Memorandum

To: United States Department of Agriculture (USDA) Forest Service, Black Hills National Forest (BHNF)

From: Science Applications International Corporation (SAIC)

Date: October 17, 2003

Subject: A Framework for Revising Deer and Elk Strategic Management Direction on the BHNF, SAIC project number 01-0209-04-4456-106.

The purpose of this memorandum is to review and update the status of white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) habitats on the BHNF and to establish a framework of habitat parameters or desired conditions, which will aid the USDA-Forest Service in developing alternatives to better manage deer and elk habitats. Identification of habitat parameters and desired conditions will reduce BHNF biologists' reliance on habitat capability (HABCAP) output thresholds as a primary decision-making tool and better facilitate adaptive management of deer and elk habitats.

This memorandum is organized in the following sections. Section 1-0 is an introduction to the HABCAP model and a discussion of deer and elk habitat condition and management since European settlement on the BHNF. Section 2-0 reviews deer ecology, deer management literature and presents deer management approach considerations on BHNF. Section 3-0 covers the same topics for elk on the BHNF. Section 4-0 lists references cited in this memorandum.

1-0. INTRODUCTION/BACKGROUND

The USDA-Forest Service uses the habitat capability computer model, HABCAP, to assess the relative importance of vegetation cover types and to predict the outcome of forest management practices on wild cervids (DePerno 1998). Habitat capability is the ability of a unit of land to support wildlife species given certain vegetation characteristics (DePerno 1998). One output of HABCAP is a habitat effectiveness (HE) value, which predicts an area's ability to provide deer and elk with cover, forage, and security. According to the HABCAP model "…cover is a function of tree canopy; forage is a function of the herbaceous and shrub vegetation; and security is a function of road density" (USDA-Forest Service 2001). A HABCAP analysis was completed for the 1997 Forest Plan (USDA-Forest Service 1997), and use of the model was upheld in the 1999 Appeal Decision (USDA-Forest Service 2001). However, BHNF biologists discovered that HABCAP overestimated the amount of land functioning both as cover and forage to deer and elk. Therefore, HE values listed in the management area guidelines in the 1997 Forest Plan exaggerate actual habitat effectiveness for deer and elk on BHNF (USDA-Forest

Service 2001). Biologists corrected some HABCAP model errors and recalculated deer and elk HE values in the Phase I Amendment to the Forest Plan. However, the South Dakota Department of Game, Fish and Parks (SDGFP) Division of Custer State Park (CSP) and Division of Wildlife recommend that cover should also be a function of shrub structure as well as ponderosa pine (*Pinus ponderosa*) canopy closure. There is a need to improve understory modeling for shrub cover, ground cover and specific understory species responses to changes in forest structure (Marzluff et al. 2002) on the BHNF. Original HABCAP assumptions (coefficients) are derived from scientific literature that has not been widely validated with empirical data from the Black Hills (DePerno 1998). A recent study in the central Black Hills compared HABCAP predictions to actual white-tailed deer utilization derived from locations of radio-collared deer. The researchers found that HABCAP underestimated the importance of key habitat types used by white-tailed deer in all seasons (DePerno 1998). Another recent study from the Black Hills conducted in CSP tested HABCAP-generated maps of HE against elk telemetry data. Juntti et al. (2002) found that utilization of an arithmetic mean to integrate HABCAP model components and weighted forage values (3x and 4x) produced HE values more closely aligned with actual elk location data from CSP than predicted in the original model. The original model uses a geometric mean to integrate model components and is an insensitive predictor of HE for small habitat components (Juntti et al. 2002). Research suggests a strong association between seasonal forage quality and quantity and subsequent growth and survival of elk (Merrill and Boyce 1991, Cook et al. 1996) and application of habitat effectiveness models without consideration of forage condition may no longer be appropriate (Roloff et al. 2001).

The HABCAP model is a valid tool for comparing forest management alternatives on the BHNF (Rumble 2002, Wrede 2002). Increased validation and development of HABCAP model components such as forage value, topographic and vegetative security cover (Roloff et al. 2001), and effects of fire, would enhance its credibility and utility for predicting HE. Validation and development has been recently conducted to address deficiencies in the HABCAP model and its coefficients for elk habitat in the Black Hills (Rumble et al. In Press). Those findings should be incorporated into modifying HABCAP.

However, continued use of habitat effectiveness models such as HABCAP as the primary decision-making tool is not recommended until vegetation information and other parameters are available at scales relevant to elk and deer biology, and models are calibrated and validated for local use (Roloff et al. 2001) on the BHNF. Marzluff et al. (2002) state, "Just confirming that the expected habitats develop as predicted is not enough. We need to confirm that wildlife is surviving and reproducing in the habitats as predicted." Deer and elk management approaches incorporated in this document should help address this goal. As stated by Marzluff et al. (2002), few habitat models sufficiently evaluate forest management strategies at levels that adequately incorporate temporal and spatial trends in forest growth; and analysis does not normally consider the wildlife related economic impacts of proposed forest management alternatives.

Consequently, short-term reductions in the quality and quantity of wildlife habitat that can occur when implementing long-term strategies, and their economic impact to local communities may not be considered. This is especially a concern when large tracts of forest are slated for a single management prescription. The rate and type of understory succession following different timber harvest and management strategies can positively or negatively impact deer and elk population dynamics in an area. Therefore, it is appropriate to maximize field observation and experience when evaluating the effects on wildlife of proposed habitat alterations. However, it is impractical to rely only on observation applied post hoc. Models allow managers a practical way to evaluate different management schemes on a landscape basis, and these models can be extended to consider economic impacts. The HABCAP models the USDA-Forest Service has relied upon are not a perfect mirror of reality, but they are being improved, and do provide a useful tool for evaluating some effects of alternative timber harvest strategies. In addition, models provide a quantitative component for alternative analysis that may be lacking when there is not sufficient, or experienced, professional judgment to adequately evaluate alternative management strategies. Therefore, it is important that the USDA-Forest Service continue to incorporate current research into the various HABCAP models, update these models, and use the models as informational resource tools when evaluating management alternatives. Field data collection, model verification, and professional judgment must also be incorporated into management decisions effecting deer and elk populations.

1-1. BLACK HILLS POST-EUROPEAN SETTLEMENT, FIRE HISTORY AND EFFECTS ON VEGETATION

Thilenius (1972) stated in a USDA-Forest Service publication of the Black Hills, "Almost the entire forest is in a disturbed condition from logging, livestock grazing, mining operations, wildfire and fire protection." In order to understand effects of changes to deer and elk habitats, post-European settlement impacts need to be considered. Fire suppression has likely caused widespread degradation of deer and elk habitats in the Black Hills. Dendrochronology data reveal average fire intervals at Devil's Tower National Monument, Wyoming (west of the Bearlodge Ranger District): before 1770, a 27-year mean; from 1770 to 1900, a 14-year mean; and after 1900, a 42-year mean (Fisher et al. 1987). The increase in the fire return interval is attributed to successful fire suppression efforts (Parish et al. 1996).

Brown and Sieg (1996) reported a mean fire interval of 16 years from 1388 to 1900 for the south-central Black Hills of South Dakota. Mean fire intervals in savanna ecotones of the southern Black Hills of South Dakota ranged from 10-12 years (Brown and Sieg 1999). These fire intervals suggest that frequent fire (due to lightning and deliberate ignition by Native Americans) was historically present in the Black Hills and that fire suppression since post-European settlement is mostly responsible for altered changes in plant community structure and density (Brown and Sieg 1996, 1999). Fire histories for other portions of the Black Hills are needed to better explain fire's role in ecosystem management. Although frequent, natural fires

are generally not tolerated by society, large-area and/or stand-replacing fires (both natural and human caused) still occur (Table 1-1).

Table 1-1. Summary of Known Natural and Human Caused Fires and Acreages (300+ acres) Within the Black Hills Proper[1] Since 1880 (USDA-Black Hills National Forest 2002)

Years	Total Known Number of Fires	Total Estimated or Known Acres Burned		Years	Total Known Number of Fires	Total Estimated or Known Acres Burned
1880s	4	3,000		1950s	3	5,196
1890s	10	83,400		1960s	14	45,832
1900s	2	2,000		1970s	4	6,811
1910s	17	12,944		1980s	10	57,752
1920s	1	788		1990s	4	24,328
1930s	14	74,629		2000-2002	13	158,372
1940s	4	12,514				

[1] Includes all land ownerships: state, federal and private

The largest (ten-thousand-plus acres), single-event fires occurred in 1931, 1939, 1960, 1964, 1985, 1988, 1990, 2000, three in 2001, and two in 2002. However, in the past two years (2000-2002), the total number of acres burned (158,372) is more than all acres burned (152,433) the past 59 years from 1940-1999. One crucial reason for discussing recent fires and burned acreage on the BHNF is that deer and elk habitat management is a revision issue for the Land and Resource Management Plan Phase II Amendment. Secondly, in the last two years, over 10% of BHNF system lands have burned. Thirdly, Forest Service management of burned-area vegetation on the BHNF will have the single most influential impact on habitat conditions, unlike any other time in BHNF history.

Fire suppression, combined with other habitat alterations, has resulted in diverse negative impacts on deer and elk habitats. Historical fires and recent stand-replacing fires (Table 1-1) thinned ponderosa pine stands and created open stands with abundant shrubs and forbs in the understory (Sieg and Severson 1996). Frequent fires also created many different age classes of ponderosa pine, enhancing forage diversity across the Black Hills landscape (Uresk and Severson 1998). Disturbances, such as fire, benefit sprouting hardwoods and create various age

classes of species such as quaking aspen (*Populus tremuloides*) and bur oak (*Quercus macrocarpa*). The balance between cover and forage is often temporarily changed following moderate to high intensity burns. These changes in vegetation structure, diversity, distribution, abundance and availability are especially important when discussing big game habitat management in the Black Hills.

Deer typically thrive on seral vegetation (Longhurst et al. 1982) and conversion of deciduous forest, such as aspen and bur oak, to ponderosa pine types has reduced diversity of forage available to deer (Schneeweis 1967, Kranz and Linder 1973, Uresk and Severson 1998). Invasion of ponderosa pine into meadow habitats has reduced forb, shrub, and grass availability to foraging deer and elk. Late successional and old growth forests with nutritious understories and a well developed overstory are also important to deer and elk for winter forage, lichen production and snow interception (Hanley et al. 1983). However, in the Black Hills, an increase in the density and percent canopy cover of ponderosa pine stands across most landscapes, in combination with silvicultural treatments that favor ponderosa pine regeneration, have resulted in large areas of pine forest with depauperate understories, thus reducing available forage (Stefanich 1995, Parrish et al. 1996).

Less water is available in riparian areas that are valued by white-tailed deer (Parrish et al. 1996) due partially to increased evapotranspirational loss from expanded pine forests (Stewart and Thilenius 1964) and reduction in active beaver dam complexes (Parrish et al. 1996).

Judicious use of livestock grazing can be a tool to maintain good wildlife habitat. Many of the same shrub and forb species that benefit deer are also palatable for livestock (Longhurst et al. 1982). Kranz and Linder (1973) found that cattle in the Black Hills preferred aspen communities over mixed aspen-pine and pine, with preference related to understory grass production in aspen stands.

Another impact to deer and elk habitats is road construction and road density. Not all roads and their impacts are created equal. High road densities (miles of road/square mile area) alter both human and animal behavior, which contribute to animal displacement and stress (Boyle and Samson 1985, Millspaugh 1999). Roads are a direct loss in habitat and increased vehicular volume indirectly degrades habitat. In the 1990s up to 1,400 deer per year were killed in vehicle collisions in the Black Hills (Parrish et al. 1996).

And lastly, urban sprawl and private land development of 14 acres or 14 football fields per day (Rocky Mountain Elk Foundation 2000) add to rapid loss of traditional deer and elk habitats.

2-0. WHITE-TAILED DEER AND MULE DEER ON THE BHNF

This section primarily provides a review of white-tailed deer ecology, management literature and management considerations for the Black Hills. Much of the scientific literature on deer in the Black Hills focuses on white-tailed deer. This is reflected in the 1997 BHNF Land and Resource Management Plan and in this technical memorandum.

There is very little Black Hills research to date on mule deer ecology. However, two separate, current research studies by South Dakota State University/SDGFP Division of Wildlife and the University of Missouri at Columbia/SDGFP Division of CSP will provide valuable mule deer habitat information at a later date. At time of availability, those findings should be incorporated for mule deer habitat management.

2-1. REVIEW OF DEER ECOLOGY LITERATURE

Mule and white-tailed deer were conspicuous components in early Euro-Americans' descriptions of the Black Hills fauna (Parrish et al. 1996), but both were nearly extirpated by the early 1900s due to over harvesting. Modern wildlife management, particularly regulated harvest, restored deer population from their known historic lows in the early 1900s to probable record numbers by the mid-1900s (Griffin et al. 1999). Since the 1960s, deer habitat has declined (Schneeweis 1967, Dietz 1973) in the Black Hills with a corresponding decline in deer numbers since the mid-1970s (Griffin et al. 1992, Stefanich 1995, DePerno et al. 2002).

The Black Hills deer population is comprised of approximately 75% white-tailed deer and 25% mule deer (Parrish et al. 1996). White-tailed deer are generally associated with forested habitats, while mule deer inhabit more open, rugged habitat (Parrish et al. 1996). Parrish et al. (1996) reported that throughout much of the Black Hills there is not yet a clear habitat distinction between the two species and their ranges overlap in many areas. However, results from the two above-referenced mule deer studies will lend quantifiable and qualifiable data for further evaluation. What is known is that mule deer are relatively more abundant in the southern Black Hills of both South Dakota and Wyoming, where open, rocky habitat is more prevalent (Sieg and Severson 1996). Forage and cover found in mountain mahogany (*Cercocarpus montanus*) communities provide important mule deer habitat and likely warrant separate management guidelines for mule deer. There are few food habit studies of mule deer in the Black Hills, but it is possible that both species have similar diets (Hill and Harris 1943, Schenck et al. 1972, Richardson and Petersen 1974).

2-2. WHITE-TAILED DEER SEASONAL MOVEMENTS

Most of the white-tailed deer population in the Black Hills is migratory with distinct summer and winter ranges (Stefanich 1995, Parrish et al. 1996). Spring migration in the northern and central Black Hills from winter to summer ranges occurs from mid-April to mid-May (Griffin et al. 1999, Stefanich 1995) and typically is accomplished within 5 days. Most white-tailed deer in the central Black Hills are on summer ranges 3 weeks prior to fawning (Griffin et al. 1999).

Fall migration from summer to winter range is much more variable with movement beginning from October through mid-February in northern Black Hills (Stefanich 1995) and from mid-August to February in the central Black Hills (Griffin et al. 1999). Some white-tailed deer utilize transitional habitat for 3 to 4 weeks between seasonal ranges in the northern and central Black Hills (Stefanich 1995, Griffin et al. 1999). Once initiated, migration to winter range is also accomplished in a few days.

Historically, Black Hills white-tailed deer moved to winter range in December or January depending on snow depth, but over the past 20 years deer have been observed on winter ranges in October and early November (Griffin et al. 1999, Stefanich 1995). The cause(s) of this shift in migration behavior is unknown and white-tailed deer spending more time on already stressed winter range has generated concern among agency biologists (Griffin et al. 1999). Changes in historic private land use in the Black Hills from cropland and meadows to residential development has further reduced and degraded available white-tailed deer winter habitat (Griffin et al. 1999).

During transition from winter to summer range in spring, deer are susceptible to debilitation and death due to poor nutritional condition combined with increasing metabolic rates (Sieg and Severson 1996). Sieg and Severson (1996) recommend mitigating spring nutrition deficits of deer by enhancing growth of forbs and tall shrubs on spring transitional ranges and winter range. Griffin et al. (1999) found some deer in the central Black Hills using transitional habitat during fall migration for up to 4 weeks. However, once migration is initiated, most deer are on their desired winter or summer range within a few days (Griffin et al. 1999). Therefore, enhancement of spring transitional forage may be best accomplished on known winter ranges.

2-3. WHITE-TAILED DEER SEASONAL HABITAT

White-tailed deer selection of foraging habitats in winter and summer ranges is dependent on the understory plant community, yet, the availability of overstory-understory types varies between summer and winter ranges (DePerno et al. 2002). Plant communities and habitat types vary considerably across the Black Hills, depending upon geologic formation, soils, precipitation, elevation and temperatures. Thilenius (1972) offers discussion of various deer habitat

classification in the Black Hills, which will not be discussed in detail here. However, because of these habitat differences, deer select their habitat preferences by availability and distribution. Good deer habitat must have quality forage in adequate quantities and cover which shelters from weather and predators. Determining the proper mix of forage and cover to benefit deer, while managing for the viability of other species within the Black Hills ecosystem, is complex (Sieg and Severson 1996). Deer do not travel far from bed sites to foraging areas, especially on wintering grounds (Kennedy 1992). Therefore, juxtaposition between cover and forage may be crucial. White-tailed deer habitat in the northern Black Hills will be very different from white-tailed deer and mule deer habitat in the extreme southern Black Hills. Landscape management approaches should evaluate plant community types that occur within a project area and accordingly, management practices that improve and enhance deer habitat should fit the natural variability of the landscape.

Spring and Summer Home Range

In the northern Black Hills, female white-tailed deer selected agricultural lands and both mature and immature aspen stands in the spring (Kennedy 1992). Hardwood stands, which provide abundant forage, combined with screening cover were best predictors of white-tailed deer diurnal, summer use (Stefanich 1995). Hardwood stands were further characterized by less wind, more chokecherry (*Prunus virginianus*) and close proximity to water. Peak use of dense aspen habitats with dense, tall shrub cover indicated importance as fawning habitat in the northern and central Black Hills (Kennedy 1992, DePerno et al. 2002). Summer nocturnal habitat use is significantly different with use of open habitat types of meadows, riparian areas and/or open pine relative to proximity of dense cover (Stefanich 1995).

White-tailed deer in the central Black Hills spend most of their time in ponderosa pine forest habitats, which dominate the landscape (DePerno et al. 2002). In summer, white-tailed deer selected dense pine canopies (71% to 100% canopy cover; DePerno et al. 2002), which suggested this may allow deer to avoid heat stress (Bunnell et al. 1986, Hoffman and Alexander 1987) and reduce cutaneous water loss (Parker and Robbins 1984).

However, habitats dominated by deciduous cover are limited (<12%) in the central Black Hills (DePerno et al. 2002) which may explain why deer in the central Black Hills seek dense pine canopies compared to deer in the northern Black Hills which selected hardwoods (Stefanich 1995). Further, tall shrub sapling densities were nearly three times lower in the central Black Hills (1,113.03 + 321.07 stems/ha) compared to the northern Black Hills (3,246.84 +164.87 stems/ha: Hippensteel 2000). On summer range in the central Black Hills, white-tailed deer selected shrub habitat 1.8 to 4.1 times more frequently than shrub habitat occurs on the Forest which demonstrates that the central Black Hills lack sufficient understory and escape cover and that white-tailed deer select a shrub component more than what is available (DePerno et al. 2002).

During summer, overstory-understory associations selected by male white-tailed deer did not differ from habitat availability. Both sexes selected pine/juniper (*Juniperus spp.*), aspen/other shrub, spruce (*Picea glauca*) /juniper, and spruce/other shrub habitat associations with males also selecting pine/other shrubs. Pine/grass/forb and pine/bearberry (*Arctostaphylos uva-ursi*) were avoided by females and spruce/litter was avoided by males. In general, both sexes selected understory range types that comprised 15% of the landscape in winter and 9% of the landscape in summer (DePerno et al. 2002).

Information on seasonal movements of mule and white-tailed deer in the southern Black Hills will be available upon research completion (Griffin Pers. Comm. 2002).

Fall and Winter Home Range

White-tailed deer transitional and winter ranges in northern Black Hills include lower elevation areas dominated by woody draws. These areas are used diurnally for cover and agricultural fields were used nocturnally for forage (Stefanich 1995). Close proximity of pine cover to agricultural fields was a factor in deer use of these two habitats (Kennedy 1992). Kennedy (1992) found that white-tailed deer also selected ponderosa pine that contained >70% overstory canopy cover and closed stands of both mature (>22.8 cm dbh) and immature (12.7 – 22.8 cm dbh) pine. Use of pine/bur oak habitat was high but did not exceed availability (Kennedy 1992). Spruce, aspen and mixed aspen/pine habitats were avoided in winter (Kennedy 1992). White-tailed deer appear to be attracted to short-lived, active logging areas during the winter due to plowed road travel-ways, and availability of felled ponderosa pine and lichen (*Usnea spp*.) (Stefanich 1995, Schneeweis et al. 1972).

White-tailed deer in the central Black Hills selected forested habitat with shrubs 1.5 to 4.7 times more frequently than shrub habitats occurred on the BHNF (DePerno et al. 2002). Deer selected pine/grass/forb, pine/bearberry, burned pine/grass/forb, and pine/other shrub habitat associations, whereas burned pine/litter was avoided (DePerno et al. 2002). Pine-shrub habitats are likely selected by central Black Hills white-tailed deer in winter because of thermal cover benefits and high quality forage, particularly bearberry/juniper, and snowberry (*Symphoricarpos occidentalis*) (DePerno et al. 2002).

Information on seasonal movements of mule and white-tailed deer in the southern Black Hills will be available upon research completion (Griffin Pers. Comm. 2002).

Burned Home Range

Radio-collared mule and white-tailed deer initially moved from traditional summer home ranges within the intensively burned perimeter of Jasper fire (83,508 acres) of August-September, 2000 (Griffin Pers. Comm. 2002). It is reasonable to state that movements occurred due to temporary

loss of forage and cover in late summer with no appreciable recovery prior to winter. However, by spring 2001, those same deer returned to their summer range of either burned, partially burned or unburned portions of the fire area. This demonstrates high site fidelity to traditional home ranges, which negates anecdotal belief that deer readily abandon traditional home ranges.

DePerno (1998) studied white-tailed deer habitat within post-burned areas of the 1939 McVey and 1991 Horse Creek Fires of the central Black Hills. Burned pine/litter was avoided by does and bucks in summer. White-tailed deer likely selected burned habitat in winter due to persistent presence of bearberry, snowberry, and juniper in the understory of burned pine stands that are typically absent in the understory of unburned pine communities (DePerno et al. 2002). However, juniper spp. and bearberry are not fire tolerant. Common ground juniper (*Juniperus communis*) is shade tolerant and requires a minimum of 40% overstory shading. Therefore, the presence of juniper and bearberry within DePerno's study area indicated either a mosaic of fire intensities in which juniper, bearberry and some of the overstory canopy were not burned or sufficient time had passed since the 1939 fire to allow for forest succession, which favors conditions necessary for common ground juniper establishment.

2-4. DEER SEASONAL FOOD HABITS

Availability of preferred food items is influenced by factors including presence, abundance, distribution, snow depth and competition.

Spring and Summer Food Habits

Spring and summer forage in the Black Hills includes aspen stands with vetchling (*Lathyrus ochrolaucus*), Saskatoon serviceberry (*Amelanchier alnifolia*), shinyleaf spiraea (*Spiraea lucida*), bur oak and American vetch (*Vicia americana*) (Schneeweis et al. 1972). Additional important forage includes grasses (especially bluegrass *Poa spp.*), forbs, agricultural crops and fungi (Hill and Harris 1943, Hill 1946, Schenck et al. 1972, Dietz 1973) and various fruit-producing shrubs such as rose (*Rosa spp.*), western snowberry, serviceberry (*Amelanchier spp.*), chokecherry (*Prunus melanocarpa*) and raspberry (*Rubus strigosus*).

Fall and Winter Food Habits

The most important fall and winter deer food in the Black Hills are Oregon grape (*Berberis repens*), bearberry (a.k.a. kinnikinnick), common juniper, snowbrush ceanothus (*Ceanothus velutinus*) and forbs (Hill and Harris 1943, Hill 1946, Schneeweis et al. 1972, Schenck et al. 1972, Dietz 1973, DePerno 1998). When these species are abundant and evenly distributed, they are highly preferred and palatable (ratio of utilization: availability from Hill 1946) forage and may be excellent indicators of deer range condition.

As availability decreases of the low growth forms of Oregon grape and bearberry with increasing snow depths, common juniper and lichens become more important. Preference for bur oak is low but utilization during heavy snow depths occurs because availability of more preferred species is reduced (Schneeweis et al. 1972). Bur oak buds and twigs are not nutritionally adequate for winter forage because of low digestibility, inadequate protein and low crude fat; although acorn mast provides important nutrition (Severson and Kranz 1978). In the central Black Hills, western snowberry provides additional winter forage (Dietz 1973, DePerno 1998). Mountain mahogany (Schenck et al. 1972) is available as winter forage in the southern Black Hills (Schneeweis et al. 1972).

Hill (1946), Hill and Harris (1943), Schneeweis et al. (1972), Schenck et al. (1972) and Dietz (1973) found that white-tailed deer use of ponderosa pine was low to moderate in the fall and winter. Schneeweis et al. (1972) found an increase of pine use with an increase in available pine logging slash in late winter. However, Hippensteel (2000) analyzed winter diets of white-tailed deer in the central Black Hills and found they were composed of approximately 40% ponderosa pine, 30% grass, 20% shrub, and 5% forbs. This suggests an increasing dependence on pine from the 1940s to the late 1990s and supports the assertion that winter range forage in the central Black Hills and throughout the Black Hills is in poor condition.

Also noteworthy is the occurrence of western snowberry in deer diets across the Black Hills. However, snowberry should not be interpreted as preferred deer forage. While snowberry fruits are important food items, snowberry browse is an unpalatable forage (Hill 1946). DePerno et al. (2002) emphasizes that much of the habitat in the central Black Hills does not contain shrubs and is not acceptable habitat for deer. Nutritional value of snowberry is poor and further refines this to imply that deer are simply eating what is available, and what is available is nutritionally undesirable.

2-5. STATE WILDLIFE MANAGEMENT AGENCIES: DEER MANAGEMENT INFORMATION

The South Dakota Department of Game, Fish and Parks advocates long-term habitat management to improve, enhance, maintain and protect quality mule and white-tailed deer habitat, particularly shrub and forb forage (Wrede 2002). Further, SDGFP recommends that management and monitoring efforts focus on habitat quality and quantity and healthy deer (Wrede 2002). Low reproduction rates, high fawn loss and poor condition of deer indicate that Black Hills summer and winter habitats are not supporting healthy animals. In fact, a 35-year-old SDGFP publication identified the same SDGFP concerns in 1967. Schneeweis (1967) documented extremely poor browse and shrub conditions that lowered carrying capacity for deer and affected herd condition. According to DePerno et al. (2002), approximately 80% of the

habitat in the central Black Hills is unacceptable for white-tailed deer due to lack of desirable shrubs.

A compounding factor is that the amount of winter range is also limited, particularly due to urban sprawl, agricultural development and social intolerance for depredation of ornamentals and agricultural crops.

The Wyoming Game and Fish Department (WGF) manages deer on the Wyoming side of the BHNF in Hunt Units 1-6 that comprise Herd Unit 706 for white-tailed deer and Herd Unit 751 for mule deer. Both of these Herd Units are a mix of private lands and land administered by the BHNF. Therefore, population data reflecting only deer numbers on the Wyoming side of the BHNF are not available (Sandrini 2002a). WGF sets post-hunting season (PHS) population objectives for species by Herd Unit. The white-tailed deer PHS population objective in Herd Unit 706 is 40,000 animals. The white-tailed deer PHS population projection for 2002 was approximately 28,000. The mule deer PHS population objective for Herd Unit 751 is 20,000 animals and the projected 2002 PHS population was 20,700 (Sandrini 2002a). Although the mule deer projected PHS population is at the target level, WGF managers believe that most of these animals are dependent on private lands within the Herd Unit (Sandrini 2002a). Similarly, white-tailed deer utilize mostly private lands. This is particularly true for both species in winter where deer presence on agricultural lands may represent a management conflict (Sandrini 2002a). Some burned areas on south facing slopes and mountain mahogany shrublands on the BHNF are used to a lesser extent by both species (Sandrini 2002a). Inadequate deer forage on the BHNF in Wyoming is cited as a prime concern for deer managers with WGF (Sandrini 2002a). This puts pressure on private lands where deer may be perceived as a nuisance and reduces deer utilization of National Forest System Lands that affects public hunting opportunities (Sandrini 2002a).

Poor deer forage conditions on the BHNF in Wyoming may be evidenced by low fawn/doe ratios. One 2001 WGF survey found this ratio to be 28 fawns per 100 does (Sandrini 2002a). According to Sandrini (2002b), "the 2001 observed *(white-tail deer)* preseason fawn/doe ratio of 28/100 was 60% of the previous five-year average. This low productivity was likely due to the compounding effects of drought conditions during the summer of 2000 followed by a harsh winter and then localized epizootic hemorrhagic disease (EHD) outbreaks in the summer of 2001. It should be noted mule deer productivity in the Black Hills only declined 20% from its 5-year average in 2001; further suggesting EHD played a role in suppressing white-tailed deer productivity. Even attributing the poor reproduction of 2001 to weather conditions and disease, the reproductive output of this population continues to be quite low, and appears to be declining. Given favorable weather, reproduction is still high enough to create growth in the population. However, the output is low enough that this population will not respond quickly after catastrophic events such as harsh winters or disease outbreaks. The average preseason fawn/doe

ratio of this herd from 1979 to 2001 was 67/100. Prior to 1992 all observations were above this average, and since 1992 all observations have been below this average. Much of the reproductive decline is thought to be attributable to habitat changes throughout the herd unit, especially on the BHNF."

Anderson (2001) further states "White-tailed deer habitat in this region *(Black Hills herd unit)* has undergone numerous changes in the last couple of decades. There has been a decline in the amount of hardwood-dominated areas as well as a decrease in dense, screening cover. Many of the shrub communities have aged and are not as palatable as they were 20 years ago. In addition, many of the haystacks throughout the region have been fenced off to prevent deer depredation. All of these factors have contributed to a long-term decline in white-tailed deer reproduction in the *(Black Hills herd unit)*. The habitat changes are particularly noticeable on much of the Black Hills National Forest. The resulting decrease in white-tailed deer numbers and hunting quality is reflected in the harvest statistics for hunt area 4, which is dominated by National Forest land. Hunter success in area 4 has averaged 40% lower than the rest of the DAU *(Data Analysis Unit)* since 1990. In conjunction with the lower success rate, the days/animal has averaged 65% higher than the rest of the DAU."

2-6. DEER SPRING AND SUMMER RANGE RECOMMENDATIONS

Timber harvest and forest management also affect the quality of deer habitat. Uresk and Severson (1998) recommend maintaining a variety of stocking levels (i.e., density) in ponderosa pine to enhance cover and forage on deer summer range. They state that floristic species richness is greater in a clearcut than in unthinned stands, but total number of plant species available as forage is greater if both clearcut and unthinned stands are present. White-tailed deer are better able to balance nutritional needs from a diverse array of plant species available in varied pine stocking levels (Uresk and Severson 1998). Increasing the deciduous forest component within this area is also desirable for enhancing deer forage. Only two of seven ponderosa habitat types have aspen seral stages and only one of seven has bur oak as a seral species. Where aspen occurs as seral components in the pine understory, elimination or reduction of ponderosa pine favors development of an aspen overstory. This produces diverse community structure and a floristically rich understory (Uresk and Severson 1998). Sieg and Severson (1996) state that most deer forage is produced in stands with 40 square feet (ft^2)/acre basal area or less and also stress enhancing hardwood communities as an important component of summer range management.

Uresk et al. (1999) found that fawns selected bed sites with basal areas ranging from 47 to 70 ft^2/acre. Current standards for stocking levels on the Black Hills range from 60 to 90 ft^2/acre

basal area, which is inadequate for development of understory characteristics desirable to bedding fawns (Uresk et al. 1999).

2-7. DEER FALL AND WINTER RANGE RECOMMENDATIONS

Management/enhancement of deer winter range is the most critical task facing forest managers in the Black Hills (Sieg and Severson 1996). Winter weather, particularly deep snow, represents a survival obstacle for deer and severe winters can cause high deer mortality in the Black Hills (Sieg and Severson 1996). According to Sieg and Severson (1996), this raises a fundamental question of how to manage deer winter range. Should managers design winter habitats to accommodate the most severe winters (which is costly but would maintain deer populations at high levels) or base habitat design on average winters (deer may have periodic large die-offs, but this strategy is cost effective and quality shrub forage may be more sustainable)? This question should be addressed in the Alternative development process of the BHNF Land and Resource Management Plan Phase II environmental impact statement.

Sieg and Severson (1996) identified the following three steps for enhancing white-tailed deer winter range in the Black Hills.

1. Identify key winter ranges, assess their current habitat condition, and prioritize them for enhancement.
2. Increase protein and energy available on targeted ranges.
3. Ensure adequate cover.

Intensive management of cattle grazing on deer winter ranges is instrumental to the success of enhancement. Sieg and Severson (1996) suggest grazing systems that remove livestock before they start consuming woody vegetation - usually about mid-summer. Use of palatability ratings can aid managers in assessing livestock/range conditions (Hill 1946). Use of low palatability plants by deer indicated too great a delay in recognition of a range problem. For example, snowberry is an increaser since cattle select against it and high abundance of it indicates overgrazing.

Sieg and Severson (1996) also suggest strategies for improving forage and cover on winter range including enhancing south facing slopes and riparian areas for forage and maintenance of cover on the upper elevations of north-facing slopes. During transition from winter to summer range in spring, deer are susceptible to debilitation and death due to poor nutritional condition combined with increasing metabolic rates (Sieg and Severson 1996). Sieg and Severson (1996) recommend mitigating spring nutrition deficits of deer by enhancing growth of forbs and tall shrubs on spring transitional ranges and winter range. Therefore, enhancement of spring transitional forage may be best accomplished on known winter ranges.

2-8. DEER HABITAT AND MANAGEMENT ON THE BHNF: GENERAL SUMMARY

Good deer habitat must have quality forage in adequate quantities and cover which shelters from weather and predators. Determining the proper mix of forage and cover to benefit deer, while managing for the viability of other species within the Black Hills ecosystem, is complex (Sieg and Severson 1996). Deer do not travel far from bed sites to foraging areas; especially on wintering grounds (Kennedy 1992). Therefore, juxtaposition between cover and forage may be crucial.

Judicious management of all large herbivores (wild and domestic) can prove beneficial in achieving habitat conditions favorable to ungulates. Competition and impacts of livestock grazing to both white-tailed deer and mule deer habitat have been documented in the Black Hills (SDGFP 1995, Sieg and Severson 1996). Elk and livestock interests may be contributing to deer declines in the central Black Hills (DePerno et al. 2002). Telemetry studies conducted in the northern Black Hills showed that livestock grazing caused some localized displacement of summer resting sites for white-tailed deer (SDGFP 1995). Other studies showed that cattle grazing in an area decreases the quality of mule deer habitat, and can affect the use of hiding cover and time spent feeding versus resting (SDGFP 1995).

DePerno et al. (2002) summarize the deficiencies in deer habitat conditions by stating that high dietary overlap between deer and elk (49%), high pine consumption by deer (Hippensteel 2000) and length of cattle grazing (i.e., 1 June to 31 October in many allotments) suggest these cattle grazing systems are excessive and incompatible with improving the white-tailed deer herd.

DePerno et al. (2002) pointed out that "the Structural State Classification of the BHNF Inventory System does not lend itself to clearly explaining deer/habitat relationships. Selection of specific habitats by deer was much better explained by the availability of understory plant communities, which provides thermal cover, escape cover and food. Therefore, we more closely examined these relationships by comparing deer use of habitats in relation to the presence/absence of shrubs." Also, large area monotypic silvicultural treatments that favor reproduction of ponderosa pine are not optimal for early successional species such as deer (Stefanich 1995). Diversity across the landscape with an emphasis on early and late successional stages will better meet necessary forage and cover requirements for deer.

2-9. SUMMARY OF MANAGEMENT APPROACH CONSIDERATIONS FOR DEER

Managers need current information on habitat preferences and condition to devise a framework from which deer may be adaptively managed along with other forest resources. This section

provides a summary of management considerations for deer on the BHNF. A more thorough discussion is provided in the text discussion.

- Create, improve, increase, enhance and maintain diversity of tall shrubs, deciduous species and juniper across the entire Black Hills for year-round white-tailed deer and mule deer cover and forage.
- Conduct range condition monitoring to ensure abundance and distribution of desirable, palatable and nutritious forage across the Black Hills.
- Incorporate new research as it becomes available.
- Of the total land base, approximately 40% should be maintained as hiding/escape and thermal cover and 60% as forage (Thomas et al. 1979).
- Break up large, monotypic silvicultural treatments aimed at regenerating ponderosa pine.
- Employ large patch cuts for foraging areas adjacent to cover.
- Improve, enhance and maintain vegetative diversity on north-facing and south-facing slopes.
- Enhance, promote, conserve and maintain meadow habitat throughout the Black Hills.
- Manage spruce stands to enhance understory forage component.
- Align cover and forage in close proximity.
- Achieve forage enhancement in pine by managing to achieve basal areas of 40 ft^2/acre or lower, and with canopy closure from 0 to 40%.
- Improve, enhance, conserve and maintain deciduous riparian areas with diverse shrub understories for forage and cover.
- Use prescribed burns to increase forage in pine stands.
- Monitor, enhance, encourage, conserve and maintain moderate to high intensity burn areas to allow for establishment of native grass, forbs and shrubs.
- Increase, promote and maintain dense deciduous cover in deciduous/aspen forests.
- On fawning sites within ponderosa pine forests, basal areas should range between 47 and 70 ft^2/acre.
- Maintain 71 to 100% canopy closure in ponderosa pine stands on winter bed sites but avoid large-area monotypic silvicultural treatments.
- Develop, encourage and maintain a variety of stocking levels, densities and multiple-ages in ponderosa pine to enhance cover and forage.
- Develop, encourage and maintain a variety of age-classes and species diversity of tall shrubs.
- Create more open pine stands followed by moderate to hot prescribed burns to promote better distribution and abundance of Oregon grape, serviceberry, rose, spiraea, forbs and mountain mahogany.

- Employ management practices to improve, promote and encourage juniper spp. and bearberry.
- Remove livestock from deer winter ranges before they significantly browse shrubs.
- Monitor shrub and riparian communities to better manage elk and livestock to minimize impacts to deer browse and fawning cover.
- Create, improve, promote, enhance and maintain tall forbs and shrubs on transitional and winter range to increase nutritional value for deer in late-winter and early spring.

3-0. ROCKY MOUNTAIN ELK ON THE BHNF

This section provides a review of elk ecology and management literature and management considerations.

3-1. REVIEW OF ELK ECOLOGY AND MANAGEMENT LITERATURE

Manitoban elk (*Cervus elaphus manitobensis)* were common in the Black Hills and surrounding prairies prior to 1870, but were extirpated due to over-harvesting by 1900 (Parrish et al. 1996). Rocky Mountain elk (*Cervus elaphus canadensis*) were transplanted into the Black Hills after 1900 and were successfully established by 1920 (USDA-Forest Service 1996).

The Black Hills elk population in Wyoming and South Dakota is at or above state agency objectives (Sandrini 2002a; Wrede 2002). In the Wyoming Black Hills, which is a mix of private land, land administered by the BHNF, and other public lands, elk are managed in Herd Unit 740 (Hunt Areas 1, 116, and 117). Because there is significant interstate movement of elk between Wyoming and South Dakota, no current population estimate is available for Herd Unit 740 (Sandrini 2002a). However, the Wyoming Game & Fish Department has been attempting to reduce elk numbers since 1996. These attempts have been thwarted by limited access for hunters on private land. This is in part due to inadequate security cover on the BHNF. As a result, private lands within and bordering the BHNF provide refuge for elk during hunting seasons (Sandrini 2002a). USDA-Forest Service (1996) estimated 500 elk utilizing BHNF habitat in Wyoming. Anecdotal information from WGF suggests that this estimate may actually be 20 to 100% higher (Sandrini 2002a). Elk management is a contentious issue among some stakeholders on the BHNF. Hunters (evidenced by increasing license applications) are seeking increased elk hunting opportunities. Public land livestock grazing permittees are concerned about competition for summer forage between elk and livestock, and elk depredation on private land in winter (SDGFP 2001). Although elk are primarily grazers and have dietary overlap with domestic livestock, they can impact deer habitat by competition for browse species. Elk and livestock use and mechanical damage to aspen stands has been noted in the Black Hills and current cooperative projects with BHNF and the USDA Rocky Mountain Research Station will

lend better understanding to elk and livestock use of aspen stands in the central and southern Black Hills (Deisch Pers. Comm. 2002). And, a study of deer, elk and livestock diet competition is currently being conducted by South Dakota State University and SDGFP.

The primary elk management objective of WGF and SDGFP in the Black Hills is to maximize recreational opportunities and minimize elk depredation of forage on adjacent private land, while maintaining current population levels (Sandrini 2002a; Wrede 2002).

On the BHNF, elk use a variety of habitats. They exhibit a preference for forested riparian areas, forested stringers in meadows, deciduous stands of birch (*Betula* spp.) and aspen, dense forest for thermal and security cover, and openings or relatively open forest for foraging (USDA - Forest Service 1996). Elk select forage areas and cover areas based on levels of human disturbance (Rice 1988) and patterns vary daily and seasonally (Millspaugh 1999). Cover and forage areas must be interspersed across elk range (Millspaugh 1999). Migration by elk from summer to winter range in the Black Hills is limited and dependent on winter severity and snow depth (SDGFP 2001). Therefore maintenance of good winter forage and cover conditions on summer range and maintaining adequate severe winter range may be advisable (SDGFP 2001).

Elk diet consists of grass and forbs throughout the summer (SDGFP 2001). In the southern Black Hills, elk diets are composed of 50% grass, 45% forbs, and 5% shrubs (Wydeven and Dahlgren 1983). In winter elk eat marginally more shrubs and aspen, particularly mountain mahogany. Lichen may also be used in winter to some extent (Sandrini 2002a). When populations are below carrying capacity, overlapping diets between elk and deer is not considered an important management issue. Elk competition with deer is more likely as populations increase toward carrying capacity and resources become limited. If competition does arise for forage, elk typically dominate deer (Sieg and Severson 1996). Elk diets overlap more closely with cattle and forage competition can be a management concern on both summer and winter ranges (Sieg and Severson 1996). When cattle are allowed to graze all summer on deer and elk winter ranges, competition for forage may increase sharply (SDGFP 2001). Additionally, cattle displace elk through space competition (Rice 1988).

Forest management in the Black Hills, particularly fire suppression, has altered elk habitat in the last 100 years. Section 1-1 gives a summary of Black Hills fire history and post-European settlement impacts to the Black Hills. Frequent fires historically maintained more open habitats with vigorous grass and forb understories (Parrish et al. 1996). Today the Black Hills are dominated by dense mature ponderosa pine stands with depauperate understories (Parrish et al. 1996). Uresk and Severson (1989) found that understory diversity and biomass are both inversely related to pine canopy density. Recommendations for improving elk forage in the Black Hills involve creating openings in the pine canopy or reducing pine-stocking levels. Uresk and Severson (1989) report forage production of 2,200 pounds (lb)/acre in clearcuts, 1,000

lb/acre in stands where basal area is reduced to less than 40 ft^2/acre, and 500 to 400 lb/acre in stands where basal area is reduced to 60 to 80 ft^2/acre. However, dense slash remaining after treatment significantly reduces forage response to reduction in canopy closure (Bopray 1987). It is important that elk and livestock use of recently thinned and logged areas, including prescribed burns, be deferred from use until improved forage conditions result. In all practicality, fencing to exclude wild ungulates is costly but livestock grazing systems can be employed to achieve desired results. It is important that habitat conditions be evaluated to determine proper carrying capacity of domestic and wild ungulates. Coordination between BHNF and state wildlife management agencies is imperative. Wild ungulate hunting seasons and harvest levels are the responsibility of state wildlife management agencies. A recent study in CSP describes summer bed site characteristics of elk in the southern Black Hills (Millspaugh et al. 1998). CSP has an extensive road network and has about 1.5 million visitors annually, with the highest density during the peak summer season. Human disturbance such as roads, trails, logging, and other activities can influence elk selection of habitat (Lyon and Ward 1982). However, elk selection of bed sites in the CSP study was not influenced by distance from roads or trails. This suggests that elk were choosing bed sites for thermal rather than security cover (Millspaugh et al. 1998). Elk chose bed sites on northern aspects with higher basal area (54 ft^2/acre), greater canopy closure (54%), and higher stocking (271 trees per acre) than random sites. Millspaugh et al. (1998) also suggest that elk were selecting understory substrates at bed sites that facilitate heat transfer, such as surfaces with pine needle litter and bare ground. Elk thrive in some areas with no thermal cover, but are better able to cope with heat constraints with adequate thermal cover. Therefore, Millspaugh et al. (1998) recommend maintenance of appropriate thermal cover on elk summer range in the Black Hills.

Data from CSP suggested that vegetative security cover is important during fall hunting seasons (Millspaugh et al. 2000, Roloff et al. 2001). Security cover is defined as "vegetation capable of hiding 90% of a standing elk from the view of a human at a distance of $\leq$200 ft" (Thomas et al. 1979). Attributes defining security cover for elk in CSP include a combination of coniferous forest with heights 6.5 to 20 ft, stocking of >370 trees/acre (>4 in. dbh), and 70% understory cover <10 ft tall. Roloff et al. (2001) also suggest the possibility of topographic barriers being selected as security cover by elk in summer on CSP. Hillis et al. (1991) recommend maintaining fall (hunting) security areas of 250 acres of timber that has not been manipulated at least 0.5 miles from an open road; and at least 30% of a herd's range should provide security cover.

Open roads and associated traffic affect elk habitat use (USDA-Forest Service 1996). Lyon and Ward (1982) found that roads had a predictable influence on elk habitat use based on the average number of vehicles per day and the road maintenance frequency. HABCAP estimates buffers around roads, inside which elk are not assumed to utilize (USDA-Forest Service 1996). However, Millspaugh et al. (1998) found that elk habituated to predictable disturbances associated with roads and trails. Elk adapted their behaviors to avoid predictable disturbance

both diurnally and seasonally. Elk avoided areas near roads during periods of heavy use (e.g., hunting seasons, daytime during summer) but selected these areas during periods of low use (e.g., night and winter). However, elk avoided areas adjacent to hiking trails with unpredictable human foot traffic (Millspaugh 1999). Also roads through high quality cover may have less impact on elk use than roads through low quality cover (Hillis et al. 1991). SDGFP (2001) ecommend road densities of no more than 1 mile of open road per 640 acres. SDGFP (2001) made the following recommendations for elk in the BHNF.

"The Wildlife Division supports the following practices on the Black Hills National Forest:

1. The use of logging, prescribed burning, and livestock grazing.
2. Expansion of the elk population on the National Forest commensurate with forage and habitat needs as part of multiple use management. This equates to 21,344 AUMs *(Animal Unit Months)* for elk, total wildlife AUMs of 94,212 and 128,000 AUMs for livestock.
3. A combination of logging and prescribed fire to enhance forage production and habitat diversity.
4. Design of timber sales to provide blocks of hiding/thermal cover on at least 30% of a timber sale area and avoid monotypic cuts over large areas in the 80 basal area range.
5. Additional emphasis on 1 to 10 acre patch cuts adjacent to cover areas to increase forage.
6. Clearing pine trees from meadows and deciduous tree stands.
7. Defer site preparation (e.g. ripping of grass areas) that provides for pine regeneration within five years.
8. Use of rest rotation grazing systems for livestock management.
9. Establishing no more than one mile of open road per square mile of area.
10. Research to determine specific competition between elk, deer, and cattle on the National Forest, the amount and type of forage produced, elk movement and habitat use and impacts from diverse recreational use."

3-2. SUMMARY OF MANAGEMENT APPROACH CONSIDERATIONS FOR ELK

This section provides a summary of management considerations for elk on the BHNF.

- Create a variety of stocking levels in ponderosa pine to enhance cover and forage for elk.
- Promote and maintain dense coniferous/deciduous stands located ≥ 0.5 miles from open roads to provide security cover on summer and winter ranges.
- Promote and maintain conditions for summer thermal cover in ponderosa pine on north slopes, with >271 trees per acre, >54% canopy cover, and >40 ft^2/acre basal area.

- Promote conditions for security cover that may occur on winter or summer range in ponderosa pine at 370 trees per acre, with trees 6 to 20 ft tall, and a 70% understory cover of shrubs 10 ft tall.
- Utilize patch cuts and shelter-wood harvests, where basal area is reduced to 40 ft^2/acre or less to enhance a forb-shrub understory component in pine stands (summer and winter ranges).
- Promote, create, improve and maintain a scattered and diverse shrub component for improved forage conditions.
- Monitor deciduous tree and shrub communities for livestock and ungulate use.
- Employ grazing systems that remove livestock by mid-summer in deciduous and riparian areas.
- Monitor deciduous tree and shrub communities after moderate to high intensity burns (both prescribed and wild) to determine recovery, condition and carrying capacity of wild and domestic ungulates.
- Achieve and maintain lower road densities to minimize fragmentation of elk habitat on all ranges at ≤1 mile of open road per 640 acres. Create and maintain large road and area closures to reduce motorized and human disturbances.

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