GAME REPORT

Seasonal Movements, Home Ranges, and Survival of White-tailed Deer and Mule Deer in the Southern Black Hills, South Dakota 1998-2003

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Abstract

Seasonal movements, migrations, home ranges, and mortality of white-tailed deer (Odocoileus virginianus dacotensis) and mule deer (Odocoileus hemionus hemionus) in the southern Black Hills of South Dakota were evaluated from February 1998 to December 2003. During January, February, and March 1998-2001, white-tailed and mule deer were captured and ear-tagged. A total of 176 white-tailed deer was captured with a sample of 81 adult (15 males, 66 females) and/or yearling deer radiocollared. A total of 58 mule deer was captured with a sample of 31 adult (9 males, 22 females) and/or yearling deer radiocollared. Spring migration from winter to summer ranges for white-tailed deer was in a north to northwest direction, commenced in mid-May, and was completed by late-May. Spring migration from winter to summer ranges for mule deer was in a north to northeast direction, commenced in mid-May, and was completed by late-May. Fall migration from summer to winter ranges for white-tailed deer was in a south to southeast direction and extended from September through late-December. Fall migration from summer to winter ranges for mule deer was in a south to southwest direction and extended from October into January. Most deer were on winter ranges by the end of November. Duration of most migrational movements occurred within 2-5 days of initiation.

Distance of migration for 44 radiocollared female white-tailed deer ranged from 1.99 km (1.24 miles) to 53.94 km (33.52 miles) with an average of 23.30 km (14.48 miles). Distance of migration for 7 radiocollared male white-tailed deer ranged from 5.76 km (3.58 miles) to 23.01 km (14.3 miles) with an average of 15.79 km (9.81 miles). Migration distances between male and female white-tailed deer in the southern Black Hills were significantly different ($F_{1,119}$ = 8.443, P = 0.004). Distance of migration for 17 radiocollared female mule deer ranged from 0.71 km (0.44 miles) to 56.4 km (35.05 miles) with an average of 16.03 km (9.96 miles). Distance of migration for 8 radiocollared male mule deer ranged from 2.25 km (1.4 miles) to 46.57 km (28.94 miles) with an average of 12.17 km (7.56 miles). Migration distances between male and female mule deer in the southern Black Hills were similar ($F_{1,23}$ = 0.225, P = 0.618).

Summer home ranges for female white-tailed deer averaged 204.94 ha (506.41 acres; n=38) with an average core use area of 30.07 ha (74.30 acres). Summer home ranges for male white-tailed deer averaged 541.07 ha (1,336.98 acres; n=3) with an average core use area of 92.98 ha (229.75 acres). Winter home ranges for female white-tailed deer averaged 347.00 ha (857.44 acres; n=36) with an average core use area of 54.51 ha (134.69 acres). Winter home ranges for male white-tailed deer averaged 314.98 ha (778.32 acres; n=4) with an average core use area of 71.80 ha (177.42 acres). A significant interaction ($F_{1,77}$ = 5.232, P =0.025) occurred between sex and season for home range size (95% ADK). In winter, 95% Adaptive Kernel Method (ADK) home ranges did not differ ($F_{1,38}$ = 0.068, P = 0.796) between males and females. However, in summer, 95% ADK home ranges were larger ($F_{1,39}$ = 11.485, P = 0.002) for males than females. Similarly, a significant interaction ($F_{1,77}$ = 4.763, P = 0.032) occurred between sex and season for 50% core areas. In winter, no difference ($F_{1,38}$ = 1.58, P = 0.216) occurred in 50% core areas for male and female white-tailed deer. However, in summer male core use area was greater ($F_{1,39}$ = 15.969, P < 0.001) than for females.

Summer home ranges for female mule deer averaged 354.04 ha (874.83 acres; n=15) with an average core use area of 55.46 ha (137.04 acres). Summer home ranges for male mule deer averaged 622.69 ha (1538.67 acres; n=8) with an average core use area of 124.63 ha (307.96 acres). Winter home ranges for female mule deer averaged 511.26 ha (1,263.32 acres; n=12) with an average core use area of 102.24 ha (252.64 acres). Winter home ranges for male mule deer averaged 632.96 ha (1,564.04 acres; n=5) with an average core use area of 73.08 ha (180.58 acres). Seasonal 95% ADK home ranges did not differ ($F_{1,36}$ = 2.539, P = 0.120) between male and female mule deer. However, a significant interaction ($F_{1,36}$ = 4.797, P = 0.035) did occur between sex and season for the 50% ADK home range size. Although 50% ADK winter home ranges did not differ ($F_{1,15}$ = 0.477, P = 0.500) between males and females; summer 50% ADK home ranges were larger ($F_{1,21}$ = 8.986, P = 0.007) for males than females.

Site fidelity for migrating white-tailed deer and mule deer to specific home ranges was high. Almost all deer returned to the same winter or summer home ranges in all years except after the Jasper Fire in the fall of 2000. The Jasper fire burned approximately 33,791 ha (83,500 acres) in August of 2000 and disrupted some of the normal migrational movements and fidelity of some individuals. However, after one year post-fire, all surviving deer showed fidelity to original summer and winter home ranges.

Annual female white-tailed deer mortality ranged from 13 to 46%. Combining accidental with natural mortality, approximately 32% of radiocollared females died from natural causes and 4% were harvested each year. Annual male white-tailed deer mortality ranged from 0 to 67%. Combining accidental with natural mortality, approximately 20% of radiocollared males died from natural causes and 20% were harvested each year.

Annual female mule deer mortality ranged from 0 to 38%. Combining accidental with natural mortality, approximately 30% of radiocollared females died from natural causes. Annual male mule deer mortality ranged from 50 to 100%. Approximately 60% of radiocollared males were harvested each year. No male mule deer died from natural causes.

PREFACE

This report summarizes data gathered by South Dakota Department of Game, Fish, and Parks and South Dakota State University, Wildlife and Fisheries Sciences personnel during February 1998-December 2003, on seasonal movements, home ranges, and mortality of white-tailed and mule deer in the southern Black Hills, South Dakota. This study (Pittman-Robertson Project W-75-R, Study Number 7583) was initiated in February 1998 to document seasonal movements, migration timing, and home ranges of white-tailed and mule deer in the southern Black Hills. South Dakota State University, Wildlife and Fisheries Sciences initiated a companion study (Pittman-Robertson Project W-75-R, Study Number 7593) in February 1998 to determine and document habitat selection of white-tailed and mule deer in the southern Black Hills, South Dakota.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Appendix | Page

Seasonal Movements, Home Ranges, and Survival of White-tailed Deer and Mule Deer in the Southern Black Hills, South Dakota, 1998-2003

INTRODUCTION

Ludlow (1875) reported that deer were abundant in the Black Hills in 1874. However, by the turn of the century, unrestricted harvest had decimated deer populations. Through conservative hunting season design, deer numbers rebounded to record numbers by the mid-1900's. However, in the mid-1900's, liberalized antlerless harvest caused herd reductions that brought deer numbers in line with available habitat. Based on traditional deer management principles, herds should have subsequently rebounded from this heavy harvest. Such was not the case. Since the early 1970's, harvest management has been conservative but herd numbers have continued to decline. While there have been short-term population increases associated with mild winters, long-term trends have been steadily downward.

Most management agencies support the hypothesis that habitat deterioration has been the primary cause of the deer decline (Griffin et al. 1992). Most habitats in the Black Hills are steadily shifting towards climax communities dominated by ponderosa pine. Richardson and Petersen (1974) suggested that old wildfire burns were key winter habitats for deer in the Black Hills but expressed concern over ponderosa pine regeneration. Pine climax communities will not support as many deer as early successional stages but impacts of mid-successional stages have not been quantified. Aspen (*Populus tremuloides*) is an important species for deer in the Black Hills (Richardson and Petersen 1974, Kennedy 1992, DePerno 1998, DePerno et al. 2002). In the southern Black Hills, aspen habitats represent a small portion (<1%) of available habitat for deer (Dubreiul 2003).

Dwindling deer habitat has created conflicts between the deer resource and other users of the Black Hills National Forest. Effects of management for timber, grazing, and recreational interests within forest lands on the deer resource have not been determined in the southern Black Hills. Owens (1981) and Mundinger (1981) reported clearcuts and prescribed fire should not exceed 8 hectares (20 acres) when managing for deer on winter or summer ranges. They further concluded that if selective thinning was to be used as the silvicultural practice, then approximately 70% crown cover should be maintained. These results and recommendations are often in conflict with timber management objectives. Thilenius and Hungerford (1967) noted that deer and cattle both consumed browse but competition was light on moderately stocked ranges. Observations of deer and cattle interactions suggest cattle have an effect on deer habits (Dusek et. al. 1989, Loft et. al. 1987) and condition (Jenks and Leslie 2003). Conflicts between deer and cattle intensify with increased grazing pressure (Loft et al. 1987). Loft et al. (1993) noted that mule deer tended to avoid areas that were used by cattle. Extended cattle use of aspen stands or riparian areas in the vicinity of deer has been observed to displace deer and/or disrupt their habits in the northern Black Hills (Griffin et al. 1994) and in the central Black Hills (Griffin et al. 1999), and a reduction in grazing time has been recommended (DePerno 1998, DePerno et al. 2002).

Historically, at least a portion of deer herds in the Black Hills have utilized private cropland or meadows for feeding, especially during winter. Tebaldis (1982) reported the same occurrence in Wyoming. However, in the Black Hills, large areas of these private agricultural lands and meadows have been converted or are being converted to housing developments, resulting in a reduced winter habitat base. One too many houses occupies most meadows on winter ranges in the southern Black Hills. Peek (1984) pointed out that if sufficient cover remained, housing developments did not necessarily alter deer use of the area but free-ranging dogs from housing developments could preclude presence of deer. Conversion of meadows to housing means more deer concentrate on a reduced land base and thus, increase use of less than desirable habitat.

Increasing use of United States Forest Service lands by recreationalists, livestock permittees, and timber industries has created an increase in roads that characterize Black Hills National Forest lands. Increasing numbers of roads on Black Hills National Forest may negatively impact deer (DePerno 1998, DePerno et al. 2000). Disturbance to deer from vehicles and habitat loss to roads may be a factor. In the central Black Hills, DePerno (1998) determined that deer selected higher slope locations on winter and summer range, possibly to avoid humans, vehicles, or predators. The Black Hills National Forest has a Forest Development Road System that is currently 8,375 road kilometers (5,204 miles) and occupies 6029 ha (14,900 acres) (U.S. Dept. of Agriculture, BHNF, 1996). The Forest has approximately 5,520 kilometers (3,430 miles) of wheel track roads not considered a part of the Forest Development Road System. Building of roads has increased on a yearly basis and only 785 of 8,375 kilometers (488 of 5,204 miles) of roads are currently closed to motorized use. The Black Hills National Forest contains approximately 484,625 ha (1.2 million acres) of public land.

Road densities average approximately 6.9 km (4.3 miles) of road for every square mile of public land. Because disturbance may force deer to use inferior habitats, DePerno (1998) and DePerno et al. (2000, 2002) recommended reducing road densities and closing roads in the central Black Hills.

Sieg and Severson (1996) noted that fires were an important ecological force in the Black Hills region, and that few quantitative data were available on historic fire frequency in the Black Hills. Fire reduces the invasion of pine into meadows and aspen stands. The complete dominance of other vegetation by ponderosa pine is detrimental to wildlife, domestic livestock, and watersheds (Richardson and Petersen 1974). Even with the importance of fire to the ecosystem in the Black Hills, the trend has been to quickly extinguish all fires that are natural or man-made. Fire suppression has likely caused widespread degradation of deer and elk (Cervus elaphus) habitats in the Black Hills (SAIC 2003a). In August 2000, the Black Hills experienced its largest recorded fire. The Jasper fire started as a result of arson, and burned approximately 33,791 ha (83,500 acres) in the southern Black Hills. During 2000-2002, the total number of acres burned in the Black Hills (158,372 acres) was similar to those burned in the period from 1940-1999 (152,433 acres) (SAIC 2003a). These recent fires are likely the result of fire suppression over the past 50 years in the Black Hills. The result of these large fires are areas of severe burns with areas of moderate to light surface burns that decrease pine encroachment and thus, increase forage production. Stand replacing fires thin ponderosa pine stands and create areas with abundant shrubs and forbs in the understory (Sieg and Severson 1996). In fact, shrub production may double as a result of fire (Harestad and Rochelle 1982). The McVey Burn (21,850 acres) occurred in the central Black Hills in 1939 resulting in a successional stage change from climax to early successional. This allowed grasses, forbs, and shrubs to increase from pre-fire conditions. Over the past 65 years, deer have used the McVey Burn area for winter range. The Jasper fire burned areas consisting of white-tailed deer winter ranges and mule deer summer ranges in the southern Black Hills, and will likely create areas of increased and improved habitat conditions.

Black Hills deer populations consist of 80% white-tailed deer and 20% mule deer (Wallin and Rice 1980). Through season design, Black Hills buck only deer licenses had historically been the only hunting license that virtually guaranteed a big game hunter a place to hunt in South Dakota. Licenses had been unlimited for both resident and nonresident hunters and season dates have included the entire month of November. Annually, approximately 15,000 hunters had participated in this season. Due to declining herd numbers, antlerless harvest had been controlled through limited quota licenses. Thus, demand in popular hunting units exceeds supply.

In response to hunter concern for the quality of Black Hills deer hunting, a citizen task force was created to recommend seasonal design changes for the 1996 Black Hills hunting season. This resulted in a limited-license season design. The limited-license season initially offered a resident quota of 6,000 buck-only licenses for the Black Hills during the month of November. Also, this buck-only license had a 2-point or better (on one antler) restriction that attempted to reduce hunting pressure on yearling bucks. Additionally, a total of 5,400 any-deer or any-white-tailed licenses were issued in four units with a 10 through 19 November season. Also, each unit offered an additional 8% of licenses for nonresidents. A similar season design (with reduced license numbers) was used in the 1998-2003 Black Hills hunting season.

Deer herds have historically provided recreational opportunity and substantial economic benefits to the Black Hills area. Big game hunters spend an average of $630.00/ season/person (U.S. Dept. of Interior and U.S. Dept. of Commerce 1996). Based on consumptive and nonconsumptive use, Williamson and Doster (1981) estimated capitalized value for white-tailed deer was approximately $1,657 per animal nationally. Historically, consumptive demand for hunting licenses that allow harvest of either sex cannot be met in the Black Hills and nonconsumptive users are increasing.

Little research has been conducted on mule deer in the Black Hills of South Dakota. Food habit studies for mule deer in the Black Hills are lacking, but diets are assumed to be similar to that of white-tailed deer (Richardson and Petersen 1974). Mule deer tend to occupy more open habitats with rough topography, and as a result are more abundant in the southern Black Hills (Sieg and Severson 1996). Recently, more research has been initiated on mule deer in the Black Hills. In 2003, a study on mortality and habitat use by mule deer fawns was initiated (SDGF&P unpublished data). Habitat selection of mule deer in the southern Black Hills was reported by Dubreuil (2003), and in this report we document home ranges, migrational movements, and mortality of mule deer in the southern Black Hills.

The decline of white-tailed deer in the Black Hills has been well documented. Data on age structure, harvest, reproductive rates, and survival rates (DePerno et al. 2000) have shown recruitment (Wallin and Rice 1980, Rice 1984) and habitat quality (DePerno 1998, DePerno et al. 2001, 2002, 2003) to be a major problem. Food habits studies (e.g., Schneeweis et al. 1972, Osborn 1994, Hippensteel 2000) demonstrated that white-tailed deer depend on poor quality forage during winter and summer. Habitat selection, escape cover utilized, and feeding/resting habitats of adult male and female white-tailed deer has been documented in the northern Black Hills (Kennedy 1992), central Black Hills (DePerno 1998, DePerno et al. 2001, 2002, 2003), and southern Black Hills (Dubreuil 2003). DePerno (1998), and DePerno et al. (2001, 2002) made recommendations to land management agencies on how to improve existing deer habitats. Additionally, mortality and habitat use of white-tailed deer fawns has been documented in the northern (Benzon 1993), central (Benzon 1998), and southern Black Hills (Schmitz, unpublished data). Home ranges and migrational movements for white-tailed deer have been documented in the northern (Griffin et al. 1994, Stefanich 1995) and central Black Hills (Griffin et al. 1999). In this report we document home ranges, migrational movements, and mortality of white-tailed deer in the southern Black Hills.

Migration of white-tailed deer and mule deer were generally described by Richardson and Petersen (1974) for the southern Black Hills. However, it was believed that migration of white-tailed and mule deer in the Black Hills have undergone a radical change over the past 20 years. Richardson and Petersen (1974) reported that timing of fall migration depended upon snow depth. Historically, deer moved onto winter range in December and January. Since the early 1980's substantial deer numbers have been observed on winter range in October and early November (Griffin et al. 1994, Griffin et al. 1999). Deer are moving to winter ranges when snow cover is absent; thus, snow cover is not a factor initiating migration. In the northern Black Hills, 59% of radiocollared deer were on winter ranges before 1 November (Griffin et al. 1994). Similarly, in the central Black Hills, 71% of migrating radiocollared deer migrated during September and October (Griffin et al. 1999). Cause of timing shift in migration is unknown. Speculations as to cause of this movement have ranged from poor summer habitat conditions to learned behavior due to early winter storms. Nevertheless, documentation and determination of population factors that have changed migration patterns must be ascertained. Deer populations spending greater time periods on already stressed winter ranges cannot be beneficial to overall herd health.

OBJECTIVES

1. To determine seasonal movements, migrations, home range characteristics, and mortality of white-tailed deer and mule deer in the southern Black Hills, South Dakota.

2. To study the effects of the Jasper Fire on seasonal movements, home ranges, and mortality of white-tailed deer and mule deer in the Southern Black Hills, South Dakota.

STUDY AREA

The Black Hills is an isolated extension of the Rocky Mountains located in southwestern South Dakota and northeastern Wyoming. The Black Hills extend approximately 190 kilometers (118 miles) in a north to south direction and 95 kilometers (59 miles) east to west (Petersen 1984), and encompass 8,420 km^2 (Fescke and Jenks 2002). Topography varies from rugged, mountainous terrain to broad grass-covered valleys. Elevations of the Black Hills range from 973 to 2,202 m above mean sea level (Orr 1959, Turner 1974). Temperatures are typical of a continental climate and mean annual temperatures range from 5° C to 9° C (41° F to 48.2° F) with an extreme range of -40° C to 44° C (-40° F to 111.2° F) (Thilenius 1972). Mean annual precipitation is over 66 cm in the northern region of the Black Hills, but may be less that 45 cm in the southwestern Black Hills (Orr 1959). Yearly snowfall may exceed 254 cm at higher elevations (Thilenius 1972).

The southern Black Hills study area(43° 40' N to 44° 0' N - 104° 03' W to 103° 37' W) includes Custer and Pennington counties of South Dakota (Fig. 1). The study area is composed of separate winter and summer ranges used by migratory white-tailed deer and mule deer. Public land within the study area is managed primarily for timber production, livestock grazing (varies from 1 June through 31 October), recreation, and winter range for wild cervids by the USDA Forest Service, Hell Canyon and Mystic Ranger Districts.

Dominant overstory vegetation on white-tailed and mule deer winter range consists of ponderosa pine (Pinus ponderosa). Primary understory vegetation on winter range consists of various forbs and grasses, snowberry (Symphoricarpos albus), serviceberry (Amelanchier alnifolia), woods rose (Rosa woodsii), juniper (Juniperus communis) and cherry species (Prunus spp.). The major mule deer wintering area is located in the southwestern portion of the study area and consists of large stands of mountain mahogany (Cercocarpus montanus) interspersed with mountain juniper (Juniperus scopulorum).

Dominant overstory vegetation on summer range of both deer species consists of stands of ponderosa pine and white spruce (Picea glauca) that are interspersed with small stands of quaking aspen (Populus tremuloides). Understory vegetation on deer summer range consists of grass and forb species and various shrub species, including Oregon grape (Berberis repens), juniper, bearberry (Arctostaphylos uva-ursi), snowberry, and serviceberry. Mule deer summer ranges also contain stands of mountain juniper and mountain mahogany.

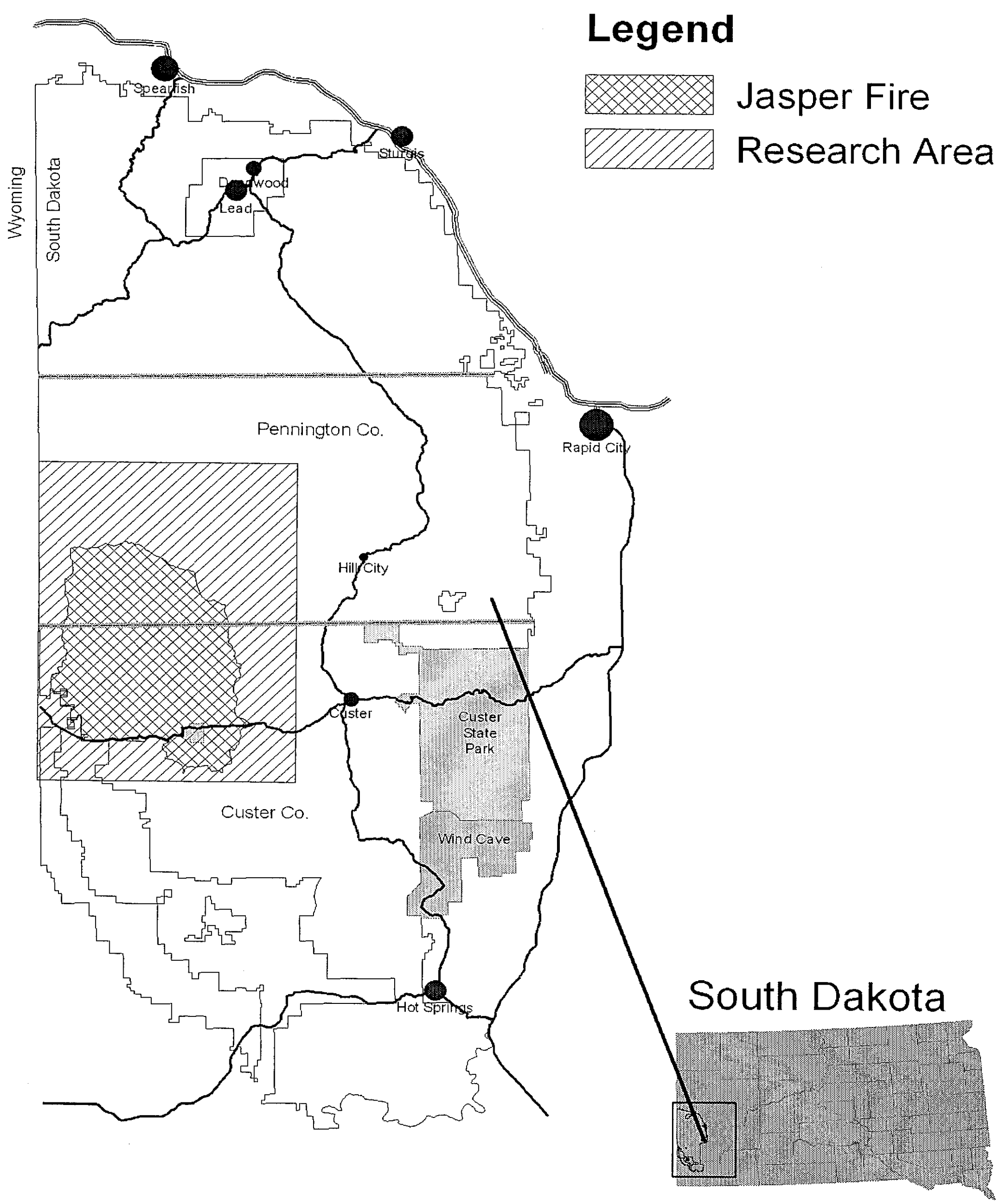

Figure 1. Location of study area in the southern Black Hills, South Dakota, 1998-2003.

METHODS

To accomplish study objectives, three study segments were initiated: 1) to capture and mark white-tailed and mule deer on winter ranges; 2) to determine deer movements, subsequent home ranges, and survival; and 3) to determine deer habitat use within home ranges. All study segments were worked on as a cooperative study between South Dakota Department of Game, Fish and Parks, and South Dakota State University, Wildlife and Fisheries Sciences. South Dakota Department of Game, Fish and Parks is reporting the first two study segments in this Completion Report. The third study segment was reported by South Dakota State University, Wildlife and Fisheries Sciences (Dubreuil 2003).

Capture and Marking

During 1998-2001, white-tailed and mule deer were captured in January, February, and March, on winter ranges in the southern Black Hills (Fig. 2). Trapping was conducted using modified, single-gate Clover traps (Clover 1956) baited with second cutting alfalfa (*Medicago sativa*) hay. Deer were trapped on 4 areas consisting of United States Forest Service Land and private lands in the southern Black Hills.

All captured deer were classified as fawns, yearlings, or adults based on body size and incisor wear. Hind leg lengths and shoulder girth measurements were collected for future comparisons of deer size between age classes and study areas in the Black Hills.

All deer were marked with cattle ear tags (Y-Tex Corporation, Cody, Wyoming, USA) that were color coded to location of capture and numbered for individual identification. Sexes were marked in different ears (females-right ear, males-left ear) for sex identification when numbers could not be read. In addition, 112 radio-equipped neck collars (Telonics Inc., Mesa, Arizona, USA) were placed on selected adult and yearling female and male white-tailed and mule deer during the various trapping periods.

Deer Capture Form

Date	Spp	Sex	Age	Girth	Leg	Tag No.	Tag Color	Freq.	Weather	Trap Location	Comments

Figure 2. Deer capture form, southern Black Hills, South Dakota, 1998-2001.

Movements and Home Range

Radiocollared deer were visually located from the ground every 1-3 days from March 1998 through July 2002 (Fig. 3). Additionally, radiocollared deer were monitored until December 2003 to determine deer mortality. Deer were radiotracked at various times of the day to maximize observations of diurnal activities (Hayes and Krausman 1993, Kernohan et al. 1996). Nocturnal locations were not obtained due to the terrain of the southern Black Hills; triangulation is not a reliable method. Spotlighting attempts were made, but only enhanced locations of the most accessible deer, and thus were discontinued. Radio signals were received with truck-mounted omni-directional (Telonics Inc., Mesa, Arizona, USA) and hand-held four-element directional yagi antennas with a Telonics Model TR-2 receiver (Telonics Inc., Mesa, Arizona, USA). Radiocollars contained a mercury tip-switch that allowed determination of activity through head-up or head-down positions (Beier and McCullough 1988, Hansen et al. 1992). Also, radiocollars contained a mortality sensor with a 4 hour inactivity delay. All locations of radiocollared deer were assigned Universal Transverse Mercator (UTM) coordinates using handheld GPS equipment and were plotted on 7.5 minute USGS topographic quadrangles.

Winter and summer home ranges and core areas within home ranges of radiocollared deer were determined using UTM coordinates entered into Program Calhome (Kie et al. 1996). All locations were used in the program to generate home ranges and core use areas.

Every attempt was made to obtain locations on individual deer to maximize sample size. However, mortality of deer, scheduling conflicts, and other factors affected sample size objectives on some deer. Therefore, home ranges were calculated for all deer with 15 or more locations on winter and summer ranges. Deer migration timing, distances, and trends were determined through use of radiocollared animals.

Recovery data on tagged deer and radiocollared deer were used to document location and types of mortality. Also, movement data were enhanced by observations of tagged deer by the general public, hunters, and South Dakota Department of Game, Fish and Parks personnel throughout the Black Hills.

Deer Location Form

Data No._______ Date__________ Time___________ Frequency__________

Activity_______Feeding 01, Bedding 02, Standing 03, Walking 04, Running 05, Fawning 06, Nursing 07, Unknown 08.

Location E____________________ N_____________________________

Elevation________________________________

Topography____________ Riparian 01, Draw 02, Upland 03, Agricultural 04, Pasture-Meadow 05.

Comments:

Slope(%)_______ 0-10 01, 11-25 02, 26-50 03, 51-75 04, 76-90 06.

Slope Position_______low slope 01, mid-slope 02, upper slope 03.

Aspect_____________ N 01, NE 02, E 03, SE 04, S 05, SW 06, W 07, NW 08, Flat 09.

Ambient Temp (C)__________ Microsite Temp (C)____________________

Ppt.___________ Snow 01, Rain 02, Fog 03, None 04.

Sky____________ Clear 01, Broken 02, Complete cloud cover 03.

Wind___________ Breeze 01, Wind 02, Gusts 03, None 04.

Snow Depth (cm)__________ Sinking Depth (cm)___________

Distance to road________________________

Class of Road_____________ Paved highway 01, Paved secondary 02, Gravel sec 03, Tertiary 04, Trail or 2-track 05.

Distance to Adjacent Edge_______Adjacent Edge Type_______________

Distance to water__________ Distance to Active Logging______________

Cover type________________ Understory union_______________________

Wildlife Structural Stage________________________________

PIPO assc.__________________ Aspen Group___________________________

PIGL assc.__________________ Other_________________________________

Coniferous Crown Cover(%)______ Deciduous Crown Cover(%)____________

Figure 3. Deer location form, southern Black Hills, South Dakota, 1998-2003.

Analytical Methods

Home ranges were estimated using Program Calhome (Kie et al. 1996). Program Calhome estimates home ranges based on the Adaptive Kernel Method (ADK)(Worton 1989). A 95% utilization distribution was used for home range sizes and a 50% utilization distribution was used to represent core use area. Smoothing parameters were not adjusted from the default settings used in the ADK analysis. Additionally, 95% and 50% minimum convex polygons (MCP) (Mohr 1947) were determined for comparisons with other studies. Analysis of Variance (ANOVA) was used to compare home range sizes between males and females of both white-tailed and mule deer. Also, ANOVA was used to compare home range sizes between southern Black Hills deer and those of deer from other study areas in the northern (Griffin et al. 1994) and central Black Hills (Griffin et al. 1999). Alpha was set at 0.05 and all analyses were performed using SYSTAT (Wilkinson 1990).

Migration distances were determined using the center of ADK home ranges on winter and summer ranges and computing a straight-line distance between home ranges. Therefore, because of the terrain in the Black Hills, migration distances presented should be regarded as minimum distances traveled. Migration distances were calculated for all deer that moved from winter to summer range. Before a migration distance was determined, deer had to remain at a location for a season to consider it a permanent home range. ANOVA was used to compare migration distances between sexes and study areas.

Survival rates were calculated using the Kaplan-Meier procedure (Kaplan and Meier 1958) modified for a staggered entry design (Pollock et al. 1989) for the following 3-month periods (seasons): January-March (winter), April-June (spring), July-September (summer), and October-December (fall). Survival rates were calculated by sex, year, and season and compared using Program CONTRAST (Hines and Sauer 1989); alpha was set at $P \leq 0.05$. A Bonferroni correction factor was used to maintain the experiment-wide error rate when performing multiple Chi-square tests (Hopkins and Gross 1970, Neter and Wasserman 1974, Neu et al. 1974).

RESULTS

Capture and Marking of White-tailed Deer

A total of 176 white-tailed deer was trapped during four trapping periods in January-March 1998-2001. There were 127 individual deer marked with cattle ear tags or radiocollars (Appendix 1). Thirty-nine white-tailed deer were retrapped and classified as recaptures. Capturing by age and sex included 63 adult females, 9 adult males, 5 yearling females, 6 yearling males, 22 female fawns, and 22 male fawns (Table 1). Radiocollared adult and yearling white-tailed deer totaled 81 (66 females, 15 males) deer. Trap related mortalities due to capture myopathy, stress, or broken bones occurred on 10 of 176 deer for a capture mortality rate of 5.68%. Age and sex of the trapped sample may not reflect age and sex components of the population due to capture locations and/or differential trapping vulnerability.

A total of 4,776 radiolocations were obtained for analysis of migrational movements and home ranges of white-tailed deer. Excluded from the analysis were seven white-tailed deer (2 females, 5 males) that did not migrate and thus, remained on one range throughout the study.

Capture and Marking of Mule Deer

A total of 58 mule deer was trapped during four trapping periods in January-March 1998-2001. There were 43 individual deer marked with cattle ear tags or radiocollars (Appendix 1). Fourteen mule deer were retrapped and classified as recaptures. Capturing by age and sex included 23 adult females, 5 adult males, 1 yearling female, 3 yearling males, 6 female fawns, and 5 male fawns (Table 2). Radiocollared adult and yearling mule deer totaled 31 (22 females, 9 males). Trap related mortalities due to a broken bone occurred on 1 of 58 deer for a capture mortality rate of 1.72%. Age and sex of the trapped sample may not reflect age and sex components of the population due to capture locations and/or differential trapping vulnerability.

A total of 2,057 radiolocations were obtained for analysis of migrational movements and home ranges of mule deer. Excluded from the analysis were three mule deer (1 female, 2 males) that did not migrate and thus, remained on one range throughout the study.

Table 1. White-tailed Deer captured in the southern Black Hills, SD, January-March, 1998-2001.

		Age and Sex of Tagged Deer								
Study site	Tag Color	Adult Female	Adult Male	Yearling Female	Yearling Male	Fawn Female	Fawn Male	Total Trapped	Total Tagged	Radio Collars
Pass Creek	Red	6	1	1	2	3	3	20	16	10
Wind-Mill	Red	17	5	0	2	1	3	34	28	19
Teepee	Black	6	2	0	1	3	6	25	18	11
Sawmill	Black	6	0	0	1	5	2	24	13	7
FS 456	Black	15	1	2	0	5	5	40	28	17
Sallee	Yellow	10	0	0	0	3	2	20	15	11
Pitts	Yellow	2	0	1	0	1	0	5	4	3
Hop Spring	Yellow	2	0	1	0	1	1	8	5	3
Upper Roby	Green	0	0	0	0	0	0	0	0	0
Roby	Green	0	0	0	0	0	0	0	0	0
Totals		63	9	5	6	22	22	176	127	81

Table 2. Mule Deer captured in the southern Black Hills, SD, January-March, 1998-2001.

		Age and Sex of Tagged Deer								
Study site	Tag Color	Adult Female	Adult Male	Yearling Female	Yearling Male	Fawn Female	Fawn Male	Total Trapped	Total Tagged	Radio Collars
Pass Creek	Red	0	0	0	0	0	0	0	0	0
Wind-Mill	Red	0	0	0	0	0	0	0	0	0
Teepee	Black	0	0	0	0	0	0	0	0	0
Sawmill	Black	0	0	0	0	0	0	0	0	0
FS 456	Black	0	0	0	0	0	0	0	0	0
Sallee	Yellow	0	0	0	0	0	0	0	0	0
Pitts	Yellow	0	0	0	0	0	0	0	0	0
Hop Spring	Yellow	12	1	0	3	3	3	31	22	15
Upper Roby	Green	5	4	0	0	3	2	19	14	10
Roby	Green	6	0	1	0	0	0	8	7	6
Totals		23	5	1	3	6	5	58	43	31

Migration Timing

Spring migration of white-tailed and mule deer from winter to summer range followed the same pattern throughout the study with minor yearly variations. Spring migration generally occurred between mid and late-May. Migration was completed approximately 2-3 weeks prior to parturition for Black Hills deer. Seven radiocollared white-tailed deer (2 females, 5 males) and 3 mule deer (1 female, 2 males) did not migrate and were considered resident deer. Duration of movement from winter to summer range was short. Most deer were on established summer ranges within 5 days of initiation of migration. Several deer accomplished this movement within 2-3 days. Deer that had short migrational distances accomplished migrations in one day.

Fall migration for both species of deer from summer to winter ranges was more variable than spring migration. This variation was more evident between years and species. Timing of initiation of migration for white-tailed deer varied from September to late-December with most deer arriving on winter range by the end of November. Mule deer tended to migrate at a later date. Initiation of migration for mule deer generally occurred from October to the end of December. Some mule deer stayed on summer range areas well into January or February. Duration of fall migrational movements was similar to those in spring for both species. Migrations usually took less than 5 days to complete; most took less than 3 days.

Once spring or fall migration was initiated, most radiocollared deer moved directly to their respective winter or summer ranges. There were no staging areas in the southern Black Hills. Staging areas are defined as temporary habitats used for brief or extended periods of time between winter and summer home ranges.

Direction of Migrations

Most white-tailed deer migrated in a north or northwest direction to summer ranges. This direction resulted in deer occupying higher elevations on summer ranges. Direction of mule deer migrations was more variable than those of white-tailed deer. Most mule deer moved in a north or northeast direction to summer ranges. Some mule deer moved in an easterly direction. Large elevational shifts were not as evident in mule deer migrations. Reverse directions were used to return to winter ranges. Due to the expediency with which radiocollared deer migrated, exact routes of migration could not be documented using standard telemetry techniques and VHS radiocollars.

Distances of Migrations for White-tailed Deer

Migration distance for male and female radiocollared white-tailed deer averaged 19.54 km (12.14 mi.; n=51) and ranged from 1.99 to 53.94 km. Distance of migration for radiocollared females averaged 23.30 km (14.48 mi.; n=44) and ranged from 1.99 to 53.94 km (Table 3). Distance of migration for radiocollared males averaged 15.79 km (9.81 mi.; n=7) and ranged from 5.76 to 23.01 km (Table 4). Migration distances between male and female white-tailed deer in the southern Black Hills were significantly different ($F_{1,119}$ = 8.443, P = 0.004).

Distances of Migrations for Mule Deer

Migration distance for male and female radiocollared mule deer averaged 14.79 km (9.19 mi.; n=25) and ranged from 0.71 to 56.40 km. Distance of migration for radiocollared females averaged 16.03 km (9.96 mi.; n=17) and ranged from 0.71 km to 56.40 km (Table 5). Distance of migration for radiocollared males averaged 12.17 km (7.56 mi.; n=8) and ranged from 2.25 to 46.57 km (Table 6). Migration distances between male and female mule deer in the southern Black Hills were similar ($F_{1,23}$ = 0.225, P = 0.618).

Table 3. Migration distances for radiocollared female white-tailed deer in the southern Black Hills, South Dakota, 1998-2003.

Collar Frequency	Migration Distance Kilometers	Migration Distance Miles
150.100a	22.94	14.25
150.120a	23.16	14.39
150.160b	14.89	9.25
150.230b	16.25	10.10
150.240b	53.94	33.52
150.300a	21.36	13.27
150.300b	23.24	14.44
150.310a	25.54	15.87
150.310b	25.32	15.73
150.340	24.05	14.94
150.610	29.77	18.50
150.650a	1.99	1.24
150.650b	26.94	16.74
150.670	27.00	16.78
150.740b	27.26	16.94
150.820a	28.51	17.72
150.820b	23.88	14.84
150.850	18.26	11.35
150.870a	28.53	17.73
150.870b	15.29	9.50
150.880	11.97	7.44
150.890b	25.44	15.81
150.900	17.95	11.15
150.940a	17.81	11.07
151.070	31.11	19.33
151.080a	12.20	7.58
151.080b	32.47	20.18
151.110a	14.83	9.22
151.130a	23.79	14.78
151.130b	40.07	24.90
151.160b	24.84	15.44
151.180	20.09	12.48
151.190	26.68	16.58
151.220a	27.28	16.95
151.250b	21.03	13.07
151.290a	28.27	17.57

Table 3. Cont.

Collar Frequency	Migration Distance Kilometers	Miles
151.310	19.92	12.38
151.330a	25.80	16.03
151.420b	15.75	9.79
151.440	23.87	14.83
151.500b	22.92	14.24
151.500c	22.46	13.96
151.725a	19.70	12.24
151.775b	20.77	12.91

Table 4. Migration distances for radiocollared male white-tailed deer in the southern Black Hills, South Dakota, 1998-2003.

Collar Frequency	Migration Distance Kilometers	Miles
150.210a	23.01	14.30
150.250	16.01	9.95
150.450	8.97	5.57
150.630	21.72	13.50
151.270b	5.76	3.58
151.330b	14.30	8.89
151.430	20.76	12.90

Table 5. Migration distances for radiocollared female mule deer in the southern Black Hills, South Dakota, 1998-2003.

	Migration Distance	
Collar Frequency	Kilometers	Miles
150.020	20.59	12.79
150.110a	9.06	5.63
150.120b	1.40	0.87
150.210b	4.72	2.93
150.430	7.29	4.53
150.740a	0.71	0.44
150.790b	4.14	2.57
150.810b	41.56	25.83
151.060b	55.76	34.65
151.090	7.58	4.71
151.140	7.50	4.66
151.210b	56.40	35.05
151.230b	34.49	21.43
151.270a	2.16	1.34
151.390	11.90	7.39
151.480	3.47	2.16
151.775a	3.72	2.31

Table 6. Migration distances for radiocollared male mule deer in the southern Black Hills, South Dakota, 1998-2003.

	Migration Distance	
Collar Frequency	Kilometers	Miles
150.160a	15.22	9.46
150.240a	14.22	8.84
150.420	2.28	1.42
150.970a	3.05	1.90
151.060a	2.25	1.40
151.100a	2.72	1.69
151.120	11.05	6.87
151.170b	46.57	28.94

Home Range

Adaptive Kernel Method (ADK)

White-tailed Deer

Summer 95% ADK home ranges for white-tailed deer females (*n*=38) averaged 204.94 ha (506.41 acres); average 50% ADK core use area was 30.07 ha (74.30 acres) (Table 7). Summer 95% ADK home ranges for white-tailed deer males (*n*=3) averaged 541.07 ha (1,336.98 acres); average 50% ADK core use area was 92.98 ha (229.75 acres) (Table 8). Winter 95% ADK home ranges for white-tailed deer females (*n*=36) averaged 347.00 ha (857.44 acres); average winter 50% ADK core use area was 54.51 ha (134.69 acres) (Table 9). Winter 95% ADK home ranges for white-tailed deer males (*n*=4) averaged 314.98 ha (778.32 acres); average winter 50% ADK core use area was 71.80 ha (177.42 acres) (Table 10). A significant interaction ($F_{1,77}$ = 5.232, P =0.025) occurred between sex and season for home range size (95% ADK). In winter, 95% ADK home ranges did not differ ($F_{1,38}$ = 0.068, P = 0.796) between males and females. However, in summer, 95% ADK home ranges were larger ($F_{1,39}$ = 11.485, P = 0.002) for males than females. Similarly, a significant interaction ($F_{1,77}$ = 4.763, P = 0.032) occurred between sex and season for 50% core areas. In winter, no difference ($F_{1,38}$ = 1.58, P = 0.216) occurred in 50% core areas for male and female white-tailed deer. However, in summer male core use area was greater ($F_{1,39}$ = 15.969, P < 0.001) than for females.

Table 7. Summer home range size and core use area size for radiocollared female white-tailed deer in the southern Black Hills, South Dakota, 1998-2003. (Number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency	Summer Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
150.100a (55)	238.70	589.83	35.35	87.35
150.160b (21)	238.70	589.83	31.55	77.96
150.230b (39)	882.40	2,180.41	144.90	358.05
150.240b (26)	41.96	103.68	10.63	26.27
150.300a (16)	126.80	313.32	21.94	54.21
150.300b (37)	528.70	1,306.42	64.89	160.34
150.310a (27)	187.80	464.05	29.80	73.64
150.310b (84)	294.30	727.22	39.33	97.18
150.340 (54)	116.20	287.13	15.51	38.33
150.610 (62)	148.60	367.19	30.54	75.46
150.650b (40)	69.66	172.13	10.22	25.25
150.670 (120)	256.90	634.80	20.60	50.90
150.740b (21)	100.80	249.08	28.75	71.04
150.820a (17)	88.95	219.80	23.56	58.22
150.820b (31)	74.71	184.61	16.96	41.91
150.850 (123)	166.80	412.16	25.95	64.12
150.870b (40)	117.90	291.33	19.85	49.05
150.880 (82)	262.00	647.40	59.44	146.88
150.890b (52)	78.44	193.83	9.04	22.34
150.900 (70)	305.00	753.66	44.87	110.87
150.940a (54)	139.50	344.70	36.99	91.40
151.070 (48)	94.27	232.94	19.03	47.02
151.080a (39)	78.69	194.44	7.08	17.49
151.080b (29)	32.96	81.44	3.83	9.46
151.110a (36)	197.00	486.79	16.68	41.22
151.130a (17)	231.80	572.78	22.03	54.44
151.130b (42)	118.80	293.55	18.46	45.61
151.160b (47)	216.50	534.97	33.80	83.52
151.180 (36)	198.40	490.25	24.06	59.45
151.190 (71)	186.20	460.10	35.10	86.73
151.220a (40)	36.18	89.40	6.37	15.74
151.290a (58)	370.30	915.01	39.90	98.59
151.310 (111)	480.10	1,186.33	43.40	107.24
151.330a (16)	81.34	200.99	9.69	23.94
151.420b (50)	539.20	1,332.36	68.40	169.02
151.440 (68)	194.30	480.12	11.73	28.98
151.725a (44)	126.90	313.57	36.28	89.65
151.775b (38)	199.80	493.71	26.15	64.62

Table 8. Summer home range size and core use area size for radiocollared male white-tailed deer in the southern Black Hills, South Dakota, 1998-2003. (Number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency	Summer Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
150.250 (84)	605.80	1,496.93	84.14	207.91
150.630 (55)	300.70	743.03	51.09	126.24
151.430 (48)	716.70	1,770.97	143.70	355.08

Table 9. Winter home range size and core use area size for radiocollared female white-tailed deer in the southern Black Hills, South Dakota, 1998-2003. (number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency	Winter Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
150.100a (30)	273.90	676.81	44.86	110.85
150.160b (18)	424.60	1,049.19	36.25	89.57
150.240b (22)	730.80	1,805.81	51.17	126.44
150.300b (17)	237.60	587.11	35.34	87.33
150.310b (61)	421.00	1,040.29	61.25	151.35
150.340 (84)	468.30	1,157.17	80.13	198.00
150.610 (43)	367.00	906.86	70.99	175.42
150.650b (34)	261.60	646.41	66.91	165.33
150.670 (74)	183.60	453.68	38.74	95.73
150.740b (55)	197.00	486.79	49.33	121.89
150.820a (26)	533.90	1,319.27	76.96	190.17
150.820b (20)	138.90	343.22	36.21	89.47
150.850 (23)	336.30	831.00	69.13	170.82
150.870a (29)	200.00	494.20	31.28	77.29
150.870b (15)	90.18	222.83	17.22	42.55
150.880 (29)	246.40	608.85	53.72	132.74
150.890b (48)	193.60	478.39	16.60	41.02
150.900 (55)	424.20	1,048.20	48.45	119.72
150.940a (20)	277.80	686.44	67.55	166.92
151.070 (138)	426.40	1,053.63	68.41	169.04

Table 9 con't.

Radio Collar Frequency	Winter Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
151.080a (25)	145.00	358.30	25.91	64.02
151.080b (15)	190.00	469.49	15.16	37.46
151.110b (17)	112.40	277.74	40.81	100.84
151.130a (30)	260.00	642.46	41.54	102.65
151.160b (61)	779.40	1,925.90	132.00	326.17
151.180 (40)	228.70	565.12	60.11	148.53
151.190 (80)	378.20	934.53	79.77	197.11
151.220a (26)	457.70	1,130.98	47.70	117.87
151.220b (19)	275.40	680.51	55.90	138.13
151.290a (22)	194.10	479.62	25.78	63.70
151.310 (46)	244.80	604.90	59.23	146.36
151.420b (58)	354.40	875.72	54.45	134.55
151.440 (84)	1,384.00	3,419.86	105.70	261.18
151.500b (36)	359.80	889.07	96.23	237.78
151.500c (17)	281.00	694.35	60.88	150.43
151.775b (46)	413.90	1,022.75	40.53	100.15

Table 10. Winter home range size and core use area size for radiocollared male white-tailed deer in the southern Black Hills, South Dakota, 1998-2003. (number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency	Winter Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
150.210a (15)	112.40	277.74	20.86	51.55
150.250 (25)	445.50	1,100.83	77.49	191.48
150.630 (50)	537.20	1,327.42	81.64	201.73
151.430 (23)	164.80	407.22	107.20	264.89

Home Range

Adaptive Kernel Method (ADK)

Mule Deer

Summer 95% ADK home ranges for mule deer females (n=15) averaged 354.04 ha (874.83 acres); average 50% ADK core use area was 55.46 ha (137.04 acres) (Table 11). Summer 95% ADK home ranges for mule deer males (n=8) averaged 622.69 ha (1,538.67 acres); average 50% ADK core use area was 124.63 ha (307.96 acres) (Table 12).

Winter 95% ADK home ranges for mule deer females (n=12) averaged 511.26 ha (1,263.32 acres); average winter 50% ADK core use area was 102.24 ha (252.64 acres) (Table 13). Winter 95% ADK home ranges for mule deer males (n=5) averaged 632.96 ha (1,564.04 acres); average winter 50% ADK core use area was 73.08 ha (180.58 acres) (Table 14). Seasonal 95% ADK home ranges did not differ ($F_{1,36}$ = 2.539, P = 0.120) between male and female mule deer. However, a significant interaction ($F_{1,36}$ = 4.797, P = 0.035) did occur between sex and season for the 50% ADK home range size. Although 50% ADK winter home ranges did not differ ($F_{1,15}$ = 0.477, P = 0.500) between males and females; summer 50% ADK home ranges were larger ($F_{1,21}$ = 8.986, P = 0.007) for males than females.

Table 11. Summer home range size and core use area size for radiocollared female mule deer in the southern Black Hills, South Dakota, 1998-2003. (Number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency	Summer Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
150.020 (28)	260.30	643.20	38.60	95.38
150.110a (30)	357.00	882.15	76.47	188.96
150.120b (39)	806.70	1,993.36	146.70	362.50
150.430 (82)	324.60	802.09	64.80	160.12
150.790b (62)	282.70	698.55	75.77	187.23
150.810b (44)	173.60	428.97	24.84	61.38
151.060b (18)	58.06	143.47	12.00	29.64
151.090 (46)	365.40	902.90	49.39	122.04
151.140 (55)	102.10	252.29	25.65	63.38
151.210b (17)	90.80	224.37	16.19	40.01
151.230b (25)	582.80	1,440.10	49.63	122.64
151.270a (23)	679.80	1,679.79	44.20	109.22
151.390 (58)	484.00	1,195.96	85.32	210.83
151.480 (121)	524.90	1,297.03	88.13	217.77
151.775a (50)	217.80	538.18	33.95	83.89

Table 12. Summer home range size and core use area size for radiocollared male mule deer in the southern Black Hills, South Dakota, 1998-2003. (Number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency	Summer Home Range Size		Core Use Area Size	
	hectares	acres	hectares	acres
150.160a (22)	564.90	1,395.87	131.60	325.18
150.240a (19)	1,259.00	3,110.99	231.00	570.80
150.420 (36)	657.60	1,624.93	92.56	228.72
150.970a (32)	582.50	1,439.36	147.40	364.23
151.060a (16)	225.90	558.20	23.67	58.49
151.100a (35)	748.80	1,850.28	187.70	463.81
151.120 (28)	247.50	611.57	15.28	37.76
151.170b (22)	695.30	1,718.09	167.80	414.63

Table 13. Winter home range size and core use area size for radiocollared female mule deer in the southern Black Hills, South Dakota, 1998-2003. (number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency		Winter Home Range Size		Core Use Area Size	
		hectares	acres	hectares	acres
150.020	(84)	135.90	335.81	36.08	89.15
150.120b	(53)	897.50	2,217.72	228.10	563.64
150.430	(34)	463.10	1,144.32	92.37	228.25
150.790b	(18)	862.50	2,131.24	191.80	473.94
150.810b	(77)	234.40	579.20	51.63	127.58
151.060b	(23)	1,392.00	3,439.63	252.70	624.42
151.090	(47)	279.50	690.64	83.00	205.09
151.140	(19)	77.44	191.35	9.22	22.78
151.210b	(37)	749.00	1,850.78	84.37	208.48
151.230b	(28)	349.00	862.38	111.20	274.78
151.390	(46)	123.70	305.66	21.90	54.11
151.480	(38)	571.10	1,411.19	113.90	281.45

Table 14. Winter home range size and core use area size for radiocollared male mule deer in the southern Black Hills, South Dakota, 1998-2003. (number of locations used in Program Calhome, Adaptive Kernel Method).

Radio Collar Frequency		Winter Home Range Size		Core Use Area Size	
		hectares	acres	hectares	acres
150.420	(30)	924.70	2,284.93	187.60	463.56
150.970a	(48)	288.10	711.90	24.40	60.29
151.100a	(45)	300.70	743.03	17.29	42.72
151.120	(59)	1,528.00	3,775.69	98.80	244.13
151.170b	(15)	123.30	304.67	37.31	92.19

Home Range

Minimum Convex Polygon Method (MCP)

White-tailed deer

Minimum convex polygon home ranges are reported for purposes of comparison between other studies on white-tailed deer. Summer 95% MCP home ranges for females (*n*=38) averaged 128.43 ha (317.35 acres); average 50% MCP core use area was 22.09 ha (54.58 acres). Summer 95% MCP home ranges for males (*n*=3) averaged 335.70 ha (829.51 acres); average 50% MCP core use area was 78.34 ha (193.58 acres). Winter 95% MCP home ranges for females (*n*=37) averaged 205.19 ha (507.02 acres); average winter 50% MCP core use area was 36.89 ha (91.16 acres). Winter 95% MCP home ranges for males (*n*=4) averaged 199.89 ha (493.93 acres); average winter 50% MCP core use area was 40.83 ha (100.89 acres). A significant interaction ($F_{1,78}$ = 4.620, P =0.035) occurred between sex and season for home range size (95% MCP). In winter, 95% MCP home ranges did not differ ($F_{1,39}$ = 0.005, P = 0.944) between males and females. However, in summer, 95% MCP home ranges were larger ($F_{1,39}$ = 11.655, P = 0.002) for males than females. Similarly, a significant interaction ($F_{1,78}$ = 6.848, P = 0.011) occurred between sex and season for 50% MCP core areas. In winter, no difference occurred in 50% core use areas for male and female white-tailed deer ($F_{1,39}$ = 0.076, P = 0.784). However, summer male core use area was greater ($F_{1,39}$ = 16.888, P < 0.001) than for females.

Home Range

Minimum Convex Polygon Method (MCP)

Mule deer

Minimum convex polygon home ranges are reported for purposes of comparison between other studies on mule deer. Summer 95% MCP home ranges for females (*n*=15) averaged 231.30 ha (571.54 acres); average 50% MCP core use area was 46.41 ha (114.68 acres). Summer 95% MCP home ranges for males (*n*=8) averaged 341.69 ha (844.32 acres); average 50% MCP core use area was 58.05 ha (143.44 acres). Winter 95% MCP home ranges for females (*n*=13) averaged 285.63 ha (705.79 acres); average winter 50% MCP core use area was 56.72 ha (140.16 acres). Winter 95% MCP home ranges for males (*n*=5) averaged 348.86 ha (862.03 acres); average winter 50% MCP core use area was 54.45

ha (134.55 acres). Seasonal 95% MCP home ranges did not differ ($F_{1,37}$ = 1.720, P = 0.198) between male and female mule deer. Also, seasonal 50% MCP home ranges between male and female mule deer did not differ ($F_{1,37}$ = 0.094, P = 0.761).

Site Fidelity

Site fidelity for migrating white-tailed and mule deer to seasonal home ranges was high. All deer returned to the same winter or summer home ranges in all years except immediately following the Jasper Fire in fall 2000. The Jasper Fire burned approximately 33,791 hectares (83,500 acres) in August-September of 2000 and disrupted normal migrational patterns and fidelity of 9 deer; three mule deer and 6 white-tailed deer.

Three mule deer females had summer ranges severely burned by the Jasper Fire. All 3 mule deer females moved to new summer range areas after the fire. One deer moved to the east of the fire perimeter and 2 moved to the west of the fire perimeter. In summer 2001, 2 of these deer moved back to their original summer ranges. The third mule deer was killed by a mountain lion (*Puma concolor*) before it could have moved back to its traditional summer range.

Six white-tailed deer (2 males, 4 females) were affected by the Jasper Fire. A male white-tailed deer had both summer and winter ranges burned by the fire. This deer moved to a temporary summer range and then to a new winter range in fall 2000. In 2001, it returned to the original range it had previously occupied prior to the Jasper Fire. The second male white-tailed deer had its winter range burned, and selected a new area to spend the season. It died during migration to summer range.

Three white-tailed females had winter ranges affected by the fire, and one had its summer range affected. The female with the burned summer range, set up a temporary summer range, and then returned the following year to its traditional summer range. Of the 3 deer that were affected on winter ranges, all selected new winter ranges in fall and winter 2000. One of these deer died on the new winter range, and the other 2 survived and returned to their original winter range the following fall.

Site fidelity was computed for all remaining deer in the study. They returned to the same winter and summer ranges throughout the study. Some deer had portions of winter ranges burned in the Jasper Fire and still utilized these areas in fall/winter 2000.

Mortality Estimates

Survival rates and cause-specific mortality of radiocollared white-tailed and mule deer were calculated February 1998 to December 2003.

More female white-tailed deer died in spring (*n* = 25, 50%) than fall (*n* = 11, 22%), winter (*n* = 9, 18%), or summer (*n* = 5, 10%; Table 15). When seasons were combined, natural mortality (*n* = 36, 72%) was the primary cause of female deaths followed by accidental (*n* = 9, 18%) and harvest (*n* = 5, 10%)(Table 15). Natural causes accounted for most female mortality in spring (*n* = 21, 84%), winter (*n* = 7, 78%) and summer (*n* = 3, 60%) whereas hunting (*n* = 5, 45%) and natural causes (*n* = 5, 45%) were the main causes of female mortality in fall (Table 15). Specific causes of mortality included unknown (*n* = 18), coyote (Canis latrans)/canid (*n* = 18), vehicle kill (*n* = 7), illegal kill (*n* = 3), hunter kill (*n* = 2), and mountain lion (*n* = 2).

More male white-tailed deer died in fall (*n* = 6, 50%) than spring (*n* = 4, 33%), winter (*n* = 1, 8%), or summer (*n* = 1, 8%; Table 15). When seasons were combined, harvest (*n* = 7, 58%) was the primary cause of male deaths followed by natural (*n* = 5, 42%) causes (Table 15). Hunting accounted for all male mortality in fall (*n* = 6, 100%), whereas natural causes were the main factor in winter (*n* = 1, 100%), summer (*n* = 1, 100%), and spring (*n* = 3, 75%; Table 15). Specific causes of mortality included hunter kill (*n* = 6), coyote/canid (*n* = 2), unknown (*n* = 2), illegal kill (*n* = 1), and mountain lion (*n* = 1).

More female mule deer died in spring (*n* = 8, 50%) than winter (*n* = 6, 38%), summer (*n* = 1, 6%), or fall (*n* = 1, 6%; Table 16). When seasons were combined, natural mortality (*n* = 15, 94%) was the primary cause of female deaths followed by harvest (*n* = 1, 6%)(Table 16). Natural causes accounted for most female mule deer mortality in spring (*n* = 7, 88%), winter (*n* = 6, 100%), summer (*n* = 1, 100%), and fall (*n* = 1, 100%; Table 16). Specific causes of mortality included mountain lion (*n* = 9), unknown (*n* = 4), coyote/canid (*n* = 2), and illegal kill (*n* = 1).

All male mule deer died from hunting in fall (*n* = 9, 100%; Table 16). When seasons were combined, harvest (*n* = 9, 100%) was the only cause of male deaths (Table 16).

Table 15. Cause-specific, seasonal mortality for white-tailed deer in the southern Black Hills, South Dakota, 1998-2003.

Cause of Mortality	Winter	Spring	Summer	Fall	Total
Harvest	0	0(1)[a]	0	5(6)	5(7)
Natural	7(1)	21(3)	3(1)	5	36(5)
Accidental	2	4	2	1	9
Total	9(1)	25(4)	5(1)	11(6)	50(12)

[a] female(male)

Table 16. Cause-specific, seasonal mortality for mule deer in the southern Black Hills, South Dakota, 1998-2003.

Cause of Mortality	Winter	Spring	Summer	Fall	Total
Harvest	0	1	0	0(9)[a]	1(9)
Natural	6	7	1	1	15
Accidental	0	0	0	0	0
Total	6	8	1	1(9)	16(9)

[a] female(male)

Annual female white-tailed deer mortality ranged from 13 to 46% (Table 17). Combining accidental mortality with natural mortality, approximately 32% of radiocollared females died from natural causes and 4% were harvested each year (Table 17). Annual male white-tailed deer mortality ranged from 0 to 67% (Table 17). Combining accidental mortality with natural mortality, approximately 20% of radiocollared males died from natural causes and 20% were harvested each year (Table 17).

Annual female mule deer mortality ranged from 0 to 38% (Table 18). Combining accidental mortality with natural mortality, approximately 30% of radiocollared females died from natural causes and 0% were harvested each year (Table 18). Annual male mule deer mortality ranged from 50 to 100% (Table 18). Approximately 60% of radiocollared males were harvested each year and 0% died from natural causes (Table 18).

Overall (1998-2003), survival rate of female white-tailed deer was 0.07; annual survival rates ranged from 0.54 to 0.87 and differed ($X_5^2 = 12.3$, $P = 0.031$; Table 17) among years; survival rates differed between 1999 and 2003 ($X_1^2 = 6.9$, $P = 0.008$) and 2001 and 2003 ($X_1^2 = 8.7$, $P = 0.003$). Overall (1998-2003), survival rate of male white-tailed deer was 0.09. Annual survival rates ranged from 0.33 to 1.0 and were different among years ($X_5^2 = 80.8$, $P < 0.001$); survival rates differed between 1998 and 1999 ($X_1^2 = 10.0$, $P = 0.002$), 1998 and 2001 ($X_1^2 = 10.7$, $P = 0.001$), 1998 and 2002 ($X_1^2 = 30.0$, $P < 0.001$), 1999 and 2000 ($X_1^2 = 10.0$, $P = 0.002$), 1999 and 2003 ($X_1^2 = 10.0$, $P = 0.002$), 2000 and 2001 ($X_1^2 = 10.7$, $P = 0.001$), 2000 and 2002 ($X_1^2 = 30.0$, $P < 0.001$), 2001 and 2003 ($X_1^2 = 10.7$, $P = 0.001$), and 2002 and 2003 ($X_1^2 = 30.0$, $P < 0.001$).

Overall (1998-2003), survival rate of female mule deer was 0.10; annual survival rates ranged from 0.61 to 1.00 and were different among years ($X_5^2 = 23.1$, $P < 0.001$; Table 18); survival rates differed between 1998 and 2001 ($X_1^2 = 8.1$, $P = 0.004$). Overall (1999-2001), survival rate of male mule deer was 0.0; annual survival rates ranged from 0.0 to 0.5 and were different among years ($X_3^2 = 22.3$, $P < 0.001$); survival rates differed between 1999 and 2001 ($X_1^2 =$ infinity, $P < 0.001$) and 2000 and 2001 ($X_1^2 = 6.3$, $P = 0.01$).

Table 17. Survival rates and harvest, natural, and total mortality for female and male white-tailed deer in the southern Black Hills, South Dakota, 1998-2003.

Sex	Year	At-Risk[a]	Harvest Mortality (%)	Natural Mortality (%)[b]	Total Mortality (%)	Survival Rate	Confidence Interval	Variance
Females	1998	12	0 (0)	4 (33)	4 (33)	0.6667	± 0.2385	0.0148
	1999	36	3 (8)	12 (33)	15 (42)	0.5833	± 0.1447	0.0055
	2000	27	2 (7)	6 (22)	8 (30)	0.6923	± 0.1683	0.0074
	2001	37	0 (0)	17 (46)	17 (46)	0.5405	± 0.1531	0.0061
	2002	20	0 (0)	4 (20)	4 (20)	0.8000	± 0.1753	0.0080
	2003	16	0 (0)	2 (13)	2 (13)	0.8750	± 0.1621	0.0068
	Annual Mean	25	1 (4)	8 (32)	9 (36)	0.6930		
Males	1998	2	0 (0)	0 (0)	0 (0)	1.000	± 0.0000	0.0000
	1999	6	2 (33)	1 (17)	3 (50)	0.5000	± 0.3099	0.0250
	2000	3	0 (0)	0 (0)	0 (0)	1.0000	± 0.0000	0.0000
	2001	11	1 (9)	4 (36)	5 (45)	0.5455	± 0.2725	0.0193
	2002	6	3 (50)	1 (17)	4 (67)	0.3333	± 0.2385	0.0148
	2003	2	0 (0)	0 (0)	0 (0)	1.0000	± 0.0000	0.0000
	Annual Mean	5	1 (20)	1 (20)	2 (40)	0.7298		

[a]Number of radiocollared deer at the beginning of the monitoring period.
[b]Includes natural (i.e., coyotes, dogs, mountain lions, malnutrition, sickness, and unknown causes) and accidental causes (i.e., drowning and vehicle kill).

Table 18. Survival rates and harvest, natural, and total mortality for female and male mule deer in the southern Black Hills, South Dakota, 1998-2003.

Sex	Year	At-Risk[a]	Harvest Mortality (%)	Natural Mortality (%)[b]	Total Mortality (%)	Survival Rate	Confidence Interval	Variance
Females	1998	2	0 (0)	0 (0)	0 (0)	1.0000	± 0.0000	0.0000
	1999	14	0 (0)	4 (29)	4 (29)	0.7143	± 0.2256	0.0133
	2000	17	0 (0)	4 (24)	4 (24)	0.7647	± 0.2099	0.0115
	2001	13	1 (8)	4 (31)	5 (38)	0.6154	± 0.2645	0.0182
	2002	8	0 (0)	1 (13)	1 (13)	0.8750	± 0.2475	0.0160
	2003	6	0 (0)	2 (33)	2 (33)	0.6667	± 0.3772	0.0370
	Annual Mean	10	0 (0)	3 (30)	3 (30)	0.7727		
Males	1998	N/A						
	1999	8	4 (50)	0 (0)	4 (50)	0.5000	± 0.2450	0.0156
	2000	5	3 (60)	0 (0)	3 (60)	0.2000	± 0.1568	0.0064
	2001	2	2 (100)	0 (0)	2 (100)	0.0000	± 0.0000	0.0000
	2002	N/A						
	2003	N/A						
	Annual Mean	5	3 (60)	0 (00)	3 (60)	0.2333		

[a]Number of radiocollared deer at the beginning of the monitoring period.
[b]Includes natural (i.e., coyotes, dogs, mountain lions, malnutrition, sickness, and unknown causes) and accidental causes (i.e., drowning and vehicle kill).

DISCUSSION

Prior to this study, little research had been conducted to determine habitat use, movements, and home ranges of white-tailed and mule deer in the southern Black Hills of South Dakota. Similar research was conducted on white-tailed deer in the northern Black Hills from 1990-1992 (Kennedy 1992, Griffin et al. 1994) and in the central Black Hills from 1993-1997 DePerno 1998, Griffin et al. 1999). Food habit studies (Schneeweis et al. 1972, Osborn 1994, Hippensteel 2000) on white-tailed deer in the northern and central Black Hills have been conducted and food habit studies have been conducted in the southern Black Hills on white-tailed and mule deer (Zimmerman 2004). In conjunction with this study, Dubreuil (2003) studied habitat selection of white-tailed and mule deer in the southern Black Hills. This study was conducted to answer questions concerning deer movements, home ranges, and habitat selection in the southern Black Hills.

During the study, deer were located during daylight hours due to safety and logistical considerations. However, it is believed that home ranges, movements, and use of habitats were minimally biased. In the southern Black Hills, there was no evidence of deer moving long distances from seasonal bed or loaf sites to feed as has been reported for white-tailed deer in Montana (Dusek et al. 1989) and on winter ranges in the northern Black Hills (Kennedy 1992, Griffin et al. 1994). Deer were frequently observed feeding in or adjacent to habitats used for resting. Given the need for deer to reduce activity to conserve energy in winter (Moen 1976), and that deer were frequently observed active during the day, it is possible that nocturnal locations may have resulted in identification of more loafing deer sites (resting and rumination) during winter. Nevertheless, a decrease in winter activity at sunset would be consistent with observations of penned (Ozoga and Verme 1970) and wild (Beier and McCullough 1990) white-tailed deer in Michigan.

Results on habitat use, home range, and movements reflect the unique ecosystem of the Black Hills. The Black Hills have a wide variety of interacting factors that can influence white-tailed and mule deer management. These factors include hunting, timber management, livestock grazing, mining, residential development, roadway construction, and use of the Black Hills as a recreation and vacationing area.

Migrations and Home Ranges

Timing of Migrations for White-tailed Deer

Peak timing of migration to summer ranges in the southern Black Hills occurred between mid and late-May in all years. There was no difference in timing of migration between male and female white-tailed deer. Migration was completed approximately 2-3 weeks prior to parturition. White-tailed deer migrated after spring "green-up" of vegetation had occurred at both lower and higher elevations in the southern Black Hills. In the southern Black Hills, deer may have stayed on winter ranges to utilize new vegetation to increase body condition before migrating to summer ranges. This also was reported for all of the Black Hills by Richardson and Petersen (1974). Deer in the southern Black Hills migrated during the same time period as deer in the central Black Hills (DePerno 1998, Griffin et al. 1999, DePerno et al. 2000, 2002, 2003). Central Black Hills deer migrated between 17-23 May in all years (DePerno 1998, Griffin et al. 1999). This later migration differed from white-tailed deer migrations in the northern Black Hills; northern Black Hills deer migrated from mid-April to mid-May (Griffin et al. 1994).

Timing of migration during the last 2 weeks of May in the southern Black Hills was later than observed by Mundinger (1982) in northwestern Montana. Hoskinson and Mech (1976) noted onset of spring migration each year coincided with loss of snow cover, a rise in temperature, and a decrease in cloud cover and that most deer were on summer ranges between mid-April and mid-May. In northeast Minnesota, Nelson and Mech (1981) observed deer initiating migration in late March or early April when temperatures increased and snow pack decreased. Similarly, Brinkman (2003), Swanson (2005) and Burris (2005) noted spring migrations in mid-April in relation to increasing temperature and decreasing snow depth. Van Deelen et al. (1998) documented median dates of migration of 4 April for deer in Michigan and Sitar (1996) detected migration dates of 15-30 March in Michigan. Stefanich (1995) reported the timing of migrations in the northern Black Hills of Wyoming occurred between late April and the second week of May. Spring migration timing is likely a function of weather conditions and will vary with geographic region and topography. Later spring migration of deer in the southern Black Hills may be a method of increasing body condition prior to parturition at higher elevations on summer ranges. DePerno (1998) and DePerno et al. (2003) stated that deer in the central Black Hills migrate just prior to parturition to give birth in areas that provide thermal cover, maximum forage, and concealment cover for fawns. The same strategy is likely occurring in the southern Black Hills.

Migration to winter range for white-tailed deer in the southern Black Hills was more variable than migration to summer ranges. Fall migration extended from September through late-December in most years. Most white-tailed deer were on winter range before the end of the November rifle hunting seasons in the southern Black Hills. Deer in the central Black Hills (Griffin et al. 1999) and in the northern Black Hills (Griffin et al. 1994) were reported to have the same variability in the timing of fall migrations. Migrations occurred from mid-August to late-December in the northern and central Black Hills.

Winter range habitat had no apparent effect on timing of migration to wintering areas. The first deer that migrated moved to habitats that visually appeared to be in the same condition as those on summer range. There were limited planted crops in the southern Black Hills as compared to the northern Black Hills. Therefore, early migration may be a learned behavior for white-tailed deer in the southern Black Hills.

Richardson and Petersen (1974) reported that 30.5 cm (12 inches) of loose snow or 15.2 cm (6 inches) of crusted snow was sufficient to initiate fall migrations. With migrations occurring in the Black Hills in August and September, it is believed that migrations currently occur earlier than historically reported.

Migration to winter range was slightly affected each year due to differences in weather. Presence of cold weather or snowfall resulted in earlier movement of deer to winter range. Nelson and Mech (1981) noted that deer migrated after the first freeze in Minnesota. In northern areas, cold temperature and snow depths exert great influences on seasonal deer movements (Rongstad and Tester 1969, Ozoga and Gysel 1972, Verme 1973, Brinkman 2003, Swanson 2005, Burris 2005). Teirson et al. (1985) stated that snow depth of 38 cm commenced deer movement but that no relationship was detected between ambient temperature and movements. Deep snow on summer ranges in the northern Black Hills usually resulted in migration to winter range (Griffin et al. 1994).

Historically in the southern Black Hills, deer moved to winter ranges in December and January. Weather conditions tend to be milder in the southern Black Hills compared to the central or northern Black Hills. Factors affecting migration of deer in the southern Black Hills are poorly understood and may result from learned behavior more than environmental factors such as habitat and weather conditions.

Timing of Migrations for Mule Deer

No information is available on movements of mule deer in the Black Hills of South Dakota. Richardson and Petersen (1974) noted that migration is semiannual and that when snow depths increase at higher elevations, deer move downward; in the spring, as snow depths decrease, deer move to higher elevations. As with white-tailed deer migration timing, it was believed that mule deer move to summer ranges as vegetation "green-up" occurs at higher elevations (Richardson and Petersen 1974).

Peak timing of migration to summer ranges for both sexes of mule deer in the southern Black Hills occurred from mid-May to late-May in all years. Migration was completed approximately 2 weeks prior to parturition. Reasons for timing of migration are not fully understood. Mule deer persisted on winter ranges after snow melt on both winter and summer range areas; thus, spring "green-up" may be why deer were still present on winter ranges into late May. Both white-tailed deer and mule deer in the southern Black Hills showed similar migration timing to summer ranges.

Timing of spring migrations in other mule deer studies in western states showed somewhat similar patterns to southern Black Hills mule deer. Carrel et al. (1999) noted that deer in Arizona start spring migration in late March with completion of migration by mid-May. Thomas and Irby (1990) reported that migrational timing varied among years, and generally occurred in March-May. Also, Loft et al. (1989) concluded that migration timing varied among years with snow conditions and timing ranged from early-April to the first part of July. Garrott et al. (1987) noted migrations from April to mid-June in northwest Colorado. In Montana, Wood et al. (1989) stated that spring migrations occurred in late-March or early April. Other studies have determined that migrations varied from March through May (Kucera 1992, Milner and Unsworth 1996, Nicholson 1995). Timing of spring migrations will vary somewhat among regions due to topographical features and variation in precipitation. Migrations for mule deer in the southern Black Hills were most likely a function of spring green-up and not to snow depth.

Fall migrational timing from summer to winter ranges for mule deer in the southern Black Hills was more variable that spring migration. Richardson and Petersen (1974) reported that 30.5 cm (12 inches) of loose snow or 15.2 cm (6 inches) of crusted snow was sufficient to initiate fall migration. Migrations of mule deer in the southern Black Hills varied from year to year and occurred from October to January. Most mule deer were on winter ranges by the end of November.

Other studies noted that fall migration timing varied and occurred from September to January. Wood et al. (1989) determined migration in the fall occurred from mid-October to late-December in Montana. Kucera (1992) noted fall migration in California occurred in September-October for both males and females and varied with the presence or absence of major fall storms. Also, Nicholson (1995) in California detected departure from summer range during the first week in October and that migration occurred until the third week in January. In northwest Colorado, Garrott et al. (1987) noted the same fall migration pattern for 3 years with migrations starting in early-October with most deer arriving on winter range by early November. Additionally, Garrott et al. (1987) stated that fall migration was not strongly correlated with weather. Thomas and Irby (1990) concluded that migrations occurred from October to November, and Carrel et al. (1999) found migrational timing to occur from late September to early October and ending by early November.

Fall migrations of mule deer in the southern Black hills were similar in timing to other areas in the western states. Variables such as weather conditions, elevational differences, habitat, and topography influence migration timing of mule deer. As with white-tailed deer, the southern Black Hills winter range habitat had no apparent effect on timing of migration to wintering areas for mule deer. The first deer that migrated moved to habitats that visually appeared to be in similar condition to that of summer range habitat.

Historically in the southern Black Hills, deer moved to winter ranges in December and January. With migrations beginning to occur in the Black Hills in August and September, it is believed that migration occurred earlier than historic times. Weather conditions tend to be milder in the southern Black Hills when compared to the central or northern Black Hills. Factors impacting changes in the migrations of mule deer in the southern Black Hills may result from learned behavior more than environmental factors such as habitat and weather conditions.

Duration of Migrations

Duration of migration from winter or summer ranges for white-tailed and mule deer in the southern Black Hills was relatively short. Individual deer movements usually took less than 2-3 days. Duration of migration for white-tailed deer was similar to that in the northern (Griffin et al. 1994) and central Black Hills (Griffin et al. 1999) even though migration distances differed among regions. Nelson and Mech (1981) determined that white-tailed deer that migrated 29 km or less took an average of 1.8 days while those traveling farther averaged 7 days. Teirson et al. (1985) concluded white-tailed deer moved up to 16 km in 24 hours. Wood et al. (1989) in Montana noted that average movements of 5.9 km (range 1-80 km) of mule deer took less that 8 days and one doe migrated overnight. Carrel et al. (1999) noted that individual deer in one population took 1-2 weeks to complete migrations with distances varying between 14.8 and 72.2 km (average 50.9 km). In the southern Black Hills, and other areas, duration of migration may be related to distance that individual deer migrate.

White-tailed deer and mule deer in the southern Black Hills are believed to move in a more or less straight-line direction between ranges with no major wanderings. Rongstad and Tester (1969) and Brinkman (2003) detected similar results for female white-tailed deer in Minnesota.

Migration Distances for White-tailed Deer

In the southern Black Hills, migration distances assume that deer traveled on a relatively straight line between ranges. Female migration distances averaged 23.30 km and males averaged 15.79 km. Female deer in the northern Black Hills (Griffin et al. 1994) averaged 15.66 km between centers of activities. Female and male white-tailed deer in the central Black Hills averaged 32.35 km and 26.06 km, respectively (Griffin et al. 1999). Migration distances between the different study areas in the Black Hills differed between females and males. Migration distances are a function of elevational changes in the different regions of the Black Hills. Southern Black Hills white-tailed deer do not have to migrate as far as central Black Hills white-tailed deer to reach desired elevations on summer ranges, but have to travel farther than northern Black Hills deer.

Migration distances from other studies conducted on white-tailed deer vary according to area. Lesage et al. (2000)

detected no difference between migration distance and sex in southeastern Quebec, but noted that migration distances varied according to winter areas used. Migration distances averaged 26.4 km and 9.7 km in 2 different study areas. Stefanich (1995) in the northern Black Hills of Wyoming detected average migrations of 18.5 km (range 9.2 to 30.9 km). Murphy et al. (1986) noted an average movement of 10.2 km for deer in central Wisconsin. Mean distance between center of activities in summer and winter for seven does in northeast Minnesota was 22.7 km with a range of 12.4 km to 37.8 km (Hoskinson and Mech 1976). Verme (1973) noted a mean distance of 13.8 km between tag sites and kill sites in Michigan (range 0.8 to 51.5 km). Sitar (1996) also in Michigan, concluded that male white-tailed deer moved farther, although not significantly, than females. Averages for males and females ranged from 11.67 to 13.67 km and 7.91 to 8.05 km, respectively. Nelson and Mech (1981) stated that migration distance of deer in Minnesota ranged from 15 to 40 km.

Female white-tailed deer in the southern Black Hills migrated farther than males. Females may have migrated to higher elevations than males to find more suitable fawning habitats. In the central Black Hills, DePerno (1998) and Deperno et al. (2000, 2002, 2003) postulated that females migrate from winter to summer range just prior to parturition to give birth in areas that provide thermal cover, maximum forage characteristics, and concealment cover for fawns, whereas males migrate to sites with high quality forage to maximize body condition. Male white-tailed deer do not have the stresses of parturition and lactation and may find suitable habitats at lower elevations (DePerno et al. 2000, 2002, 2003). Males can spend more time loafing on summer ranges due to decreased energy demands.

Migration Distances for Mule Deer

In the southern Black Hills, migration distances assume that deer traveled on a relatively straight line between ranges. Female migration distances averaged 16.02 km (range 0.71 to 56.4 km) and males averaged 12.17 km (range 2.25 to 46.57 km). Average distances did not differ between male and female mule deer. Also, other researchers have noted there was no difference between male and female mule deer migration distances (Carpenter et al. 1979, Thomas and Irby 1990, Carrel et al. 1999, Brown 1992,).

Reported migration distances in other studies are generally farther than migrations of mule deer in the southern

Black Hills. Nicholson (1995) found that average migration distances varied for California mule deer that resided at different elevational levels. Male and female mule deer that were below 1500 m elevation migrated an average of 12.6 km (range 8.6 to 19.8 km), and deer that were above 1500 m in elevation migrated an average of 8.1 km (range 4.4 to 11.3 km). Brown (1992) in southeastern Idaho recorded average migration distances of 19.5 and 19.9 km for male and female mule deer, respectively. In northwest Colorado, Garrott et al. (1987) noted average migration distances for female mule deer of 27 and 43 km for 2 different study areas. Thomas and Irby (1990) detected average distances of 46 km for males and 56 km for females. An average migration distance of 40 km (range 19 to 51 km) was recorded by Loft et al. (1989) in California. Carrel et al. (1999) studied mule deer in Utah and Arizona and noted average migration distances of 50.9 km (range 14.8 to 72.2 km) in one group of deer and average distance of 22.6 km (range 8.8 to 58.3 km) in another group of deer.

Migration distance of mule deer varied among different areas in the country. This variation is more than likely due to differences in topography, habitats, elevations, and distances between winter and summer ranges. Southern Black Hills mule deer did not migrate great distances between summer and winter ranges.

Home Range Characteristics

Burt (1943) defined home range as the area used by an individual during its normal activities such as food gathering, mating, and caring for young. Home range size, shape, and location for white-tailed and mule deer vary depending on many factors including seasons, geographic region, topography, and climate. Also, characteristics of home ranges depend on distances traveled by deer to satisfy daily and seasonal requirements. As with other migratory deer herds, most deer in the southern Black Hills have two distinct home ranges. Deer moved to higher elevation ranges in summer and to lower elevation ranges in winter.

When making comparisons with home ranges among different studies, researchers must be aware of different methods used to analyze size of home ranges. Home ranges were compared using the Adaptive Kernal Method (Kie et al. 1996). Home range sizes were estimated using the Minimum Convex Polygon (MCP) method (Kie et al. 1996) for use in comparisons with other studies. MCP home ranges, although reported in the results, are not discussed in this report.

Home Ranges of White-tailed Deer

White-tailed deer home range size varied between seasons and sexes in the southern Black Hills. On winter range, female white-tailed deer had average home ranges that were larger than average summer home ranges. In New Brunswick, Drolet (1976) concluded that summer home ranges of deer were smaller than winter ranges. In contrast, winter home ranges were smaller than summer home ranges in Minnesota (Nelson and Mech 1981), in the Adirondacks of New York (Teirson et al. 1985), and in Michigan (Van Deelen et al. 1998). Nelson and Mech (1981) noted that assembled deer (yarded deer) had little movement after February and thus, their winter ranges were substantially smaller than summer ranges.

Average winter home range size for female white-tailed deer in the southern Black Hills was 347 ha. Female winter home ranges in the southern Black Hills were generally larger than for other deer populations. Reports of winter home ranges for female white-tailed deer include estimates of 161 to 480 ha (Rongstad and Tester 1969), 132 ha (Teirson et al. 1985), 65 ha (Mundinger 1982), 44 ha (Nelson and Mech 1981), 47 ha (Dusek 1987), and 102 to 112 ha Lesage et al. (2000). Hoskinson and Mech (1976) noted that female deer in the central Superior National Forest of northeast Minnesota had average winter home ranges of 26 ha. In the northern Black Hills (Griffin et al. 1994), winter home ranges averaged 418.87 ha, and in the central Black Hills (Griffin et al. 1999), winter home ranges averaged 202.93 ha.

Winter home ranges in the southern Black Hills did not differ from winter ranges in the northern Black Hills but differed from winter ranges in the central Black Hills. Large home ranges in the northern Black Hills were due to movements between agricultural fields and resting/loafing areas on forested land (Kennedy 1992, Griffin et al. 1994). There were limited available agricultural lands in the southern Black Hills, so large winter ranges in this area may be due to greater travel distances needed to meet daily nutritional requirements. Also, this may be the reason that winter home ranges are larger than summer ranges for females in the southern Black Hills. Females were traveling to acquire resources to meet nutritional requirements that coincide with pregnancy in the winter. Poor winter range habitat in the southern Black Hills force deer to travel farther to meet daily requirements.

Male white-tailed deer in the southern Black Hills had average winter ranges that were smaller than average summer ranges. Average winter home range size for males in the southern Black Hills was 314.98 ha. Male winter home ranges were generally larger than for other deer populations. Male winter home ranges in the central Black Hills were 277.08 ha (Griffin et al. 1999) and did not differ from those in the southern Black Hills. Other reports of winter home range size for male white-tailed deer include estimates of 150 ha (Teirson et al. 1985), 32 ha (Dusek 1987), and 193 to 272 ha (Lesage et al. 2000). Smaller home ranges in winter versus summer for males may be a function of recovery from the stresses of rutting behavior. Males spend more time resting/loafing and reduce feeding in winter compared to females. In the central Black Hills, males were bedded at 64% of locations on winter range compared to 48% for females (DePerno 1998). During winter months, increased time spent bedding by males likely conserved energy (DePerno 1998, DePerno et al. 2002, 2003).

Average summer home range size for female white-tailed deer in the southern Black Hills was 204.94 ha. This was in general agreement with results for other deer populations; 48-410 ha (Hoskinson and Mech 1976), 221 ha (Teirson et al. 1985), and 190-210 ha (Stefanich 1995). Summer home ranges in the southern Black Hills were statistically larger than summer ranges in the northern Black Hills (131.09 ha, $P = 0.020$) (Griffin et al. 1994), and central Black Hills (130.91 ha, $P = 0.009$) (Griffin et al. 1999). Summer ranges in the southern Black Hills were larger than ranges reported in Montana (70 ha, Leach and Edge 1994) and Minnesota (83 ha, Nelson and Mech 1981).

During fawning and summer, deer used relatively small areas (Table 7, core use areas), possibly because habitat needs were well met during these periods (Murphy et al. 1986). DePerno (1998) and DePerno et al. (2003), noted that females in the central Black Hills used areas on summer range that contained greater amounts of horizontal cover. Horizontal cover measurements were less in the southern Black Hills than the northern or central Black Hills (Dubreuil 2003). Larger summer home ranges in the southern Black Hills may be due to the lack of adequate horizontal cover. Horizontal cover was important to fawns, which are most susceptible to predation (Loft et al. 1987). Benzon (1998) detected high horizontal cover at fawn bedsites. Fox and Krausman (1994) suggested that condition and type of cover used for fawning may influence survival of fawns and that activity in sparse vegetation would attract predators. Nelson and Mech (1981) noted that radio-tagged does reduced the size of home ranges after parturition apparently as a result of the need to minimize energy expenditures during lactation. Similar results were detected in eastern South Dakota (Sparrow and Springer 1970) and Michigan (Beier and McCullough 1990). Ozoga et al. (1982) noted that deer increased their movements, as fawns became more mobile and social intolerance toward other deer decreased.

Average summer home range size for southern Black Hills white-tailed males was 541.07 ha (Table 8). Male summer home ranges were generally larger than for other deer populations. However, contrary to females, summer home ranges for males in the southern Black Hills were larger than winter home ranges. Dusek (1987) and Teirson et al. (1985) noted larger summer than winter home ranges for males in Montana and New York, respectively. Male white-tailed deer in the central Black Hills (Griffin et al. 1999) had summer home range sizes of 598.61 ha. Reports of summer home range sizes for male white-tailed deer in other studies include 319 ha (Nelson and Mech 1981), 233 ha (Teirson et al. 1985), 255 ha (Dusek 1987), and 1144 to 1247 ha on 2 study sites in Quebec (Lesage et al. 2000). Males seemed to wander more in summer than in winter. Males do not experience the stress during the summer that they have recovering from the rut during the winter and males do not need to stay as close to a particular fawning area as do females.

Home Ranges of Mule Deer

Mule deer home range sizes varied between seasons and sex in the southern Black Hills, but were not statistically different. On winter range, male and female mule deer had average home ranges that were larger than average summer home ranges. Male and female home ranges were similar on both winter and summer ranges. This result also was recorded in other studies (Robinette 1966, Milner and Unsworth 1996, Severson and Carter 1978).

In the southern Black Hills, average winter home range size for females was 511.26 ha. Females may need to travel farther to meet nutritional requirements that coincide with pregnancy in the winter due to poor winter range habitat. Average winter home range sizes fall within those determined in other studies. Reports of winter home range size for female mule deer include estimates of 341 ha in Montana (Wood et al. 1989), 340-600 ha (Pac et al. 1988), 1357 ha (Nicholson 1995), and a range of 134-1138 ha from 3 different study sites in California (Kie et al. 2002).

In the southern Black Hills, average winter home range size for males was 632.96 ha. These home range sizes were larger than home ranges recorded in other studies. Wood et al. (1989) determined average winter home ranges of 364 ha (range 83 to 841 ha). Pac et al. (1988) recorded ranges from 340 to 360 ha over a 2 year period in Montana. Nicholson (1995) noted winter home ranges of 396 ha for mule deer males in California.

Average summer home range size for female mule deer in the southern Black Hills was smaller than winter home range size. Summer home ranges averaged 354.04 ha, which was similar to other mule deer populations; 288 ha (Wood et al. 1988), 891-1216 ha over 2 years (Milner 1996), 89-113 ha (Loft et al. 1993), 93-664 ha (Kie et al. 2002), 140-640 ha (Pac et al. 1988), and 554.2 ha (Nicholson 1995). As with white-tailed deer, mule deer will use relatively small areas during fawning and summer, (Table 11). This may be a function of better habitat conditions on summer compared to winter ranges, along with smaller core areas used during the first month after parturition. The reduction in the size of home ranges after parturition also may be explained by the need to minimize energy expenditures during lactation.

In the southern Black Hills, average summer home range size for mule deer males was smaller than winter home ranges. Summer home ranges for males averaged 622.69 ha. Average male summer home range size was comparable to other male mule deer populations; 1458 to 2635 ha over a 2 year study in Idaho (Milner 1996), 450 to 1830 ha (Pac et al. 1988), 393.3 ha (Nicholson 1995).

Site Fidelity for White-tailed Deer

Radiocollared white-tailed deer in the southern Black Hills exhibited high site fidelity between seasons and years. This result was consistent with conclusions of Beier and McCullough (1990), Sitar (1996), and Van Deelen et al. (1998), in Michigan, and with deer in other northern locations (Ozoga et al. 1982, Teirson et al. 1985). Additionally, deer in the northern Black Hills (Griffin et al. 1994) and central Black Hills (Griffin et al. 1999) exhibited high site fidelity. Stefanich (1995) and Leach and Edge (1994) detected high fidelity to summer ranges in Wyoming and Montana, respectively. Nelson and Mech (1981) noted that deer demonstrated high fidelity to specific areas and were traditional in their use of summer and winter ranges. Lesage et al. (2000) noted high fidelity of deer to seasonal home ranges used in previous years. Verme (1973) stated that Michigan deer possessed a strong homing instinct and returned to traditional yards each winter. However, Teirson et al. (1985) stated that fidelity to a specific winter range was less than for summer ranges. Variation in snow depth and snow characteristics may influence winter use. In Montana, Dusek (1987), noted high site fidelity despite differences in winter severity. In the southern Black Hills, individual radiocollared white-tailed deer used the same summer and winter area throughout the study. High site fidelity may be a learned behavior and may be an important factor in management of habitats in the southern Black Hills.

Site Fidelity for Mule Deer

As with white-tailed deer in the southern Black hills, radiocollared mule deer exhibited high site fidelity between seasons and years, which is consistent with other studies (Gruell and Papez (1963), Robinette (1966), Carpenter et al. (1979), Wood et al. (1989), Loft et al. (1993), Nicholson (1995) and Carrel et al. (1999). Pac et al. (1988) detected high fidelity in Colorado to specific winter ranges and to individual winter home ranges. In southeastern Idaho, Brown (1992) concluded that male and female mule deer used the same summer ranges during each year they were monitored; winter range fidelity also was high, but lower than summer range fidelity. In northwest Colorado, Garrott et al. (1987) noted that all adult deer demonstrated strong fidelity to seasonal movements, returning to the identical locales used on summer and winter ranges in previous years. Thomas and Irby (1990) noted that deer relocated for more than one year did not shift summer or winter ranges between years. In the southern Black Hills, individual radiocollared mule deer used the same summer and winter area throughout the study. High site fidelity among mule deer may be a learned behavior and may be an important factor in management of mule deer habitats in the southern Black Hills.

Mortality of White-tailed deer

In the southern Black Hills, mortality of female white-tailed deer resulted primarily from natural (72%), accidental (18%), and harvest (10%) causes (Table 15). In the central Black Hills, natural mortality causes were 71%, followed by harvest mortality (22.6%) and accidental mortality (6.5%) causes (DePerno et al. 2000). Natural mortality causes for white-tailed females observed in the southern Black Hills were similar to those in the central Black Hills (DePerno et al. 2000), but were greater than in other studies (12 to 52%, Nelson and Mech 1986, Dusek et al. 1989, Van Deelen et al. 1997, Whitlaw et al. 1998). Annual survival for female white-tailed deer (69%) in the southern Black Hills was higher than in the central Black Hills (57%), but was on the lower end of other studies for white-tailed deer females (65 to 80%, Gavin et al. 1984, Fuller 1990, Nixon et al. 1991, Whitlaw et al. 1998).

Mortality of male white-tailed deer in the southern Black Hills resulted primarily from harvest (58%), followed by natural (42%) causes (Table 15). In the central Black Hills, mortality of male white-tailed deer was similar to the southern Black Hills and resulted primarily from harvest (67%), followed by natural (33%) causes (DePerno 1998). In hunted populations, harvest mortality is usually the highest form of mortality among male white-tailed deer. McCullough (1979) noted that harvest mortality accounted for all mortality in adult males. Nelson and Mech (1986) concluded that 50% of adult male mortality was the result of hunting. Van Deelen et al. (1997) reported mortality rates from hunting in adult male white-tailed deer of 72%. During this study, hunting was the leading cause of mortality of white-tailed males in the southern Black Hills.

In northern latitudes, winter is typically the season when most natural deaths occur (Mautz 1978). Data from this study indicates that female white-tailed deer were most susceptible during spring with 50% of deer dying during this time. Following hunting mortality during the fall (50%), natural mortality in the spring was the second leading cause of mortality among male white-tailed deer (33%). In the central Black Hills of South Dakota, DePerno et al. (2000) concluded that the highest mortality (53%) for female white-tailed deer occurred in the spring. In the southern Black Hills, this higher spring mortality was most pronounced during 2001. The Jasper Fire burned 33,791 ha (83,500 acres) in the southern Black Hills, some of which encompassed white-tailed deer winter range. In spring 2001, 46% of radiocollared white-tailed females died from natural causes. This is believed to be a direct result of loss of habitat on winter range during the Jasper Fire. In subsequent years, after vegetation in the Jasper Fire area recovered, natural mortality was much lower (20% in 2002, 13% in 2003). Also, male white-tailed deer had a higher natural mortality (36%) after the Jasper Fire, indicating an increase in natural mortality due to the effects of the Jasper Fire. Natural mortality of male white-tailed deer decreased after natural re-vegetation in the Jasper Fire area (17% in 2002 and 0% in 2003).

Mortality of mule deer

This study is the first to document causes of mortality among mule deer in the Black Hills of South Dakota. In the southern Black Hills, mortality of female mule deer resulted almost exclusively from natural (94%) causes (Table 16). Only one mule deer female died from hunting (6%). The annual survival rate of 77% for female mule deer in the Black Hills was comparable to other studies on mule deer (67-88%, White and Bartmann 1983, Hamlin and Mackie 1989, Unsworth et al. 1999, Grassel 2000). Carrel et al. (1999) concluded that annual female survivorship for mule deer along the Utah and Arizona border was 75%. Wood et al. (1989) also noted survival rates of 75% for adult females. McCorquodale (1999) documented an annual survival rate of 80% for female black-tailed deer in Washington.

Mortality of female mule deer in the Black Hills occurred mainly in the winter and spring with the main cause of mortality resulting from mountain lion predation. Of 21 radiocollared females, 43% died from mountain lion predation. Carrel et al. (1999) documented that 19.4% of mule deer deaths were caused by mountain lions in a study along the Utah and Arizona border. During 1999-2001, annual mortality due to mountain lions predation ranged from 18-23% on female mule deer in the southern Black Hills of South Dakota. In the southern Black Hills, mortality due to mountain lions was higher than reported in other studies. Anderson et al. (1992) estimated that cougars annually killed 8-12% of the mule deer population on the Uncompahgre Plateau, Colorado. Similarly, Shaw (1980) estimated that cougars annually removed 15-20% of the mule deer population on the Kaibab Plateau in Arizona. Although mortality rates on mule deer had not been studied in the Black Hills in the past, the high mortality associated with mountain lions in the Black Hills of South Dakota was associated with an increasing mountain lion population during this study. Fecske (2003) estimated the total number of mountain lions in the Black Hills to be 127-149 lions with an estimated carrying capacity of 152 mountain lions. More research may be needed to determine if there is a negative impact on the mule deer population due to mountain lion predation.

The annual survival rate of 23% for male mule deer in the southern Black Hills was much lower than other studies (50%-61%, Wood et al. 1989, Carrel et al. 1999, McCorquodale 1999). All male mule deer in the southern Black Hills died as a result of harvest mortality (100%) (Table 16). Harvest mortality has accounted for the majority of mortality in other studies. Wood et al. (1989) noted that hunting was the only cause of death identified among marked adult male mule deer. In Montana, Pac et al. (1988) documented that hunting was the major known cause of mortality among male mule deer with 6 of 7 known deaths from hunting. Carpenter et al. (1979) noted that harvest accounted for 69.3% of the adult male mortality in Colorado. Harvest mortality comprised 64% of male mule deer mortality in the western Great Basin of California (Bleich and Taylor 1998). Carrel et al. (1999) reported a lower hunting mortality on mule deer bucks of 37.5%, and Bender et al. (2004) reported that harvest mortality was the primary mortality for male black-tailed deer in Washington, accounting for 47-67% of all mortality. Harvest mortality was the only recorded form of mortality on mule deer males in the southern Black Hills.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

In the late 1980's, declining deer populations in the Black Hills of South Dakota prompted the South Dakota Department of Game, Fish and Parks to evaluate possible causes of long-term declines in deer populations. To address the problem of declining deer numbers, the Black Hills Research Committee Interagency Study Team was created. Team members include South Dakota Department of Game, Fish and Parks, South Dakota State University, Wyoming Game Commission, Wyoming Cooperative Fish and Wildlife Research Unit, Rocky Mountain Forest and Range Experiment Station, Black Hills National Forest, National Park Service, and Bureau of Land Management. Study team function has been to coordinate research, money, and land management efforts with the purpose of arresting Black Hills deer population decline. This study is the final stage of a three part study that encompassed the northern, central, and southern Black Hills. Objectives of research were to determine habitat use, migrations, movements, home ranges, nutrition, and condition of deer in the Black Hills.

Other studies in the Black Hills on movements, migrations, and home ranges have concentrated on white-tailed deer (Griffin et al. 1994, Griffin et al. 1999). The southern Black Hills contains habitat that is suited to mule deer and thus, this species was added to the research in that region of the Black

Hills. As with other research in the Black Hills, this study revealed that white-tailed and mule deer in the southern Black Hills have small summer and winter home ranges. Many precautions arise from these findings that should be of concern relative to other resource use in the Black Hills. Female white-tailed and mule deer may be sensitive to physical alterations of habitats within or near their home ranges. Management should be designed to minimize excess disturbance to areas where deer are known to frequent on summer and winter ranges. As was noted with the Jasper Fire, large-scale alterations of habitat may displace deer from traditional areas and decrease survival. Although deer returned to traditional areas, disturbances can impact deer habits. Timber harvest, cattle grazing, mining activities, and recreational use in the Black Hills all have the potential to affect deer behavior within these small home ranges. Timber practices conducted in specific deer home ranges need to address habitat characteristics selected by deer in these areas. Cattle grazing and cattle presence and their effect on deer and deer behavior in pine and aspen stands or in riparian areas are known. Cattle remove understory components in pine and aspen stands that are important to deer. Observations of deer and cattle interactions indicate that cattle have an effect on deer habits (Dusek et al. 1989, Loft et al. 1987 DePerno et al. 2000, 2002, 2003). Loft et al. (1993) noted that mule deer tended to avoid areas that were used by cattle. Extended cattle use of riparian areas in the vicinity of deer has been shown to displace deer and/or disrupt their habits in this study. Also, cattle can compete with deer for preferred forage (Jenks et al. 1996) resulting in reduced nutritional condition (Jenks and Leslie 2003). Other resource user activities will disturb deer that have established home ranges in disrupted areas.

High fidelity of both mule deer and white-tailed deer to specific home ranges should be of concern when considering management of the deer resource. This study demonstrated that winter and summer range site fidelity is high for both white-tailed and mule deer. Historic winter ranges may need to be protected and managed by the Black Hills National Forest to a higher level of intensity, because loss of habitat will negatively impact deer use of the remaining range. Therefore, habitat management activities need to be closely monitored. Tierson et al. (1985) stated that fidelity of deer to a seasonal range suggest that management of this habitat is more important than once thought. Habitat improvements in unused winter ranges may be cost ineffective if deer movement and home range fidelity cannot be altered. Habitat improvements may not show an increase in use by deer because of traditional home range and site fidelity. Encroachment and development of housing developments should be evaluated to determine the effect to white-tailed and mule deer on critical winter ranges in the Black Hills. As new development continues, more deer will be forced into already stressed winter ranges on the Black Hills National Forest.

The Jasper Fire burned 33,791 ha (83,500 acres) in August of 2000. This fire displaced some white-tailed and mule deer from traditional ranges. All surviving deer demonstrated high fidelity to these traditional ranges by returning within one year after the fire. Robinette (1966) noted this same occurrence in 1942 after a 6,070 ha (15,000 acre) wildfire in Utah and the destruction of food and cover caused deer to shift home ranges temporarily. Deer shifted their home ranges 3 to 5 km in response to the wildfire on winter ranges, but returned when vegetation recovered (Robinette 1966). Dubreiul (2003) and Zimmerman (2004) provide more information of the effects of the Jasper Fire in the southern Black Hills.

Cattle are grazed from 1 June to 31 October on deer winter and summer ranges in the Black Hills. Loft et al. (1987) noted that hiding cover in aspen vegetation types was not reduced through mid-season in ungrazed treatments, but was significantly reduced under moderate to heavy grazing. Increases in cover of aspen understories were detected after 2 years of cattle exclusions (Loft et al. 1987). In the Black Hills, cattle should be removed from important habitat areas at an earlier date to allow vegetation to recover so that wildlife will have forage during the winter months (DePerno et al. 2000, 2002). Also, regeneration of browse species is needed on wintering areas. High fidelity to specific sites should be considered while management schemes are being created. Management considerations that encompass deer use of aspen and pine habitats will have positive effects on all deer herds in the Black Hills.

Migrating deer herds in the Black Hills rely on season specific habitats to maximize reproduction and maintain nutritional condition. Mature, closed ponderosa pine stands must be available to provide cover needed for deer during winter months. In the southern Black Hills, both white-tailed deer and mule deer showed selection for pine stands with greater than 70% canopy cover (Dubreiul 2003). Timber stands must not be managed for monotypic "park like" stands as diversity and understory are vital to deer. Strategies to increase understory vegetation production in pine stands on winter ranges needs to be addressed. This must include using fire as a management tool to reduce fuel and litter in the understory and rejuvenate forb and shrub production. Pockets of ponderosa pine must be preserved that provide >70% overstory canopy cover with areas of increased browse production in adjacent ponderosa pine stands. Pre-commercial and commercial thinning of timber will improve deer habitats if understory forage production is improved while adequate overstory remains to intercept snowfall. Future land use policy should be carefully evaluated to ensure that habitat management practices do not continue to adversely affect white-tailed deer and mule deer winter habitat in the southern Black Hills. Habitat improvement recommendations for deer in the Black Hills can be located in DePerno (1998), DePerno et al. (2000, 2001, 2002, 2003) and Dubreuil (2003).

The importance of aspen habitats to white-tailed deer in the northern Black Hills seems to be greatest during the fawning period (May-June) and throughout summer (Kennedy 1992, Griffin et al. 1994). In the central Black Hills, white-tailed deer selected aspen habitats and areas with high shrubs (DePerno 1998). However, DePerno (1998) documented a lack of aspen habitats in central Black Hills (<5%). In the southern Black Hills aspen habitat is lacking and represents a small portion (<1%) of available habitat for deer (Dubreiul 2003). It is speculated that in the Black Hills, in excess of 60% of the aspen habitat has converted to conifers (pine and spruce) since European Settlement (Bartos 2001). The southern Black Hills has lost more aspen and shrubs than the northern and central areas of the Black Hills. This may account for the significantly larger summer home ranges of white-tailed deer in the southern Black Hills when compared to the central and northern Black Hills. The Jasper Fire burned 33,791 ha (83,500 acres) of forest in August/September of 2000 and rejuvenated old stands of aspen in areas of the southern Black Hills. A survey conducted in 2001 detected a total of 516 ha (1275.7 acres) of aspen within the Jasper Fire area (Cogan et al. 2002). Aspen stands averaged 0.49 ha (1.2 acres) each and accounted for 1.5% of the total area burned (Cogan et al. 2002). These stands must be protected to become viable clones. Aspen stands that do exist in the southern Black Hills lack the understory cover that aspen stands contain in the northern Black Hills. This understory cover is important to deer and provides relatively undisturbed fawning areas with much needed forage for lactation, and cover for essential protection of fawns. Female deer may be sensitive to physical alterations of habitats where hiding cover is an essential component in the community. Grazing by livestock or silvicultural practices that alter aspen habitats being used by deer will alter deer behavior and impact survival. Furthermore, management should be designed to minimize disturbance to deer during the spring fawning season. Delaying of cattle grazing in important fawning and fawn-rearing habitats may increase survival of white-tailed deer fawns.

Current USDA Forest Service strategies are aimed at timber production of ponderosa pine. Deer reliance on aspen emphasizes the need for management of existing aspen habitats in the Black Hills and to arrest ponderosa pine encroachment into these areas. Aspen management should include the creation of more acres of aspen stands within the Black Hills National Forest. Also, aspen management should include creation of aspen clearcuts that are free of pine "seed" trees. Aspen stands that are established and are being encroached upon by pine should be cleared of surrounding pine. Furthermore, cattle must be excluded from these areas. This would improve forage production in the areas directly adjacent to aspen stands. Deer use of aspen stands with dense, diverse understories has been documented (Kennedy 1992, DePerno 1998). Existing aspen stands in the southern Black Hills must be managed to create and maintain these dense, diverse understories.

The South Dakota Department of Game, Fish and Parks can use the results of this study to assist management of white-tailed and mule deer in the southern Black Hills. Population control is necessary to maintain or enhance recruitment in deer herds and ensure healthy habitat conditions on deer winter ranges. Proper male to female sex ratios must be maintained through harvest strategies to ensure a healthy deer herd. Methods to determine a more accurate carrying capacity must be developed. Recommendations pertaining to setting hunting seasons for deer in the Black Hills must continue to incorporate more than just deer numbers in hunting units. Early deer movements and timing of movements onto winter ranges concentrate deer and make them more vulnerable to hunting activities. Hunting season design and timing should be evaluated based on quality and quantity of the deer population. Deer movements can help to determine timing of hunting seasons and hunting unit boundaries in the Black Hills. This study indicated that hunting was the only cause of mortality of male mule deer in the southern Black Hills. Future studies may need to be conducted to determine the effects that hunting has on the population dynamics of mule deer in the southern Black Hills. Further research is needed on the impacts that mountain lion predation has on the mule deer populations in the Black Hills. This study was not designed to determine if forms of mortality were additive or compensatory. Future research may be needed to answer these questions.

Cooperation between USDA Forest Service personnel and the South Dakota Department of Game, Fish and Parks must be increased to determine methods of increasing forage production on National Forest Service lands. More research may be needed in the Black Hills to better understand how deer react to intense cattle grazing or logging. It is known that these activities impact deer behavior, but it is not known to what extent this occurs in the Black Hills. The USDA Forest Service has the responsibility of managing habitat needs to determine how forbs and shrubs can be increased in the Black Hills and on Forest Service Land. Winter ranges have been identified in the Black Hills (Kennedy 1992, DePerno 1998, Dubreuil 2003). Priority must be given to these areas to increase the availability and quality of forage and escape cover. The USDA Forest Service must utilize all research that has been conducted in the Black Hills to better manage the Black Hills for proper and improved habitat conditions for deer. All organizations must work together so that deer management can be accomplished within the best interest of white-tailed and mule deer in the Black Hills.

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APPENDICES

Appendix 1. Southern Black Hills, SD, deer trapping records for January-March 1998-2001.

Date	Trap	Tag	Tag	Radio

Trapped	Location*	Color	Number	Freq.	Age	Sex	SPP.
2/10/1998	TEEPEE #1	BLACK	1	151.290a	A	F	WT
2/11/1998	WINDMILL #3	RED	1	150.850	A	F	WT
2/13/1998	WINDMILL #3	RED	2	151.250a	A	M	WT
2/14/1998	WINDMILL #1	RED	3	150.670	A	F	WT
2/14/1998	WINDMILL #2	RED	4	151.400	A	F	WT
2/23/1998	PASS CREEK #1	RED	5	MORT	A	F	WT
2/23/1998	PASS CREEK #2	RED	6	151.160a	Y	M	WT
2/23/1998	WINDMILL #2	RED	7	151.110a	A	F	WT
2/23/1998	TEEPEE #2	BLACK	1R**		R**	R**	WT
2/23/1998	TEEPEE #3	BLACK	2		F	F	WT
2/24/1998	PASS CREEK #2			MORT	A	F	WT
2/24/1998	WINDMILL #3	RED	8	151.440	A	F	WT
2/24/1998	TEEPEE #1	BLACK	3		F	F	WT
2/25/1998	PASS CREEK #1			MORT	Y	F	WT
2/25/1998	WINDMILL #1	RED	9	151.220a	A	F	WT
2/25/1998	WINDMILL #2	RED	10		A	F	WT
2/25/1998	TEEPEE #1	BLACK	1R		R	R	WT
2/25/1998	TEEPEE #2	BLACK	4		F	M	WT
2/25/1998	TEEPEE #3	BLACK	5	151.310	A	F	WT
2/25/1998	SAWMILL #1	BLACK	6		F	F	WT
2/26/1998	PASS CREEK #2	RED	11		F	F	WT
2/26/1998	TEEPEE #2	BLACK	7	151.725a	A	F	WT
2/27/1998	PASS CREEK #1	RED	12	151.460	Y	F	WT
2/28/1998	PASS CREEK #1	RED	13	151.500a	A	F	WT
2/28/1998	TEEPEE #1	BLACK	1R		R	R	WT
3/1/1998	PASS CREEK #1	RED	11R		R	R	WT
3/17/1998	PASS CREEK #1	RED	14	150.790a	A	F	WT
3/17/1998	PASS CREEK #2	RED	15		F	F	WT
3/17/1998	HOP SPRINGS #2	YELLOW	1	151.480	A	F	MD
3/18/1998	HOP SPRINGS #1	YELLOW	2	151.775a	A	F	MD
3/19/1998	PASS CREEK #1	RED	16		F	F	WT
3/19/1998	HOP SPRINGS #2	YELLOW	3		F	M	MD
1/13/1999	HOP SPRINGS #4	YELLOW	3R	151.060a	Y	M	MD
1/13/1999	UPPER ROBY #1	GREEN	1		F	F	MD
1/13/1999	ROBY #1	GREEN	2	150.110a	A	F	MD
1/14/1999	TEEPEE #3	BLACK	2R	150.100a	Y	F	WT
1/14/1999	SAWMILL #2	BLACK	8	151.430	Y	M	WT
1/14/1999	HOP SPRINGS #1	YELLOW	4	151.270a	A	F	MD
1/14/1999	HOP SPRINGS #4	YELLOW	5	151.120	Y	M	MD
1/14/1999	ROBY #3	GREEN	3	151.410a	A	F	MD
1/15/1999	TEEPEE #2	BLACK	9		F	M	WT
1/15/1999	SAWMILL #1	BLACK	10		F	F	WT
1/15/1999	HOP SPRINGS #2	YELLOW	6		F	F	MD
1/15/1999	HOP SPRINGS #3	YELLOW	7	151.170a	A	M	MD
1/15/1999	HOP SPRINGS #4	YELLOW	8		F	M	WT
1/15/1999	UPPER ROBY #3			MORT	A	F	MD
1/15/1999	ROBY #1	GREEN	4	151.090	A	F	MD

Appendix 1 con't.

Date	Trap	Tag	Tag	Radio

Trapped	Location*	Color	Number	Freq.	Age	Sex	SPP.
1/15/1999	ROBY #2	GREEN	5	151.140	A	F	MD
1/16/1999	WINDMILL #2	RED	17		F	M	WT
1/16/1999	HOP SPRINGS #1	YELLOW	9		F	M	MD
1/16/1999	HOP SPRINGS #2	YELLOW	10	151.210a	A	F	MD
1/16/1999	HOP SPRINGS #3	YELLOW	11	151.100a	Y	M	MD
1/17/1999	WINDMILL #1	RED	18	151.070	A	F	WT
1/17/1999	WINDMILL #2	RED	19		F	M	WT
1/17/1999	TEEPEE #3	BLACK	11		F	M	WT
1/17/1999	SAWMILL #3	BLACK	12	MORT	A	F	WT
1/17/1999	UPPER ROBY #1	GREEN	6		F	F	MD
1/17/1999	UPPER ROBY #2	GREEN	7	151.390	A	F	MD
1/17/1999	UPPER ROBY #3	GREEN	8		F	M	MD
1/21/1999	WINDMILL #2	RED	20		F	F	WT
1/21/1999	TEEPEE #1	BLACK	13		F	M	WT
1/21/1999	SAWMILL #3	BLACK	8R		R	R	WT
1/22/1999	WINDMILL #1	RED	17R		R	R	WT
1/22/1999	SAWMILL #1	BLACK	14		F	F	WT
1/22/1999	SAWMILL #2	BLACK	15		F	F	WT
1/22/1999	UPPER ROBY #2	GREEN	9	151.350	A	F	MD
1/23/1999	WINDMILL #2	RED	21	151.190	A	F	WT
1/23/1999	SAWMILL #2	BLACK	16	151.130a	A	F	WT
1/23/1999	SAWMILL #3	BLACK	10R		R	R	WT
1/23/1999	HOP SPRINGS #3	YELLOW	5R		R	R	MD
1/23/1999	UPPER ROBY #3	GREEN	10	150.240a	A	M	MD
1/23/1999	ROBY #2	GREEN	11	150.430	Y	F	MD
1/24/1999	WINDMILL #2	RED	8R		R	R	WT
1/24/1999	TEEPEE #3	BLACK	17		F	M	WT
1/24/1999	HOP SPRINGS #1	YELLOW	12		A	F	MD
1/24/1999	HOP SPRINGS #3	YELLOW	3R		R	R	MD
1/24/1999	UPPER ROBY #1	GREEN	12	150.420	A	M	MD
1/24/1999	UPPER ROBY #3	GREEN	13	150.160a	A	M	MD
1/24/1999	ROBY #2	GREEN	14	151.370a	A	F	MD
1/25/1999	WINDMILL #1	RED	22		A	F	WT
1/25/1999	TEEPEE #1	BLACK	18	150.450	A	M	WT
1/25/1999	TEEPEE #2	BLACK	19		F	F	WT
1/25/1999	TEEPEE #3	BLACK	20	150.250	A	M	WT
1/25/1999	SAWMILL #1	BLACK	21	150.300a	A	F	WT
1/25/1999	HOP SPRINGS #2	YELLOW	13		F	F	MD
1/25/1999	TEEPEE #2	BLACK	9R		R	R	WT
1/26/1999	TEEPEE #1	BLACK	22		F	M	WT
1/26/1999	TEEPEE #2	BLACK	23	150.340	A	F	WT
1/26/1999	TEEPEE #3	BLACK	24	150.630	Y	M	WT
1/26/1999	FS 456 #1	BLACK	25	150.650a	A	F	WT
1/26/1999	FS 456 #2			MORT	F	M	WT
1/26/1999	HOP SPRINGS #1	YELLOW	14		A	F	MD
1/26/1999	UPPER ROBY #2	GREEN	15	150.740a	A	F	MD
1/26/1999	UPPER ROBY #3	GREEN	13R		R	R	MD

Appendix 1 con't.

Date	Trap	Tag	Tag	Radio

Trapped	Location*	Color	Number	Freq.	Age	Sex	SPP.
1/26/1999	ROBY #1	GREEN	16		A	F	MD
1/26/1999	ROBY #3	GREEN	5R		R	R	MD
1/27/1999	PASS CREEK #2	RED	23	150.810a	A	F	WT
1/27/1999	SAWMILL #2	BLACK	15R		R	R	WT
1/27/1999	FS 456 #2	BLACK	26	MORT	A	F	WT
1/27/1999	FS 456 #3	BLACK	27	150.570	A	F	WT
1/27/1999	HOP SPRINGS #1	YELLOW	6R		R	R	MD
1/27/1999	HOP SPRINGS #4	YELLOW	8R		R	R	WT
1/27/1999	UPPER ROBY #1	GREEN	17		F	F	MD
1/28/1999	FS 456 #1	BLACK	28		F	M	WT
1/29/1999	TEEPEE #1	BLACK	29	150.870a	A	F	WT
1/29/1999	TEEPEE #3	BLACK	18R		R	R	WT
1/30/1999	WINDMILL #1	RED	24		A	F	WT
1/30/1999	WINDMILL #2	RED	20R		R	R	WT
1/30/1999	WINDMILL #3	RED	25	150.900	A	F	WT
1/30/1999	WINDMILL #3	RED	16R		R	R	WT
1/30/1999	SAWMILL #1	BLACK	15R		R	R	WT
1/30/1999	FS 456 #1	BLACK	30		F	F	WT
2/3/1999	PASS CREEK #2	RED	26		F	M	WT
2/3/1999	FS 456 #1	BLACK	31		F	M	WT
2/3/1999	FS 456 #2	BLACK	32	150.890a	A	F	WT
2/3/1999	FS 456 #3	BLACK	33		F	M	WT
2/3/1999	SALLEE #3	YELLOW	15	150.230a	A	F	WT
2/4/1999	PASS CREEK #2	RED	27	150.470a	A	F	WT
2/4/1999	WINDMILL #1	RED	28		A	F	WT
2/4/1999	WINDMILL #3	RED	29	150.210a	Y	M	WT
2/4/1999	SAWMILL #1	BLACK	15R		R	R	WT
2/4/1999	FS 456 #1	BLACK	34		F	M	WT
2/4/1999	FS 456 #3	BLACK	35	151.230a	A	F	WT
2/4/1999	SALLEE #3	YELLOW	17	150.310a	A	F	WT
2/4/1999	PITTS #3	YELLOW	16	150.610	A	F	WT
2/5/1999	WINDMILL #2	RED	30	150.940a	A	F	WT
2/5/1999	SAWMILL #2	BLACK	19R		R	R	WT
2/5/1999	FS 456 #2	BLACK	?R		R	R	WT
2/5/1999	PITTS #1	YELLOW	20	151.330a	A	F	WT
2/5/1999	HOP SPRINGS #1	YELLOW	4R		R	R	MD
2/5/1999	HOP SPRINGS #2	YELLOW	6R		R	R	MD
2/5/1999	HOP SPRINGS #3	YELLOW	18	150.880	Y	F	WT
2/5/1999	HOP SPRINGS #4	YELLOW	19	150.970a	Y	M	MD
2/6/1999	HOP SPRINGS #2	YELLOW	13R		R	R	MD
2/6/1999	PITTS #2	YELLOW	21		F	F	WT
2/6/1999	FS 456 #2	BLACK	35R		R	R	WT
2/6/1999	FS 456 #3	BLACK	36	151.180	A	F	WT
2/6/1999	SAWMILL #2	BLACK	15R		R	R	WT
2/6/1999	WINDMILL #1	RED	31		F	M	WT
2/10/1999	SAWMILL #2	BLACK	15R		R	R	WT
2/10/1999	SAWMILL #3	BLACK	39	150.820a	A	F	WT

Appendix 1 con't.

Date	Trap	Tag	Tag	Radio

Trapped	Location*	Color	Number	Freq.	Age	Sex	SPP.
2/10/1999	FS 456 #1	BLACK	33	151.080a	A	F	WT
2/10/1999	FS 456 #2	BLACK	33R		R	R	WT
2/10/1999	FS 456 #3	BLACK	38		A	F	WT
2/11/1999	SAWMILL #3	BLACK	40	150.120a	A	F	WT
2/11/1999	FS 456 #2	BLACK	33R		R	R	WT
2/11/1999	FS 456 #3	BLACK	41	151.420a	A	F	WT
2/11/1999	SALLEE #2	YELLOW	22	150.090a	A	F	WT
2/11/1999	PITTS #2	YELLOW	16R		R	R	WT
2/11/1999	UPPER ROBY #2	GREEN	6R		R	R	MD
2/12/1999	FS 456 #1	BLACK	34R		R	R	WT
2/12/1999	UPPER ROBY #3	GREEN	18	150.020	A	F	MD
2/13/1999	SAWMILL #2	BLACK	15R		R	R	WT
2/13/1999	SAWMILL #3	BLACK	43	151.160b	A	F	WT
2/13/1999	SAWMILL #3	BLACK	42		F	M	WT
2/13/1999	PITTS #3	YELLOW	23	151.500b	Y	F	WT
1/17/2000	HOP SPRINGS #1	YELLOW	4R		R	R	MD
1/17/2000	HOP SPRINGS #2	YELLOW	24	151.210b	A	F	MD
1/17/2000	SALLEE #2	YELLOW	25	151.420b	A	F	WT
1/17/2000	FS 456 #1	BLACK	44	150.740b	A	F	WT
1/17/2000	FS 456 #3	BLACK	45		F	F	WT
1/17/2000	SAWMILL #3	BLACK	46		F	F	WT
1/18/2000	SALLEE #1	YELLOW	26		F	F	WT
1/18/2000	SALLEE #3	YELLOW	28		F	F	WT
1/18/2000	FS 456 #2	BLACK	47		F	M	WT
1/19/2000	SALLEE #2	YELLOW	26R		R	R	WT
1/20/2000	UPPER ROBY #3	GREEN	18R		R	R	MD
1/21/2000	UPPER ROBY #2	GREEN	19		F	M	MD
1/21/2000	FS 456 #2	BLACK	45R		R	R	WT
1/26/2000	UPPER ROBY #2	GREEN	20	151.170b	A	M	MD
1/26/2000	HOP SPRINGS #1	YELLOW	27	150.790b	A	F	MD
1/26/2000	HOP SPRINGS #2	YELLOW	29	150.090b	A	F	MD
1/26/2000	SALLEE #2	YELLOW	26R		R	R	WT
1/26/2000	FS 456 #2	BLACK	48		F	F	WT
1/26/2000	FS 456 #2	BLACK	49	150.310b	Y	F	WT
1/26/2000	FS 456 #3	BLACK	50		F	F	WT
1/26/2000	SAWMILL #1	BLACK	15R	150.470b	Y	F	WT
1/27/2000	UPPER ROBY #3	GREEN	21	150.810b	A	F	MD
1/27/2000	HOP SPRINGS #4	YELLOW	30		F	M	MD
1/27/2000	SALLEE #2	YELLOW	31	150.650b	A	F	WT
1/28/2000	SALLEE #2	YELLOW	32	150.890b	A	F	WT
1/28/2000	FS 456 #3	BLACK	51	151.370b	A	F	WT
1/29/2000	UPPER ROBY #1	GREEN	6R	150.210b	Y	F	MD
1/29/2000	HOP SPRINGS #2	YELLOW	33	151.230b	A	F	MD
1/29/2000	SALLEE #2	YELLOW	26R		R	R	WT
1/29/2000	FS 456 #1	BLACK	52		F	F	WT
1/30/2000	FS 456 #3	BLACK	45R		R	R	WT
1/30/2000	SAWMILL #3	BLACK	53		F	M	WT
1/31/2000	SALLEE #3	YELLOW	34		F	F	WT

Appendix 1 con't.

Date	Trap	Tag	Tag	Radio

Trapped	Location*	Color	Number	Freq.	Age	Sex	SPP.
1/31/2000	FS 456 #3	BLACK	45R		R	R	WT
2/2/2000	SALLEE #2	YELLOW	26R		R	R	WT
2/5/2000	HOP SPRINGS #2	YELLOW	35	150.120b	A	F	MD
1/29/2001	PASS CREEK #1	RED	32	151.410b	A	M	WT
1/29/2001	PASS CREEK #2	RED	33	151.130b	A	F	WT
1/29/2001	WINDMILL #1	RED	34	151.775b	A	F	WT
1/29/2001	WINDMILL #3	RED	35	151.370c	A	F	WT
1/29/2001	SALLEE #2	YELLOW	52	150.160b	A	F	WT
1/29/2001	HOP SPRINGS #1	YELLOW	54		F	F	WT
1/29/2001	HOP SPRINGS #2	YELLOW	57	151.060b	A	F	MD
1/29/2001	HOP SPRINGS #5			MORT	A	F	WT
1/30/2001	PASS CREEK #1	RED	36		F	M	WT
1/30/2001	TEEPEE #1	BLACK	13R	150.110b	A	M	WT
1/30/2001	TEEPEE #3	BLACK	54	150.240b	A	F	WT
1/30/2001	FS 456 #1			MORT	Y	F	WT
1/30/2001	FS 456 #2	BLACK	55	151.220b	A	F	WT
1/30/2001	SALLEE #1	YELLOW	59		F	M	WT
1/30/2001	SALLEE #2	YELLOW	60	150.300b	A	F	WT
1/30/2001	SALLEE #3	YELLOW	61	151.725b	A	F	WT
1/30/2001	HOP SPRINGS #2	YELLOW	62		F	F	MD
1/31/2001	PASS CREEK #2	RED	37	151.250b	A	F	WT
1/31/2001	FS 456 #2	BLACK	56	150.820b	A	F	WT
1/31/2001	SALLEE #1	YELLOW	63	151.080b	A	F	WT
1/31/2001	HOP SPRINGS #3	YELLOW	64	150.090c	A	F	WT
1/31/2001	HOP SPRINGS #5	YELLOW	65	150.870b	A	F	WT
2/1/2001	WINDMILL #1			MORT	Y	M	WT
2/1/2001	WINDMILL #2	RED	38	151.330b	A	M	WT
2/1/2001	FS 456 #1	BLACK	57	151.500c	A	F	WT
2/1/2001	FS 456 #2	BLACK	58	150.470c	A	F	WT
2/1/2001	SALLEE #1	YELLOW	26R	150.230b	Y	F	WT
2/1/2001	SALLEE #2	YELLOW	66		F	M	WT
2/1/2001	HOP SPRINGS #1	YELLOW	24R		R	R	MD
2/1/2001	HOP SPRINGS #3	YELLOW	18R		R	R	WT
2/2/2001	WINDMILL #1	RED	39		Y	M	WT
2/2/2001	WINDMILL #2	RED	40	150.210c	A	M	WT
2/2/2001	FS 456 #2	BLACK	59	151.110b	Y	F	WT
2/7/2001	PASS CREEK #1	RED	42		F	M	WT
2/7/2001	WINDMILL #2	RED	41	150.970b	A	M	WT
2/7/2001	FS 456 #1	BLACK	55R		R	R	WT
2/7/2001	FS 456 #2	BLACK	60	150.100b	A	M	WT
2/8/2001	PASS CREEK #2	RED	43	151.100b	Y	M	WT
2/8/2001	WINDMILL #1			MORT	F	M	WT
2/9/2001	WINDMILL #1	RED	44	150.940b	A	F	WT
2/9/2001	WINDMILL #2	RED	45	151.270b	A	M	WT
2/9/2001	FS 456 #2	BLACK	61	151.290b	A	F	WT

* Trap locations are listed in Appendix 3.
** R-signifies recapture

Appendix 2. Southern Black Hills, South Dakota, deer recovery records 1998-2002.

Date Trapped	Trap Location*	Tag Color	Tag Number	Radio Freq.	Age	Sex	SPP.	Date Recovered	Recovery Location East UTM	Recovery Location North UTM	Recovery Method**
2/10/1998	TEEPEE #1	BLACK	1	151.290a	A	F	WT	12/16/1999	586150	4863500	4
2/11/1998	WINDMILL #3	RED	1	150.850	A	F	WT	5/16/2001	601080	4838180	2
2/13/1998	WINDMILL #3	RED	2	151.250a	A	M	WT	11/21/1999	600100	4835500	1
2/14/1998	WINDMILL #1	RED	3	150.670	A	F	WT	4/3/2003	598057	4843354	5
2/14/1998	WINDMILL #2	RED	4	151.400	A	F	WT				
2/23/1998	PASS CREEK #1	RED	5	MORT	A	F	WT	2/23/1998	599880	4841880	3
2/23/1998	PASS CREEK #2	RED	6	151.160a	Y	M	WT	3/30/1998	599700	4842600	8
2/23/1998	WINDMILL #2	RED	7	151.110a	A	F	WT	12/26/1998	596340	4849380	4
2/24/1998	PASS CREEK #2			MORT	A	F	WT	2/24/1998	600070	4841250	3
2/24/1998	WINDMILL #3	RED	8	151.440	A	F	WT				
2/24/1998	TEEPEE #1	BLACK	3		F	F	WT				
2/25/1998	PASS CREEK #1			MORT	Y	F	WT	2/25/1998	599880	4841880	3
2/25/1998	WINDMILL #1	RED	9	151.220a	A	F	WT	10/18/1999	598300	4843320	6
2/25/1998	WINDMILL #2	RED	10		A	F	WT				
2/25/1998	TEEPEE #2	BLACK	4		F	M	WT				
2/25/1998	TEEPEE #3	BLACK	5	151.310	A	F	WT				
2/25/1998	SAWMILL #1	BLACK	6		F	F	WT				
2/26/1998	PASS CREEK #2	RED	11		F	F	WT				
2/26/1998	TEEPEE #2	BLACK	7	151.725a	A	F	WT	10/19/1998	590880	4858820	4
2/27/1998	PASS CREEK #1	RED	12	151.460	Y	F	WT	2/1/2000			8
2/28/1998	PASS CREEK #1	RED	13	151.500a	A	F	WT	3/9/1998	600880	4840550	8
3/17/1998	PASS CREEK #1	RED	14	150.790a	A	F	WT	5/24/1998	589760	4860400	2
3/17/1998	PASS CREEK #2	RED	15		F	F	WT				
3/17/1998	HOP SPRINGS #2	YELLOW	1	151.480	A	F	MD	1/1/2003	582863	4846207	2
3/18/1998	HOP SPRINGS #1	YELLOW	2	151.775a	A	F	MD	4/7/1999	580950	4845710	7
3/19/1998	PASS CREEK #1	RED	16		F	F	WT				
1/13/1999	HOP SPRINGS #4	YELLOW	3R	151.060a	Y	M	MD	11/25/1999	583250	4846600	1
1/13/1999	UPPER ROBY #1	GREEN	1		F	F	MD				
1/13/1999	ROBY #1	GREEN	2	150.110a	A	F	MD	5/8/2000	583540	4855100	7
1/14/1999	TEEPEE #3	BLACK	2R	150.100a	Y	F	WT	11/12/2000	598900	4848900	1
1/14/1999	SAWMILL #2	BLACK	8	151.430	Y	M	WT	5/25/2001	584430	4842380	6
1/14/1999	HOP SPRINGS #1	YELLOW	4	151.270a	A	F	MD	2/17/2000	582050	4844850	7

Appendix 2 con't.

Date Trapped	Trap Location*	Tag Color	Tag Number	Radio Freq.	Age	Sex	SPP.	Date Recovered	Recovery Location East UTM	Recovery Location North UTM	Recovery Method**
1/14/1999	HOP SPRINGS #4	YELLOW	5	151.120	Y	M	MD	11/7/2001	586800	4846200	1
1/14/1999	ROBY #3	GREEN	3	151.410a	A	F	MD	6/3/2000	577480	4851660	2
1/15/1999	TEEPEE #2	BLACK	9		F	M	WT				
1/15/1999	SAWMILL #1	BLACK	10		F	F	WT				
1/15/1999	HOP SPRINGS #2	YELLOW	6		F	F	MD				
1/15/1999	HOP SPRINGS #3	YELLOW	7	151.170a	A	M	MD	11/20/1999	582400	4847600	1
1/15/1999	HOP SPRINGS #4	YELLOW	8		F	M	WT				
1/15/1999	UPPER ROBY #3			MORT	A	F	MD	1/15/1999	578440	4848140	3
1/15/1999	ROBY #1	GREEN	4	151.090	A	F	MD	3/15/2001	577070	4849960	7
1/15/1999	ROBY #2	GREEN	5	151.140	A	F	MD	5/29/2001	579573	4856373	7
1/16/1999	WINDMILL #2	RED	17		F	M	WT				
1/16/1999	HOP SPRINGS #1	YELLOW	9		F	M	MD	11/1/2000	589920	4835870	1
1/16/1999	HOP SPRINGS #2	YELLOW	10	151.210a	A	F	MD	4/13/1999	581790	4846050	4
1/16/1999	HOP SPRINGS #3	YELLOW	11	151.100a	Y	M	MD	11/20/2000	582300	4848400	1
1/17/1999	WINDMILL #1	RED	18	151.070	A	F	WT	5/20/2002	581300	4869240	4
1/17/1999	WINDMILL #2	RED	19		F	M	WT	11/20/2003	596150	4851200	1
1/17/1999	TEEPEE #3	BLACK	11		F	M	WT	11/7/1999	591000	4843120	1
1/17/1999	SAWMILL #3	BLACK	12	MORT	A	F	WT	1/17/1999	588460	4842940	3
1/17/1999	UPPER ROBY #1	GREEN	6		F	F	MD				
1/17/1999	UPPER ROBY #2	GREEN	7	151.390	A	F	MD	4/27/2003	578342	4848588	2
1/17/1999	UPPER ROBY #3	GREEN	8		F	M	MD				
1/21/1999	WINDMILL #2	RED	20		F	F	WT				
1/21/1999	TEEPEE #1	BLACK	13		F	M	WT				
1/22/1999	SAWMILL #1	BLACK	14		F	F	WT				
1/22/1999	SAWMILL #2	BLACK	15		F	F	WT				
1/22/1999	UPPER ROBY #2	GREEN	9	151.350	A	F	MD				
1/23/1999	WINDMILL #2	RED	21	151.190	A	F	WT	2/1/2003	592156	4866262	2
1/23/1999	SAWMILL #2	BLACK	16	151.130a	A	F	WT	4/2/2000	588360	4841140	5
1/23/1999	UPPER ROBY #3	GREEN	10	150.240a	A	M	MD	10/5/1999	590620	4848130	6
1/23/1999	ROBY #2	GREEN	11	150.430	Y	F	MD				
1/24/1999	TEEPEE #3	BLACK	17		F	M	WT	11/5/2000	595300	4858300	1
1/24/1999	HOP SPRINGS #1	YELLOW	12		A	F	MD				

Appendix 2 con't.

Date Trapped	Trap Location*	Tag Color	Tag Number	Radio Freq.	Age	Sex	SPP.	Date Recovered	Recovery Location East UTM	Recovery Location North UTM	Recovery Method**
1/24/1999	UPPER ROBY #1	GREEN	12	150.420	A	M	MD	11/28/2001	581939	4848358	1
1/24/1999	UPPER ROBY #3	GREEN	13	150.160a	A	M	MD	11/27/1999	577850	4842800	1
1/24/1999	ROBY #2	GREEN	14	151.370a	A	F	MD	3/29/1999	577350	4850990	7
1/25/1999	WINDMILL #1	RED	22		A	F	WT	11/12/1999	602400	4850350	1
1/25/1999	TEEPEE #1	BLACK	18	150.450	A	M	WT	8/31/1999	592040	4850740	7
1/25/1999	TEEPEE #2	BLACK	19		F	F	WT	3/1/1999	589360	4841860	2
1/25/1999	TEEPEE #3	BLACK	20	150.250	A	M	WT	1/4/2002	604338	4858774	4
1/25/1999	SAWMILL #1	BLACK	21	150.300a	A	F	WT	10/17/1999	588840	4841730	6
1/25/1999	HOP SPRINGS #2	YELLOW	13		F	F	MD				
1/26/1999	TEEPEE #1	BLACK	22		F	M	WT				
1/26/1999	TEEPEE #2	BLACK	23	150.340	A	F	WT	2/18/2002	589767	4841584	7
1/26/1999	TEEPEE #3	BLACK	24	150.630	Y	M	WT				
1/26/1999	FS 456 #1	BLACK	25	150.650a	A	F	WT	8/12/1999	589750	4863638	4
1/26/1999	FS 456 #2			MORT	F	M	WT	1/26/1999	587040	4842670	3
1/26/1999	HOP SPRINGS #1	YELLOW	14		A	F	MD	4/26/2001	578240	4845910	2
1/26/1999	UPPER ROBY #2	GREEN	15	150.740a	A	F	MD	10/2/1999	578600	4848500	7
1/26/1999	ROBY #1	GREEN	16		A	F	MD				
1/27/1999	PASS CREEK #2	RED	23	150.810a	A	F	WT	5/27/1999	588360	4884670	2
1/27/1999	FS 456 #2	BLACK	26	MORT	A	F	WT	1/27/1999	587040	4842670	3
1/27/1999	FS 456 #3	BLACK	27	150.570	A	F	WT	2/27/1999	586370	4841550	5
1/27/1999	UPPER ROBY #1	GREEN	17		F	F	MD				
1/28/1999	FS 456 #1	BLACK	28		F	M	WT				
1/29/1999	TEEPEE #1	BLACK	29	150.870a	A	F	WT	5/7/2000	592160	4862500	4
1/30/1999	WINDMILL #1	RED	24		A	F	WT				
1/30/1999	WINDMILL #3	RED	25	150.900	A	F	WT	9/1/2002	598992	4845495	2
1/30/1999	FS 456 #1	BLACK	30		F	F	WT				
2/3/1999	PASS CREEK #2	RED	26		F	M	WT				
2/3/1999	FS 456 #1	BLACK	31		F	M	WT				
2/3/1999	FS 456 #2	BLACK	32	150.890a	A	F	WT	5/31/1999	585280	4863540	4
2/3/1999	FS 456 #3	BLACK	33		F	M	WT				
2/3/1999	SALLEE #3	YELLOW	15	150.230a	A	F	WT	5/15/1999	585020	4849300	2
2/4/1999	PASS CREEK #2	RED	27	150.470a	A	F	WT	3/8/1999	599080	4843100	5

Appendix 2 con't.

Date Trapped	Trap Location*	Tag Color	Tag Number	Radio Freq.	Age	Sex	SPP.	Date Recovered	Recovery Location East UTM	Recovery Location North UTM	Recovery Method**
2/4/1999	WINDMILL #1	RED	28		A	F	WT	3/9/2000	598460	4843400	5
2/4/1999	WINDMILL #3	RED	29	150.210a	Y	M	WT	11/10/1999	598300	4847950	1
2/4/1999	FS 456 #1	BLACK	34		F	M	WT	11/1/2000	578800	4864200	1
2/4/1999	FS 456 #3	BLACK	35	151.230a	A	F	WT	5/15/1999	583690	4848780	2
2/4/1999	SALLEE #3	YELLOW	17	150.310a	A	F	WT	11/30/1999	592620	4864600	6
2/4/1999	PITTS #3	YELLOW	16	150.610	A	F	WT	5/12/2001	579240	4870740	4
2/5/1999	WINDMILL #2	RED	30	150.940a	A	F	WT	11/10/2000	599300	4864300	1
2/5/1999	PITTS #1	YELLOW	20	151.330a	A	F	WT	10/18/1999	582160	4841050	5
2/5/1999	HOP SPRINGS #3	YELLOW	18	150.880	Y	F	WT				
2/5/1999	HOP SPRINGS #4	YELLOW	19	150.970a	Y	M	MD	11/26/2000	583300	4848900	1
2/6/1999	PITTS #2	YELLOW	21		F	F	WT	11/12/1999	581300	4841900	1
2/6/1999	FS 456 #3	BLACK	36	151.180	A	F	WT	10/16/2001	584579	4865407	2
2/6/1999	WINDMILL #1	RED	31		F	M	WT	11/2/2001	594700	4854300	1
2/10/1999	SAWMILL #3	BLACK	39	150.820a	A	F	WT	5/10/2000	584600	4854960	2
2/10/1999	FS 456 #1	BLACK	37	151.080a	A	F	WT	8/31/2000	594150	4858830	4
2/10/1999	FS 456 #3	BLACK	38		A	F	WT				
2/11/1999	SAWMILL #3	BLACK	40	150.120a	A	F	WT	9/13/1999	584750	4840660	4
2/11/1999	FS 456 #3	BLACK	41	151.420a	A	F	WT	5/25/1999	582520	4868250	2
2/11/1999	SALLEE #2	YELLOW	22	150.090a	A	F	WT	5/25/1999	585420	4862180	2
2/12/1999	UPPER ROBY #3	GREEN	18	150.020	A	F	MD	9/15/2001	619554	4853805	2
2/13/1999	SAWMILL #3	BLACK	43	151.160b	A	F	WT				
2/13/1999	SAWMILL #3	BLACK	42		F	M	WT				
2/13/1999	PITTS #3	YELLOW	23	151.500b	Y	F	WT	5/12/2000	585920	4862130	2
1/17/2000	HOP SPRINGS #2	YELLOW	24	151.210b	A	F	MD	4/14/2001	581390	4845630	6
1/17/2000	SALLEE #2	YELLOW	25	151.420b	A	F	WT				
1/17/2000	FS 456 #1	BLACK	44	150.740b	A	F	WT	2/17/2001	585900	4841220	4
1/17/2000	FS 456 #3	BLACK	45		F	F	WT				
1/17/2000	SAWMILL #3	BLACK	46		F	F	WT				
1/18/2000	SALLEE #1	YELLOW	26		F	F	WT				
1/18/2000	SALLEE #3	YELLOW	28		F	F	WT				
1/18/2000	FS 456 #2	BLACK	47		F	M	WT				
1/21/2000	UPPER ROBY #2	GREEN	19		F	M	MD				

Appendix 2 con't.

Date Trapped	Trap Location*	Tag Color	Tag Number	Radio Freq.	Age	Sex	SPP.	Date Recovered	Recovery Location East UTM	Recovery Location North UTM	Recovery Method**
1/26/2000	UPPER ROBY #2	GREEN	20	151.170b	A	M	MD	11/16/2000	578200	4850200	1
1/26/2000	HOP SPRINGS #1	YELLOW	27	150.790b	A	F	MD				
1/26/2000	HOP SPRINGS #2	YELLOW	29	150.090b	A	F	MD	3/29/2000	582220	4845770	7
1/26/2000	FS 456 #2	BLACK	48		F	F	WT				
1/26/2000	FS 456 #2	BLACK	49	150.310b	Y	F	WT				
1/26/2000	FS 456 #3	BLACK	50		F	F	WT				
1/26/2000	SAWMILL #1	BLACK	15R	150.470b	Y	F	WT	5/14/2000	588880	4847460	4
1/27/2000	UPPER ROBY #3	GREEN	21	150.810b	A	F	MD	2/22/2002	577380	4848000	8
1/27/2000	HOP SPRINGS #4	YELLOW	30		F	M	MD				
1/27/2000	SALLEE #2	YELLOW	31	150.650b	A	F	WT	3/8/2001	583160	4842500	4
1/28/2000	SALLEE #2	YELLOW	32	150.890b	A	F	WT	6/3/2001	583830	4860460	2
1/28/2000	FS 456 #3	BLACK	51	151.370b	A	F	WT	4/28/2000	583300	4861600	4
1/29/2000	UPPER ROBY #1	GREEN	6R	150.210b	Y	F	MD	6/3/2000	583180	4855060	8
1/29/2000	HOP SPRINGS #2	YELLOW	33	151.230b	A	F	MD	5/25/2001	585940	4844360	4
1/29/2000	FS 456 #1	BLACK	52		F	F	WT				
1/30/2000	SAWMILL #3	BLACK	53		F	M	WT				
1/31/2000	SALLEE #3	YELLOW	34		F	F	WT				
2/5/2000	HOP SPRINGS #2	YELLOW	35	150.120b	A	F	MD				
1/29/2001	PASS CREEK #1	RED	32	151.410b	A	M	WT	11/17/2002	599500	4841600	1
1/29/2001	PASS CREEK #2	RED	33	151.130b	A	F	WT				
1/29/2001	WINDMILL #1	RED	34	151.775b	A	F	WT				
1/29/2001	WINDMILL #3	RED	35	151.370c	A	F	WT	5/8/2001	599090	4845280	4
1/29/2001	SALLEE #2	YELLOW	52	150.160b	A	F	WT				
1/29/2001	HOP SPRINGS #1	YELLOW	54		F	F	WT				
1/29/2001	HOP SPRINGS #2	YELLOW	57	151.060b	A	F	MD	2/18/2002	581597	4846322	7
1/29/2001	HOP SPRINGS #5			MORT	A	F	WT	1/29/2001	583280	4847450	3
1/30/2001	PASS CREEK #1	RED	36		F	M	WT				
1/30/2001	TEEPEE #1	BLACK	13R	150.110b	A	M	WT	5/11/2001	585090	4857480	4
1/30/2001	TEEPEE #3	BLACK	54	150.240b	A	F	WT				
1/30/2001	FS 456 #1			MORT	Y	F	WT	1/30/2001	586560	4842160	3
1/30/2001	FS 456 #2	BLACK	55	151.220b	A	F	WT	4/28/2001	585810	4841490	5
1/30/2001	SALLEE #1	YELLOW	59		F	M	WT				

Appendix 2 con't.

Date Trapped	Trap Location*	Tag Color	Tag Number	Radio Freq.	Age	Sex	SPP.	Date Recovered	Recovery Location East UTM	Recovery Location North UTM	Recovery Method**
1/30/2001	SALLEE #2	YELLOW	60	150.300b	A	F	WT				
1/30/2001	SALLEE #3	YELLOW	61	151.725b	A	F	WT	5/18/2001	584838	4858849	4
1/30/2001	HOP SPRINGS #2	YELLOW	62		F	F	MD				
1/31/2001	PASS CREEK #2	RED	37	151.250b	A	F	WT	8/29/2001	595758	4861807	2
1/31/2001	FS 456 #2	BLACK	56	150.820b	A	F	WT				
1/31/2001	SALLEE #1	YELLOW	63	151.080b	A	F	WT				
1/31/2001	HOP SPRINGS #3	YELLOW	64	150.090c	A	F	WT	3/10/2001	583020	4845890	2
1/31/2001	HOP SPRINGS #5	YELLOW	65	150.870b	A	F	WT	12/28/2001	581542	4862242	2
2/1/2001	WINDMILL #1			MORT	Y	M	WT	2/1/2001	598120	4843940	3
2/1/2001	WINDMILL #2	RED	38	151.330b	A	M	WT	11/26/2001	594600	4859700	1
2/1/2001	FS 456 #1	BLACK	57	151.500c	A	F	WT	6/13/2001	591450	4864925	4
2/1/2001	FS 456 #2	BLACK	58	150.470c	A	F	WT	5/26/2001	585231	4866275	5
2/1/2001	SALLEE #1	YELLOW	26R	150.230b	Y	F	WT	6/1/2002	590915	4855555	2
2/1/2001	SALLEE #2	YELLOW	66		F	M	WT				
2/2/2001	WINDMILL #1	RED	39		Y	M	WT				
2/2/2001	WINDMILL #2	RED	40	150.210c	A	M	WT	11/21/2002	598520	4843412	1
2/2/2001	FS 456 #2	BLACK	59	151.110b	Y	F	WT	5/31/2001	582762	4838487	4
2/7/2001	PASS CREEK #1	RED	42		F	M	WT				
2/7/2001	WINDMILL #2	RED	41	150.970b	A	M	WT	6/14/2001	587010	4860320	2
2/7/2001	FS 456 #2	BLACK	60	150.100b	A	M	WT	4/8/2001	582020	4838900	2
2/8/2001	PASS CREEK #2	RED	43	151.100b	Y	M	WT				
2/8/2001	WINDMILL #1			MORT	F	M	WT	2/8/2001			3
2/9/2001	WINDMILL #1	RED	44	150.940b	A	F	WT	3/19/2001	597210	4838275	7
2/9/2001	WINDMILL #2	RED	45	151.270b	A	M	WT	11/3/2003	595150	4848150	1
2/9/2001	FS 456 #2	BLACK	61	151.290b	A	F	WT	4/25/2001	585330	4840410	2

*Exact Trap locations located on Appendix 3.
**Recovery Method: 1-Hunting, 2-Unknown, 3-Trap Mortality, 4-Coyote Predation, 5-Road Kill, 6-Illegal Kill, 7-Mountain Lion Predation, 8-Other.

Appendix 3. Southern Black Hills, South Dakota trapping locations January-March 1998-2001.

Trap Location	East UTM	North UTM	Township, Range, Section
Pass Creek #1	599880	4841880	T4S R3E Section 4
Pass Creek #2	600070	4841250	T4S R3E Section 9
Windmill #1	598120	4843940	T3S R3E Section 32
Windmill #2	598280	4844640	T3S R3E Section 32
Windmill #3	598260	4845500	T3S R3E Section 29
TeePee #1a	589620	4842350	T4S R2E Section 4
TeePee #1b	589530	4842580	T4S R2E Section 4
TeePee #2	589920	4842570	T4S R2E Section 4
TeePee #3	590280	4842600	T4S R2E Section 4
Sawmill #1	588700	4842180	T4S R2E Section 5
Sawmill #2	588750	4842520	T4S R2E Section 5
Sawmill #3	588460	4842940	T4S R2E Section 5
FS 456 #1	586560	4842160	T4S R2E Section 6
FS 456 #2	587040	4842670	T4S R2E Section 6
FS 456 #3	587200	4842980	T4S R2E Section 6
Sallee #1	582620	4841700	T4S R1E Section 3
Sallee #2	582840	4841860	T4S R1E Section 2
Sallee #3	582010	4841580	T4S R1E Section 2
Pitts #1	580910	4842060	T4S R1E Section 4
Pitts #2	580810	4842220	T4S R1E Section 4
Pitts #3	580390	4842550	T4S R1E Section 4
Hop Springs #1	581780	4845660	T3S R1E Section 27
Hop Springs #2	582380	4846040	T3S R1E Section 27
Hop Springs #3	582780	4846620	T3S R1E Section 23
Hop Springs #4	583060	4846710	T3S R1E Section 23
Hop Springs #5	583280	4847450	T3S R1E Section 23
Upper Roby #1	578060	4848640	T3S R1E Section 17
Upper Roby #2	578660	4848670	T3S R1E Section 17
Upper Roby #3	578440	4848140	T3S R1E Section 17
Roby #1	577520	4850310	T3S R1E Section 7
Roby #2	577710	4850980	T3S R1E Section 8
Roby #3	577810	4851820	T3S R1E Section 5