk, occurrence of necrotic stomatitis would be negligible and would not likely differ from the current two to three mortalities per year. Alternative 1, as well as Alternative 3, 4, and 5, would supply elk on the refuge with sufficient forage through native range habitat improvements, enhanced forage production through irrigation, and supplemental feeding in the worst winters. Impacts would be negligible.

Psoroptic Scabies

As described in Chapter 3 (see page 130), psoroptic mites are spread through direct contact, and prevalence in a herd is likely density related (Peterson 2003; Disease Expert Meeting 2002; Smith and Roffe 1994). There would be no additional impact on prevalence of psoroptic scabies in the elk herd in the long term under Alternative 1 because elk numbers and the supplemental feeding program would remain the same as baseline conditions.

Helminths and Lungworms

As described in Chapter 3 (see page 130), lungworm parasitism and lungworm infection is density dependent in elk (Disease Expert Meeting 2002). In the long term lungworm transmission among elk and prevalence in the Jackson elk herd would be greatest under Alternatives 1 and 5 because supplemental feeding would occur nearly every winter and high elk numbers would be maintained.

Bovine Tuberculosis and Bovine Paratuberculosis

These diseases are not currently affecting the Jackson elk or bison herds. However, if the Jackson elk and bison herds did contract bovine tuberculosis or bovine paratuberculosis, greater animal densities on the refuge and more frequent supplemental feeding would increase transmission (Williams 2001; Demarais et al. 2002), and subsequent prevalence and mortality. The relative risk of bovine tuberculosis and paratuberculosis becoming established in the Jackson elk or bison herds would be similar under a given management alternative. Therefore, impacts on the Jackson elk and bison herds from both diseases are discussed together.

Only the relative risk of the Jackson elk and bison herds acquiring either bovine tuberculosis or paratuberculosis, or the impacts of its spread if the herd became infected, is presented. The most likely way the herd could contract either disease is from domestic livestock (Peterson 2003; Disease Expert Meeting 2002) or contact with captive cervids (Thorne et al. 1992).

Alternative 1 would provide an ideal environment for these diseases to be spread and maintained in the Jackson elk herd (Disease Expert Meeting 2002) due to the intensive supplemental feeding program and high elk densities (Demarais et al. 2002; Thorne et al.1982; Thorne et al. 2002). If bovine tuberculosis became established in elk on the refuge, prevalence could be higher than in other herds (5.5% for an elk herd in Canada and 2.5% for a white-tailed deer herd in Michigan, for example) due to high winter density. Prevalence estimates for bovine paratuberculosis are not available, but it is thought that elk on the refuge would maintain infection (Disease Expert Meeting 2002). In addition to transmission between elk, Alternative 1 would also be most likely to result in transmission between bison and elk, as bison would continue to increase and the two species would mix.

Malignant Catarrhal Fever

As described in Chapter 3 (see page 132), no cases of malignant catarrhal fever have been reported in the Jackson bison or elk herd (HaydenWing and Olson 2003). The most effective control of this disease is preventing contact with hosts (e.g., domestic sheep), especially during calving or nursing periods (Heuschele and Reid 2001). The risk that this disease would infect the herd under Alternative 1 would be greater than under the other alternatives because more animals would be present and the chances that any one of them would have had contact with infected sheep would also be higher.

Chronic Wasting Disease

As discussed in Chapter 3 (beginning on page 132), chronic wasting disease is transmitted between animals, but the exact mode of transmission is unknown (Williams, Miller, et al. 2002); however, transmission does appear to be related to the density of susceptible hosts and environmental contamination. Because so little about the means of transmission and other critical factors in predicting the potential risk of the disease is known, risk is only presented in relative terms.

Wildlife disease experts ranked the management alternatives based on the relative impacts that the disease might have on the Jackson elk herd, should it become established (Disease Expert Meeting 2002). Rankings were based on two primary factors: (1) supplemental feeding frequency and duration, and (2) the number of elk on the refuge. Prevalence of chronic wasting disease under Alternative 1 would be similar to that under Alternative 5, and greater than under Alternatives 2, 3, 4, and 6 (Table 4-6).

If chronic wasting disease became established in the Jackson elk herd, it is likely that prevalence would fall within the range seen in free-ranging and confined elk (2%–4%, Miller and Williams 2003; up to 59%, Peters et al. 2000; HaydenWing and Olson 2003). Mortality would reflect prevalence and, depending on the extent of infection, negligible to major increases could be possible. Prevalence and mortality would likely be highest under Alternatives 1 and 5 and lower under Alternatives 4 and 3. High concentrations due to supplemental feeding would not occur under Al

TABLE 4-6: RELATIVE PREVALENCE OF CHRONIC WASTING DISEASE IN THE JACKSON ELK HERD IF IT BECAME ESTABLISHED ON THE REFUGE

Relative Prevalence	Alternative	Number of Elk on the Refuge	Supplemental Feeding
Lowest Prevalence	6 (similar to 2)	2,400–3,200	None
↓	2	1,200–6,000	None
	3	1,000–2,000	2 of 10 years
	4	4,000–5,000	5 of 10 years
Highest Prevalence	1 and 5	5,000–7,500	9 of 10 years

ternatives 2 and 6 after winter feeding was phased out, and prevalence would be lowest under these alternatives.

Calving, Age and Sex Ratios, and Recruitment

Influences on age and sex ratios from harvest strategies under Alternative 1 would likely remain similar to those under existing conditions. The practice of supplemental feeding has not been shown to alter pregnancy rates and calf production as these rates are similar in fed and unfed elk populations (Peek et al. 2002; B. Smith 2001). At present, the Wyoming Game and Fish Department is emphasizing antlerless harvest in order to lower herd size to the objective of approximately 11,000 elk, as well as to decrease hunting pressure on antlered elk (WGFD "2002 Annual Big Game Herd Unit Report"). If fewer antlerless tags are issued after the herd is at objective levels, fewer calves might be harvested, resulting in higher calf-to-cow ratios.

Brucellosis would negligibly impact production and recruitment rates for the portion of the Jackson elk herd that winters on the refuge and the entire Jackson elk herd in the short term under Alternative 1.

Impacts to production and recruitment from septicemic pasteurellosis would be tied to mortality levels, as reproduction is unaffected. Impacts on production and recruitment under Alternative 1 would be similar to those under Alternative 5, and greater than under Alternatives 2, 3, 4 and 6.

The Jackson elk population is not currently infected by bovine tuberculosis, bovine paratuberculosis, or chronic wasting disease. If these diseases became established in Jackson Hole, they would affect production and recruitment through increased mortality and lowering the number of animals that produce calves. Numbers of calves produced each year would decline, with a smaller population size and fewer adult females. These diseases could also affect age ratios because older animals would be more susceptible.

If bovine tuberculosis or paratuberculosis became established in the herd, it is likely that the impact on production would be low. For example, if prevalence of either disease was similar to that known to occur in other herds (5.5% for a Canadian elk herd; Hadwen 1942), then a maximum of 5% of the potential calf production could be lost; this would constitute a negligible decrease in production and recruitment. However, higher elk densities than occur under free-ranging conditions could mean higher prevalence and greater losses. Age ratios could change in the long term because older animals tend to have higher probability of being infected (Rodwell, White, and Boyce 2001) and dying.

Impacts from chronic wasting disease would also be caused indirectly through changes in mortality, the level of which would depend on prevalence in the herd. Experts believe prevalence would lie between levels found in free ranging and confined elk (2%–4% to 59%–100%, respectively). Relative impacts on production and recruitment under Alternative 1 would be similar to those under Alternative 5, and greater than under Alternatives 2, 3, 4, and 6 (Table 4-6). Rankings were based on supplemental feeding frequency and duration, as well as on the number of elk wintering on the refuge.

Mortality

Excluding harvest, annual mortality of mature elk (age 1 or older) in the Jackson herd is expected to remain similar to current estimates of approximately 3% (Lubow and Smith 2004). Winter elk mortality on the refuge would continue to remain at current low levels of 1%–2% of the population because nearly annual supplemental feeding alleviates the effects of occasionally severe winters and inaccessible native vegetation due to deep snow. Deaths would continue to primarily result from natural causes, disease, and vehicle collisions. Mortality levels would remain low under Alternative 1 unless non-endemic diseases infected the elk herd or competition for standing forage with bison caused increased mortality.

Early calfhood mortality would continue to be variable and higher than that of older elk. Mortality of radio-collared elk calves, assessed in 1990–92 and in 1997–99, increased from 15.2% of calves to 27.5% during the second study period. Elk calves were smaller, had slower growth rates, and the period in which deaths occurred was longer in 1997–99 than in the initial study period, probably due to cool April temperatures and larger total elk numbers (Smith et al. 2005). The neonatal loss of 15% was similar to mortality in Colorado elk (Bear 1989) and red deer in Scotland, areas with minimal predation, and it was considerably less than the 31% loss in Yellowstone National Park (Singer et al. 1997) and 66% in Idaho (Schlegel 1976).

Of the diseases described above, only septicemic pasteurellosis is both potentially fatal and currently present in the Jackson herd. Mortality from this disease in the refuge herd has been negligible and would likely vary with the number of elk and frequency and duration of supplemental feeding. Mortality under Alternative 1 would be expected to be similar to what would occur under Alternative 5, and greater than under Alternatives 2, 3, 4, and 6.

Mortality related to other potentially fatal diseases not yet in the herd would vary similarly if the herd became infected, but higher numbers of bison under Alternative 1 could increase impacts from some diseases. Potential prevalence and mortality from diseases such as bovine tuberculosis, bovine paratuberculosis, and chronic wasting disease would depend on density, number of elk and/or bison at the refuge, and the frequency and duration of supplemental feeding.

Because higher bison numbers could increase mortality due to bovine tuberculosis or bovine paratuberculosis, prevalence and potential mortality would be highest for these diseases under Alternative 1. Potential prevalence and mortality in the long term would likely be higher than the 5.5% described for a Canadian elk herd (Hadwen 1942) because of high densities, growing bison numbers, and the intensive supplemental feeding program on the refuge. Because these diseases are chronic and develop slowly, and older animals tend to have higher probability of being infected (Rodwell, Whyte, and Boyce 2001) and exhibiting clinical symptoms, adult elk mortality would increase in the long term as the number of clinical cases increased.

Bison numbers would not affect chronic wasting disease in elk wintering on the refuge, and mortality would be similar to Alternative 5 and greater than under Alternatives 2, 3, 4, and 6. If the Jackson elk herd became infected, prevalence would likely fall within the range seen in free-ranging elk (2%–4%) and confined elk (59%–100%).

Harvest strategy would continue to be the primary cause of mortality in the Jackson elk herd and would likely remain similar to current management under Alternative 1. There could be a decreased emphasis on antlerless harvest after the herd objective of 11,000 elk was reached. Management actions under this alternative would not change low levels of predation on the elk herd.

Health, Sustainability, and Naturalness

The Jackson elk herd could maintain relatively good health and continue to be self-sustaining under Alternative 1 if its current disease status and health conditions persisted and a serious non-endemic disease did not infect the herd. However, both bison and elk would be fed under this alternative, regardless of the size of the populations on the refuge, and it is assumed that the bison population in particular would increase dramatically over time. This concentration of animals would present a high risk of transmitting existing and new diseases, thereby jeopardizing herd health and sustainability in the long term.

Barring the introduction of serious non-endemic disease, the herd would continue to be genetically viable. Under Alternative 1 the herd would continue to be strongly affected by management programs. Harvest would influence parameters such as elk numbers, mortality, movements, seasonal distribution to an extent, age and sex ratios, and breeding ratios. Supplemental feeding would influence numbers, nutritional status, mortality, disease, and movements and distribution.

Due primarily to elevated disease risks, long-term health and sustainability of the elk herd would be lower under Alternative 1 than any other alternative.

Under this alternative management would continue to affect the distribution of the population. Rather than many groups of elk roaming in search of available forage, as occurred naturally, the refuge portion of the herd and other elk in Jackson elk herd using feedgrounds would continue to be concentrated together in a relatively small area for several months each winter.

Several population processes would continue to operate at unnatural levels. Notably, winter mortality would be much lower than natural due primarily to the supplemental feeding program on the refuge. Under natural conditions, mortality rates are different among age and sex classes, but winter feeding would tend to nullify these differences. Also because of the winter feeding program, production and recruitment rates would be unnatural and calves that are born out of the normal calving season would continue to have a high chance of survival.

Of all alternatives, Alternative 1 would result in the lowest level of naturalness in the elk herd even though some aspects of naturalness (e.g., sex ratio, fewer hunter-killed bison) would be higher than under some alternatives.

Conclusion

In the long term under Alternative 1 an estimated 11,000 elk would be in the Jackson elk herd. Elk numbers would remain similar to baseline conditions. Reduction of the herd to objective size through hunting would alter numbers to a minor extent. The herd would be larger than under Alternatives 2, 3, 4, and 6, similar to herd size under Alternative 5.

Movements and distribution would be similar to baseline conditions in the long term due to nearly annual winter supplemental feeding on the refuge. Large concentrations of elk would continue to focus in winter on feedgrounds and nearby areas during periods of supplemental feeding. Recruitment and annual winter survival would remain higher than in non-fed populations in similar environments. Bison numbers would continue to grow, increasing competition with elk for available forage on the refuge, and would likely increase the level of winter feeding.

Habitat conservation and management on the refuge would continue to provide a beneficial effect through increasing available standing forage and habitat. Under Alternative 1 these benefits to elk could gradually be eroded as the bison herd increased.

The risk would be the highest of any alternative for a non-endemic infectious disease quickly spreading through the elk population, due primarily to the winter feeding program and the growing numbers of bison. Therefore, this alternative has the greatest risk of a non-endemic infectious disease having a major adverse impact on survival, population size, and sustainability. The prevalence of brucellosis in the elk herd would remain similar to baseline levels initially and could increase as the bison population grows and interactions between elk and bison on the refuge increase.

Of all alternatives, Alternative 1 would result in the lowest level of long-term health, sustainability, and naturalness in the elk herd.

Due to continued large concentrations of elk on refuge feedlines and growing concentrations of bison on feedlines, there would be an elevated potential for the elk population to be impaired if a non-endemic infectious disease became established in the elk herd. Otherwise, Alternative 1 would not cause impairment to the elk population in the park.

ALTERNATIVE 2

This alternative would minimize human influence on the elk herd. Little would be done to enhance native winter forage and the use of imported feed on the refuge during the winter would be phased out. Ending this program would be accomplished gradually in the short term, by eliminating supplemental feeding in mild winters, then in average winters, and so on. During the latter part of the short-term period, feeding would only occur in winters of above-average and severe snow conditions. Hunting in the refuge and park would be stopped.

Analysis

Numbers of Elk Wintering on the National Elk Refuge and on Native Winter Range

Short-term Effects. During the first few years of the initial 10- to 15-year period, elk numbers on the refuge would increase due to the elimination of hunting on the refuge and the park and continued low levels of mortality associated with the supplemental feeding program on the refuge. Numbers of elk wintering on the refuge could also increase as more and more elk in adjacent areas learn that the refuge has become a safe zone (B. Smith, pers. comm. 2003). When elk are not supplemented with winter feed, a greater number would switch to feeding on native winter range in the analysis area. Although the number of elk on native winter range would vary annually according to the severity of the winter and the stage of the feeding program reduction, numbers would increase during non-feeding years above the estimated 4,400–7,900 that have used native range during the last 15 years. Elk numbers wintering on native range would remain similar to these numbers during feeding years but would decrease gradually as the Jackson elk herd approaches the 11,000 objective.

Long-term Effects. Estimates based on the forage accounting model by Hobbs et al. (2003) indicate that the refuge would overwinter between 1,200 and 6,000 elk without supplemental feeding. The current number of elk on the refuge is larger than available native forage can sustain and has been kept artificially high with supplemental feeding. Without forage cultivation and when feeding was completely discontinued, elk numbers on the refuge would presumably drop to within these numbers, and more elk would switch to native winter range. As a result, elk numbers on native winter range would be greater than the estimated 2,900–5,200 under baseline conditions and Alternative 1. The number of elk wintering in the park is less likely to grow, because much of it is covered in deep snow and offers little additional habitat beyond what is used now.

Eliminating hunting on the refuge would allow more elk to use this transitional range, potentially increasing winter use as well. However, eliminating hunting would also confound the effects of reducing and eventually eliminating supplemental feeding, as elk would see the refuge and parklands as safe zones. Despite this lack of harvest, once supplemental feeding had been phased out, elk numbers on the refuge and in the park would fluctuate more naturally (dependent on weather and predators) and more widely than under current conditions or Alternative 1. Increased mortality would occur primarily during severe winters, and perhaps during above-average winters. During all years, fewer and more widely dispersed elk would remain on the refuge. In the long term, refuge elk would be allowed to "self-regulate" based on numbers that native forage could sustain. Mortality on the refuge and in the park would primarily be due to natural processes such as predation and starvation.

Elk Numbers in the Jackson Elk Herd

Short-term Effects. Immediate cessation of hunting on the refuge and the elk reduction program in the park would increase numbers in the short term. Because the park and the refuge together contributed an average of approximately 35% of the total annual herd reductions, the Wyoming Game and Fish Department could have difficulty keeping the Jackson elk herd close to objective during the 10–15 year period when supplemental feeding was gradually phased out. As reductions in the frequency of supplemental feeding fostered greater reliance on native vegetation, elk numbers on the refuge would gradually decrease. Phasing out feeding near the end of the 10–15 year period would result in minor declines (up to 20%) of elk wintering on the refuge and negligible to minor declines in the Jackson elk herd.

Eliminating hunting would also have immediate effects on summering elk. To the extent they would winter on the refuge and in the park while supplemental feeding continued, the number of elk in the herd and on summer range would increase. A large portion of these elk would spend the summer in the park, and increases in this segment of the herd could occur. Elk in other segments might be subject to hunting on their return to the refuge in the winter (Gros Ventre River basin) or travel through the park to the refuge and avoid being hunted (Teton Wilderness and Yellowstone National Park).

Long-term Effects. In the long term, elk numbers in the Jackson herd under Alternative 2 would be lower than under baseline conditions and Alternative 1. Elk on the refuge could drop to 1,200, and total herd numbers would range from an estimated 8,100 to 11,000, similar to herd size under Alternative 3. This range was calculated through combining known minimum averages for various portions of the herd (e.g., 1,200 on the refuge, 2,500 on the Gros Ventre feedgrounds and 4,400 on native winter range).

Factors decreasing elk numbers in the long term include the elimination of supplemental feeding, cultivation, and irrigation on the refuge, and forage competition with bison. At the same time, other aspects of Alternative 2 would increase elk numbers. Eliminating harvest in the park and the refuge would decrease fall mortality, contribute to higher total herd numbers, and to some extent decrease mortality due to forage shortages during severe winters. In addition, increased forage created through the Jackson Interagency Habitat Initiative, a joint effort by the U.S. Forest Service, the Wyoming Game and Fish Department, and other partners, would reduce winter mortality.

When the Jackson elk herd was at objective (baseline levels), elk numbers wintering in the park would average approximately 360, with a range of 140 to 860. Winter severity would continue to influence elk numbers, with more elk able to winter in the park during average or milder-than-average winters when there is less snow and more available forage. During winters with accessible forage, park elk numbers could increase compared to historical levels due to the elimination of hunting on the refuge and in the park. No hunting would increase the attraction of this transition range and the length of time elk would remain there. Habitat improvement efforts in Bridger-Teton National Forest would also increase the number of elk on native winter range. In addition, if concerted efforts were made to actively restore migrations, elk numbers on native winter range would be greatly increased.

Distribution and Movements of Elk

Short-term Effects. Eliminating hunting on the refuge and the elk reduction program in the park, as well as changes in cultivation, irrigation, and prescribed burning on the refuge, habitat enhancements off the refuge and the park, and the gradual elimination of supplemental feeding would all influence distribution and movement of elk.

Eliminating hunting on the refuge and the elk reduction program in the park would increase elk movements and distribution in the fall and probably in the winter as well. In addition to spending time in traditional non-hunt areas, elk would extend time spent in newly designated non-hunt areas. Supplemental feeding would continue to attract elk to feedgrounds and adjacent areas until there were substantial reductions in frequency of supplemental feeding years. During non-feeding years, elk movements and distribution would increase due to reliance on native forage and wider distribution would become relatively more common.

As supplemental feeding was phased out, distribution of elk to native winter range would increase. This is in part because adults would require food elsewhere, but also because calves would become accustomed to feeding on native forage and would be progressively less likely to ever be exposed to supplemental feeding. Currently, as elk get older, they stand a greater and greater chance of discovering a feedground or learning about locations by following experienced individuals. Once fed, typically they return year after year. After several non-feeding years occur back to back, proportionally more elk would be unaware of feedgrounds and would remain on native winter range even during years when supplemental food was provided (B. Smith, pers. comm. 2003).

Prescribed fire on the refuge has helped create more nutritious grasses for elk and its elimination in this alternative would result in negligible changes to distribution on the refuge. Conversion of cultivated fields to native vegetation would also provide less forage than is currently the case, and result in the more widespread dispersion of elk onto native winter range.

This would be furthered by forage enhancements in the Gros Ventre River drainage and Buffalo Valley planned by the Wyoming Game and Fish Department, the U.S. Forest Service and other partners as part of this alternative. These enhancements would begin in the short term and would provide additional forage, attract elk to improved areas, and allow more elk to subsist on native range. Some elk could wander farther into the Gros Ventre River drainage, discover WGFD feedgrounds, and increase densities there. If attempts to acquire conservation easements were successful, these procurements would prevent further loss of habitat to development, providing elk with continuing sources of good habitat and promoting wider distribution.

Long-term Effects. The actions described above to feeding, forage, and hunting, as well as elimination of the park elk reduction program would continue to influence elk movements and distribution in the long term.

Based on modeled estimates (Hobbs et al. 2003), the refuge could support between 1,200 and 6,000 elk without any cultivation or supplemental feeding depending on the severity of winter and other factors. At the high end of the range, elk numbers would approximate current conditions although, because feedlines would disappear, densities and distribution would change. Short-duration feedline concentrations are currently approximately 500 elk/acre. Major declines in densities compared to Alternative 1 would occur when elk numbers are at the low end of the range. On average across the refuge and assuming an even distribution, densities would be decreased to a moderate (35%) degree, 0.32 elk/acre compared to 0.51 elk/acre under baseline conditions. Because elk would not distribute evenly, these numbers should be used only for comparing alternatives, rather than as absolutes.

In addition to redistributing elk on the refuge itself, eliminating supplemental feeding on the refuge would increase elk movements and distribution across native winter range throughout the analysis area. Results of modeling (Hobbs et al. 2003) indicate that elk could winter in areas such as the Gros Ventre River drainage, south of Jackson in the Snake River Canyon, and in lower portions of Hoback Canyon. Feedgrounds in these area could stop many elk from moving farther. It is possible that elk might also venture over geographic divides in search of better winter range as they have been recorded doing in areas of Colorado. In several spots in Colorado, elk routinely cross the divide at elevations of between 9,000 and 12,000 feet as part of their migration to winter or summer range (Larkins 1997). The divide between the Gros Ventre and Green River basins is 9,000–10,000 feet in elevation (Hinshaw 1989) and may be similarly passable. A wildlife fence currently limits movements to the west and south of the refuge.

More elk might winter in the Buffalo Valley area, and many would use areas immediately to the east of the refuge and the Gros Ventre River drainage; some elk could discover and join the Gros Ventre feedgrounds, inflating traditional numbers at those sites and potentially causing changes from current distribution if many elk did this. Other elk might move to nearby areas in the southern part of the park and winter on south-facing hills or other areas with forage available due to less snow cover. More elk would also venture onto private lands.

The potential impact to elk summering in various locations was analyzed using two possible scenarios from studies conducted on elk using the refuge in the winter. The first is from an analysis of radio-collared elk studied in 1978–82, which indicated about half (48%) of elk wintering on the refuge spent the summer inside Grand Teton National Park. The remainder summered in Yellowstone National Park (28%), the Teton Wilderness (12%) and the Gros Ventre River drainage (12%) (Smith and Robbins 1994). The two scenarios analyzed bracket this range; one assumes about one-third of elk wintering in the refuge summer in the park, and the other assumes about one-half do so.

Assuming the park segment comprised approximately 50% of the refuge wintering herd, between 600–3,000 elk would summer in the park, a minor to major decrease compared to numbers under Alternative 1. Elk numbers in the other three segments, the Gros Ventre, Teton Wilderness, and Yellowstone National Park segments, would experience negligible to minor decreases. If the park segment represented one-third of the refuge herd size, elk numbers in the park would be reduced to between 400 and 2,000, a moderate to major decrease. Under this scenario, elk numbers in the other three segments would experience minor decreases to negligible increases.

Because they migrate only a short distance to the refuge for the winter, elk that traditionally summer in Grand Teton National Park (the Grand Teton segment) would be less likely than other segments to discover adequate winter range than other segments and would continue to seek out the refuge. Elk in the other segments could have more success in finding winter range during their migration because they cover more potential habitat along their migration. Because the park offers sanctuary from hunting, additional elk could winter here or in the currently hunted northern end of the refuge in this alternative.

The forage enhancements described above would also provide additional winter range for elk in the long term with resulting increases in the scope of their distribution. It is possible that elk could migrate to the Green River basin. However, there are obstacles to migration including landowner intolerance. In addition, livestock feeding operations and WGFD feedgrounds lie along the migration route, and it is likely that elk would go no farther than the feedgrounds should they encounter them. Over time many elk that now winter on the refuge could find the Gros Ventre feedgrounds, greatly increasing numbers and impacts in that area. Working with private landowners to increase tolerance of elk and concerted agency efforts could potentially foster migration.

Elk Behavior, Social Interactions, and Nutrition

Short-term Effects. Converting cultivated areas on the refuge to native vegetation, and gradually reducing years of supplemental feeding on the refuge under Alternative 2 would affect elk behavior, social interactions, and nutrition. Feedline behavior and competitive social interactions on the refuge would occur only in feeding years.

Because the method of reducing supplemental feeding would eliminate winter feeding first in the mildest winters, there would be relatively little snow cover and vegetation would be accessible. Nutrition would remain high, and elk would be negligibly affected by the lack of feeding in these years. Ration or pellet composition might need to be changed to allow for later initiation of supplemental feeding during these years. A higher fiber formula as recommended by Baker and Hobbs (1985) for mule deer could be one possibility. Initiation of supplemental feeding would be based on assessments of forage utilization (jointly done by WGFD and NER personnel) and potentially on the January 1 index of winter severity (Farnes et al. 1999) calculations for elk.

As supplemental feeding became less frequent and cultivated fields were converted to native vegetation, elk would compete for native forage during increasingly severe winters, and nutrition would be decreased. Total herbaceous forage available on the refuge would be lower by a minor amount than under baseline conditions and short-term conditions under Alternative 1. However, elk numbers would eventually decrease on the refuge, and individual elk would be able to gain higher levels of nutrition from vegetation than if the population numbers continued at levels similar to baseline conditions and Alternative 1. Lower densities would also mean fewer cases of psoroptic scabies, which contributes to nutritional stress in elk (Thorne et al. 2002).

Long-term Effects. Competition among elk and between elk and bison for forage, and displacement of elk by bison in transition and winter habitat would be less severe under this alternative than in the long term under Alternative 1. During shortages of native forage, aggressive social interactions involving competition for food with other elk and with bison could increase.

Localized competition with bison for standing forage would occur despite fewer bison on the refuge under this alternative, and elk might move to areas with less desirable forage in order to avoid conflicts with bison. In general, however, broader distributions of elk and bison would diminish competition between the two species.

Nutritional status under Alternative 2 would be similar to that in elk populations that are not food-supplemented. Elk are adapted to survive severe winters and can sustain energetic debt and weight loss of up to 25% during more severe winters (Wisdom and Cook 2002). Other known adaptations in ungulates include thick winter fur, metabolism reduction by nearly one-third, behavioral adaptations (bedding down for long periods during severe weather), and great reliance on stored body fat (Mitchell, McCowan, and Nicholson 1976; Mautz 1978). Although some elk could die during above-average (i.e., more severe) winters because of decreased nutrition and body condition, eventually the number of elk would decrease and food might be more available. Low numbers of elk on the refuge might be able to maintain good nutritional levels on native forage. Implementing Alternative 2 would result in more malnutrition in severe winters and moderate to major increases in mortality in severe winters compared to baseline levels.

Less forage on the refuge could be partially offset by the greater long-term palatability of some native species (Brock, pers. comm. 2003) during years when below-average and average snow depths allow access to these bunch grasses. Another factor that will help in offsetting nutritional deficiencies is the effort agencies would make to enhance the quality and quantity of forage in Bridger-Teton National Forest and Buffalo Valley.

Disease Prevalence and Transmission.

Bovine Brucellosis

Prevalence in Herd — Under Alternative 2 prevalence for brucellosis in the refuge portion of the Jackson elk herd would likely remain unchanged from current levels in the short term. In the long term, elk density on the refuge would be reduced as the supplemental feeding program was phased out, elk numbers on the refuge would be reduced to 1,200–6,000 animals, and elk would be more widely distributed across native forage. In addition, if obstacles can be removed, it is possible that migration to winter range outside Jackson Hole could be reestablished (theoretically; see "Distribution and Movements of Elk: Long-term Effects"). In the absence of a supplemental feeding program, brucellosis prevalence in elk is just 1%–3% (Rhyan et al. 1997; Ferrari and Garrott 2002) and less in some locations (Smith and Roffe 1994). It appears that this low prevalence in elk herds that do not use feedgrounds is maintained by contact with other elk or bison from herds on feedgrounds. Returning to densities more typical of natural populations would result in a much lower risk of contact with aborted fetuses and a major reduction in the long-term prevalence rates approaching those of other elk populations that are not fed during winter. For the entire Jackson herd (of which the refuge elk are a portion) there would only be a moderate long-term reduction in prevalence because approximately 2,500 elk would continue to be fed on the state-operated Gros Ventre feedgrounds. Elk numbers would likely be higher than 2,500, and possibly much higher if many refuge elk dispersed to the Gros Ventre drainage and found those feedgrounds.

Transmission among Elk — The chance of transmission among elk would drop with decreasing density and a lower chance of contact among elk and contaminated fetuses or birth sites. In the short term, the chance of transmission would be reduced by a moderate amount (Disease Expert Meeting 2002). However, as elk learn new movement and distribution patterns, a major decrease is likely. A similar, minor to moderate reduction in transmission among elk in the entire herd unit is likely.

Transmission from Bison to Elk — There would be a major reduction in transmission of brucellosis from bison to elk on the refuge for four reasons: (1) numbers of bison and elk would be greatly reduced compared to Alternative 1, (2) the supplemental feeding program would be eliminated and would reduce contact between elk and bison, (3) brucellosis prevalence in the bison herd would be decreased, and (4) fewer abortions would result from reduced prevalence. In the absence of the supplemental feeding program, elk and bison might still commingle to some degree on the refuge, but they would not be as concentrated as they would be on feedlines. In areas where both elk and bison are present and there is no feeding program, interspecies transmission is low (Ferrari and Garrott 2002).

Septicemic Pasteurellosis

Because the epidemiology of this disease in elk is poorly understood (Smith 2001), impacts from the alternatives are discussed in relative terms. Potential impacts on prevalence would be lowest under alternatives that reduce the number of elk on the refuge and reduce the supplemental feeding program. Potential impacts are expected to be lowest under Alternatives 2, 3, and 6. Potential impacts under Alternative 2 would be expected to be similar to Alternatives 3 and 6 and lower when compared to all other alternatives. For more detailed discussion, see the corresponding section for elk under "Disease Prevalence and Transmission" for the impacts of Alternative 1.

Necrotic Stomatitis

An increased incidence of necrotic stomatitis in the Jackson elk herd could occur if sufficient high quality forage was not available and elk were forced to use poor forage such as coarse woody vegetation. Prevalence of necrotic stomatitis could increase by a negligible to minor degree depending on winter severity under Alternative 2 compared to Alternative 1 because relatively high numbers of elk (up to 6,000) could remain on the refuge with no forage enhancements or supplemental feeding. However, under baseline conditions excessive use of coarse woody vegetation occurs with little prevalence of necrotic stomatitis. Adverse impacts on mortality, production, and recruitment in the Jackson elk herd would be the same as the impacts on prevalence (negligible to moderate depending on winter severity) under Alternative 2 compared to Alternative 1.

Necrotic stomatitis is not transmissible; hence, transmission among elk would not be a factor under any of the management alternatives.

Psoroptic Scabies

Supplemental feeding results in direct contact between elk, increasing the chance for transmission of psoroptic mites among elk. Prevalence of psoroptic scabies in the Jackson elk herd would decline where winter feeding was reduced. For this reason, prevalence of psoroptic scabies in the elk herd under Alternatives 2 (similar to Alternatives 3, 4, and 6) would decrease by a negligible to minor amount under compared to Alternative 1 due to the reduction in the winter feeding program and the reduced number of elk in the herd.

Helminths and Lungworms

Lungworm transmission and prevalence in the elk herd would be lowest under Alternative 2 (and Alternative 6) because supplemental feeding would be reduced on the refuge in the short term, and eliminated in the long term, and lower numbers of elk would winter on the refuge compared to Alternative 1. Impacts would be less than under all other alternatives. Lungworm transmission among elk and prevalence in the elk herd would be higher under Alternatives 3 and 4, and would be greatest under Alternatives 1 and 5 because winter feeding would occur nearly every year and high elk numbers would be maintained.

Bovine Tuberculosis and Paratuberculosis

Bovine tuberculosis and bovine paratuberculosis are not present in the Jackson elk herd. The relative risk among the alternatives that either of these diseases would become established would be lowest under Alternative 2 because the supplemental feeding program would be eliminated.

If bovine tuberculosis or bovine paratuberculosis infected the Jackson elk herd in the short term before the elimination of winter feeding, the potential for transmission and therefore potential prevalence would be much lower under Alternative 2 than under Alternative 1. In the short term, prevalence is likely to be lower by a moderate amount compared to Alternative 1 as locally high densities of elk in western portions of the park and elsewhere in the Jackson herd unit might provide focal points of transmission (B. Smith, pers. comm. 2003). In the long term both the potential for transmission and prevalence would be lower by a major amount than under Alternative 1. Because many fewer bison would use the refuge under this alternative, both the potential for transmission of these diseases from bison to elk, and prevalence in bison in the analysis area, would be reduced by a major amount.

Malignant Catarrhal Fever

The risk of elk or bison that now feed on the refuge contracting malignant catarrhal fever would be greatest under Alternative 2 because elk and bison would disperse more widely and would have a greater chance of coming into contact with domestic sheep herds and potentially contracting the virus that causes malignant catarrhal fever. However, this would be offset by decreases in numbers and density of both elk and bison compared to Alternative 1.

Overall, potential for impacts from this virus would be lowest under Alternatives 2, 3, and 6 because elk numbers would be reduced (1,200–6,000 under Alternative 2; 1,000–2,000 under Alternative 3; 2,400–3,200 under Alternative 6) in the long term, and supplemental feeding would not occur under Alternatives 2 and 6. Even though winter feeding would occur in severe winters under Alternative 3, the potential for impacts would be less than under Alternatives 1, 4, and 5.

Chronic Wasting Disease

Based on presumed transmission and prevalence of chronic wasting disease as described in Chapter 3 (see page 132) prevalence under Alternative 2 (and Alternative 6) would increase slowly compared to alternatives in which supplemental feeding, ungulate concentrations, and a greater likelihood of environmental contamination in localized areas would occur (Alternatives 1 and 5; and Alternatives 3 and 4 to a lesser extent).

Under Alternative 2 if migration to the Green River basin occurred, there would be a moderate increase in risk of chronic wasting disease becoming established in the Jackson elk herd compared to Alternative 1. Some contact between Jackson elk and adjacent herds in the Green River and Wind River drainages presently occurs (B. Smith, pers. comm. 2003). This risk would be similar to but greater than that under Alternative 3. If this disease became established in the Jackson elk herd, prevalence would ultimately lie within the range seen in free-ranging and confined elk (see discussion under Alternative 1).

Despite unknowns identified above, the alternatives were ranked for the rate of transmission and prevalence of chronic wasting disease based on two primary factors, (1) supplemental feeding frequency and duration, and (2) the number of elk on the refuge. High concentrations due to winter feeding would not occur under Alternative 2 (or Alternative 6) after winter feeding was phased out, and prevalence of chronic wasting disease under these alternatives would be lower than all other alternatives (see Table 4-6).

Because surveillance would be accomplished through sampling harvested elk, agency removals might be necessary under Alternative 2 to contribute to WGFD surveillance goals.

Calving, Age and Sex Ratios, and Recruitment

Short-term Effects. Sex and age ratios in portions of the Jackson elk herd would begin to change in the short term because elk hunting on the refuge and the elk reduction program in the park would not occur. In these unhunted portions of the herd, sex ratios would start to resemble those found in unhunted elk populations (about 33 branch-antlered bulls and 17 spikes per 100 cows; DeSimone et al. 1993) and in unhunted European red deer populations (about 50 bulls per 100 cows; Mitchell, Staines, and Welch 1977). Bull-to-cow ratios would become higher than those recorded for the Jackson elk herd in winter 2004 (33 bulls per 100 cows, comprised of 25 branch-antlered bulls and about 8 spikes per 100 cows). The prime-aged male cohort would become a larger proportion of elk in these areas because hunters would no longer be removing them at a higher rate than other sex or age categories.

Impacts on production and recruitment rates for the refuge portion of the Jackson elk herd associated with brucellosis would not be expected to change in the short term.

Long-term Effects. Sex and age ratios in non-hunted parts of the herd would be more similar to those in non-hunted elk populations, as described above. Reducing calf loss due to brucellosis would represent a negligible increase (less than 1%) in Jackson elk herd production and recruitment.

Disease might also affect production and recruitment. Those diseases that spread by means of contact with infected elk or bison, such as septicemic pasteurellosis, and bovine paratuberculosis and tuberculosis, would run the lowest risk of spread in alternatives with lower densities and wider distribution, such as Alternative 2. They would therefore have the least impact on production and recruitment. Under Alternative 2 potential production losses from bovine tuberculosis or paratuberculosis would be reduced by a moderate amount over time compared to potential losses under Alternative 1. Because prevalence would likely be low if infection occurred, and because losses in calf production under the latter would be negligible, potential calf production could be increased by a negligible amount under Alternative 2. The absolute impact of these diseases on production in the herd would be low. Impacts on production and recruitment from septicemic pasteurellosis under Alternative 2 (and Alternative 6) would be similar to those under Alternative 3 and lower than under all other alternatives.

Adverse impacts on production and recruitment from necrotic stomatitis in the Jackson elk herd would be similar to its prevalence, that is, negligible to moderate depending on winter severity, under Alternative 2 compared to Alternative 1.

The negligible decrease in prevalence of psoroptic scabies expected under Alternative 2, which would be similar to impacts under Alternatives 3, 4, and 6, would not likely affect production and recruitment of the Jackson elk herd in the long term. Adult bull mortality from psoroptic scabies would decrease negligibly under Alternative 2 compared to Alternative 1 due to the reduction in the winter feeding program and the reduced number of elk in the herd.

There are no impacts at present from chronic wasting disease. If this disease became established in Jackson Hole, it would affect production and recruitment through increased mortality and lowering the number of animals that produce calves. Numbers of calves produced each year would decline with a smaller population and fewer adult females to produce calves. Chronic wasting disease may affect older animals to a greater extent. This is also true of bovine paratuberculosis and tuberculosis.

Impacts on calving and ratios from chronic wasting disease would be caused indirectly through changes in mortality, the level of which would depend on prevalence in the herd. Experts believe prevalence would lie between levels found in free ranging and confined elk (2%–4% to 59%–100%, respectively). Relative impacts on production and recruitment under Alternative 2 (and Alternative 6) would be lower than potential impacts under all other alternatives (Table 4-6).

Mortality

Short-term Effects. Elk mortality would be lower in the short term, at least during the early years of Alternative 2, compared to baseline conditions and Alternative 1 due to the elimination of the refuge elk hunt and the park elk reduction program. Decreases in mortality would primarily affect elk wintering on the refuge.

Currently, elk hunted on the refuge and in the park make up about 34%–35% of the total harvest of the Jackson elk herd, with the park contributing about 23%, the refuge about 11%, and other areas 67% of total herd harvest (WGFD 1989–2003). When hunting on the refuge and the elk herd reduction program in the park stopped, more elk might move into protected areas (park, refuge).
Winter mortality would gradually increase on the refuge as supplemental feeding was phased out, especially if the fence was maintained at the southern and southwestern sides of the refuge. Because the number of elk and competition for what could be scarce food resources on native winter range would increase, mortality in the herd would also increase. Elk from the park segment would primarily be affected.

Some elk that otherwise would have been attracted to supplemental feed on the refuge might instead move south of the park to private lands, where they could cause depredation and possibly increase the risk of disease transmission to cattle. Elk from other segments would likely find wintering areas to the northeast and east of the refuge, including the Gros Ventre feedgrounds.

Long-term Effects. In the long-term, the lack of supplemental feeding or cultivated forage on the refuge would increase mortality, but cessation of hunting would continue to reduce it. Because supplemental feeding, cultivation, and irrigation on the refuge would have been phased out after the initial 10–15 years, elk would subsist on natural forage alone, especially if the fence on the southern and southwestern sides of the refuge prevented access to some native winter range. In the long term winter mortality would be higher than under baseline conditions and under Alternative 1 ranging from 1% to about 20% (an estimated 23%) of elk formerly fed on the refuge. Levels would reflect winter severity, ranging from very low during mild winters to high during severe winters (B. Smith, pers. comm. 2002; Hobbs et al. 2003). The estimated range for mortality is similar to mortality in Yellowstone National Park's northern elk herd from March 2000 to February 2003 (S. B. Evans and L. D. Mech, University of Minnesota, unpubl. data). Preliminary results from 91 radio-collared animals indicated that mean annual mortality averaged 17% and ranged from 7% to 22%. Elk that wintered outside the park, where they were exposed to hunting, and elk that wintered primarily inside the park where no hunting occurred but wolf densities and use was higher, did not experience significantly different mortality rates.

As elk ventured further from the refuge in search of native forage, they would be more likely to occupy private lands, where they could depredate hay crops, or mingle with livestock. In those cases management action by WGFD personnel could be required and could include depredation hunts, agency removal, or relocation of elk. The Wyoming Game and Fish Department also anticipates increased conflict between elk and non-agricultural landowners, with depredations to ornamental shrubbery, horse hay, and increased vehicle collisions in and around subdivisions (Holz, pers. comm. 2003).

Although more predation would be expected under Alternative 2, this increase would likely be compensatory. More elk would experience some degree of energetic debt, relying on body fat and lean body mass to survive winter. Severe winters would cause lower physical condition in some, making them easier prey. Calves, mature bulls already stressed physiologically from rut activities, and older animals would be the most likely cohorts to experience higher predation.

In the long term mortality from septicemic pasteurellosis under Alternative 2 would be similar to those under Alternatives 3 and 6 and lower than under all other alternatives. Necrotic stomatitis is rare on the refuge now, and it is fatal only in serious cases when infections become chronic and the animals lose teeth and eventually die of starvation. Although prevalence of this disease could increase by a negligible to minor amount (see "Disease Prevalence and Transmission" above), mortality related to it would not likely increase beyond negligible levels in the long term.

Adult bull mortality from psoroptic scabies would decrease negligibly under Alternative 2 due to the reduced number of elk in the refuge herd as well as lower elk concentrations stemming from the elimination of the refuge feeding program.

Alternative 2 would potentially result in a moderate reduction in mortality caused by bovine tuberculosis or paratuberculosis compared to Alternative 1, because prevalence and thus the number of clinical cases would be reduced by a moderate amount.

Chronic wasting disease is generally fatal, and models predict eventual extirpation of affected populations (Gross and Miller 2001). This means it can have population-wide lethal effects and lead to population decline, although whether whole populations will become extinct or not is unknown. Recent estimates of chronic wasting disease prevalence in affected free-ranging populations were 2%–4% in elk and 15%–18% in deer (Miller and Williams 2003). The impact on mortality in the herd would be directly related to prevalence. Relative mortality among the alternatives would therefore likely parallel rankings described above under "Disease Prevalence and Transmission," i.e., it would likely be lowest under Alternative 2 and 6 compared to all other alternatives (Table 4-6), and next lowest under Alternative 3.

Most conceptual models suggest that non-fed populations (e.g., the elk herd under Alternatives 2 and 6) would likely survive at higher numbers and/or for a longer time than would fed populations, but in the worst case might be about the same as fed populations (Roffe, pers. comm. 2004).

Data on free-ranging elk have shown a very slow rate of increase in prevalence of the disease, while game farms / research facilities have suggested that fairly rapid spread of infection is possible (Williams and Young 1980; M. W. Miller, Wild, and Williams 1998; M. W. Miller et al. 2000). Given these factors, it is assumed that alternatives with less supplemental feeding, e.g. fewer years of concentrating elk and contaminating the environment, would decrease mortality in the long term. These differences might only be apparent with large-scale changes, as it is considered unlikely that even lowering the number of supplemental feeding years by half would substantially alter the high potential for transmission through environmental contamination.

Health, Sustainability, and Naturalness

Short-term Effects. The health and sustainability of the Jackson elk herd would increase gradually as supplemental feeding was phased out and there was greater reliance on natural forage. Lower elk numbers and concentrations that would begin to occur later in the short term would result in lower disease prevalence and transmission of current diseases such as brucellosis as well the risk of contracting or spreading any non-endemic infectious disease.

Naturalness would increase gradually in the short term under Alternative 2 as elk increasingly disperse according to the distribution of available forage on native range. Natural phenomena, such as winter weather and predators, would have an increasingly stronger influence on mortality. Numbers, density, sex and age ratios, potential for disease transmission and behavior would all much more closely approximate elk populations under natural conditions as supplemental feeding decreases. Human effects would occur at a much reduced level through some winter feeding, agency removals, and vehicle collisions, but these would decline as elk numbers decreased over time.

Long-term Effects. Health and sustainability under Alternative 2 would be greater than what would occur under all other alternatives, except Alternative 6. These qualities would be most similar to those under Alternative 3.

Herd health would improve because of increased dispersion of elk and bison as supplemental feeding was discontinued on the refuge and forage improvements by the U.S. Forest Service, the Wyoming Game and Fish Department, and other partners were made. Brucellosis seroprevalence and transmission would be reduced compared to Alternative 1. Transmission risk and the likelihood of major adverse impacts from other diseases would also be lowered. For these reasons, long term health and sustainability of the elk herd would be highest under Alternative 2 (along with Alternative 6).

Barring the introduction of serious non-endemic disease, the herd would continue to be genetically viable and self-sustaining at lower numbers although elk numbers could drop substantially if winters of above-average severity and pre-winter drought occur repeatedly for several consecutive years. As discussed in impacts of Alternative 1, an average of about 5,000 elk currently survive annually on native range. This could increase following forage improvements. However, even with these improvements, some mortality in the herd would occur as elk progressively rely on native winter range.

As in the short term, the elk herd would be progressively more subject to the influence of natural factors in the long term under this alternative. Climate and amounts of native forage would be particularly influential on numbers, movements, distribution, and mortality.

Production and recruitment rates, winter mortality, nutritional status and distribution would also be more natural. Mortality rates among age and sex classes would mimic unfed populations, including higher mortality rates in calves born out of season.

Elk behavior would also become more natural. Competitive social interactions associated with feedlines and displacement of elk would decrease because there would be fewer elk and bison, wider ungulate distribution, and lower densities.

Effects of hunting would continue to be negligible and could be reduced in the long term if herd size and distribution decreased to a major extent. Harvest would have a minimal influence on the sex ratio because elk hunting would continue to occur outside the boundaries of the park and the refuge and it is expected that only a small number would be killed annually. Increases in mortality due to vehicle accidents or agency removals as a result of wider distribution would be negligible to minor, compared to baseline conditions and Alternative 1.

Of all alternatives, Alternative 2 (and Alternative 6) would result in the highest level of naturalness in the elk herd.

Conclusion

In the long term under Alternative 2 the Jackson elk herd would consist of an estimated 8,100–11,000 elk. The total herd size would fluctuate, decreasing during severe winters to perhaps as low as 8,000 (approximately) but rebounding during other years. The herd would be smaller than under baseline conditions and Alternative 1 in some years, similar in size to Alternatives 3 and 6, and smaller than Alternatives 4 and 5. In the long term this alternative would lower the number of elk that winter on the refuge and summer in the park. Wintering elk numbers on the refuge would decrease to between 1,200 and 6,000. More elk would forage on native winter range in Bridger-

Teton National Forest outside of the refuge and the park.

Wintering elk would disperse in search of natural forage as supplemental feeding stopped over time. Increased mortality would result initially and as more and more elk competed for natural vegetation. When supplemental feeding stopped, the herd would be more responsive to natural conditions, and winter mortality would fluctuate with winter severity, precipitation regimes, and standing forage. Recruitment and annual survival would decrease compared to Alternative 1 and would be closer to levels found in non-fed populations in similar environments. The above impacts would occur to a lesser extent if large numbers of dispersing elk discovered the Gros Ventre feedgrounds and continued to be fed in winter.

Calf production in the long term could increase during consecutive years of mild weather due to reduced brucellosis abortions, lower elk densities, and more available native forage.

Ceasing harvest on the refuge and the park could imbalance herd segments. However, increases in mortality caused by greater reliance on native vegetation and predation would offset the lack of harvest and reduce differences in herd segment mortality levels. Harvest mortality in other areas could decrease overall as more elk might avoid hunters by remaining within the park and on the refuge.

The risk of a non-endemic infectious disease quickly spreading through the elk population after being introduced into the herd would be lowest under Alternative 2 (along with Alternative 6). Low risk would be due to the elimination of the nearly annual supplemental feeding program and the reduction in bison and elk numbers. Alternative 2 (along with Alternative 6) would also have the lowest risk of such a disease having major adverse impacts to survival and population sustainability. The prevalence of brucellosis in the Jackson elk herd would be moderately lower than under Alternative 1.

Alternative 2 (along with Alternative 6) would result in higher levels of long-term health, sustainability, and naturalness in the Jackson elk herd than what would occur under Alternatives 1, 3, 4, and 5.

Barring the introduction of serious non-endemic disease, Alternative 2 would not impair the elk population in the park. Alternative 2 (along with Alternative 6) would have the lowest potential for impairment. Attempts to maintain low natural densities of elk and bison would decrease adverse effects.

ALTERNATIVE 3

This alternative would actively manage elk and bison to keep numbers at designated levels (1,000–2,000 elk, 800–1,000 bison) by minimizing supplemental feeding and using habitat improvement and changed hunting regimes to encourage elk and bison to disperse. Feeding would be reduced over time so that, by year 10–15, imported feed would be used only in the most severe winters. Hunting on the refuge and the elk reduction program in the park would be key to maintaining numbers at their desired levels.

Analysis

Numbers of Elk Wintering on the National Elk Refuge and on Native Winter Range

Short-term Effects. During the initial 10 to 15 years of plan implementation, elk numbers on the refuge would be reduced as supplemental feeding was gradually reduced, as competition for forage with bison continued, and as elk began to forage on native range in other areas. Harvest, especially of Grand Teton National Park segment elk, would be increased initially to decrease the number wintering on the refuge. The combination of this increased harvest, enhanced winter range outside of the refuge, and decreases in supplemental feeding would gradually result in fewer elk on the refuge. Elk mortality would primarily be related to hunter harvest, as only negligible increases in non-harvest mortality of up to 3%–4% per year would be expected. Within 10–15 years, it is anticipated that the number of elk on the refuge would be between 1,000 and 2,000, the population objective under this alternative.

Conversely, the number of elk would gradually increase on native range as supplementing feeding was slowly reduced and eliminated in all but the most severe winters. Elk numbers on native winter range would increase during non-feeding years and initially remain relatively similar to existing conditions (4,400–7,900 elk) during years with supplemental feeding. However, as progressively more elk winter on native range, knowledge among the herd of the refuge feedground location would decline and the number during feeding years would drop. It is possible that a negligible increase in the number of elk occupying habitat in the park would occur during mild winters.

The recovery of woody vegetation and prevalence of brucellosis would help in deciding whether the elk herd has been sufficiently reduced. If woody vegetation and brucellosis objectives appear reachable when elk numbers are still higher than objective, the number of elk on the refuge would be allowed to remain at those levels. On the other hand, if 1,000–2,000 elk on the refuge maintain unacceptable levels of brucellosis and adversely impact woody vegetation, then refuge elk numbers could be decreased.

Feeding would be eliminated first in milder-than-average winters, then in average winters, and then in above-average winters. Ultimately, feeding would take place only in severe winters, an estimated 2 of every 10 years depending on snow and weather conditions. Fewer years of feeding would cause elk wintering on the refuge to increase their reliance on native winter range during non-feeding years. Increased dispersal and closure of hunt areas on the northern fifth of the refuge and the southern part of the park would encourage elk to stay in those areas during transition and winter months rather than move to the refuge feedgrounds.

Option A under this alternative would not change irrigation and cultivation practices on the refuge from current management. As elk numbers decrease, continued production of forage would better sustain the 1,000–2,000 elk and 800–1,000 bison remaining on the refuge. This also means that, when winters are severe and supplemental feeding was required, the number of feeding days would be reduced compared to current conditions. Option B would result in the return of cultivated forage to native range.

Long-term Effects. Elk numbers on native winter range would increase and those on the refuge would decrease in the long term.

Modeling for Overwintering Elk

Modeling by Hobbs et al. (2003) suggests that up to 3,700 elk could winter on the refuge (long-term average snow depth with average pre-winter precipitation) and 1,000 bison without supplemental feeding and with no forage deficit or depletion of energetic reserves under Alternative 3. As many as 5,000 could subsist on the refuge if accruing a forage deficit would be acceptable. During winters of above-average snow or preceded by drought conditions, however, elk numbers on the refuge would decrease due to dispersal in search of additional forage and also because of higher mortality. The likely low end of the range would be 1,000–2,000 elk. However, the model shows that under certain conditions of above-average winters preceded by drought, the refuge might have no elk. This is probably unrealistic, particularly given a trend toward increasingly mild winters and the estimated number of elk wintering on native range in recent years (B. Smith, pers. comm. 2003).

As in the short term, fewer elk on the refuge would primarily be maintained through hunter harvest, particularly of the Grand Teton National Park segment. Other factors that would contribute to maintaining refuge numbers at about 1,000–2,000 include winter feeding only in severe winters, reliance on available standing forage in most years, reliance on native vegetation (Option B of Alternative 3), improved habitat conditions in Bridger-Teton National Forest, and competition with 800 or more bison. As stated previously, the objective of 1,000–2,000 elk on the refuge would depend on the degree to which disease prevalence and restoration of woody vegetation was achieved and the ability to increase harvest levels for the park segment.

Elk would disperse to native winter range in search of food. As progressively more lose the memory of the refuge feedground, numbers would continue to fall and eventually stabilize at 1,000–2,000. Numbers on native winter range would be greater than the estimated 4,400–7,900 under existing conditions, and greater than the 2,900–5,200 under baseline conditions and Alternative 1. Closing some areas of the refuge to hunting, along with portions of the park to the elk reduction program, as well as improvements in habitat quality in Bridger-Teton National Forest would also help disperse elk and would contribute to larger numbers of elk on native winter range. Some elk would continue to return to the refuge to winter on restored native range or on standing cultivated forage.

Irrigation and cultivation practices on the refuge would continue to affect elk numbers. In Option A these practices would be the same as under Alternative 1 and would not change amounts of forage produced by farming practices. With only 1,000–2,000 elk wintering on the refuge, present forage production would better sustain elk, along with approximately 800–1,000 bison, during average and above-average winters than under baseline conditions and under Alternative 1 (5,000–7,500 elk and 800 bison, with the number of bison continuing to increase). Option B would be the same as under Alternative 2, in which cultivation and irrigation would be eliminated and 2,400 acres of cultivated fields would be converted to native vegetation. This option would produce less forage, and fewer elk would subsist on amounts of available native vegetation. Modeling by Hobbs et al. (2003) and other work indicate that forage amounts would be adequate for the reduced population of elk and bison remaining on the refuge. Elk numbers on native winter range would be greater than under Option A because supplemental feeding would be eliminated.

When the Jackson elk herd is at objective (baseline levels), elk numbers wintering in the park would average approximately 360, with a range of 140 to 860. Winter severity would continue to influence elk numbers, with more elk able to winter in the park during average or milder-than-average winters.

Elk Numbers in the Jackson Elk Herd

Short-term Effects. Changes in the number of elk wintering on the refuge would be reflected to an extent in the Jackson elk herd. Greater harvest of elk using the refuge would lower total herd size, but dispersal of elk wintering on the refuge onto improved habitat in Bridger-Teton National Forest winter range and targeted reductions in the Grand Teton segment (which would have the hardest time finding alternative winter range) would help minimize the reduction in other herd segments. Gradually decreasing the frequency and duration of supplemental feeding on the refuge would cause greater reliance on native vegetation and lower elk numbers on the refuge. Many of the elk that would otherwise have used the refuge would disperse to native range beyond refuge boundaries, onto Bridger-Teton National Forest and into the park. Elk numbers in the Jackson elk herd would, on average, decrease over time by a negligible to moderate amount. However, in many years, elk numbers would be at or above the herd objective.

Long-term Effects. The total Jackson herd under Alternative 3 would decrease compared to baseline conditions and Alternative 1, to an estimated 7,900 to 11,000, approximately the same size as under Alternative 2. The lower end of this range is a combination of the lowest number of elk estimated on native winter range, on the refuge and the number of elk fed on the Gros Ventre feedgrounds. The upper end of the range would continue to be capped at approximately 11,000 elk by the state's elk harvest program.

Distribution and Movements of Elk

Short-term Effects. Aspects of Alternative 3 that would influence elk movements and distribution in the short term include changes in hunting practices, the reduction of supplemental feeding years, and habitat enhancements.

Immediate effects on movements and distribution would stem from increased harvest and changes in hunt areas. Fall, and likely winter, elk distribution would increase because, in addition to spending time in traditional non-hunt areas, elk would increase forage use and time spent in newly designated non-hunt areas such as the northern fifth of the refuge and Antelope Flats, the Kelly hayfields, and Blacktail Butte in the park. Some elk could choose to spend more time in transition areas, in potential wintering areas in the park and the northern part of the refuge, and areas eastward.

An early season hunt in either the southern or middle of the refuge (or both) is a likely possibility under this alternative. Another option would be to open the southern end of the refuge to visitors instead of a hunt. Either would be used to help move elk northward where they could be hunted. Either or both of these activities would particularly influence movements and distribution of elk that arrive on the refuge early (i.e., the Grand Teton National Park segment). Some of these elk, if not harvested on their way through hunt areas, might find the newly closed one-third of the refuge or closed portions of the park.

For those elk that were successful in reaching the feedlines, winter distribution would remain similar to baseline conditions during the first few years as supplemental feeding continues.

The gradual reduction in supplemental feeding to approximately 2 winters of 10 (depending on the severity of winter weather) would increase dispersal onto surrounding winter range compared to baseline conditions and Alternative 1. Cultivated fields on the refuge would continue to attract elk. In years when snow crusting events made cultivated fields with high forage production inaccessible to elk, mechanical means would be used to increase elk access and extend their use of these areas.

More elk could winter in the Buffalo Valley area, and many would use areas immediately to the east of the refuge and in the Gros Ventre River drainage; some elk could discover and join the Gros Ventre feedgrounds. Other elk could move to nearby areas in the southern part of the park and winter on south-facing hills or in other areas with forage available due to less snow cover. In above-average and severe winters more elk could follow the environmental gradient to the refuge, which is at a lower elevation than the park and adjacent national forest lands and therefore would likely have less snow. If elk attempted to move to potential winter range south of Jackson in the Snake River Canyon or in lower portions of the Hoback Canyon, many could be stopped from moving farther by the state feedgrounds in these areas.

Most of the shift in winter distribution would involve elk in the Yellowstone National Park, Teton Wilderness, and Gros Ventre segments, as those in the Grand Teton National Park segment are considered most likely to continue wintering on the refuge.

A negligible amount of prescribed fire on the refuge, as well as in the park, would continue to enhance forage and habitat and attract elk to treated areas, as under baseline conditions and Alternative 1. In addition, the U.S. Forest Service, the Wyoming Game and Fish Department, and other partners would enhance habitat in Bridger-Teton National Forest east of the refuge in the Gros Ventre River basin and in Buffalo Valley, which would increase elk distribution. The Wyoming Game and Fish Department might be able to adjust hunting strategies in order to help elk find and stay on enhanced winter range outside the refuge and park (Kilpatrick, pers. comm. 2003). Increasing distribution and movements potentially could lead to the use of some wintering areas outside Jackson Hole. Success would depend on wide elk distribution, interagency cooperation, and coordination with and cooperation from private landowners. If attempts to acquire conservation easements were successful, these procurements would prevent further loss of habitat to development, providing elk with continuing sources of good habitat and promoting wider distribution.

Under Alternative 3 vaccination for brucellosis would occur if a safe vaccine was developed with a minimum efficacy of 50% for elk and bison. Current vaccine efficacy is estimated at up to 25% for elk and undetermined for bison due to equivocal preliminary research results.

If the vaccine was in biobullet form and delivered by air gun to elk on refuge feedgrounds, elk responses could vary on a daily basis. When elk were vaccinated during 1989–91, small numbers of elk regularly ran from the report of the air gun, but soon returned to feeding (Griffin, pers. comm. 2002). Larger responses, such as the movement of large numbers or all animals away from a particular feeding area might also occur (B. Smith, pers. comm. 2002). Because supplemental food would remain available, these larger movements are not expected to last for more than a day for most elk, and impacts would be minor. Conducting vaccinations on an irregular basis (for example, every second or third day) could mean that elk might less readily become accustomed to the activity, and some elk could abandon a particular feedground (Cole, pers. comm. 2002).

Vaccination teams and feed truck drivers would monitor and record elk response daily, and the vaccination program would be adjusted as needed to avoid more serious effects. Most elk are considered likely to return to the feedlines after being disturbed (B. Smith, pers. comm. 2003).

Long-term Effects. Lower elk numbers, changes in hunting practices, a gradual reduction in supplemental feeding to about 2 of 10 years, and habitat enhancements on native winter range would influence elk movements and distribution in the long term under Alternative 3 in feeding years. Brucellosis vaccination activities would continue to cause short-duration negligible to minor increases in elk movements and distribution during delivery as described above. Changes in hunting practices, including the closure of traditional hunting areas and the opening of new, non-traditional areas, would continue to increase movements and distribution in the long term.

Localized areas of competition with the approximately 800–1,000 bison wintering on the refuge would alter elk distribution, particularly because of reductions of supplemental feeding and increased reliance on standing forage. This competition could cause elk to move to areas with less desirable forage in order to avoid conflicts with bison. In general, however, overall competition with bison would decrease under Alternative 3 compared to the competition under Alternative 1 with its long-term continued growth of the bison herd. Competition would decrease compared to baseline conditions, in which approximately 5,600 elk and 800–1,000 bison share the refuge in winter.

Habitat enhancements on and off the refuge and the use of prescribed fire on the refuge and the park would continue in the long term to enhance forage and attract elk to treated areas, as under baseline conditions and Alternative 1. Effects from successful land acquisition within refuge boundaries would also continue under the long term. Many elk that now winter on the refuge could find the Gros Ventre feedgrounds and remain in that area for the winter and possibly in other seasons.

The distribution among segments would differ from averages over the last several years. Elk numbers in the park segment would experience major decreases, down to between 500 and 1,000 elk compared to existing conditions of approximately 2,400–3,600. Elk numbers in the other three segments, the Gros Ventre, Teton Wilderness, and Yellowstone National Park segments, would experience minor to moderate decreases if increased use of native winter range does not occur. If there was increased use of winter range, which would be anticipated, elk numbers from these segments would experience minor decreases to minor increases.

Elk Behavior, Social Interactions, and Nutrition

Short-term Effects. Aspects of Alternative 3 that would influence elk behavior and social interactions in the short term include possible brucellosis vaccination, changes in hunting practices, and gradual reductions in the number of elk wintering on the refuge and years of supplemental feeding. Fewer elk, the reduction of supplemental feeding years, changes in hunting areas, possible changes in irrigation and cultivation on the refuge, and habitat enhancements on and off the refuge would affect elk nutrition.

As hunting and reductions in winter feeding take place, fewer elk and bison would spend the winter on refuge lands. Interactions among elk and displacement of elk by bison would likely decrease as a result, both overall and particularly in years when no supplemental feed was available. During feeding years the types of interactions that occur now would continue, although eventually at a lower level as progressively fewer animals were aware of the feedlines. Competition for standing forage following the cessation of feeding would increase over that during feeding, as it does now. Because bison numbers would be held to 800 to 1,000, displacement of elk by bison would be less of an impact than under Alternative 1.

Changes in hunting practices would also cause short-duration adverse effects, with the extent dependent on disturbance levels. Opening the southern part of the refuge early in the season would cause agitation and nervousness, increased energetic expenditures from running from hunters and the sounds of weapons firing, and a possible loss of nutrition as elk alter their foraging behavior. These elk would respond especially strongly to gunfire and human activities because they have become accustomed to the lack of hunting in these areas. They could experience prolonged periods of disturbance if they ran from the newly established hunt area to other long-established areas. Conversely, closing traditional harvest areas, such as the Blacktail Butte / Kelly hayfields area in the park and the northern fifth of the refuge, would decrease elk agitation, nervousness, energetic expenditures from running, and potentially enhance nutrition by encouraging foraging.

The beneficial effects on social interactions of reducing supplemental feeding on the refuge under Alternative 3 would be similar to but less intense than effects that would occur under Alternative 2. Both competition among elk, and displacement of elk by bison would decrease as numbers decrease, and far fewer of each during feeding years than under Alternative 1 would occupy the refuge.

Nutrition for those elk on feedlines during the estimated 2 of 10 winters they were fed (severe winters only) would be similar to those using the feedlines now. Ration or pellet composition might need to be changed to allow for a later start of supplemental feeding. A higher fiber formula, as recommended by Baker and Hobbs (1985) for mule deer, might be one possibility. Because the method of reducing feeding would eliminate feeding first in the mildest winters with the lowest snow cover and greatest access to vegetation, nutrition gained by foraging on native winter range would remain high and would be negligibly affected in those years. As supplemental feeding was reduced to fewer winters, and elk made greater use of native vegetation during increasingly severe winters, nutritional status could be decreased. However, ongoing reductions in elk numbers would gradually offset these effects on nutrition.

Under Option A irrigation and cultivation practices, and the nutrition available to elk and bison feeding on standing forage, could be similar to baseline conditions.

Under Option B conversion of cultivated fields to native vegetation on the refuge would decrease the amount of available forage but increase nutritional content of that which remains. Despite a 50% reduction in available forage on areas that had been under cultivation, conversion to native species, particularly bunch grasses which hold nutrients in plant parts longer than some cultivated species, would at least partially offset losses in mild years (Brock, pers. comm. 2003). During winters with above-average snow, if snow depths make this vegetation inaccessible to elk, nutrition and body condition would be poorer. Total herbaceous forage amounts would be similar to those described under impacts of Alternative 2, less than under baseline conditions and in the short term under Alternative 1 by a minor amount.

As noted above, activities associated with vaccination could cause increased nervousness and excitability in elk. During acclimation activities, some animals could become frightened and leave feedlines because of these activities. Others could remain outside the feeding area and not benefit from supplemental feeding. Agitated elk could gore others, expend energy running, and be involved in social interactions more frequently than usual. If the elk respond in this way, individual elk would eat less and injuries would increase. More severe effects would include escalated aggression among elk resulting in serious injury or death, and aggressive interactions between elk and bison (B. Smith, pers. comm. 2002). Increased aggression could occur if elk from one part of a feedline quickly move away and then converge on another part of the feedline already occupied by elk. Generally, these effects would be minor because they would occur in only a small portion of the population, and/or for a short period of time. However, as noted above, behavior would be monitored, and mitigation, such as maintaining a brisk pace when dispensing alfalfa pellets, would be used to minimize aggression among elk.

Long-term Effects. The same factors identified above would also influence social interactions and nutrition in the long term. Habitat improvement efforts outside the refuge and park could also affect nutritional status in the long term.

Fewer bison and elk would result in less intra- and interspecific competition, with fewer aggressive encounters and fewer displacements than under Alternative 1.

Vaccination activities, which would occur during feeding years if an efficacious vaccine was available, would continue to cause short-duration disturbance, including increased excitability, energetic expenditures, and aggressive interactions in the long term. Changes in hunting practices, including the closure of traditional hunting areas and the opening of new, non-traditional areas, would also cause effects similar to those described above, with the exception of increased aggressive interactions.

Because supplemental feeding would continue in severe winters (estimated to occur in roughly 2 of 10 winters depending on weather and snow conditions), cultivation of standing forage on the refuge would continue under Option A, and numbers of elk and bison would be reduced through hunting, nutrition of remaining elk might not experience adverse effects beyond those in an unfed herd. Although some elk could die during above-average winters because of decreased nutrition and body condition, refuge elk at low numbers, as prescribed under this alternative, might be able to maintain good nutritional levels on native forage.

Disease Prevalence and Transmission

Bovine Brucellosis

Prevalence in Herd — Under Alternative 3 vaccination of elk for brucellosis might or might not take place, depending on whether a highly effective vaccine (>50% efficacy) was developed. Current efficacy of Strain 19 is estimated at 25%–30% (Thorne, Walthall, and Dawson 1981; Herriges et al. 1989; Roffe et al. 2002) under clinical conditions and would likely be less than 25% under field conditions. Field vaccination does not prevent infection but could cause modest reductions in abortion (Wyoming Brucellosis Coordination Team 2005). Compared to Alternative 1, brucellosis prevalence in the Jackson elk herd is not expected to change in the very short term under Alternative 3 if vaccination does not occur. Over the 10–15 year initial period in which hunting would be stepped up and supplemental feeding phased out, brucellosis prevalence in elk on the refuge would begin to decline, even in the absence of vaccination. Changes in where hunting was allowed and habitat enhancement outside the park and refuge would also encourage wider dispersion of elk and bison. These factors would combine to reduce prevalence in elk by a moderate amount (high end of moderate range) in the long term compared to Alternative 1. Prevalence in the absence of vaccination would be higher than under Alternative 2, as supplemental feeding would continue in severe winters. The number of viable bacteria expelled during an abortion is extremely high (Alexander, Schnurrenberger, and Brown 1981; Davis et al. 1995) and a single abortion on a feedline could expose many of the elk feeding there at the time (Thorne 2001). For this reason, the occurrence of winter feeding is more important than absolute numbers of elk in determining transmission rates, and hence prevalence.

Use of an effective vaccine could substantially reduce prevalence regardless of other management actions that would take place under Alternative 3. Simulations showed that 30%–40% of all elk calves would need to be successfully immunized (made resistant to infection) every year for more than 25 years to eradicate brucellosis (Gross, Miller, and Kreeger 1998). Lower levels of immunization (e.g., 10%) reduced, but did not eliminate, brucellosis. If a suitable vaccine was developed that is more than 50% efficacious in preventing infection and abortion, and it could be delivered to approximately 80% of susceptible elk calves on the refuge every year, a moderate reduction of 40% in seroprevalence for the refuge portion of the Jackson elk herd would result (Gross, Miller, and Kreeger 1998)). This translates to an approximate 13.5% reduction in seroprevalence across the entire Jackson elk herd, a minor beneficial impact.

Transmission among Elk —If a suitable vaccine was developed and it could be delivered to a high proportion of susceptible cows and calves on the refuge every year, the impact would be a major reduction in transmission among elk for the refuge portion of the Jackson elk herd due to a major reduction in prevalence and the associated decline in the number of abortions that would occur. If no abortions occurred, the risk of transmission would be almost eliminated (HaydenWing and Olson 2003). In the Jackson elk herd as a whole, a moderate to major reduction in the potential for brucellosis transmission among elk if the vaccination program was implemented for refuge elk would be possible. In the absence of a vaccine, there would still be a moderate to major reduction in transmission risk for refuge elk because of the dramatic reduction in supplemental feeding, lower elk numbers, and wider dispersion of wintering elk. This would translate to a minor to moderate reduction for the Jackson elk herd as a whole.

Transmission from Bison to Elk — Reductions in the number of both elk and bison, in prevalence, and in winter feeding would mean a lowered chance of transmission from bison to elk in the long term. There would be less chance of direct contact between the species, and fewer abortions on the refuge. Without elk vaccination, the risk of transmission from bison to refuge elk would experience a moderate decrease. Vaccination of elk and bison would result in moderate short term and major long term beneficial impacts.

Septicemic Pasteurellosis

Potential impacts on prevalence of this disease would be lowest under alternatives that reduce the number of elk on the refuge and reduce the winter feeding program. Potential impacts under Alternatives 3 would be expected to be among the lowest (along with Alternatives 2 and 6) of all alternatives.

Necrotic Stomatitis

Alternative 3 (as well as Alternatives 1, 4, and 5) would supply elk on the refuge with sufficient forage through native range habitat improvements, enhanced forage production on the refuge through irrigation, and supplemental winter feeding in the worst winters. Therefore, the occurrence of necrotic stomatitis would be negligible and would not likely differ from the current two to three mortalities per year. This would likely remain the case even if forage production were discontinued (Option B) because standing forage would continue to be adequate for low numbers of refuge elk.

Psoroptic Scabies

The negligible beneficial effects on elk health would be the same as described under Alternative 2 but more limited due to continued supplemental feeding in some years.

Helminths and Lungworms

Lungworm transmission and prevalence in elk under Alternative 3 and associated impacts would be similar to Alternative 4, greater than under Alternatives 2 and 6, and less than under Alternatives 1 and 5.

Bovine Tuberculosis and Paratuberculosis

Bovine tuberculosis and bovine paratuberculosis are not present in the Jackson elk herd. The relative risk among the alternatives that either of these diseases would become established would be low under Alternative 3 because of the reduction of winter feeding to severe winters only. Risk would be higher than under Alternatives 2 and 6 but lower than under Alternatives 1, 4, and 5. See the discussion for elk under the impacts of Alternative 1, "Disease Prevalence and Transmission" for more details.

If bovine tuberculosis or paratuberculosis became established in the refuge portion of the herd, the potential for transmission and prevalence would be lower in alternatives where density and numbers would be reduced, such as Alternative 3. The extent of this reduction would be moderate or major in the refuge elk, and minor to moderate throughout the whole Jackson herd. Moderate to major reductions in the potential for transmission from bison to elk would also occur, and prevalence in the bison herd would be moderately lower than under Alternative 1.

Malignant Catarrhal Fever

The risk of refuge or park elk or bison contracting this disease from domestic sheep would be higher in this alternative than under Alternative 1, as animals would disperse more widely. Because agencies would support attempts to establish elk migration to winter range outside Jackson Hole in both this and Alternative 2, the risk would be highest in these two alternatives. However, the continuation of cultivation and supplemental feeding in the most severe winters would continue to encourage elk and bison to remain on the refuge, risk would be less than under Alternative 2. Because Alternatives 2 and 3 also result in a dramatic decrease in the numbers of elk and/or bison on the refuge and less contact through feedlines, transmission between elk and from bison to elk and prevalence of this disease would likely be less. Therefore, the relative potential for impacts would be lowest under Alternatives 2, 6 and 3 because elk numbers would be reduced and/or winter feeding would be reduced or not occur.

Chronic Wasting Disease

Under Alternative 3 there would be a moderate increase in risk of chronic wasting disease becoming established in the Jackson elk herd compared to Alternative 1 if migration to the Green River basin was established. As noted in other sections, the presence of an infected animal does not necessarily mean the disease will be transmitted among elk wintering on the refuge.

Potential prevalence of chronic wasting disease under Alternative 3 would likely be higher than under Alternatives 2 and 6 and lower than Alternatives 4 and 5 (Table 4-6). The primary factors in making this conclusion are the frequency of winter feeding and number of elk.

If chronic wasting disease became established in the Jackson elk herd, it is likely that prevalence would fall within the range seen in free-ranging and confined elk (see discussion under Alternative 1). Total impact on the herd would depend on how the disease spread in the population. Prevalence and transmission of chronic wasting disease would likely be related to the proportion of population on feed, seasonal duration of feeding, and the yearly frequency of feeding.

Calving, Age and Sex Ratios, and Recruitment

Short-term Effects. Age and sex ratios could change somewhat under Alternative 3 due to increased winter mortality, hunting, and reduced prevalence of brucellosis. The increased mortality on and off the refuge not related to hunting would mainly affect older elk of both sexes, calves, and some prime bulls entering the winter energetically stressed due to rut activities.

Hunting mortality would initially primarily affect adult female elk, as the Wyoming Game and Fish Department would target this portion of the population to reduce herd growth. This strategy would likely result in an initial increase in bull-to-cow ratios, primarily in the Grand Teton National Park segment and the Yellowstone National Park segment to a lesser degree. To achieve adequate harvest levels on cows, it might be necessary to delay closure of the north end of the refuge to hunting and the Blacktail Butte/Kelly hayfields area in the park to elk reduction until after the elk numbers on the refuge and the park are at or near objective.

Once population objectives were met on the refuge and in the park, anticipated near the end of the first 15 years of implementation, the proportion of harvested cows would decrease, perhaps declining to the point that the ratio of bulls to cows in the population could end up being lower than what it would be under Alternative 1 (where refuge cows are also hunted more frequently than bulls). The proportion of calves in the population would increase by a negligible amount.

Long-term Effects. The trends beginning to occur near the end of the first 15 years of implementation (see "Short-term Effects" above) would continue in the long term, with the following exceptions. After the refuge and park population objectives have begun to be achieved, or when they were nearing achievement, harvest strategies would be modified on the refuge and the park. The park elk reduction program would be designed to increase the average bull-to-cow ratio in the Grand Teton segment to 35 bulls to 100 cows and maintain it over the long term. This ratio would be higher than the baseline Jackson elk herd ratio of 24 mature bulls to 100 cows, but it would be representative of native, non-hunted populations. Summer surveys in the park have provided the best baseline estimates for bull-to-cow ratios, which have ranged from 12 to 29 mature bulls to 100 cows (GTNP unpubl. data).

This would be a minor to major increase in the proportion of bulls, as compared to baseline conditions and Alternative 1.

Increasing the bull-to-cow ratio in the park would result in only a minor increase in the ratio in the Jackson elk herd, because this segment would comprise only about 9% of the larger herd. Increases to the Jackson elk herd ratio due to a higher bull-to-cow ratio in park elk would be less than under Alternative 5, and greater than under Alternative 4. Bull-to-cow ratios in the other herd segments would not be expected to change because overall numbers in these herd units would not change appreciably.

It is currently estimated that brucellosis reduces calf production by up to 5% on the refuge (Oldemeyer, Robbins, and Smith 1993, as adjusted for lower seroprevalence). This loss would decrease by a minor to moderate amount without vaccination under Alternative 3 simply from reductions in prevalence and transmission discussed above. If vaccinations were given, the loss of calf production on the refuge would decrease by a major amount. However, vaccinating or not vaccinating would translate to a negligible benefit to calf production herdwide because the degree of calf production loss on the refuge is currently negligible in relation to the Jackson elk herd as a whole.

If septicemic pasteurellosis infected the Jackson elk herd, it would affect production and recruitment through increased mortality (see "Mortality" section below). Potential impacts on production and recruitment under Alternative 3 would be similar to those under Alternatives 2 and 6 and lower than under all other alternatives.

If bovine tuberculosis, bovine paratuberculosis, chronic wasting disease, or other non-endemic infectious diseases were to become established in the Jackson elk herd, the rate of transmission would be considerably less than would likely occur under Alternative 1. If losses in any particular sex or age class from these diseases were to occur, hunting strategies could be changed to reestablish objectives. If herd size decreases from disease, hunting could be stopped temporarily or fewer tags issued. Given expected low prevalence of any introduced infectious diseases and the ability to absorb any losses by small changes in harvest strategies, impacts to production and recruitment would likely be negligible.

Mortality

Short-term Effects. Harvest mortality during the short term would be increased compared to baseline conditions and Alternative 1. The harvest program would be primarily responsible for a 60%–85% decrease in elk numbers on the refuge, from approximately 5,000–7,500 to an estimated 1,000–2,000 by year 15 of plan implementation. Non-harvest mortality would gradually increase by a negligible amount as the refuge feeding program was concurrently scaled back and greater reliance on native vegetation occurred during all but severe winters, especially if the fence at the southern and southwestern sides of the refuge prevented access to some native winter range. The refuge would manage for a maximum of 5% mortality and, if necessary, would provide supplemental feeding in some additional years to prevent higher mortality. With elk at low numbers on the refuge, it is estimated that feeding would be needed in only the most severe winters to achieve this objective.

As refuge elk density decreased, fewer brucellosis-caused abortions (which currently reduce potential births by an estimated 5%) would occur, partially offsetting increases in mortality described above.

Long-term Effects. In the long term, harvest on the refuge and the park would decrease substantially from baseline conditions and compared to Alternative 1 because of the reduced number of elk wintering on the refuge. Harvests could be more conservative in years following greater non-harvest elk mortality. In many years, total harvest in the herd unit would remain similar to baseline conditions and Alternative 1.

Non-harvest mortality in the Jackson elk herd would range from 1% to something less than 16% over baseline conditions, depending on the severity of the winter. This range was based on modeled estimates (Hobbs et al. 2003) adjusted for objective herd size and active Gros Ventre feedgrounds. In mild winters, mortality would be lower than in winters of above-average severity. In the most severe winters, supplemental feeding of refuge elk would keep mortalities close to the existing 1%–2%. Initiation of supplemental feeding would be based on assessments of forage utilization (done jointly by WGFD and NER personnel) and potentially on the January 1 index of winter severity (Farnes et al. 1999) calculations for elk. Additional feeding would occur if refuge elk average greater than 5% mortality over a 10-year period. Therefore, barring the spread of infectious and fatal disease, this part of the Jackson herd would not be expected to experience mortality rates higher than 5%. An estimated 2,500 elk are also fed on the Gros Ventre feedgrounds and would experience only limited mortality. Given these factors, the 16% Jackson herd mortality modeled for above-average winters is likely too high.

Non-hunting mortality occurs during winters when elk are not receiving supplemental feed would result both directly and indirectly from poor physical condition, energetic debt, and weight loss associated with competition for native forage. Mortality of refuge elk would be monitored and maintained at no greater than 5%. Refuge elk at low numbers would be able to maintain good nutritional levels on native forage in most winters.

Indirect impacts resulting from a loss of body condition in some elk would be increased susceptibility to predation by mountain lions or wolves.

Reduction in the prevalence of psoroptic scabies under Alternative 3 from decreases in density and numbers of elk would decrease adult bull mortality negligibly compared to Alternative 1.

Impacts from septicemic pasteurellosis on mortality under Alternative 3 would be similar to those under Alternatives 2 and 6 and lower than under all other alternatives.

Increased dispersion and lowered densities resulting from actions in this alternative would decrease the potential that bovine tuberculosis or bovine paratuberculosis would spread in Jackson elk should elk in the herd contract the disease compared to Alternative 1. Potential impacts on mortality would be greater than under Alternatives 2 and 6 and lower than all other alternatives.

Potential prevalence of chronic wasting disease and impacts on mortality would likely be higher than under Alternatives 2 and 6 and lower than under all other alternatives (Table 4-6; and see the discussion under "Mortality" in Alternative 2 for more detail).

Health, Sustainability, and Naturalness

Short-term Effects. The health and sustainability of the Jackson elk herd would increase gradually as supplemental feeding on the refuge was progressively reduced to fewer years, elk relied more on standing forage, and animals were more widely distributed. Ungulate concentrations would be gradually reduced on the refuge over 10–15 years. As described above, the prevalence of existing diseases and the risk of transmitting these or any new diseases should they become established in the herd would also decrease with lower numbers and densities of elk on the refuge. Effects would be similar but more limited than what would occur under Alternative 2 because supplemental feeding and high ungulate concentrations would continue to occur in severe winters.

Herd health would also increase if a safe vaccine was developed with an efficacy of 50% or better and elk were vaccinated.

Barring the introduction of serious non-endemic disease, the Jackson elk herd would be between an estimated 8,000 and 11,000 animals and would continue to be genetically viable.

Naturalness would also increase gradually in the short term under Alternative 3 as elk increasingly distribute themselves according to availability of native forage. Natural phenomena, such as winter weather and predators, would have an increasingly stronger influence on mortality, similar to but more limited than what would occur under Alternatives 2.

Long-term Effects. Health and sustainability under Alternative 3 would be similar, but less than under Alternatives 2 and 6, because supplemental feeding would continue to occur in severe winters.

Forage improvements in the Gros Ventre drainage and the Buffalo Valley would likely improve health and sustainability of the herd in the long term. The prevalence of existing disease and risk of contracting or spreading new disease would be lowered by reductions in density and elk numbers.

Reducing the number of winters when supplemental feeding occurred, which would reduce both numbers and density of elk and bison on the refuge, would substantially reduce the prevalence of brucellosis, with health benefits as described above. Vaccination could further reduce prevalence and increase health of the herd, although this improvement would be negligible if the vaccine could only be delivered during an estimated 2 winters out of 10. In the long term seroprevalence rates in elk would be expected to become more similar to those in northern Yellowstone National Park, although perhaps not as much as under Alternative 2.

Barring the introduction of serious, non-endemic disease or extreme decreases in population size, the elk herd would number between 8,000 and 11,000 animals and would be self-sustaining and genetically viable.

The long-term health and sustainability of the elk herd would be lower than under Alternatives 2 and 6 and higher than Alternatives 1, 4, and 5.

As supplemental feeding was decreased, the herd would become more influenced by natural factors such as climate and amounts of native forage.

Production and recruitment rates would be more natural and calves born outside of the normal birthing season would be less likely to survive, as they are in unfed herds. Winter mortality rates would be closer to those in unfed populations, as would sex ratios and age classes. Elk would distribute themselves more naturally, and expend more energy accessing winter forage. Continued hunting and monitoring to manage mortality and sex and age ratios would help refuge elk mimic natural, unfed populations.

Elk behavior would become more natural, similar to that described for Alternative 2, and competitive social interactions, including displacement by bison, would decrease.

Overall, Alternative 3 would result in a higher level of naturalness in the elk herd than would Alternatives 1, 4, and 5. Naturalness would be less than under Alternative 2 and 6, mainly because of continued winter feeding in some years.

Conclusion

In the long term under Alternative 3 there would be an estimated 7,900–11,000 elk in the Jackson elk herd. The herd would be smaller than under baseline conditions and Alternatives 1 in some years, similar in size to Alternatives 2 and 6, and smaller than under Alternatives 4 and 5.

Alternative 3 would decrease numbers of elk that winter on the refuge. Over time, most of the elk wintering on the refuge would be part of the Grand Teton segment that summers in the park. Hunting and decreases in supplemental feeding would result in decreases of this segment from approximately 2,400–3,600 to 500–1,000, a major reduction compared to current conditions.

The elk herd would increase its movements and distribution due to reductions in the supplemental feeding program, and increased winter mortality would occur. In the long term the herd would be more heavily influenced by natural conditions, and winter mortality would fluctuate with winter severity, precipitation regimes, and standing forage in most years. Recruitment and annual survival would decrease compared to Alternative 1 and would be closer to levels found in non-fed populations in similar environments.

The risk of a non-endemic infectious disease quickly spreading through the elk population would be lower than under Alternatives 1, 4, and 5, and higher than Alternatives 2 and 6 because supplemental feeding and high ungulate concentrations would continue to occur in severe winters. The prevalence of brucellosis in the Jackson elk herd would be moderately lower than under Alternative 1.

Alternative 3 would result in higher levels of long-term health, sustainability and naturalness in the Jackson elk herd than what would occur under Alternatives 4 and 5 although levels would be somewhat lower than under Alternatives 2 and 6. Nutritional status, distribution, behavior and sex and age ratios in refuge elk would more closely mimic those of a natural, unfed population.

Barring the introduction of serious non-endemic disease, Alternative 3 would not impair the elk population in the park. Alternative 3 would have a lower potential for impairment than would Alternatives 1, 4, and 5, and a higher potential for impairment than under Alternatives 2 and 6.

ALTERNATIVE 4

Under this Alternative 4,000–5,000 elk and 450–500 bison would winter on the refuge. Forage production on the refuge would be increased, but supplemental feeding would be cut back to above-average and severe winters (roughly 5 out of 10 winters on average). Elk hunting on the refuge and the elk herd reduction program in the park would continue, and a refuge bison hunt would be initiated. Vaccination with existing vaccines would take place.

Analysis

Elk Numbers Wintering on the National Elk Refuge and on Native Winter Range

Short-term Effects. The number of elk wintering on the National Elk Refuge would be gradually decreased to 4,000–5,000 from the 5,000–7,500 under baseline conditions and Alternative 1. This decrease would be accomplished through a short-term increase in harvest in the park and on the southern part of the refuge. The reduction in herd size would come from the park segment. After elk numbers have reached objective levels, the reduction of supplemental feeding years to above-average and severe winters would help maintain wintering elk at reduced levels. Supplemental feeding would first be eliminated in milder-than-average winters and then in average winters. Because feeding would not occur in these years, a progressively larger portion of the Jackson herd would become accustomed to wintering in native range and numbers on the refuge would decrease (B. Smith, pers. comm. 2003; see "Distribution and Movements of Elk" in Alternative 2 for more information).

Numbers on native winter range during supplemental feeding on the refuge would remain similar to the 2,900–5,200 under baseline conditions and Alternative 1 for the first several years until non-feeding years were more frequent and more elk became accustomed to using native winter range.

Long-term Effects. Through a combination of hunting and forage production, the refuge would continue to be managed to support 4,000–5,000 elk, a moderate reduction from Alternative 1. Some elk that were not hunted would disperse to native winter range during years when supplemental feed was not available; the number of elk wintering on native range would be less than under Alternatives 2, 3, or 6, but greater than other alternatives.

Although hunting would, as under Alternative 3, target the Grand Teton segment of elk, the number of elk wintering in the park would continue to be similar to baseline levels and could increase slightly during non-feeding years. The number of elk summering in the park, which includes the Grand Teton segment of refuge elk, would decrease. Winter range enhancement efforts by the U.S. Forest Service, the Wyoming Game and Fish Department, and other partners on Bridger-Teton National Forest would help sustain higher numbers of elk on these areas in winter than what occurs under baseline conditions or would occur under Alternative 1.

Elk Numbers in the Jackson Elk Herd

Short-term Effects. Changes in the refuge wintering population due to short-term increased harvest and reductions in supplemental feeding could result in a short-term, negligible to minor reduction in total herd numbers.

Long-term Effects. As supplemental feeding became less frequent and hunting continued, the Jackson herd would continue to decrease to a level at or above the herd objective of 11,000 animals. If lowest likely numbers were used for native winter range during the last 15 years (4,400) and the low end of those on the refuge under this alternative (4,000) were combined with the average number of elk fed on the Gros Ventre River feedgrounds, the total (10,500) would be slightly below the herd objective of 11,000 elk. This total would likely be a low estimate even for severe winters, as supplemental food would be provided on the refuge and numbers of elk on the refuge would be in excess of 4,000.

Distribution and Movements of Elk

Short-term Effects. Aspects of Alternative 4 that would influence elk movements and distribution in the short term include the reduction of years of supplemental feeding on the refuge, enhanced cultivation practices on the refuge, exclosures, changes in hunting practices, habitat enhancements, and brucellosis vaccination.

As the numbers of elk that winter on the refuge were reduced to objective levels of 4,000–5,000, supplemental feeding on the refuge would be gradually eliminated during milder-than-average and average winters, and elk movements and distribution during non-feeding years would increase due to reliance on standing forage and native winter range. Wider distribution would gradually occur more frequently as non-feeding years become more common. Strategies such as an early season hunt, harassment, or general public access in the southern third of the refuge would further increase elk movements and distribution away from this traditionally safe area and toward areas to the north and east, at least temporarily. These elk, primarily from the Grand Teton National Park segment, could move to the northern part of the refuge, or perhaps north and east into Bridger-Teton National Forest.

Farming practices would continue to attract elk to cultivated fields on the refuge, as occurs under baseline conditions and under Alternative 1. Enhanced irrigation and cultivation, including increased use of sprinkler irrigation, would aim to increase forage production and quality compared to current levels and would likely increase time spent by elk in cultivated fields. In years when snow crusting events made cultivated fields with high forage production inaccessible to elk, mechanical means would be used to increase access for elk.

The three exclosures designed to protect woody vegetation (1,600 acres compared to less than 20 acres under baseline conditions) would cause localized changes in ungulate distribution. Elk would lose access to approximately 7% of available acreage on the refuge, and densities would likely increase to a minor extent until the refuge wintering herd was reduced to objective levels.

The aspen enclosure, as currently designed, would be wider east to west than north to south, and could hinder north-south movements of elk. Although the fence would be designed to minimize this effect, concave areas of fence could temporarily stop elk and direct their movements (Cole, pers. comm. 2003).

A negligible amount of prescribed fire on the refuge, as well as in the park, would continue to enhance forage and habitat and attract elk to treated areas, as under baseline conditions and Alternative 1. In addition, the U.S. Forest Service, the Wyoming Game and Fish Department, and other partners would enhance habitat in Bridger-Teton National Forest east of the refuge in the Gros Ventre River basin and in Buffalo Valley, which would increase elk distribution, particularly in years when feeding does not occur on the refuge.

If attempts to acquire conservation easements or acquisition of private lands within approved refuge boundaries were successful, these procurements would prevent further loss of habitat to development, providing elk with continuing sources of good habitat and promoting wider distribution.

The Fish and Wildlife Service would permit the Wyoming Game and Fish Department to vaccinate using Strain 19 until a more efficacious vaccine was available. Vaccine delivery would take place during winter supplemental feeding on the refuge, causing short duration disturbance and negligible to minor changes in movements and distribution (USFWS 2002a; see impacts of Alternative 3). Elk responses could vary on a daily basis from negligible effects to temporary moderate effects, such as elk leaving the vicinity of the feeding area where vaccine delivery was taking place. If a sufficiently effective oral vaccine was developed that would be safe for elk and bison, as well as non-target species, and that could be delivered on a wider scale than on feedgrounds, then vaccine delivery during non-feeding years could temporarily change distribution because it would be delivered in feed.

Long-term Effects. Changes in elk movements and distribution would stem primarily from fewer years of supplemental feeding, converting to sprinkler irrigation, enhancing winter range in Bridger-Teton National Forest, substantially reducing the number of elk in the park, and moderately reducing elk on the refuge or opening the southern third of the refuge to limited public use. Vegetation exclosures on the refuge would continue to cause minor changes in elk movements and distribution. Vaccination activities would continue to produce negligible to minor short-duration effects. These effects would occur only during years of supplemental feeding unless oral delivery becomes possible.

Moderate to major reductions in the number of elk from hunting would decrease densities. The objective for numbers of the park herd segment that winters on the refuge would be 1,300–1,600, below baseline conditions and numbers under Alternative 1.

Vegetation exclosures would continue to cause localized changes in ungulate distribution and block access to approximately 9% of total available acreage on the refuge. The aspen exclosure in the northern part of the refuge would increase densities to a minor extent in the approximately 200 elk that traditionally winter there. Although exclosures to protect willow and cottonwood in the southern part of the refuge would decrease the number of acres available to elk by 1,100, elk densities would decrease by a minor amount because of lower elk numbers on the refuge. During winters without supplemental feeding (an estimated 50% of winters), densities would likely decline further due to reliance on standing forage and native vegetation, and wider distribution. Feedline concentrations of approximately 500 elk/acre would continue to occur on average for about 2 hours on approximately 70 days during 4 to 5 winters out of 10.

The shape of the aspen enclosure would continue to temporarily stop elk and direct their movements (Cole, pers. comm. 2003).

Reduction of supplemental feeding to an estimated 4–5 winters out of 10 would stimulate many elk that have traditionally wintered on the refuge to increase their use of surrounding native winter range. Elk would disperse to areas of suitable winter range on the refuge and in the park, as well as to adjacent federal areas where habitat would be enhanced under this and other alternatives. More elk might use areas immediately east of the refuge and the Gros Ventre River drainage; some elk could discover the Gros Ventre feedgrounds, increasing densities in these areas in winter and possibly other seasons. Others might move to nearby areas in the southern part of the park and winter on south-facing hills or other areas with forage available due to less snow cover. If elk attempted to move to potential winter range south of Jackson in the Snake River Canyon or in the lower portions of the Hoback Canyon, state feedgrounds in these areas might stop many elk from moving farther.

Most of the shift in winter distribution would involve elk in the Yellowstone National Park, Teton Wilderness, and Gros Ventre segments. The Wyoming Game and Fish Department might be able to adjust hunting strategies in order to help elk find and stay on enhanced winter range (Kilpatrick, pers. comm. 2003). Elk in the Grand Teton National Park segment would be the most likely to continue wintering on the refuge. These changes in distribution and movements would be less extensive than under Alternatives 2 and 3 because feeding would continue to attract elk to the refuge in 4–5 years out of 10.

Elk numbers in the Grand Teton National Park segment would experience moderate to major decreases from Alternative 1. Elk numbers in the other three segments would experience negligible to minor decreases if increased use of native winter range does not occur. If there were increased use of winter range, elk numbers from these segments would experience minor increases.

Elk Behavior, Social Interactions, and Nutrition

Short-term Effects. Aspects of Alternative 4 that would influence elk behavior and social interactions in the short term include reductions in elk and bison numbers on the refuge, gradual reductions in years of supplemental feeding on the refuge, changes in hunting practices, and brucellosis vaccination. Fewer elk and bison, the reduction of supplemental feeding years, changes in irrigation on the refuge, and habitat enhancements on and off the refuge would affect elk nutrition.

Displacement of elk during competition with bison for forage in transition and winter habitat on the refuge, the park, and adjacent lands would gradually decrease under Alternative 4 as bison and elk numbers were lowered during the initial 10–15 years. During the early years concurrent reductions in winter feeding would offset this effect to some degree on the refuge because elk and bison numbers, although decreasing, would be similar to baseline conditions and higher than objective. As ungulate numbers decrease, and more non-feeding years occur, competition and aggressive social interactions on the refuge would be reduced, although some competition for forage during non-feeding years would also occur. With more years passing without supplemental feeding, elk and bison distribution would increase as the animals rely more on native winter range. Fewer animals would be present on the refuge.

Changes in hunting practices would also cause short-duration adverse effects, with the extent dependent on disturbance levels. Creating a disturbance on the southern part of the refuge early in the season would disturb elk in these traditionally safe areas, increasing agitation and nervousness, energetic expenditures, and possibly decreasing nutrition because of reductions in foraging.

Vaccination for brucellosis, using Strain 19 initially and other more efficacious vaccines when available, would cause negligible to minor short-duration adverse effects due to disturbance during supplemental feeding. If the vaccine were delivered only during supplemental feeding, these disruptions would gradually become less common during the initial 10–15 years of Alternative 4. The specific types of behavioral changes associated with vaccination are described in the "Elk

Behavior, Social Interactions and Nutrition" section in Alternative 3, above.

Nutritional status under Alternative 4 could be enhanced initially through changes in irrigation to enhance refuge forage production, and habitat enhancements on and off the refuge. At the same time, changes in the refuge supplemental feeding program could begin to affect elk nutrition. These changes include later onset of feeding as well as fewer years in which feed was supplemented. To allow for later start of supplemental feeding, ration or pellet composition might need to be changed. A higher fiber formula, as recommended by Baker and Hobbs (1985) for mule deer, might be one possibility. As these changes were implemented, more elk could experience lower nutrition, although the decrease would have negligible adverse effects overall on refuge elk. Toward the end of the short term, increases in forage production and decreases in the number of elk on the refuge would mean better nutritional status for refuge elk.

Long-term Effects. Because the number of bison wintering on the refuge would be decreased, displacement of elk by bison during competition for standing forage would decrease under Alternative 4. During non-feeding years with shortages of standing forage, aggressive social interactions involving competition for food with other elk and with bison would increase.

In the long term, nutritional status could be lower in some years than under baseline conditions and Alternative 1, although the decrease would have negligible adverse effects. Supplemental feeding would continue to occur during severe and above-average winters. Fencing would remove a negligible amount of herbaceous forage compared to baseline conditions and Alternative 1. Still, more forage would be available per elk because of reduced numbers.

The effects of prescribed fire, habitat enhancements, changes in irrigation and hunting practices on the refuge, and brucellosis vaccination described in the short term, would continue.

Disease Prevalence and Transmission

Bovine Brucellosis

Prevalence in Herd — Alternative 4 includes the use of existing Strain 19 brucellosis vaccine for elk until a more effective vaccine was developed. Vaccination with Strain 19 would provide some level of protection against brucellosis-induced abortion and infection in elk (Thorne et al. 1981, Roffe et al. 2002).

The Wyoming Game and Fish Department conducted several clinical trials on the use of Strain 19 *Brucella abortus* in vaccinating cow and calf elk (Thorne et al. 1981, Herriges et al. 1989). Combined results suggest that Strain 19 may provide protection in 30% of vaccinated cow elk when they are exposed to *Brucella* organisms in the field at doses that do not exceed 7.5×10^7 colony forming units (CFU). In field situations, *Brucella* organisms can range in concentration from 2.4×10^8 to 1.4×10^{13} CFU per gram of infected fetal materials and vaginal exudates associated with live births and abortions (Alexander, Schnurrenberger, and Brown 1981; Thorne 2001). Several reports question the validity of the results of WGFD vaccination trials based primarily on flaws in scientific method (Smith and Roffe 1997; Adams, Petersen, and Williams 1998; Burnham, McCarty, and Anderson 1998; Garton 1998).

It appears that a single dose of Strain 19 may be as high as 25% effective in calves under clinical conditions (Roffe et al. 2002; Herriges et al. 1989). For Strain 19 to be as effective in field conditions, the following assumptions must be met:

1. All biobullets would effectively administer the proper dose of Strain 19 and the trauma associated with the impact of the bullet would not hinder the transmission of Strain 19 to the elk's body.
2. Strain 19 would be administered to calves before they became infected by *Brucella* in the field.
3. Vaccinated calves that later became pregnant would be at a high nutritional status during their pregnancy.
4. Vaccinated elk would not subsequently become exposed to *Brucella* organisms at significantly higher doses than used in clinical trials.

5. Immunity to a field strain dose of *Brucella* would not require booster vaccination of older animals.

To the extent that these assumptions were not met under field conditions, the efficacy of Strain 19 in calves under field conditions would be less than 25%. Field vaccination does not prevent infection but would cause modest reductions in abortion (Wyoming Brucellosis Coordination Team 2005).

When abortions occur on feedlines, other elk commonly investigate, and sniff and/or lick aborted fetuses and associated vaginal material (Thorne et al. 1978) where the concentration of *Brucella* organisms is significantly higher than doses used in clinical trials. (Although Cook (1999, as cited by Roffe et al. 2002) calculated that a 10 centimeter diameter area of skin contained about 4.1×10^6 organisms and suggested that this amount may be a "realistic field exposure.")

It is also unknown how many calves or cows could be vaccinated on the refuge. During 1989–91, approximately 45% of calves and 4% of cows were vaccinated on the refuge. Because vaccination of cows is less effective in reducing abortions, female calves are usually the target of a vaccination effort. On WGFD feedgrounds, a much higher percentage, 98%–100% of calves, are vaccinated. Although Alternative 4 would strive to vaccinate as many calf elk as possible, difference in feeding operations and the number of elk at each feeding area at the refuge make 98%–100% vaccination highly unlikely. Because elk at the state feedgrounds are more habituated to humans, vaccination success using air guns and biobullets is higher.

Vaccination would occur on the refuge only during above-average winters in an estimated 5 years out of 10, when elk would be concentrated on feedlines for an average of 70 days and could become accustomed to human activity. A negligible to minor decrease in abortions from vaccination from Strain 19 could occur under Alternative 4.

The dose of Strain 19 in biobullets would induce few, if any, abortions when administered to pregnant cow elk. At doses used in earlier WGFD clinical vaccination trials, Strain 19 induced abortion in about 30% of pregnant elk (Thorne et al. 1981). However, this problem appears to have been remedied by lower doses of vaccine (Thorne et al. 2002). This lower dose would be used in biobullets on the refuge. There do not appear to be any safety concerns in using Strain 19 to vaccinate calf elk.

An additive, minor to moderate decrease in prevalence would be associated with reductions in elk numbers and increased dispersion resulting from actions in Alternative 4. These actions include reductions in the frequency of winter feeding, hunting both bison and elk, and improving winter habitat outside the park and refuge.

Use of a vaccine that was at least 50% effective (similar to Alternative 3) could substantially reduce prevalence regardless of other management actions that would take place under Alternative 4, particularly if upwards of 80% of calves could be immunized (i.e., successfully vaccinated). In this case, 40% or more of calves on the refuge would be prevented from aborting. If the vaccine prevented infection, its effect on the refuge herd would translate to a 18%–20% reduction in seroprevalence in the Jackson herd, a minor beneficial impact. A more highly effective vaccine could achieve moderate reductions in the herd. Simulations by Gross et al. (1998) showed that immunizing 30%–40% of all elk calves every year for more than 25 years would be required to eradicate brucellosis.

Transmission among Elk — Transmission among elk would be lower than under Alternative 1 by a minor to moderate amount in this alternative in the long term because prevalence would be lower, there would be fewer elk, densities would decrease, winter feeding would be less frequent, and elk would disperse to cultivated forage and native winter range, including improved habitat outside the refuge and park. The use of Strain 19 might additionally lower risk of transmission through negligible to minor decreases in abortion described above.

If a more efficacious vaccine (>50% efficacy, for example) was developed and delivered to a high proportion of susceptible elk on the refuge, transmission would decrease as prevalence and abortions decreased, e.g. by a moderate amount compared to Alternative 1. This translates to a minor to possibly moderate decrease in the Jackson herd, depending on the effectiveness of the vaccine.

Transmission from Bison to Elk — Impacts under Alternative 4 would be similar to those under Alternative 3. Lower numbers of both bison and elk would reduce chances of direct contact between the species and fewer abortions on the refuge. Vaccinating elk with an effective vaccine would result in moderate, long-term, beneficial impacts, similar to Alternative 3.

Septicemic Pasteurellosis

Potential impacts on prevalence would be lowest under alternatives that reduce the number of elk on the refuge and reduce the winter feeding program. Alternative 4 would have mid-range potential for impacts compared to the other alternative, lower than under Alternatives 1 and 5, and higher than under Alternatives 2, 3, and 6. For more detailed discussion, see the corresponding section for elk under Alternative 1.

Necrotic Stomatitis

An increased incidence of necrotic stomatitis in the Jackson elk herd would occur if sufficient high quality forage was not available and elk were forced to use poor forage such as coarse woody vegetation. This alternative would supply elk on the refuge with sufficient forage through native range habitat improvements, enhanced forage production on the refuge through irrigation, and supplemental winter feeding in the worst winters. Therefore, the risk of increased prevalence of necrotic stomatitis in the Jackson elk herd would be approximately equal to that under Alternative 1.

Psoroptic Scabies

The negligible beneficial effects on elk health would be the same as described under Alternative 2 but more limited due to more limited reductions to the supplemental feeding program. Potential prevalence under Alternative 4 would be lower than what would occur under Alternatives 1 and 5.

Helminths and Lungworms

Lungworm transmission and prevalence in elk under Alternative 4 and associated impacts would be similar to those under Alternative 3, greater than under Alternative 2 and 6, and less than under Alternatives 1 and 5.

Bovine Tuberculosis and Paratuberculosis

Bovine tuberculosis and paratuberculosis are not present in the Jackson elk herd. The relative risk among the alternatives that either of these diseases would become established would be mid-range under Alternative 4 because winter feeding would continue to occur in about half of possible winters. Risk would be higher than under Alternatives 2, 3, and 6 but lower than under Alternatives 1 and 5. See the discussion for elk under impacts of Alternative 1, “Disease Prevalence and Transmission” for more detail. The following impact analyses assume that these diseases have been established in the herd.

If either were to become established in refuge elk, potential impacts would be slightly greater than Alternatives 2, 3, and 6 in all categories, but would be lower than under Alternatives 1 and 5. Locally high densities of elk in western portions of the park and elsewhere in the Jackson herd unit might provide focal points of transmission (B. Smith, pers. comm. 2003)

Malignant Catarrhal Fever

There are no reports of malignant catarrhal fever occurring in the Jackson bison or elk herds (HaydenWing and Olson 2003). The risk of infection in the Jackson elk or bison herds would be similar under Alternatives 4 and 5 because animal numbers would be reduced and habitat improvement and winter feeding would encourage elk and bison to remain on the refuge during winter. Risk would be less than under the Alternatives 1, 2, 3, and 6.

Large changes in density would be needed to see a difference in potential impacts among alternatives. Because specific changes in prevalence in the herds, herd production, recruitment, mortality, and transmission are unknown for any of the alternatives, alternatives were ranked based on the relative impacts that could occur, should malignant catarrhal fever become established in the Jackson elk or bison herds.

Potential for impacts would be intermediate under Alternative 4 due to a moderate number of elk

(4,000–5,000) and winter feeding in an estimated 5 out of 10 years. This potential would be less than under Alternatives 1 and 5, and more than under Alternatives 2, 3, and 6.

Chronic Wasting Disease

Under Alternative 4 the risk of chronic wasting disease becoming established in the Jackson elk herd would be similar to the risk under Alternative 1 due to similar numbers of elk and frequent winter feeding. This risk would also be similar to that under Alternative 5 and it would be lower than under Alternatives 2, 3, and 6.

Prevalence of chronic wasting disease under Alternative 4 would be higher than under Alternatives 2, 3, and 6 and might be lower than under Alternatives 1 and 5 due to fewer feeding years (Table 4-6). Risk of transmission would follow this same ranking.

If chronic wasting disease became established in the Jackson elk herd, it is likely that prevalence would fall within the range seen in free-ranging elk (2%–4%) and confined elk (59%–100%). Prevalence in the Jackson elk herd might be higher than it would be otherwise, and closer to that experienced in confined situations, because elk are very concentrated in the winter when on feedlines.

Calving, Age and Sex Ratios, and Recruitment

Short-term Effects. Although age and sex ratios would initially be similar to baseline conditions and to those expected under Alternative 1, ratios would likely change somewhat under Alternative 4 due to increased winter mortality, reduced prevalence of brucellosis, and hunting. Furthermore, a larger number of elk would winter on native range, as compared to baseline conditions and Alternative 1, which would subject a proportionately large portion of the Jackson elk herd to a higher mortality rate. As in other alternatives, increased mortality on and off the refuge would mainly affect older elk of both sexes and calves, and some prime bulls entering the winter energetically stressed due to rut activities, the same cohorts vulnerable to mortality under Alternative 1.

Long-term Effects. The current bull-to-cow ratio in the park segment would be lower than in more natural (e.g. unfed, unhunted) populations and has recently varied between 12–29 bulls per 100 cows. Hunting would particularly harvest cow elk to help readjust this ratio, and would in the long term decrease bull tags for refuge elk as needed when objectives for the number of refuge elk (4,000–5,000 in this alternative) were achieved. Ultimately, the park segment would be managed to achieve an average ratio of 35 bulls to 100 cows, a minor to major increase over current conditions.

The ratio of bulls to cows in the Jackson herd currently averages 24:100. Increasing the bull-to-cow ratio in the park segment, which would comprise about 14%–15% of the herd, would translated to a minor increase in the whole herd ratio. These increases would be less than under Alternative 5, in which up to 2,500 elk would be maintained in the park segment, and greater than under Alternative 3, in which the park segment would be reduced to 500–1,000 elk.

The influence of weather, less supplemental feeding and hunting of cows would all contribute to higher mortality, particularly in calves. This would be somewhat mitigated by several factors, including lower losses from existing or potential disease. However, even with vaccination of 100% of refuge calves and cows by year 3 with Strain 19, reductions in calf mortality related to lower prevalence of brucellosis and potential spread of disease not yet in the herd would be negligible.

In the long term, as the prevalence of brucellosis declines due to reduced feeding, lower elk and bison densities, Strain 19, and possibly a more effective vaccine in the future, production and recruitment would increase by a negligible amount. If a more effective vaccine was found, production and recruitment losses from brucellosis would be reduced by a moderate amount because prevalence and the number of abortions would be reduced. However, because so few calf deaths are related to brucellosis, even eliminating it from the herd would only increase recruitment by less than 0.5% in any given year, which is negligible.

If chronic wasting disease, bovine tuberculosis, or bovine paratuberculosis became established in

Jackson Hole, they would affect production and recruitment mainly by lowering the number of animals that produce calves. Numbers of calves produced each year would decline with a declining population size and fewer adult females to produce calves. These diseases could also affect age ratios because they would increase mortality in older animals particularly. See the "Mortality" section below for potential effects.

Mortality

Short-term Effects. The gradual reduction in years of supplemental feeding would negligibly increase mortality levels on the refuge by 3%–4% in some years compared to baseline conditions and under Alternative 1. Average winter mortality on the refuge would increase from 1%–2% annually to an estimated 1%–5%. Modeled estimates support the assessment that annual natural survival of adult elk in the entire herd has also been high, 96.8% for bulls and 97.2% for cows (Lubow and Smith 2004). After several years, a larger proportion of elk would winter on native range and be subject to natural factors affecting mortality, including loss of body condition, predation, and starvation. The start of supplemental feeding would be based on assessments of forage utilization (done jointly by WGFD and NER personnel) and potentially on the January 1 index of winter severity calculations for elk (Farnes et al. 1999). Although supplemental feeding on the refuge would occur in above-average and severe winters, its initiation would likely be delayed compared to current start dates. Overall, a higher total winter mortality rate of approximately 5% would be expected. Increases in mortality would be less than would occur under Alternative 2 but approximately the same as under Alternative 3.

Long-term Effects. The same negligible increase in mortality in refuge elk related to fewer feeding years and increased vulnerability to natural conditions, such as weather and predation, as described above would continue in the long term. The increase would be kept small by reducing numbers through hunting and by doubling the amount of cultivated forage on the refuge.

Higher mortality for the portion of elk that would switch to native range would be mitigated in above-average and severe winters by the presence of supplemental feed.

The increase in predation and scabies would be negligible under Alternative 4, as would loss of body condition as supplemental feed would be available during winters of above-average or severe intensity. Brucellosis would decrease in prevalence as noted above.

Under Alternative 4, mortality from septicemic pasteurellosis would be greater than under Alternatives 2, 3, and 6 and less than under Alternatives 1 and 5.

The following impacts would potentially occur if bovine tuberculosis, bovine paratuberculosis, and chronic wasting disease infected the Jackson elk herd.

Because bovine tuberculosis and bovine paratuberculosis are chronic, slowly developing diseases, older animals tend to have higher probability of being infected (Rodwell et al. 2001) and exhibiting clinical symptoms. Adult elk mortality would increase in the long term as the number of clinical cases increased. It is likely that the absolute impact of bovine tuberculosis or paratuberculosis on production in the herd would be low. For example, if prevalence of either disease was 5% (as was prevalence for a Canadian elk herd; Hadwen 1942), then a maximum of 5% of the Jackson elk herd could be lost; this would constitute a negligible to minor increase in mortality.

If chronic wasting disease infected the Jackson elk herd, mortality would follow prevalence, and likely fall within the range seen in free-ranging and confined elk (2%–4% to 59%–100%, respectively), with effects ranging from negligible to major. Rankings of the alternatives for potential impacts from chronic wasting disease were based on winter feeding frequency and duration, as well as on the number of elk wintering on the refuge. The relative impacts on mortality under Alternative 4 would be greater than under Alternatives 2, 3, and 6 and less than under Alternatives 1 and 5 (Table 4-6).

Health, Sustainability, and Naturalness

Short-term Effects. As in Alternatives 2 and 3 but to a more limited extent, the health and sustainability of the Jackson elk herd would be increased gradually as supplemental feeding was reduced to progressively fewer years and there was greater reliance on standing forage and wider ungulate distribution. Although high concentrations would continue to occur on the refuge feedgrounds during above-average and severe winters (an estimated 4–5 years of 10), brucellosis prevalence and transmission would be reduced compared to baseline conditions and Alternative 1 due to reductions in numbers, feeding frequency, and vaccination. Alternative 4 would lower the risk of future population declines or depopulation events from bovine tuberculosis, for example, or other non-endemic disease compared to alternatives with annual feeding (Alternatives 1 and 5) but high risk could continue to be maintained by the level of supplemental feeding under Alternative 4.

Increased harvest would lower the Grand Teton National Park portion of the refuge wintering herd, decreasing refuge elk numbers. This would produce a more sustainable situation, with fewer elk being more able to survive on standing forage without supplemental feed.

Naturalness would also increase gradually in the short term under Alternative 4 as elk increasingly distribute themselves according to the distribution of available forage on native range and natural phenomena, such as winter weather and predators, would have an increasingly stronger influence on mortality in some years. Mortality would increase in average winters to an estimated 3.5% (Hobbs et al. 2003), compared to the 1%–2% baseline and Alternative 1. These effects would be similar but more limited than what would occur under Alternatives 2, 3, and 6.

Long-term Effects. Alternative 4 would continue to enhance health and sustainability of the Jackson elk herd in the long term although to a lesser extent than would Alternatives 2, 3, and 6. Health and sustainability under Alternative 4 would be greater than under Alternatives 1 and 5. The reasons are similar to those described above for short term effects.

Wider distribution of elk would result in moderate reductions in both the prevalence and potential transmission of brucellosis, as well as potential for spread of diseases not yet in the population. Transmission risk and the likelihood of major adverse impacts from other diseases would be less than under Alternatives 1 or 5, but higher than Alternatives 2, 3, and 6.

Barring the introduction of serious, non-endemic disease or extreme decreases in population size, the Jackson elk herd would continue to be self-sustaining at 11,000 animals and would maintain genetic viability. Winter mortality could increase negligibly during average winters.

Overall, the long-term health and sustainability of the elk herd would be lower than under Alternatives 2, 3, and 6 and higher than under Alternatives 1 and 5.

The elk herd would be more natural than under baseline conditions and Alternative 1 because supplemental feeding would be reduced. Natural factors such as climate and amounts of native forage would have a much greater influence on numbers, movements, distribution, and mortality. Increased use of exclosures on the refuge would alter elk distribution and reduce the naturalness of movements to some extent.

Increases in naturalness would likely be negligible under Alternative 4. Elk would distribute themselves more naturally, expend more energy accessing winter forage, and maintain a more natural, lower nutritional status, but only in mild or average winters. Production and recruitment rates would be more natural and calves born outside of the normal birthing season would be less likely to survive in these years. Winter mortality patterns would be more natural compared to baseline level and Alternative 1 due to a reduced winter supplemental feeding program and greater elk use of native winter range and standing forage.

Elk behavior would also become more natural. Competitive social interactions associated with feedlines would decrease.

Elk reduction for the park segment would help to achieve a more natural bull-to-cow ratio for both refuge elk and in the Jackson herd.

Possible increases in elk distribution during some non-feeding years might cause more animals to be killed by vehicles or agency removals, but these increases in mortality would likely be negligible.

Alternative 4 would result in a higher level of naturalness in the elk herd than would Alternatives 1 and 5. Naturalness would be less than under Alternative 2, 3, and 6 mainly because of the continuation of winter feeding in an estimated 4–5 years of 10.

Conclusion

In the long term under Alternative 4 there would be an estimated 11,000 elk in the Jackson elk herd and fewer elk wintering on the refuge. The herd would be similar in size to that under Alternatives 1 and 5, and larger in some years than Alternatives 2, 3, and 6.

Compared to Alternative 1, Alternative 4 would emphasize enhanced forage production on the refuge to sustain approximately 4,000–5,000 elk. Eliminating supplemental feeding during average and milder-than-average winters, in addition to creating a disturbance on the southern end of the refuge, would decrease elk numbers and densities. Approximately 1,600 acres of exclosures on the refuge to protect woody vegetation would alter distribution and increase elk densities outside the fences. In combination, these influences could cause densities on the refuge outside the feedlines to remain the same as under Alternative 1. Nonharvest mortality would increase negligibly from baseline conditions.

More elk in the Jackson herd would increase their movements and distribution and respond in a more natural way to winter forage availability, compared to baseline conditions and Alternative 1, due to greater reliance on native range and standing forage in mild and average winters. Negligibly increased winter mortality could occur in some of these years.

The risk of a non-endemic infectious disease quickly spreading through the elk population would be intermediate among the alternatives. The risk would be lower due to reduction of winter feeding and fewer bison and elk, but higher than under Alternatives 2, 3, and 6. Alternative 4 would have an intermediate risk of such a disease having major adverse impacts to survival and population sustainability.

The prevalence of brucellosis in the Jackson elk herd would be moderately lower than under Alternative 1. Strain 19 would be used to vaccinate elk on the refuge during supplemental feeding periods and would be replaced when a more efficacious vaccine was available for use. Lower levels of infection in the herd would negligibly increase elk numbers due to reduced abortion rates. The approximately one-third of the Jackson elk herd that spends the winter on native range would not be directly affected by Alternative 4, although competition for native forage could increase when feeding does not take place on the refuge.

Alternative 4 would result in higher levels of long-term health, sustainability and naturalness in the Jackson elk herd than what would occur under Alternatives 1 and 5, and lower levels than what would occur under Alternatives 2, 3, and 6.

Barring the introduction of serious non-endemic disease, Alternative 4 would not impair the elk population in the park. If such a disease did become established in the herd, Alternative 4 would have a lower potential for impairment than would Alternatives 1 and 5, and a higher potential for impairment than Alternatives 2, 3, and 6. Although the potential risk of impairment would be lower than under Alternative 1, potential risk would be elevated somewhat due to continued feeding of elk and bison on the refuge.

ALTERNATIVE 5

This alternative would be similar to Alternative 1, as supplemental feeding would continue as it is now. Changes include improved irrigation to help increase forage production on the refuge, fencing of woody vegetation, a bison hunt on the refuge to reduce numbers to 350–400, and vaccination of elk with Strain 19. Although elk hunting would continue, the park segment would be targeted.

Analysis

Elk Numbers Wintering on the National Elk Refuge and on Native Winter Range

Approximately 5,000–7,500 elk would winter on the refuge. Refuge elk numbers would remain similar to baseline conditions and numbers under Alternative 1. If the Jackson elk herd objective was met and maintained, the average number of elk on the refuge would be approximately 5,574. This number is the average of elk counted during 5 of the last six winters (a partial count was not included), adjusted for a Jackson elk herd size of 11,000.

Adjusted estimates of elk numbers on native winter range would range from 2,900–5,200, and average 3,700 elk, similar to baseline conditions and Alternative 1. Elk wintering in the park (360 on average) are included in these estimates.

Elk Numbers in the Jackson Elk Herd

Based on recent conditions, when the Jackson elk herd ranged from 13,000 to 15,000, herd totals would likely be higher than the herd objective (11,000) on average if elk wintering on the refuge numbered between 5,000 and 7,500. Achieving the 11,000 herd size objective would be difficult without reducing numbers of elk on the Gros Ventre feedgrounds or on native winter range. For example, elk on native winter range now number about 4,400–7,900, the Gros Ventre feedgrounds averages 2,500 elk, and the number at the refuge and in the park ranges from 5,000 to 7,500 elk. At the low end of the range, this totals 11,900, and assuming high end numbers, 17,900. If refuge elk numbers remained the same, mortality would need to increase for elk wintering on native forage or feeding at the Gros Ventre feedgrounds would need to be reduced to achieve whole herd objectives.

Distribution and Movements of Elk

The changes in this alternative that would affect distribution and movements of elk include the fencing of woody vegetation, doubling cultivated forage on the refuge, and hunting geared to reduce elk numbers in the Grand Teton National Park segment. Alternative 5 would have negligible to minor effects on elk movements and distribution compared to baseline conditions and what would occur under Alternative 1.

Alternative 5 would increase sprinkler irrigation to enhance forage production and quality compared to current levels, resulting in elk spending more time in cultivated fields. In years when snow crusting events made cultivated fields with high forage production inaccessible to elk, mechanical means would be used to increase access for and to extend elk use of these areas. Hunting in designated areas of the park and the refuge would continue to cause elk to move through and away from these areas during harvest periods, as it does under existing management and would do under Alternative 1.

Exclosures designed to protect woody vegetation (1,600 total acres compared to less than 20 acres under baseline conditions) would cause negligible localized changes in ungulate distribution, as elk would lose access to approximately 7% of formerly available areas on the refuge. The aspen enclosure could slightly change migratory pathways of elk (Cole, pers. comm. 2003).

Harvest efforts would aim to reduce the portion of the Grand Teton National Park segment that winters on the refuge to less than 2,500 elk, a negligible to minor impact. Elk numbers in the other three segments, the Gros Ventre, Teton Wilderness, and Yellowstone National Park segments, would increase to a minor extent.

Vaccine delivery with Strain 19 would take place during winter supplemental feeding on the refuge, causing short-duration disturbance and negligible to minor changes in movements and distribution (USFWS 2002a; see impacts of Alternative 4). Potential changes in elk behavior are described under impacts of Alternatives 3 and 4; impacts would likely be minor and temporary.

Elk Behavior, Social Interactions, and Nutrition

Short-term Effects. Aspects of Alternative 5 that would affect elk behavior, social interactions, and/or nutrition include brucellosis vaccination, vegetation exclosures, changes in irrigation practices on the refuge, and reduced competition with bison.

Vaccination for brucellosis would take place during winter supplemental feeding on the refuge, which would occur for about 70 days during 9 of every 10 years. Vaccine delivery would cause negligible to minor short-duration adverse effects to elk behavior, social interactions, and nutrition (see descriptions in Alternatives 3 and 4).

Displacement of elk during competition with bison for forage in transition and winter habitat would decrease under Alternative 5 during the initial 10 to 15 years as bison numbers were gradually reduced from 800–1,000 to the objective of 350–400.

Nutrition could gradually be enhanced because the amount of native forage available to elk could increase as bison numbers were reduced. In the short term, amounts of herbaceous vegetation available on the refuge would be negligibly lower than under baseline conditions and amounts under the short term of Alternative 1. Amounts would remain similar because improvements in forage production on the refuge would mitigate the loss of herbaceous forage made inaccessible by vegetation exclosures (1,600 acres).

Long-term Effects. Social interactions involving forage competition and displacements of elk by bison would continue to be lower than under baseline conditions and Alternative 1 due to lower numbers of bison.

Vaccination would continue to cause short-duration, negligible to minor effects due to disturbance. If oral vaccine delivery became possible, disturbance would be less than if ballistic delivery were used.

Elk nutrition could continue to be enhanced in the long term due to fewer bison, reduced competition with bison, and greater forage production on the refuge. Changes in irrigation practices would continue to mitigate the loss of forage due to exclosures. Amounts of herbaceous vegetation available on the refuge would continue to be similar to, but negligibly lower than under baseline conditions and long-term conditions under Alternative 1. Greater amounts of standing forage would be available to elk primarily because bison numbers would be reduced by half.

Disease Prevalence and Transmission

Bovine Brucellosis

Prevalence in Herd — Under Alternative 5 prevalence of brucellosis in the Jackson elk herd and transmission of brucellosis among elk would likely remain unchanged from current levels in the short term because elk numbers wintering on the refuge and the winter feeding program would be similar to the current conditions.

An attempt would be made to vaccinate 80% of calves each year. As noted in the impacts for Alternative 4, vaccination with Strain 19 could provide some modest level of protection against brucellosis-induced abortion in elk (Thorne et al. 1981; Roffe et al. 2002), although it would not prevent brucellosis infection (Wyoming Brucellosis Coordination Team 2005).

Because elk would still be fed 9 out of 10 years, and because only one abortion on the feedlines could result in many elk being infected, the refuge would maintain higher prevalence than would occur in the absence of feeding. In the absence of vaccination, seroprevalence on the refuge has declined in recent years due to natural cycling of brucellosis or through reduction of crowding on feedlines resulting from feeding program improvements (see Figure 3-3; B. Smith, pers. comm. 2003).

In the remainder of the Jackson elk herd, elk wintering on the Gros Ventre feedgrounds would be vaccinated by WGFD personnel, while those on native ranges (approximately 32% under Alternative 5) would not. However, brucellosis prevalence in elk that winter on native range would be lower than in elk that winter on feedgrounds and would not likely change under Alternative 5.

Transmission among Elk — In the short term, transmission among elk would not change. In the long term, a minor decrease in transmission among elk would occur because the vaccination program would serve to reduce the number of abortions that occur. The relationship between transmission risk among elk on feedlines and prevalence is not likely a linear relationship (but curvilinear) because a single abortion (which could occur even when prevalence is low) could infect the bulk of elk feeding in the area of the abortion (Thorne 2001).

Transmission from Bison to Elk — In the short term, there would be no change in the transmission to elk with or without vaccination. In the long term, and without vaccination, a negligible decrease in brucellosis transmission from bison to elk could occur due to decreased numbers of bison, thus reducing contact between the species. This assumption may be incorrect since seropositive rates have declined on the refuge while bison numbers, and transmission opportunities, have increased. With vaccination, abortion and possibly potential transmission would be further reduced. Therefore, the impact could be a negligible to minor reduction in brucellosis transmission from bison to elk, compared to Alternative 1.

Septicemic Pasteurellosis

Potential impacts are expected to be lowest under Alternatives 2, 3, and 6, and highest under Alternatives 1 and 5.

Potential impacts under Alternative 5 would be the same as Alternative 1, and higher than under Alternatives 2, 3, 4, and 6. For more detailed discussion, see the corresponding section for elk under "Disease Prevalence and Transmission" in Alternative 1.

Necrotic Stomatitis

Because this alternative would supply elk on the refuge with sufficient forage through enhanced forage production on the refuge through irrigation, and supplemental winter feeding in the worst winters, no increase in the prevalence of necrotic stomatitis over current conditions or Alternative 1 is expected.

Psoroptic Scabies

There would be no impact on the prevalence of psoroptic scabies in the elk herd under Alternative 5, and there would be no impact on mortality and transmission among elk compared to baseline conditions and what would occur under Alternative 1.

Helminths and Lungworms

Lungworm transmission and prevalence in elk under Alternative 5 and associated impacts would be similar to Alternative 1 and greater than under Alternatives 2, 3, 4, and 6.

Bovine Tuberculosis and Paratuberculosis

Bovine tuberculosis and paratuberculosis are not present in the Jackson elk herd. The risk among alternatives that either of these diseases would become established would be relatively high because of essentially annual winter feeding. Risk would be lower than under Alternative 1 and higher than under Alternatives 2, 3, 4, and 6. See the discussion for elk under impacts of Alternative 1, "Disease Prevalence and Transmission," for more detail. The following impact analyses assume that these diseases have been established in the herd.

Impacts on the Jackson elk herd, and all other species, associated with bovine tuberculosis under Alternative 5 would be similar to those under Alternative 1 in all categories, because elk numbers and the winter feeding program would be similar under both alternatives.

The potential for transmission of bovine tuberculosis or bovine paratuberculosis from bison to elk in the long term under Alternative 5 would be lower by a minor amount because (1) bison numbers would be reduced, and (2) prevalence in the bison herd would be lower by a negligible to minor amount. Locally high densities of elk in western portions of the park and elsewhere in the Jackson herd unit might provide focal points of transmission (B. Smith, pers. comm. 2003)

Malignant Catarrhal Fever

There are no reports of malignant catarrhal fever occurring in the Jackson bison or elk herds. The risk of introduction into the Jackson elk and bison herds is described in greater detail under "Disease Prevalence and Transmission," impacts of Alternative 1.

The risk of infection in Jackson elk under Alternative 5 would be lower than under Alternatives 1, 2, 3, and 6, and similar to Alternative 4. Under Alternative 5, as well as Alternative 4, numbers would be reduced and habitat improvement and winter feeding would encourage elk and bison to remain on the refuge during winter.

Potential impacts would be worst under Alternatives 1 and 5 because elk numbers and density would be highest and winter feeding would occur nearly every year. This potential for impacts would be greater than under Alternatives 2, 3, 4, and 6.

Chronic Wasting Disease

Under Alternative 5, the risk of chronic wasting disease becoming established in the Jackson elk herd would be similar to the risk under Alternative 1 and would be higher than under Alternatives 2, 3, 4, and 6 (see Table 4-6).

If chronic wasting disease became established in the Jackson elk herd, prevalence would likely fall within the range seen in free-ranging and confined elk. Elk concentrations under Alternative 5 would be similar to those under Alternative 1, and higher than under Alternatives 2, 3, 4, and 6.

Calving, Age and Sex Ratios, and Recruitment

Alternative 5 would have negligible effects on calving and recruitment compared to baseline conditions and Alternative 1. Brucellosis vaccination on the refuge, alterations to hunting practices, and potential impacts from diseases could alter age and sex ratios.

Production and recruitment losses for the refuge portion of the Jackson elk herd from brucellosis would be expected to be reduced by a minor to moderate amount because prevalence would be reduced similarly, resulting in fewer abortions. It is estimated that currently there is a maximum 5% loss of elk calves to brucellosis caused abortion on the refuge (Oldemeyer, Robbins, and Smith 1993, as adjusted for lower seroprevalence). A minor to moderate reduction in the 5% loss would constitute a negligible increase in elk production and recruitment in the Jackson elk herd in the long term.

The risk of an outbreak of septicemic pasteurellosis, which disproportionately affects calves, would remain similar to the risk under baseline conditions and what would occur under Alternative 1.

If bovine tuberculosis, bovine paratuberculosis, or chronic wasting disease became established in the refuge, they would affect production and recruitment through increased mortality and lowering the number of animals that can produce calves. Numbers of calves produced each year would decline with a declining population size and fewer adult females to produce calves. These diseases could also affect age ratios because they would increase mortality in older animals particularly.

As described in Alternatives 3 and 4, harvest strategies would be modified to achieve a bull-to-cow ratio for elk in the Grand Teton segment that mimics that in an unfed, unhunted and more natural population. The current ratio of 12–29 bulls per 100 cows would be increased to 35, a minor to major increase in this segment, and a minor increase in the herd (see Alternatives 3 and 4 for additional information).

Mortality

Mortality of elk wintering on the refuge would remain low, at 1%–2%, as it is currently. Hunting would continue to take elk from the refuge, and in particular those in the park segment. Exclosures on the refuge, particularly the large aspen enclosure to the west of Long Hollow, could enhance hunter success and increase mortality by channeling elk movements during fall migration onto the refuge around fenced areas.

Potential impacts from septicemic pasteurellosis under Alternative 5 would be the same as under Alternative 1, and higher than under Alternatives 2, 3, 4, and 6.

The following impacts would potentially occur if bovine tuberculosis, bovine paratuberculosis, or chronic wasting disease infected the Jackson elk herd.

If bovine tuberculosis and paratuberculosis infected the herd, impacts on the Jackson elk herd under Alternative 5 would be similar to those under Alternative 1. Older animals tend to have a higher probability of being infected with these chronic, slowly developing diseases (Rodwell, White, and Boyce 2001) and exhibiting clinical symptoms. Hence, adult elk mortality would increase in the long term as the number of clinical cases increased.

If chronic wasting disease infected the Jackson elk herd, prevalence would likely fall within the range seen in free-ranging and confined elk (2%–4% to 59%–100%, respectively). Mortality would reflect prevalence and, depending on the extent of infection, negligible to major increases could be possible. Potential impacts from chronic wasting disease under Alternative 5 would be similar to impacts under Alternative 1.

Health, Sustainability, and Naturalness

The health and sustainability of the Jackson elk herd would be similar to levels under baseline conditions and Alternative 1 due to continuation of nearly annual winter feeding. Alternative 5 would concentrate thousands of elk and hundreds of bison on feedlines for several months nearly every year. These annual concentrations would continue to maintain high risk of facilitating a high level of transmission among elk if a non-endemic infectious disease were to become established in the herd, thereby jeopardizing herd health and sustainability in the long term. Brucellosis vaccination could decrease prevalence and increase herd health by a minor to moderate degree in the long term.

Barring the introduction of serious non-endemic disease, the Jackson elk herd would continue to be genetically viable and self-sustainable at 11,000. Alternative 5 would have no effect on elk genetic viability compared to baseline conditions and Alternative 1.

Naturalness would remain similar to baseline conditions and Alternative 1, and several population processes would continue to operate at unnatural levels. Notably, winter mortality would be lower than natural due to the winter feeding program on the refuge. Under natural conditions mortality rates are different among age and sex classes, but winter feeding would tend to nullify these differences. Elk would continue to expend less energy accessing winter forage than they would without supplemental feeding, and they would continue to maintain a higher level of nutrition. Also because of the winter feeding program, recruitment rates would be unnatural, and calves born out of the normal calving season would continue to have a high chance of survival. Several of these factors could reduce fitness of the elk herd, which could have long-term implications.

Seasonal distribution and movements would continue to be unnatural under Alternative 5. Rather than many groups of elk roaming in search of available forage, as occurred naturally, the herd would continue to be concentrated together in a relatively small area for several months each winter.

Maintaining a ratio of approximately 35 bulls to 100 cows in the Grand Teton National Park segment of the Jackson herd unit would enhance naturalness in the herd. This ratio would be representative of a native, non-hunted population and higher than under baseline conditions.

Overall, naturalness under Alternative 5 would remain similar to naturalness under Alternative 1 and would be lower than under Alternatives 2, 3, 4, and 6 mainly because of the continuation of winter feeding.

Conclusion

In the long term under Alternative 5 there would be at least 11,000 elk in the Jackson elk herd. The herd would be similar in size to that under Alternatives 1 and 4, and larger in some years than under Alternatives 2, 3, and 6. The number of elk wintering on the refuge would also be similar to baseline conditions and Alternative 1.

Alternative 5 would be similar to Alternative 1, except that a vaccination program would be in place and brucellosis-related abortions in elk that winter on the refuge could be lower by a minor degree. Elk numbers would increase negligibly due to reduced abortion rates.

Movements and distribution would be similar to baseline conditions and levels under Alternative 1 in the long term due to nearly annual winter supplemental feeding on the refuge. Large concentrations of elk would continue to focus in winter on feedgrounds and nearby areas. Production, recruitment, and annual winter mortality would remain similar to baseline and Alternative 1 and would be lower than levels found in non-fed populations in similar environments.

The risk of a non-endemic infectious disease quickly spreading through the elk population would be high due to the near-annual winter feeding program. Therefore, this alternative would have a high risk of a major adverse impact to survival, population size, and sustainability. The risk would be higher than Alternatives 2, 3, 4, and 6, and lower than Alternative 1.

Levels of long-term health, sustainability, and naturalness in the elk herd under Alternative 5 would be higher than under Alternative 1, and lower than levels under Alternatives 2, 3, 4, and 6.

Barring the introduction of serious non-endemic disease, Alternative 5 would not impair the elk population in the park. Alternative 5 would have higher potential for impairment from disease than would Alternatives 2, 3, 4, and 6 and similar potential to Alternative 1.

ALTERNATIVE 6

This alternative is very similar to Alternative 2, which would minimize management and eliminate winter supplemental feeding on the refuge over time. However, under this alternative feeding would be eliminated sooner, and both elk and bison would be hunted. If an effective vaccine for brucellosis became available, it would be administered if delivery would not depend on winter feeding.

Analysis

Numbers of Elk Wintering on the National Elk Refuge and Native Winter Range

Short-term Effects. During the initial 5 to 10 years, the number of elk wintering on the refuge would be reduced to an estimated 2,400–2,700. These reductions would occur primarily through hunting to decrease the number of elk wintering on the refuge, particularly elk that summer in the park. These numbers would also be achieved through non-harvest mortality as cultivated forage and supplemental feeding were phased out, particularly in harsh winters. The number of elk on the refuge could be reduced below 2,400 if satisfactory willow recovery did not occur and additional fencing was required.

Elk on native winter range would continue to vary annually according to the severity of the winter and the stage of the feeding program reduction. Their numbers would likely initially increase during non-feeding years above the estimated 4,400–7,900 that have used native range during the last 15 years.

Long-term Effects. When monitoring indicated that woody vegetation had recovered to objective levels, the number of elk wintering on the refuge would be allowed to increase to an estimated 2,800–3,200, although refuge elk numbers could decrease to an estimated 1,200 in some years.

Estimated numbers of elk on native winter range would likely remain higher than estimated numbers at baseline conditions. Baseline estimates, which assume feeding during 9 or 10 winters and a total herd size of 11,000, indicate approximately 2,900–5,200 elk on native winter range (average, 3,700). Increased elk distribution due to the elimination of feeding on the refuge and habitat improvements outside the park and refuge could also help increase the number of elk subsisting on native range.

Similar to Alternative 2, numbers of elk wintering in the park could increase negligibly as reductions in the refuge supplemental feeding program were made. If the elk herd reduction program was eliminated in the southern part of the park, more elk might use these areas as transitional or winter range.

Elk Numbers in the Jackson Elk Herd

Short-term Effects. As reductions in the refuge feeding program progress, winter mortality would increase and Jackson elk herd numbers would decrease.

Long-term Effects. Elk numbers in the Jackson herd under Alternative 6 would be lower than under baseline conditions and Alternative 1 in the long term. Factors decreasing elk numbers on the refuge in the long term could also lower numbers in the Jackson herd. These factors include the elimination of refuge supplemental feeding, greater elk reliance on native vegetation, and forage competition with bison. In addition, increased forage created through the Jackson Interagency Habitat Initiative, a joint effort of the U.S. Forest Service, Wyoming Game and Fish Department, and other partners, would reduce winter mortality.

Total herd numbers would range from an estimated 9,300 to 11,000. This range was calculated though combining known minimum averages for elk on native winter range (4,400), 2,500 elk on the Gros Ventre feedgrounds and an average minimum of 2,400 elk wintering on the refuge. Total herd numbers would range from 9,700 to 11,000 if a minimum of 2,800 elk wintered on the refuge in the long term.

Distribution and Movements of Elk

Short-term Effects. Winter distribution would likely remain similar to baseline conditions for several years as supplemental feeding was phased out. Seasonal movements between summering areas and the refuge would continue. Increases in elk movements and distribution would become more frequent, and would occur earlier in this alternative than in others where feeding was decreased. During the approximately five-year phaseout of supplemental feeding on the refuge and elk transition to greater use of native range, the U.S. Fish and Wildlife Service and the National Park Service would work with the Wyoming Game and Fish Department to resolve commingling issues.

As in Alternative 2, as progressively more elk were recruited into the population and were not supplementally fed during their lifetimes, numbers on the refuge could decrease. Distribution would be wider and movements farther as more elk explored native range off the refuge, although fencing on the southern and southwestern boundaries of the refuge would limit movement in these directions. Results of modeling (Hobbs et al. 2003) indicate that elk could winter in areas such as the Gros Ventre River drainage, south of Jackson in the Snake River Canyon, lower portions of Hoback Canyon, Buffalo Valley, and the Gros Ventre River drainage. Some could also discover and use the Gros Ventre feedgrounds, increasing densities near the feedgrounds. In above-average and severe winters, more elk could follow the environmental gradient to the refuge, which is at a lower elevation than the park and the adjacent national forest and would have less snow. If elk attempted to move to potential winter range south of Jackson Hole in the Snake River Canyon or in lower portions of the Hoback Canyon, many could be stopped by feedgrounds in these areas.

Forage enhancements in the Gros Ventre River drainage and Buffalo Valley by the Wyoming Game and Fish Department, the U.S. Forest Service, and other partners, which would begin in the short term, would provide additional forage, attract elk to improved areas, and allow more elk to subsist on native range.

Elk densities on the refuge would gradually decrease as elk numbers were reduced below baseline conditions and distribution became more dependent on standing forage rather than feedgrounds. Cultivated fields on the refuge would continue to attract elk. When snow crusting occurs, mechanical means would be used to increase elk access to and use of cultivated areas with high forage production.

A short-term, early season harvest on the southern portion of the refuge, or public access, would further increase elk movements and distribution away from this traditionally safe area and toward areas to the north and east, at least temporarily. These elk, primarily from the Grand Teton National Park segment, might move to the northern part of the refuge, or perhaps north and east into Bridger-Teton National Forest.

Elk movements and distribution would be negligibly altered by a variety of exclosures in both the short and long terms to protect cottonwood and aspen. Although these exclosures would prevent access to approximately 3% of available acreage on the refuge, densities would decline due to fewer elk compared to baseline conditions and Alternative 1, mitigating this loss.

Distribution of elk among the four segments could change, as elk in the park segment would be particularly targeted for harvest.

Late in the short-term period, brucellosis vaccination could occur if safe vaccines were developed with a minimum efficacy of 50% for both bison and elk that could be delivered ballistically or orally. Both forms of delivery could be administered in the park or the refuge.

Ballistic vaccination would cause negligible to minor, short-duration increases in movements and distribution, similar to effects described in “Distribution and Movements of Elk” under Alternative 3.

If a sufficiently effective oral vaccine were developed that would be safe for elk and bison as well as non-target species, and deliverable through localized food supplementation, vaccine delivery could temporarily change distribution by a negligible to minor extent.

Long-term Effects. The elimination of winter supplemental feeding would continue to influence elk movements and distribution in the long term. During all years, fewer elk would remain on the refuge and more would winter on native range. Vegetation exclosures on the refuge would continue to cause minor changes in elk movements and distribution. Prescribed fires on the refuge and the park would continue in the long term to attract elk to treated areas, as under baseline conditions and Alternative 1. Outside the park and the refuge, the U.S. Forest Service, the Wyoming Game and Fish Department, and other partners would continue to enhance habitat in Bridger-Teton National Forest east of the refuge in the Gros Ventre River basin and in Buffalo Valley, which would increase elk distribution in those areas. Some elk could wander farther into the Gros Ventre River drainage, discover WGFD feedgrounds, and increase densities there. Effects from successful land acquisition within refuge boundaries could increase available winter habitat.

Moderate to major declines in densities on the refuge would occur when elk numbers were approximately 2,400–2,700. Later, when vegetation objectives have been achieved and elk numbers increase to 2,800–3,200, densities would be increased by a negligible to moderate amount. On average, densities on the refuge would be decreased to a moderate (50%) degree. The bulk of this decrease in numbers would be borne by the park segment of elk, which would experience moderate or major decreases. The other segments would experience minor decreases in density and numbers. Short-duration feedline concentrations of approximately 500 elk/acre would no longer occur.

If, in the long term, the southern part of the park and the northern fifth of the refuge were closed to hunting, elk movements and distribution would increase in these areas in the fall and perhaps in the winter as well in some areas until or unless snow crusting and/or depths caused them to move to other areas with better access to forage. If standing forage on the refuge was deemed adequate for objective numbers of wintering elk and bison, cultivated fields could be converted to native habitat and would not attract elk and bison to the same extent they do now.

Elk in the park segment would be the most likely to continue wintering on the refuge. This is in part because their migration is shorter and they are less likely to discover alternative winter range. Elk in the other segments would be more likely to find winter range as they migrate south and southwest from summering areas in southern Yellowstone National Park, the Teton Wilderness, and the Gros Ventre River drainage. The Wyoming Game and Fish Department might be able to adjust hunting strategies in order to help these elk find and stay on newly enhanced winter range outside the refuge (Kilpatrick, pers. comm. 2003).

Elk Behavior, Social Interactions, and Nutrition

Short-term Effects. Aspects of Alternative 6 that would influence elk behavior and social interactions, and nutrition in the short term include reductions in elk and bison numbers on the refuge, gradual reductions and elimination of supplemental feeding on the refuge, changes in hunting practices, and possible brucellosis vaccination. Habitat enhancements off the refuge and the park and changes to irrigation and farming practices on cultivated areas of the refuge would also affect elk nutrition.

Relatively rapid reductions in supplemental feeding and numbers of elk and bison would result in fewer competitive social interactions associated with feedlines. Interactions common on feedlines would be much less prevalent during non-feeding years although competition over standing forage would increase in these years compared to baseline conditions and Alternative 1.

The nutritional status of elk could be reduced in some years as the phase out of winter feeding began. Although reductions would occur first in the mildest winters when vegetation would remain accessible due to relatively little snow cover, the number of feeding years would be reduced as quickly as possible, with the goal of eliminating feeding in five years. In the early years, nutritional status would remain high and would be negligibly affected by the lack of feeding. As supplemental feeding occurred in fewer winters and elk relied on standing forage during increasingly severe winters, nutritional status could be decreased, depending on winter severity and access to forage. The continued production of standing forage could help mitigate this, and impacts to nutrition in the short term might be only negligible or minor.

Exclosures of 700 acres on average and reductions in the number of elk on the refuge would help reduce the foraging on woody vegetation in this alternative, particularly in mild winters. Exclosures would negligibly reduce amounts of herbaceous vegetation available to elk compared to baseline conditions and Alternative 1.

If effective brucellosis vaccines were developed, vaccination activities would cause negligible to minor short-duration adverse effects due to disruption of normal elk behavior. If the vaccine was delivered ballistically, elk could experience increased nervousness and excitability. Energetic expenditures from running and aggressive social interactions and displacements would increase. Delivery of an effective oral vaccine in supplemental feed would temporarily change distribution in the herd if it was not a feeding year otherwise. Changes in elk distribution and densities at vaccine delivery sites could cause short-duration, localized increases in aggressive social interactions. Additional analysis under the National Environmental Policy Act might be needed prior to implementation.

Long-term Effects. During shortages of native forage, aggressive social interactions involving food competition for food with other elk and with bison could increase.

Competition for forage in winter habitat would increase under Alternative 6 compared to baseline conditions and Alternative 1. Wider ungulate distribution and reduced numbers would partially mitigate increases in forage competition.

Displacements of elk by bison would continue to occur on the refuge but broader distributions of elk and bison would diminish competition between these two species more than under Alternative 1, where bison numbers would not be controlled.

Nutritional status under Alternative 6 would more closely mimic free-ranging, non-fed elk populations. Impacts would be similar to Alternative 2, but less severe because of bison reductions. There could be more malnutrition, increased use of woody vegetation in severe winters, and moderate to major increases in mortality in severe winters compared to negligible levels under baseline conditions. Although some elk might die during above-average and severe winters because of decreased nutrition and body condition, at low numbers most might be able to maintain adequate nutritional levels on native forage. Continued production of forage on the refuge for 15 years or more and habitat enhancement of areas outside the refuge would help in this regard.

Initiation of supplemental feeding would be based on assessments of forage utilization (done jointly by WGFD and NER personnel) and potentially on the January 1 index of winter severity (Farnes et al. 1999) calculations for elk. In addition, ration or pellet composition might need to be changed to allow for later initiation of supplemental feeding. A higher fiber formula as recommended by Baker and Hobbs (1985) for mule deer might be one possibility.

Vaccination activities, if an oral vaccine was available, would continue to cause negligible to minor, short-duration disturbance, including increased excitability, energetic expenditures, and aggressive interactions.

Disease Prevalence and Transmission

Bovine Brucellosis

Prevalence in Herd — Under Alternative 6, reductions in density on the refuge and wider dispersion of elk would reduce contact with infected elk, bison, or fetuses and result in major reductions in the prevalence of brucellosis in refuge elk in the long term. Prevalence would likely drop to those typical of unfed populations in the region, e.g. 1%–3%. For the entire herd (of which the refuge elk are a portion) there would only be a moderate long-term reduction in prevalence because approximately 2,500 elk would continue to be fed on the state-operated Gros Ventre feedgrounds.

Transmission among Elk — Impacts to transmission would be similar to those in Alternative 2. The experts indicated the probability of transmission would be reduced by a moderate amount in the short term and a major amount in the long term compared to Alternative 1. This is likely for Alternative 6 as well. A similar, minor to moderate reduction in transmission among elk in the entire herd unit would be likely.

Transmission from Bison to Elk — Because of increased dispersion outside the refuge, lower numbers of both bison and elk on the refuge, and lower numbers of bison overall, there would be a major reduction in transmission of brucellosis from bison to elk on the refuge.

Septicemic Pasteurellosis

Impacts from this disease under Alternative 6 would be most similar to those under Alternatives 2 and 3 and lower when compared to all other alternatives. For more detailed discussion, see the corresponding section for elk under "Disease Prevalence and Transmission," Alternative 1.

Necrotic Stomatitis

An increased incidence of necrotic stomatitis in the Jackson elk herd could occur if sufficient high quality forage was not available and elk were forced to use poor forage such as coarse woody vegetation. This could be the case in Alternative 6, especially before elk numbers were decreased and during the phasing out of winter feeding. Therefore, negligible to minor increases similar to Alternative 2 are possible.

Psoroptic Scabies

Winter feeding results in direct contact between elk, increasing the chance for transmission of psoroptic mites. Prevalence of psoroptic scabies in the Jackson elk herd would therefore decline under Alternatives 6, a minor benefit compared to Alternative 1.

Helminths and Lungworms

Lungworm transmission and prevalence in the elk herd would be lowest under Alternative 6 (similar to Alternative 2) because winter feeding would be reduced and eventually eliminated. Lungworm transmission among elk and prevalence in the elk herd would be higher under Alternatives 3 and 4, and would be greatest under Alternatives 1 and 5 because winter feeding would occur nearly every year, or every year, and high elk numbers would be maintained.

Bovine Tuberculosis and Paratuberculosis

Bovine tuberculosis and bovine paratuberculosis are not present in the Jackson elk herd. The relative risk among the alternatives that either of these diseases would become established would be lowest under Alternatives 6 and 2 because the winter feeding program would be eliminated. See the discussion for elk under impacts of Alternative 1, "Disease Prevalence and Transmission," for more details. Should either become established, potential prevalence would be initially moderately lower compared to Alternative 1, but reduced by a major amount in the long term because the feeding program would be eliminated and elk numbers reduced.

Malignant Catarrhal Fever

There are no reports of malignant catarrhal fever occurring in the Jackson bison or elk herds (HaydenWing and Olson 2003) and the most effective control of infection risk would be to prevent susceptible species from contacting reservoir hosts (e.g. domestic sheep).

If elk or bison leave Jackson Hole, they would have a greater chance of coming into contact with domestic sheep herds and potentially contracting the virus. Hence, the risk of contracting malignant catarrhal fever would be greatest under Alternatives 2 and 3 because historical elk migration routes could be reestablished and elk and bison could disperse from the refuge during winter. Risk under Alternative 6 would be higher than under Alternatives 1, 4, and 5 because winter feeding would be eliminated and elk would disperse. If the disease became established, the potential for spread would be lowest under this alternative because supplemental feeding would be phased out quickly.

Chronic Wasting Disease

The risk of chronic wasting disease becoming established in the Jackson elk herd under Alternative 6 would be moderately higher than under Alternative 1 because increased dispersion increases the chance of contact with an infected elk or environmental contamination.

Potential prevalence and transmission of chronic wasting disease under Alternative 6 should it become established would likely be similar to what would occur under Alternative 2 and lower than all other alternatives (Table 4-6).

Calving, Age and Sex Ratios, and Recruitment

Short-term Effects. Age and sex ratios would initially be similar to baseline conditions and to those expected under Alternative 1, but ratios would likely change somewhat under Alternative 6 due to increased winter mortality and hunting. Eliminating supplemental feeding would be more likely to increase mortality in older animals or calves, as well as some prime bulls entering the winter energetically stressed due to rut activities.

Long-term Effects. Because numbers would be reduced and forage production would continue (for at least 15 years), winter mortality rates would likely decrease. Brucellosis related deaths in calves would also decline, with minor to moderate benefits to refuge elk, although this would only make a negligible contribution to production and recruitment in the herd.

Impacts on production and recruitment from septicemic pasteurellosis under Alternative 6 would be similar to those under Alternatives 2 and 3 and lower than under all other alternatives.

Adverse impacts on production and recruitment from necrotic stomatitis in the Jackson elk herd would be similar to prevalence, that is, negligible, under Alternative 6 compared to Alternative 1.

Adult bull mortality from psoroptic scabies would decrease negligibly under Alternative 6.

The potential number of clinical cases of bovine tuberculosis and paratuberculosis, if either disease infected the herd, would be substantially lower under Alternative 6 compared to Alternative 1. Production losses would be lower be a major amount over time. However, the absolute impact of these diseases on production in the herd would be low. As an example, if prevalence of bovine tuberculosis or paratuberculosis was 50%, and 5% of those developed clinical disease, then a maximum of 2.5% of the potential calf production could be retained; this would constitute a negligible increase in production and recruitment.

Impacts from chronic wasting disease would be caused indirectly through changes in mortality, the level of which would depend on prevalence in the herd. Experts believe prevalence would lie between levels found in free ranging and confined elk (2%–4% to 59%–100%, respectively). Relative impacts on production and recruitment under Alternative 6 would be similar to those under Alternative 2 and less than Alternative 1 as well as Alternatives 3, 4, and 5 (Table 4-6). Rankings were based on winter feeding frequency and duration as well as on the number of elk wintering on the refuge.

Mortality

Short-term Effects. Winter mortality would gradually increase under Alternative 6 as supplemental feeding was reduced and elk relied more and more on standing forage, especially if the fence at the southern and southwestern sides of the refuge prevented access to some native winter range. Mortality rates would not be expected to rise on native winter range, but because the number of elk on native winter range would increase (as opposed to being supplementally fed), the number of elk subject to higher mortality would increase.

As feeding was slowed or stopped, elk particularly from the park segment could seek food on private land in the area and be subject to removal by the Wyoming Game and Fish Department. Elk from other segments would likely find wintering areas to the northeast and east of the refuge, and few management removals would be necessary. Increases in movements and distribution could increase the number of elk deaths from vehicle collisions.

During the approximately five-year phaseout of supplemental feeding and transition to native range, the U.S. Fish and Wildlife Service and the National Park Service would work with the Wyoming Game and Fish Department to resolve commingling issues.

Harvest mortality during the short term would be increased compared to baseline conditions and Alternative 1. As supplemental feeding was reduced, the number of elk outside of the refuge during hunting season could increase, and more elk could be available to hunters on national forest lands.

As refuge elk density decreases, fewer brucellosis-caused abortions (which currently reduce potential births by an estimated 5%) would occur, partially mitigating increases in mortality.

Long-term Effects. Elk mortality would be expected to be higher in the long term than all alternatives except Alternative 2. Levels would be greater than the 5% per year under baseline conditions and Alternative 1 but the high end of the range would likely be less than the potential 23% in severe winters estimated under Alternative 2 (17% if 2,500 elk were supplementally fed at the Gros Ventre feedgrounds).

Mortality from starvation, and from predation and disease related to poor body condition, would continue to increase as supplemental feeding was phased out, as well as standing forage. Reductions in the bison population, closure of some existing areas to elk hunting and improvement of habitat outside the refuge would help mitigate mortality. Winter mortality would reflect winter severity, very low during mild winters to high during severe winters (B. Smith, pers. comm. 2002; Hobbs et al. 2003).

The Wyoming Game and Fish Department anticipates increased conflict between elk and nonagricultural landowners, with depredations to ornamental shrubbery, horse hay, and increased vehicle collisions in and around subdivisions (Holz, pers. comm. 2003). In the long term, management removals because of these conflicts would decline as population numbers decline.

Harvest numbers on the refuge and in the park would also decline as harvest quotas decreased. Increased hunting opportunities would likely occur in other areas.

Although more predation would be expected under Alternative 6, this increase would likely be compensatory. The elk lost to predation would have been lost to starvation or disease because of poor body condition. Calves, mature bulls already stressed physiologically from rut activities, and older animals would be the most likely cohorts to experience higher predation.

Mortality from septicemic pasteurellosis under Alternative 6 would be similar to those under Alternative 2 and lower than under all other alternatives.

Prevalence of necrotic stomatitis could increase negligibly during above-average and severe winters compared to Alternative 1 because no supplemental feeding would occur after 5–10 years,. However, cases remained rare in the winters of 2002–3 and 2003–4 when severe overbrowsing of woody vegetation occurred, suggesting only negligible increased mortality would occur under Alternative 6.

Adult bull mortality from psoroptic scabies would decrease negligibly under Alternative 6 due to the reduced number of elk in the refuge herd as well as lower elk concentrations stemming from the elimination of the refuge feeding program.

Alternative 6 (like Alternative 2) would potentially result in a moderate reduction in mortality caused by bovine tuberculosis or paratuberculosis compared to Alternative 1, if either disease infected the herd, because prevalence and thus, the number of clinical cases would be reduced by a moderate amount.

Increases in mortality from chronic wasting disease, should it infect the herd, would parallel increases in prevalence. Hence, impacts on mortality would be lowest under Alternatives 6 and 2 compared to all other alternatives (Table 4-6). See the discussion under “Mortality” in Alternative 2 for more detail. Rankings were based on winter feeding frequency and duration as well as on the number of elk wintering on the refuge.

Health, Sustainability, and Naturalness

Short-term Effects. The health and sustainability of the Jackson elk herd would increase as supplemental feeding was eliminated and elk relied more and more on standing forage (both native and cultivated). Alternative 6 would be similar to Alternative 2 in terms of health and sustainability. With the elimination of winter feeding, wider distribution, and reductions in bison and elk numbers, lower ungulate concentrations would result in lower disease prevalence and transmission of current diseases such as brucellosis, as well as of any non-endemic infectious disease. Alternative 6 (and Alternative 2) would lower the risk of future population declines or depopulation events from bovine tuberculosis, for example, or other nonendemic disease.

Herd health would also increase if a safe vaccine was developed with an efficacy of 50% or better that could be delivered orally or ballistically to a free-ranging herd and if bison were vaccinated. Vaccination and its effects could occur in the short term whenever these conditions were met.

Barring the introduction of serious non-endemic disease, the elk herd would continue to be self-sustainable and maintain genetic viability at a herd size of approximately 9,300–11,000 after the refuge portion of the herd was reduced to the objective level.

Naturalness would also increase in the short term under Alternative 6 as elk increasingly distributed themselves as they sought available forage on native range, and environmental factors, such as winter weather and predators, would have an increasingly stronger influence on mortality. Mortality would increase in some winters and more closely approximate mortality in non-fed herds. These effects would be similar but more limited than under Alternative 2. Fewer of these human-related deaths might occur when elk numbers were at objective levels.

Long-term Effects. These same trends would continue in the long term. Lower numbers would eventually allow elk to subsist on native range, lowering the risk of transmitting existing or new diseases. Herd size would be maintained at 9,300–11,000 and mortality would approximate that in unfed populations.

Harvest would be adjusted to allow some natural fluctuations in herd size while maintaining the objective. Exchanging nearly annual supplemental feeding with foraging on native vegetation, along with increased overwinter mortality of the less fit, could be expected to increase the overall fitness of the herd (Mills, pers. comm. 2003). Impacts to fitness would likely be subtle and would take many years to affect a population (McDonald, pers. comm. 2003; Boyce, pers. comm. 2003).

Long term health and sustainability of the elk herd under Alternative 6 would be similar to these qualities under Alternative 2 and higher than all other alternatives.

Naturalness would increase in the herd. Production and recruitment rates would be more natural and calves born outside of the normal birthing season would be less likely to survive. Winter mortality would be more natural due to the lack of a winter feeding program on the refuge, with mortality rates differing among age and sex classes in a more natural way. Elk would distribute themselves more naturally, expend more energy accessing winter forage, and maintain a more natural, lower nutritional status. Elk behavior would also become more natural. Competitive social interactions and displacements associated with feedlines would be eliminated.

Harvest quotas in the long term would strive to maintain sex ratios of approximately 35 bulls to 100 cows in the park segment as under Alternatives 3, 4, and 5. Sex ratios of the Jackson elk herd as a whole would be similar to ratios under baseline conditions and Alternative 1. Possible increases in elk distribution could cause more animals to be killed by vehicles or agency removals, but these increases in mortality would be negligible.

Alternative 6 would result in a higher level of naturalness in the elk herd than would Alternatives 1, 3, 4, 5. Naturalness would be similar to Alternative 2 because of the elimination of winter feeding.

Conclusion

In the long term under Alternative 6, there would be an estimated 9,300–11,000 elk in the Jackson elk herd and fewer elk wintering on the refuge. The elk herd would increase its movements and distribution and increased winter mortality would occur. After supplemental feeding was stopped, the herd would be more responsive to natural conditions and winter mortality would fluctuate with winter severity, precipitation regimes, and standing forage on native range, similar to Alternatives 2 and 3. Recruitment and annual survival would be close to levels found in non-fed populations in similar environments. Alternative 6 (along with Alternative 2) would result in higher levels of long-term health, sustainability, and naturalness in the Jackson elk herd than what would occur under Alternatives 3, 4, and 5.

The risk of a non-endemic infectious disease quickly spreading through the population or having major adverse impacts to elk survival would be among the lowest of all the alternatives because of eliminating contact associated with the feedlines, reduced numbers, and increased dispersion. The prevalence of brucellosis in the Jackson elk herd would be moderately lower than under Alternative 1.

Barring the introduction of serious non-endemic disease, Alternative 6 would not impair the elk population in the park. Alternative 6 (along with Alternative 2) would have the lowest potential for impairment from disease.

MITIGATION

Several measures have been built into the alternatives to mitigate reductions in winter feeding on the refuge, including continued flood irrigation (Alternative 3, Option A), improved forage quality on the refuge's cultivated fields (Alternative 6), restoration of winter range in Bridger-Teton National Forest (Alternatives 2, 3, and 6), and establishment of migrations to winter range outside of the Jackson Hole area (Alternatives 2 and 3). Another measure that would mitigate reduced elk numbers discussed in some alternatives would be the potential use of conservation easements to allow elk grazing on private lands or to reduce conflicts between elk and livestock and payments to landowners to have elk graze on their property rather than grazing and wintering livestock on the property.

CUMULATIVE EFFECTS

TRANSPORTATION IMPROVEMENTS

The reconstruction of U.S. 26/287 west of Togwotee Pass would cause short-term disturbance and displacement of some Jackson elk during construction stages and could affect elk migration in the Buffalo Valley area. The reconstruction would disturb about 16 acres of "crucial elk habitat" along the existing road corridor and could increase elk mortality due to vehicle collisions as a result of greater traffic volume. Along some portions of the highway the project retaining walls, guardrails, and passing lanes would also create both short- and long-term movement barriers. Long-term impacts would be somewhat greater due to the generally wider highway and the presence of retaining walls and guardrails in some areas. Upgrading the existing highway would be unlikely to result in extensive effects in terms of blocking migration routes or movement corridors. It is anticipated that effects on overall herd dynamics would be minimal.

Cumulative effects would not occur under Alternatives 1 and 5 because elk distribution, seasonal movements, and mortality rates would remain similar to baseline conditions. Alternative 4 could result in negligible cumulative effects if elk mortality rates increased in average winters. Under Alternatives 2, 3, and 6, more elk would use native winter range and the Jackson elk herd would be smaller in some years due to higher mortality compared to Alternatives 1 and 5.

FEDERAL LAND MANAGEMENT ACTIVITIES

Grand Teton National Park Fire Management

Mechanical treatments could result in a small reduction in elk habitat, reduced habitat quality, and short-term disturbance effects that could displace more mobile animals in proximity to Wildland Urban Interface (WUI) areas. However, these actions are not expected to adversely affect elk at a population level because habitat effectiveness in these areas and the immediate vicinity has already been reduced. WUI areas represent a small part of habitat available to park wildlife and the vast majority of wildlife habitat in Grand Teton National Park occurs outside developed areas.

Prescribed fire could be used to maintain and restore more diverse vegetative communities in landscapes where natural fire regimes have been disrupted. Prescribed fires could alter plant communities and displace individual elk from certain portions of habitat in the short and long terms, but the long-term effects could create vegetative diversity that favors native wildlife species.

Alternative 1 would not result in cumulative effects as a result of Grand Teton National Park fire management. Alternatives 2–6 would convert formerly cultivated areas in the southern portion of the park to native vegetation. These conversion activities could disturb and displace elk from nearby habitat in the short term if elk were present, adding to the short-term habitat losses. These activities would likely affect few elk because they are widely dispersed in the park during the summer.

Eliminating the elk reduction program in the park under Alternative 2 could result in more elk remaining in the southern portion of the park, thereby increasing the number of elk that were affected by the short-term effects of prescribed fires. Closing the Antelope Flats/Blacktail Butte elk reduction area in the park under Alternative 3, and potentially under Alternative 6, could also result in this effect, but to a lesser extent. Since fewer elk would be present in the park during the summer under these alternatives than under Alternatives 1, 4, and 5, this effect might not occur. Any cumulative effects would be relevant to elk affected by short-term disturbance and loss of habitat due to Grand Teton National Park recreation infrastructure improvements.

Grand Teton National Park Recreation Infrastructure Improvements

Potential construction of a multi-use trail from Moose to the north Jenny Lake junction would result in site-specific, temporary impacts along planned trail routes during the summer. The finished trail would attract additional recreationists along the Snake River corridor during the summer and possible cross-country skiers in the winter. The trail construction phase would likely displace elk within or near work areas in the short term and make habitat unavailable. If pathways were separate from existing roads, long-term impacts to elk could include loss of habitat, loss of the use of habitat near the new pathways, and changes in movements and distribution. Improved human access to parts of the park could increase levels of disturbance to elk and alter distribution and habitat use. The range and specific details of the improvements are unknown at this time.

Improvements to the Gros Ventre campground would result in site-specific, temporary impacts during construction and would result in a minor increase in the number of summer campers and the potential for elk to be displaced. The improvements would increase disturbance to elk in summer and alter distribution and habitat use; effects would likely be negligible because habitat effectiveness in these areas is already reduced.

Alternative 1, in combination with the effects of Grand Teton infrastructure improvements, would not result in cumulative effects. Alternatives 2–6 could result in additional elk disturbance with some displacement as a result of infrastructure improvements because of greater human presence in southern portions of the park during conversion of formerly cultivated areas to native vegetation.

Eliminating the elk reduction program in the park under Alternative 2 could result in more elk remaining in the southern portion of the park, increasing the potential for additional disturbance and displacement of elk from suitable habitat. Closing the Antelope Flats/Blacktail Butte elk reduction area in the park under Alternative 3, and potentially under Alternative 6, might also result in this effect but to a lesser extent. Because fewer elk would be present in the park during the summer under these alternatives than under Alternatives 1, 4, and 5, this effect might not occur.

Grand Teton/Yellowstone National Parks and John D. Rockefeller, Jr., Memorial Parkway Temporary Winter Use Plan

Throughout the analyses in the *Temporary Winter Use Plan Environmental Assessment*, the assumption was made that any effects of oversnow vehicles and winter recreation on wildlife would be exacerbated during severe winters due to increased energetic costs and chronic, severe under-nutrition. Impacts on elk from winter use would vary from none to adverse and moderate. The total number of snowmobiles allowed into the park would be similar to historical levels, but because all visitors would be traveling in guided groups, oversnow vehicles users would be less likely to interact with wildlife, resulting in fewer disturbances to elk.

Compared to historical conditions, beneficial impacts on all facets of interactions between wildlife and oversnow vehicles would occur. While the total number of oversnow vehicles allowed in the parks would approximate the historical average, all users would be led by professional guides, who would be trained how to avoid causing wildlife displacement or stress, and who would be familiar with likely wildlife locations along the road system. Under such conditions, oversnow vehicles would be less likely to interact with wildlife, resulting in less mortality, less stress, less displacement, and fewer population-level impacts. The impacts would not be of sufficient magnitude to adversely affect elk.

No impacts to elk in adjacent national forest and other lands outside the park units are anticipated. Because the selected alternative would allow a number of snowmobiles into the parks that are near the historical average daily visitation, it would be unlikely to result in significant visitor displacement to surrounding federal, state, or county land, except during high use periods (Christmas week and Presidents Day weekend).

Alternatives 1 and 5, and Alternative 4 in above-average winters would not result in cumulative impacts on elk from planned winter use activities. Alternatives 2, 3, 4 in average or below average winters, as well as Alternative 6, would increase the number of elk on native winter range. When combined with winter use, this could result in more displacement of elk from winter habitat. Elk in areas designated as crucial winter range would not be affected because closures would continue.

Bridger-Teton National Forest Fuels Management Projects

Bridger-Teton National Forest has identified 15 fuels reduction projects in the primary analysis area, and several others in the secondary analysis area in the upper Green River watershed. These projects would alter about 9,400 acres of national forest land and could temporarily diminish forage opportunities directly following various fuel reduction treatments. However, in the long term most of these projects would improve elk transition and winter habitat.

Cumulative effects of thinning projects on the Jackson elk herd would vary among the alternatives considered for bison and elk management. Because of reduced or eliminated winter feeding on the refuge, Alternatives 2, 3, and 6 would result in more elk wintering on native range and potentially moving into project areas. Some elk could experience diminished foraging opportunities in the short term if they arrived while or shortly after project activities had occurred. In the long term, enhanced forage in these areas would benefit elk. These projects would benefit fewer elk under Alternatives 1, 4, and 5 during above-average and severe winters, because winter supplemental feeding would continue to attract elk to the refuge and limit their distribution. Some Jackson elk would benefit from projects in transitional habitat under all alternatives, but distinct cumulative effects would not be expected under Alternatives 1, 4, and 5. The Moose-Gypsum projects and the Green River Lakes campground project would only affect elk that had dispersed into the secondary analysis area under Alternatives 2, 3, and potentially 6.

Bridger-Teton National Forest Travel Management Plan Updates / Moose-Gypsum Projects

The proposed Moose-Gypsum travel management projects in the secondary analysis area would alter existing elk habitat, including elk winter range in the secondary analysis area. The proposed projects could temporarily diminish forage opportunities in some areas due to reductions in forage areas directly following various fuel reduction treatments and increased off-highway vehicle opportunities. However, in the long term the proposed projects could result in enhanced forage for elk due to the regeneration of nutrient-rich undergrowth. These projects could result in cumulative effects on Jackson elk that could disperse into the upper Green River watershed under Alternatives 2, 3, and potentially 6, by reducing the availability of forage in some areas.

The Moose-Gypsum projects is considering the establishment of new campsites while closing some campsites that are in sensitive areas, such as next to stream and river banks. Establishing new campsites could increase the potential for human/elk interactions in the short term, although closing other sites would offset this increase. Closing sites in sensitive areas would decrease the potential for interactions that could disturb and displace elk from more critical habitat. In the long term these projects could result in beneficial cumulative effects to Jackson elk that could disperse into the upper Green River watershed under Alternatives 2, 3, and potentially 6.

BLM Snake River Resource Management Plan

Greater public access or use in areas of sensitive wildlife habitat, including overnight camping, would likely increase the potential for detrimental, direct effects to vegetation and forage, and/or increased conflicts between humans and wildlife. Impacts to elk forage could occur if livestock grazing was allowed by the acquiring or managing agencies or entities. Continued management of conservation easements for open space and wildlife habitat would protect elk migration routes, corridors, and habitat. Pursuit of a long-term protective withdrawal to prohibit the staking and development of mining claims would also benefit elk by preventing potential adverse impacts to foraging or wintering habitats.

No cumulative effects would be expected under Alternatives 1 and 5 because these alternatives would not affect the amount of disturbance to elk or increase the potential for encounters. Alternatives 2, 3, 4 in average or milder than average winters, as well as Alternative 6, would increase elk distribution in some years and the potential for disturbance due to human encounters, although seasonal closures would mitigate this potential increase.

BLM Upper Green River Special Recreation Management Area Recreation Project Plan

Projects considered in the *Recreation Project Plan* would affect a total of about 16.5 acres (less than 1% of the total management area), excluding the main road re-surfacing. Construction activity is not anticipated to impact wintering Jackson elk in the upper Green River watershed.

None of the bison and elk management alternatives being considered in this environmental impact statement would result in cumulative effects on the Jackson elk herd. Although some Jackson elk could move into the upper Green River area to winter under Alternatives 2, 3, and possibly 6, these animals would not be expected to remain in other seasons.

Pinedale Anticline Oil and Gas Exploration and Development Project

Oil and gas development activities in the Pinedale anticline project area are not anticipated to specifically impact elk populations. Seasonal restrictions and other measures would be implemented to minimize impacts to other big game populations. None of the proposed bison and elk management alternatives would contribute measurably to these effects and would not result in cumulative effects on elk in the Pinedale anticline study area.

SNAKE RIVER RESTORATION ACTIVITIES

Construction of the Snake River restoration measures by the U.S. Army Corps of Engineers could impact habitat for a variety of wildlife species, including elk migration corridors, along the river. This environmental restoration project would prevent further degradation of habitat and facilitate habitat recovery. To avoid conflicts with migrating elk, the environmental assessment states that work should cease by November 15, unless prior coordination with the Wyoming Game and Fish Department had taken place. Improvements in water quality and elk habitat along the Snake River would continue to benefit elk in the long term.

Cumulative effects would not be expected to occur under Alternatives 1 and 5 because these alternatives would not increase or alter elk distribution or the potential for disturbance. Alternatives 2, 3, 4 in average or milder than average winters, as well as Alternative 6, would increase elk distribution in some or all years and the potential for disturbance in the short term due restoration activities. Restricting the work season would decrease the potential for disturbance, displacement from habitat, and changes to migrations.

POPULATION GROWTH AND PRIVATE LAND DEVELOPMENT

Primary Analysis Area

Projected population increases in both Teton and Sublette counties would continue to create a demand for private land development. Habitat loss, increases in elk / human encounters and conflicts, vehicle collisions with elk, and changes to elk movements could occur.

Additional development that is near or adjacent to the Snake River would be subject to the Natural Resource Overlay (NRO) zoning district requirement (see Chapter 1, "Reasonably Foreseeable Actions"), which would help sustain elk migration in those areas by protecting migration routes and crucial winter ranges. Residential development of the platted and zoned parcels within the primary analysis area to the south and west of the Jackson Hole Airport has greatly reduced the potential for elk migration between Grand Teton National Park, summer habitat on private lands, and the National Elk Refuge south of Moose.

Two narrow corridors of open land near Gros Ventre Junction might sustain the major east-west migration in the Jackson Hole Airport area.

The northernmost area is protected by conservation easements, while the narrow corridor to the south is partially included in the NRO district and appears to be a private open space component of the Bar-B-Bar Meadows subdivision. These protected lands might continue to support a migration corridor through the area, though it is not known whether they would provide sufficient habitat to sustain such a corridor for the long term.

Additional development on private lands in the Buffalo Valley area would be outside or on the perimeter of elk winter range, and would be subject to NRO district requirements. Such development, if it occurred, would not be expected to adversely affect elk use of the winter range in the area.

Alternatives 1 and 5, as well as Alternative 4 in above-average and severe winters, would not alter elk distribution and migration or result in cumulative effects. Alternatives 2, 3, and 4 in average or milder than average winters, and potentially Alternative 6, would increase elk distribution in some or all years, and human population growth and development would likely affect more elk under these alternatives. NRO zoning district requirements would decrease the likelihood of adverse effects.

Additional development of the private parcels along the Gros Ventre River could affect the movement of elk between Jackson Hole and existing feedgrounds to the east. Under Alternatives 2, 3, and potentially 6, undeveloped portions of this corridor would support the movement of elk between Jackson Hole and the upper Green River basin to the southeast. Additional development along the Gros Ventre River could also adversely affect these movements.

Secondary Analysis Area

Within the secondary analysis area in Sublette County, ongoing and future subdivision and development of agricultural lands could disrupt migration routes and reduce the availability of elk winter range in the upper Green River valley. Development or activities in these areas would not affect Jackson elk under Alternatives 1, 4, and 5 because elk movements and distribution either would not increase from current distribution (Alternatives 1 and 5) or would increase to a limited extent in some years (Alternative 4).