MANAGEMENT OF ELK IN SOUTH DAKOTA

SOUTH DAKOTA DEPARTMENT OF GAME, FISH AND PARKS
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This document is a general overview for the Division of Wildlife and serves to provide important background and historical data relative to elk management and research in South Dakota. This document will be utilized by Department staff and Commission on frequent basis to understand current elk management issues and evaluate future elk management direction. This document may be updated as needed.

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ACRONYMS AND ABBREVIATIONS

ASQ	Allowable Sale Quantity (of timber)
ARSD	South Dakota Administrative Rule
AUM	Animal Unit Month
BHNF	Black Hills National Forest
BLM	Bureau of Land Management within the USDI
CCF	Hundred Cubic Feet (timber volume)
CGNF	Custer Gallatin National Forest
CHAP	Controlled Hunting Access Program
CSP	Custer State Park
DBH	Diameter at Breast Height of a tree 4.5' from ground level
DOW	Division of Wildlife for SDGFP
EHAP	Elk Hunting Access Program
FEIS	Final Environmental Impact Statement
FS	Forest Service within the USDA
HABCAP	Habitat Capability Model
HE	Habitat Effectiveness
MA	Management Area
MOU	Memorandum of Understanding
MPB	Mountain Pine Beetle
MUSYA	Multiple Use and Sustained Yield Act
MVUM	Motorized Vehicle Use Map
NEPA	National Environmental Policy Act
NGPC	Nebraska Game and Parks Commission
NWP	Norbeck Wildlife Preserve on BHNF
OHV	Off-highway Motorized Vehicle
OSPRA	Oglala Sioux Parks and Recreation Authority
OSV	Over-snow Motorized Vehicle
Plan	Reference to a Forest Service Land and Resource Management Plan
ROD	Record of Decision for a FEIS
RST	Rosebud Sioux Tribe
SDCL	South Dakota Codified Law
SDGFP	South Dakota Department of Game, Fish and Parks
SD	South Dakota
SS	Structural Stage. Size and canopy cover classification for ponderosa pine
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
VDT	Variable Density Thinning
WGFD	Wyoming Game and Fish Department
WICA	Wind Cave National Park
YNP	Yellowstone National Park

INTRODUCTION

The elk (*Cervus elaphus*) is the largest hunted member of the deer family (Cervidae) residing in South Dakota. Prior to European settlement, elk once ranged over the entire state of South Dakota but were extirpated by the late 1800s due to unregulated harvest and market hunting. Cooperative transplant efforts between western state and federal agencies began in the early 1900s to re-introduce elk into the Black Hills of South Dakota.

The re-establishment of elk in South Dakota is a wildlife management success story. In 2020, several thousand elk roamed free, primarily in the Black Hills forested region along with several smaller herds that occupied prairie and/or agriculture landscapes. Public demand for elk hunting opportunities is strong, with approximately 23,600 applications submitted for the 1,400 available elk licenses in 2020. Elk populations in the first part of the 2000s were likely most affected by available forage, drought, harvest, predation, and landowner tolerance.

This elk management document provides important historical background and significant biological information for the formulation of sound elk management. Elk survey methods and management tools are presented, along with a thorough discussion of research, land management, citizen involvement, and challenges and opportunities. The management of elk and their habitats can be complex for wildlife and habitat managers. While not an exclusive list, the following topics were discussed during the document development and include: habitat; additional forage since the 1997 Black Hills National Forest Land and Resource Management Plan; depredation; inter-state and tribal coordination; prairie elk management; elk-vehicle collisions; hunting regulations; disease; captive cervid game farming; predation management; multiple use; and mining, energy development and transmission. These challenges and opportunities serve as the foundation for the objectives and strategies outlined in the Elk Action Plan (SDGFP 2021).

The South Dakota Department of Game, Fish, and Parks (SDGFP) manages wildlife and associated habitats for their sustained and equitable use, and the benefit, welfare and enjoyment of the citizens of this state and its visitors. South Dakota's elk resources demand prudent and increasingly intensive management to accommodate numerous and varied public demands and growing impacts from people. The "*Management of Elk in South Dakota*" publication serves as an informational document to assist in decision making and implementation of actions to ensure elk populations and their habitats are managed appropriately, addressing both biological and social tolerances, while considering the needs of all stakeholders. Furthermore, this document will aid in the decision-making process of the SDGFP Commission and serves to inform and educate the sportsmen and women, landowners, and other publics of South Dakota to whom it will ultimately benefit. SDGFP will work closely with private landowners, Black Hills National Forest, Wind Cave National Park and sportsmen and women to overcome the challenges and take advantage of opportunities regarding the future management of elk in South Dakota.

HISTORICAL BACKGROUND

In the early 1800s, elk (*Cervus Spp.*) were one of the most common native ungulates in North America (Bryant and Maser 1982). Manitoban elk (*Cervus elaphus manitobensis*) was the subspecies found in the Dakotas and throughout the central plains (Bryant and Maser 1982). Available records for South Dakota, although not voluminous, were sufficient to indicate statewide distribution of elk and showed that in the early part of the nineteenth century, elk were abundant especially in the Black Hills (Murie 1951). Long before early European settlers and explorers, elk were an important part of North American Indians' subsistence economy, and although the elk were less essential than bison and deer, they often served as a vital source of food, clothing, implements, weapons, decorations, spiritualism, and sources of currency (McCabe 2002). Millspaugh and Brundige (1996a) noted that the Oglala Sioux tribe of the Great Plains recognized elk as a spirit animal associated with courage, persistence, strength, love and passion. The canine teeth were prized by Native Americans as ornaments, and as recognition of status.

Elk were a prominent food source during the exploration and early settlement of much of the United States and southern Canada (O'Gara and Dundas 2002). In the early 1800s, the Lewis and Clark expedition reported an abundance of elk in what is now southeastern South Dakota. Elk were well distributed along the Missouri River corridor, and as the expedition continued northward into what is now North Dakota, elk sightings became common place. Murie (1951) also reported elk were abundant in the early 1800s, especially in the Black Hills. Parkman (1910), chronicling the journeys of travelers to California via the Oregon Trail, called the Black Hills a hunter's paradise and wrote of "the broad dusty paths made by the elk, as they filed across the mountain-side". With the onset of white settlers into South Dakota and the Black Hills, elk populations were extirpated across the state and in the Black Hills by the late 1800s. By the 1870s, only scattered herds of Manitoban elk remained east of the Missouri River in South Dakota, and by 1875, only a few elk remained outside of the Black Hills (Dodge 1877). Following the gold rush into the Black Hills in 1876, elk populations decreased drastically (O'Gara and Dundas 2002). The last native elk in South Dakota was believed to be killed in 1888 (Rice 1988). The natural range of elk in North America was reduced to Manitoba, Saskatchewan, and the Rocky Mountains and West Coast provinces and states of Canada and the United States (O'Gara and Dundas 2002).

Conflicting reports exist pertaining to when elk were released and where they were reintroduced in the Black Hills area of South Dakota. Rice (1988) reported that elk reintroduction efforts into South Dakota were initiated in the early 1900s. Most of the elk that were used to repopulate the elk herds in the Black Hills region were transplanted from western states, including Idaho, Montana, and Wyoming and consisted of the Rocky Mountain subspecies (*Cervus elaphus nelsoni*). Records indicate that the first release was conducted in the Northern Black Hills of Wyoming when approximately 100 head of Rocky Mountain elk were released in 1911 by Wyoming and South Dakota State agencies (Rice 1988). In 1912, 21 elk from Idaho were released, and in 1913, the same number was again released in the Northern

Black Hills of Wyoming (Rice 1988). The last recorded out-of-state transplant of elk into the Black Hills region of South Dakota occurred in 1916 when 50 elk were transplanted to Custer State Park (CSP) and 25 elk were released into Wind Cave National Park (WICA) from Gardiner, Montana (Millspaugh and Brundige 1996a, Lovaas 1973). Rice (1988) stated that by 1928, herds in the Black Hills area had grown to an estimated 1,000 elk, and damage to agricultural crops required population control. As a result, the first elk season was held in 1928.

All known reintroductions and transplants of elk into, within, or out of the Black Hills Region from 1911 to 2019 can be found in Appendix 1. Most transplants occurred in WICA and CSP. Once populations in those areas increased, transplants to other parts of the Black Hills were conducted (1970-1972, 1980, 1985-1986, and 1990; Appendix 1). From 1971 to 1994, an estimated 754 elk were moved from WICA to various tribal entities across South Dakota as WICA was known as the source for elk for both State and Tribal agencies in South Dakota to enhance population needs. The most recent translocation of elk into South Dakota occurred in 1993, when 161 elk were moved to three Indian reservations in South Dakota from Theodore Roosevelt National Park in North Dakota. Elk in some areas of the prairie region of South Dakota are likely expansions of those transplanted elk.

ELK HUNTING

Historical Harvest

Management strategies for elk populations in South Dakota have changed throughout the years. As early as 1920 intermittent hunting seasons were started within CSP and the surrounding areas. In 1928 the management direction was to eradicate elk outside of WICA and CSP with the use of hunting seasons (Rice 1988). The first structured elk hunting season began on November 1, 1931 and ran until the 20th of the month within three hunting units located in the Black Hills. These units were arranged to specifically target elk herds near WICA and CSP. With a few exceptions, firearm seasons continued through 1952 with some years having very liberal seasons of over 800 licenses available (Table 1). Season closures occurred in 1933, 1938, 1940, and 1950. In 1953 hunters were allowed to harvest an elk on a Black Hills deer tag with no records kept of the harvest results. The elk season was closed from 1960-1964. In 1965 the season was opened with 120 licenses issued to manage the elk herd to minimum levels outside of WICA and CSP. The elk season was closed in 1969 and reopened in 1970. In 1971, the firearm elk units were restructured into two units (Appendix 2), replacing varying unit structures and territories used to intensively control specific elk herds. In 1975, the direction was to manage for an aesthetic elk herd, not a huntable population, allowing deer hunters and tourists to observe an elk sporadically but to limit the agricultural damages caused by elk.

Table 1. Black Hills Firearm elk season in South Dakota, 1940-2019.

Year	Licenses Sold	Total Harvest	Harvest Success (%)	Applications
1940			Firearm Season Closed	
1941	917	250	-	-
1942	150	128	87	-
1943	-	109	-	-
1944	304	144	-	-
1945	633	231	-	-
1946	523	192	37	-
1947	834	225	23	-
1948	146	35	-	-
1949	934	355	38	-
1950			Firearm Season Closed	
1951	1,197	250	21	-
1952	350	80	23	-
1953			Included in Hills Deer Season	
1954			Included in Hills Deer Season	
1955			Included in Hills Deer Season	
1956			Included in Hills Deer Season	
1957			Included in Hills Deer Season	
1958			Included in Hills Deer Season	
1959			Included in Hills Deer Season	
1960			Firearm Season Closed	
1961			Firearm Season Closed	
1962			Firearm Season Closed	
1963			Firearm Season Closed	
1964			Firearm Season Closed	
1965	120		23	-
1966	300	92	46	-
1967	130	70	55	-
1968	350	80	23	-
1969			Firearm Season Closed	
1970	50	26	52	-
1971	180	63	35	-
1972	199	73	37	-
1973	170	65	38	-
1974	145	53	37	-
1975	145	58	40	-
1976	160	0	0	-
1977	160	29	18	-
1978	140	39	28	-

Year	Licenses Sold	Total Harvest	Harvest Success (%)	Applications
1979	140	27	19	-
1980	180	40	22	1,321
1981	230	65	28	-
1982	270	60	22	-
1983	342	103	30	-
1984	495	104	21	-
1985	488	173	35	-
1986	472	155	33	3,061
1987	479	161	34	-
1988	308	100	33	-
1989	249	107	43	-
1990	231	104	45	-
1991	222	134	61	-
1992	253	155	61	-
1993	324	219	68	6,026
1994	449	293	65	6,770
1995	548	368	67	7,730
1996	670	413	62	9,068
1997	805	508	63	9,708
1998	752	510	67	10,514
1999	1,019	669	66	11,120
2000	1,083	747	69	11,953
2001	1,124	721	64	12,114
2002	1,229	886	72	11,998
2003	1,572	1,056	67	11,852
2004	1,798	1,101	61	13,538
2005	2,670	1,395	52	14,687
2006	2,470	1,358	55	13,392
2007	2,075	1,064	51	13,916
2008	1,675	863	52	13,083
2009	1,366	783	57	12,915
2010	1,059	560	53	12,197
2011	866	472	55	11,031
2012	570	416	73	9,665
2013	620	374	60	11,274
2014	664	472	71	11,461
2015	922	657	71	12,126
2016	1,745	1,087	62	12,692
2017	1,581	1,047	66	12,201
2018	1,124	717	64	11,871
2019	1,108	686	62	12,396

Starting in 1980, SDGFP was managing the elk herd for an increasing population. The population was estimated at 1,000 animals and the population objective was set at 1,400 to 1,600 elk, to be reached by 1996 (Rice 1982). This initiated an effort to transplant elk from WICA to several locations throughout the Black Hills. A three-unit harvest structure was developed in 1980 that started to resemble the current firearm hunting unit boundaries (Appendix 2). In 1984 Unit 4 was added, and by 1986 Unit 5 was included along with the addition of an archery season occurring in Unit 2 (Appendix 3). By 1993 the firearm hunting unit boundaries changed again to include Unit 7 and further resemble current harvest units (Appendix 2). One year later, in 1994, licenses were sold for Unit 6, which later became Prairie Firearm Unit 15 in 2004. The prairie elk season began in 1995 to manage the elk populations outside of the Black Hills Fire Protection District (Appendix 4).

By 1996 the elk population estimates had tripled in size and continued to grow, nearly doubling again by 2001. Severe drought conditions affected the Black Hills from 2001-2007 and these conditions, along with the increasing elk herd, led to elk depredation issues and increased landowner complaints. Ultimately the numbers of elk licenses were increased to address the growing impact of elk depredation on private land. In 2001 elk license sales totaled 1,124 firearm licenses, 140 archery licenses, and 42 prairie licenses (Table 2). In 2005 the drought conditions continued, with the most drastic elk depredation impacts observed in Unit 3 which consists of extensive private land holdings. While the elk populations were beginning to level off, they weren't yet at socially acceptable levels given the prolonged drought conditions. In 2005 the highest number of licenses were issued totaling 2,670 black hills firearm licenses, 267 archery licenses, and 89 prairie licenses (Table 2). By 2006 the elk population estimates indicated a decline. Licenses were slowly reduced from 2,470 to 620 firearm and 247 to 107 archery licenses between 2006 to 2013, respectively (Table 2). With the decrease in harvest the elk population rebounded to more acceptable levels and increasing survival rates and population growth rates suggested an increasing population in 2015. In order to maintain the population within desired levels, licenses were again increased in 2016 and have remained relatively consistent into 2019 at 1,100 to 1,750 firearm licenses and 216 to 280 archery licenses each year (Table 2).

The prairie elk season has followed a slightly different trajectory. License sales remained constant through 2008, peaked in 2009 at 133 licenses, then returned to just under 100 between 2012 to 2015. From 20016-2019 license sales increased and have remained around 140-150 license each year (Table 2).

Table 2. Black Hills and Prairie elk unit license sales in South Dakota, 1990-2019.

Year	Firearm Licenses	Archery Licenses	Prairie Licenses	Total Licenses Sold
1990	231	60	-	291
1991	222	50	-	272
1992	253	50	-	303
1993	324	60	-	384
1994	449	74	-	523
1995	548	85	-	633
1996	670	105	-	775
1997	805	115	27	947
1998	752	120	38	910
1999	1,019	130	44	1,193
2000	1,083	123	37	1,243
2001	1,124	140	42	1,306
2002	1,229	151	306	1,686
2003	1,572	192	82	1,846
2004	1,798	192	90	2,080
2005	2,670	267	89	3,026
2006	2,470	247	79	2,796
2007	2,075	237	76	2,388
2008	1,675	202	76	1,953
2009	1,366	185	133	1,684
2010	1,059	144	134	1,337
2011	866	126	128	1,120
2012	570	97	97	764
2013	620	107	96	823
2014	664	106	92	862
2015	922	196	98	1,216
2016	1,745	280	148	2,173
2017	1,581	269	149	1,999
2018	1,124	219	139	1,482
2019	1,108	216	140	1,464

SDGFP has offered various tag types and their distributions have changed over recent years. In 1989, only an ”any elk” tag type and a “bull elk” tag type were used to harvest elk in the firearm season, and only the ”any elk” tag type was used in the archery season. In 1994, the addition of an antlerless tag type was introduced in present day Unit 2 and Prairie Unit 15. By 1996 all firearm units had antlerless tags available. The archery season continued to only have ”any elk” tag types until 2001 when the Gregory Prairie Elk Unit added an antlerless tag type. The next year the majority of the archery seasons had an antlerless tag type (excluding present

day Unit 5 and Unit 7). From 2002 to 2020, the "bull elk" tag type was replaced with "any elk" tags.

Season Structure

All elk hunting seasons are only open to residents of South Dakota. If a hunter is drawn for their first choice elk tag (Firearm, Prairie, or Archery) they are required to wait 9 years to apply for that drawn elk license again. Hunters are not able to get multiple elk licenses within one season, and licenses are non-transferable. In the Black Hills of South Dakota, the 3-year average (2017 to 2019) hunter density for both archery and firearm seasons combined within each hunting unit ranged from 28 hunters/100 square miles in H2A to 3 hunters/100 square miles in H5A (Figure 1).

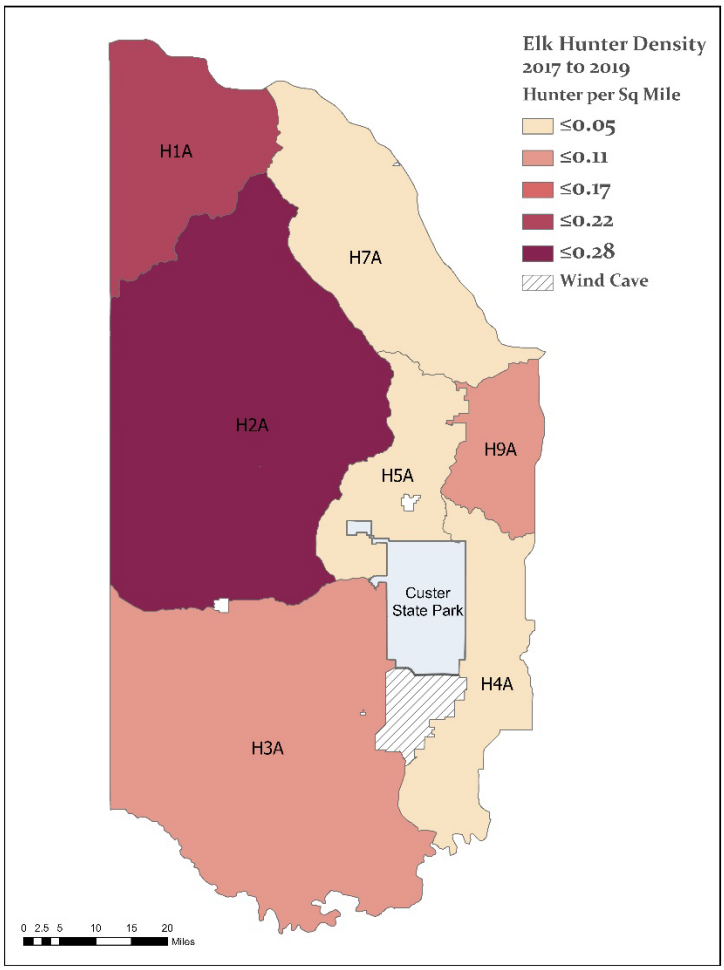


Figure 1. Three-year average hunter density in the Black Hills of South Dakota, 2017-2019.

Black Hills Firearm Season

From 1953 to 1959 the firearm seasons were open with no limits and harvest information was not documented. In the 1970s the implementation of structured harvest surveys provided game managers with essential elk harvest data to manage the amount of harvest pressure applied to the elk population. In the 1980s goals were set to increase the elk population and by the early 2000s the goal was to decrease the population.

Since the 1940s, harvest information was collected with the exception of 1953-1959, and the season was closed 1960-1964. Hunter success rates ranged from an average of 46% from 1940-1950, 40% from 1965-1969, 30% from 1970-1989, 63% from 1990-1999, 60% in 2000-2009 and 64% in 2010-2019 (Table 1). Dramatic increases in license sales in 2005 increased harvest to nearly 1,400 elk, but also lowered hunter success rates by 9 percent (Figure 2). Licenses were reduced to 570 in 2012 and success increased to 73%, and success rates remained fairly stable through 2019 (Figure 2). The number of applicants for each tag available has ranged from 18.6 in 1993 to a low of 5.4 in 2006, up to 18.2 in 2013, and was 11.2 in 2019 (Figure 3). Firearm seasons varied by license type but in 2019 encompassed the dates of October 1st – 31st and December 1st-31st.

Prairie Season

Beginning in 1995 the Prairie Elk seasons were initiated to address elk depredation issues outside of the Black Hills Fire Protection District. The first hunting unit to be created was located in the northeastern corner of Bennett County to address elk movement off the Pine Ridge and Rosebud Reservations. This season began with two "bull elk" licenses and hunters reported 100% success. By 2003, the license sales increased to 72 to address increasing elk depredation on private lands, with a total of 41 elk harvested (Table 3). Hunter success rates fluctuated from >80% for the first few years, to an average of 50% from 2000 to 2013. From 2014 to 2019 hunter success has averaged 72% (Figure 2). Antlerless harvest consisted of 32% of the total harvest from initiation to 2002 and increased to 51% from 2003-2019. The prairie elk season has expanded through the years from a small corner of Bennett County to include the entire county and into Mellette County, along with additional units added in Gregory County, several small units along the Northern Black Hills, Fall River County, Harding County, and a West River unit that covers most of Western South Dakota (Appendix 4).

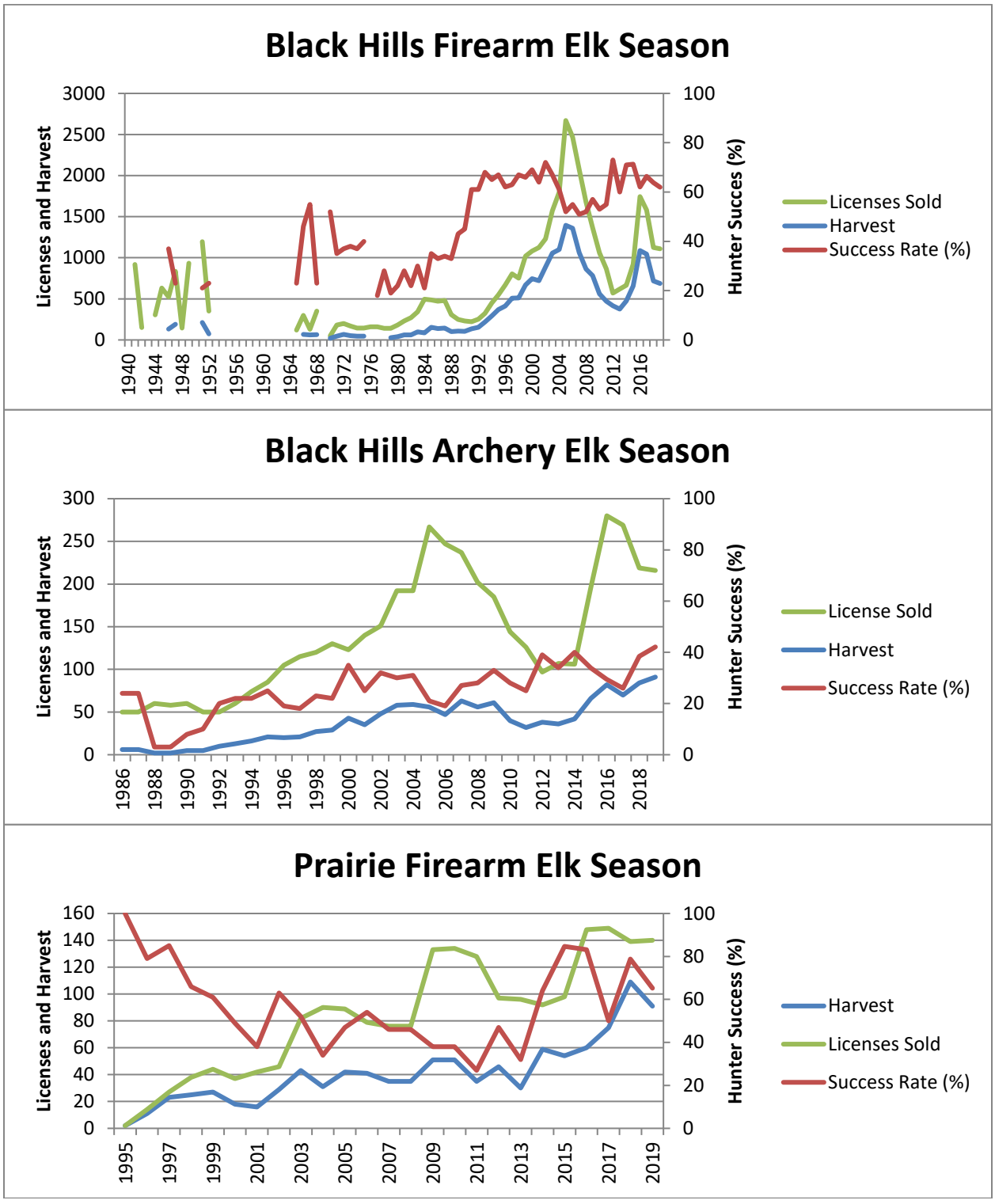


Figure 2. Black Hills and Prairie elk harvest, success, and license sales.

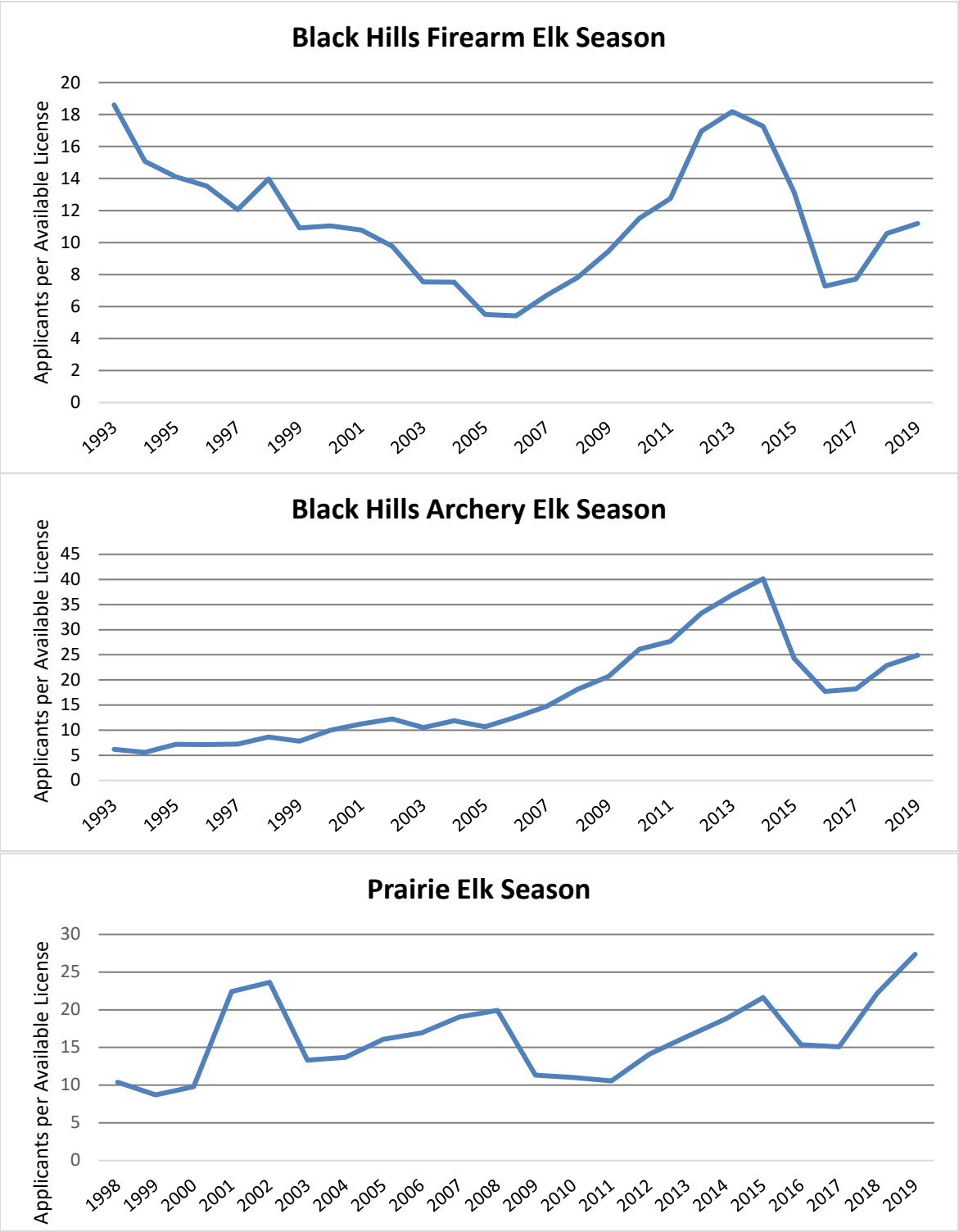


Figure 3. Hunter demand, measured as applicants per available limited elk license, for Black Hills firearm, Black Hills archery, and prairie elk seasons in South Dakota.

Table 3. Harvest statistics for Unit 11 Firearm Prairie Elk Management Unit, 1995-2019.

Year	Applicants	Licenses Sold	Harvest Success	Bull Harvest	Antlerless Harvest	Total Harvest
1995	-	2	100%	2	0	2
1996	-	6	83%	4	1	5
1997	-	18	94%	7	10	17
1998	268	32	69%	8	14	22
1999	278	36	61%	16	6	22
2000	263	27	48%	9	4	13
2001	607	32	44%	11	3	14
2002	745	36	72%	18	8	26
2003	811	72	57%	24	17	41
2004	706	56	36%	8	12	20
2005	742	53	38%	10	10	20
2006	634	36	64%	12	11	23
2007	614	36	58%	14	7	21
2008	593	36	67%	10	14	24
2009	537	57	37%	13	8	21
2010	530	55	42%	9	14	23
2011	510	60	32%	12	7	19
2012	447	35	63%	11	11	22
2013	559	35	37%	7	6	13
2014	530	31	77%	12	12	24
2015	689	38	76%	14	15	29
2016	815	54	61%	16	17	33
2017	852	54	63%	12	22	34
2018	810	79	87%	26	43	69
2019	884	79	70%	21	35	56

In 1996, the Gregory County (Unit 30) prairie elk season began with a limited harvest of elk that moved between Nebraska and South Dakota. This season was aimed at addressing elk damage to private row crops that began in 1992. Gregory County is primarily privately owned land with approximately 60% cultivated crops and the remainder of the land use is hay land, pasture, and wooded breaks. A maximum of 10 licenses were issued for this season from 2000 to 2010. Licenses were reduced from 2011 (8) to 2014 (2) and the hunting unit was closed in 2015 (Table 4). Hunter success averaged 34% and an average of 33% of the harvest was antlerless elk. An archery season was also held in this unit between 2001 and 2011 with 2-6 licenses sold annually (Table 5). In 2007 one bull elk was harvested during this archery season; this was the only successful harvest for this archery season. Variable unit boundaries for this season included

areas in Nebraska and hunters from both states were able to hunt this unit prior to the 2013 season (Appendix 4).

Table 4. Harvest statistics for Unit 30 Firearm Prairie Elk Management Unit, 1996-2014.

Year	Applicants	Licenses Sold	Harvest Success	Bull Harvest	Antlerless Harvest	Total Harvest
1996	-	8	75%	4	2	6
1997	-	8	75%	4	2	6
1998	127	6	50%	2	1	3
1999	105	8	63%	3	2	5
2000	99	10	50%	3	2	5
2001	335	10	20%	0	2	2
2002	342	10	40%	2	2	4
2003	281	10	20%	1	1	2
2004	249	10	20%	2	0	2
2005	311	10	50%	1	4	5
2006	266	10	10%	1	0	1
2007	275	10	20%	1	1	2
2008	260	10	20%	2	0	2
2009	239	10	40%	3	1	4
2010	208	10	20%	2	0	2
2011	200	8	0%	0	0	0
2012	178	4	75%	3	0	3
2013	174	4	0%	0	0	0
2014	131	2	0%	0	0	0

Table 5. Harvest statistics for Unit 30 Archery Prairie Elk Management Unit, 2001-2011.

Year	Applicants	Licenses Sold	Harvest Success	Bull Harvest	Antlerless Harvest	Total Harvest
2001	1	5	0%	0	0	0
2002	0	4	0%	0	0	0
2003	2	2	0%	0	0	0
2004	3	5	0%	0	0	0
2005	0	6	0%	0	0	0
2006	6	5	0%	0	0	0
2007	3	6	17%	1	0	1
2008	8	6	0%	0	0	0
2009	31	6	0%	0	0	0
2010	35	4	0%	0	0	0
2011	28	2	0%	0	0	0

In 1994 Prairie Unit 6 in Butte County, which later became Unit 15 in 2004, was created to address depredation issues caused by elk moving from Wyoming and a growing resident herd within this area. The number of licenses allocated ranged from 24-31 from 2004-2014 depending on the amount of damage and estimated size of the elk herd each year. From 2015-2019 the number of licenses dropped to 12-20 (Table 6). Hunter success averaged 35% with an average of 42% of the harvest antlerless elk (Table 6). Unit boundaries remained consistent with small additions to the northern extent (Appendix 4).

Table 6. Harvest statistics for Unit 15 Firearm Prairie Elk Management Unit, 2004-2019.

Year	Applicants	Licenses Sold	Harvest Success	Bull Harvest	Antlerless Harvest	Total Harvest
2004	277	24	38%	5	4	9
2005	379	26	65%	9	8	17
2006	436	30	57%	7	10	17
2007	558	30	40%	4	8	12
2008	661	30	33%	7	3	10
2009	318	31	16%	3	2	5
2010	231	29	41%	5	7	12
2011	267	30	33%	4	6	10
2012	222	26	31%	4	4	8
2013	271	26	35%	4	5	9
2014	246	20	45%	6	3	9
2015	348	20	15%	2	1	3
2016	296	19	32%	5	1	6
2017	263	20	15%	2	1	3
2018	163	12	67%	8	0	8
2019	141	13	0%	0	0	0

Prairie Unit 9 was initiated in 2009. An expanding herd of elk, that likely originated from elk moving north out of the Black Hills, began causing damage on private property near St. Onge, SD creating a need for a harvest season. License sales ranged from 30-40 during the first 3 years and then they were cut in half as the population reached a manageable size by 2012 (Table 7). In 2016 there were 50 licenses issued to address increased damage issues, and was then reduced to 20 licenses in 2018 and 2019 (Table 7). Hunter success averaged 44% with 45% of the harvest antlerless elk (Table 7). Unit size has remained consistent in the area around St. Onge; however, in 2013 an additional area that was formerly part of Unit 7 in the Black Hills Firearm Season was added to Prairie Unit 9 to continue to manage a migrating herd of elk that established across Interstate 90 near Tilford, SD (Appendix 4).

Table 7. Harvest statistics for Unit 9 Firearm Prairie Elk Management Unit, 2009-2019.

Year	Applicants	Licenses Sold	Harvest Success	Bull Harvest	Antlerless Harvest	Total Harvest
2009	414	35	57%	10	10	20
2010	508	40	33%	8	5	13
2011	375	30	17%	4	1	5
2012	190	17	29%	2	3	5
2013	170	16	31%	3	2	5
2014	351	29	72%	11	10	21
2015	518	30	50%	6	9	15
2016	516	50	26%	8	5	13
2017	479	50	28%	8	6	14
2018	340	20	65%	8	5	13
2019	381	20	80%	6	10	16

Prairie unit 27 was added to the prairie elk season in 2012 to address property damage caused by an elk herd that likely originated from elk moving south out of the Black Hills Unit 3 (Appendix 4). Harvest success has averaged 49% with 2015 much above average (Table 8).

Table 8. Harvest statistics for Unit 27 Firearm Prairie Elk Management Unit, 2012-2019.

Year	Applicants	Licenses Sold	Harvest Success	Bull Harvest	Antlerless Harvest	Total Harvest
2012	322	15	47%	7	0	7
2013	406	15	20%	3	0	3
2014	467	10	40%	4	0	4
2015	564	10	80%	8	0	8
2016	645	25	32%	4	4	8
2017	661	25	56%	10	4	14
2018	458	20	60%	9	3	12
2019	475	20	60%	7	5	12

Prairie unit 35 was added to the prairie elk season in 2018 to address increasing elk damage to private property from elk originating on USDA Forest Service lands in Harding County. During 2018 and 2019, 8 “any elk” licenses were offered for all of Harding County. Eight male elk and seven male elk were harvested in 2018 and 2019, respectively. In 2020, this hunting unit was split into western (35A) and eastern (35B) units.

The Prairie West River Area (WRA) unit was initiated in the 2020 season and covered all West River counties excluding the existing elk units and areas within the boundaries of Native American Reservations (Appendix 4). In 2020 there were 10 “any elk” licenses and 20 “antlerless elk” licenses available.

The prairie firearm season dates have been variable and included seasons running from July 15-Aug 31, September 1-October 31, September 15-October 31, October 20-December 31 and December 1-31. Yearly harvest for all prairie firearm seasons ranged from 16-51 elk from 1997-2014, then in 2015-2019 harvest increased to 54-109 elk (Table 9). Total prairie licenses sales peaked in 2009-2011 and again in 2016-2019 (Figure 2).

Table 9. Prairie Firearm Elk season harvest statistics, 1997-2019.

Year	Applicants	Licenses Sold	Harvest Success (%)	Total Harvest
1997	268	27	85	23
1998	395	38	66	25
1999	383	44	61	27
2000	362	37	49	18
2001	942	42	38	16
2002	1,087	46	63	29
2003	1,092	82	52	43
2004	1,232	90	34	31
2005	1,432	89	47	42
2006	1,336	79	54	41
2007	1,447	76	46	35
2008	1,514	76	46	35
2009	1,508	133	38	51
2010	1,477	134	38	51
2011	1,352	128	27	35
2012	1,369	97	47	46
2013	1,580	96	32	30
2014	1,725	92	64	59
2015	2,119	98	55	54
2016	2,272	148	40	60
2017	2,249	149	50	75
2018	3,080	139	79	109
2019	3,831	140	65	91

Black Hills Archery Season

The archery elk season began in 1986, with one unit in the central Black Hills. By 2005, unit boundaries matched the rifle season unit structure (Appendix 3). The 2019 season dates were September 1st-30th. Archery hunter success rate remained relatively stable averaging 34% for 2010-2019 (Figure 2). The demand for archery licenses grew from 372 applicants in 1993 to 5,382 in 2019 (Table 10). The demand for these limited archery licenses reached a high of almost 40 applicants for each available license in 2014, dropping to 18 in 2016 and increased to 25 in 2019 (Figure 3).

Table 10. Black Hills Archery Elk season harvest statistics, 1986-2019.

Year	Applicants	Licenses Sold	Hunter Success (%)	Total Harvest
1986	-	50	24	6
1987	-	50	24	6
1988	-	60	3	2
1989	-	58	3	2
1990	-	60	8	5
1991	-	50	10	5
1992	-	50	20	10
1993	372	60	22	13
1994	413	74	22	16
1995	609	85	25	21
1996	748	105	19	20
1997	834	115	18	21
1998	1,034	120	23	27
1999	1,016	130	22	29
2000	1,232	123	35	43
2001	1,573	140	25	35
2002	1,846	151	32	48
2003	2,020	192	30	58
2004	2,277	192	31	59
2005	2,844	267	21	56
2006	3,116	247	19	47
2007	3,491	237	27	63
2008	3,660	202	28	56
2009	3,826	185	33	61
2010	3,761	144	28	40
2011	3,486	126	25	32
2012	3,228	97	39	38
2013	3,952	107	34	36

2014	4,256	106	40	42
2015	4,761	196	34	66
2016	4,965	280	29	82
2017	4,892	269	26	70
2018	5,006	219	38	84
2019	5,382	216	42	91

Custer State Park Firearm Season

In Custer State Park (CSP), firearm seasons began in 1962 with 60 “any elk” tags available. Elk licenses in CSP ranged from 60 licenses to a high of 180 licenses between 1962 and 1987. Between 1988 and 2009, “any elk” license numbers became consistent with 36 to 41 licenses offered. In 2010, licenses were reduced, and from 2016 to 2019, 9 licenses were available for hunters (Table 11). Elk hunter success remained high in CSP. Since 1962, only 8 years resulted in hunter success lower than 80% with many years of success between 90% - 100% (Table 11). Hunter application numbers have been recorded since 1985. Applicants grew from a low of 742 in 1985 to a high of 11,374 in 2007. Applications stabilized in the late 2010’s at approximately 9,000. The popularity of the CSP elk season has grown and the number of applicants increased accordingly. Historically, season dates for the CSP elk season ran from the middle of September to early October. Season dates in 2019 were from October 1 – 31.

In 1979, an antlerless elk season was added within CSP with 50 licenses available. Antlerless elk license numbers in CSP were used as a management tool to control population numbers. License numbers have ranged from 0 in closed seasons during 1988 -1993 and 2011- 2015, to a high of 148 licenses in 2004 (Table 12). Hunter success was variable with most years having success above 70% (Table 12). Applications for the antlerless elk season in CSP have stabilized around 3,500 with a high of 4,313 in 2005 (Table 12). The antlerless elk season in CSP was closed in 2019.

Table 11. Custer State Park firearm “any elk” season harvest statistics, 1962-2019.

Year	Applicants	Licenses Sold	Harvest Success (%)	Total Harvest
1962	NA	60	100	60
1963	NA	60	NA	NA
1964	NA	80	99	79
1965	NA	80	100	80
1966	NA	80	100	80
1967	NA	120	98	117
1968	NA	192	95	183
1969	NA	120	99	119
1970	NA	96	99	95
1971	NA	96	99	95
1972	NA	150	96	144
1973	NA	192	96	184
1974	NA	144	86	124
1975	NA	96	NA	NA
1976	NA	150	83	125
1977	NA	80	83	66
1978	NA	120	74	89
1979	NA	120	68	82
1980	NA	120	80	96
1981	NA	120	86	103
1982	NA	150	66	99
1983	NA	180	78	141
1984	NA	165	70	116
1985	742	135	66	89
1986	909	80	69	55
1987	2,226	75	84	63
1988	1,432	40	85	34
1989	1,739	35	86	30
1990	NA	35	100	35
1991	NA	35	94	33
1992	2,932	36	86	31
1993	3,406	36	100	36
1994	4,094	36	94	34
1995	4,696	36	100	36
1996	5,221	36	100	36
1997	5,679	36	97	35
1998	6,377	41	98	40
1999	6,934	40	100	40
2000	7,704	39	100	39
2001	8,150	41	95	39

2002	8,575	41	93	38
2003	9,165	41	95	39
2004	9,682	40	100	40
2005	11,138	41	95	39
2006	10,672	41	95	39
2007	11,374	41	93	37
2008	10,998	36	97	35
2009	10,823	36	86	31
2010	10,823	21	76	16
2011	8,022	11	91	10
2012	6,582	4	100	4
2013	7,860	4	100	4
2014	8,092	5	100	5
2015	9,136	8	100	8
2016	8,958	9	89	8
2017	8,828	9	88	8
2018	8,670	9	86	8
2019	8,949	9	100	9

Table 12. Custer State Park firearm antlerless elk season harvest statistics, 1979-2019.

Year	Applicants	Licenses Sold	Harvest Success (%)	Total Harvest
1979	NA	50	86	43
1980	NA	NA	NA	NA
1981	NA	120	33	39
1982	NA	45	44	20
1983	NA	105	95	100
1984	NA	90	61	55
1985	NA	90	65	59
1986	NA	45	60	27
1987	NA	40	85	34
1988	NA	NA	NA	NA
1989	NA	NA	NA	NA
1990	NA	NA	NA	NA
1991	NA	NA	NA	NA
1992	NA	NA	NA	NA
1993	NA	NA	NA	NA
1994	903	29	97	28
1995	1,392	40	98	39
1996	1,661	70	93	63
1997	1,928	80	91	73

1998	2,189	85	95	81
1999	2,401	90	82	74
2000	2,740	100	81	81
2001	2,931	100	76	76
2002	3,104	121	68	82
2003	3,266	129	74	95
2004	3,514	148	86	127
2005	4,313	126	71	89
2006	3,651	126	73	92
2007	3,774	60	53	32
2008	3,655	40	58	23
2009	3,550	20	95	19
2010	3,197	5	80	4
2011-2015	NA	0	NA	NA
2016	3,138	20	90	18
2017	3,436	29	86	24
2018	3,175	23	19	4
2019	NA	0	NA	NA

Custer State Park Archery Season

Archery hunting in CSP began in 1966 with an early archery season. In 1989, a late archery season was added. Season dates in 2019 were September 1 to 30 for the early archery elk season. The late archery season was closed 2012 to 2019. Historical season dates for the late archery season were in late November and early December.

License numbers during the early archery elk season ranged from 10 in 1968 to a high of 60 from 1982 through 1988. In 1989, with the addition of the late archery season in CSP, licenses were reduced to 5. From 1989 to 2019, license numbers ranged from 3 to 8 per year (Table 13). Hunter success during the early archery season ranged from 0% to 100% and was variable (Table 13). Applicants for the early archery season ranged from 87 in 1985 to a high of 4,055 in 2019.

The late archery season in CSP was initiated in 1989 and ran through 2011 with license numbers generally ranging from 40 to 50 (Table 14). Hunter success for the late archery season ranged from 0% in 2010 and 2011 to a high of 35% in 1993. The number of applicants for the late archery season ranged from 129 in 1993 to 2,012 in 2009 (Table 14).

Table 13. Custer State Park early archery elk season harvest statistics, 1966-2019.

Year	Applicants	Licenses Sold	Harvest Success (%)	Total Harvest
1966	NA	20	50	10
1967	NA	21	24	5
1968	NA	10	100	10
1969	NA	23	13	3
1970	NA	20	55	11
1971	NA	20	85	17
1972	NA	30	37	11
1973	NA	20	25	5
1974	NA	20	5	1
1975	NA	20	NA	NA
1976	NA	40	NA	NA
1977	NA	30	23	7
1978	NA	40	23	9
1979	NA	50	4	2
1980	NA	50	18	9
1981	NA	NA	NA	NA
1982	NA	60	18	11
1983	NA	60	NA	NA
1984	NA	60	NA	NA
1985	87	60	15	9
1986	NA	60	18	11
1987	NA	60	12	7
1988	74	60	7	4
1989	NA	5	20	1
1990	NA	5	40	2
1991	107	5	20	1
1992	NA	5	60	3
1993	249	5	0	0
1994	249	5	40	2
1995	441	5	20	1
1996	503	5	80	4
1997	687	5	20	1
1998	775	5	60	3
1999	850	8	50	4
2000	1,067	8	50	4
2001	1,309	8	38	3
2002	1,575	8	38	3
2003	1,642	8	50	4
2004	2,196	8	38	3

2005	2,385	8	38	3
2006	2,700	8	38	3
2007	2,956	8	25	2
2008	3,084	8	25	2
2009	3,134	8	25	2
2010	3,031	5	0	0
2011	2,000	3	33	1
2012	2,078	3	0	0
2013	2,740	3	100	3
2014	3,029	4	100	4
2015	3,600	4	75	3
2016	3,707	3	33	1
2017	3,704	3	33	1
2018	3,772	3	50	2
2019	4,055	3	100	3

Table 14. Custer State Park late archery elk season harvest statistics, 1989-2019.

Year	Applicants	Licenses Sold	Harvest Success (%)	Total Harvest
1989	NA	40	8	3
1990	NA	40	15	6
1991	NA	40	30	12
1992	138	40	13	5
1993	129	40	35	14
1994	213	40	28	11
1995	387	50	18	9
1996	443	50	31	13
1997	555	50	13	6
1998	597	50	26	13
1999	667	50	20	10
2000	792	50	26	13
2001	980	50	22	11
2002	1,170	50	10	5
2003	1,136	50	26	13
2004	1,526	46	15	7
2005	1,579	49	12	6
2006	1,823	48	21	10
2007	1,913	50	5	2
2008	2,007	50	14	6
2009	2,012	49	13	6
2010	1,872	30	0	0
2011	1,473	15	0	0
2012-2019	NA	0	NA	NA

Hunter Access

There were over 1.1 million acres of land open to public hunting access within the Black Hills elk hunting units and over 2.6 million acres in the Prairie Elk hunting units in 2019. Most of this public land was managed by the US Forest Service – Black Hills National Forest (BHNF), Grand River National Grassland (GRNG), Buffalo Gap National Grassland (BGNG), and Fort Pierre National Grassland, with smaller portions managed by the US Bureau of Land Management, South Dakota Office of School & Public Lands, and SDGFP. A large portion of the land made publicly accessible for hunting elk by SDGFP was leased from private landowners through the Walk-In Area (WIA) program. The WIA program payments ranged from less than $1/acre for rangeland to $6/acre for undisturbed habitat and allowed all types of hunting during all legal hunting seasons.

SDGFP also leased land through the Controlled Hunting Access Program (CHAP) and the Elk Hunting Access Program (EHAP). The CHAP program paid between $6 and $10 per hunter day and if the private landowner provided access to over 1,000 acres of land an additional $250 base payment was made. The range in pay per hunter day was dependent on how many restrictions were placed on the CHAP area. If all seasons of hunting and all legal methods of take were allowed, they received $10 per hunter day. If a landowner only allowed archery elk hunting, they would receive $6 per hunter day.

EHAP started in 2006 in response to landowners requesting assistance for depredation by elk on their properties largely due to elk coming out of WICA. South Dakota Game, Fish, and Parks developed EHAP to increase hunter harvest on private lands that have higher than landowner tolerable elk use. EHAP provided a flat lease rate per acre plus an additional 2% for every elk harvested. Elk harvest on lands enrolled in EHAP was relatively high making up over 20% of the harvest in their respective units in most years (Table 15). The program was expanded to the entire Black Hills in 2014 and to the Prairie Elk Unit in 2018.

Table 15. Land enrolled in Elk Hunting Access Program (EHAP) and elk harvested on those lands in relation to elk harvested within hunting units.

Year	2014	2015	2016	2017	2018	2019
Unit 3						
Acres Enrolled in EHAP	18,730	24,530	27,193	26,890	14,675	23,290
Unit 3 Total Elk Harvested	90	83	154	163	144	132
Elk Harvested on EHAP	19	25	37	34	28	46
% of Elk Harvested on EHAP	21%	30%	24%	21%	19%	35%
Unit 11						
Acres Enrolled in EHAP					1,565	2,045
Unit 11 Total Elk Harvested					69	57
Elk Harvested on EHAP					15	29
% of Elk Harvested on EHAP					22%	51%

All lands that were open to public hunting access except the EHAP's were depicted in the annually published South Dakota Hunting Atlas, through interactive maps on the SDGFP website, downloadable layers for Garmin Global Positioning System (GPS) units, and on maps within the SDGFP Android and Apple smartphone app. The EHAP lands were only made available to elk hunting license holders upon request, but SDGFP continues to evaluate methods to fairly distribute this opportunity among hunters while at the same time not overwhelming landowners with more hunters than needed to address the elk depredation.

POPULATION SURVEYS

Harvest Surveys

Hunter survey cards are emailed and/or mailed to all elk license holders to obtain information on the number of hunting recreation days, sex and age (adult/calf) of elk harvested, type of land hunted (public vs. private), the number of elk shot but not recovered, and mean satisfaction of the hunt. All license holders who list an email in their licensing profile receive an email at the end of the season followed by two reminder emails over a 2-week period. All license holders that do not list an email, and those that do not respond to the email survey, are sent paper surveys followed by two or three subsequent mailings at 12–14-day intervals in order to maximize response rate and precision by limiting non-response bias.

Responses to email surveys are received through an Internet link using the Qualtrics survey website. Postage paid survey cards are returned to the SDGFP office in Pierre, South Dakota, where the data are compiled and analyzed. Hunters can also report harvest information to mailed surveys through an internet response system, which records answers directly to the database.

Returned hunter surveys are entered and summarized and harvest statistics are generated for each unit. Proportional statistics from the sample are then accepted as representative of the unit population of hunters and applied to the total number of hunters in that unit. Hunters who do not respond to the survey are included in the hunter population when harvest statistics are estimated. The minimum acceptable response rate is established at 85%. Confidence intervals are calculated to monitor precision and accuracy.

A total of 216 resident licenses were issued for the 2019 Archery Elk season. All license holders were sent a survey at the end of the season and 193 responded for an 89% response rate. Approximately 79% of responding hunters used the Internet. Respondents reported hunting an average of 11.08 days for a total of 2,393 days of recreation (Table 16). The projected harvest was 77 bulls and 14 cows for an overall success rate of 42% (Table 16). Hunter satisfaction was based on a numerical scale from 1 (very dissatisfied) to 7 (very satisfied) and averaged 5.61 for the season (Table 17). Approximately 95% of responding hunters reported hunting on public land, 4% on private land they did not own, and 1% on private land they owned.

A total of 1,108 licenses were issued for the 2019 Black Hills Firearm Elk season. All license holders were sent a survey at the end of the season and 924 responded for an 83% response rate. Approximately 79% responded using the Internet. Respondents reported hunting an average of 5.00 days which projects to a total of 5,540 days of recreation for the season (Table 18). The projected harvest was 332 bulls and 354 cows for an overall success rate of 62% (Table 18). Hunter satisfaction was based on a numerical scale from 1 (very dissatisfied) to 7 (very satisfied) and averaged 5.48 for the season (Table 17). Approximately 88% of responding

hunters reported hunting on public land, 9% on private land they did not own, and 5% on private land they owned.

A total of 140 licenses were issued for the 2019 Prairie Firearm Elk season. All license holders were sent a survey at the end of the season and 111 responded for an 79% response rate. Approximately 79% responded using the Internet. Respondents reported hunting an average of 5.73 days for a total of 802 days of recreation (Table 19). The projected harvest was 41 bulls and 50 antlerless elk for an overall success rate of 65% (Table 19). Hunter satisfaction was based on a numerical scale from 1 (very dissatisfied) to 7 (very satisfied) and averaged 5.43 for the season (Table 17). Approximately 18% of responding hunters reported hunting mostly on public land, 66% on private land they did not own, and 16% on private land they owned.

Table 16. 2019 Black Hills Archery Elk season harvest statistics by unit.

2019 Archery Elk Harvest Projections

Last Revised: 16 March 2020

	Resident Licenses				Harvest Projections										Land Hunted Most		
Unit Type	Appl. 1st Choice *	Avail.	Sold	Resp.	Success	Bulls	Cows	Bull Calves	Cow Calves	Total Elk Harvest	CI (95%)	Elk Shot Not Recover	Average Satisfctn Score	Average Days Hunted	Public	Own	Other Private
H1A-21	705	20	20	85%	81%	15	0	0	0	15	+/-1	5	5.9	12.3	18	0	0
H1A-23	7	5	5	60%	33%	0	3	0	0	3	+/-0	1	5.4	6.3	9	0	0
H2A-21	3,831	50	50	88%	51%	44	0	1	0	45	+/-3	12	5.8	13.4	86	0	2
H2A-23	82	5	5	80%	12%	0	6	0	0	6	+/-2	0	5.0	7.3	42	0	0
H3A-21	557	15	15	93%	55%	14	0	0	0	14	+/-2	1	6.0	13.5	18	3	5
H3A-23	8	5	5	80%	27%	0	5	0	0	5	+/-2	1	5.2	7.1	16	0	1
H5A-21	28	2	2	100%	50%	1	0	0	0	1	+/-0	0	6.0	12.5	2	0	0
H7A-21	164	5	5	80%	60%	3	0	0	0	3	+/-0	0	6.6	13.0	5	0	0
	5,382	**222**	**216**	**89.4%**	**42.1%**	**76**	**14**	**1**	**0**	**91**	**+/- 10**	**20**	**5.61**	**11.08**	**196**	**2**	**8**
															95%	1%	4%

The response rate for all units combined is: 89.4%

Satisfaction scale of 1=very dissatisfied to 7=very satisfied.

* Number of 1st drawing applicants with that unit as 1st choice.

Table 17. Summary comparison of Archery, Black Hills Firearm, and Prairie Elk season from 2014-2019.

Archery Elk Season

Year	# Apps 1st Choice	Licenses Sold	Harvest Bulls	Harvest Cows	Harvest Total	Success Rate	Avg. Days Hunted	Average Satisfaction
2014	4,256	106	38	4	42	40%	11.68	5.61
2015	4,761	196	55	12	66	34%	11.74	5.39
2016	4,965	280	57	25	82	29%	11.11	5.40
2017	4,892	269	50	20	70	26%	11.29	5.60
2018	5,006	219	65	19	84	38%	11.70	5.50
2019	5,382	216	77	14	91	42%	11.08	5.61

Black Hills Firearm Elk Season

Year	# Apps 1st Choice	Licenses Sold	Harvest Bulls	Harvest Cows	Harvest Total	Success Rate	Avg. Days Hunted	Average Satisfaction
2014	11,461	664	295	178	472	71%	5.85	5.46
2015	12,126	922	312	345	657	71%	6.66	5.54
2016	12,692	1,745	363	724	1,087	62%	4.59	5.42
2017	12,201	1,581	364	682	1,047	66%	4.77	5.50
2018	11,871	1,124	315	402	717	64%	5.08	5.36
2019	12,396	1,108	332	354	686	62%	5.00	5.48

Prairie Firearm Elk Season

YEAR	# Apps 1st Choice	Licenses Sold	Harvest Bulls	Harvest Cows	Harvest Total	Success	Avg. Days Hunted	Average Satisfaction
2014	1,725	92	33	25	59	64%	3.73	5.31
2015	2,119	98	29	25	54	55%	4.59	5.34
2016	2,272	148	32	27	60	40%	4.76	4.68
2017	2,249	149	41	34	75	50%	6.43	4.81
2018	3,080	139	59	51	109	79%	5.55	5.58
2019	3,831	140	41	50	91	65%	5.73	5.43

Table 18. 2019 Black Hills Firearm Elk season harvest statistics by unit.

2019 Black Hills Firearm Elk Harvest Projections

Last Revised: 16 March 2020

	Resident Licenses				Harvest Projections										Land Hunted Most		
Unit Type	Appl. 1st Choice *	Avail.	Sold	Resp.	Success	Bulls	Cows	Bull Calves	Cow Calves	Total Elk Harvest	CI (95%)	Elk Shot Not Recover	Average Satisfctn Score	Average Days Hunted	Public	Own	Other Private
H1A-21	1,194	60	60	82%	76%	42	4	0	0	45	+/-3	1	5.88	8.0	54	5	0
H1B-23	45	20	20	80%	31%	0	6	0	0	6	+/-2	0	4.69	5.5	19	1	0
H2A-21	8,686	250	248	88%	79%	179	14	2	2	197	+/-5	23	5.84	7.2	225	12	3
H2B-23	227	75	72	90%	55%	0	34	2	3	40	+/-3	2	5.17	4.0	71	0	0
H2C-23	63	75	74	74%	31%	0	23	0	0	23	+/-5	3	4.36	3.6	57	0	4
H2D-23	10	25	24	79%	37%	0	8	0	1	9	+/-2	0	4.95	4.7	24	0	0
H2E-23	90	75	75	87%	54%	0	32	2	6	40	+/-3	2	5.21	4.6	72	0	0
H2F-23	74	75	73	76%	58%	0	40	3	0	42	+/-4	1	5.72	3.5	68	0	0
H2G-23	40	75	73	77%	79%	1	50	3	4	57	+/-4	8	6.26	2.5	64	0	0
H2H-23	7	15	14	93%	15%	0	2	0	0	2	+/-1	1	4.92	6.3	14	0	0
H2I-23	6	15	15	93%	57%	0	9	0	0	9	+/-1	2	6.00	3.1	10	0	0
H2J-23	4	15	15	87%	46%	0	6	1	0	7	+/-2	0	5.55	2.5	10	0	0
H3A-21	1,401	80	78	83%	82%	61	1	1	0	64	+/-3	5	5.86	5.6	41	20	13
H3B-23	18	15	15	87%	69%	0	9	0	1	10	+/-1	1	5.62	4.4	14	0	0
H3C-23	3	15	15	80%	58%	0	8	1	0	9	+/-2	0	5.50	3.4	15	0	0
H3D-23	3	15	15	73%	55%	0	8	0	0	8	+/-2	1	5.36	2.1	12	0	3
H3E-23	18	50	49	86%	43%	0	19	2	0	21	+/-3	1	5.10	4.0	26	1	18
H3F-23	20	50	50	84%	45%	0	21	0	1	23	+/-3	4	4.89	4.0	25	0	17
H3G-23	8	50	49	76%	32%	0	15	0	1	16	+/-4	1	4.30	4.0	40	0	3
H4A-21	65	10	10	80%	100%	9	1	0	0	10	+/-0	0	6.75	3.3	0	3	8
H4B-23	3	10	10	70%	43%	0	4	0	0	4	+/-2	0	5.14	7.3	4	1	3
H5A-21	65	5	4	100%	75%	3	0	0	0	3	+/-0	0	5.75	10.5	2	1	0
H7A-21	271	10	10	90%	100%	9	1	0	0	10	+/-0	0	6.89	7.6	7	1	1
H7B-23	15	10	10	70%	86%	0	9	0	0	9	+/-1	1	6.00	4.7	9	0	0
H9A-21	57	10	10	90%	100%	10	0	0	0	10	+/-0	1	6.67	4.3	0	3	7
H9B-23	3	20	20	85%	59%	0	11	0	1	12	+/-2	0	5.36	3.4	2	0	14
	12,396	**1,125**	**1,108**	**83.2%**	**61.9%**	**314**	**333**	**18**	**21**	**686**	**+/- 57**	**59**	**5.48**	**5.00**	**884**	**50**	**92**
															86%	5%	9%

The response rate for all units combined is: 83.2%

Satisfaction scale of 1=very dissatisfied to 7=very satisfied.

* Number of 1st drawing applicants with that unit as 1st choice.

Table 19. 2019 Prairie Elk season harvest statistics by unit.

2019 Prairie Firearm Elk Harvest Projections

Last Revised: 16 March 2020

	Resident License				Harvest Projections										Land Hunted Most		
Unit Type	Appl. 1st Choice *	Avail.	Sold	Resp.	Success	Bulls	Cows	Bull Calves	Cow Calves	Total Elk Harvest	CI (95%)	Elk Shot Not Recover	Average Satisfctn Score	Average Days Hunted	Public	Own	Other Private
09A-21	350	10	10	56%	60%	6	0	0	0	6	+/-3	0	5.6	9.8	0	0	10
09A-23	31	10	10	60%	100%	0	10	0	0	10	+/-0	2	6.8	4.7	0	0	10
11A-23	39	18	18	89%	88%	0	15	0	1	16	+/-1	0	6.1	2.9	1	0	17
11B-21	529	16	16	81%	69%	10	1	0	0	11	+/-2	0	5.2	6.4	5	5	6
11C-21	221	16	15	80%	67%	10	0	0	0	10	+/-2	0	4.4	4.3	4	4	6
11D-23	95	30	30	77%	65%	0	17	1	1	20	+/-3	0	5.5	4.2	1	1	25
15A-21	131	8	8	75%	0%	0	0	0	0	0	+/-0	0	3.8	10.5	0	3	4
15A-23	10	5	5	100%	0%	0	0	0	0	0	+/-0	0	3.3	5.4	0	2	2
27A-21	454	10	10	100%	70%	7	0	0	0	7	+/-0	0	5.7	9.0	2	3	4
27A-23	21	10	10	80%	50%	0	5	0	0	5	+/-2	0	5.8	5.1	5	0	5
35A-21	1,950	8	8	88%	86%	7	0	0	0	7	+/-1	0	6.4	7.6	5	2	1
	3,831	**141**	**140**	**79.9%**	**65.2%**	**40**	**48**	**1**	**2**	**91**	**+/- 13**	**2**	**5.43**	**5.73**	**24**	**21**	**87**
															18%	16%	66%

The response rate for all units combined is: 79.9%

Satisfaction scale of 1=very dissatisfied to 7=very satisfied.

* Number of 1st drawing applicants with that unit as 1st choice.

A total of 3 resident licenses were issued for the 2019 CSP Early Archery Elk season which was open from September 1-30. There was no Late CSP Archery season in 2019. Respondents reported hunting an average of 5.0 days for a total of 15 days of recreation (Table 20). All hunters reported harvesting adult bulls. Historic early and late season archery data for CSP can be found in Tables 13 and 14.

Table 20. Summary comparison of the 2014-2019 Custer State Park Early Archery Elk seasons.

Year	Applications	Licenses	Bull Harvest	Cow Harvest	Success	Avg. Days Hunted
2014	3,023	4	4	0	100%	8.8
2015	3,600	4	3	0	75%	16.3
2016	3,707	3	1	0	33%	15
2017	3,704	3	1	0	33%	9.7
2018	3,772	3	2	0	50%	11.0
2019	4,055	3	3	0	100%	5.0

A total of 9 resident licenses were issued for the 2019 CSP Firearm Elk season which was open from October 1-31. Season dates changed from a late September hunt to an early October hunt in 2018. Respondents reported hunting an average of 2.8 days for a total of 25 days of recreation (Table 21). All hunters reported harvesting adult bulls. Historic CSP firearm elk season table can be found in Table 11. There was no Antlerless CSP Firearm season in 2011-2015 and again in 2019 (Table 12 and Table 22).

Table 21. Summary comparison of the 2014-2019 Custer State Park Firearm Bull Elk seasons.

Year	Applications	Licenses	Bull Harvest	Cow Harvest	Success	Avg. Days Hunted
2014	8,084	4	4	0	100%	1.0
2015	9,136	8*	8	0	100%	1.9
2016	8,958	9*	8	0	89%	2.8
2017	8,828	9*	8	0	88%	2.3
2018	8,670	9*	8	0	86%	5.7
2019	8,949	9*	8	0	89%	2.8

*Licenses include one RMEF raffle tag valid in CSP or any Black Hills unit with an “any elk” tag type.

Table 22. Summary comparison of the 2014-2019 Custer State Park Firearm Antlerless Elk seasons.

Year	Applications	Licenses	Bull Harvest	Cow Harvest	Success	Avg. Days Hunted
2014	NA	Closed	NA	NA	NA	NA
2015	NA	Closed	NA	NA	NA	NA
2016	3,138	20	0	18	90%	2.2
2017	3,436	29	0	24	86%	2.1
2018	3,175	23	0	4	19%	3.4
2019	NA	Closed	NA	NA	NA	NA

Incisor Tooth Surveys

Successful hunters are required to check-in harvested elk to a SDGFP representative within 24 hours (ARSD 41:06:04:19), at which time the middle two incisor teeth are removed from the harvested elk for aging purposes. Numerous check stations throughout the Black Hills are also established during the elk season to provide better convenience for hunters. Age structure data are used to assess herd status and evaluate harvest strategies.

In 2019 approximately 720 usable elk teeth were returned from hunters. All Black Hills teeth visually determined to be > 1 year of age were sent to Matson's Laboratory (Manhattan, MT) to be aged using cementum annuli techniques. Of the 359 Black Hills firearm and archery bull teeth aged, 74% were assessed to be 4+ years of age or older (Figure 4). For CSP, 100% of the bulls harvested (11) were 4+ years of age.

In the past 10 years, ages of bulls harvested during the Black Hills firearm and archery seasons averaged 2% calves, 6% yearlings, 41% 2-3 year-olds, and 50% 4+ years of age. Since age data collection began in the Black Hills units in 1991, overall 34% of bulls harvested during the firearm and archery seasons have been 4+ years of age.

Elk harvest ages in the Black Hills have been very similar between 2017, 2018 and 2019 (Figure 4). The 20-year average for Black Hills unit bulls harvested in the firearms and archery seasons combined was 3% calves, 7% yearlings, 48% 2-3 year-olds, and 42% 4+ years of age.

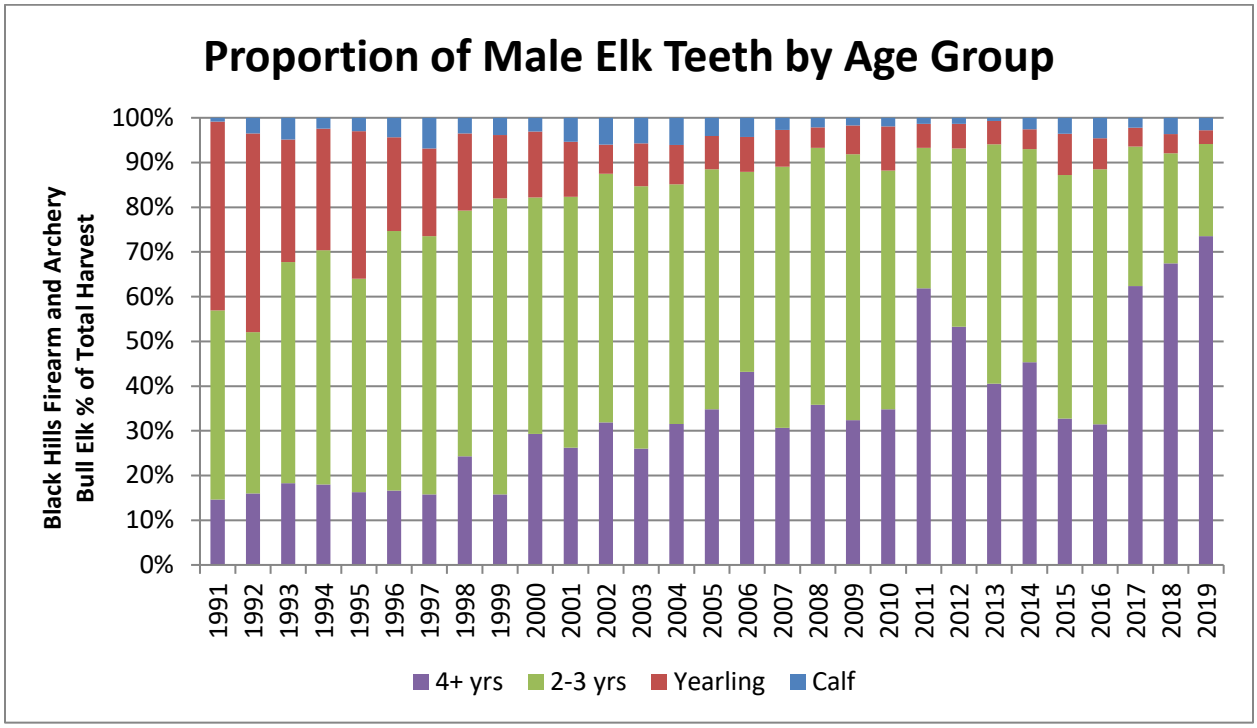


Figure 4. Age distribution of hunter harvested bull elk in the Black Hills firearm and archery seasons, 1991-2019.

Age structure data were also collected for all elk harvested in CSP. In 2019, 100% of elk harvested during the CSP firearm and archery seasons were 4+ years of age (Figure 5). In 2017-2019, ages of bulls harvested during the CSP firearm and archery seasons averaged 21% 2-3 years old, and 79% 4+ years of age.

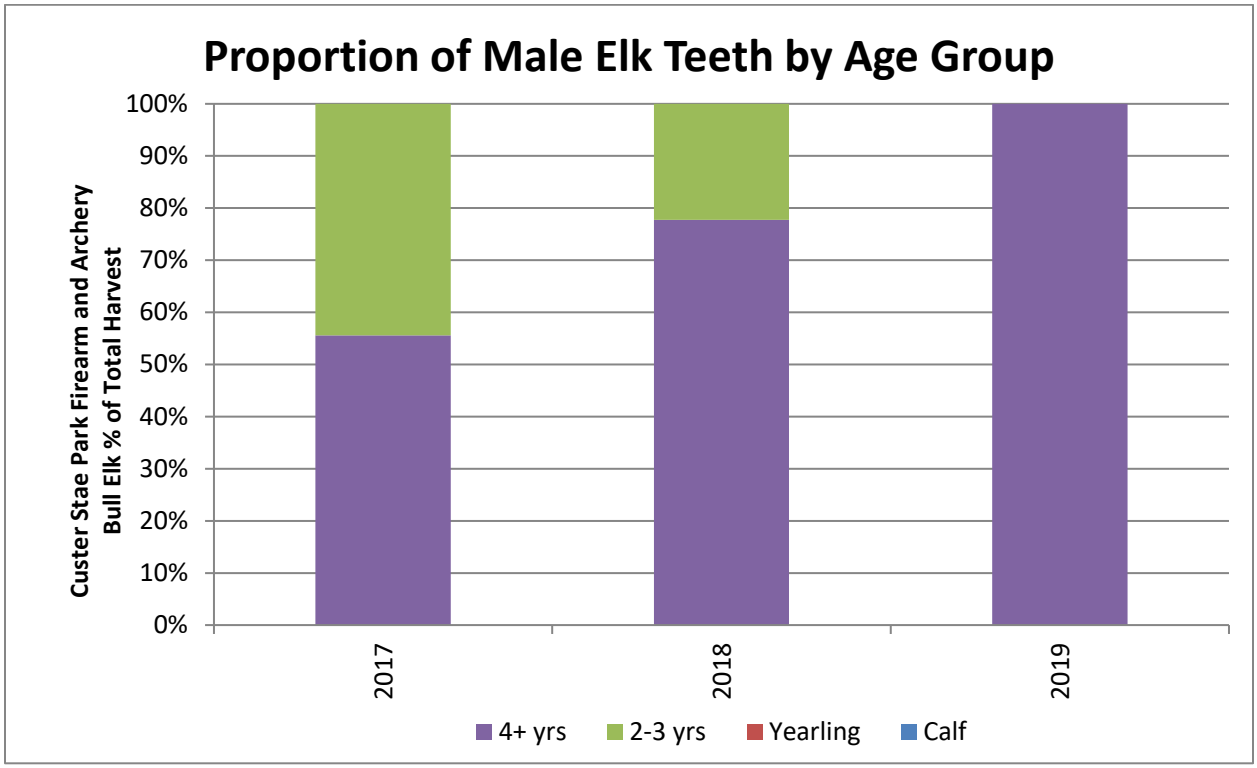


Figure 5. Age distribution of hunter harvested bull elk in the CSP firearm season, 2017-2019.

Aerial Surveys

Elk populations in the Black Hills of South Dakota have been surveyed using aerial survey methodology as early as the 1950s (Appendix 5). Early projections of elk were based on assumed detection probabilities from the aircraft, whereas later projections were based on sightability models developed in Idaho (Unsworth et al. 1991) and South Dakota (Jarding 2010, Phillips 2011). Early aerial survey efforts were usually restricted to sampling efforts within a single hunting unit, and although they may have represented elk densities in a few limited areas they were not sufficient to estimate elk numbers across the Black Hills.

Aerial surveys of elk in CSP began in 1948 using a fixed-wing aircraft. Aerial surveys were discontinued, and it was not until 1979 that continuous annual surveys were conducted. Elk populations were surveyed using helicopter survey methodology from 1979-2013 (Appendix 6). The entire park was flown at 300 feet AGL along transects ranging from 500-800 m apart. SDGFP staff flew 3 consecutive days in September for fall estimates and 3 consecutive days between January-March for winter estimates. Early projections (1979- winter 2010-11) of elk were based on a maximum subherd count with an assumed detection probability of 90% from

the aircraft, whereas later projections (fall 2011-2013) were based on a Poisson Mark-Resight model using radio-telemetry detection probabilities. Using the maximum subherd count method, the maximum number counted within each subherd during the three consecutive surveys was used in the final estimate. Fall counts were used primarily for determining demographic ratios (i.e., calf:cow, bull:cow) and the winter counts were used primarily to determine winter abundance following the hunting season.

In 2009 efforts began to develop an elk aerial sightability model specific to the Black Hills of South Dakota (Jarding 2010, Phillips 2011). Sightability trials using radio-collared individuals were conducted during January and February when elk were concentrated on wintering areas in 2009-2012. During model development the survey was flown using an R-44 helicopter with two observers and a pilot. The helicopter survey crews flew systematic search patterns following transects spaced 650-1,000 ft. apart, at speeds of 40-50 mph, and heights of 100-150 ft. above the ground. During the four years of data collection, survey crews flew over 176 groups of elk that contained at least one radio-collared individual. Crews detected 107 of the 176 groups on the first pass, indicating an overall sightability rate of 60.8%. Once an elk group was sighted, the search pattern was interrupted to collect information on group size, activity, % visual obstruction, % snow cover, light intensity, terrain ruggedness and to record a GPS location. If a group of elk was missed during the survey trial, the survey crew would then use radio telemetry to locate the group and collect the needed information.

Eighteen different logistic regression models were formulated in Program R using different combinations of predictor variables. The top two models, carrying 92% of the weight included: % visual obstruction, group size, % snow cover and activity. However, the p-value for activity was >0.05; thus indicating an insignificant variable. As a result, model averaging was performed for the variables % visual obstruction, group size and percent snow cover. The final model estimated elk sightability as $\mu = 0.1446 – 0.0361$ (% visual obstruction) + 0.1001 (group size) + 0.0158 (% snow cover) and was selected to correct for elk missed during the 2013 aerial survey work in the Black Hills.

In 2013, following declining elk populations and public discontent, SDGFP initiated an aerial survey of the entire Black Hills elk population including CSP. Aerial surveys of the entire Black Hills were completed in 2013, 2016, and 2020. In 2013, the elk population aerial estimate for the Black Hills hunting units (excluding WICA and CSP) and CSP was 5,077 (95% CI: 4,807 – 6,116) and 284 (95% CI: 202 – 712), respectively. The population estimate in 2016 was 7,185 (95% CI: 6,692 – 9,068) for the Black Hills hunting units and 455 (95% CI: 404 – 733) for CSP.

In 2020, approximately 277 hours of elk surveys within the Black Hills were conducted from February 06 to March 01, using three R-44 helicopters each carrying two observers and a pilot. The Black Hills was divided into 252 South Dakota subunits and 21 Wyoming subunits; 100% of these subunits were flown. Helicopter survey crews flew systematic search patterns (i.e.,

transects) within each subunit, spaced 650-1000 ft. apart, at speeds of 40-50 mph, and heights of 100-150 ft. above ground level. To avoid double counting, adjacent subunits were flown with minimal time delays. Once a group of elk was detected the search pattern was interrupted to record information on group size, % visual obstruction, % snow cover, and to record a GPS location. Pictures were taken and analyzed for groups that exceeded 50 individuals to ensure accurate counts (Figure 6).

Figure 6. Photo of elk herd during aerial sightability survey, 2016.

A total of 5,834 elk were counted in 2020 in the Black Hills hunting units excluding CSP and WICA National Park. The Program R "sightability model package" was used to formulate the

corrected population estimate and 95% confidence interval using the Wong variance estimator. The 2020 sightability model winter estimate of elk in the Black Hills (excluding CSP and WICA) was 6,483 (95% CI: 6,098 – 7,958) elk.

Within CSP, 435 elk were counted, and the model adjusted 2020 estimate was 457 (95% CI: 442 – 544). Survey crews also counted 1,519 elk in portions of the Wyoming Black Hills, with a model adjusted estimate of 1,687 (95% CI: 1,584 - 2,118) elk.

Aerial surveys provide information on the wintering distribution of elk in the Black Hills (Figure 7). However, because elk migrate between winter and fall hunting season, population models use previous years' harvest distribution to estimate the distribution of elk in the fall based on the Black Hills aerial survey population estimate. Unit license allocations and unit population estimates and trends are then combined to ensure overall Black Hills elk are managed within the established objective range.

Because of time and expenses required to accomplish aerial surveys, complete aerial surveys have been conducted once every 4 years. Population estimates from aerial surveys are compared with modeled population projections to validate modeling efforts in years without surveys.

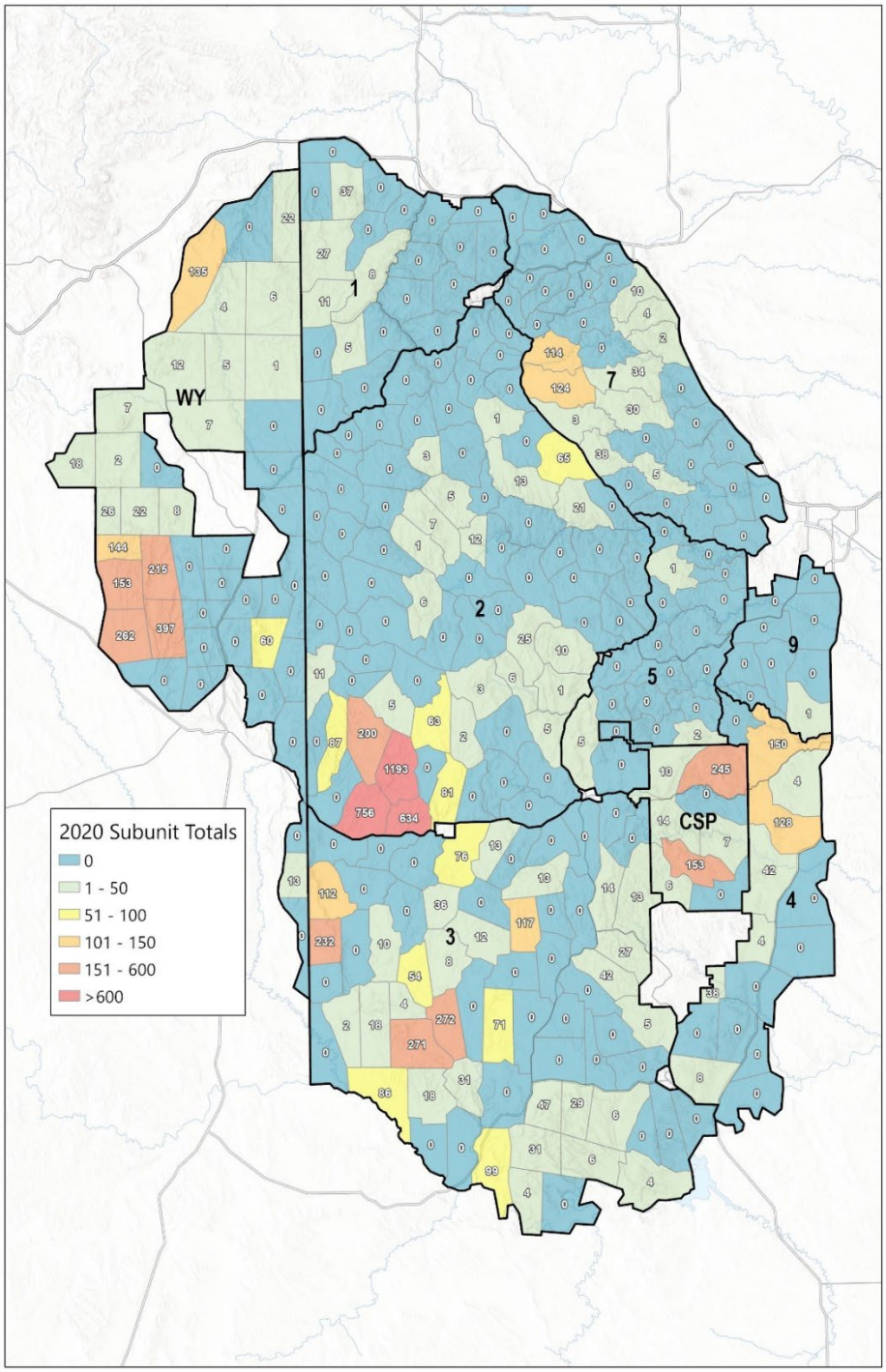


Figure 7. Aerial survey observations from winter sightability survey in 2020, Black Hills, South Dakota.

Herd Composition Surveys

Pre-hunting season herd composition surveys are completed by driving roads or hiking in areas of known elk concentrations in August. Surveys are concentrated in locations across the Black Hills according to where elk are distributed and can be observed. All elk herds that are observed in their entirety are classified to numbers of calves, cows, and bulls. Location and date of observations are also recorded to reduce double-counting occurrences. Herd composition survey data are analyzed to assess sex and age ratios.

Sex ratios are calculated as bulls:100 cows, but potentially could under-represent bulls as large calf/cow groups are likely more detectable during this time of year. Elk survey protocol during previous years allowed surveys to be completed in both August and September, but annual differences in ratios could be reflective of monthly observations if sampling strategies differed between years.

Age ratios are calculated as calves:100 cows and are used as an indicator of fall recruitment into the population. An annual recruitment rate is derived using fall age ratio data along with previously gathered survival rates of radio-collared calves from October through May.

In 2019, 1,363 elk were classified throughout the Black Hills and 188 in CSP during the fall herd composition survey. Age and sex ratios, along with binomial (95%) confidence intervals using groups as the sampling unit were calculated for each Black Hills and CSP. Herd composition in the Black Hills was 28 bulls:100 cows (95% CI: 24-32) and 43 calves:100 cows (95% CI: 37-48, Figures 8 and 9). The long-term 15-year bull ratio was 30 bulls:100 cows, while the 3-year average (2017-19) that was used in modeling predictions of future populations was 27 bulls:100 cows. The long-term 15-year fall recruitment average was 48 calves:100 cows, while the 3-year average was 43 calves:100 cows. In CSP, herd composition was 25 calves:100 cows (95% CI: 17-37) and 28 bulls:100 cows (95% CI: 19-39) in 2019 (Figure 8, Figure 9, Table 23, Table 24). In CSP, the long term 15-year average (2005–2019) was 36 bulls:100 cows while the 3-year average (2017-2019) was 28 bulls:100 cows. The long-term 15-year recruitment average was 30 calves:100 cows, while the 3-year average (2017-2019) was 42 calves:100 cows (Figure 9, Table 24).

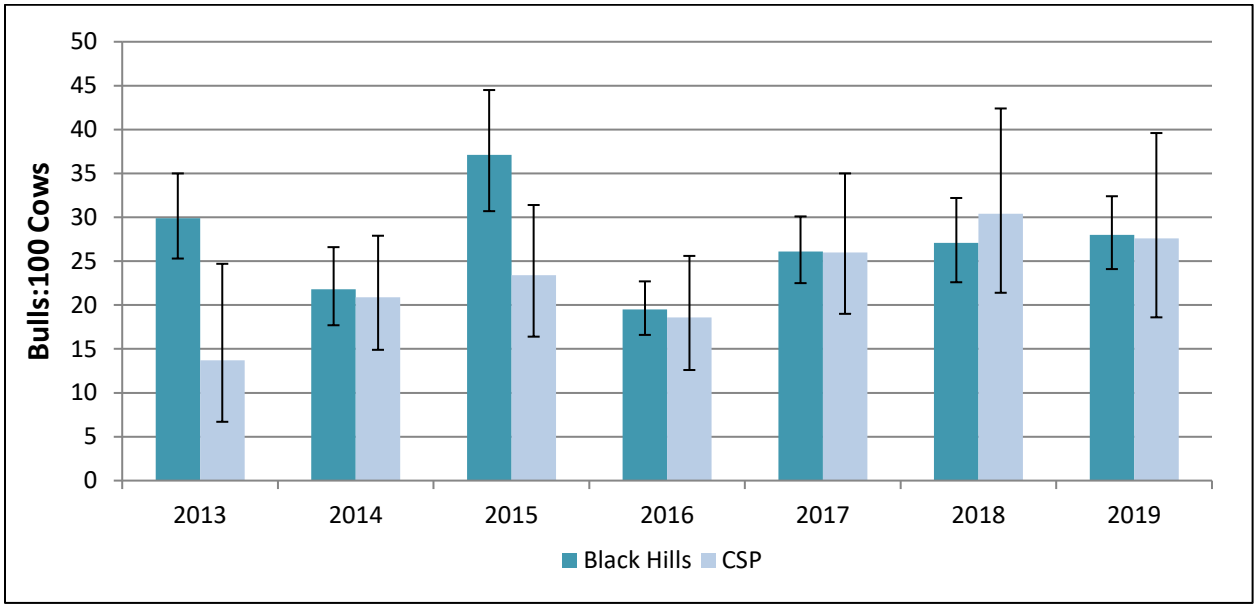


Figure 8. Fall sex ratios of elk (with 95% error bars) in the Black Hills and CSP, 2013-2019.

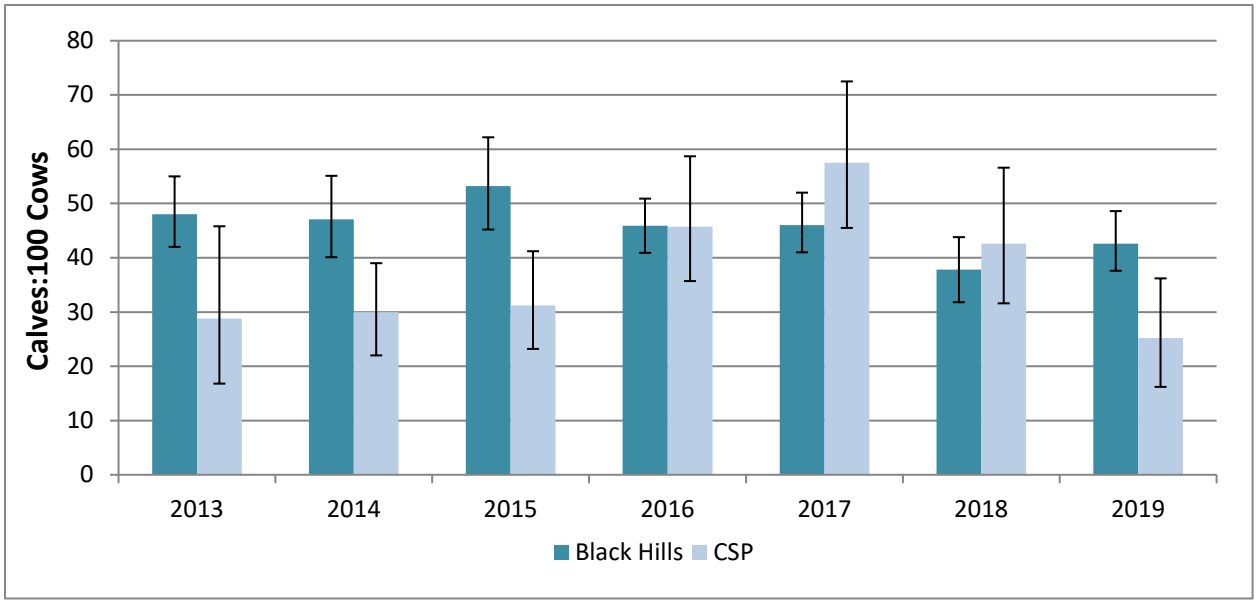


Figure 9. Fall age ratios of elk (with 95% error bars) in the Black Hills and CSP, 2013-2019.

Table 23. Herd composition surveys conducted in August and September using daytime vehicle ground surveys in the Black Hills, South Dakota, excluding Custer State Park, from 2005 to 2019.

Year	Total Classified	Bulls	Cows	Calves	Bull:100 Cow	Bull:Cow lower CI	Bull:Cow upper CI	Calf:100 Cow	Calf:Cow lower CI	Calf:Cow upper CI
2003	748	88	436	224	20.2	16.1	25.4	51.4	43.7	60.3
2004	816	140	454	222	30.8	25.5	37.3	48.9	41.7	57.4
2005	529	104	288	137	36.1	28.9	45.2	47.6	38.8	58.3
2006	222	30	129	63	23.3	15.7	34.5	48.8	36.2	65.9
2008	361	103	179	79	57.5	45.2	73.3	44.1	33.9	57.5
2009	1,208	165	685	358	24.1	20.3	28.5	52.3	46.0	59.4
2010	1,079	201	596	282	33.7	28.7	39.6	47.3	41.1	54.5
2011	1,140	145	651	344	22.3	18.6	26.7	52.8	46.4	60.2
2012	1,283	209	718	356	29.1	25.0	34.0	49.6	43.7	56.3
2013	1,131	190	636	305	29.9	25.4	35.1	48.0	41.8	55.0
2014	995	137	575	283	23.8	19.8	28.7	49.2	42.7	56.7
2015	784	153	412	219	37.1	30.7	44.5	53.2	45.0	62.5
2016	1,622	191	981	450	19.5	16.6	22.7	45.9	41.0	51.2
2017	1,511	229	878	404	26.1	22.5	30.1	46.0	40.9	51.7
2018	956	157	580	219	27.1	22.5	32.2	37.8	32.2	44.0
2019	1,363	224	799	340	28.0	24.1	32.4	42.6	37.4	48.2

Table 24. Herd composition surveys conducted in August and September using daytime vehicle ground surveys in Custer State Park, South Dakota, from 2003 to 2019.

Year	Total Classified	Bulls	Cows	Calves	Bull:100 Cow	Bull:Cow lower CI	Bull:Cow upper CI	Calf:100 Cow	Calf:Cow lower CI	Calf:Cow upper CI
2003	1060	200	628	232	31.8	27.0	37.2	36.9	31.7	42.8
2004	789	167	479	143	34.9	29.1	41.5	29.9	24.	35.9
2005	478	98	285	95	34.4	27.1	42.9	33.3	26.2	41.8
2006	203	53	106	44	50	35.7	69.0	41.5	28.8	58.3
2007	567	197	307	63	64.2	53.6	76.6	20.5	15.4	26.6
2008	275	92	157	26	58.6	45.1	75.5	16.6	10.6	24.4
2009	418	81	283	54	28.6	22.2	36.4	19.1	14.1	25.2
2010	150	68	71	11	95.8	68.6	133.8	15.5	7.5	27.5
2011	137	38	88	11	43.2	29.1	62.5	12.5	6.1	22.0
2012	55	4	38	13	10.5	2.8	25.0	34.2	17.2	61.9
2013	104	10	73	21	13.7	6.5	24.7	28.8	17.2	45.5
2014	332	46	220	66	20.9	15.0	28.3	30.0	22.5	39.2
2015	317	48	205	64	23.4	16.8	31.7	31.2	23.3	41.0
2016	327	37	199	91	18.6	12.8	25.9	45.7	35.4	58.2
2017	367	52	200	115	26.0	18.9	34.8	57.5	45.5	72.1
2018	256	45	148	63	30.4	24.4	41.9	42.6	31.4	56.7
2019	188	34	123	31	27.6	118.6	39.7	25.2	16.7	36.6

Herd composition surveys were conducted annually in CSP using fall helicopter surveys from 1979-2013 (Appendix 7). For fall helicopter surveys, the entire park was flown at 300 feet AGL along transects ranging from 500-800 m apart. CSP staff flew 3 consecutive days in September and recorded calf:cow and bull:cow ratios. From 1979-2013 herd composition counts resulted in an average calf to cow ratio of 35 calves per 100 cows (95% CI: 31-39) and an average bull to cow ratio of 30 bulls per 100 cows (95% CI: 24-36; Appendix 7). The range included a low of 13 calves and a high of 60 calves per 100 cows; for bulls the range included a low 7 bulls and a high of 96 bulls per 100 cows.

Population Models

Population projection models are used to annually estimate abundance when aerial estimates are not available, and project future elk populations and growth rates (λ). The two age-class sex-specific projection model has two stages within each year, the first represents new elk added to the fall population when calves are born and survive to the beginning of the hunting season, and the second stage removes elk that die each year from September 1 to August 31. Elk deaths are related to multiple causes, the majority include harvest, wounding loss, predation, vehicle accidents, starvation, and disease. The population projection is repeated across multiple years to evaluate changes in elk abundance as a function of proposed hunting season changes (Figure 10).

The model initiates with an estimate of fall adult elk in the Black Hills by multiplying the late winter helicopter survey population estimate by adult survival from March to September 1. Adult (>1 year old) bull and cow cohorts are then estimated by multiplying the fall population by 3-year averages from herd composition surveys. As an example, adult bulls are estimated by multiplying the fall adult population by the proportion of adult bulls (i.e., antlered elk) observed among all adult elk from herd composition counts. New calves are recruited into the fall population by multiplying adult cows by the proportion of calves observed among calves and cows from herd composition surveys. This completes the first stage of the projection model, accounting for fall calf recruitment (Figure 10).

The 2nd stage removes all deaths that are expected to occur annually from September 1 to August 31. Average annual mortality estimates for adult bulls, adult cows and calves (~3 to 14 months old), based on known fate data from radio-collared elk in the Black Hills, are used to remove deaths and project each cohort to the next year. Because changes to hunting licenses are used to increase or decrease annual mortality rates of antlered and antlerless elk, the model adjusts deaths based on increases or decreases to antlered and antlerless licenses. Assuming additive harvest mortality, changes in license type allocations from the previous year are multiplied by 5-year average license type success rates, and the resulting harvest difference for adult bulls, adult cows and calves is added to or subtracted from each cohort. Calves are then aged into the adult cohort, assuming a 50:50 sex ratio. This completes the annual cycle, resulting in a pre-fall recruitment population. The process is repeated for subsequent years as illustrated in Figure 10.

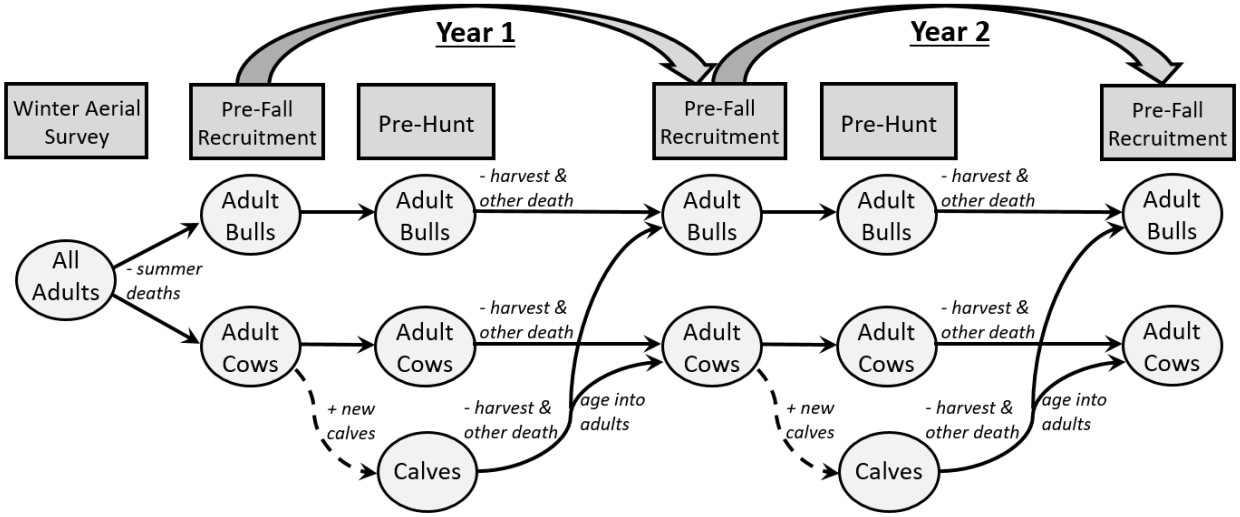


Figure 10. Graphical illustration of the elk population projection model used to predict population growth rates as a function of varying hunting season recommendations.

Data from aerial surveys in 2020 resulted in an estimate of 6,483 elk wintering in the Black Hills. A 3-year average of 27 adult bulls:100 adult cows from 2017-2019 fall herd composition data was used to estimate adult bulls and adult cows after multiplying the 2020 aerial survey estimate by adult survival from March 1 to September 1 (98%). Calves were recruited into the fall population by multiplying the adult cows by the 2017-2019 average of 43 calves:100 adult cows. Annual (Sep. 1 to Aug. 31) calf survival (75%), adult female survival (79%), and adult bull survival (70%), were used to project each population cohort to the next year, and changes in harvest were recommended that aligned population growth rate objectives with estimated λ from the model.

A different projection model is used in CSP to estimate abundance and rate of change during years when aerial estimates are not available. Data from aerial surveys in 2020 resulted in an estimate of 457 elk wintering in CSP. The aerial survey estimate is used to project the population through time using a Lefkovitch matrix model. The matrix model is a post-breeding model which includes male and female calves, male and female yearlings, 2+ year old males, 2-7 year-old females, and 8+ year-old females. Survival rates, pregnancy rates, and fecundity are used to estimate future abundance. Confidence intervals for annual abundance estimates are developed using Monte Carlo simulation methods, which fully accounts for uncertainty in all input variables. To predict how different tag recommendations impact growth rates, change in harvest is assumed to be additive, and harvest simulations are conducted to ensure CSP is maintaining the elk population objective.

Survival Monitoring

Obtaining knowledge of calf and adult elk survival rates is useful for understanding population dynamics and projecting elk trends in the Black Hills. Annual rates of change within an elk population are influenced primarily by adult female survival. Another important metric is the number of calves that reach one year of age. In 2012 and 2013, 71 neonatal calves ≤10 days old were captured and fitted with VHF radio collars. Data from the collars suggested a high survival rate of 75% (95% CI = 56-84%) from birth to one year old, and 12 of 16 mortalities were caused by mountain lion predation (Simpson 2015).

From 2015 to 2020, adult cow survival in the Black Hills was monitored annually by maintaining a representative sample of radio-collared cow elk. Adult cows were captured via helicopter dart gunning and chemically immobilized using a combination of butorphanol, azaperone, and medetomidine (BAM; ZooPharm, Laramie, WY). Immobilized animals were mostly monitored with VHF radio collars, but all 35 captured cow elk in 2020 were fitted with GPS collars to provide additional data on elk movements and habitat use. Blood samples were collected in previous years to evaluate pregnancy status, but these efforts were ceased in 2019 because precise ages were not collected on collared animals and thus results were determined to be of minimal value.

Monitoring alive or dead status occurred within 12-16 days post-capture and all mortalities (<16 days post capture) were labeled as capture-related mortalities, except for vehicle mortalities. Monitoring then occurred one time each month between the 1st -15th for each collared individual. All mortalities were investigated to verify death of the animal via physical evidence. In most cases, cause-specific mortality was not identifiable except for vehicle collisions and hunter harvest. Hunter harvest is an important metric used in population modeling and collar reporting by hunters is a vital step in obtaining the most accurate data possible. Survival rates are calculated from time-to-event data using a hierarchical piecewise constant hazard model, smoothed among monthly intervals. The multinomial distribution partitioned hazards to estimate cause-specific mortality rates that are used in population projection models (Table 25). Population models are heavily data driven and reliable abundance and trend estimates require statistically valid survival estimates.

Table 25. Black Hills adult (>1-year-old) cow elk annual survival and cause-specific mortality rates, 2015-2019.

Year	Survival	Harvest Rate	Other Mortality Rate	# Monitored
2015	87% (78 - 94%)	7% (2 - 13%)	6% (2 - 12%)	81
2016	76% (67 - 83%)	20% (13 - 28%)	5% (2 - 9%)	102
2017	70% (61 - 78%)	21% (14 - 30%)	9% (4 - 15%)	109
2018	82% (75 - 88%)	10% (6 - 16%)	8% (4 - 13%)	116
2019	85% (78 - 91%)	9% (5 - 14%)	6% (3 - 11%)	141

ELK RESEARCH IN SOUTH DAKOTA

Resource Selection

Elk habitat use was quantified by Rice (1988) via six radio-collared cow elk (598 locations) released from WICA into the BHNF. The majority of feeding sites were almost exclusively devoid of ponderosa pine overstory. When limited canopy did exist, it was in areas characterized by either bur oak (*Quercus macrocarpa*) or quaking aspen (*Populus tremuloides*). These areas were heavily utilized especially when such habitats comprised less than 1% of home range. The edge of openings experienced the greatest elk use and the level of use decreased with increasing distance from the forest interface. During the spring, summer and fall seasons, elk seldom ventured more than 90 meters (98 yards) from forest edges during daylight hours. However, during the onset of the rut and hunting seasons, use of forest edge openings changed drastically and elk use shifted to smaller openings (<5 acres) surrounded by forested cover. Observations during the winter months indicated elk use of openings greatly expanded and elk were often observed in the middle of openings over a 1/4 mile from forested areas. Openings created or maintained by both wild land fire and prescribed burns were extensively used year-round (Rice 1988). Millspaugh (1995) documented similar findings where 24 adult radio-collared elk within CSP exhibited high proportional use of meadows and burned areas especially during the winter months. Loafing and resting habitat use was highly variable and depended greatly on the weather conditions. In general, milder weather conditions resulted in greater elk use of more open canopy habitats. Conversely, adverse weather conditions (e.g., strong winds, extreme cold or extreme heat) caused elk to utilize habitats with a greater percentage of canopy closure (Millspaugh 1995). During July and August, feeding/loafing areas were selected within 800 meters of a water source (Rice 1988). Escape cover utilized was also variable and depended mainly on type, duration and repetitiveness of disturbance. Elk generally selected for dense stands of ponderosa pine (>75% canopy cover) in relatively rugged terrain during long or repetitive disturbance events (Rice 1988). Within CSP,

Millspaugh (1995) noted elk exhibited high use of pine stands in the summer, which may have been related to thermoregulatory and human disturbance factors.

Millspaugh et al. (1998) investigated 131 diurnal bed sites from 26 elk within CSP from 5 June – 30 August 1994 - 1996. Greater overstory canopy closure, tree basal area and lower microsite temperature were the variables contributing most to elk microsite use, all which corresponded to north facing slopes. These data suggest that thermoregulatory factors did influence where elk select summer diurnal bed sites within the Black Hills and management of sufficient thermal cover should be considered (Millspaugh et al. 1998). A similar study conducted by Rumble and Gamo (2011a) was conducted from 1998 – 2001. During this time, 412 locations from 52 radio-collared elk in the northern and central Black Hills were investigated; 225 of which were classified as bed sites and 187 as feeding sites. Stand and microhabitat were also quantified at 509 random sites for the resource selection analysis. Western snowberry was the most important variable for classifying bedded or feeding elk from random sites. Roads were the most definitive variable in separating random sites from elk sites, indicating the avoidance of roads. Rumble and Gamo (2011a) stated that as the BHNF continued to become a more open forest, increased forage for elk became available; however, an open to moderate canopy forest could be negated by the increased human disturbance associated to the high density of roads (Rumble and Gamo 2011a).

Within the central Black Hills, Stubblefield et al. (2006) investigated 28 environmental attributes potentially associated with elk summer range occupancy (773 locations) from 1998 – 2001. Within the entire study area, research findings indicated that elk concentrated in landscapes that emphasized forage potential. Summer elk locations were positively correlated with elevation, proportion of non-road-dissected habitat, shape complexity of meadows, proportion of forest stands with ≤ 40% overstory canopy cover, and proportion of aspen (*Populus tremuloides*). Elevation had the greatest association to elk locations which was thought to be related to increased forage potential via precipitation and the productive soil type (i.e., Stovho Soil Complex) present there. The proportion of intact habitat not divided by roads was the second highest ranked variable suggesting that elk avoided areas near roads open to motorized vehicles. Stubblefield et al. (2006) suggested making landscapes available where elk have the potential to distance themselves > 500 m (545 yards) from improved roads.

Within CSP, Benkobi et al. (2004) collected 12,067 locations of 21 female and 15 male elk from 1993 - 1997. From this a spatially explicit deterministic habitat model (Arc-Habcap) was developed to predict the habitat effectiveness for elk within the boundaries of CSP. Habitat effectiveness was best calculated using an arithmetic average of all model components (i.e., forage, cover and cover-forage proximity) and weighting the forage value by 3 because it was discovered that good forage habitats were used 3-6 times more than good cover habitats. It was also discovered that elk selected forage and cover areas ≤ 100 m from cover-forage edges and as a result areas 100 m (109 yards) or less from cover-forage edges received an optimum (i.e., 1) cover-forage proximity (HDV) rating. Arc-Habcap predicted that the area in close proximity to roads was ineffective elk habitat; however, elk used these areas of ineffective

habitat in the same proportion they were available; thus eliminating areas adjacent to roads was not supported by the data. Roads were further categorized into primary, secondary and primitive roads and it was noted that areas immediately adjacent to primary and secondary roads received relatively less elk use then habitats that were further away. Primary roads were found to have the greatest negative effects out to a distance of approximately 300-350 m (327-382 yards). Model predictions of habitat effectiveness did not depict elk dispersion patterns in CSP and the authors suggested substantial modifications were necessary in order to improve model performance (Benkobi et al. 2004). Further model testing was conducted by Rumble et al. (2007) using telemetry data collected in the Black Hills. From 1998 to 2001, Rumble et al. (2007) obtained 1,235 VHF daytime elk locations from forty-six cow elk and an additional 2,676 night locations via six GPS collared cow elk. The distribution of elk predicted by the ArcHSI model, relative to proximity of forage and cover, differed from the telemetry locations. Telemetry locations and the predicted distribution of elk relative to primary roads were similar; however, elk were located further from secondary roads than the model predicted. The predicted habitat suitability index (HSI) was also tested and output from the model was categorized as good (> 0.7), fair (0.42 to 0.7) and poor (≤ 0.42). Elk selected these areas in proportion to availability during summer but not winter. In both summer and winter, elk strongly selected areas that the model predicted to have good forage HSI and avoided areas that the model predicted to be fair or poor. Selection for areas predicted to have better forage was more pronounced during winter. Throughout the summer months, elk selected grasslands, aspen, and white spruce (< 40 percent canopy closure) for forage and use did not exceed availability for all structural stages of ponderosa pine. During winter, elk selected grasslands and ponderosa pine (< 40 percent canopy closure) for foraging while avoiding ponderosa pine that obtained 40 to 70 percent canopy closure (Rumble et al. 2007). Schmitz (2011) documented similar findings where elk selected for canopy cover ≤ 38% and avoided areas that had ≥ 86% canopy cover.

To assist in the National Environmental Policy Act (NEPA) process which mandates environmental analysis for land management projects that were likely to have a significant impact on wildlife and their habitats, Juntti and Rumble (2006) developed the Arc Habitat Suitability Index (ArcHSI) model, a geographical information system (GIS) model that estimated the ability of an area to meet the food and cover requirements of an animal species. The program used the Rocky Mountain Region Resources Inventory System (RMIS Data Dictionary 1988) to describe the potential of habitats based on the food (FV) and cover (CV) values for certain wildlife species, namely deer and elk. The habitat distribution of feeding and cover (HDV) and road effects were also incorporated into the model. The Habitat Suitability Index (HSI) was then calculated using the formula: $HSI = \frac{3FV+CV+HDV}{5}$. Effects of roads were modeled based on road classification (i.e., primary, secondary and primitive). ArcHSI model outputs included an ArcINFO coverage, INFO summary and an open ArcVIEW project. Generated HSI values were categorized as poor (0 – 0.33 HSI), fair (>0.33 – 0.67 HSI), or good (>0.67 HSI).

From August 1998 through October 2001, 76 radio-collared elk were monitored several times per month in an effort to determine vegetative characteristics of habitat use by male and

female elk in the western Black Hills of South Dakota (Rumble and Gamo 2011b). Six hundred and fifteen elk use sites and 509 random sites were characterized according to vegetation type. When elk utilized aspen stands, they utilized the stands for bedding and foraging equally. They were also more likely to select sites with less than 70% canopy cover. While utilizing grasslands, 98% of elk observations were recorded as foraging. When located in ponderosa pine stands with canopy cover from 0-40% (*n* = 232), elk were equally likely to be bedded or foraging. In pine stands with 41-70% (*n* = 180) canopy cover, elk were bedded 60% of the time and foraging 40% of the time. Elk utilized pine stands with greater than 70% (*n* = 20) canopy cover for bedding and foraging 65% and 35% of the time, respectively. Rumble and Gamo (2011b) reported that elk selected sites that provided 50-60% obstruction of a standing elk at 61 m which was less than what was reported for random sites.

As an effort to investigate resource selection pertaining to parturition sites, Lehman et al. (2016) captured and radio-marked 58 female elk ≥2 years of age and evaluated 100 parturition sites from those females during the birthing season from 2011 -2013 within CSP and the central Black Hills. At the largest macrohabitat scale there was no observed evidence that female elk selected parturition sites to reduce risk of predation; rather they selected sites in areas with greater proportions of open canopy stands, intermediate rugged topography, and lower road densities (Lehman et al. 2016). This suggests that parturient elk may be fundamentally influenced by forage availability and human disturbance, rather than predation risk, at larger scales. At the microhabitat scale female elk selected areas closer to water and avoided roads. Further, at the microhabitat scale, there was some evidence of selection for different predator avoidance strategies depending upon landscape characteristics. Within coniferous forests, females selected parturition sites with security cover exhibiting intermediate obscurity which might allow elk to better visually detect approaching predators. However, in grasslands, females selected parturition sites with less visibility which might provide hiding cover for dam and calf. Selection of macrohabitat primarily for forage availability may have been required to meet the nutritional demands of lactation. Similar findings were documented by Rice (1988) where five calving sites were investigated to quantify habitat use. The five sites had three similar characteristics: 1) all were located in openings less than 1 acre in size; 2) ground cover consisted of herbaceous vegetation, shrubs and downed timber; 3) at least one side of the opening was adjacent to a stand of dense ponderosa pines with virtually 100% canopy closure. Unfortunately, none of the research evaluated calf survival as a function of parturition site selection, as a result it was unclear whether management activities that increase resources that were selected for would indeed enhance survival. As an example, it was clear elk avoid roads. However, before implementing a management strategy to reduce road density or close roads in the Black Hills, it would be prudent to identify an increase in elk survival in areas with less roads.

Roads and Human Disturbance

The BHNF has the greatest road density (2.2 mi/mi^2) of any other national forest in the country (USDA 1997). To quantify the potential impacts of high road densities and increased human activity towards elk, Rumble et al. (2005) equipped GPS telemetry collars onto two bulls and six cow elk to quantify movements during three consecutive hunting seasons (i.e., limited entry archery elk, limited entry firearm elk, and limited entry firearm deer). Movements increased on the opening weekends of each hunting season and an increase of activity was also observed the day after Thanksgiving during the firearm deer season. Throughout the three hunting seasons, elk dispersion patterns relative to roads varied. Elk were closer to primary and secondary roads during the archery season. As human disturbance increased during the firearm deer and elk seasons, elk movement increased and avoidance of primary and secondary roads was observed. The greatest distance between successive daytime elk locations occurred the last week of the firearm deer season which coincided with the highest quantified hunter-days. Foraging behavior also changed once the hunting seasons began. Before the hunting seasons, elk selected open grassland meadows during daylight periods and avoidance of open meadows was documented when hunting seasons began. Elk responded to increased human disturbance most notably by increasing movements. Weight loss by elk during the late fall and winter could occur as a result of the additional energy expenditures caused by human disturbance, and elk occupying the BHNF could benefit from additional road closures and reduced human disturbance (Rumble et al. 2005).

Elk and hunter space-use sharing in CSP was investigated from 1993 – 1996 via 36 adult radio-collared elk (21 cows and 15 bulls). Space-use sharing was negatively correlated to increased hunter density, secondary road-use and tertiary road density (Millspaugh et al. 2000a). Also, space-use sharing occurred less in areas dominated by overstory-killed habitat and more in areas dominated by heavily forested habitats. Over the four seasons analyzed (i.e., early archery, trophy rifle, antlerless rifle, and late archery) space-use sharing for cow elk and hunters was lowest during the late archery season while bull elk exhibited the lowest space-use sharing during the trophy rifle hunt. Space-use sharing was highest for both bulls and cows during the early archery season which was thought to be a bi-product of the lower hunter densities (Millspaugh et al. 2000a). Elk avoidance of roads was found to be correlated with season, time of day, and amount of traffic. Elk were most tolerant of roads in winter and least tolerant during the summer months when human disturbance was greatest. Elk avoided areas that were occupied by humans and selected those areas when humans were not present (Millspaugh 1995). Flight response during daylight hours was generally one mile from any human caused disturbance. During the night, flight response toward human disturbance decreased to around ¼ mile (Rice 1988).

Rice (1988) noted via anecdotal observations, hunter disturbance had the greatest effect on elk movements and habitat use. Feeding areas used just prior to the hunting seasons were either abandoned or used exclusively at night and use on small openings next to escape cover increased greatly. Thick stands of ponderosa pine with virtually 100% canopy closure were

utilized greatly during the hunting seasons. Presence of cattle also caused alterations in movements and habitat use. Visual observations indicated when cattle were introduced into a pasture used by elk, the elk either vacated the pasture or used areas within those pastures not occupied by cattle. Changes in feeding behavior appeared to be the result of space competition rather than forage. Elk responses to timber harvest was variable as some individuals vacated areas of logging disturbance entirely and others returned to areas periodically when disturbance ceased (e.g., weekends) or immediately after logging activity was completed. However, timber harvest occurring during the study was limited; as a result, few observations were recorded.

Mountain Pine Beetle

Mountain pine beetle (*Dendoctronus ponderosae*) outbreaks over the last twenty years have created disturbance across much of the Western United States elk range, including the Black Hills. Recent research in Colorado (Ivan et al. 2018), Montana (Lowrey et al. 2020) and Wyoming (Lamont et al. 2019) has evaluated changes in elk resource use related to pine beetle-affected forests. While researchers agree forage production was increased in pine beetle-affected forests because of increased understory growth when mature coniferous trees were killed (Ivan et al. 2018, Lamont et al. 2020), there is contradicting results about elk selection for beetle-affected areas. At the study area scale, Lamont et al. (2019) found elk were less likely to use beetle-affected areas in the summer, mostly during daylight hours, instead choosing green coniferous bedding areas, but as disturbance by hunters increased during the fall, the elk selected for beetle-affected areas (Lamont et al. 2020). During crepuscular, feeding hours, avoidance of beetle-affected areas decreased, and within their home range, there was no selection for or against beetle-affected areas (Lamont et al. 2019). Lamont et al. (2020) discussed relatively little human disturbance occurred during the summer in their south-central Wyoming study area compared to significant hunting pressure in the fall when elk switched their preference toward beetle-affected areas for hiding cover during the day. In contrast to the Wyoming study area, the Black Hills National Forest, with the greatest road density of any National Forest, receives high rates of human disturbance in both the summer, from recreational vehicles and hikers, and during the fall hunting season. As a result, elk in the Black Hills may be more likely to select hiding cover provided by beetle-affected areas during the day in the summer when disturbance is relatively high, similar to resource use during the fall in Wyoming. Further, Ivan et al. (2018) found elk occupancy was positively correlated with beetle-affected forests throughout Colorado during all phases of the mountain pine beetle outbreak. In conclusion, while results were inconclusive whether or not elk were using beetle-affected areas more than when they were green coniferous forests, there was consensus beetle-affected areas provide additional forage that may result in less competition for forage with cattle grazing in grassy meadows.

Movements and Home Range

From June 1973 to February 1975, 32 elk were marked with ear flags, color banded collars, or radio collars within WICA as an attempt to document herd organization, movements and distribution. Marked elk were observed 713 times and located 113 times via telemetry. Three relatively distinct cow-calf herds were identified. The three herds were classified as northwestern (Beaver Creek), east (Boland Ridge), and southwestern (Gobbler Knob), occupying areas between 4.5 mi^2 - 10.0 mi^2. Intermingling between herds occurred during brief periods in January and February and it was documented that only a few elk crossed the west fence into the BHNF during spring, summer and early fall. Elk use appeared to be greater on east and south facing slopes and elk seemed to avoid steep slopes during all seasons (Varland et al. 1978).

In 1980, 1985 and 1986, 85 elk were transplanted from WICA to 6 different release sites within the BHNF. Release site locations included CSP, Mud Springs, Pass Creek, Deerfield Lake, Medicine Mountain and the Castle Creek drainage. Released individuals were marked with ear-tags, neck collars or radio collars. Data collected through visual observations and six radio-collared individuals, indicated no capture myopathy occurred as a result of the transplants. Approximately 83% of all transplanted elk joined existing resident elk herds. The remaining 17% returned to WICA after being released (Rice 1988). Of those that were released at the CSP site (*n* = 20), 7 returned back to WICA. Of the 13 that remained within or adjacent to CSP, annual home range size varied between 6 - 15 mi^2. From 1981 to 1986, 7 were legally harvested and one was poached, resulting in an overall harvest rate of 61.5%. Elk released in 1980 near Mud Springs (*n* = 10) demonstrated increased movements resulting in larger home range sizes, ranging from 18 – 30 mi^2. Three of the 10 elk were harvested over the five-year period. In 1985, an additional 17 elk were transplanted to the same release site and 6 of the 17 (35%) were harvested during the 1985 and 1986 hunting seasons. Of the 11 elk originally released at the Castle Creek drainage site, three returned to their original home range in WICA and four were legally harvested from 1981 through 1986, resulting in a 50% harvest rate. Elk released near Medicine Mountain (*n* = 10) also demonstrated extensive movements, establishing numerous small home ranges between movements. Harvest rate over the 5-year period was 40%. In 1985, 17 elk were released in the Pass Creek/Martin Draw area, of which, two returned to WICA. Seven of the remaining 15 were legally harvested during the 1985 and 1986 hunting seasons. In 1986, four previously marked elk that had returned to WICA were re-released to Deerfield Lake. No observations from this transplant were made (Rice 1988).

Within CSP, twenty-four adult elk (14 cows and 10 bulls) were captured and fitted with VHF radio collars from 1 July – 30 August 1993. From July 1993 through September 1994, radio-collared individuals were relocated 2-5 times per week resulting in 3,145 telemetry locations (Millspaugh 1995). Throughout the study, elk in CSP were segregated into five distinct cow-calf herds and five bull herds with annual home ranges overlapping 18% (*n* = 5, SE= 3.2) for cows and 27% (*n* = 6, SE = 5.8) for bulls. Mean 95% annual home range size was 19.5 mi^2 for cows and 23.5 mi^2 for bulls. Home range sizes differed ($P<0.05$) for bulls between fall and winter, fall

and summer, spring and winter, and spring and summer. Sizes of home ranges for cows differed between fall and winter, fall and spring, and fall and summer. Radio-collared individuals did not exhibit migratory behavior and were considered residents (Millspaugh 1995). Herd organization of cow elk in CSP was further investigated from 1994 – 1997; research findings indicated five distinct resident cow herds remained within CSP, each utilizing a specific area within the park. Throughout the duration of the study, subherd range sizes were variable ranging between 5.9 mi^2 – 25.9 mi^2 in size. Minimal range overlap was observed among subherds during any season and range sizes varied across years. Low site fidelity in both summer and winter was observed along with changes in use patterns within herd ranges. This was attributed to habitat alteration (e.g., logging), human activity (e.g. hunting, hiking, wildlife viewing), changes in matriarchal leadership of elk and differences in sampling approach (Millspaugh et al. 2004).

Within WICA, twenty elk (10 males, 10 females) were radio-collared and monitored from May 1996 to August 1997. From the 1,595 locations collected, two distinct cow herds were identified. Home range size (95%) for cows during winter averaged between 8.8 mi^2 – 16.2 mi^2. Summer 95% home range size averaged between 10.2 mi^2 – 21.6 mi^2. Summer 95% home range size of bulls within the park did not differ. Back and forth movements of elk across the WICA boundary fence and the BHNF in the south west corner of WICA were equal and frequent. Using the line/weight method, reports of elk moving into the park were 582 and reports moving out were 554. Movement across the boundary fence was greatest in spring, with 52.1% of total movements out of the park occurring between May - July (Bauman et al. 1999). Through the analysis of photographs, video footage, and visual observations, Bauman et al. (1999) noted that if elk were not disturbed they would spend considerable time (i.e., several minutes) at the fence before jumping. Three experimental one-way gates were installed in 1999 and monitored. Results indicated that the one-way gates were an effective tool to allow elk to leave WICA but not return (Bauman 1998).

Benkobi et al. (2005) investigated elk movements and home range size by monitoring 48 radio-collared cow elk in the northern and central Black Hills between August 1998 and October 2001. Females occupying the northern study area tended to move in a northeasterly direction during winter; however, migratory behavior was not consistent or definitive, as some elk remained on portions of their established summer range. This was contrary to elk occupying the central part of the Black Hills where a more distinctive migration pattern from north to south existed between summer and winter ranges. Mean migration dates from summer to winter range was 23 November (95% CI = 11 days) and from winter to summer, 18 April (95%CI = 6.5 days). The migration by elk in the central study area coincided with snow depths of approximately 20 cm or greater and variation in migration dates to the winter range was attributed to annual variation in snow accumulation. Little evidence of interstate movements between South Dakota and Wyoming existed during the duration of this study and elk that resided on the Wyoming side appeared to be year-round residents (Benkobi et al. 2005).

Home range sizes varied greatly between the northern and central study areas in both winter and summer seasons. In the northern Black Hills, winter home range size averaged 40.3 mi^2 (SE= 2.0) and in the central study area average winter home range size was 137.0 mi^2 (SE= 7.8). Summer home range size averaged 38.5 mi^2 (SE = 1.6) in the northern study area and 63.0 mi^2 (SE = 2.3) in the central study area. Larger summer home ranges of elk were correlated to greater road densities because human disturbance increases elk movements and alters behavior. Summer home ranges in the northern and central Black Hills were 2.8 to 4.5 times larger than home ranges of elk in CSP which may be explained by the total road densities being two times greater in the central and northern Black Hills compared to road densities in CSP (Benkobi et al. 2005). Furthermore, site fidelity was investigated for 25 (20 cows and 5 bulls) elk that were available during three consecutive summers. Findings indicated only one of the 25 elk used a significantly different summer range within the 3-years (Stubblefield et al. 2006).

From 1 January 2007 – 1 May 2010, 105 elk were captured and fitted with VHF (*n* = 83), store-on-board GPS (*n* = 17) and live-uplink GPS (*n* = 5) radio-collars in the Black Hills of South Dakota. To document movements relative to management unit boundaries and cause-specific mortality factors, 51,737 locations were collected and for accuracy purposes 50,486 GPS locations were used to determine movements. Results indicated 73% of collared elk utilized more than one game management unit (GMU) throughout the year and 30% were located in multiple GMU during the hunting seasons. Cow elk annual home range size averaged 54.2 mi^2 (*n* = 10, SE = 14.9). Cow seasonal home range size was 16.9 mi^2 (*n* = 17, SE = 2.9) during summer and 21.2 mi^2 (*n* = 10, SE = 5.8) for winter (Schmitz 2011).

Population Dynamics

Mortality and recruitment of elk occupying WICA were investigated as an effort to quantify the effects of CWD and cougar predation. From 2005 – 2009, 202 elk (83 subadult males and 119 subadult/adult females) were fitted with GPS collars. Twenty-eight mortality events were documented involving collared individuals and an additional 42 mortalities from unmarked elk were investigated throughout the course of the study. Of the 70 deceased elk investigated, 53 were tested for CWD (16 natural causes, 14 cougar predation, 8 vehicle collisions, 9 hunting/wounding loss, 2 fence entanglements, 2 rut-related injuries and 2 unknowns); of which, 18 were positive. Twelve of the 16 (75%) elk that died from natural causes tested positive for CWD. Annual survival rates were similar for males and females and averaged 86% (SE = 0.025). Leading causes of annual mortality (0.14) included hunting (0.07, SE = 0.019), CWD (0.03, SE = 0.012) and cougar predation (0.03, SE = 0.012). Pregnancy rates for subadults was 9.5% (*n* = 21, SE = 6.6%) and adults 76.9% (*n* = 104, SE = 4.2%). Average calf perinatal survival rates (1 February – 1 September) were 0.49 (SE = 0.085) (Sargeant et al. 2011).

Sargeant et al. (2011) emphasized that CWD was not known to occur within WICA until 2002; thus, 3% annual loss associated to the disease was a noteworthy statistic and greatly exceeds rates quantified in the greater Black Hills. It was believed that high elk densities facilitated the rapid spread within WICA. It was further noted that the effects of CWD, increased predation,

and reduced recruitment have reduced the rate of increase for elk occupying WICA to approximately λ = 1.00 (SE = 0.027) during the past decade (2000 – 2010; Sargeant et al. 2011). Jacques et al. (2003) investigated elk CWD prevalence during the 1998-99 and 2001 elk hunting seasons. A total of 537 hunter-harvested elk collected primarily from the southern Black Hills and CSP were tested for CWD and overall prevalence of infection was 0.0%.

From 1 January 2007 – 1 May 2010, 105 elk (76 females, 29 males) were monitored throughout the Black Hills of South Dakota. Cow elk annual survival rates in 2007, 2008 and 2009 were 56% (*n* = 39, SE = 0.06), 68% (*n* = 41, SE = 0.06) and 62% (*n* = 45, SE = 0.06) respectively. Annual survival rates for radio-collared bull elk in 2007, 2008 and 2009 were 90% (*n* = 10, SE = 0.09), 57% (*n* = 14, SE = 0.1) and 53% (*n* = 19, SE = 0.1), respectively. Throughout the duration of the study, 62 mortalities were documented, of which hunter harvest accounted for 77% (66% harvest, 11% wounding loss; *n* = 48), predation 11% (*n* = 7), road-kills 3% (*n* = 2) and unknown 8% (*n* = 5; Schmitz 2011).

To investigate the declining elk population in CSP and adjacent elk management units, Lehman et al. (2017) captured and radio-marked 58 female elk ≥2 years of age and 125 calves during the parturition season. Yearling elk (1 – 2 years old; n=14) were monitored for annual survival from calves that survived to 1 year old. Annual survival for female elk ≥2 years of age varied from 80% (*n* = 40, SE = 0.06) in 2011 to 93% (*n* = 42, SE = 0.04) in 2013. Yearling survival was 94% (*n* = 14). Calf survival varied from 7% (*n* = 30, SE = 0.04) in 2011 to 27% (*n* = 37, SE = 0.08) in 2012. Lambda varied from 0.87 in 2011 to 1.01 in 2013 (Lehman et al. 2017).

In a companion study to Lehman et al. (2017), Simpson (2015) radio-marked 40 female elk ≥2 years of age during the winter of 2012. Thirty-five of these radio-marked elk were recaptured in the winter of 2013 and an additional 9 female elk ≥2 years of age were radio-marked. During the two parturition seasons, a total 71 calves were radio-collared and monitored throughout the study. Annual female elk survival ≥2 years of age was 87% (*n* = 40, SE = 0.06) in 2012 and 83% (*n* = 43, SE = 0.04) in 2013. Annual calf survival was 65% (*n* = 37, SE = 0.04) in 2012 and 76% (*n* = 34, SE = 0.08) in 2013. Pregnancy rates of adult elk varied significantly between years with 93% (*n* = 40) in 2012 and 66% (*n* = 43) in 2013 (Simpson 2015).

Since 2015, adult cow survival in the Black Hills was monitored annually by maintaining a representative sample of radio-collared cow elk. As of March 2020, there were 149 cows being monitored approximately once monthly to assess annual survival rates and cause-specific mortality. Adult cow harvest correlated very closely with cow elk harvest rates (R^2 = 0.99) and annual cow elk mortality rates (R^2 = 0.91; Table 26).

Table 26. Black Hills adult (>1-year-old) cow elk annual survival and cause-specific mortality rates, 2015-2019.

Year	Survival*	Harvest Rate	Other Mortality Rate	# Monitored	Cow Elk Harvest
2015	87% (78 - 94%)	7% (2 - 13%)	6% (2 - 12%)	81	345
2016	76% (67 - 83%)	20% (13 - 28%)	5% (2 - 9%)	102	724
2017	70% (61 - 78%)	21% (14 - 30%)	9% (4 - 15%)	109	682
2018	82% (75 - 88%)	10% (6 - 16%)	8% (4 - 13%)	116	402
2019	85% (78 - 91%)	9% (5 - 14%)	6% (3 - 11%)	141	354

*Survival rates were calculated from time-to-event data using a hierarchical piecewise constant hazard model, smoothed among monthly intervals. The multinomial distribution partitioned hazards to estimate cause-specific mortality rates.

Lehman et al. (2017) evaluated population dynamics as a function of empirical calf and adult female survival and pregnancy rates from 2011 to 2015. Results suggested an increasing population (λ = 1.03; 95% CI = 0.93-1.13) in CSP, and similar to other ungulate population dynamics, growth was primarily driven by adult female survival, although calf survival, with greater variation than adult survival, can influence the majority of year-to-year variation in lambda. Changes in elk populations in 2013 ($\widehat{N}$ = 5,064), 2016 ($\widehat{N}$ = 7,185), and 2020 ($\widehat{N}$ = 6,483), estimated from aerial helicopter surveys, as a function of variable antlerless harvest management, affecting adult female survival, strongly support sensitivity of adult female survival and follow growth rates predicted by Lehman et al. (2017; Table 26). Population growth rate management objectives to increase elk abundance in the Black Hills from 2013 to 2016 were met by reducing antlerless elk harvest tag allocation, resulting in an annual growth rate of 12% each year. Subsequent desires to reduce the elk population in the Black Hills were similarly met with an increase in "antlerless elk" license allocation between 2016 and 2020, resulting in an average population reduction of 3% each year.

Sightability

Lanka et al. (1993) attempted to determine if the winter sightability model developed in Idaho by Samuel et al. (1987) could produce accurate elk population estimates in Black Hills habitats during the summer. A systematic drive count took place within WICA on 29 August 1992 utilizing 65 stationary line observers and 165 drivers. Due to logistical reasons (e.g., gaps within the drive line, poor communication, loss of daylight), a portion of WICA was not sampled. The 364 elk counted during the survey was considered a minimum count. Aerial surveys were flown in September 1992; the areas sampled by the drive count were flown twice and the estimates for trial one were 241 (+/- 55) and trial two were 302 (+/-57). Lanka et al. (1993) noted that the

variability was likely caused by elk behavior (e.g., bedded elk in forested habitats) during late morning and early afternoon and the fact that the model being tested was developed during winter when elk were more active, in larger groups, and occupied more open habitats. Model accuracy between surveys was below expected at 73% (Lanka et al. 1993).

Anderson et al. (1998) examined the precision and accuracy of two summer helicopter sightability models that were developed for elk in Wyoming. Significant variables in model A included group size, activity and percent canopy cover where Model B used two variables, elk group size and percent canopy cover. Both models A and B were also compared to a winter elk sightability model developed in Idaho that incorporated group size, percent vegetation cover, and percent snow cover. The models were tested and compared against well-documented populations of elk in Wind Cave National Park and Starkey Experimental Forest and Range. Model estimates of elk abundance were more accurate and precise from Model B, suggesting elk activity had little influence on summer elk detection. Comparisons of the Idaho model and Model B were similar for small groups of elk (≤ 10 elk); however, the Idaho model overestimated detection of large groups (30-45 elk/group) in moderate canopy cover (> 30% vegetation cover); thus the authors recommended using Model B during summer elk surveys where elk occurred in larger groups (i.e., >20) and suggested using the Idaho model during summer surveys where elk occurred in smaller groups (i.e., < 20).

In January 2007, 40 adult female and 10 adult male elk were captured and radio-collared as part of an elk movement study conducted by SDGFP personnel. During the study, survey crews flew over 63 groups of elk that contained at least one radio-collared individual. Crews detected 40 of the 63 groups on the first pass, indicating an overall sightability rate of 63.5%. Logistic regression analysis indicated that combined percent vegetative cover and group size had the greatest impact on sightability (Jarding 2010).

As an effort to increase sample size of elk sightability observations from Jarding (2010) and improve model selection, sightability trials were flown in the winters 2010 and 2011 when variable snow conditions existed. The helicopter survey crew (a pilot and two observers) followed the survey protocol developed by Jarding (2010). Throughout the three years, 89/152 groups were detected that included at least one radio-collared elk. Overall sightability was 58.6%. The best selected model included percent vegetation, group size, and percent snow cover, which correctly classified 73.7% of the 152 observations. Group size had the greatest effect on elk sightability and groups containing > 50 individuals had detection probabilities >95%. Percent vegetation cover had a negative effect on detection while snow cover had a positive effect (Phillips 2011). Sightability trials continued in 2012 by SDGFP personnel to improve model selection when snow cover existed. Twenty-four observations were added to the analysis, with an average detection probability of 75%. During the four years of data collection, survey crews flew over 176 groups of elk that contained at least one radio-collared individual. Crews detected 107 of the 176 groups on the first pass, indicating an overall sightability rate of 60.8%. The top two models, carrying 92% of the weight included: percent visual obstruction, group size, percent snow cover and activity. Model averaging was

performed for the variables percent visual obstruction, group size and percent snow cover. The final model estimated elk sightability as $\mu = 0.1446 – 0.0361$ (percent visual obstruction) + 0.1001 (group size) + 0.0158 (percent snow cover) and was selected to correct for elk missed during the 2013, 2016 and 2020 aerial surveys in the Black Hills (SDGFP, unpublished data). Furthermore, ground detection was investigated by Jarding (2010) via spotlight surveys from 10-21 August of 2008 and 2009 between Hill City and Deadwood. During the two years of surveys, 29 groups containing 88 elk were observed. Distance sampling analysis could not be performed because of small sample sizes and it was noted that road transects and distance sampling procedures were not practical techniques for indexing elk populations within the Black Hills (Jarding 2010).

Diet

Between July 1976 to August 1977, food habitats of elk were determined in WICA by examining 92 feeding sites and 30 rumen samples. During spring and summer, graminoids (grasses, sedges and rushes) were the most common forage class in rumen samples. Forbs were the most prevalent forage class consumed during fall and winter. Elk use of browse throughout the study was generally low (Table 27, Wydeven and Dahlgren 1983).

Table 27. Elk forage use in WICA as determined by examining feeding sites and rumen samples, 1976-1977 (Wydeven and Dahlgren, 1983).

	Percent Elk Use			
Plant taxa	**Fall**	**Winter**	**Spring**	**Summer**
Graminoids	34.8%	38.3%	73.6%	86.7%
Forbs	58.4%	52.6%	18.4%	5.4%
Browse/Shrubs	6.8%	9.1%	8.0%	7.9%

As an effort to evaluate elk winter and summer diet composition and quality between years, seasonally (summer and winter), and intra-seasonally (summer), a minimum of 15 elk fecal samples were collected on winter and summer ranges at 2-week intervals from June-August and from January-March of 1995 and 1996. In the winters of 1995 and 1996 elk consumed 47% grass, 31% shrubs, 20% ponderosa pine and 2% forbs (Hippensteel 2000). Throughout the study, summer diets on average consisted of 37% grasses, 32% shrubs, 16% ponderosa pine, and 15% forbs. The most common shrubs eaten by elk in both the summer and winter were Oregon grape (*Berberis repen*) and fringed sagewort (*Artemisia frigida)*. Blue grama (*Bouteloua gracilis*) and needle-and-thread grass (*Hesperostipa comata*) were the most common grasses, and old-man's beard (*Usnea spp.*) and red clover (*Trifolium pretense*) were the most common forbs (Hippensteel 2000).

To assess the potential dietary overlap between deer and elk, fecal samples were collected from both species on five deer winter and summer ranges at 2-week intervals from June –

August of 1994 and 1995 and from January – March of 1995 and 1996. Summer dietary overlap of elk and deer was approximately 44% and winter dietary overlap averaged 49.1%. Plants commonly eaten by both deer and elk included three grasses; redtop (*Agrostis stolonifera*), blue grama, and needle-and-thread grass and five shrubs/browse; serviceberry (*Amelanchier spp.*), fringed sagewort, paper birch (*Betula papyrifera*), ponderosa pine (*Pinus ponderosa*), and woods rose (*Rosa woodsia).* Throughout the duration of the study, elk ate a larger amount of grasses than deer and deer ate more ponderosa pine, forbs, and shrubs. According to the fecal nitrogen and fecal phosphorus concentrations, deer consumed a higher quality diet than elk throughout the study (Hippensteel 2000).

A similar study was conducted by Zimmerman (2004), where fecal samples of white-tailed deer, mule deer, elk and cattle were collected at 2-week intervals in burned and unburned habitats (Table 28). Research findings indicated that total graminoids was evident in elk diets more in the winter than summer, contrary to what Wydeven and Dahlgren (1983) documented in WICA. Major plants consumed by elk in burned vs. unburned areas were not significantly different; however, forage digestibility was greater in burned areas. Summer dietary overlap of elk and white-tailed deer were similar in burned and unburned areas but competition between elk and white-tailed deer throughout all seasons heightened in unburned habitats due to the poorer quality habitat available. Summer dietary overlap of elk and cattle was greater in burned areas (36.7%) vs. unburned areas (30.4%); however, the greatest dietary overlap between elk and cattle occurred in the fall (50.2%) in burned areas (Zimmerman 2004).

Table 28. Elk forage use as determined by fecal sampling in the Southern Black Hills, 2002-2003 (Zimmerman 2004).

	Percent Elk Use	
Plant taxa	**Winter**	**Summer**
Graminoids	70.0%	42.5%
Forbs	8.7%	28.6%
Browse/Shrubs	19.4%	26.4%

Keller (2011) evaluated the factors affecting temporal and spatial selection of resources by the large herbivore community in CSP. Habitat overlap among all species was highest during winter and lowest during the summer. Female bison and pronghorn, both sexes of bison and elk, and white-tailed deer and elk used habitat in a similar manner during most seasons. For all seasons except summer, habitat overlap was most associated with high forage biomass and water at the edges of habitat patches. During fall and winter, habitat overlap among all species increased at areas of high forage biomass and diversity and areas of high patch edge density. During spring, habitat overlap among all species increased near intermittent streams at areas of high patch edge density. During summer high habitat overlap among all species was found close to intermittent streams, and away from flowing streams and ponds. Seasonal carrying capacity

estimates incorporating all factors were highest during the winter (2,864 ungulates), intermediate during spring (1,636 ungulates) and fall (1,353 ungulates), and lowest during the summer (1,012 ungulates). The model optimized seasonal stocking densities at 25% allocation of total forage production at 500–659 bison, 212–699 elk, 100–584 mule deer, 100–795 white-tailed deer, and 100–541 pronghorn. Comparison of current stocking densities to forage production suggest utilization of many forage species may be above 25% but generally below 50%. The incorporation of resource selection greatly decreased carrying capacity estimates for some species. Total seasonal carrying capacity estimates that did not incorporate resource selection were 84–144% higher (Keller 2011).

Elk population estimates within CSP were constrained by the amount and allowable use of certain grasses and forbs. Little bluestem (*Schizachyrium scoparium)* was a particularly important species constraining elk population estimates, the amount of spatially available little bluestem constrained elk population estimates during all seasons. However, this species comprised <2.8% of elk diets during any season, so it was not likely to limit elk populations. The only graminoid that constrained elk populations was the allowable use of sedge during the spring, which was an important forage species to both bison and elk during this season. The allowable use of forbs including northern bedstraw (*Galium boreale)*, indianwheat (*Plantago patagonica)*, and common yarrow (*Achillea millefolium)*, were limiting constraints on elk populations during all seasons.

In general, tradeoffs existed between maximizing bison and elk, elk and white-tailed deer, and pronghorn and mule deer populations. Coexistence of bison and elk populations was dependent on the availability of palatable grasses, while forbs and shrubs were important for white-tailed deer, elk, mule deer and pronghorn. Keller's results were useful in examining theoretical relationships related to stocking densities and forage production, and tradeoffs in optimizing ungulate population numbers within CSP, rather than a strictly applied estimate of ungulate carrying capacities (Keller 2011).

Capture Techniques

From 1969 through 1972, 657 elk were trapped in WICA using a modified bison corral trap and a single helicopter to herd the animals into the trap. Lovaas (1973) recommended the use of two helicopters to improve efficiency and effectiveness of trapping elk.

Ten elk were successfully immobilized using a combination of 500 mg Telazol and 60 mg Xylazine Hydrochloride (HCI) within CSP. Yohimbine HCI was used as the antagonist and 40 mg were administered intravenously resulting in a mean recovery time of 14.0 minutes. Weight and dosage of Yohimbine resulted in varied recovery times (Millspaugh et al. 1995).

Twenty-four elk were trapped in 117 trap nights (7.4 trap nights/elk) from 1 July to 30 August 1993 within CSP. One, side collapsible modified Clover trap and eight "scissor" folding Clover traps were baited with salt blocks. Captures included 13 calves, 5 bulls (4 spikes and 1 branch-

antlered bull) and 6 cows. Disadvantages to summer trapping elk included potential overheating, damage to antlers, and cows and calves becoming separated; however, advantages were less risk to pregnant cows, high trap success, small field crew needed, and fewer weather logistics to overcome (Millspaugh et al. 1994).

Twenty-five free ranging elk were captured using three separate techniques (helicopter net-gunning, *n* = 7; Clover trapping, *n* = 7; and, corralling *n* = 11) for an on-going study evaluating the behavioral and physiological effects of human disturbances on elk (Millspaugh et al. 2000b). Once captured, blood samples were collected to quantify numerous serological parameters as an effort to measure potential tissue and muscle damage caused by capture related stressors. Results indicated that capture techniques requiring less time from capture to release (i.e., helicopter net-gunning) greatly reduced tissue and muscle damage. Millspaugh et al. (2000b) suggested that corralling and Clover trapping elevates several biochemical parameters that were indicative of tissue and muscle damage potentially resulting in capture myopathy (Millspaugh et al. 2000b).

One hundred and five elk were captured, and radio-collared in January and February of 20O7, and January through April of 2008 and 2009, collectively. Elk were either net-gunned or darted from a helicopter using a Mod 500 in 2007 and a Robinson-44 (Quicksilver Air, Peyton, Colorado) in 2008 and 2009. Additional elk were captured by darting from ground blinds or tree stands set up over bait sites (Schmitz 2011). ln 2007, each drugged elk was immobilized with Carfentanil Citrate and reversed with Naltrexone HCL. A combination of Bulorphanol, Azaperone and Medetomidine (BAM; ZooPharm, Laramie, WY) was used to immobilize elk in 2008 and 2009. BAM was reversed using a mixture of Antisedan, Naltrexone, and Tolazoline (Mich et al. 2008).

During 2015-2019 a total of 229 female elk were captured within the Black Hills. These adult or yearlings were captured via helicopter dart gunning or netting and chemically immobilized using BAM (ZooPharm, Laramie, WY). Immobilized animals were fitted with either VHF (n=179) or GPS (n=35) radio-collars.

General Elk Research within South Dakota

During the fall of 1993 and 1994, chest girth and eviscerated weight were recorded from 57 harvested elk in CSP. Logistic regression equations were developed for estimating both eviscerated ($y = 0.024x^{1.81}$) and intact body weight ($y = 2.76x – 128.46$) from chest girth (Millspaugh and Brundige 1996b).

From 1995 – 1997, 558 fecal samples were collected to measure fecal glucocorticoid levels to determine physiological responses of elk to various stressors. Fecal glucocorticoid levels peaked in the summer for both bull and cow elk subherds which were explained independently by high vehicle use along primary roads, high road densities and mean temperatures. Concentrations were lowest in the winter; however, more research was needed to determine if

annual glucocorticoid secretion may be related to seasonal metabolic rhythms (Millspaugh et al. 2001).

In an attempt to compare data from GPS and very high frequency (VHF) collars, six GPS and 44 VHF collars were attached to cow elk from August 1998 – December 2000. Two GPS collars malfunctioned and did not operate correctly. Four of the GPS collars were store-on-board and obtained locations on 88% of attempts. Researchers noted that they obtained more data from each GPS collar that was deployed for 10 months than was obtained in 2.3 years from three technicians tracking 10 times as many elk with VHF telemetry collars (Rumble et al. 2001a).

In 2011, it was documented that one of the 34 pregnant cow elk (3%) being monitored within CSP experienced dystocia while giving birth and died approximately 4 days after the cow was visually observed exhibiting labor. A field necropsy revealed a fully developed calf lodged in the birth canal (Lehman et al. 2012).

Cook et al. (2013) examined 861 female elk from 21 herds across the western United States including South Dakota from 1998 to 2007. In South Dakota; age, pregnancy rates, and lactation status were examined for 18 adult females during the spring (late Feb. – early April) of 2007. Of the 18 elk sampled, 17 were tested for pregnancy and 82.4% were pregnant. Across all study herds, pregnancy rates varied from 68.6-100% and lower pregnancy rates were documented for females greater than 15 years of age. From 2015 to 2019, blood was drawn to evaluate pregnancy status of 229 elk captured and radio-collared during survival studies conducted by SDGFP. Pregnancy rates of winter-captured cow elk were determined to be 92%, 83%, 78%, and 80% in 2015, 2016, 2017, and 2018, respectively.

Lehman et al. (2016) captured and radio-marked 58 female elk ≥2 years of age and 125 calves during the parturition season from 2011 – 2013. Over the three-year study period 100 parturition sites were measured. Median dates for parturition were 1 June in 2011, 28 May in 2012, and 3 June in 2013. Ninety percent of births occurred by 15 June over the 3-year period of the study.

PUBLIC LAND MANAGEMENT

Game Production Areas

As of 2020, SDGFP owned and managed 12 Game Production Areas (GPAs) encompassing 20,940 acres in the Black Hills. Elk occasionally occurred on these GPAs, but none truly possessed habitat of a quantity or quality enough for them to be considered year-round elk habitat in the Black Hills. General habitat management objectives on Black Hills GPAs were designed to benefit a wide array of wildlife species and public uses. Practices such as pine thinning were used to encourage hardwood and browse species; prescribed burning, haying, and limited grazing were used to manage grassland species; and annual cropping used to produce food habitat plots for resident wildlife. Of the 12 GPAs in the Black Hills, two – Harrison-Badger-Trucano GPA in Lawrence County and Pleasant Valley GPA in Custer County - were managed primarily to provide seasonal elk habitat in the form of thermal cover and planted forage (i.e., food habitat plots), with the principal management objective to hold elk on the GPA for private land depredation abatement.

At the time of this publication, SDGFP's land acquisition efforts across the state – including the Black Hills - focused on securing in fee-title native habitat types that supported resident and migratory wildlife species while providing various wildlife related recreational opportunities. This approach has resulted in a widely distributed land inventory of high-quality habitat types that was both biologically sound and publicly acceptable. Land acquisition priorities included parcels that provided a connection or corridor between other public lands; additions to existing GPAs, parcels that enhanced or facilitated public access to GPAs and other public lands, in-holding and round-out parcels that consolidated or connected existing GPAs, and parcels that provided buffers or were necessary for maintaining or enhancing the integrity of existing GPAs and other public lands.

Custer State Park

Custer State Forest became Custer State Park after action by the state legislature in 1919. Custer State Park encompasses 70,750 acres of forests and grasslands in the Black Hills of South Dakota (Figure 11). Geography varies from steep granitic spires in the northwest part of the park, forested rolling topography in the main body and grading eventually into grasslands on the eastern and southern boundaries. Elevation ranges from 3,760 to 6,700 feet above sea level. Vegetation is dominated by white spruce/ponderosa pine mix on north slopes at higher elevations, by pure ponderosa pine on most forestlands, and by mixed-grass prairie on grasslands. Elk were reintroduced into Custer State Park in 1915.

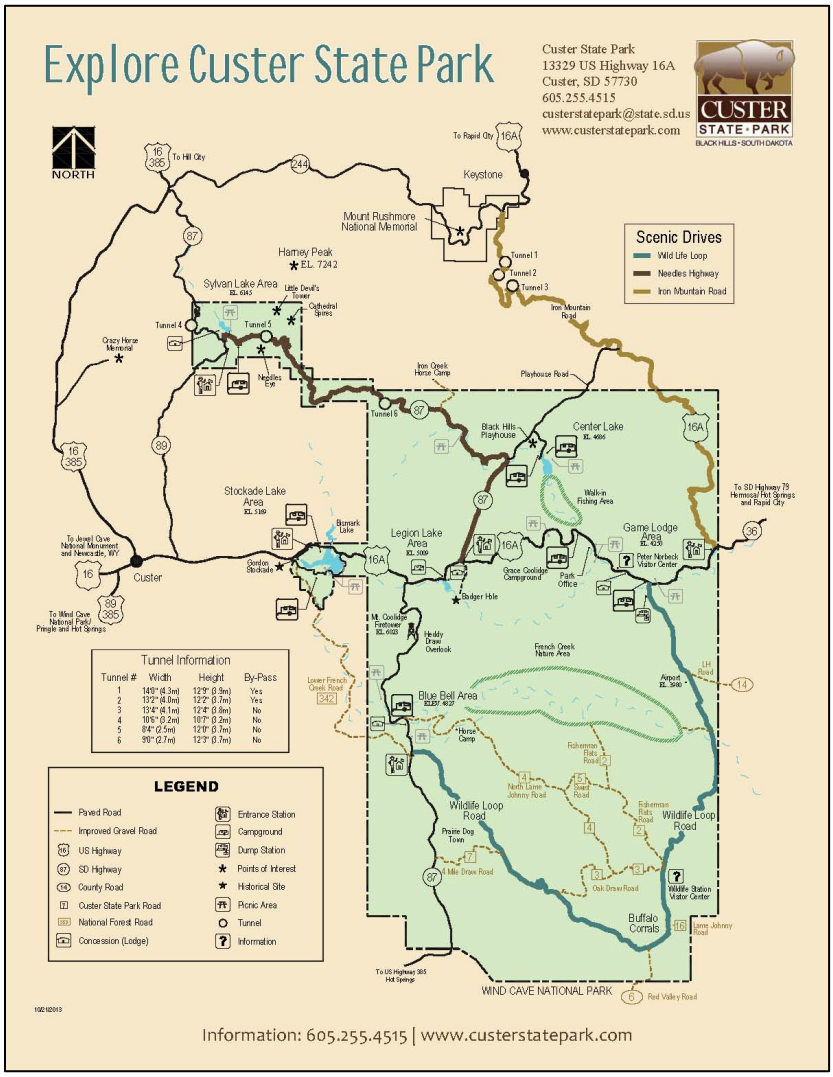


Figure 11. Recreation map of Custer State Park in the southern Black Hills, South Dakota.

CSP manages wildlife for species diversity, visitor view ability and watchable opportunities, and to provide a high-quality recreational hunting opportunity. The elk population objective considers viewing and recreational opportunities as well as social aspects such as landowner tolerance from adjoining landowners to the east of CSP. But most importantly, the population objective considers precipitation data and forage production, elk resource selection, as well as historical trend information and demographic data.

Determining the size and composition of ungulate communities that landscape can support is difficult, especially when ungulate communities are diverse. Theoretical carrying capacity models can be useful tools to guide management decisions; however, these models make some assumptions about forage production, forage availability, and diet overlap. Spatially-explicit

information of forage production, diet, space-use, and resource overlap was developed that used linear optimization to optimize stocking densities of bison (*Bison bison*), elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*Odocoileus virginianus*) (Keller 2011). Results of the theoretical optimization model indicated that during the spring season with 25% allocation of forage that carrying capacity for CSP would be 698 elk (Keller 2011). It was noted in Keller (2011) that elk and bison population numbers were a problem for the carrying capacity model as the minimum population constraint was often violated during the initial model runs. Elk compete with both bison and white-tailed deer for forage and space in CSP, which likely confounded the linear optimization model (Keller 2011). As presented in Keller (2011) forage production was best predicted by current annual spring precipitation, previous year spring precipitation, and ordinal date of last spring frost. This model explained 40% of the variation in forage biomass in CSP.

Additionally, when evaluating forage production under normal precipitation conditions (Keller 2011), CSP had 62,830,016 lbs. of dry herbaceous biomass available (Table 29). CSP allocated 25% of that biomass for wildlife use, and 25% would equate to 15,707,504 lbs. of dry herbaceous biomass. Based upon recent evidence of resource selection of rangeland versus forestland (n = >240,000 satellite locations), elk selected forested habitats 79% of the time and rangelands 21% of the time. Extrapolating a value of 12.2 lbs./day for elk use in CSP (Keller 2011), and projecting 800 elk for a population objective, elk were estimated to consume 3,548,142 lbs. of dry herbaceous biomass on rangelands and forests. Landowner tolerance east of CSP declined when elk were between 950-1100 animals from 1999-2003, and management for a population >950 animals should be avoided.

Table 29. Dry forage (lbs.), population objectives, and allocation table for large ungulates in Custer State Park (modified from Keller 2011).

	Pounds dry forage (25%)	Objective[b]	Range% - Forest%	Range	Forest
Available[a]	15,707,504		48%-52%	7,604,664	8,102,840
Bison	7,745,351	950	75%-25%	5,809,013	1,936,338
Elk	3,548,142	800	21%-79%	745,110	2,803,032
Pronghorn	284,824	350	80%-20%	734,992	183,748
Mule Deer	260,508	200	60%-40%	156,305	104,203
White-tailed deer	918,740	800	15%-85%	42,724	242,100
Bighorn	327,953	200	10%-90%	32,795	295,157
Utilized forage % used	13,085,517			7,520,939 99%	5,564,578 69%

[a]Pounds of dry forage available in CSP during a normal precipitation year. The 15,707,504 lbs. would be 25% of the annual production for CSP.
[b]Winter population objective for each species in CSP.

Wind Cave National Park

WICA was established in 1903 as the eighth national park in the United States and was located in the southern Black Hills. Expansions to the park over time have resulted in the park's current size of 33,614 acres. WICA was bordered by CSP to the north, BHNF to the west and private land to the south and east (Figure 12).

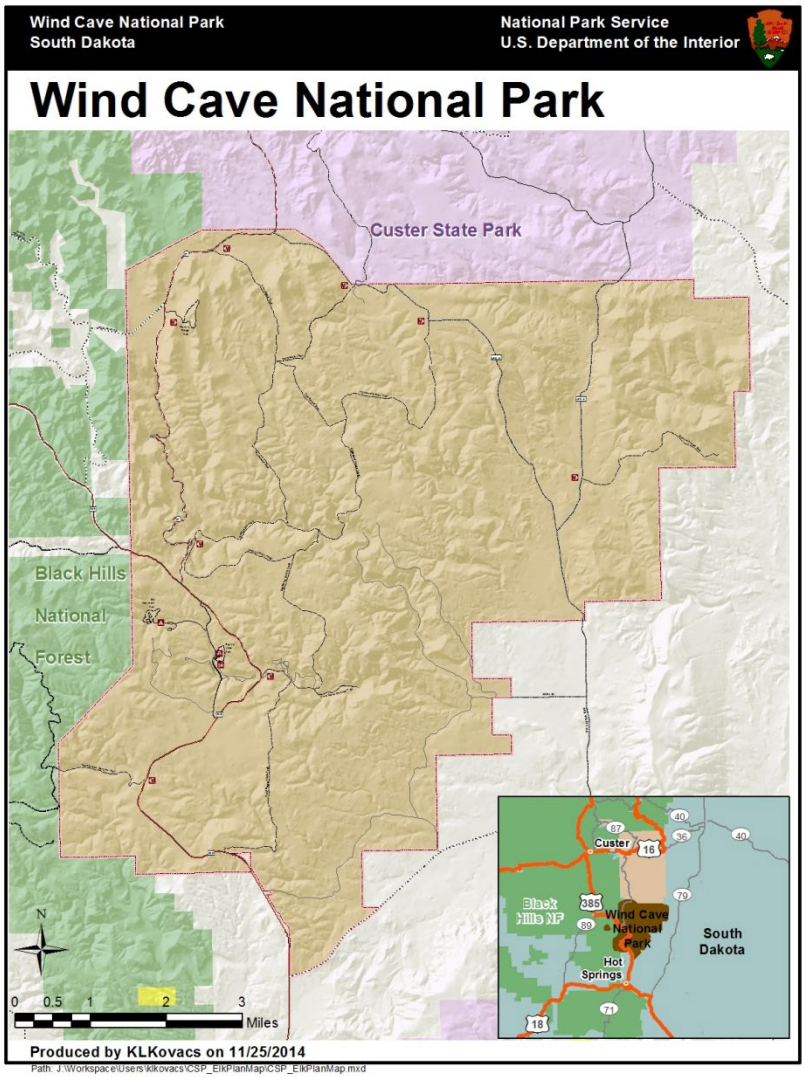


Figure 12. Map of Wind Cave National Park (WICA).

The landscape of WICA is predominately mixed-grass prairie and ponderosa pine (*Pinus ponderosa*) forest. Elk were reintroduced to WICA between 1914 and 1916 after extirpation from the Black Hills. Due to its classification as a National Park (no hunting allowed) and the high fence associated with the perimeter of WICA, this semi-isolated elk population grew over

time. Over the years, elk from WICA were transplanted to other areas within South Dakota and throughout the west (Appendix 1) to establish elk herds in suitable habitat. These translocations served as a tool to also manage the elk population within WICA.

In July 2002, the National Park Service Director issued a memo stating, "deer or elk will not be translocated from areas where chronic wasting disease (CWD) was known to occur". In November 2002, CWD was documented in a cow elk in WICA. At this point, WICA was no longer able to use live translocation of elk as a management tool. Since the confirmation of CWD within cervids, a total of 154 elk, 2 white-tailed deer, and 10 mule deer have been confirmed with the disease in WICA through June 30, 2020. With a high-fenced park containing an elk herd with limited movement outside of WICA, no allowable hunting harvest, and limited mortality caused by natural death, disease and predation, WICA identified a need to revise the existing elk management plan for future actions.

In 2009, WICA made available to the public the “Final Elk Management Plan and Environmental Impact Statement” (NPS 2009). Through this process, WICA considered the following alternatives for future management directions: 1) hunting outside of WICA; 2) roundup and live shipment to a slaughterhouse or processing facility or euthanasia; 3) sharp shooting; 4) contraception (sterilization); 5) fertility control agent. Other alternatives considered but dismissed from further analysis: 1) hunting inside of WICA; 2) translocation of elk; 3) habitat alterations; 4) fencing in elk; 5) aerial sharp shooting; 6) predator reintroduction. Hunting outside of WICA was selected by the National Park Service as the preferred management alternative.

To facilitate the preferred management alternative, WICA increased the height of 4.5 miles of fence on the west side from four feet to 7 feet and completed the installation of 20 “jump gates” on the west and north sides of WICA to allow for movement of elk outside of WICA (Figure 13). When lowered, the height of the jump gates ranged from 4-5 feet, easily allowing elk to exit or enter the boundaries of WICA (Figure 14). For a specified time period before the elk hunting seasons outside of WICA, the jump gates were lowered to facilitate elk dispersal into Management Unit 3. Prior to the start of the elk seasons (late June), the jump gates were then raised to prohibit elk traveling back into WICA, thus making these elk available for hunter harvest. The jump gates were then again lowered after the December “antlerless elk” season to allow for seasonal movement.

The jump gates were first used as a management tool in 2011. Trail cameras were positioned at some locations to determine the effectiveness of the jump gates. While difficult to quantify, elk have been observed both exiting and entering WICA. SDGFP has responded to this passive movement of elk by adjusting the number of antlerless elk licenses, primarily in Management

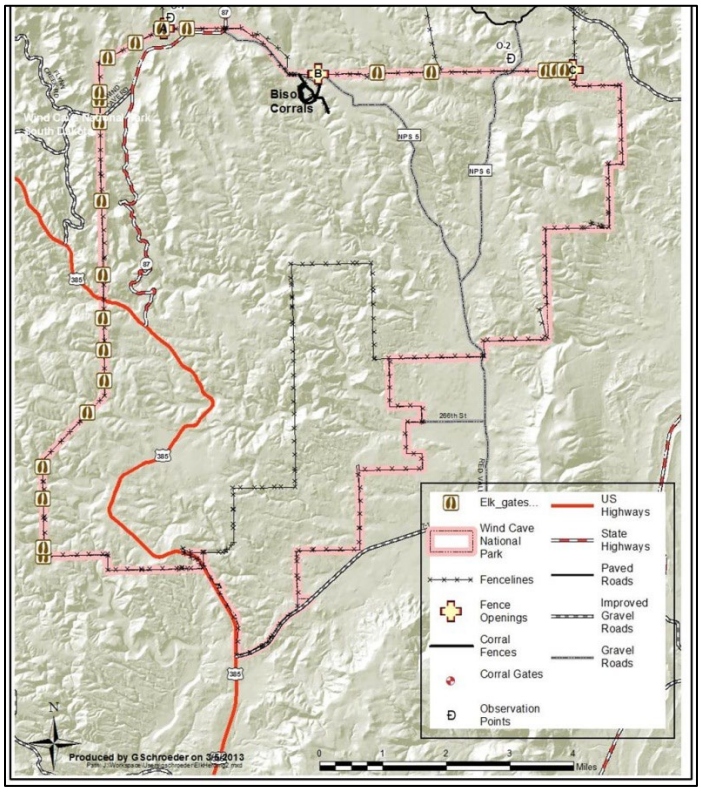


Figure 13. Elk jump gate locations on north and west perimeter fences at Wind Cave National Park.

Figure 14. Photo of double wide elk jump gate in lowered position (Photo Credit: Wind Cave National Park).

Unit 3 to manage within the population objective and landowner tolerance of this unit and to assist WICA in reducing this elk population to a manageable level. WICA has identified a population objective of 232-475 elk in the park. The 2020 winter elk population was estimated at 230-270 elk (Greg Schroeder, personal communication).

As a result of continued growth in the WICA elk herd that far exceed the population objective, additional management activities were implemented in 2012-2014. On December 15, 2012, sixty-nine horseback riders moved 14 elk from WICA into the southeastern portion of CSP.

To increase the number of elk moved, WICA, SDGFP and the Rocky Mountain Elk Foundation cooperatively worked together to move elk using helicopters as a hazing technique. Designated locations of the perimeter fence were identified and temporarily opened to move elk into Management Unit 3 and CSP. On March 1, 2013, 197 elk (6 mature bulls, 5 spike bulls, and 186 cows and calves) were hazed into CSP. On March 8, 2013, 192 elk (19 mature bulls, 3 immature bulls, 1 spike bull and 169 cows and calves) were hazed into CSP. In total, 26 radio-collared elk were moved from WICA to CSP, which allowed biologists an opportunity to monitor movements.

Again, on March 12-13, 2014, helicopters were used to move 39 elk (27 mature bulls and 12 cows and calves) into CSP and another 122 elk (2 mature bulls and 120 cows and calves) into Management Unit 3. WICA staff monitored the movements of these elk after they left the park.

It was determined that the jump gates and moving elk to areas outside of WICA through hazing efforts was not accomplishing the goals of reducing elk numbers within the boundaries of WICA. Additionally, high prevalence rates of CWD within the boundaries of WICA brought about concerns about moving elk to other areas of the Black Hills and Custer State Park. As a result, the jump gates were permanently raised to minimize elk movement to areas surrounding WICA. To reduce numbers of elk within a now closed population, WICA employed the use of trained volunteers with a contingent of Park staff to remove elk within the boundaries of WICA. SDGFP assisted with the selection of volunteers through an application process and WICA ran the cull operation. During the winters of 2016/17, 2018, and 2020, WICA staff and trained volunteers culled a total of 262, 25, and 30 elk, respectively. With this culling effort, WICA elk populations were maintained at approximately 230-270 elk in 2020.

Black Hills National Forest

The Black Hills National Forest encompasses western South Dakota and northeastern Wyoming, covering an area approximately 110 miles north to south and 70 miles east to west (USDA 2006). The BHNF fire protection district within South Dakota is approximately 1.9 million acres, of which 1.1 million acres were administered and managed by BHNF. The remaining acreages are in private ownership (~790,000 acres) and a scattering of other federal and state lands (Bureau of Land Management, National Park Service, SDGFP, South Dakota School and Public Lands).

Black Hills National Forest classifies and inventories vegetative diversity by structural stages (SS) which delineate the dominant plant cover by tree size, stem diameter at breast height (DBH = 4.5 feet above ground level) and overstory crown cover (Table 30). Developed stages of tree stands, pine for example, are classified by the most dominant SS. Pine has a dominant influence on understory plants which shapes the type of forage available for elk and other ruminants, including domestic livestock. In the Black Hills pine forests, understory production increases as the overstory stocking level (basal area) and crown cover decreases (Pase and Hurd 1957) and plant diversity demonstrates a similar pattern (Uresk and Severson 1989, Uresk and Severson 1998).

Table 30. Structural stage or dominant plant cover by size, diameter (DBH) and percent crown cover (USDA 2005).

SS Code	Structural Stage	Tree Size Class	Diameter (DBH)	% Crown Cover
1	grass-forb	non-stocked	--	0 – 10
2	shrub-seedling	established	< 1”	11 – 100
3A	sapling-pole	small, medium	1 to <9”	11 – 40
3B				41 – 70
3C				71 – 100
4A	mature	large, very large	9” and above	11 – 40
4B				41 – 70
4C				71 – 100
5	late successional	large, vary large	varies	varies

Eighty-nine percent of the lands managed by the BHNF are forested lands (USDA 2005). Forest lands are at least 10% stocked by trees of any size and are at least 1 acre and 120 feet wide. Unimproved roads and trails, streams and small clearings in forest areas are considered forest lands if less than 120 feet wide (Walters et al. 2013). The most common forest type is ponderosa pine (*Pinus ponderosa*) at 92%. Ponderosa pine (herein referred to as pine) occurs in 13 plant associations from the higher elevation, mesic coniferous forests/woodlands with greater than 60% canopy cover to the lower elevation, dry coniferous forests/woodland types

with less than 50% canopy cover. The dry coniferous forests/woodlands are the most dominant ecological group within the entire Black Hills (Marriott and Faber-Langendoen 2000, USDA 2005).

The remaining forest lands on BHNF are comprised of 6% aspen (*Populus tremuloides*), bur oak (*Quercus macrocarpa*) and paper birch (*Betula papyrifera*); 2% Black Hills white spruce (*Picea glauca*) and less than 1% juniper woodlands (*Juniperus spp*.) (USDA 2005). There are scattered inclusions of less than 100 acres each of Lodgepole pine (*Pinus contorta*) in the northern Black Hills and non-native Douglas fir (*Pseudotsuga menziesii*) in Norbeck Wildlife Preserve (NWP) (USDA 2013a).

The remaining vegetative cover types are non-forested. There are 4,400 acres of shrublands (dominated by greater than 40% crown canopy of shrubs and less than 10% tree crown cover) (USDA 2005, 2013a) in which mountain mahogany (*Cercocarpus montanus*) make up over 95% of the mapped upland shrub cover type (USDA 2013a).

There are 105,805 acres of grasslands as prairie and interior types with less than 10% tree crown cover and grasslands included species such as blue grama (*Bouteloua gracillis*), buffalograss (*Buchloe dactyloides*), oatgrass (*Danthonia spp.*) green needlegrass (*Stipa viridula*), wheatgrass (*Pascophyrum smithii, Elytrigia spp.*) and non-native graminoids such as smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*) and Timothy (*Phleum pretense*) (USDA 2005, 2013a).

In 2005, BHNF reported 77,606 acres of riparian areas and wetlands (montane and low elevation) which included 3,470 miles of perennial and intermittent streams on BHNF (USDA 2005). In 2007, BHNF reported 6,542 acres of "meadow" because it changed the classification of "meadow" to include cover types more representative of wet meadows with hydric sedges (*Carex spp.*) and rushes (*Juncus spp*.) (USDA 2013a). The remaining percentage of BHNF lands included barren rocky areas, water bodies (>100 acres), and administrative structures.

Elk and Forest Planning

Elk are evaluated in the Forest Planning process because of public demand and interest in the species and are labeled as a *demand species* along with five other game animals and fish (USDA 2005). Elk have a different set of considerations within the Norbeck Wildlife Preserve (NWP), as discussed in the following section. BHNF can implement site-specific considerations for elk if abundance, availability and condition of elk habitat have been proposed by the public (including SDGFP) and identified by BHNF as important and substantial land management issues, but BHNF was not required to do so. One avenue which established a process for SDGFP and BHNF to communicate and exchange information was the 1985 Memorandum of Understanding (MOU) between all FS Units in South Dakota and SDGFP. Both agencies acknowledged that while significant populations of fish and wildlife were on lands under FS jurisdiction, these species were also of importance to South Dakota. It was in the mutual benefit of BHNF and

SDGFP to cooperate and exchange information to ensure wildlife, fisheries and their habitats on BHNF were managed in the best interest of the public and ecology (USDA SDGFP 1985).

Norbeck Wildlife Preserve

A separate and very unique portion of BHNF has its own set of management guidelines and direct working relationship with SDGFP; that was the 35,000 acre Norbeck Wildlife Preserve (MA 5.4A). Within the NWP, elk are classified as a *focus species*, which includes selected game animals and birds that breed in or spend a significant portion of their life requirements within NWP (Griebel et al. 2007). While the NWP has a small population of elk, it was disproportionately important for elk and sportsmen for several reasons:

- Effects of proposed management in the NWP *must* consider impacts to elk and other focus species (USDA SDGFP 2009, USDA 2010a). Elk are afforded site-specific considerations in management over and above general BHNF planning.
- SDGFP and BHNF cooperated in a long-term habitat management project on 26,727 acres to improve or maintain certain habitat features for focus species, including elk (USDA SDGFP 2009, Brundige 2010, Deisch 2010, USDA 2010a, 2010b). The level of detail in vegetation treatments and partnership was precedent setting and could be a template for treatments for elk outside the NWP boundary.
- The NWP shares a 20 miles southern boundary with northern CSP and elk commonly cross between the two land units (Brundige 2010). Habitat projects adjacent to this boundary are done in a cooperative fashion between SDGFP and BHNF.
- NWP provides a fairly remote and quiet experience for humans, including hunters, looking for solitude and a "walk-in" area free from distractions likely found elsewhere on BHNF.
- The last active livestock allotment within NWP was recently phased out by BHNF. The FS's decision was based on several administrative challenges and impacts to some of the focus species (USDA 2010d).

Big Game Winter Range

Land and resource management emphasis on BHNF is categorized by geographic areas, known as management areas (MA). Each MA has a concentrated emphasis on land management prescriptions for certain multiple uses. BHNF employs six general MA categories which range from little human use to extensive use. The category which focuses on intensively managed landscapes included MA's that elk likely uses. As of 2020, there were no designated elk calving grounds or traditional migratory routes identified within the BHNF. However, big game winter range (MA 5.4) has always been identified as a focus in BHNF planning efforts since the first BHNF Plan in the 1980s. This category weights management guidelines of BHNF towards high quality winter and transitional habitats for big game (mule deer, white-tailed deer, elk, bighorn sheep and turkey).

Big game winter range, as identified by BHNF, encompasses 396,516 acres or 31.8% of the BHNF with an emphasis on a vegetative mosaic (USDA 2006). The topography is typically lower elevations where snow depths do not impede big game travel and may include spring

fawning/calving areas. Elk may use these and adjacent areas year-round. An objective within big game winter range is to increase understory forage production within pine stands which were 9" DBH or less (SS 3A, 3B and 3C – Table 30) while providing for a variety of SS across the landscape. A BHNF Plan standard (mandatory course of action and deviation requires a Plan amendment) requires BHNF to design livestock management strategies to be compatible with big game winter range objectives. A guideline suggests that increases in forage favor wildlife, while also providing for livestock. Another objective beneficial to elk is an open-road density of 1 mi/mi^2 or less from December 15 through May 15 which is likely achieved by seasonal road closures and reduction of new road construction. Over-the-snow vehicles (OSV) are restricted to designated routes. One desired outcome of diverse, high-quality winter range on BHNF is to reduce the time spent by big game, including elk, on adjacent private lands (USDA 2006).

The current BHNF boundary between big game winter range (MA 5.4) and non-big game winter range (MA 5.1) was developed during the first BHNF Plan in the early 1980s. Landscape changes brought about by the Jasper fire in 2000 and an increasing elk herd resulted in an expanding elk range. In 2003, a new assessment of elk seasonal ranges was made by SDGFP and Rocky Mountain Elk Foundation (RMEF) which identified winter range reaching further north of the BHNF designated boundary (RMEF 2003). This new information did not change the winter range boundary designated by the BHNF Plan. However, the BHNF Plan continued to mitigate human disturbances to wintering big game by closing some roads and trails from December 15 through May 15 within the expanded range.

Silviculture Practices

Ponderosa pine is successful at regenerating and healthy seed is produced almost every year with abundant crops every two to five years (Boldt and Van Deusen 1974) throughout most geographic areas within the Black Hills. Shepperd and Battaglia (2002) attributed the prolific growth and establishment of pine to the growing season precipitation and climatic influences. It is a challenge for all landowners within the Black Hills to keep up with pine regeneration to maintain or create less dense understory and "dog-hair" stands. Because of pine's prosperous growth, BHNF is a very active, intensively managed public forest and is the most viable timber producing forest within its FS region that extends into Colorado.

Black Hills National Forest identifies and classifies 865,890 acres in South Dakota and Wyoming that are "*suitable*" and available for timber production (USDA 1997). Federal planning regulations (36 CFR 219.14) require lands suited or not suited for timber production to be identified as part of the forest planning process (found in Appendix G of USDA 2006). Black Hills National Forest has an objective to manage 1,037,100 acres, or 84% of the suitable timber base in certain percentages of pine SS for a diverse pine ecosystem (Table 30).

Pine regeneration is monitored and pine stands that are stocked with a minimum of 150 pines/acre are certified as regenerated. Regeneration is a requirement (2408 Standard, USDA 2006) and most silvicultural treatments employed on BHNF are used to accomplish regeneration. Treatments to eliminate a pine stand are rare and are analyzed as "type

conversions" which change vegetation from a forest to early successional stage such as grass/forb. Pine is also completely removed when it invades areas it did not naturally occur in and would not have occurred due to recurring fire; those habitats include hardwood stands and meadows.

Accepted silviculture practices treat, or create, the following pine stands: even-aged, two-aged or uneven-aged systems. Prescriptions generally include shelterwood, clear-cut, seed tree, group selection and individual tree selection (USDA 2006). The very common shelterwood system removes a portion of the mature overstory but leaves a very low basal area (BA) of residual mature trees to reseed the area. This system creates and perpetuates an even-aged overstory and mid-or understory of pine which are essentially rotated as growing stock. Once the mature overstory pine is removed, the mid-story sapling pine flourished and become the next generation of mature pine (Smith 1962, Alexander 1987). The quantity and quality of understory forage (non-pine) that is available for wild and domestic ungulates is dependent upon the stage of growth and density of the pine stand, and past mechanical or fire treatments.

The types of silvicultural treatments that most benefit elk depend upon what aspect of habitat is needed within an elk's home range compared to existing conditions. A mosaic of pine SSs across a landscape benefit elk and their habitat requirements. Generally, the greatest forage production per acre for ungulates is within SS1 and SS2 followed by SS3A and SS4A (Table 30) depending upon soil type, aspect and other physical and biological factors. Many vegetation treatments which enhance elk habitat, benefit a myriad of other species including livestock. Elk prefer diverse habitats with healthy native vegetation and riparian areas.

Vegetation treatments include:

- In some situations, it is the non-commercial treatments of small-diameter pine that most affect elk habitat. Small-diameter pine can act as weather breaks, shade and screening cover but conversely, can also shade out and out-compete understory forage.
- Small openings, or patch clear-cuts (PCC), generate forage and edge contrast. PCCs are recommended for elk because they created pockets (typically < 20 acres) of forage near escape cover.
- Non-typical pine treatments such as retention of groups of similar-aged pine and removal of other adjacent trees, rather than a plantation-like appearance of a pine stand, can create a desirable mix of forage and screening cover for elk. The intermittent overstory canopy provides shade and intercepts snow.
- Retention of very large-diameter pine with overlapping canopies intercepts snow and provides summer shade.
- Variable density thinning (VDT) provides stand diversity by varying the density of pine by slope and aspect. This pine treatment allows for heavier timber on north and east-facing slopes while lowering timber basal areas on south and west-facing slopes. South and west slopes can generally have poor pine growing potential with the trade-off of providing more understory production when pine was heavily thinned (Pase and Hurd 1957). Elk benefit from enhanced forage in the winter on sun-exposed sites and seek

north-facing slopes for shade in the summer. VDT creates a more natural configuration of pine across a watershed after years of fire suppression. Varying the spatial arrangement of pine SS's, allows for pine regeneration while restoring hillsides to a less manufactured appearance.

- Heavier pine densities can be retained next to roads and trails to create screening cover for elk and other wildlife. Opening the forest canopy farther from the road provides forage and solitude.
- Prescribed fire reduces ground and overstory fuels, and enhances native grasses, forbs and shrubs.
- Selective cuts remove pine from hardwoods, meadows and riparian areas. The most important aspect of hardwood treatment was to ensure that regenerating shoots were protected from wild and domestic ungulates by hinging, slash retention and/or fencing. Hinging could be used in riparian areas to discourage livestock trampling and heavy browsing by deer.

Forage Availability and Allocation

Black Hills National Forest defines its rangelands as lands capable of producing forage for grazing and browsing animals which may consist of upland meadows, riparian sites, open-canopy forests, or closed-canopy forests which have understory vegetation. Range resource managers seek to manage the vegetation of BHNF for the benefit of all users of the forage and habitat (USDA 1996a).

Forage production was calculated for the BHNF 1983 Plan and allocation of forage among wild and domestic ungulates apparently was determined on a site-by-site basis, such as a particular allotment (USDA 1981). However, the 1997 Revised Forest Plan (USDA 1996a) allocated forage to livestock, deer and elk across the entire BHNF, not just by certain areas (USDA 1997). There were 135 grazing allotments (USDA 2013a) on BHNF with approximately 262 permittees (USDA 2004b) in both South Dakota and Wyoming. Allocation (Plan Objective #301) across BHNF in Wyoming and South Dakota has remained the same for the Phase II Forest Plan used today (USDA 2006) with the following caveats:

- Wildlife spend 85% of their foraging time on BHNF and 15% off BHNF.
- 50% of the forage produced is available for use by livestock and wildlife (USDA 1996b; Plan Guideline #2505, USDA 2006).
- Livestock generally graze BHNF five months from June 1 – October 31.
- Estimation of wildlife forage needs is calculated on a 100% (year-round basis)
- Livestock are considered cattle with age classes of yearlings, bulls, dry-cows and cows with calves. There are no sheep, goat, horse or buffalo allotments on BHNF.
- Forage utilization and condition depend on variables such as weather, use patterns and different species' diet overlap for forage.
- AUM (animal unit month) is the tenure of one animal-unit for one month. For 1 livestock AUM, it is considered one mature 1,000-pound cow and her calf with the average daily forage consumption of 33-lbs. of dry matter/day. An elk AUM was 0.462 and a deer was 0.1.

In 1996, BHNF employed a forage model that based forage production on various attributes such as percent crown cover and basal area for non-crystalline soils (Pase 1958) and crystalline soils (Uresk and Severson 1989). Crystalline soils were present over the granite core of the Black Hills. Basal area was defined as a cross-sectional area of a stand of trees measured at DBH and expressed as ft^2/ac. It was estimated that 466,000,000-lb of forage/year or 466 million-lbs. (expressed herein as million for millions of pounds) were produced and applying proper use guidelines of 50% for all livestock, deer and elk, the balance remaining for consumption was 233 million-lbs. forage/year.

For both South Dakota and Wyoming on BHNF, all ungulates have 233 million-lbs. of forage/year available and the allocation breakdown is livestock 127 million-lbs. (54.5%), and wildlife 106 million-lbs. (45.5%).

Elk Thermal Cover

Thermal cover is defined as "cover used by animals to ameliorate the effect of weather and optimally, it was provided by a stand of coniferous trees, 30-60 acres in size, at least 40 feet tall, with a canopy cover of at least 70%" (Lyon and Christensen 1992, USDA 2005). This could equate to SS 3C, 4C and 5 (Table 30). Thermal cover is a BHNF Plan objective specific only to the Norbeck Wildlife Preserve (USDA 2006) and was originally adopted in the 1980's as an elk habitat requirement for cold weather, although thermal cover was used to mitigate extreme hot weather as well. Research was conducted in portions of the Black Hills where elk used thermal cover during extreme winter weather (Millspaugh 1995) and for diurnal bedding sites during warm summer temperatures (Millspaugh et al. 1998).

Cook et al. (2005) compared big game studies which tested the hypothesis that the sheltering effect of thermal cover was of sufficient magnitude to enhance the well-being and productivity of big game. The study found that the hypothesis lacked veracity and there was no significant, positive effect of thermal cover on herd productivity. "Weather-moderating effects of thermal cover were probably insufficient to be of much biological value" (Cook et al. 2005). Thermal cover can also be in the form of other animals, topography and a combination of weather events (Lyon and Christensen 1992).

Cook et al. (2005) contended that it was intuitive to observe that dense forests can moderate harsh weather, but there was no definitive magnitude of thermal cover effects. In fact, it was found that in dense forests, thermal cover was detrimental to elk energetics and could not substitute for lack of nutritious forage. Instead, managers should spend more time and effort considering forage value in relation to thermal cover. The approach of managing for an abundance and quality of available forage should be implemented.

Vulnerability and Visual Obstructions

Vulnerability was a measure of elk susceptibility to harvest during the hunting season (Lyon and Christensen 1992). Vulnerability was a term that was developed specific to an area of Montana

that experienced “elk populations and hunter numbers at 30-year highs” resulting in a decline in bull/cow ratios due to substantial harvest of bull elk, liberal license allocations and high road densities (Hillis et al. 1991). To date, “vulnerability” has not been found to be an issue in the Black Hills regarding viable elk populations and bull/cow ratios. SDGFP limited elk hunting licenses to residents only by lottery and set harvest quotas to ensure bulls were not over-harvested.

Visual obstructions aid basic animal instincts to perceive risk and allow the animal to minimize or eliminate imminent harm. A rugged landscape also contributes visual obstructions in many forms of terrain and objects which break up or camouflage the outline of the animal (Brundige 2010, Deisch 2010). Visual obstructions benefit a multitude of species, not just elk.

A popular term in elk literature to describe one form of visual obstruction was “security blocks”, areas where large acreages of dense trees were retained (Hillis et al. 1991). Rather than a set prescription of forest management, Hillis et al. (1991) state “interpretation of the guidelines was needed to ensure that the result makes biological sense for local conditions and not to meet some generalized guidelines, but to provide functional habitat”. Another term was “security cover”, which may be an important component of elk habitat in high disturbance areas and during seasonal disturbances (e.g., hunting) (Millspaugh et al. 2000a). Security cover can be provided by the boles of trees, smaller tree foliage and crowns, understory vegetation, and non-vegetative features. There are no BHNF Forest Plan requirements for “security cover” “security blocks” or “hiding cover” as described by Hillis et al. (1991) and Christensen et al. (1993). BHNF Plan has suggestions for “screening cover” specifically along roads where the vegetation affords it. In summary, prescriptive vegetation treatments can create or retain visual obstructions between wildlife and humans, especially along roads and trails where elk perceive risk. Within the past 5 years, screening cover has diminished due to pine mortality from MPB and related logging efforts, but this habitat metric has not been quantified.

Non-FS Lands

Lands adjacent to BHNF and within the Fire Protection Boundary are also available to wildlife which use both BHNF and non-FS lands within their respective home ranges. The BHNF 1997 Revised Forest Plan assumes that wildlife spends 15% of their time on lands outside the BHNF boundary (USDA 1996b).

BHNF Range Monitoring

To address the ecological and social needs to provide forage for all ungulates on BHNF, wild and domestic, BHNF, along with a task force of range and wildlife experts, elected to set proper herbivore use guideline, or percent forage utilization by weight (Table 31). Use at 50% generally was thought to leave the rangeland in satisfactory condition. Unsatisfactory condition implies that herbivory did not occur at expected levels. Use was not established in the first 1983 Forest Plan but was made as an amendment to the Plan in 1988 (USDA 1988) and the maximum levels remain the same in 2020 (USDA 2006).

Table 31. BHNF Forest Plan Guideline #2505 allowable forage use and residual levels. Livestock and wild herbivore allowable forage use or residual levels on rangelands by grazing system and range condition (Percent Utilization by Weight Each Year).

Season of Use	Satisfactory Condition	Unsatisfactory Condition
Continuous Use	0-45%	0-40%
Continuous Use	55-60%	0-55%
Deferred Rotation	0-50%	0-45%
Rest Rotation	0-55%	0-50%

Note: Use levels for riparian areas were different (USDA 2006).

BHNF monitors utilization during the growing season and employs various methods (USDA 1996b). There are four Ranger Districts on BHNF. Some allotments occur on the South Dakota and Wyoming border and therefore, may include lands in both states. Each Ranger District on BHNF monitors range condition and annual pasture/allotment utilization as staffing, funding, and District priorities allow. Monitoring is reported in BHNF annual reports. The degree of monitoring and the associated reporting varies among Districts from year to year. Therefore, monitoring results cannot be directly compared from year to year or among Districts. Methodology is generally used according to the Interagency Technical Guides and the USFS Region 2 Rangeland Analysis and Management Training Guide (USDA 1996b).

There are two major types of monitoring, short-term and long-term. Short-term, or implementation, monitoring is used to determine how the BHNF Plan directives are being met. Per each term grazing permit, the permittee is responsible for proper utilization of the forage by their livestock, and the USFS monitors livestock use to ensure the permittee is in compliance with the permit. Short-term range monitoring techniques vary depending on the resources monitored. Key areas of livestock use are the main sites monitored. Examples of short-term monitoring include, but are not limited to:

- Range readiness used in the spring determines soils and vegetation conditions. BHNF reports that “rangelands are generally ready for grazing when soils become firm after winter and spring precipitation, and when plants reach the defined stage of growth, at which time grazing initiates under the specific management plan without long-lasting damage” (USDA 2013a).

- Ocular utilization estimates are a qualitative visual evaluation of utilization of riparian and upland herbaceous or woody browse by all grazing and browsing species. Ocular estimates are based on a description representing a broad range (class) of utilization rather than a precise amount (USDA 1996b, USDA 2013a).

- Stubble height measures the residual height on streamside vegetation which a certain amount is needed to be left at the end of the grazing period or at the end of the grazing season for maintenance of plant vigor and stream bank protection and to aid in holding sediments for rebuilding degraded stream banks (USDA 2013a). Measurements of the residual sedges (*Carex* spp.) are taken along the greenline. Specifically, 3 to 4 inches of residual *Carex* spp. are required for spring pastures and 4 to 6 inches for summer and fall pastures (USDA 1996b).
- Photographs and photo-points are easily repeated to document visual changes on the landscape over time. Photos are used along monitoring plots and transects.
- Browse use of willows, shrubs, woody vines or young deciduous trees in any year by livestock or wildlife is monitored (Standard 2505 – USDA 2006). Browse is limited to 40% of the total individual leaders produced in that year and is not to be confused with 40% use on each leader.

The second type of FS monitoring is long-term, or effectiveness, monitoring. Effectiveness monitoring evaluates how successful management actions are moving the vegetation and other factors toward desired conditions as established in the Forest Plan and Allotment Management Plans (AMPs). Uplands and riparian areas are the focus of effectiveness monitoring which is primarily the responsibility of the FS but BHNF invites permittees to participate. Trends (up, down, or stable) for a variety of rangeland resource parameters are monitored in riparian areas and uplands at benchmark areas on each allotment. Examples of long-term, effectiveness monitoring include, but are not limited to:

- Cover-frequency index (also known as Daubenmire) is a permanent transect for repeated, quantitative vegetation monitoring. Understory canopy cover and frequency (percent) by plant species, ground cover (litter, bare, rocks) are recorded (USDA 1996b). Changes in plant species or ground cover offer trend data to indicate how the vegetation is responding to environmental factors, including herbivory by wild and domestic ungulates.
- Photographs and photo-points.
- Greenline/cross section methods are used in riparian areas to describe and quantify riparian areas. Transects are perpendicular and parallel to the stream and plants are recorded at a particular intercept (USDA 1996b).
- Multiple indicator method (MIM) combines up to 10 metrics to capture both short-term and long-term changes in a variety of riparian conditions (vegetation, streambank stability, stubble height and many others). The data can be used to track changes or capture site conditions (Burton et al. 2011).

Monitoring results summarized from the latest BHNF monitoring report (USDA 2013a) indicate that in general, and regardless of methodology, of those allotments monitored, upland conditions and trends are steady or upward in moving toward desired vegetation conditions as outlined in the Forest Plan. The few downward trends are attributed to activity on a prairie dog town, noxious weeds, an increase in an undesirable fescue species, and presence of bare ground due to weeds or heavy utilization in a particular spot. Forage utilization throughout most of the allotments surveyed is within Forest Plan standards (2505 – Proper Allowable Use

Guidelines, USDA 2006) and allotment management objectives. The 2013 monitoring report (USDA 2013a) indicated that "measured forage utilization exceeded proper allowable use guidelines on a small number of areas within certain pastures and some allotments. Adjustments were made and corrective actions were taken as needed. Browse use was not specifically reported in the 2013 report (USDA 2013a).

PRIVATE LANDS

Private Land Forage Availability

The 1997 Revised BHNF Forest Plan (USDA 2005) estimated forage availability on USFS lands and on non-Forest System lands (primarily private). Approximately 584,300,000 pounds of forage were estimated to be produced on mostly private lands found within the exterior perimeter of the BHNF property boundary. Many of these lands were hayed and grazed by livestock, but the Forest Plan estimated 186,980,000 pounds of forage were available for wildlife use after these activities. Although these forage estimates were substantial, and SDGFP acknowledges private land contributions to wildlife management and actively manages to abate depredation on private lands, private land forage estimates were not be used to evaluate the elk population objective in the Black Hills. Rather, SDGFP relied primarily on forage availability on public lands managed by the USFS. This approach was utilized in attempt to maximize elk use of public forage resources while concurrently minimizing potential impacts experienced on private lands.

Depredation Management

Elk management in South Dakota is a complex and adaptive process that must include careful consideration of the biological, social, economic, and political impacts. Wildlife managers must make careful decisions that recognize these considerations because wildlife is a public-trust resource yet utilizes private lands throughout the year. Wildlife depredation has been a source of conflict between private landowners and governmental agencies for many years (Davis et al. 1987). In some hunting units in the Black Hills and the majority of hunting units on the prairie, private land is the primary type of property where elk occur and hunting opportunity exists. Elk on private land are an important consideration because sportsmen and women greatly seek any opportunity to hunt elk. In 2019, there were over 34,500 applicants for all elk hunting seasons in South Dakota. Successful wildlife management programs must work cooperatively with farmers and ranchers to be effective (Bookhout 1996). SDGFP diligently works to maintain a balance between viable elk populations, social tolerances, and the needs of a variety of stakeholders. Cooperative partnerships with private landowners are an essential component to elk management and private lands serve an important role regarding elk management. Without cooperative partnerships, it would not be possible to meet the agency's responsibility of successfully managing South Dakota's elk population. The public also supports management of wildlife that is causing damage to personal property, especially when non-lethal techniques are employed (Reiter et al. 1999).

As the elk population increased in South Dakota in the 1990's, SDGFP worked with the South Dakota Legislature to establish a funding mechanism to provide wildlife damage abatement services. In 1998, a five-dollar surcharge was established on most types of hunting licenses. Fifty percent of these funds are allocated to SDGFP's wildlife damage management program and the other fifty percent go to hunter access programs. The establishment of this funding was the financial foundation for which SDGFP's elk depredation abatement program was initiated. From the year 2000 through 2019, SDGFP spent nearly $2.8 million addressing elk depredation on private lands. Annual expenditures ranged from approximately $86,000 to $320,000 and assisted between 50 to over 100 landowners (Table 32). These dollar values represent only direct payments to landowners and don't reflect the thousands of hours and tens of thousands of miles utilized by staff to implement these programs and haze elk. Funds expended for elk damage abatement under the WDM program have increased substantially over the last several years due to an increase in program maximums as well as an expanding elk population in many Prairie Elk units. Because these programs are entirely funded by sportsmen and women, SDGFP requires that all landowners participating in elk depredation programs sign an agreement that states, *"the Producer agrees to allow reasonable, free public hunting access to non-family members who obtain proper permission" and "the Producer agrees NOT to charge any person or entity* a *fee or payment for elk hunting access".* To achieve successful elk management, it is imperative that sportsmen and women have access to private lands when revenues from hunting licenses are used to operate such programs and wildlife populations are largely managed through regulated hunting.

The demand for elk damage abatement services fluctuates annually due to weather events (i.e., drought or harsh winters) and seasonal variations, elk populations, and changes to elk habitat (e.g., fire, agricultural development, logging practices, and human encroachment). However, the most significant factors that affect social tolerance and demand for elk damage abatement services are elk population herd size, landowners' financial status, and weather patterns. Lacey et al. (1993) found that tolerance for wildlife depredation quickly diminished as landowners' economic dependency on their land increased. When the estimated elk population peaked in the Black Hills in 2004 through 2006, South Dakota was also experiencing severe drought conditions in many areas and as a result of these two factors, SDGFP experienced record numbers of requests for assistance from landowners as well as record amounts of expenditures to reduce elk damage on private property. In a survey conducted by Longmire (2014a) 26% of area landowners indicated that elk had caused damage to their property within the last year. In another survey, Longmire (2014b) reported that 45% of responding landowners who were surveyed indicated that elk damage was a problem. Requests for damage abatement services typically involve damage to growing crops (i.e., alfalfa, barley, wheat, and corn), damage to stored-feed supplies (i.e., hay or stored-grain), damage to fences, and grazing competition between livestock and elk on meadows. Frisina and Morin (1991) also stated that competition for forage between elk and cattle has generated intense conflicts in many western states. Nevertheless, 64% of landowners that received SDGFP elk depredation abatement services were satisfied with the assistance provided in 2013 (Longmire 2014a).

Table 32. Breakdown of annual expenditures (fiscal year 2000-2019) of SDGFP's elk depredation abatement program components.

Fiscal Year	Food Plots	Stackyards/Panels/ Fencing	Total Expenditures
2000	$101,703	$10,850	$112,553
2001	$103,875	$24,250	$128,125
2002	$94,362	$8,870	$103,232
2003	$83,329	$12,500	$95,829
2004	$91,067	$12,775	$103,842
2005	$96,742	$16,550	$113,292
2006	$83,266	$11,115	$94,381
2007	$97,896	$14,400	$112,296
2008	$106,156	$5,125	$111,281
2009	$99,788	$12,300	$112,088
2010	$93,767	$5,000	$98,767
2011	$81,058	$4,900	$85,958
2012	$76,129	$10,000	$86,129
2013	$78,193	$24,982	$103,175
2014	$70,952	$15,750	$86,702
2015	$99,430	$123,055	$222,485
2016	$115,343	$158,191	$273,534
2017	$121,667	$76,944	$198,611
2018	$144,024	$176,671	$320,695
2019	$163,507	$95,078	$258,585

SDGFP designed its elk damage abatement programs to address most of these types of requests for assistance. The most widely used program component to address crop damage is cost-share assistance for growing-season food-plots. In fiscal year 2019, SDGFP spent over $163,000 in cost-share assistance to cooperating landowners. Landowners that have elk-use in alfalfa fields or other crop fields are eligible for up to $8,000 of cost-share assistance to establish and manage these fields, annually. Up to an additional $4,000 is available for producers that have elk-use in non-crop areas that are hayed. For example, elk may continually utilize an alfalfa field throughout the summer months immediately after haying activity occurs to utilize the new growth. Elk find these fields highly attractive and depending on other factors (e.g., availability of other forage) may attract large concentrations of elk. In this case, the landowner would be eligible for some level of cost-share assistance based upon the number of elk that use the field and the extent of elk-use, provided that the landowner signs the agreement with SDGFP (which states no fee-hunting and they must allow reasonable hunting access). Another program component that provides long-term solutions is the permanent stackyard (i.e., protective fencing) and protective panel program. In these programs, landowners are reimbursed for materials to construct a permanent stackyard or purchase protective panels, up to a maximum

of $10,000. Depending on individual needs and available funding, some landowners are eligible for multiple contracts over several years. This program has provided permanent solutions to elk depredation to hay and other stored feed supplies for many years, and in some areas chronic problems have been completely resolved.

Another management technique utilized in the elk damage abatement program is different forms of hazing. SDGFP routinely works with landowners to employ different hazing practices to scare animals away from problem areas. These techniques include: pyrotechnics, propane cannons, hazing with ATV's, rubber bullets, and helicopters. SDGFP also implements depredation pool hunts where licensed hunters are enlisted to harvest elk in strategic locations to reduce impacts to private property. This management tool typically only removes a small number of animals at a specific location, but more importantly helps haze the animals away from the immediate area because of the human disturbance. During the winter of 2013-2014, SDGFP implemented one depredation pool hunt and removed five antlerless elk. The hazing effect of the hunting pressure was enough to move the elk several miles away from the problem area. Since then, SDGFP has used depredation pool hunts both in the Black Hills and on the prairie to address specific damage complaints as well as to place additional pressure on elk herds moving across entire elk units.

The final program available to landowners is cost-share assistance for the replacement of fence materials because of damage caused by elk crossing fences. When elk cross barbed-wire fences, they can cause substantial damage to the fence (Bauman et al. 1999). SDGFP utilizes aircraft-grade aluminum cable strung along the top of fences to reduce the damage caused by elk when crossing the fence. This technique has proven successful if the area where the cable is applied has a fence in good condition with an adequate number of wooden posts. SDGFP also provides replacement posts and wire to cooperating landowners. Since 2000, SDGFP has provided cooperating landowners with over 65 miles of cable to protect fences within the Black Hills area. Cooperating landowners are limited to $15,000 but dependent upon individual needs and available funding some landowners were eligible for multiple contracts over several years.

Finally, while grazing competition between livestock and elk exists in South Dakota, most sportsmen/women and landowners agree that it is possible to manage effectively for both. Longmire (2014a) found that 82% of hunters and 80% of landowners agreed that it was possible to manage for both elk and livestock grazing in the Black Hills. In Montana, wildlife officials have found success by implementing certain grazing management practices that benefit both elk and cattle (Frisina and Morin 1991). Elk depredation abatement programs in 2020 did not address requests for assistance regarding grazing impacts to pastures or meadows, under most circumstances. However, SDGFP provides hazing devices (i.e., propane cannons and pyrotechnics) and technical assistance to landowners that have concerns of elk grazing on grasslands. In a few circumstances SDGFP also temporarily hazes elk away from these areas with ATV's and vehicles. If these conflicts occurr near or during on-going hunting seasons, SDGFP directs hunters to these areas for increased harvest and hazing pressure.

During the legislative session of 2014, SDGFP was successful at introducing legislation which increased the non-refundable application fee that sportsmen and women pay when applying for elk licenses or purchasing preference points for elk. Sixty-seven percent of hunters and 58% of landowners indicated that they were willing to pay an additional five-dollars (a total of ten-dollars) for this non-refundable application fee (Longmire 2014a). This legislation became effective on July 1, 2014 and generated an estimated $150,000 annually. This funding is earmarked for enhanced elk depredation abatement services for landowners to raise the social tolerance for higher numbers of elk in the Black Hills. In 2013, 38% of landowners indicated that their tolerance would increase to some degree if SDGFP enhanced current elk depredation services while 51% of landowners indicated that their tolerance would stay about the same (Longmire 2014a). Due to this information and because elk hunting is held in very high regard with South Dakota hunters, SDGFP believes that increased funding for enhanced levels of elk depredation programs was a valuable use of these funds.

Landowner Licenses and Preference System

Since elk populations and elk habitats in South Dakota's agricultural dominated landscapes are limited, and elk hunting opportunities in South Dakota are highly desired (Figure 3), only residents of South Dakota are eligible to apply for elk licenses. The majority of elk hunting opportunity exists in the Black Hills elk management units, which comprised <4% of the state. Approximately 41.6% of the Black Hills Fire Protection District in South Dakota is owned by private landowners, therefore landowner tolerance for higher populations of elk limits elk population objectives. Limited elk populations in prairie management units reside predominantly on private lands and conflicts with agricultural production are common. South Dakota Game, Fish, and Parks and the Commission acknowledges the important role landowners serve in providing habitat requirements for wildlife, including elk. As a result of this recognition, preference is offered for those qualified landowners interested in the opportunity to hunt elk.

The following are requirements as established in South Dakota Administrative Rule (ARSD) for resident only elk landowner/operator preference licenses for Black Hills, Black Hills Archery, and Prairie Elk hunting seasons (landowner/operator preference was not available for CSP elk hunting licenses):

- Qualifying landowner-operation applicants can apply for preference every year.
- Fifty percent of the licenses are available to persons who qualify for landowner-operator preference.
- A minimum of 240 acres of land within an elk unit which has had at least 500 days of elk use since the last day of the previous application period is required to qualify. An elk use day is any day an elk feeds or waters on private land.
- For purposes of elk preference eligibility, members of the qualifying landowner-operator's family including grandparents, parents, spouse, children, children's spouse,

or grandchildren who live on the ranch or in the closest community and have an active role in the ranch operation also qualify.

- Only one qualifying applicant per ranch unit per year can apply for a landowner-operator preference elk license in each elk hunting season. A ranch unit is described as all private property owned and leased for agricultural purposes by written agreement by an individual qualifying landowner or a qualifying corporation, limited liability company, partnership or trust in the state. Only one shareholder, member, partner or trust beneficiary of a qualifying corporation, limited liability company, partnership or trust may apply under landowner-operator preference for each elk hunting season. A ranch unit may not be subdivided for the purpose of qualifying for more than one landowner-operator preference in a specific elk season.
- A landowner or tenant, but not both, may claim landowner preference for the same qualifying property. Employment on a farm or ranch alone does not qualify an individual for landowner preference.
- Restrictions on landowner preference for legal entities. Shareholders of a corporation, members of a limited liability company holding a membership interest in the company, partners in a partnership, and beneficiaries of a trust entitled to the current income and assets held in trust; all organized and in good standing under the laws of the State of South Dakota are eligible for landowner preference if:

  (1) The entity holds title to no less than the minimum number of acres of private land located within the hunting unit applied for as established in rule;
  (2) The shareholder, member, partner, or trust beneficiary applying for landowner preference is a resident; and
  (3) The shareholder, member, partner, or trust beneficiary is responsible for making the day-to-day management decisions for agricultural purposes on the farm or ranch.
- The landowner preference elk license is not restricted to the land owned or operated but can be used anywhere within the respective elk management unit.

Unlike the application restriction for the Black Hills firearm, archery, and the prairie elk hunting seasons, where a person who receives an elk hunting license in one of these seasons as a first choice in the first lottery drawing in any of the nine preceding years may not apply for a license, one qualifying applicant per ranch unit per year may apply for a landowner-operator preference elk license every year, even if they held a landowner preference elk license the previous year.

Qualified applicants using landowner preference for available elk licenses vary greatly from season type and unit. From 2016-2020 in the Black Hills firearm season, an average of 21.4% of all “any elk” licenses were issued to applicants with landowner preference, with a range of 19.6% in 2019 to 24.1% in 2016 for all units combined. In 2020, “any elk” licenses issued to applicants with landowner preference by unit ranged from 12.5% in Unit 2 to 50% in Units 3 and 4 (Figure 15).

From 2016-2020 in the Black Hills archery season, an average of 8.7% of all “any elk” licenses were issued to applicants with landowner preference, with a range of 5.1% in 2018 to 12.9% in 2020 for all units combined. In 2020, “any elk” licenses issued to applicants with landowner preference by unit ranged from 0% in Unit 5 to 34.3% in Unit 3 (Figure 16).

From 2016-2020 for the prairie elk season, an average of 45.5% of all “any elk” licenses were issued to applicants with landowner preference, with a range of 40.7% in 2017 to 50.0% in 2020 for all units combined. In 2020, 50% of “any elk” licenses were issued to applicants with landowner preference in all prairie elk hunting units (Figure 17).

Since all land within the prairie elk units and much of the southern portion of Unit 3 within the Black Hills is private land, there is an obvious demand by landowners and operators within these respective units for landowner preference elk licenses. In all elk seasons and their respective units, there is minimal interest for using landowner/operator preference for antlerless elk licenses. See Figures 15-17 for number of applicants by season type using landowner/operator preference.

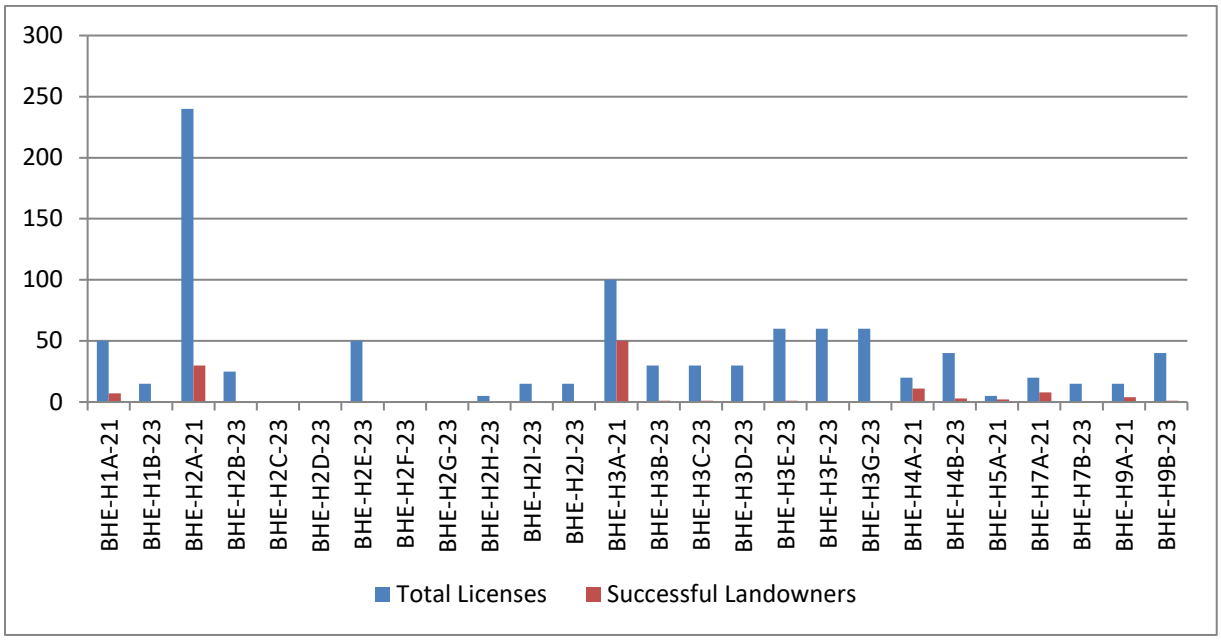


Figure 15. 2020 Black Hills Rifle elk licenses and successful landowner applicants by management unit.

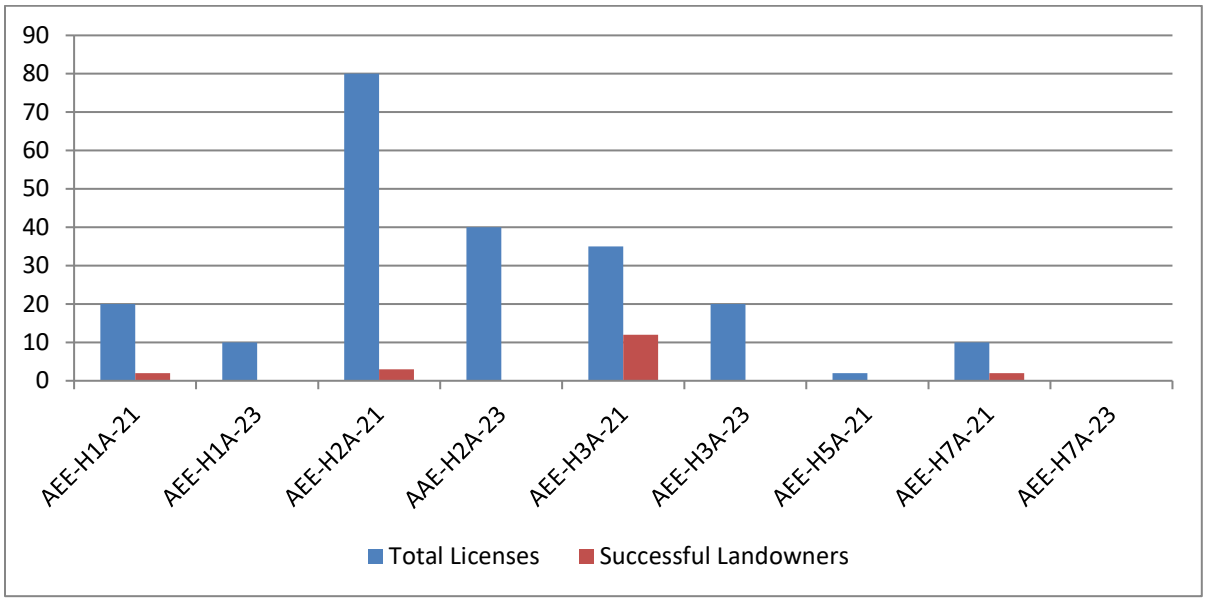


Figure 16. 2020 Black Hills Archery elk licenses and successful landowner applicants by management unit.

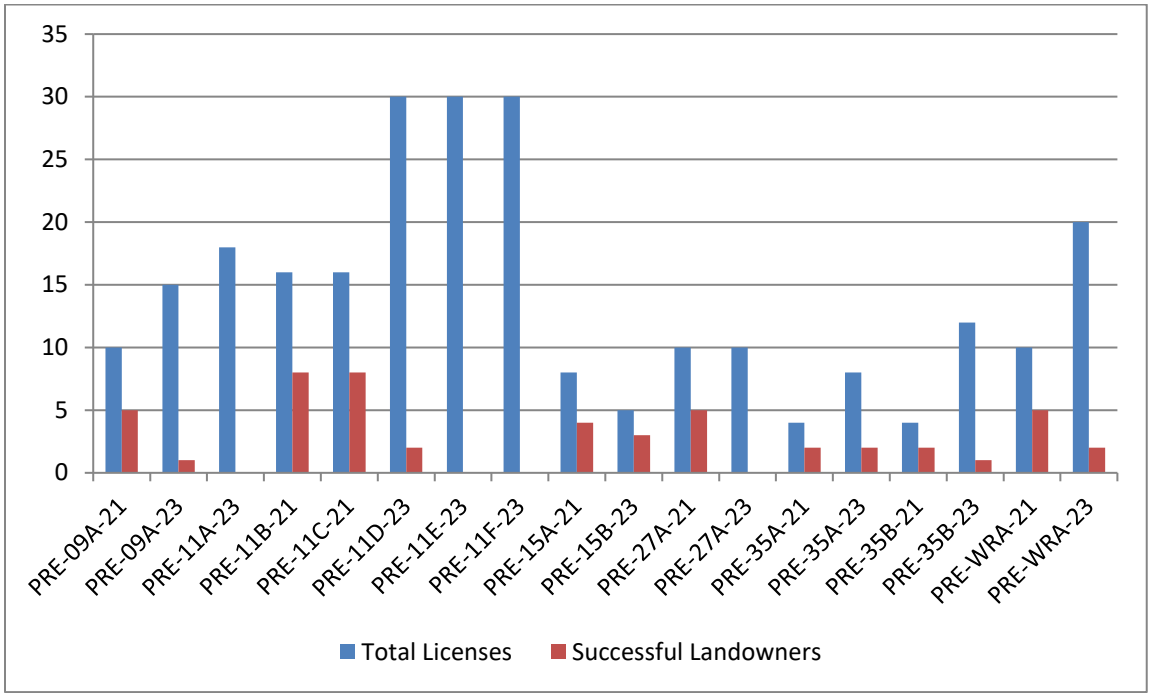


Figure 17. 2020 Prairie elk licenses and successful landowner applicants by management unit.

Wildlife Partners Program

South Dakota Game, Fish, and Parks recognizes landowners as a most essential partner in ensuring agency responsibilities for managing South Dakota's fish and wildlife trust resources were met. Wildlife management not only involves biological and science-based habitat management practices, it also includes careful consideration of the wide array of social values held by both the general public and South Dakota landowners.

Since the 1970's, SDGFP offered an evolving toolbox of voluntary wildlife habitat incentive programs to landowners though the Wildlife Partners Program (WPP). One objective of SDGFP's WPP is to provide cost-share incentives to cooperating landowners who establish wildlife habitat on their lands, thereby helping to sustain and enhance local wildlife populations. These habitat incentives are designed to (1) meet the biological needs of a variety of resident and migratory wildlife species, (2) complement conservation program opportunities offered through the federal Farm Bill, and (3) meet the needs and desires of private landowners seeking to restore, protect, and enhance wildlife habitat on their lands.

Social tolerances of wildlife populations also play an integral role in successful wildlife management. Wildlife populations can at times exceed management objectives or impact agricultural operations. Offering habitat-based management programs that address both wildlife needs and social tolerances on private lands are important in meeting our wildlife trust management responsibilities.

The following habitat practices are available to landowners in the Black Hills with an interest in providing habitat for elk and other resident wildlife species:

<u>Wildlife Habitat Fencing</u>

This practice involves using fences to protect and enhance existing wildlife habitat, and better manage livestock grazing to benefit grassland dependent wildlife, with a special emphasis placed on riparian areas. Riparian areas provide important habitat for many wildlife species and are arguably the most important yet most under-managed habitat in the state. Healthy riparian areas provide water and shelter for both livestock and wildlife, while also improving water quality and aquatic habitats by filtering runoff and capturing sediment.

<u>Grassland Habitat Enhancements</u>

This practice involves reestablishing and managing grassland vegetation on previously farmed areas as year-round habitat for wildlife. Plantings involve either a dense nesting cover mixture of alfalfa, sweet clover and western, intermediate, or tall wheatgrass; or a mixture of native warm and cool season grasses and native forbs. Grassland habitat restoration activities on previously cropped land also becomes a widely utilized practice by cooperators who are reseeding marginal cropland areas back to grass as part of managed grazing systems.

Woody Habitat Establishments

This practice involves planting woody cover plots to benefit resident small and big game species. Since their inception over 30 years ago, woody cover plots have been one of the most popular and long-lived habitat programs offered by SDGFP. For a number of years participation in SDGFP's woody cover planting program had waned as landowners utilized more lucrative and flexible opportunities for woody cover planting available through the Conservation Reserve Program (CRP). However, diminished opportunities available through CRP and a renewed desire by landowners in providing higher quality winter cover for wildlife on their property has increased participation in this program

Food Habitat Plots

This practice involves planting and maintaining annual food habitat plots to benefit resident big game and small game species. Since their inception in 1988, food habitat plots are the most popular habitat program offered by SDGFP. With Conservation Reserve Program fields providing abundant nesting and fawning cover, the need for strategically located food plots to boost small game and big game winter survival and provide much desired hunting opportunities propell this activity's success.

Wildlife habitat management practices utilized through WPP aid migratory and resident wildlife populations by (1) helping meet their annual life cycle needs, (2) providing additional natural resource benefits by complementing other conservation program opportunities offered through the federal Farm Bill, (3) helping maintain social tolerance towards wildlife populations, and (4) providing financial and technical assistance to cooperating landowners seeking to improve wildlife habitat on their lands.

Improved wildlife habitat and healthy wildlife populations resulting from this project also provide opportunities for countless hours of consumptive and non-consumptive wildlife related recreational activities to many South Dakotans and visitors to the state. Landowners cooperating with SDGFP through these programs also agree to open their lands to reasonable use by the public.

Conservation Easements

A conservation easement is a deed restriction placed on a piece of property to protect its natural resource values, such as traditional agricultural land-use, wildlife habitat, or open space. Easements are either sold or donated by the landowner to a qualifying conservation organization or government agency, and constitutes a legally binding agreement that prohibits certain development (e.g., commercial or residential) from occurring on the property. An easement does not grant ownership nor does it absolve the property owner from traditional owner responsibilities, such as property tax.

A conservation easement permits the holder certain rights regarding use of the land, while the ownership of the land remains with the private property owner. However, the easement

holder is also held responsible for monitoring and enforcing upon the current and future property owners the restrictions and condition imposed by the easement.

While conservation easements may restrict or permit certain public uses of the land, they generally do not require public access. The decision to allow public access is left to the individual property owner. Using conservation easements, several organizations have protected wildlife habitat, natural areas, and open spaces on several thousand acres of private land in the Black Hills. Owing principally to costs associated with such a program, SDGFP does not have a program to acquire or hold conservation easements, nor are there any plans to implement an easement program for elk management.

CITIZEN INVOLVEMENT AND OUTREACH

Why engage the public in elk management?

According to the Public Trust Doctrine and reaffirmed through the North American Model of Wildlife Conservation, fish and wildlife populations are held in trust and managed by the agency within each state charged with conserving those resources for current and future public use and enjoyment (Organ et al. 2012). As such, effective wildlife management and decision-making includes consideration of public perceptions and opinions, along with potential responses to management policies. This necessitates that state wildlife agencies develop opportunities for broad and meaningful public participation that welcome the input of non-traditional stakeholders, in addition to those participating in hunting, fishing, and trapping activities.

Along with hunter harvest and biological data collected, public involvement is an important component in developing and implementing elk management in South Dakota. Public participation helps ensure decisions are made in consideration of public needs and preferences. It can help resolve conflicts, build trust, and inform the public about elk management in South Dakota. Successful public participation is a continuous process, consisting of a series of activities and actions to inform the public and stakeholders, as well as obtain input regarding decisions which affect them. Public involvement strategies provide more value when they are open, relevant, timely, and appropriate to the intended goal of the process. It is important to provide a balanced approach with representation of all stakeholders.

Human dimensions of elk in South Dakota

South Dakota Department of Game, Fish, and Parks (SDGFP) mission is “We serve and connect people and families to the outdoors through effective management of our state’s parks, fisheries and wildlife resources.” SDGFP demonstrates its public trust commitment through its long history of engaging the public and using social science data to inform decisions related to fish and wildlife management. A historical overview of human dimensions of elk in South

Dakota was detailed in the 2015 elk management plan (SDGFP 2015). Here, we present the 2019 – 2020 public involvement process used to update this document and the *South Dakota Elk Action Plan* (SDGFP 2021).

2021: elk management for the next 10 years

SDGFP is responsible for conserving and managing elk populations and their habitats for current and future generations of residents, visitors, and sportswomen and men to enjoy. In 2015, when the first South Dakota elk management plan was written, elk were primarily in and around the Black Hills area (roughly parts of 9 counties). Since then elk have expanded from the Black Hills and other areas onto additional habitats of the prairie. In response, GFP increased the number of elk hunting units that currently encompass all or parts of 16 counties: Bennett, Butte, Custer, Fall River, Gregory, Haakon, Harding, Jackson, Jones, Lawrence, Meade, Mellette, Pennington, Perkins, Stanley, and Tripp counties. The expanding elk management range brought with it, new landowners and variety of land uses, different (and sometimes competing) preferences for accessing and using elk (both hunting and other recreation), and most importantly, varying degrees of tolerance for elk among landowners.

Moving from a relatively small-scale management scope (Black Hills Fire Protection District region only) to one on a larger landscape-scale (currently nearly half of the state), while at the same time acknowledging changing land use and ownership patterns as well, is a complex setting in which GFP is tasked with managing public trust resources (elk) for the benefit of current and future generations. Effectively managing elk populations at multiple spatial scales requires flexible and adaptive management goals and objectives that strike a balance between biological/ecological needs of elk and elk habitat with social needs/expectations (to the extent possible). Successful implementation of landscape-scale management goals and objectives takes all interested elk enthusiasts working together and adapting to biological/ecological and social changes.

Mixed-method approach: build a better foundation of knowledge

No single citizen or group of citizens is able to represent the views of every person in a population of interest; therefore, when possible, combining different techniques (i.e., mixed-methods) is preferred to using a single public involvement approach. A mixed-methods approach is a research design popular in social science disciplines, in which researchers/managers collect, analyze, and integrate both quantitative (e.g., counts, numbers) and qualitative (e.g., text, pictures) data. Numerous peer-reviewed studies demonstrate that a mixed methods approach enhances applied projects in a variety of contexts. Mixed-method approaches are useful in cases when the aim is to identify and describe multiple stakeholder perspectives or where researchers desire a more complete understanding of a situation, particularly from the perspective of the population of interest. They also are useful when researchers collect qualitative data to inform the development of quantitative surveys. Finally, mixed-method approaches provide underlying narratives to help explain quantitative results;

thus, enhancing the data-collection protocol because they allow researchers to confirm quantitative findings with qualitative experiences.

GFP uses a combination of informal and formal techniques to reach a broader segment of the public. Multiple avenues for public involvement and outreach (e.g., public listening sessions, invited stakeholder meetings, open public comments – both written and presented verbally at Commission meetings) were used to write the first elk management plan, as well as to update the Elk Action Plan in 2021 (SDGFP 2021). These approaches were designed to involve the public at various stages of plan development and to ensure opportunities for participation were accessible to all citizens.

Similar to the public input process used in 2015 to write the first elk management plan, in 2020 additional public involvement opportunities (e.g., public meetings, open comment forms on webpage, public comment during Commission meetings) were also used to help incorporate the social aspects of managing elk into GFP's current development of the elk action plan for the next decade. Using multiple and mixed-methods helps GFP meet its public trust commitment by collecting input and feedback from a broad range of South Dakota elk enthusiasts and through transparent public engagement and decision-making processes. In Support, GFP solicits broad public input.

2020 Elk Management Public Opinion Survey

The purpose of the *Elk Management in South Dakota: 2020 Public Opinion Survey* was to update GFP's elk management document and develop an action plan for the next 10 years. Managing healthy elk populations across public and private land is complex and requires GFP to balance wildlife science with social considerations and expressed needs of important stakeholders, such as landowners and hunters, all of whom value and use elk differently. This survey built on the 2013 elk management public opinion survey. The 2020 survey was designed and administered to (1) provide elk managers Elk Hunting Unit (EHU)-level information, and (2) gain a better understanding of those who own land in EHUs, particularly in the newly established WRA EHU. The survey also asked elk hunting enthusiasts their opinions and perceptions about managing elk populations, their hunting experiences, and overall satisfaction (Wolter 2020). Questions were designed to understand attitudes, opinions, and perceptions about:

- elk conservation and management on private land
- current and future elk conservation and management objectives and strategies
- elk tolerance incentives for private landowners
- elk hunting experiences and overall satisfaction

2020 Elk Stakeholder Group

A stakeholder for this purpose is defined as a person, group, or organization with an interest in the management of elk and elk habitat. Because elk and elk hunting are greatly prized by many South Dakota residents, SDGFP felt it was important to have a diverse representation of stakeholders to provide input for future management of elk in South Dakota. The formation and input from this stakeholder group, however, did not inhibit SDGFP from obtaining and incorporating additional input or opinions on elk management in South Dakota.

The South Dakota Elk Stakeholder Group included representation from the following: general public, elk hunters, private landowners, public grazing lessees, conservation organizations, and public land managers. An Elk Stakeholder Group Charter (Appendix 8) was shared with all stakeholders and described the purpose, objectives, authority, roles and responsibilities of this group.

The South Dakota Elk Stakeholder held 3 stakeholder meetings (25 March 2020, 23 September 2020, and 12 February 2021). To provide multiple avenues for participation, meetings were held simultaneously in-person and virtually participation using Zoom (except the March 2020 meeting, which was virtual only due to COVID-19 considerations). Additionally, virtual meetings were recorded and posted on SDGFP's website for the public to view at their convenience. Information and supportive data were provided by SDGFP, WICA, and USFS BHNF staff to ensure all members were knowledgeable about the topics and issues discussed and deliberated by the group. Key topics and issues discussed by the stakeholder group included but were not limited to the following: results of the elk public opinion survey, elk population monitoring and status, BHNF Land and Resource Management Plan, history of elk license allocation, elk preference points and drawing structure, SDGFP elk depredation program, depredation pool hunts, landowner elk preference licenses, landowner own-land licenses, cooperative habitat projects, archery and firearm license allocations, and review of draft elk management plan.

Individual views and opinions varied amongst the broad representation of this stakeholder group. It should be noted that there were contrasting opinions at differing levels between those who wanted to maximize hunter opportunities and those who had concerns over elk and cattle forage competition and elk damage to private property. As a result, careful considerations of these opinions were included in identifying the management objectives and strategies necessary to successfully manage this elk population within biological and social carrying capacities.

NON-GOVERNMENTAL ORGANIZATIONS

Several non-governmental organizations have missions that cooperatively work to benefit elk and elk habitat in South Dakota. The Rocky Mountain Elk Foundation (RMEF) has conducted over 350 projects in South Dakota since 1990 that include land acquisitions, easements, habitat enhancement, wildlife management activities, public education and research. These projects have affected 120,557 acres, either protected, enhanced or provided public access, by the South Dakota Chapter of the RMEF. The South Dakota RMEF has 17 Chapters and over 4,400 members. Yearly volunteers conduct fund raising banquets, coordinate the Black Hills Special Elk Tag raffle (formerly known as the CSP Elk Tag) and various other events. Between 2002-2019 the South Dakota RMEF raised $478,035 with the SD Elk Tag/CSP Elk Tag raffle, and the funds went directly to South Dakota elk habitat enhancement, management and research. Nearly $38,700,000 of RMEF funding has gone to enhancing elk habitat, management, research, and outreach activities.

The Nature Conservancy (TNC) also has completed projects that benefit elk. The 4,383 acre TNC Whitney Preserve is located southwest of Hot Springs, South Dakota, and is managed for various plant and wildlife species. Management on the property includes cattle grazing allotments. Elk hunting is allowed on the preserve during the month of October. A maximum of 4 hunters share the time by splitting it into an early half and late half season structure, and hunters are allowed to harvest cow elk only. Small groups of elk utilized this property typically in the fall.

The South Dakota Division of the Izaak Walton League of America is involved in many facets of elk management in South Dakota. They have engaged in watershed and public land management and access issues. They have given support to regulations to limit the spread of CWD, suggested increased regulations on captive cervid farms to protect wild cervid populations, and provided public engagement and education opportunities.

CHALLENGES AND OPPORTUNITIES

Habitat

Habitat is defined as the place where an organism makes a living with the essentials of food, water, shelter (cover) and space. The arrangement, abundance and connectivity of these elements across the landscape, and proximity to each other, primarily dictates where organisms, elk for example, distribute themselves. In order to manage elk, it is necessary to apply what we know, and continue to study and observe elk to comprehend the interplay between elk and their habitat. An understanding of elk habitat requirements and other outside influences, such as climate and weather, humans and human activities, interactions with other wildlife and domestic livestock, is needed to interpret or predict various scenarios in elk range.

Quantity and quality of elk habitat in the Black Hills affects elk herd distribution, abundance, and productivity. A healthy, productive, and sustainable elk herd requires quality habitat throughout the year. Any loss or degradation of existing elk habitat in the Black Hills could result in a reduction in elk numbers.

Unfortunately, elk habitat in the Black Hills is impacted and fragmented by a variety of causes, including human development and expansion. The BHNF recognizes the importance of acquiring property within its boundary to prevent further habitat fragmentation. Additionally, human disturbance impacts to elk habitat are particularly true on the densely-roaded BHNF. Off-highway vehicle (OHV) use is restricted to designated areas instead of forest-wide; however, enforcement appears insufficient in many areas. While curbing or mitigating habitat loss is a significant challenge, it is essential for maintaining a sustainable elk population. Assessment of roads and trails in sensitive wildlife areas is a challenge and with each site-specific project, there is an opportunity to work with BHNF to determine if travel management is compatible with elk for a particular area.

Habitat quantity and quality is often gauged by the seasonal availability of forage in areas elk occupy. To meet nutritional requirements, elk select from a variety of plant species - grasses, forbs, and browse from trees and shrubs are all utilized. Forage condition and availability in the Black Hills are principally the result of forest and range management activities - including livestock grazing - under the control of the BHNF and private landowners. Except for its small Game Production Area holdings and Custer State Park, SDGFP has minimal direct management authority over elk habitat in the Black Hills.

Forest management practices such as logging, timber thinning, and prescribed burning can either help maintain, enhance, or degrade elk habitat, depending whether elk habitat is a considered project objective. If elk habitat is an objective during project design, forest management practices can greatly improve forage quality and quantity. Silviculture and vegetation treatments that move a large percentage of even-aged forest to a more diverse pine ecosystem are opportunities to enhance and create habitats for a variety of wildlife, including elk. A significant emphasis was placed on cutting and thinning pine trees on both public and private lands to reduce the wildfire threats and address mountain pine beetle (MPB) infestations in the 2010s, resulting in what could likely be a general improvement to elk habitat.

Grazing management on public and private land in the Black Hills, like forest management, can either benefit or degrade elk habitat. Most rangeland in the Black Hills is subjected to annual livestock grazing, with the timing, intensity, and duration greatly affecting forage quality and quantity available to elk. And like forest management objectives, grazing practices that consider the habitat needs of elk can be beneficial by rejuvenating decedent forage. However, grazing practices that give little or no consideration to elk habitat conditions can result in removal of much needed forage, and a general degradation of habitat quality and quantity. Other rangeland management activities used to benefit grazing practices, such as water

developments and fencing, can also indirectly impact elk habitat quality and quantity by affecting the intensity, distribution and duration of grazing.

Finally, prescribed burning can affect elk habitat, depending on its timing, intensity, size, weather, and the habitat treated. If elk habitat is an objective during a prescribed fire project design, it can greatly improve forage quality, quantity and beneficial cover. Prescribed burns, both in forest or rangeland habitats, could remove overgrown, decadent vegetation, and create openings that in general improve elk forage. However, on a short-term basis, fire can also negatively impact important winter browse habitat or have negative impacts on calving and spring foraging habitat.

Mountain Pine Beetles

Mountain pine beetles (MPB) are small (1/4") native beetles which burrow below the bark of host pine species, including ponderosa pine, for part of their lifecycle. An adult MPB lays eggs beneath the bark and hatched larvae feed on the tree until they emerge as flying adults the following July – August. The burrowing and feeding activity on a single tree, if compounded by hundreds or thousands of colonizing beetles, can cause injury to or kill the pine. Not all attacked trees die. However, MPB are the most prominent insect capable of killing pines (USDA 2013a).

The Black Hills is a disturbance-based ecosystem (Parrish et al. 1996). Dynamic forces historically played an important role in shaping Black Hills plant communities through fire, insects, drought, disease and wind-throw. MPB are important in setting back pine structural stages by creating holes or pockets of dead trees from a few trees to several acres. These holes in the forest canopy allow sunlight to reach the forest floor where early successional plants capture the site (Figure 18) until pine once again recovers the area. This constant but fluctuating rhythm of MPB outbreaks across the forest, along with other natural disturbances, allow for diverse habitats.

Figure 18. Increased understory due to Mountain Pine Beetle-killed pine stand. Photo credit: Bob Berwyn

Since 1996, the vast habitat occupancy and shear populations of MPB have completely changed entire watersheds across all land ownerships throughout the Black Hills of South Dakota and Wyoming, in addition to smaller pockets of dead trees. The pine beetle epidemic impacted approximately 450,000 acres on BHNF and adjacent lands and returned to endemic (natural) levels by 2016 with only 4,700 acres impacted in 2017 (Allen 2017). From 2012-2017, a collaborative partnership among South Dakota and Wyoming state, federal, and private parties non-commercially treated 1.3 million infested trees and sawmilled 1.4 million infested trees (USDA 2020a). Another 188,000 and 73,000 acres were commercially and pre-commercially thinned, respectively (USDA 2020a). Because the beetle is native, there continue to be pockets of and scattered pine mortality. As pine stands die and remain as standing dead trees, understory recapture the site resulting in increased forage production for many wildlife species. Within 5-10 years post-mortality, the majority of MPB killed pine snap below 25 feet and fall to the ground (Schmid et al. 2009), similar to the pattern after a wildfire.

Each pine stand has a unique set of variables pre-MPB mortality that sets the stage for post-MPB-mortality responses by plant communities. Variability ranges from the pine structural stages (Table 30), individual tree vigor (Larsson et al. 1983), percent stand mortality, other plant assemblages, the physical and biological environment and if there is mechanical thinning or burning to reduce post-mortality fuel loads within that stand. In some areas, the response of shade-intolerant quaking aspen is tremendous.

During the MPB epidemic in the late 1990s to early 2000s, BHNF and CSP attempted to keep ahead of the massive pine die-off by cutting and removing, or cutting and chunking, green-hit pine (pine recently attacked and dead, but needles are green and the timber is merchantable). As funding and markets allowed, abatement was fast-tracked before each new MPB flight from

June – August when emerging adult MPB find new habitat. In some limited treatments, MPB hit pine had the bark removed or logs were rolled to kill larvae. Treatments also included thinning pine that had not been beetle-hit to reduce pine densities. This treatment continued where necessary.

If MPB populations are high, most adjacent pine stands with more than 60 ft^2/ac BA are susceptible to infestation (USDA 2013a). Data on MPB infestations from 2009 through 2011 resulted in tree mortality on approximately 55,612 acres, or approximately 12 percent of BHNF pine acreage. Tree mortality rate per stand is generally 25-75%.

It is unknown how elk specifically responded in movements and behavior to changes in forest and forage structure as a result of MPB infestation. Since the heavy pine MPB-mortality, more acres are dominated by early successional vegetation of grasses, forbs and shrubs/seedlings (SS1 and SS2), which may directly benefit elk. Sapling and pole-sized pine with low to moderate canopy cover (SS3A and 3B) have increased, likely due to MPB-mortality of older, bigger trees (SS4) and logging efforts by BHNF, have resulted in a conversion of stands from mature at low densities to immature stands. Low to moderate canopy cover, depending upon the spatial arrangement on the landscape and proximity to roads, still provide elk screening cover, shade and wind breaks but also allow understory production. Heavy overstory canopy within immature pine (3C) likely inhibits abundant understory production of forage. The juxtaposition and spatial arrangement of various canopy structures should be considered to meet the variety of elk life requirements along with forage.

As expected, the MBP epidemic and logging efforts have significantly lowered the abundance and distribution of mature pine in all overstory categories from low to high (SS4A-C). With the loss of larger, mature pine due to MPB and logging efforts, competition for moisture, sunlight and nutrients are be reduced for all vegetation. It is reasonable to assume there are increases in grasses and forbs (SS1) and shrubs and pine seedlings (SS2) in some areas. In some areas, including the Northern Black Hills, noxious weeds or other invasive species have increased and competed with understory native vegetation. Anecdotal observations indicated that where hardwoods and deciduous shrubs occurred, the increased sunlight and moisture allowed these early successional woody plants to flourish in some areas. It is unclear if hardwood regeneration reached successful recruitment height (6-15 feet) and avoided heavy browsing by ungulates.

Fire

Elk have been described as a fire-dependent species because of their association with fire-dependent and fire-adapted plant communities, and because elk populations often decrease when fire frequency in these plant communities decreases (Patton and Gordon 1995). Bendell (1974) described elk as a "fire follower" due to the species' positive response to fire-caused changes in food. Fire suppression in the Black Hills has contributed to a degradation of elk and deer habitats in the Black Hills (Thilenius 1972) and is highly responsible for altered plant communities, especially an increase in distribution and density of ponderosa pine, significant

decrease in lush understories and loss of shrubs and hardwoods; all components that provide for a healthy diverse ecosystem for many wildlife species, including elk. However, records indicate approximately 660,000 acres of all land ownerships within the greater Black Hills of SD and WY have burned through wildfires from 1880-2017 (USDA 2018). Nearly 190,000 acres of BHNF lands within South Dakota have burned since 1996-2017 (USDA 2018). Understory diversity and biomass are inversely related to pine canopy cover (Uresk and Severson 1989). This pre-fire vegetation relationship can, in part, influence the severity and intensity of fires. Fire impacts to soils can influence vegetation recovery. The south-central Black Hills was historically subjected to an average fire interval of 16 years, up through early 1900's when Europeans began to settle the area (Brown and Sieg 1996). The southern Black Hills had more frequent fires with a 10–12-year return interval (Brown and Sieg 1999). Similar practices in other western states also experienced radical changes in pushing fire-prone ecosystems towards dense conifer cover (Slovkin et al. 2002). In the past 20 years, several wildfires within the Black Hills have demonstrated quite severe and intense fire behavior due to high fuel loads, dense pine crown closure and loss of natural fire breaks such as forest openings and expansive hardwood stands.

In late August/early September 2000, the Jasper fire in the southern and central Black Hills burned a total of 83,510 acres (USDA 2001). The Jasper fire impacted 39,959 acres of big game winter range (MA 5.4) in the southern portion of the fire boundary and 38,546 acres of an adjacent MA 5.1 in the north half of Jasper. MA 5.1 is designated for other resource purposes such as timber and forage. Jasper was approximately 25% larger than any other recorded fire and the effective burn area within big game winter range was expanded south in 2001 when an additional 11,896 acres burned in the Rogers Shack fire (USDA 2002). Within 2 years, 12.3% of big game winter range was converted to early successional vegetation due to near 100% pine mortality in large expanses across the landscape. Small pockets of mature pine survived (Figure 19).

Figure 19. Five years post-Jasper Fire. Small pockets of pine survived.

Over 20 years post-fire, the bulk of winter range that burned remained in SS's 1 and 2: grass, forbs and hardwood shrubs with some small diameter sapling pine. The Hell Canyon ranger district planted 6,844 acres of pine trees from 2003-2020 (Nancy Bayne, personal communication). This change to a preponderance of early successional vegetation favored big game forage and created new cover-type in the form of tall shrubs unevenly distributed across the burned area. The big trade-offs, in terms of elk habitat effectiveness, were that the high road density Jasper Fire area lost most screening cover along roads and dead trees along roadsides were removed as hazards and instead of a 100-ft or less sight distance, views were open for miles (USDA 2004a). Elk displacement easily occurs in this predominantly open country. A study in CSP found that in relationship to the 1988 Galena Fire, elk displacement by human activities was greatest in areas where cover availability was lowest, including overstory-killed habitat (Millspaugh et al. 2000a). The application of this hunter and elk space-use sharing may apply to the Jasper Fire area except that the road density is much higher on BHNF than in CSP. Elk have little opportunity to seek areas of low human disturbance (Rumble et al. 2005). Until all burned trees completely topple, standing dead trees did provide some visual barriers between elk and humans. Elk have been frequently observed leaving open meadows for burned pine (Figure 20).

Figure 20. Elk use dead, standing pine as visual obstruction.

With the high road densities and loss of road-side screening cover, elk may be more vulnerable to human disturbances and hunter harvest. As the burned pine began to break off, the downed logs provide natural barriers to the temptation to drive off-road. The post-fire abundant and quality forage is readily available for elk and likely contributes to an increasing elk population. There was a decision by BHNF to re-burn a portion of big game winter range to reduce the amount of dead trees on the ground which could function as heavy fuels in another wildfire (USDA 2012). Returning fire to the landscape kept some areas in high forage productivity if fire frequency did not impact established shrubs and hardwoods, and invasive weeds and undesirable non-native vegetation were suppressed.

In December 2016, 54,023 acres were burned in Custer State Park and some surrounding private. Named the Legion Fire, this event burned 36,418 acres within the park covering approximately 51% of CSP (Cody Stalder, personal communication).

Additional Forage from 1997 Forest Plan to 2014

Mountain Pine Beetles

The MPB epidemic has affected approximately 450,000 acres since 1996 in the Black Hills of South Dakota and northeastern Wyoming (Figure 21, USDA 2013b). The overall impacts the MPB infestation have on elk remains unknown. However, as trees died, canopy cover was reduced, resulting in the reallocation of resources (e.g., water, nutrients, sunlight), and promoted growth of other vegetation (Ritchie 2008). Grasses, forbs, and shrubs flourish (some of which may be invasive) in this early stage of forest succession and provide a benefit to elk in many areas through increased forage availability. These early stages of forest succession are only temporary unless fire or mechanical treatments hinder pioneering conifer species.

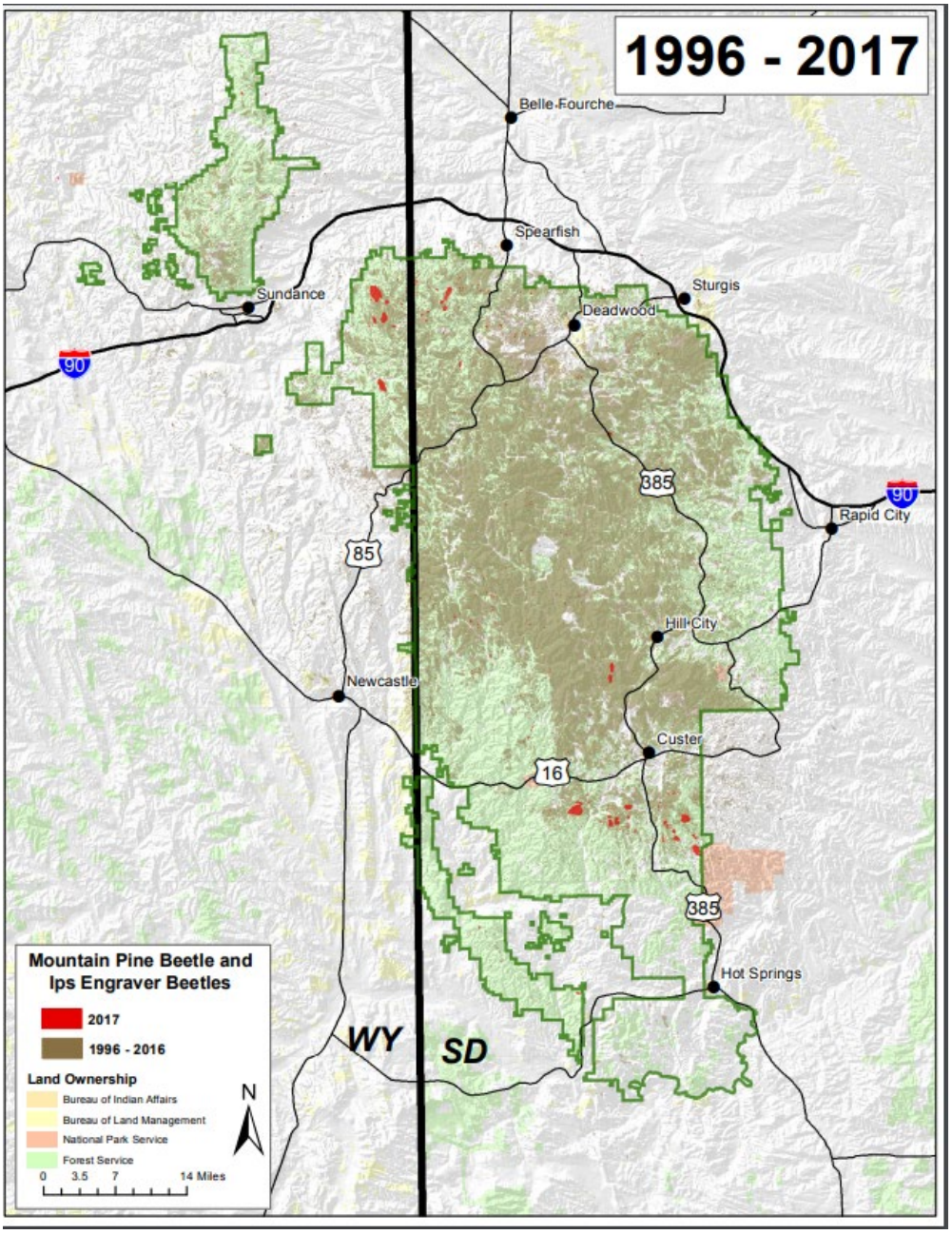


Figure 21. Mountain pine beetle and ips engraver beetle activity on the Black Hills National Forest 1996-2017 (USDA 2017)

The amount of additional forage (i.e., grasses, forbs and shrubs) the MPB infestation generated is dependent upon the overall reduction in conifer basal area and remains unknown; however, a reduction of basal area in some proportion inevitably occurred. In an effort to remain conservative while calculating additional forage, a 12.5% reduction in overall basal area was applied to the approximate 358,000 MPB infected acres within South Dakota (86% of the

416,000 acres of MPB impacts up to 2015). According to the BHNF 1997 Revised Plan, 466 million pounds of forage are produced across 1,253,120 acres of BHNF lands. This equates to an overall average of approximately 372 lbs./acre ($\frac{466,000,000}{1,253,120} = \sim 372 \text{ lbs./acre}$). Inserting the 372 lbs./acre into the non-crystalline ($y = 10^{(3.226 - 0.00936x)}$) and crystalline ($y = 0.8922 \times e^{(7.84338 - 0.02353x)}$) forage calculations for y and solving for x, the average basal area for the non-crystalline soils equation was 70 ft^2/acre and 77 ft^2/acre for the crystalline soil equation (USDA 1997). Assuming a 12.5% reduction in basal area to the 358,000 acres affected by MPB within South Dakota, results in a new basal area estimate of 61.25 ft^2/acre for non-crystalline soils and 67.375 ft^2/acre for crystalline soils. Inserting those basal area estimates in for x and solving for y, resulted in a forage estimate of approximately 458 lbs./acre. Thus, the amount of additional forage available from a 12.5% reduction of basal area on 358,000 acres affected by MPB is approximately 31 million lbs., of which 50% (15.5 million lbs.) are available for utilization (e.g., (358,000 x 458 lbs./acre = ~164 million lbs.) - (358,000 x 372 = ~133 million lbs.) = 31 million lbs.)).

Fire

Fire creates vegetative diversity and enhances elk habitat. In late August 2000, the Jasper fire in the southern and central Black Hills burned a total of 83,510 acres (USDA 2001; Figure 22), resulting in additional forage, ultimately increasing the carrying capacity of habitats for elk within the Black Hills. The Jasper fire was approximately 25% larger than any other recorded fire during the last century within the Black Hills; providing optimal winter range habitat for elk at a large scale. Nearly 190,000 acres of BHNF lands within South Dakota have burned from 1996-2017 (USDA 2018). However, BHNF forage calculations assume fires continually are occurring through time at a much smaller scale compared to the Jasper fire. Because the large-scale Jasper fire and subsequent fire events have occurred after the BHNF 1997 Revised Forest Plan, additional forage was not taken into account. Revised forage availability and allocation was not a revision topic for the BHNF 2006 Phase II Forest Plan Amendment. Additional forage calculations were recently derived by SDGFP and in an effort to remain conservative while calculating additional forage, a 50% reduction in overall basal area was applied to the approximate 83,510 burned acres.

Figure 22. Area of the Black Hills affected by the Jasper Fire, 2001.

Assuming a 50% reduction in basal area to the 83,510 acres burned, resulted in a basal area estimate of 35 ft^2/acre for non-crystalline soils and 38.5 ft^2/acre for crystalline soils, and a forage estimate of approximately 855 lbs./acre. Thus, the amount of additional forage available from a 50% reduction of basal area on 83,510 acres burned was approximately 40 million lbs., of which 50% (20 million lbs.) are available for utilization (e.g., (83,510 x 855 lbs./acre = ~71 million lbs.) - (83,510 x 372 = ~31 million lbs.) = 40 million lbs.)).

Non BHNF Public Lands

Other non BHNF public lands not included in the 1997 Revised Forest Plan forage calculations included lands owned and managed by the Bureau of Land Management (BLM) and SDGFP.

Within the Black Hills Fire Protection District approximately 12,498 acres are owned and managed by BLM. To remain conservative while estimating additional forage, 372 lbs./acre (average lbs./acre in 1997 Revised Forest Plan) was multiplied to the 12,498 acres, resulting in approximately 4.6 million lbs. of additional forage; of which, 2.3 million pounds are available for utilization. The same calculations are applied to the 20,940 acres owned and managed by SDGFP; resulting an additional 7.8 million lbs. of forage; of which, 3.9 million lbs. are available for utilization.

Summary

According to the BHNF 1997 Revised Forest Plan, approximately 233 million lbs. of forage are available for livestock and wildlife utilization; of which, 54.5% (127 million lbs.) are allocated towards livestock and 45.5% (106 million lbs.) are allocated towards wildlife. Because 86% of BHNF lands are within South Dakota, approximately 200.4 million lbs. of forage (86% of 233 million lbs.) are available within South Dakota; thus, leaving 91.2 million lbs. (45.5% of 200.4 million lbs.) of forage available on BHNF lands for wildlife utilization within South Dakota. Approximately 121.6 million lbs. of forage are needed to support 70,000 deer and 7,000 elk within the Black Hills Fire Protection District. However, because approximately 41.6% of the lands owned within the Black Hills Fire Protection are privately owned, it must be acknowledged that wildlife occupy and forage on private lands. As a result, the 1997 Revised Forest Plan acknowledged wildlife occupy and consume forage on BHNF lands 85% of the time, while the remaining 15% of the time wildlife occupy and consume forage on privately owned lands. This consideration reduced the amount of BHNF land forage needed to support 70,000 deer and 7,000 elk (121.6 million lbs.) by 15%, which equated to 103.4 million lbs. of forage (Table 33).

Table 33. A breakdown of forage availability and requirements on BHNF Lands.

	MM[3]-lbs. Forage (SD Only)
Forage available on BHNF lands within South Dakota	200.4
Forage allocated towards wildlife (45.5%) on BHNF lands within South Dakota	91.2
Forage needed to support 7,000 elk and 70,000 deer	121.6
Forage needed on BHNF lands to support 7,000 elk and 70,000 deer considering 85% occupancy	103.4
Additional forage needed on BHNF lands to support 7,000 elk and 70,000 deer	(103.4 – 91.2) = 12.2
Estimated additional forage on BHNF lands and other public lands	41.7

[3] MM = million

Conservative additional forage calculations suggested approximately 41.7 million lbs. of forage are available on BHNF lands and other public lands (Table 34), resulting in 242.1 (200.4 + 41.7) million lbs. of forage available for utilization. To reiterate, 103.4 million lbs. of forage are needed to support 7,000 elk and 70,000 deer, which means 12.2 million lbs. of additional forage (29.3% of the calculated additional forage) are utilized. To account for potential variability within the additional forage calculations, SDGFP wanted to make certain not all 242.1 million lbs. of estimated forage are allocated; thus, leaving a surplus of 29.5 million lbs. of additional forage. This surplus forage is valuable during times of sustained drought conditions.

Table 34. Calculated additional forage.

Additional Forage Scenario	Additional Forage MM[1]-lbs. Forage (SD Only)
Mountain Pine Beetles	15.5
Jasper Burn	20
Non BHNF Public lands	6.2
Total	**41.7**

[1] MM = million

The BHNF 1997 Revised Forest Plan calculated forage needs for wildlife and livestock. The Forest Plan estimated that 70,000 deer and 4,500 elk would utilize approximately 87% of the USFS forage allocation for wildlife. The estimates for deer and elk used in the Forest plan were compiled after consultation with SDGFP and WYGF, and represented state agency goals at that time. These population estimates were not based on data from research or aerial surveys, rather they were based on limited survey data and qualitative assessments of elk densities by agency staff. During the winter of 2013 SDGFP conducted an aerial survey of all elk management units in the Black Hills and calculated elk densities based on a logistic regression sightability model. The aerial survey methodology and sightability model are based on current research findings from studies conducted by South Dakota State University. The aerial survey yielded an estimate of 5,077 (95% CI 4,807-6,116; excludes WICA and CSP) elk which was the first scientific and quantitative estimate of elk in the Black Hills of South Dakota. This estimate cannot be compared with previous population estimates or goals because 2013 was the first time the entire Black Hills in South Dakota had been surveyed. It is the goal of SDGFP to base future population estimates and objectives for elk on the best scientific data available. Due to substantial changes to forest habitats caused by fires and the mountain pine beetle epidemic, forage estimates from the 1997 Forest Plan underestimated current forage availability. South Dakota Game, Fish, and Parks staff estimated current available forage based on the 1997 Forest Plan and a conservative estimate of additional forage available due to fire and the mountain pine beetle epidemic. Staff also incorporated additional available forage from SDGFP and BLM lands that are not included in the forest plan estimate.

Depredation

Cooperative partnerships with private landowners are an essential component to elk management and private lands serve an important role regarding elk management in South Dakota. Longmire (2014b) reported that 45% of responding landowners who were surveyed indicated that elk damage was a problem. Effectively addressing elk depredation is a tremendous challenge for SDGFP and fluctuates annually because of weather events (e.g., drought and severe winters), increasing elk populations, and changes that occur to elk habitat (e.g., impacts of fire, agricultural development, and logging). Elk impact private lands in many ways, and because of these impacts, SDGFP cooperatively works with many private landowners each year to resolve wildlife damage concerns. Private landowners with high intensities of wildlife damage experience a lack of tolerance for the species responsible for the damage (Conover 1998). Wildlife depredation management operates at the cross-roads of science and politics as well as economics and social tolerances. SDGFP understands that cooperative partnerships with private landowners are essential to elk management and private lands serve an important role regarding elk management in South Dakota.

Longmire (2014a) stated that 64% of landowners that received SDGFP elk depredation abatement program services were satisfied with the assistance. However, to successfully manage a larger population of elk, SDGFP needed to enhance current elk depredation abatement programs to address private landowners' concerns regarding elk depredation.

While a larger elk population in the Black Hills offers more recreational opportunity, there are increased costs to address conflicts due to elk depredation to private lands. In 2013, 38% of landowners indicated that their tolerance would increase to some degree if SDGFP would enhance their current elk depredation services while 51% of landowners indicated that their tolerance level would stay about the same (Longmire 2014a). Because social tolerance is an important element in elk management and elk hunting is held in such high regard with South Dakota sportsmen and women, SDGFP believed that enhancing its elk depredation programs was a valuable use of additional funding. During the legislative session of 2014, SDGFP successfully introduced legislation which increased the non-refundable application fee that sportsmen and women pay when applying for elk licenses or purchasing preference points for elk. Sixty-seven percent of hunters and 58% of landowners indicated that they were willing to pay an additional five-dollars (a total of ten-dollars) for this non-refundable application fee (Longmire 2014a). This legislation became effective on July 1, 2014 and generated an estimated $150,000 annually. This funding is earmarked for enhanced elk depredation abatement services for private landowners in the Black Hills and prairie elk hunting units. These monies help SDGFP provide food plots, stack yards, and protective fencing programs. SDGFP has researched new and innovative solutions to the challenges of efficient and effective management of elk depredation issues.

In areas where abundant elk populations exist, SDGFP continue to work cooperatively with landowners. In some circumstances additional efforts to reduce elk damage to private lands are not satisfactory, regardless of SDGFP's efforts. In these instances, a smaller elk population at the local level is the only viable solution. South Dakota Game, Fish, and Parks is continually challenged to find the balancing-point between recreational opportunity and impacts to private lands from elk. Areas where conflict exist between livestock and elk competition for grazing also continue to occur. Due to the complexity of these matters, this issue continues to challenge SDGFP and impact private landowners. However, by utilizing elk hunting and the associated hunting pressure, hunters play a vital role in reducing elk-livestock competition during certain times of the year (Heydlauff et al. 2006). South Dakota Game, Fish, and Parks continues to cooperatively work with willing landowners to utilize hunting as the principle form of management, when possible, to address these concerns.

While many of these management strategies have proven successful over the last 20 years, elk depredation and the associated conflicts continue to challenge SDGFP. Oftentimes these matters are complex and not only involve the management of elk but include socio-economic and political dynamics. South Dakota Game, Fish, and Parks acknowledges that its' programs are not able to completely resolve all issues regarding elk depredation; however, SDGFP has a proven history of working with private landowners and is committed to cooperatively working with private landowners to implement reasonable solutions which address most concerns.

Inter-State and Tribal Coordination

Nebraska

A small elk herd resides in southeastern Gregory County and Boyd County, Nebraska, which originated from a captive herd that escaped from an enclosure in the Ft. Randall area, after having been acquired by the Yankton Sioux Tribe in the late 1980s, who initially obtained these elk from WICA.

Upon establishment of this elk herd, an elk hunting season was initiated in 1996, primarily to address elk depredation to crop fields, which was first documented in 1992. As these elk readily moved between South Dakota and Nebraska, they were unavailable for harvest during some of the respective state's hunting season. Therefore, a Memorandum of Agreement was created between Nebraska Game and Parks Commission (NGPC) and SDGFP beginning with the first season in 1996, which allowed licensed hunters to hunt in both states. Both SDGFP and NGPC shared similar management objectives, which were to maintain a population that provided some recreational hunting opportunity, while keeping elk depredation on crop fields at a minimum. SDGFP has depredation assistance programs but utilizing licensed hunters to manage this elk herd is the most effective method available. Low harvest rates in recent years and the majority of hunters only hunting in the state where their license was issued from, resulted in SDGFP and NGPC coming to an agreement prior to the 2013 hunting season that a shared elk unit was not necessary. Beginning with the 2013 hunting season, licensed hunters could only hunt in their respective state. The elk unit in Gregory County of South Dakota was closed in 2015. In 2020, this unit was dissolved and incorporated into the Pre-WRA Unit. Coordination of license allocations, harvest, and depredation complaints continued with NGPC.

Wyoming

South Dakota shares many elk with Wyoming along the western border. Elk move to and from Wyoming across the state boundary in Butte, Lawrence, Pennington, Fall River, and Custer counties. These movements present difficulties with managing herds because of state lines and jurisdiction issues. There is no agreement with Wyoming to allow hunters from Wyoming and South Dakota to hunt across state lines. It is vitally important that both States cooperatively manage these elk herds. Considering this, SDGFP and the Wyoming Fish and Game Department (WGFD) hold coordination meetings annually to discuss elk management as well as management of other wildlife species shared by each State. Topics discussed are elk management goals, population objectives, survey data results, research findings, season design, and depredation issues. SDGFP and WGFD also coordinate on a regular basis at the regional wildlife manager level to ensure cooperation between the States. Most recently, agencies in South Dakota and Wyoming completed a coordinated aerial survey of elk in the Black Hills in both states in the winter of 2020.

Rosebud and Oglala Sioux Tribes

Elk that occur in Bennett, Mellette and Todd counties in South Dakota originated from enclosures on the Rosebud Sioux Tribe (RST) and Pine Ridge Indian Reservations. Elk were

transplanted to these enclosures as early as 1970 (Appendix 1). Over time elk were released or escaped from these enclosures. Additional transplants to enhance the free-roaming elk on RST and Pine Ridge occurred through the mid-1990s. The elk herd increased rapidly in the mid-1990s with an estimated 600 to 800 elk roaming Todd, Oglala Lakota, and Bennett Counties. Since the 1990s transplants, the Oglala Sioux Parks and Recreation Authority (OSPRA) imported elk from private game ranches which were documented moving throughout parts of Bennett County. It is speculated that elk may also be moving in from other areas (e.g., Nebraska) as occasionally a harvested elk has an ear tag or radio-collar that is not identified as belonging to RST, OSPRA or SDGFP.

With increasing elk numbers in the mid-1990s, depredation complaints on private land also increased. In response to damage occurring on stored feed and standing crops such as corn, soybeans and alfalfa grown in the area, a limited season was opened in Bennett County in 1995 in attempt to discourage elk from damaging private property. SDGFP coordinated with RST and OSPRA prior to initiating the season; however, RST was not in favor of the hunting season in Bennett County. Efforts continued to coordinate with both tribes to keep the elk on tribal lands and off adjacent private lands. Minimal management practices have occurred by the tribes to mitigate depredation on adjacent private lands. In Todd County, growing season food plots have been planted periodically by RST in an attempt to hold elk on tribal land. RST has established seasons for elk on tribal owned lands in Todd and Mellette Counties. In 1997, an attempt was made to enter into a memorandum of understanding (MOU) with OSPRA to allow tribal hunters to hunt on private lands with permission and SDGFP licensed hunters to hunt on tribal lands. According to SDGFP records, the MOU was never signed by OSPRA. OSPRA opens their hunt on the 1st of September through the end of the year. Numbers of licenses vary, but generally have been 24 to 50 bull licenses each year. Because of the considerable amount of tribal land within this elk herd's range, which encompassed portions of Todd, Bennett, Oglala Lakota, and Mellette counties, prior to developing season recommendations for this unit, previous license allocations and harvest data are shared and discussed with RST and OSPRA.

Prairie Elk Management

The prairie elk season was created in 1995 primarily to address elk depredation outside of the Black Hills. The prairie elk season allows SDGFP to work with private landowners by using hunters to reduce elk numbers on private property and to pressure elk into areas where they may not cause as much damage to private property. Because the prairie season occurs almost exclusively on private land and success rates are highly variable due to private property access and elk movements, this season is separate from the other elk seasons in the Black Hills. Elk harvest success in the prairie units is highly dependent on landowner cooperation and access to private land. One benefit to having a season on the prairie separate from the Black Hills is that it allows SDGFP to use unique season dates for each prairie unit. SDGFP put a great amount of effort into working with landowners on elk depredation and the hunting seasons in these prairie units. Landowners are consulted on elk numbers, season dates and license numbers for the prairie elk seasons. There are no surveys conducted on elk in the prairie units and thus no

estimate of population beyond the landowner and local SDGFP staff's perspective, based on observations throughout the year. Because there is no population estimate for elk in the prairie units, it is difficult to identify a numerical population objective. Objectives are set to maintain landowner tolerance of elk and minimize private property damage while maintaining a hunter harvest opportunity. Except for the current West River Area unit, prairie elk unit objective directions are determined as substantially increase, slightly increase, maintain, slightly decrease, or substantially decrease.

Butte, Lawrence and Meade Counties - Unit 9

Anecdotal observations suggest that elk crossed Interstate-90 and established a herd sometime around 2008 in prairie Unit 9. License sales ranged from 30-40 during the first 3 years and were cut in half as the population reached a manageable size (Table 7). Hunter success averaged 33% with 44% of the harvest antlerless elk (Table 7). Unit size remained consistent in the area around St. Onge, SD; however, in 2013 an additional area that was formerly part of Unit 7 in the Black Hills season was added to this Prairie Unit to continue to address a herd of elk that established across Interstate 90 near Tilford, SD (Appendix 4). Elk move back and forth across I-90 causing traffic hazards at times. Elk in this herd cause damage to fences and stored feed. SDGFP was managing this herd to maintain the total population through liberal antlerless harvest strategies in 2020. Prior to the 2020 elk season, the unit boundaries at the northern end of the unit were modified to follow more readily identified physical boundaries.

Bennett and Mellette Counties - Unit 11

Prairie Unit 11 was created in 1995 and was the first prairie unit established. Elk that occur in this unit originated from enclosures on the Rosebud Sioux Tribe (RST) and Pine Ridge Indian Reservations and increased in numbers. With increasing elk herds came depredation impacts on private land and as a result, SDGFP managed elk seasons and harvest in Bennett County have occurred every year since 1995. Initially, seasons were in place to allow limited opportunity, particularly to the landowners in the area suffering damage. Season lengths were extended to allow harvest when the elk were present on private lands. By the late 1990s, considerably more licenses were offered with an emphasis on antlerless harvest to address the growing elk population. Season dates have varied since 1995 and in 2020 the season was divided into several hunt periods to encourage hunters to harvest elk. Elk depredation is experienced as early as mid-July and to address this issue an antlerless only season was established from July 15 – August 31.

Beginning in 2011, the southwest corner of Mellette County was included into the SDGFP Bennett County unit boundary in response to elk depredation to crop fields in that area. Elk are sometimes unavailable to hunters in this area during the season; however, by including the southwest corner of Mellette County, SDGFP can utilize hunters as a method of reducing crop depredation in this area. Hunter success in Mellette County is relatively low with only about 4 elk harvested since 2011.

This unit was started with 2 bull licenses and hunters had 100% success. By 2003 the tag sales increased to 72, with a total of 41 elk harvested to address increasing elk depredation to private lands (Table 3). License sales peaked again in 2011. Hunter success rates fluctuated from >80% for the first couple years to an average of 51% over the remainder of the years. Antlerless harvest consisted of 38% of the total harvest from initiation to 2002 and increased to 47% from 2003-2013. From 2014-2019 success on antlerless licenses averaged 72% and ranged from 38-100%. Success on "any elk" tags averaged 79% and ranged from 60-100%. In response to increasing levels of damage reported by landowners, SDGFP significantly increased antlerless licenses for the 2020 elk season from 48 to 108. SDGFP was managing elk in prairie unit 11 to substantially decrease the population in 2020.

Butte County - Unit 15

Prairie Unit 15 was created in Butte County in 2004 to address depredation issues caused by elk moving to and from Wyoming and a growing resident herd in the area. Elk in this unit cause damage to fences, standing crops and stored feeds. The number of licenses allocated annually range from 20-30 depending on the amount of damage and size of the elk herd. Hunter success averages 39% with an average of 52% of the harvest antlerless elk (Table 6). Unit boundaries remain consistent with small additions to the northern extent (Appendix 4). In 2020, SDGFP was managing elk in prairie unit 15 to slightly increase the population.

Fall River County - Unit 27

This unit was established in 2012 to address property damage caused by an elk herd that likely originated from elk moving south out of Black Hills Unit 3. The elk in this unit cause damage to fences and stored feed. In 2020, SDGFP was managing this elk herd to maintain the population. Ten type 21 licenses and 5 type 23 licenses were sold in 2012 and 2013 and 10 type 21 licenses were sold in 2014. Harvest success for "any elk" tags averaged 70% in 2012 and 29% in 2013. Type 23 licenses were issued again starting in 2016.

Gregory County - Unit 30

As noted, the elk that reside in southeastern Gregory County are believed to have originated from a captive herd that escaped from a Yankton Sioux Tribe enclosure in the Ft. Randall area, nearly 30 years ago. Crop depredation by elk was first reported and documented in 1992, with a hunting season established in 1996. McCrea and Lengkeek (2000) estimated the elk population at approximately 70 animals. After a reduction in elk depredation complaints within this unit, and lower hunter success rates, fewer licenses were issued (Table 4). From 2015 to 2019, no licenses were allocated for this unit. In 2020, this unit was dissolved and included into the PRE-WRA Unit.

Harding County - Unit 35

Prairie Unit 35A was created in 2018 to address an increasing number of elk that occur predominantly on National Forest land and the surrounding private property in Harding County. There were 8 "any elk" licenses available in 2018 and 2019 and harvest success was 100% in 2018 and 86% in 2019. In 2020, the unit was split into an eastern unit (35A) and a western unit

(35B) to address different herd sizes and to more appropriately allocate antlerless licenses. There were 4 “any elk” licenses and 8 antlerless licenses available in 35A and 4 “any elk” and 12 antlerless elk licenses available in 35B for 2020.

West River Area (WRA) unit

In 2020, a new elk unit was created that encompassed all areas west of the Missouri River that were not in an existing elk unit or within the boundaries of a Native American Reservation. SDGFP received increasing damage reports from a growing elk herd along the Cheyenne River as well as an increasing number of reports of elk in prairie counties where elk had not been previously reported. The primary purpose of this unit is to create additional hunter harvest opportunity as well as to begin to address some of the damage complaints fielded by SDGFP. In 2020 there were 10 “any elk” licenses and 20 antlerless elk licenses available.

Elk-Vehicle Collisions

Elk in South Dakota primarily occur in the Black Hills area and in particular occur on BHNF lands. The BHNF has the highest density of roads within all national forests in the United States (USDA 1997). With the high density of roads and a healthy elk population, one could assume that elk-vehicle collisions would be a concern for the public. However, Longmire (2014a) reported that the majority of people surveyed were not concerned about striking an elk with their vehicle. There is a strong desire from multiple state agencies to have reliable information regarding elk-vehicle collisions for management, mitigation planning and public safety purposes in South Dakota. This information is the foundation for mitigation projects that could benefit both drivers and wildlife (Ford et al. 2009).

The South Dakota Department of Public Safety (SDDPS) and South Dakota Department of Transportation (SDDOT) track wildlife-vehicle collisions. Cramer et al. (2016) concluded the need for better tracking of wildlife vehicle collisions was an important objective. As a result of the study, the SDDOT looked at wildlife vehicle collision (WVC) hot spots during the preliminary scoping process when planning a SDDOT project. In addition, the SDDOT implemented an application for portable electronic devices in 2019. Since the implementation of the application, all WVC are recorded by roadkill cleanup contractors as a requirement of their contract with the state. Accurate data are sometimes incomplete with elk due to public interest in salvage and viewability of carcasses in the road right-a-way. The SDDOT recorded 104 elk killed on state highways via the electronic application entrees or state employee observations in the Black Hills from 2016 through 2020.

In an effort to reduce elk vehicle collisions, SDGFP and the SDDOT identified several areas where elk-crossing signs were placed to alert the traveling public of this potential hazard based upon knowledge of previous vehicle-strikes as well as public input. The placement of signage is typically at the discretion of SDDOT staff. SDDOT works closely with SDGFP to gather input on placement of wildlife crossing signage.

SDDOT plans to construct a wildlife crossing project on Interstate 90 at mile marker 8 through 12. The project would include an 8-foot fence along the interstate that funnels wildlife into a buried box culvert where wildlife can safely pass under the road. Another similar project is slated for construction on Interstate 90 near mile marker 32 by Tilford. The second SDDOT wildlife vehicle collision study (Guidelines for Wildlife Vehicle Collision Mitigation, Study SD2019) plans to use camera systems in place before and after construction on these mitigation projects to evaluate use and performance.

Hunting Regulations

Harvest Strategies

When determining unit-specific management directions (Figure 23), SDGFP staff review and analyze recruitment rates, survival, population estimates, harvest levels, hunter success, hunter comments, depredation complaints, and landowner and public input. Methods used to collect public input include hunter opinion surveys, landowner opinion surveys, harvest report cards, regional advisory panels, regional open houses, commission meetings, and staff contacts (personal, phone, email). When unit-specific management directions are determined, SDGFP staff develop season recommendations to provide the most hunting opportunity, while shifting the population towards management direction. Biological and social considerations used to develop these population objectives are not static and may change over time.

Depending on management direction identified for each elk management unit, SDGFP staff utilize various harvest tools to guide management decisions, including but not limited to cow harvest rates, license numbers, license types, and season structure.

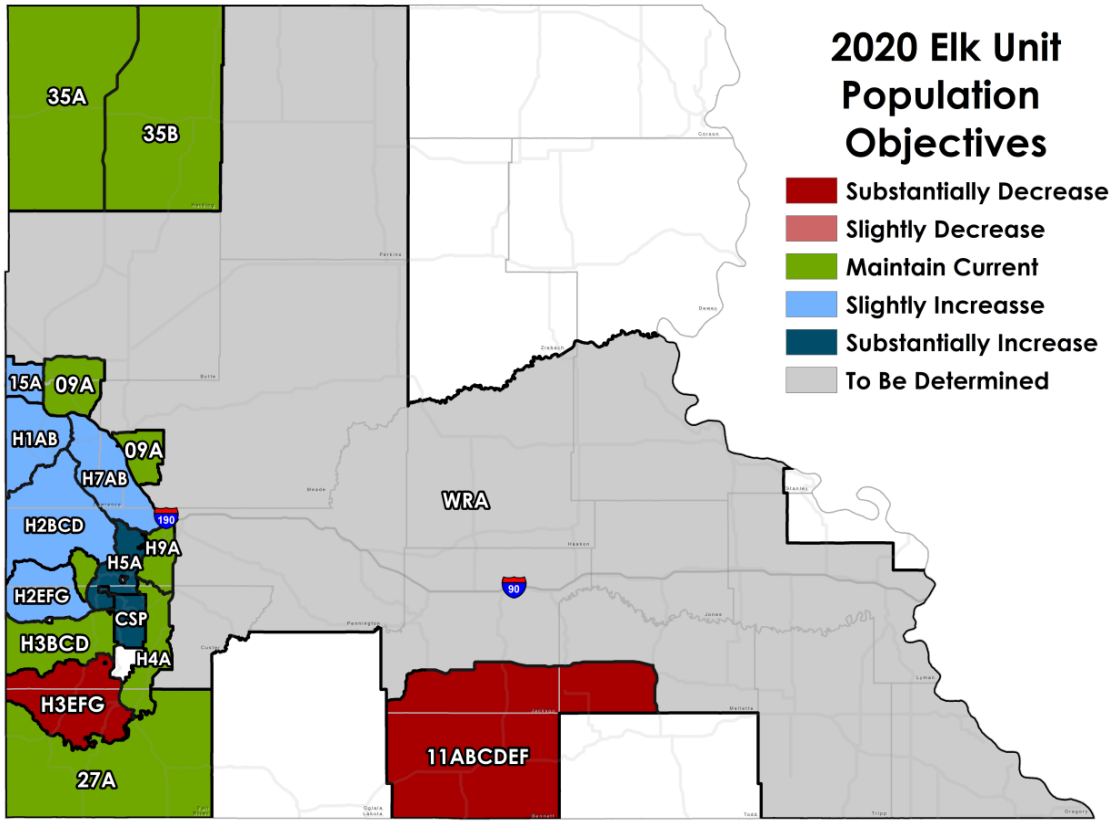


Figure 23. 2020 elk management unit directions.

Management Units

Management units are used to meet elk harvest management objectives and to facilitate the distribution of elk hunters within a specific geographic area. To ensure that unit boundaries can be easily identified, highways, roads and rivers are used as distinguishable features.

Elk distribution and movements within the Black Hills and prairie management units vary among seasons and the availability and juxtaposition of habitats. SDGFP documented seasonal movements of elk across unit boundaries from radio telemetry studies (Lehman 2015, Schmitz 2011, SDGFP unpublished data). Since elk licenses are issued at the unit level, numerous factors influence the availability of elk to hunters during the different hunting seasons; these factors include weather, current habitat conditions, and hunting pressure.

Annual evaluation of elk movements, hunter harvest statistics, hunter comments, potential elk disturbances, and major habitat changes (e.g., fires, timber harvest, pine beetle impacts) which significantly altered elk herd distributions, is necessary to ensure that management units are implemented to maximize hunter opportunities and meet harvest objectives.

Elk Drawing System

The draw process for elk licenses in the Black Hills and prairie units involves several stages (Appendix 9). The initial draw allocates 50% of licenses within each unit to qualified landowner applicants. All remaining licenses are returned to the available license pool and the 2nd draw selected licenses to be allotted to successful non-landowner applicants with 10+ years of preference and any unsuccessful landowners from the original landowner draw. This portion of the draw constitutes 30% of the licenses. The next 15% of licenses are then allotted to non-landowner applicants with 2-9 years of preference, any unsuccessful applicants with 10+ years of preference, and any unsuccessful landowners. The last 5% of licenses are allotted to any resident applicant, including the final group of non-landowner applicants with 0-1 years of preference. The draw process for CSP is similar to the above process, but without the landowner preference stage (Appendix 10). The first 33% of licenses are allotted to applicants with 15+ years of preference. The next 33% of licenses added applicants with 10-14 years of preference to the group. The final 34% of licenses added applicants with 0-9 years of preference to the group.

Due to the strong desire by resident hunters to hunt elk and limited hunting opportunity, there is always more demand than sustainable supply for elk hunting. In fact, for some hunters that are not eligible for landowner/operator preference, the opportunity to obtain an “any elk” license is a once-in-a-lifetime opportunity (Table 35).

As a result of hunter demand to draw a South Dakota “any elk” license and for other sought-after big game licenses, a thorough review and analysis of the current drawing system was conducted by the Department and Commission. A significant change to “cube” preference points was adopted by the Commission and first implemented for the 2018 big game hunting seasons. The purpose of this change was to increase the drawing odds of applicants who have more years of accumulated preference points, while still allowing applicants with fewer preference points a chance to draw a limited license. While this improves the odds for applicants with more years of preference points drawing a license, it did not guarantee them one, and is not a true top-down preference point system.

Sharing information and educating the public and those interested in hunting elk is an important aspect of elk management. Developing the proper outreach mechanism that fully explains the supply and demand for elk hunting in South Dakota helped improve understanding of the realistic chances of drawing an “any elk” license. Applicants are encouraged to view past draw statistics on the SDGFP website.

Table 35. Number of applicants by year of preference category going into the 2020 license drawing.

Years of Preference Category	Black Hills Firearm Elk	Black Hills Archery Elk	Custer State Park Firearm Elk	Custer State Park Archery Elk
0	7,214	1,443	616	319
1-5	5,161	2,359	2,073	1,242
6-10	3,123	1,586	1,533	969
11-15	2,285	1,061	1,918	977
16-20	838	223	1,517	556
21+	113	5	1,728	289
Totals	**18,734**	**6,677**	**9,385**	**4,352**

Landowner/Operator Preference

For all elk hunting seasons and units, excluding CSP, up to 50% of elk licenses are available to applicants who qualify for landowner/operator preference. Except for Black Hills Unit 3, the 50% allocation of licenses exceeds demand of applicants with landowner/operator preference. From 2016-2020, an average of 21.4% of all "any elk" licenses allocated for the Black Hills rifle elk season went to applicants qualifying for landowner/operator preference.

There are numerous opinions related to landowner/operator elk licenses. For those landowners and operators that support/tolerate elk on their lands throughout the year, a license is a way to compensate for the possible elk depredation that occurred on their property. This increased landowner tolerance, allowing a higher social carrying capacity, which in return, maximizes hunting opportunities for all hunters interested in hunting elk. An alternative method, such as landowner own-land licenses for either "any elk" or "antlerless elk", could be explored that may still meet the expectations of providing and issuing landowner/operator preference and improve elk license opportunities for non-landowner/operators.

Elk Raffle License

Since 1991, the SDGFP Commission has entered into an agreement with a nonprofit organization to conduct a raffle for one "any elk" license, limited to a South Dakota resident, that is valid in any elk management unit where "any elk" licenses are issued. Prior to the 2013 elk hunting season, this elk rifle license was valid only in CSP. As established in South Dakota Administrative Rule, the nonprofit organization must have a mission devoted to providing big game management, preservation, propagation, habitat, and research. The Rocky Mountain Elk Foundation (RMEF) has been the successful nonprofit organization to obtain and conduct the raffle for this highly sought-after South Dakota elk license.

The nonprofit organization can use proceeds from the elk raffle license to cover related advertising costs, printing and other expenses, but cannot exceed 20 percent of gross receipts.

The remaining proceeds are then deposited and approved by the SDGFP Department Secretary. All the proceeds of the elk raffle are required to be spent in South Dakota within three years after the date of the raffle drawing for the benefit of elk, including elk habitat and funding of elk research.

The Rocky Mountain Elk Foundation (www.rmef.org) is an important and valuable conservation partner, not only for the management of elk, but for other wildlife species and their habitats associated with elk. Proceeds from the raffle license are spent only as authorized by a majority vote of the RMEF Project Advisory Committee. This unique funding mechanism administered by RMEF in cooperation with SDGFP is instrumental in numerous elk habitat projects, elk research, and cooperative projects between WICA and SDGFP. It is recommended to continue with the annual allocation of this elk raffle license to help promote and fund elk conservation and management in South Dakota.

2nd Century Initiative

At her State of the State Address on January 8, 2019, Governor Noem announced her Second Century Initiative. Gov. Noem was quoted as saying, *"The first century of pheasant hunting put South Dakota on the map as a destination for every hunter. Now we must conserve and expand habitat to ensure that the second century of pheasant hunting will be as great as the first."* While many of the programs implemented from the 2nd Century Initiative are focus on pheasants and their habitats, some such as the Hunt for Habitat and the habitat stamp generate new revenue for all habitat and hunter access programs.

The Hunt for Habitat program provides an opportunity for both resident and nonresident hunters to purchase unlimited raffle tickets for the chance to win big game and bison licenses. Tickets are $10 for residents and $20 for nonresidents. There are two options available: 1) a combination package that included one “any elk” tag, one “any deer” tag and one “any antelope” tag; and 2) a package that includes a Custer State Park trophy bison tag. Winners of the package are eligible to select one of two years when the tag would be valid and can hunt any open season and location for when the license is valid. Revenue generated from the Hunt for Habitat program in 2019 and 2020 was $320,990 and $392,370, respectively.

Beginning July 1, 2020, a habitat stamp is required for anyone 18 years of age or older who purchases or applies for a hunting, fishing or furbearer license. This includes both residents and nonresidents. The habitat stamp needs to be purchased before obtaining or applying for a license or at the time of a license sale or application. The annual fee for the habitat stamp is $10 for residents and $25 for nonresidents. Revenue generated from the habitat stamp is estimated to be $5,000,000 annually.

Archery and Rifle License Allocation

The first Black Hills archery elk season occurred in South Dakota in 1986. The number of applicants for the archery elk hunting season increased from 1,232 in 2000 to 5,382 in 2019 (Table 10). This resulted in an increase from 10 to 25 applicants per available license. There

was a peak of 40 applicants per available license in 2014, with highs above 30 for the previous 2 years, when available licenses were half of the typical amount for 2012-2014. Archery hunting has increased in popularity (Figure 3). The 5-year (2015-2019) harvest success rate for archery elk hunters was 34%, compared to 66% for rifle elk hunters.

The challenge for SDGFP and the Commission when developing harvest strategies to meet population objectives is determining the appropriate allocation of archery and rifle licenses. During the 5-years previous to the development of the Elk Plan in 2013, 15% of elk licenses issued in the Black Hills were issued to archery elk applicants. An evaluation of archery licensing in other western States for similar years showed that the allocation of elk licenses to archery seasons in South Dakota (15%) was lower than other states (range 19-32%).

The previous 5-year average for "any elk" archery licenses in the Black Hills comprised 25% of the total "any elk" licenses allocated, compared to 75% for "any elk" rifle licenses. For this same time period, "antlerless" elk archery licenses in the Black Hills comprised 10% of the total licenses allocated, compared to 90% for "antlerless" elk rifle licenses. In assessing the supply vs. demand, 3.6% (420/11,739) of Black Hills firearm "any elk" applicants were successful in drawing a license, compared to 2.6% (139/5,285) of Black Hills archery "any elk" applicants in the 2019 season.

Archery and Rifle License Allocation in Custer State Park

In Custer State Park (CSP) rifle elk hunting began in 1962 and archery began in 1966. These hunts were guided and tag allocation was liberal until the late 1980s. In 1989, seasons were redistributed with the advent of an early archery hunting season, a rifle elk hunting season and a late archery elk season. With this redistribution, tag numbers were dramatically reduced, and more limited harvest started to occur. Applications for the early archery and rifle elk seasons increased steadily with the proportion in the archery season increasing from approximately 9% in 1995 to 18% in 2005 to 31% in 2019. The number of applicants for the early archery elk hunting season steadily increased from 3,600 in 2015 to 4,055 in 2019 (Table 16). For rifle applicants, there were 9,136 in 2015 and decreased slightly to 8,949 in 2019 (Table 18). Harvest success from 2015-2019 was excellent at 58% and 92% for both archery and rifle hunters respectively. Based upon demand for licenses, "any elk" licenses were 25% archery and 75% firearm.

Disease

Wild and captive elk have the potential to acquire and transmit diseases that may impact other wildlife, domestic animals, or elk populations. Disease monitoring conducted by SDGFP, WICA, and other agencies has occurred through research projects, harvest check stations, and opportunistic sampling. This section addresses pertinent elk diseases, testing results, and the knowledge of diseases potentially found in South Dakota.

Bovine Tuberculosis

Bovine Tuberculosis (TB) is caused by the bacterium *Mycobacterium bovis* and affects many ungulates including, but not limited to, cattle, bison, elk and deer. During the early stages, wild ungulates with TB often appear healthy as infection is usually localized. However, this disease can become chronic and manifest itself, resulting in emaciation, depression, and intolerance to movement (Davidson 2006). The history of TB sampling in wild elk in South Dakota is limited, with some reports of sampling with trans-locations from WICA to other areas of the Black Hills. In 1985, a total of 52 elk were tested for TB and all results came back negative for the disease (NPS 1985b). A total of 150 elk were tested for TB in January 1994, all with negative results (NPS 1994c.). Jacques (2001) tested 401 elk from 1997-1999 in the Black Hills of South Dakota and did not find any elk with TB. To date, no wild elk have tested positive for TB in South Dakota.

Bovine Viral Diarrhea

Bovine virus diarrhea (BVD) is caused by a *Pestivirus* (Williams 1999). BVD is a common disease in beef cattle and vaccination for this disease is common and generally controls the disease. This disease usually infects the fetus of cattle and depending on when the fetus is infected, causes the fetus to die and be aborted, suffer illness, be born with congenital effects, or be a carrier of the virus for life (Williams 1999). There are many strains of the virus, with the most common tested strains Type I and Type II. Williams (1999) noted that there was little interest in the possible occurrence of BVD virus in wild ruminants, and research findings suggested BVD does not appear to cause significant illness in wild ruminants including elk. Surveillance of the disease is ongoing and testing has occurred with elk populations residing in South Dakota. One elk out of 19 (5.3%) tested positive for BVD in CSP during 1980-1983 (Walker et al. 1995). In 2009, Lehman (unpublished data) tested 27 elk in CSP and documented all negative results for Type I and Type II BVD. In 2011, Lehman (unpublished data) tested 40 elk and all 40 tested positive for BVD Type I, and 38 of 40 tested positive for Type II BVD. Testing again occurred on these same populations of elk in 2012 and 2013 and of 84 elk, none tested positive for either Type of BVD. In 2012 and 2013, Simpson (2015) tested 80 elk samples in the central Black Hills and found that 6 individual elk tested positive for titers to Type I BVD and 5 individual elk tested positive for titers to Type II BVD. These seropositive results indicated that wild elk have been exposed to related *pestiviruses* and may only serve as a host to BVD virus. However, it is not known in most cases if wild species serve as a reservoir for BVDV or whether infections occurred due to contact with cattle (Van Campen et al. 2001). There is no evidence that persistently infected wild elk occur in South Dakota. The most significant vector of BVD virus

for range cattle is a persistently infected bovine carrier within a herd, and not wild ruminants (Williams 1999).

Brucellosis

Brucellosis (Bang's disease) is caused by the bacterium *Brucella abortus*. Brucellosis in wildlife is generally associated with wild elk and bison in and around Yellowstone National Park and is not found in wild or domestic cervids elsewhere in North America. Brucellosis is known to cause abortion in elk, cattle, and bison, and transmission from one animal to another usually occurred at the time of abortion as large amounts of bacteria are expelled with the infected fetus (Williams 1999). Since early transplants of elk into South Dakota originated from the Yellowstone area, brucellosis testing was conducted on transplants from WICA to other areas of South Dakota and other States.

While translocating elk from WICA in 1970-1972, Lovaas (1973) reported that 9 of 657 (1.4%) elk reacted positively to brucellosis testing and the affected elk were euthanized. Varland et al. (1978) reported that one out of 186 elk tested positive for brucellosis during a transplant operation to five Native American tribes in 1977. In 1979, a total of 38 elk were tested for brucellosis, of which, 4 were positive and euthanized (NPS 1979). In 1980, Rice (1988) documented 1 positive reaction to brucellosis out of 88 elk tested from WICA. Custer State Park conducted disease testing on elk over a 3-year period from 1980-1982 and all results were negative for brucellosis (Walker et al. 1995). From 1985 and 2013, a total of 1,089 elk were tested for brucellosis and all tested negative (NPS n.d., NPS 1985c, NPS 1985d, NPS 1986b, NPS 1994d, NPS 1994e, Lehman unpublished data, Simpson unpublished data). Elk were tested for brucellosis in conjunction with a radio-collaring effort of female elk in Custer County, SD during 2018 (n=40) and 2019 (n=50; SDGFP unpublished data). Adult or yearling elk were tested for this disease at NVSL in Ames, Iowa. These tests were conducted in cooperation with the Animal Industry Board in South Dakota. No brucellosis was found during this testing. The last recorded brucellosis positive elk in South Dakota was recorded in WICA in 1980 as part of a transplant into the Black Hills (NPS n.d.). Therefore, it is believed that brucellosis no longer exists in wild elk populations in South Dakota.

Chronic Wasting Disease

Chronic Wasting Disease (CWD) has received the most attention of all wildlife diseases within the last 20 years in South Dakota. CWD is a fatal brain disease of deer, elk, and moose that is caused by an abnormal protein called a prion. Animals infected with CWD show progressive loss of weight, poor body condition, behavioral changes, excessive salivation, increased drinking and urination, loss of muscle control and eventual death. CWD is always fatal for the infected animal. Elk with CWD have an incubation period of 1.5 to 3 years before they become clinically affected; with most succumbing < 12 months after the initial clinical signs appear, and some may survive with clinical signs > 12 months (Miller et al. 1998). Therefore, CWD is a disease that cannot be diagnosed by observation of physical symptoms because animals may be asymptomatic and many big game diseases affect animals in similar ways. In wild cervids, the

only practical method of testing for this disease is through lethal removal and sampling of infected tissue.

In South Dakota, CWD was originally discovered in seven captive elk facilities during the winter of 1997-98 and in another captive elk herd in 2002. These positive captive herds were located in Pennington, Custer, and McPherson counties. In March of 2019, a CWD positive elk was also found in a captive elk facility in Clark County, SD. Traceback was conducted and this elk was found to have originated from a captive elk facility in Meade County, SD. The Clark County elk herd (n=21) was depopulated in November of 2019 and no additional elk were found to have CWD. Additionally, the Meade County elk herd had 2 elk die of CWD in September 2019 and the remaining elk in the herd (n=5) were depopulated in October 2019 with no additional CWD found. After the disease was discovered in 1997, research was initiated in cooperation with South Dakota State University to determine the extent and prevalence of CWD in wild cervid populations. Jacques (2001) tested a total of 368 elk for CWD from 1997-1999 and found no positive CWD elk in the Black Hills region. CWD was first discovered in the wild in 2001 when a positive white-tailed deer in Fall River County was detected during the 2001 big game hunting season. The first discovered free-roaming CWD infected elk was found in 2002 in WICA. Chronic wasting disease was then discovered in a wild elk from the Southern Black Hills in 2003. From 2002 to 2019, CWD was found in 232 elk within the counties of Lawrence, Pennington, Custer, and Fall River. These include 152 elk from WICA, 32 elk from CSP, and 48 elk from hunting units within the Black Hills Fire Protection District (Figure 24).

As of April 2020, a total of 7,395 elk have been tested since testing began in 1997. Although prevalence rates from hunter harvested individuals rose slightly in the last decade, they have remained relatively low (Figure 25, Table 36). Unknowns exist with CWD and biologists and managers continue to monitor CWD in South Dakota and across the country. Research conducted in Colorado suggested that in areas of high CWD prevalence, CWD reduced survival rates of cow elk and decreased elk population growth (Monello et al. 2014). The long-term impacts of CWD on elk populations in South Dakota remain unknown.

The South Dakota Chronic Wasting Disease Action Plan was approved by the SDGFP Commission in June of 2019 and was updated in 2020 (SDGFP 2020). This is a working Action Plan with the key points including: investigating regulations regarding interstate and intrastate movement of carcasses, baiting and feeding of wildlife, use of urine-based lures, translocation of cervids, game processors, taxidermist, donation of venison, and expansion of surveillance areas to determine current presence of CWD surrounding known endemic areas. The GFP Commission revised regulations for transportation and disposal of deer and elk carcasses that applied to any harvested deer or elk that was transported from the county of harvest or from another state back into South Dakota. Communication with all stakeholders within South Dakota is key to a successful CWD Action Plan.

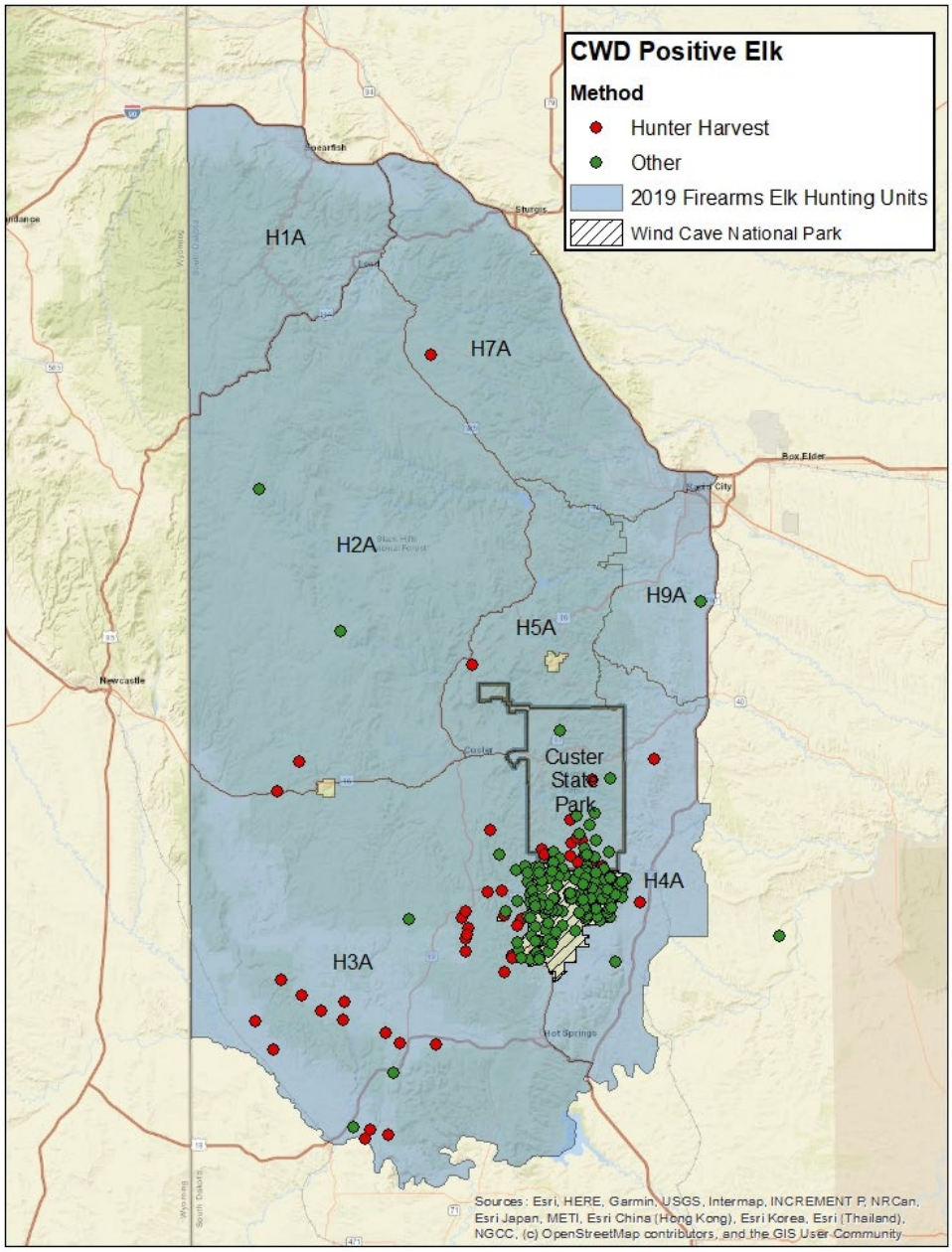


Figure 24. Chronic Wasting Disease positive wild elk in South Dakota 2001-2019.

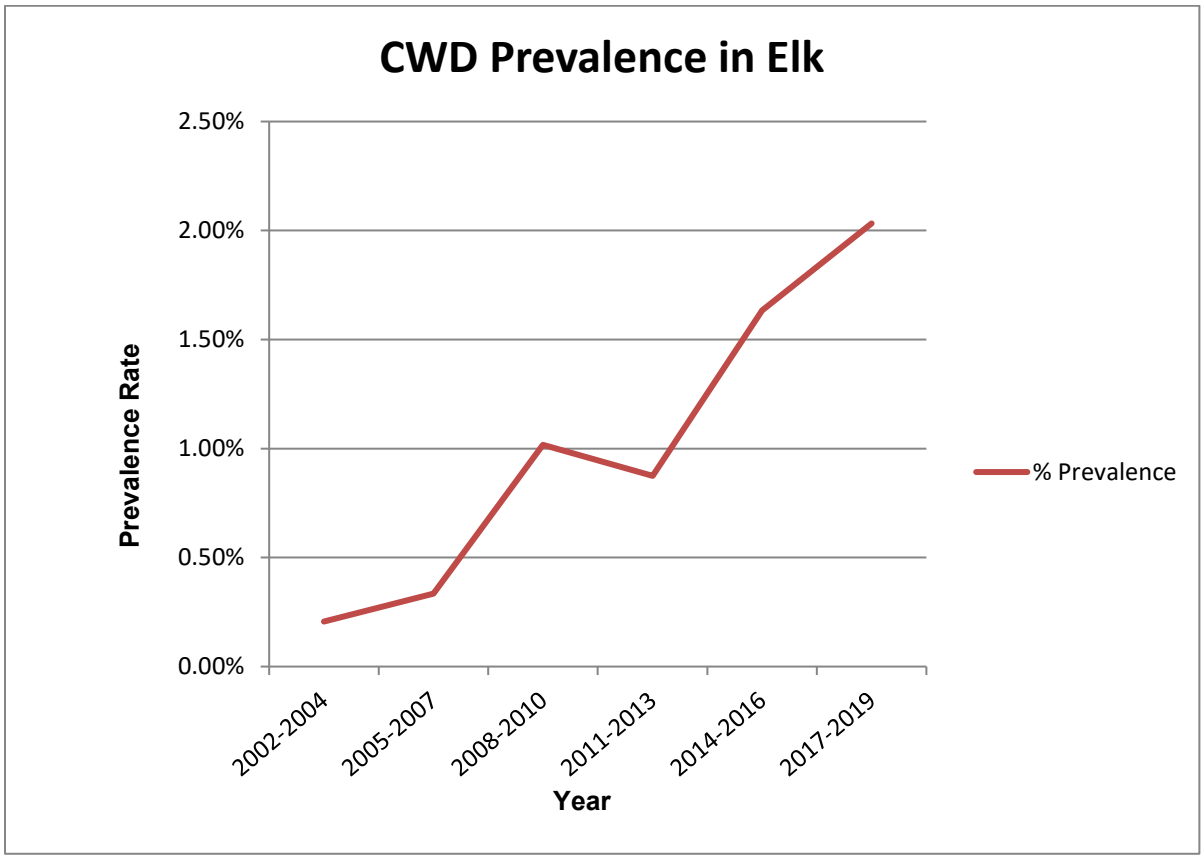


Figure 25. Three-year average prevalence rates for CWD from hunter harvested elk in South Dakota, 2002-2019.

Table 36. Number of hunter-harvested elk, number of positive CWD elk samples collected, and percent prevalence of CWD in elk from 2001-2019 in the Black Hills.

Year	Number of Hunter Harvested samples	Number of Positives	Percent Prevalence
2001	165	0	0.00%
2002	590	0	0.00%
2003	663	2	0.30%
2004	684	2	0.29%
2005	747	2	0.27%
2006	582	3	0.52%
2007	465	1	0.22%
2008	370	5	1.35%
2009	381	4	1.05%
2010	232	1	0.43%
2011	157	1	0.64%
2012	101	1	0.99%
2013	85	1	1.18%
2014	89	2	2.25%
2015	174	3	1.72%
2016	349	5	1.43%
2017	411	8	1.95%
2018	210	5	2.38%
2019	117	2	1.71%
Total	**6,572**	**48**	**0.73%**

Hemorrhagic Disease

Epizootic Hemorrhagic Disease (EHD) and Bluetongue (BT) viruses are a group of related viruses endemic to white-tailed deer populations in much of the United States including South Dakota. Collectively, EHD and BT viruses cause hemorrhagic disease, which is transmitted from animal to animal through biting flies of the genus *Culicoides*. Symptoms, which typically occur in late summer, in white-tailed deer include fever, sores in the mouth, hemorrhaging, and excessive fluid in the head and chest cavity which sometimes results in death. EHD has been identified in elk, but the impact it has on elk populations in South Dakota remains unknown. Seventy-three elk were tested for BT from 1980-1983 (Walker et al. 1995) and all results were negative for the virus. In 1990, a total of 50 elk were tested for BT in WICA during translocation efforts, and all tested negative for the virus (NPS 1990b). Lehman (unpublished data) sampled elk from 2009 to 2013 and found 13 EHD seropositive elk out of 151 samples (8.6%). Simpson (2015) found 2 EHD seropositive elk from 80 samples (2.5%) in 2012 and 2013 combined. In 2012 and 2013, SDGFP documented 4 elk had symptoms severe enough to cause death or warrant euthanasia.

These elk were all positive for EHD serotype ehdv-2, and 1 was also positive for the bluetongue virus. From 2014 through 2019, two elk were observed and suspected to have died from exposure to EHD or BT, although no laboratory test was confirmed on these two elk. Through testing by SDGFP, exposure to these viruses is documented. Surveillance for EHD and BT will continue in an effort to monitor impacts of hemorrhagic disease.

Leptospirosis

Leptospirosis is a bacterial infection that has the potential to infect numerous species of domestic and wild animals. It is caused by various serovars of *Leptospira interrogans* (Williams 1999). Antibodies to the various serovars have been detected in elk in South Dakota, but it was not known to cause symptoms. Elk were tested in CSP for Leptospirosis from 1980-1983, and tests revealed a total of 7 positive results for 2 different serovars for the bacteria out of 73 elk (Walker et al. 1995). Lehman (unpublished data) tested for 6 serovars in 124 elk that occupied the south eastern Black Hills from 2011-2013 and found 3 seropositive elk. Simpson (unpublished data) tested 80 elk over 2 years in the west-central Black Hills and found all elk negative for various serovars of leptospirosis. While both cattle and wild ruminants may become infected with *Leptospira interrogans*, the serovars they carry are different and interspecies transmission is not significant (Williams 1999). This bacterium is not considered a high risk to elk in the Black Hills.

Meningeal Worm

Meningeal worm (*Parelaphostrongylus tenuis*) is a parasitic worm found in white-tailed deer throughout most of eastern North America. It typically causes insignificant mortality in white-tailed deer in South Dakota but may cause illness and death in other ruminants including elk, mule deer, and pronghorn. Once ingested, the meningeal worms can produce severe neurologic disease with lesions usually found in the central nervous system that can result in death (Davidson 2006). The potential for meningeal worms to become established in the western United States is dependent on the presence of suitable terrestrial gastropods (e.g., snails [*Zonitoides sp*., *Discus sp*.] and slugs [*Deroceras sp*.]) (Jacques 2001). Meningeal worms need these gastropods to complete their life cycle. Jacques (2001) tested 344 elk in South Dakota from 1997-1999 and found no infections of meningeal worms. The meningeal worm is not found in elk in South Dakota due to the lower prevalence of the host gastropods. For elk in western South Dakota, the meningeal worm is not considered a disease of concern.

Paratuberculosis (Johne's Disease)

Paratuberculosis, also known as Johne's disease is caused by the bacterium *Mycobacterium avium* subspecies *paratuberculosis* (Williams 1999). This disease causes chronic infection of the intestine, resulting in severe diarrhea and loss of body condition (Williams 1999). Lehman (unpublished data) tested 151 elk from 2009-2013 for Johne's disease and all elk were negative. Simpson (unpublished data) did not detect this disease in 80 tested elk from 2012-2013. Williams (1999) stated that paratuberculosis is not common in beef cattle or wild ruminants and interspecies transmission is not likely.

Captive Cervid Game Farming

The history of captive elk in South Dakota before 1983 is not known, as no records were discovered associated to the first elk being placed in captivity within South Dakota. In 1983, legislation was passed giving Animal Industry Board (AIB) authority over 5 species of non-domestic animals held in captivity including elk, deer, moose, caribou and antelope (Miller personal communication). In 1993, HB 1002 was passed implementing regulations pertaining to the required application process and permitting of animals, premise location descriptions, inventory of animals, marking of animals, confinement from free-roaming animals, allowing inspection by AIB board, allowing denial and seizure of unlawfully held animals, and establishing a fee permit [South Dakota Codified Law (SDCL) § 40-3-24, SDCL § 40-3-25, SDCL § 40-3-26]. Data provided by AIB demonstrate the number of captive elk and the number of captive elk facilities increased from 1993 to 2004 and steadily decreased since 2005 (Figure 26; Oedekoven and Halls, personal communication). The number of facilities with captive elk peaked in 2003 at 58, and the number of captive elk peaked in 2004 at 3,356. In 1993, 10 of the 66 (15%) South Dakota counties had captive elk facilities. This number rose to a high of 37 (56%) counties in 2002, and 23 (35%) counties in 2019 were occupied with captive elk (Oedekoven and Halls, personal communication).

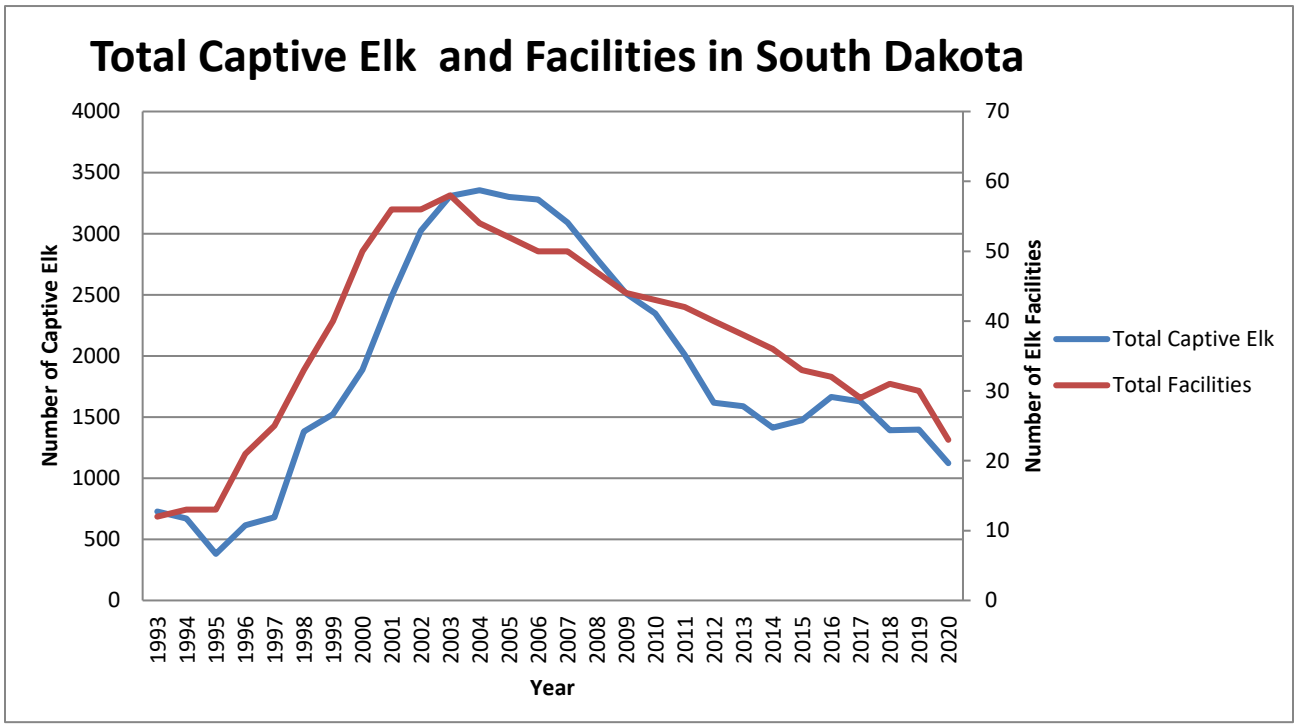


Figure 26. Total number of captive elk and captive elk facilities in South Dakota, 1993-2020.

In 1997, CWD was discovered in seven captive cervid facilities, and as a result, new legislation was passed in 1998, giving AIB statutory authority over CWD surveillance of captive cervids (SDCL § 40-5-8.6). CWD testing was mandatory on all captive cervids that died in South Dakota from 1997-2012 (ARSD § 12:68:25:03). Soon after testing became mandatory on captive elk in South Dakota, the AIB tested a total of 1,139 captive elk with 125 positive results up through October of 2002 (Dr. Oedekoven, personal communication). From October 2002 to 2019, another 4,776 captive elk have been tested with 3 positive results (Halls, personal communication). From 2012 to 2019, CWD sampling on captive cervids in South Dakota was voluntary.

Winter Feeding

SDGFP believes that elk populations should be managed under natural conditions and subsist on naturally occurring forage. While SDGFP conducts winter feeding under certain conditions, the department strongly discourages individual citizens from feeding elk and deer species. The best way to help elk survive a severe winter is to provide a year-round high-quality diet. If elk go into the winter in good condition, most are able to survive persistent deep snow, ice and cold temperatures (Washington Department of Fish and Game 2014). Considerations such as weather forecasts, severity of snow and temperatures, condition of the elk, feed site logistics, economics, effectiveness, degree of private land depredation, and the level of public concern over such feeding actions are considered before SDGFP initiates feeding operations.

In some instances, elk are fed in the winter to keep them off adjacent private property where they may cause damage. This type of feeding is often referred to as short-stop feeding. When persistent severe conditions concentrate elk or draw them into private property, SDGFP may utilize short-stop feeding as a strategy to keep elk off private lands and away from livestock and crops.

There are several drawbacks to feeding elk. Feeding elk with the proper feed in sufficient amounts is expensive. The state of Wyoming, for example, spent more than $2 million annually to feed elk and study and manage feeding ground diseases (Smith 2013). Concentrating elk at feeding sites made elk susceptible to transmission of disease such as Chronic Wasting Disease, Brucellosis, Tuberculosis and eye and respiratory infections (Dean et al. 2004). Elk are more vulnerable to predation when concentrated at feeding sites. Elk drawn to artificial feed tend to increase in numbers over time and cause damage to rangeland and adjacent private property. An elk's digestive system at times cannot process common types of feed (e.g., corn, wheat), which sometimes results in acidosis and death.

Predation Management

Understanding the relationship predators have on elk populations is essential to proper management. Numerous studies throughout the elk range in North America have investigated predator interactions with elk and their impacts on elk recruitment and population growth. For

example, Griffin et al. (2011) investigated 3-month calf survival across 12 elk populations in the north-western United States encompassing 3, 4 and 5 predator systems (e.g., mountain lions, coyotes, black bears, grizzly bears and wolves). A total of 1,999 radio marked calves were included in the analysis and results indicated that average 3-month survival decreased as the number of predator species in the system increased (i.e., 65% [SE = 0.01] three predators, 55% [SE = 0.03] four predators, 50% [SE = 0.03] five predator systems). Of the 671 mortalities documented throughout the study, 70% occurred in the first 30 days. Another collaborative analysis including 2,746 radio-collared adult female elk occupying western North America documented 1,058 mortalities, of which the largest mortality factors were hunter harvest (54.8% of all mortalities) and predation (wolf and mountain lion, 12.8%; Brodie et al. 2013).

Predators of Elk

Within the Black Hills of South Dakota, mountain lions (*Puma concolor*), coyotes *(Canis latrans*) and bobcats (*Lynx rufus*) prey on elk (Lehman et al. 2017). Mountain lion predation occurs on all age classes and throughout the year, while coyote and bobcat predation occurs primarily on newborn calves in early spring (Griffin et al. 2011). Numerous research projects investigating the impacts predators, especially mountain lions, have on elk occupying the Black Hills have been conducted. From 1 January 2007 – 1 May 2010, 105 adult elk (76 females, 29 males) were monitored throughout the Black Hills of South Dakota. Sixty-seven mortalities were documented throughout the duration of the study, of which eight were determined to be caused by mountain lions (11.9%; Schmitz 2011). From 2005 – 2009, 202 elk (83 subadult males and 119 subadult/adult females) were fitted with global positioning system (GPS) collars within WICA. Twenty-eight mortality events were documented involving collared individuals throughout the course of the study and six (21.4%) were attributed to mountain lion predation (Sargeant et al. 2011).

From 2011 – 2013, Lehman et al. (2017) captured and radio-marked 58 female elk ≥ 2 years of age and 125 calves during the parturition season in the southeastern Black Hills. Throughout the study, 18 adult mortality events were documented, of which five (27.8%) were attributed to mountain lion predation. It was estimated that 4% (95% CI; 0.01 – 0.08) of all radio-collared adult female elk occupying the study area were predated by mountain lions. Mountain lion predation accounted for 81% (*n* = 59) of all documented calf mortalities and coyote and bobcat predation accounted for 10% (*n* = 7) and 1.4 % (*n* = 1), respectively. Overall predation accounted for 93% of all documented calf mortalities throughout the three years. In summary, cause-specific mortality rates from mountain lions were 4% (95% CI = 1 - 8%) for adults and 63% (95% CI = 51 - 76%) for calves (Lehman et al. 2017).

In a similar study conducted in the west-central Black Hills, Simpson (2015) radio-marked 40 female elk ≥2 years of age and 37 calves in 2012, and nine additional female elk ≥ 2 years of age and 34 calves in 2013. Throughout the duration of the study, 12 adult cow elk mortalities were documented; 17% (*n* = 2) were caused by mountain lions, 58% (*n* = 7) were caused by hunter harvest. It was estimated that 2.3% (95% CI = 0 – 6%) of all radio-collared adult female elk occupying the west-central portion of the Black Hills were predated by mountain lions.

Furthermore, 16 calf mortalities were documented throughout the two years and mountain lion caused mortality was 75% (*n* = 12) of all mortalities. In summary, 17% (95% CI = 8 - 26%) of all radio-collared calves occupying the west-central Black Hills were predated by mountain lions. This study did not document any confirmed mortality events caused by coyote or bobcat (Simpson 2015).

Significant differences in average annual calf survival were documented between the Lehman et al. (2016; i.e., 21%; SE = 0.04) and Simpson (2015; i.e., 75%; SE = 0.03) study areas. Mortality rates caused by mountain lions were also significantly different (southeastern Black Hills-63%; west-central Black Hills-17%). In summary, research findings indicated that mountain lion predation rates of calves are greater and more variable than adult cows. Low calf survival in specific years and geographical areas within the Black Hills were documented.

Ballard et al. (2003) explained when ungulate populations were well below carrying capacity, additional mortality sources were likely additive. As a result, liberal mountain lion hunting season structure and methods were implemented in the southeastern Black Hills as an effort to potentially increase elk calf survival. Despite liberal mountain lion harvest in CSP and conservative cow harvest (6.7 cows harvest per year from 2013 to 2019), the population in CSP remained relatively stable, ranging from a high in 2013 of 506 elk to 457 in 2020. Potential reasons for limited elk population growth in CSP could be attributed to the population in CSP (4.1 elk/mi^2) being much closer to carrying capacity compared to the rest of the Black Hills (2.8 elk/mi^2). Provided density was limiting population growth, management activities reducing mountain lion abundance and reducing antlerless elk harvest would have dampened affects to population growth because of compensation occurring to some other vital rate (e.g., reduced pregnancy rates) or elk emigrating out of CSP. In addition, a higher prevalence rate of Chronic Wasting Disease was documented in CSP (13%) between 2013 and 2020 compared to the rest of the Black Hills (1.3%), which could have further limited population growth.

<u>Monitoring Impacts of Predation</u>

Critical metrics in determining population performance include annual cow survival, cow pregnancy rates and calf survival to reproductive age. Fluctuations in cow and calf survival result in different elk population trajectories; heavily influencing population growth and decline (Table 37). Considering the Black Hills is essentially a one predator system regarding elk population dynamics, analyzing trends in seasonal herd composition data (fall recruitment ratios) is a useful tool in determining if mountain lion predation on elk calves within the Black Hills is a limiting factor. Fall recruitment rates were mostly stable over the from 2009 to 2019 (ranging 38-53 calves/100 cows). From 2009 to 2019, there was a weak negative correlation (R^2 = -0.14) between the mountain lion winter population and calf recruitment the following spring, providing no support that more lions resulted in lower calf recruitment across the Black Hills. However, as demonstrated by Lehman et al. (2017), mountain lion predation rates were high at a localized scale in Custer State Park where CWD was also documented in elk since the early 2000s. In summary, a suite of covariates such as body condition, birth date, birth weight, disease and severity of environmental conditions may affect whether calves are recruited into

an elk population (Singer et al. 1997). Determining what variables have the greatest impact on calf recruitment is difficult because calf recruitment is likely dependent on a combination of multiple factors. Further, adult cow survival is documented to be the most sensitive population parameter (Lehman et al. 2017), and antlerless harvest management directly influenced adult cow harvest rates and overall survival (Table 26). Despite limited population growth in CSP after 7 years of conservative antlerless elk harvest, the elk population across the rest of the Black Hills responded closely with antlerless elk harvest, as evidenced by trends in female harvest (Table 17), survival (Table 26) and population abundance (see POPULATION SURVEYS: Aerial Surveys).

Table 37. Predicted elk population growth rates (decrease [↓], stable [●], increase [↑]c) based on recruitment, survival, and harvest rate.

Recruitment		35 Calves:100 Cows			45 Calves:100 Cows			55 Calves:100 Cows		
Annual Female Survival[a]		Low	Ave	High	Low	Ave	High	Low	Ave	High
Population Change[b] Based on Cow Harvest Rate	20%	↓↓	↓	↓	↓↓	↓	●	↓↓	↓	●
	15%	↓↓	↓	●	↓	●	●	↓	●	↑
	10%	↓	●	●	↓	●	↑	↓	●	↑
	5%	↓	●	↑	↓	●	↑	●	↑	↑↑
	0%	●	↑	↑	●	↑	↑↑	●	↑	↑↑

[a] Annual female survival rates in the absence of harvest
1) Low = 0.5-2.5 yrs old 55%, >2.5 yrs old 85%
2) Ave = 0.5-2.5 yrs old 65%, >2.5 yrs old 92%
3) High = 0.5-2.5 yrs old 75%, >2.5 yrs old 98%

[b] ↓↓: <.85 ↓: .85 - .94 ●: .95 – 1.05 ↑: 1.06 - 1.15 ↑↑: >1.15

Predator Management and Research

Mountain lion caused mortality on adult cow elk is limited (4%, southeastern Black Hills; 2.3%, west-central Black Hills); however, mountain lion predation on elk calves did have the potential to affect elk population performance in localized areas of the Black Hills. The mountain lion harvest season continued to be the number one management tool in maintaining a sustainable and socially acceptable mountain lion population (SDGFP 2019; Figure 27). From 2013 to 2019, the mountain lion season started on 26 December each year and ran through the end of March the following year. In 2020, the season was extended through the end of April. Use of dogs was prohibited except during specified hunting intervals in CSP during established seasons. A year-round season existed throughout the prairie landscapes outside the Black Hills Fire Protection District.

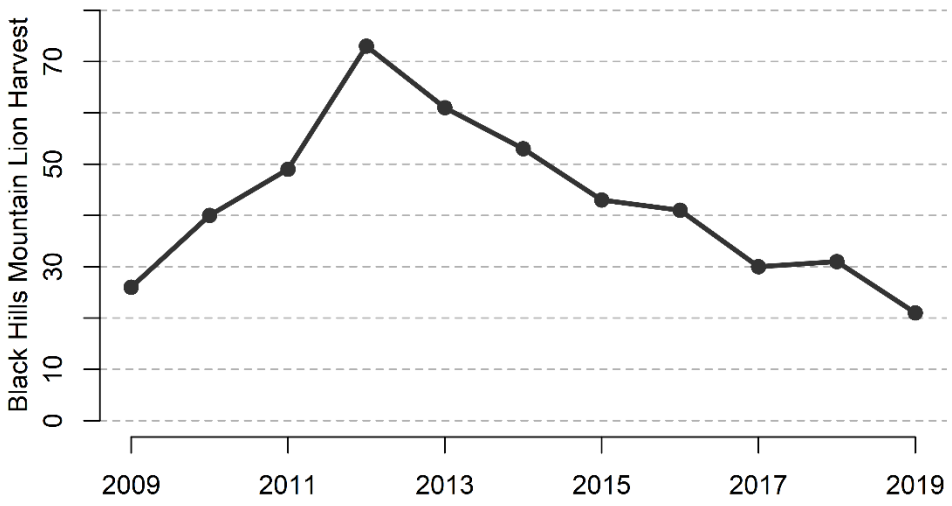


Figure 27. South Dakota Black Hills mountain lion harvest, 2009/09-2019/20.

To better understand the feeding habits of mountain lions occupying the Black Hills, along with quantifying prey selection and kill rates, 41 mountain lions (29 female; 12 males) were captured and fitted with GPS radio collars throughout the Black Hills from 2009 – 2012. Over 5,500 cluster locations (i.e., potential feeding sites) were investigated, of which 1,506 were feeding sites (kills = 1,246; scavenge = 260). Results indicated that deer (*Odocoileus spp.*) comprised the majority of mountain lion diets (83%; Smith 2014). The most common prey species was white-tailed deer (62.9%). Elk made up 5.5% of feeding sites. Kill rates averaged 0.79 ungulates/week (95% CI = 0.81 – 0.88) and varied significantly among individual (range = 0.13 – 1.75 ungulates/week) and season (e.g., summer, 0.92 ungulates/week; winter, 0.62 ungulates/week). Annual kill rates averaged 52 ungulates killed per year for females with kittens > 6 months, 42 for females with kittens < 6 months, 39 for adult females, 38 for subadult males, 35 for adult males and 33 for subadult females (Smith 2014). In addition, Smith (2014) noted that CWD infected elk potentially have an increased risk to predation. From December 2011 to April 2012, elk kills (*n* = 14) from 2 GPS collared mountain lions (1 male; 1 female) occupying WICA were tested for CWD. Nine of the 14 (64%; 95% CI = 50.3 – 78.3%) elk were positive for CWD.

Coyote and bobcat predation on elk calves within the Black Hills appeared to be limited, and typically occurred in the first 30-days of life (Simpson 2015, Lehman et al. 2016). In the CSP study area, collared calf (*n* = 125) mortality rates caused by coyotes and bobcats were 6% (*n* = 7; 95% CI: 0.0 – 0.13) and 1.5% (*n* = 1; 95% CI: 0.0 – 0.06), respectively. No mortality events caused by coyotes or bobcats involving adult elk were documented within the remaining Black Hills. Thus, research findings suggested coyote and bobcat populations have minimal impacts on elk populations. Liberal harvest strategies exist for coyotes including a statewide year-round hunting and trapping season with unlimited harvest, and a limited coyote season in CSP. A

more conservative harvest season exists for bobcats, including a 52-day hunting and trapping season (26 December–15 February) in 2020, excluding CSP.

Determining if predation is a limiting factor is extremely difficult because predator-prey dynamics are complex. If predation is found to be a limiting factor, developing solutions that make a difference would require adaptive management strategies where effective monitoring allows managers to learn, and adjust management strategies through time. Ballard et al. (2003) emphasized numerous guidelines for determining if a more aggressive approach in predator management would likely increase elk populations.

- Elk populations are below carrying capacity
- Predation identified as a major cause of mortality
- Predator management efforts can result in a significant decline in predator numbers
- Predator management efforts are focused within a geographic area (e.g., <400 mi^2)
- Predator management efforts are timed just prior to predator and/or prey reproductive periods

The Black Hills of South Dakota is not occupied by breeding populations of wolves or bears. Even though mountain lion populations increased from 2005 to 2009 and remained fairly stable from 2009 to 2020, elk populations continued to grow. Continued monitoring is necessary to ensure predation does not become a limiting factor and predator management strategies do not need to be adjusted.

Multiple Use

Management: Roads and Motorized Vehicles (non-snow)

Recreational use of public lands can produce unintentional harassment of wildlife. Numerous studies conducted in the western states (Rowland et al. 2005), published findings over the past 35 years on the effects of roads to elk, including road maintenance levels (Gardner 1971), reduction in elk habitat effectiveness (Lyon 1979a), excessive creation of edge habitat (Ebert 1972), habitat fragmentation and increased vulnerability to disturbance, poaching and disproportionate spatial harvesting (Sundstrom and Norberg 1972). Big game, particularly elk, need screening cover adjacent to secondary and primitive roads (Lyon 1979b, USDA 1975) as previously mentioned.

Elk movements and habitat use in the Black Hills is largely dictated by human activities (Rice 1988) versus weather or habitat modifications. This includes motorized use of roads and trails (Millspaugh et al. 2000a). Pulses of human intrusion are evident in the daily movements of elk (Rumble et al. 2005). Elk response to roads differs by season, time of day and road type (Lyon 1979b, Millspaugh 1999). One behavior is evident; elk compensate their normal movements by waiting to become more active during periods when human use is lowest (Millspaugh et al. 2000a).

Road type and motorized activity level are the primary components determining the influence of roads on habitat suitability. In CSP, areas near tertiary roads (dirt roads closed to the public but occasionally used for administrative purposes) are used more often than random, suggesting elk prefer to use areas near these roads. Conversely, in areas with higher open road density and during hunting seasons when activity is concentrated along these roads, elk avoid them (Millspaugh 1999).

Compared to BHNF, tertiary roads are considerably fewer in CSP and do not receive the volume of year-round motorized use. Road densities in general are much lower in CSP than BHNF and there is never authorized off-road motorized recreation (OHV) by the public. Elk hunters in CSP use tertiary roads to a greater degree than primary (paved) or secondary (gravel) roads. Elk negatively respond most acutely to roads and trails traveled (foot and motorized vehicles traffic) most heavily by hunters in the fall. Some elk are displaced onto private lands on the east side of the Park during archery seasons due to disturbance. In CSP, elk response to human activities in the fall is short-lived and after hunting seasons, elk move back into CSP and selected areas near secondary and tertiary roads in the winter. However, the negative influence of primary or paved roads open year-round to the public, which include highways, is still evident and elk dispersion is extended to 300m (327 yards) during winter (Rumble et al. 2001a). Conversely, the effects of edge that roads created with delayed phenology and green vegetation during late summer and early fall attracted elk to take advantage of this forage adjacent to primary (paved) roads at night when there is less motorized traffic.

However, on BHNF, the effects of roads and motorized traffic is compounded by the fact that up until 2010 when the Travel Management Plan was initiated (USDA 2010c), there are few restrictions on OHV recreation. Also, road densities are the highest of any national forest at 2.2 mi/mi^2 (Rumble et al. 2005). From 2012 to 2020, the BHNF has issued OHV trail use permits either as a private annual pass, a 7-day pass or a commercial pass. The sale of these permits increased dramatically in the annual private permit sales as well as the commercial permit sales (Figure 28; BHNF communication, March 2021). The commercial permits are required for each vehicle within the merchant's fleet but may have a larger impact than personal annual permits, since they are used in multiple shifts by multiple users throughout the day. These permits allow the use of OHV on the smaller trail system, no permit is required to use these vehicles on the main gravel roads within the BHNF. Therefore, permit sales only represented a small proportion of the OHV use within the BHNF boundaries.

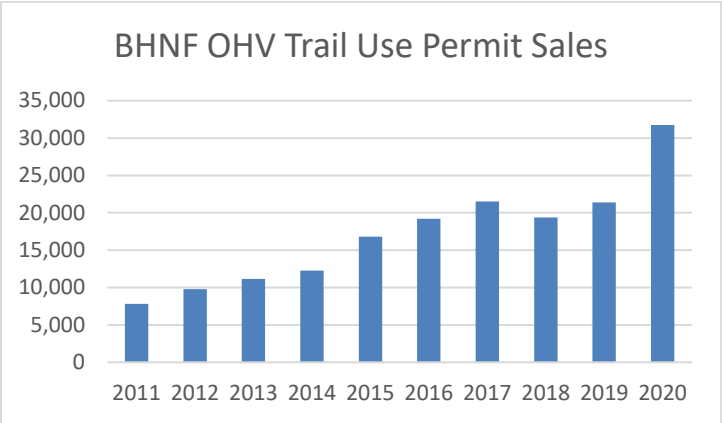


Figure 28. Total trail use permits sold for the BHNF, 2012-2020 (BHNF unpublished data, March 2021).

A study conducted in early 2000 evaluated road density impacts and found that elk could not move more than 150m from a primitive road (Rumble et al. 2005). Elk on BHNF are always further from primitive roads during hunting rifle seasons (deer and elk) and usually further from secondary and primary roads in areas of high road densities. During the archery season elk appear more tolerant of limited human activity and are closer to primary and secondary roads compared to the rifle season. Elk distribute themselves away from roads more frequently on hunting season opening weekends and the day after Thanksgiving (which is a traditional day for hunting deer in the Black Hills). Since the 2005 published study, a mountain lion season brought additional traffic to both CSP and BHNF roads as many lion hunters drive roads to find lion tracks in the snow.

In some parts of the Black Hills, where high road densities combined with high volume non-snow traffic and snowmobile trails in the winter, elk have little opportunity to seek low disturbance on a year-round basis (Rumble et al. 2005). Aggravated displacement and increased movements of elk create more than just a group of animals moving across the landscape. Motorized and human disturbances on roads result in larger home ranges, meaning elk need more area to fulfill habitat requirements of forage, water, shelter and space. Flight response causes increased demands for energy input and elk could require 0.5 hour of additional foraging time to accommodate greater movements resulting from human activity (Rumble et al. 2005). Displacement from favored foraging areas, especially in the fall and winter, create physiological stress effects (Millspaugh 1999) that are difficult to quantify. Nutritional deficit (forage less than 50% digestible) and spending more time in habitats with less forage availability are additive, meaning that some elk winter in poor condition due to constant movement to avoid roads and/or to find quality habitat (Rumble et al. 2001b, 2005). On summer range, there is the potential for cow elk to enter spring with a nutritional deficit from the previous 7-9 months and there could be added stress from human disturbances during elk lactation, despite better forage quality during summer.

Another trade-off is that in areas on public land with dwindling quality elk habitat, which includes a high use of roads by hunters and recreationalists, elk leave public land for private, even if temporary (Wertz et al. 2004). The BHNF Forest Plan strives to manage big game habitat to keep big game on BHNF winter range to reduce the time spent on private lands (USDA 2006).

Stress in elk can be measured using fecal glucocorticoids (GC). The adrenal cortex secretes GC that alters metabolic pathways and diverts energy not required for immediate survival. Chronic GC elevation causes physiological responses that inhibit digestion and growth, resulting in decreased resistance to disease, suppressed reproduction and influenced muscle wasting (Munck et al. 1984, Sapolsky 1992). Physiological responses of elk to various stressors in CSP result in limited interpretations (Millspaugh et al. 2001) but it is noted that human activity, high temperatures and normal seasonal metabolic rhythms elevated summer GC concentrations. Many factors, including direct stress by humans or predators, influence GC excretion adrenal responses but do not usually result in a lethal response (Romero 2004). These factors include age, sex, daily and seasonal behaviors, diet and body condition, herd social ranking, and reproductive status (Millspaugh and Washburn 2004). Biologists must carefully consider confounding factors and the relationship between GC concentrations and population performance or biological costs when interpreting effects of environmental or human-induced disturbances on wildlife (Millspaugh and Washburn 2004).

SDGFP and BHNF partner on several types of habitat improvement projects in BHNF elk country. For example, an unauthorized road created by the public was reclassified to foot and horse use only in an area adjacent to the Pleasant Valley SDGFP Game Production Area. Both BHNF and adjacent SDGFP land are important winter range for elk.

Snowmobiles and Over-Snow-Vehicles

The snowmobile trail system within the BHNF has been established for decades and provides 310 miles of groomed trails in South Dakota and 40 miles immediately across the Wyoming border. On a north-south axis, the South Dakota system starts 4 miles south of Spearfish, south to Lead and Deadwood in Lawrence County and then over 30 miles further south to the Pennington County line (which is approximately 11 miles south of Deerfield Lake and 8 miles north of Highway 16A). From west to east, the trails within South Dakota extend 14 miles from the WY border in the southern most portion of the trail system and approximately 19 miles east in the northern trail system near Lead. Trails may be closed for numerous reasons including but not limited to active logging operations, safety and maintenance and may be periodically rerouted seasonally or throughout the years. An area determined to be wildlife winter range on BHNF immediately west of Spearfish, SD, and 5 miles into Wyoming is closed to snowmobiling.

The South Dakota trails are maintained by SDGFP, Division of Parks and Recreation. State recreation managers have cooperative agreements with BHNF, USDI Bureau of Land Management, Barrick Mining Co., Wharf Resources and private landowners. Local economies

rely upon and benefit from this winter sport which generates approximately $131.6 million in annual economic impact to South Dakota (Allgrunn 2012). The season is from December 15 through March 31. Snowpack within the trail system is variable with generally more reliable snow in the northern portions of the trail system. Allgrunn (2012) queried residents and non-residents as to which months they typically recreated on the snowmobile trail system (Table 38). The bulk of the trail traffic occurred in January and February by both South Dakota residents and non-residents.

Table 38. Snowmobile trail use by South Dakota residents and non-residents in 2010 and 2011 (Allgrunn 2012).

Month	Residents	Non-Residents
December	35%	17%
January	75%	70%
February	86%	81%
March	45%	20%

Snowmobilers are required to stay on groomed trails except where trails are located on BHNF (other exceptions see www.gfp.sd.gov/to-do/snowmobile/default.aspx). Trails on several areas within BHNF pass through forested and open habitats. Plus, there are unlimited opportunities for off-trail riding on BHNF well outside the trail area on over 1.2 million acres (USDA 2014a).

In June 2014, the FS sought national public comment on a proposal to standardize sustainable access for over-snow vehicles designed for use over snow and run on track and/or ski or skis (OSV) on national forests and grasslands (USDA 2014b). USFS is required to evaluate OSV use on relevant USFS lands through its Travel Management Rule (36 CFR Part 212, Subpart C).

Exhaustive research was conducted on the effects of winter recreation on wildlife and natural resources in western landscapes outside of the Black Hills (Olliff et al. 1999). There was no comprehensive study or impact analysis conducted on the effects of *winter* recreation (outside of non-OSVs and hunting season use of roads) on wildlife and natural resources in the Black Hills. The effects of OSV to elk have been documented primarily in Yellowstone National Park (YNP) where elk and other wildlife species are not exposed to the same type or degree of human disturbances found in many areas throughout their range in the western United States, including the Black Hills. For example, within YNP, there is no hunting, domestic livestock grazing, active timber logging or mechanical vegetation treatments, private in-holdings with associated daily human movements and open road densities are considerably lower than BHNF.

Elk responses to OSV in YNP included increased vigilance (look/respond), travel (walking away) and, occasionally, flight or defense if elk are on or near roads, groups of elk are smaller, elk are approached by humans or their movements are impeded or hastened by OSV (Borkowski et al. 2006). Elk continued to use the same core winter range for 30 years, despite high levels of OSV

that remained confined to roads or trails and for the most part, humans did not deliberately harass wildlife. There are no observable adverse effects to elk population dynamics or demography.

Physiological responses such as elevated heart rate, blood pressure, breathing rate, and release of adrenal cortex secretes glucocorticoids (GC) or adrenaline as measures of fitness effects were monitored in companion studies (Hardy 2001, Creel et al. 2002). For elk, day-to-day variation in fecal glucocorticoid levels paralleled the number of snowmobiles when effects of weather and age were controlled. Although GC concentrations were higher in elk responses to OSV compared to wheeled vehicles, researchers found no correlation to current levels of OSV and negative effects to elk populations (Creel et al. 2002).

Based on these three studies, Borkowski et al. (2006) recommended Park managers not increase winter recreational activities but continue in the same predictable manner. Absent other forms of disturbances to elk which could cause severe or prolonged impacts, it was hypothesized that elk in YNP may have become conditioned to the same form of human winter activity of OSV use. Research on the effects of OSVs in the Black Hills may be warranted.

Motorized Elk Retrieval

In March 2010, BHNF issued a new travel management plan for motorized vehicles for other than OSVs (USDA 2010d). Today, the Forest has over 3,600 miles of open routes for motorized travel and recreation and land adjacent to roads is considered closed unless designated otherwise. There are abundant opportunities for motorized recreation and permits may be required (USDA 2020b). Motorized Vehicle Use Maps (MVUM), electronic downloads, and other federal regulations can be found on BHNF website or by visiting a BHNF Office. For non-BHNF lands, hunters can consult with the respective federal or state land management agency to determine if motorized game retrieval is allowed. Custer State Park highly regulates uses of OHVs.

The major change in travel management on BHNF came with ending decades of off-road use on most of BHNF with the exception of a few areas open to cross-country recreation, dispersed camping and elk retrieval (USDA 2010c). Retrieval of a downed elk by packing out on horse, mule, backpack or travois is always available but another option is by motorized vehicle. It is SDGFP's opinion that getting a legally harvested elk properly field dressed, body cooled and quickly transported for processing are critical to resident hunters and additional access adjacent to some roads aided in proper handling of wild game. The amount of added disturbance from motorized retrieval to other hunters is considered minor and negligible to elk due to high amount of human activity already taking place throughout the hunting seasons.

For the final BHNF travel management decision, SDGFP encouraged adoption of limited-distance for off-road motorized use to retrieve legally harvested elk. BHNF agreed to such an allowance as long as hunters honor the conditions established each year. There are

approximately 294,800 acres for off-road elk retrieval under the following conditions (USDA 2014c):

- Elk retrieval only. No other hunted species may be retrieved off-road with a motorize vehicle.
- Motorized elk retrieval is allowed only in the zones established by BHNF and as displayed on the MVUM.
- The MVUM indicate the distance allowed to retrieve up to 300 feet, or up to 1 mile within the designated Elk Retrieval Zones, from certain designated roads.
- There is no restriction on time of day.
- Only one vehicle is allowed off-road to retrieve each harvested elk, but more than one pass of this single vehicle is allowed as needed.
- Persons retrieving an elk are required to use the most direct route to and from the nearest designated road, possess a valid hunting license, and keep weapons cased during elk retrieval.
- Crossing live streams and wetlands is not permitted. Cutting fences is not allowed. Resource and infrastructure damage could result in federal fines.
- Scouting off-road in a motorized vehicle is not allowed. There must be a legally harvested, downed elk, at the end of a hunter's motorized jaunt.

South Dakota Game, Fish, and Parks worked diligently with BHNF to partner on this off-road exception for elk hunters and a joint MOU was developed (USDA-SDGFP 2010). Hunters are encouraged to be cognizant of the conditions set forth to retrieve downed elk and honor the provisions of "tread lightly" on all outdoor excursions within the BHNF.

Hiking and Camping

South Dakota Game, Fish, and Parks studied elk behavioral and physiological responses to human disturbances in CSP from 1993 – 1997 (Millspaugh 1999). The study looked at several types of human disturbances including use of roads, trails and hunters. CSP trails receive a high volume of foot and horseback traffic during peak tourist season. Use of hiking and horse trails in CSP by all user groups any time during the year affected elk movements but significantly more so in the summer when human use was greatest. Results of the study indicated elk avoid areas within 600 m (656 yards) of trails.

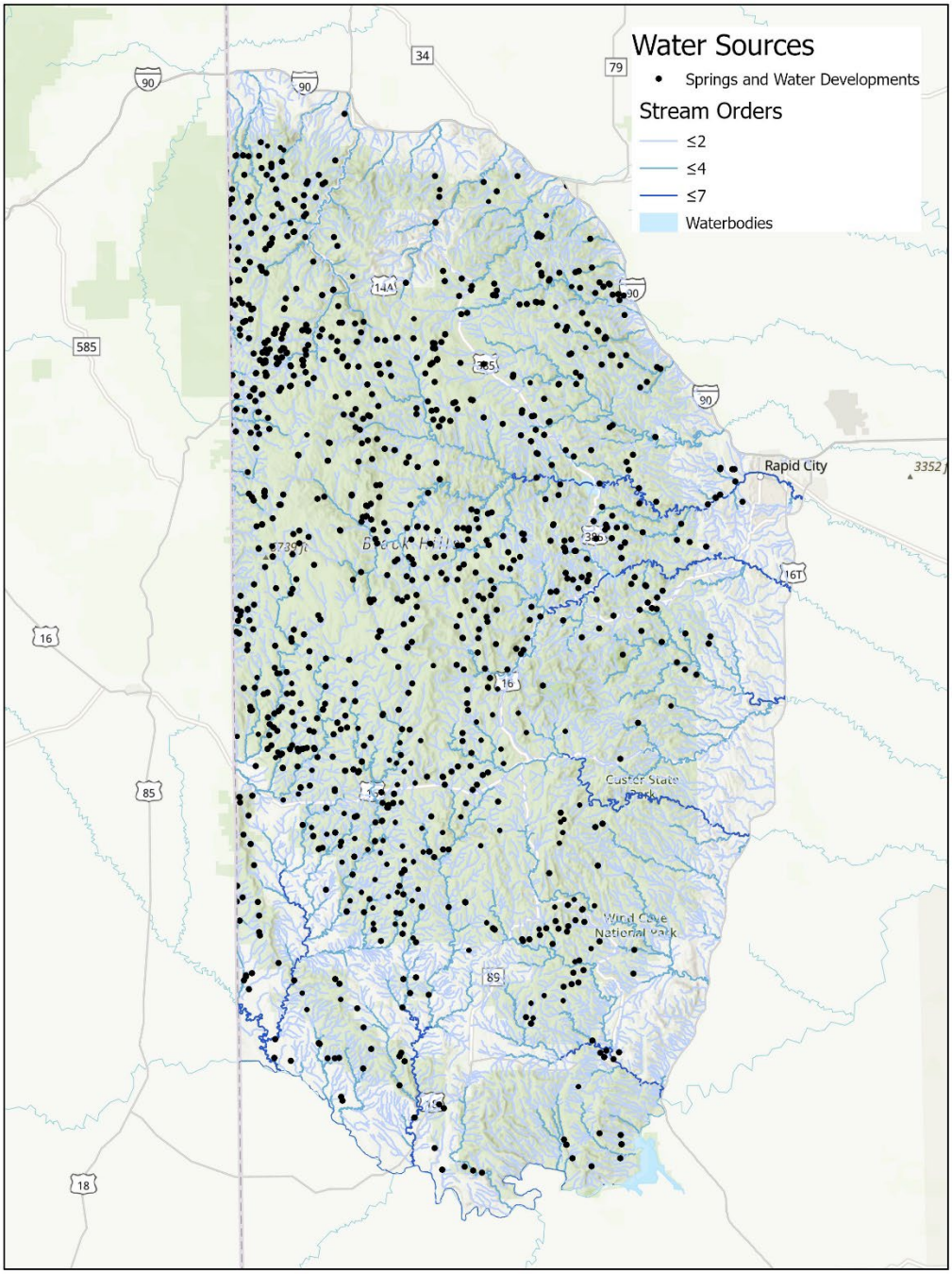
In conclusion, local research of the direct movements of elk and physiological responses due to human activities, particularly use of roads and trails, paralleled studies from other western states. The effect of roads on elk decreased as distance from roads increased, irrespective of available vegetative cover. Lyon (1979a) stated that road management was a powerful means of manipulating elk habitat. Recreation of various sorts becomes more and more a demand on public lands and to natural resources, and managing recreational and human disturbances is more challenging. Borkowski et al. (2006) suggested (based on findings by Meadow et al. 2005) that the public holds onto their strongly held beliefs and despite persuasions backed with scientific findings, most people did not change their strongly held attitudes. Never-the-less,

science and professional judgment by SDGFP continued to provide insight into elk-human interactions and impacts to elk habitat (beneficial and negative) which is considered in public land management in the Black Hills.

Dispersed camping is allowed on the BHNF where indicated on the MVUM. Open fires are never allowed within the Black Hills Fire Protection Boundary. Hunters should come prepared to camp without depending upon an open campfire for warmth and/or cooking.

Wildlife Guzzlers

Wildlife guzzlers supply surface water where water is potentially a limiting factor. Guzzlers may also entice wildlife to stay on public land. At one time, BHNF, often with the assistance of SDGFP and conservation groups, installed many guzzlers as a tangible wildlife improvement project. However, guzzler maintenance is imperative and if not conducted, guzzlers become malfunctioning watering mechanisms. Through the years, many guzzlers have fallen into disrepair and to vandalism, but some have been recently repaired primarily through the efforts of public volunteers (e.g., RMEF). Maintenance of these guzzlers is recorded by BHNF personnel. Water sources, including guzzlers, streams, wetlands, ponds, dams, reservoirs, springs and other water enhancements, are dispersed throughout BHNF (Figure 29).



Note: Water developments includes dugouts, ponds, pumps, wells, guzzlers, tanks/towers and windmills

Figure 29. Known hydrology and water sources in the Black Hills of South Dakota, source data from 2000-2014.

On BHNF, many guzzlers are installed at the end of a road or have short spur roads created for access. Placement of some guzzlers has unintentionally created nuisance disturbances by humans that defeats the well-intentioned purpose to supply water for wildlife. The maintenance of existing guzzlers and installation of additional guzzlers on BHNF is under the jurisdiction of BHNF.

Shed Hunting

Shed hunting for private use is legal on lands managed by the BHNF; however, a local BHNF office should be consulted regarding commercial uses and seasonal road closures. No permits are required for recreational or commercial collecting. As of 2017, shed hunting was legal on any South Dakota state lands (including Parks and Game Production Areas). Sheds cannot be taken from National Park Service lands as they are considered a natural feature of the land.

Mining, Energy Development and Transmission

Gold, slate, limestone, pegmatite minerals, mica, iron, clay and aggregate mining along with oil production all occur within South Dakota's elk range. Statewide, 54 mine permits total 6,300 acres; 3,368 acres of those are "affected" or "disturbed" lands (Eric Holm, personal communication). Abandoned relic mine sites, and gravel operations and quarries are not included in the affected or disturbed mine acreage total; although these sites are locally numerous, the individual areas are small. The majority of disturbance at active or inactive mines in the Black Hills and Prairie Elk Units are less than 50 acres; only 3 mine sites are over 500 acres. These permitted mines exist in various operational stages ranging from active mining to full vegetative reclamation. All types of mining that occurs in the Black Hills or Prairie Elk units are considered for long-term planning consideration in this document.

Many mining regulations are in place mitigating impacts to important wildlife habitats and species. SDCL § 45-6B-1, also known as the "South Dakota Mined Land Reclamation Act", is the state's guiding document for mine regulation. Laws in this section explicitly require mine permit applicants to comprehensively describe project area critical resources (SDCL § 45-6B-92) and determine suitability of land for mining (SDCL § 45-6B-33.3). Implementation of these laws require applicants to identify project's species use with specific intent to protect critical habitats of these species. State, as well as federal laws require projects to have a site-specific reclamation plan with the priority in re-establishing productivity of the land after mining.

In the Black Hills, the USFS regulates natural resource impacts from mineral development (habitat fragmentation or conversion) and associated infrastructure (roads, pipelines, power lines, etc.) on lands under its control. The BHNF Forest Plan is the USFS guiding document for forest use. Mining objectives found in the plan ensure that exploration, development and production of mineral and energy resources are conducted in an environmentally sound manner so that they may contribute to economic growth and the national defense (USDA 2006). The BHNF Forest Plan specifically requires mine operating plans to restrict periods of operation to reduce disturbance to deer and elk during periods of high use (USDA 2006). In the

BHNF Management Areas with emphasis toward big game winter range (MA 5.4) "operating and reclamation plans shall minimize or mitigate impacts to deer and elk habitat" (USDA 2006). NEPA also required USFS to publicize mining proposals for external review and input of their projects.

Mine vegetative reclamation is often beneficial to big game. In the Black Hills, operations at large-scale mine projects range from operational to fully reclaimed. Reclaimed sites in the predominantly forested Northern Black Hills create islands of grasslands in an increasingly exurban landscape. Some reclaimed sites in this area currently remain in a prolonged phase of closure even though fully vegetated. The sites provide wildlife with a forage opportunity and a measure of security as these sites remain closed to the public for an extended period. Wildlife benefits are not thoroughly studied at large or small reclaimed sites in the Black Hills. In 2020, mining in all elk units appear to add little significant human, forage or spatial distraction to elk success in the Black Hills or prairie units.

Various types of mining in the Black Hills continue in some variable extents. Forecasting the location and extent of mining in elk country is however wrought with uncertainties. Long-term impacts to topography and native habitat are expected as well as short-term impacts from increased human interactions and decreased forage and use. State and federal laws already promulgate protection of areas important to elk. Identification of areas important to elk is therefore necessary to utilize statutory authority and mitigation opportunities for this species.

Similar to mining, predicting the state's energy development is full of uncertainties. As of 2020, no wind or solar energy developments were proposed on elk units.

In 2020, oil exploration in South Dakota had about 1 oil rig drilling about 1 new well per month. The most optimistic oil development scenario statewide predicted northwestern South Dakota having six drilling rigs, each drilling an average of one new well per month for the next fifteen years (The Office of Governor Dennis Daugaard 2012). Energy development in the form of electrical transmission and distribution lines are already common throughout the Black Hills region. Mitigation to reduce or eliminate direct loss of wildlife is addressed in project design criteria developed by participating agencies and energy companies.

Energy transmission rights-of-way (ROW) include both pipelines and electrical transmission lines. ROW development and maintenance create long- term changes in existing elk habitats. Development of ROW include direct impacts by conversion of native vegetation and habitat fragmentation in contiguous forests. Retaining accessibility, vegetation and weed control results in early successional vegetation to persist as in long narrow ROW habitat.

Impacts to elk herds occur during construction and infrastructure concomitant to this activity. Road construction, blasting, equipment staging areas, frequent human disturbances, noisy motorized equipment is direct short-term impacts. Long term impacts are decreased security

and productivity resulting from loss of valuable habitat. Early successional vegetation commonly found in ROW has the potential to alter their movements.

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APPENDIX

Appendix 1. Transplant history of elk in South Dakota, 1911-2014.

Date	Source Location	Receiving Agency/State	Total	Sex	Age	Data Source
1911	-	N. Black Hills, SD	100	-	-	Rice 1988
1912	-	CSP[1]	65	-	-	Hipschman 1959
1912	Idaho	N. Black Hills, WY	21	-	-	Rice 1988
1912	YNP[2]	Aberdeen, SD	3	-	-	Robbins et al. 1982
1913	Idaho	N. Black Hills, WY	21	-	-	Rice 1988
1914	YNP[2]	Hot Springs, SD	2	-	-	Robbins et al. 1982
1914	Jackson Hole, WY	WICA[3]	14	9F, 5M	-	Lovaas 1973, Rice 1988
1914	Gardiner, MT	CSP[1]	25	-	-	Hedrick 1914
1915	Gardiner, MT	CSP[1]	50	-	-	Hedrick 1915
1916	YNP[2]	WICA[3]	25	-	-	Lovaas 1973
1916	Gardiner, MT	CSP[1]	50	-	-	Hedrick 1917, Millspaugh and Brundige 1996a
1924	WICA[3]	Pennsylvania Game Commission	6	-	-	Pennsylvania Game Commission 2013
1926	WICA[3]	Pennsylvania Game Commission	4	-	-	Pennsylvania Game Commission 2013
1929	WICA[3]	Texas via Carlsbad, NM	47	-	-	NPS 1978

Date	Source Location	Receiving Agency/State	Total	Sex	Age	Data Source
08/27/1963	WICA[3]	CSP[1]	153	-	-	Lovaas 1973, NPS 1963
03/21/1968	WICA[3]	CSP[1]	94	-	-	Lovaas 1973, NPS 1968
10/27/1971	WICA[3]	Oglala Sioux Tribe, SD	2	2M	2Ad	NPS 1971
1970-1972	WICA[3]	Jicarilla Apache Tribe, NM	350	-	-	Lovaas 1973
1970-1972	WICA[3]	Oglala Sioux Tribe, SD	153	-	-	Lovaas 1973
1970-1972	WICA[3]	CSP[1]	126	-	-	Lovaas 1973
03/09/1973	WICA[3]	Oglala Sioux Tribe, SD	9	9M	9Ad	NPS 1973
01/05/1976	WICA[3]	Round Valley Indian Tribes, CA	10	7F, 3M	5Calf, 5Ad/Yr	NPS 1976a
01/06/1976	WICA[3]	Chippewa-Cree Tribe, MT	26	17F, 9M	5Calf, 21Ad/Yr	NPS 1976b
01/07/1976	WICA[3]	Lower Brule Sioux Tribe, SD	50	-	-	NPS 1976c
01/07/1976	WICA[3]	Cheyenne River Sioux Tribe, SD	42	-	-	NPS 1976c
01/10/1977	WICA[3]	Oglala Sioux Tribe, SD	50	38F, 12M	22Calf, 28Ad/Yr	NPS 1977
01/11/1977	WICA[3]	Colville Tribe, WA	50	38F, 12M	23Calf, 27Ad/Yr	NPS 1977
01/11/1977	WICA[3]	Three Affiliated Tribe, ND	52	31F, 21M	26Calf, 26Ad/Yr	NPS 1977
01/12/1977	WICA[3]	Tonkana Tribe and Kaw Tribe, OK	24	17F, 7M	11Calf, 13Ad/Yr	NPS 1977
01/13/1977	WICA[3]	Oglala Sioux Tribe, SD	9	8F, 1M	2Calf, 7Ad/Yr	NPS 1977
12/15/1980	WICA[3]	CSP[1]	20	18F, 2M	6Calf, 14Ad/Yr	Rice 1988
12/15/1980	WICA[3]	Castle Creek, Black Hills, SD	11	9F, 2M	3Calf, 8Ad/Yr	Rice 1988

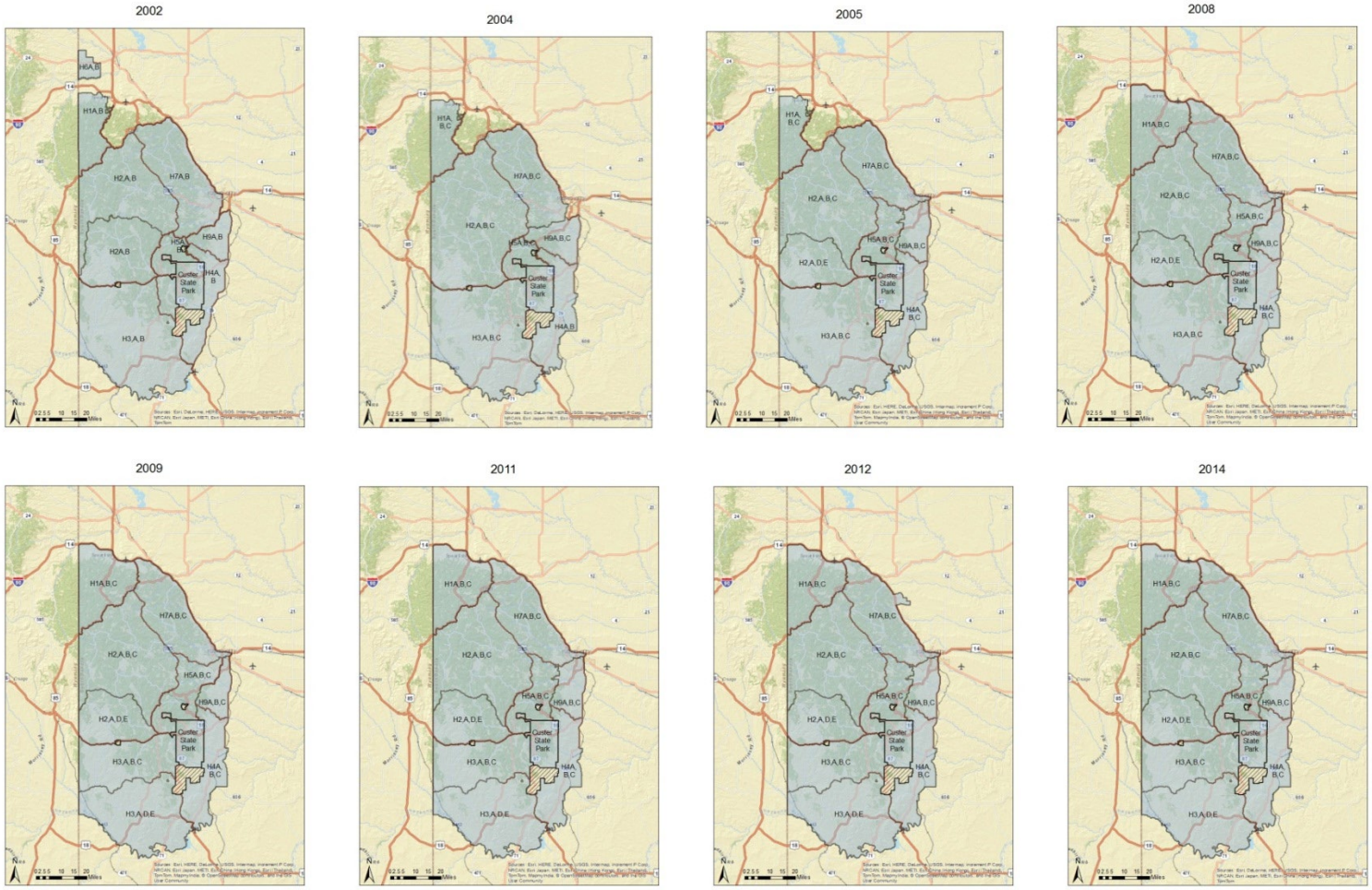
Date	Source Location	Receiving Agency/State	Total	Sex	Age	Data Source
12/15/1980	WICA[3]	Medicine Mountain, Black Hills, SD	10	9F, 1M	4 calves, 6 Ad/Yrlng	Rice 1988
12/19/1980	WICA[3]	Mud Springs, Black Hills, SD	10	8F, 2M	2 calves, 8 Ad/Yrlng	Rice 1988
12/19/1980	WICA[3]	Northern Cheyenne Tribe, MT	36	23F, 13M	8 calves, 28 Ad/Yrlng	NPS 1980
01/09/1985	WICA[3]	Mud Springs, Black Hills, SD	17	11F, 6M	7 calves, 10 Ad/Yrlng	Rice 1988
01/09/1985	WICA[3]	Pass Creek, Black Hills, SD	17	10F, 7M	10 calves, 7 Ad/Yrlng	Rice 1988
03/20/1985	WICA[3]	Theodore Roosevelt NP, ND	47	38F, 9M	3 calves, 44 Ad/Yrlng	NPS 1985a
01/28/1986	WICA[3]	Deerfield, Black Hills, SD	4	3F, 1M	4 Ad/Yrlng	Rice 1988
01/28/1986	WICA[3]	Lower Brule Sioux Tribe, SD	24	16F, 8M	9 calves, 15 Ad/Yrlng	NPS 1986a
01/28/1986	WICA[3]	Rosebud Sioux Tribe, SD	29	21F, 8M	10 calves, 19 Ad/Yrlng	NPS 1986a
01/28/1986	WICA[3]	Yankton Sioux Tribe, SD	10	7F, 3M	3 calves, 7 Ad/Yrlng	NPS 1986a
01/28/1986	WICA[3]	Sisseton-Wahpeton Oyate Tribe, SD	16	11F, 5M	5 calves, 11 Ad/Yrlng	NPS 1986a
01/28/1986	WICA[3]	Oglala Sioux Tribe, SD	42	29F, 13M	14 calves, 28 Ad/Yrlng	NPS 1986a
02/05/1990	WICA[3]	Veterans Peak, Black Hills, SD	18	16F, 2M	4 calves, 14 Ad	SDGFP 1990

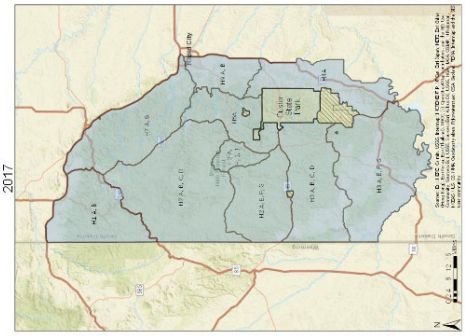
Date	Source Location	Receiving Agency/State	Total	Sex	Age	Data Source
02/05/1990	WICA[3]	Red Hill, Black Hills, SD	40	33F, 5M, 2Unk	8 calves, 32 Ad	SDGFP 1990
Feb. 1990	WICA[3]	Spokane Tribe, WA	48	41F, 7M	1 calf, 47 Ad/Yrlng	NPS 1990a
Feb. 1990	WICA[3]	Kaw Tribe, OK	48	47F, 1M	5 calves, 43 Ad/Yrlng	NPS 1990a
Feb. 1990	WICA[3]	Lower Brule Sioux Tribe, SD	103	91F, 12M	103 Ad/Yrlngs	NPS 1990a
05/03/1993	THRO[4]	Cheyenne River Sioux Tribe, SD	52	33F, 19M	21 calves, 31 Ad/Yrlng	NPS 1993
05/03/1993	THRO[4]	Oglala Sioux Tribe, SD	55	34F, 21M	18 calves, 37 Ad/Yrlng	NPS 1993
05/03/1993	THRO[4]	Standing Rock Sioux Tribe, SD	54	35F, 19M	15 calves, 39 Ad/Yrlng	NPS 1993
01/24/1994	WICA[3]	Rosebud Sioux Tribe, SD	18	16F, 2M	18 Ad/Yrlng	NPS 1994a
01/24/1994	WICA[3]	Fort Riley, KS	18	13F, 5M	2 calves, 16 Ad/Yrlng	NPS 1994a
01/24/1994	WICA[3]	Cheyenne River Sioux Tribe, SD	42	33F, 9M	1 calf, 41 Ad/Yrlng	NPS 1994a
01/24/1994	WICA[3]	Oglala Sioux Tribe, SD	71	44F, 27M	3 calves, 68 Ad/Yrlng	NPS 1994a
12/06/1994	WICA[3]	North Dakota	70	60F, 10M	70 adults	NPS 1994b
12/06/1994	WICA[3]	Oglala Sioux Tribe, SD	44	19F, 25M	-	NPS 1994b
12/06/1994	WICA[3]	Cheyenne River Sioux Tribe, SD	43	9F, 34M	-	NPS 1994b

Date	Source Location	Receiving Agency/State	Total	Sex	Age	Data Source
12/15/2012	WICA[3]	CSP[1]	14	-	-	SDGFP unpublished
03/01/2013	WICA[3]	CSP[1]	197	-	-	RMEF 2013
03/08/2013	WICA[3]	CSP[1]	192	-	-	RMEF 2013
03/12/2014	WICA[3]	Southern Black Hills, SD	122	-	-	RMEF 2014
03/12/2014	WICA[3]	CSP[1]	39	-	-	RMEF 2014
03/13/2014	WICA[3]	CSP[1]	17	-	-	RMEF 2014

[1] Custer State Park
[2] Yellowstone National Park
[3] Wind Cave National Park
[4] Theodore Roosevelt National Park

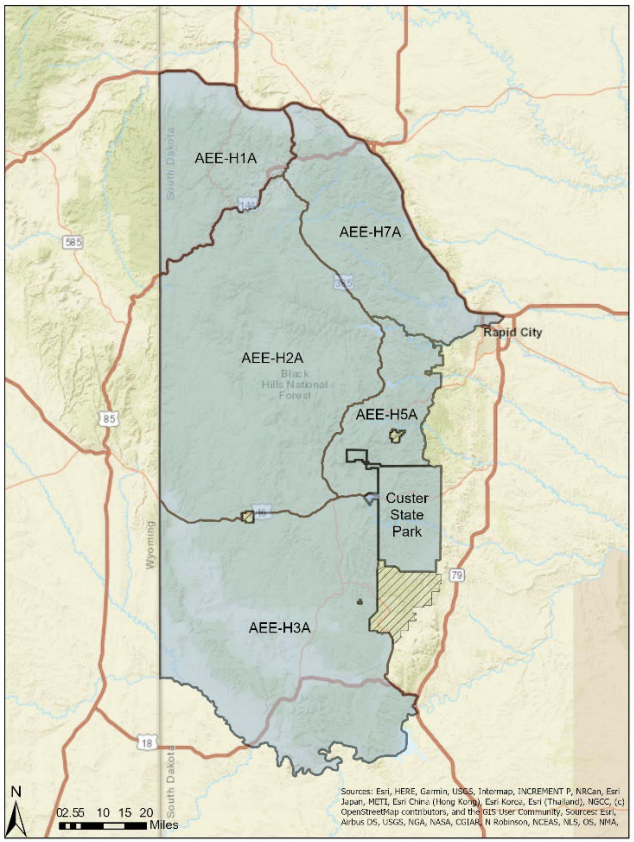
Appendix 2. Firearm elk season hunting boundary changes in the Black Hills, South Dakota, 1976-2020.


2002
H6A,B
H1A,B,C
H2A,B
H7A,B
H5A,B,C
H9A,B
H2A,B
Custer State Park
H4A,B,C
H3A,B
2004
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
Custer State Park
H4A,B
H3A,B,C
2005
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
H2A,D,E
Custer State Park
H4A,B,C
H3A,B,C
2008
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
H2A,D,E
Custer State Park
H4A,B,C
H3A,B,C
2009
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
H2A,D,E
Custer State Park
H3A,B,C
H4A,B,C
H3A,D,E
2011
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
H2A,D,E
Custer State Park
H3A,B,C
H4A,B,C
H3A,D,E
2012
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
H2A,D,E
Custer State Park
H3A,B,C
H4A,B,C
H3A,D,E
2014
H1A,B,C
H7A,B,C
H2A,B,C
H5A,B,C
H9A,B,C
H2A,D,E
Custer State Park
H3A,B,C
H4A,B,C
H3A,D,E

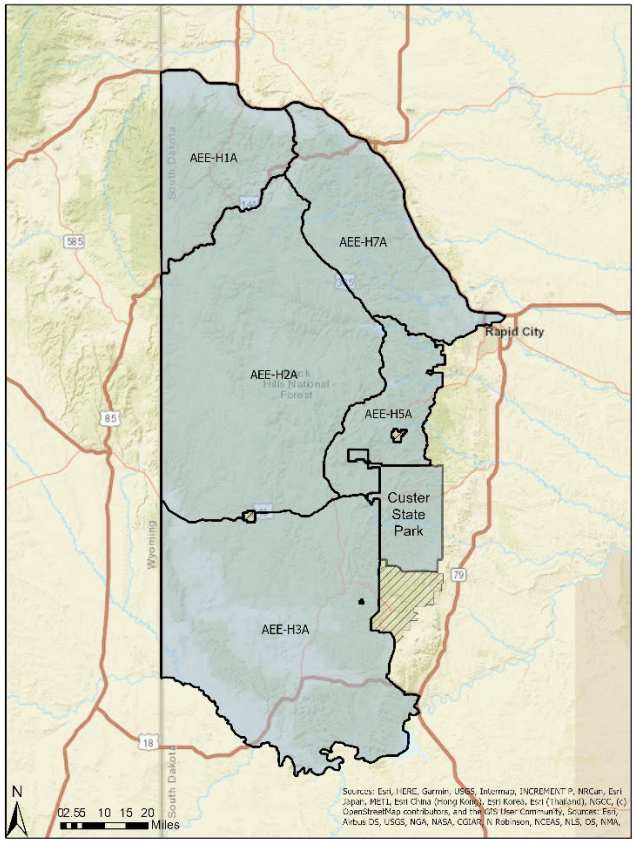

2017

Appendix 3. Archery elk season hunting unit boundary changes in the Black Hills, South Dakota, 1986-2020.

2014

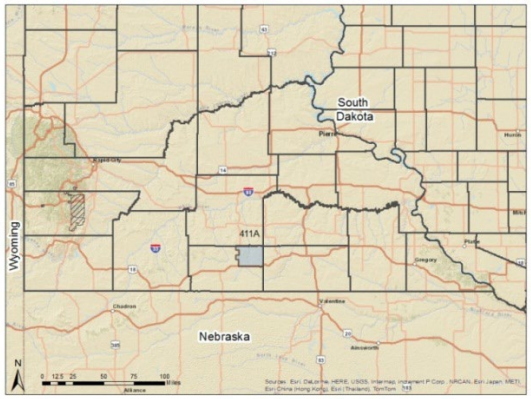

AEE-H1A
AEE-H7A
AEE-H2A
AEE-H5A
AEE-H3A
Rapid City
Custer State Park
Black Hills National Forest
South Dakota
Wyoming
N
0 2.5 5 10 15 20
Miles

2017

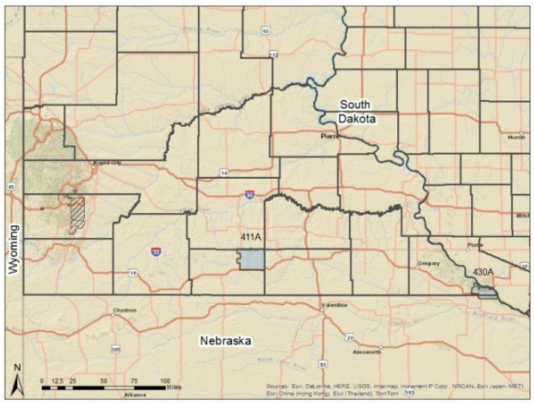

AEE-H1A
AEE-H7A
AEE-H2A
AEE-H5A
AEE-H3A
Rapid City
Custer State Park
Hills National Forest
South Dakota
Wyoming
N
0 2.5 5 10 15 20
Miles

Appendix 4. Prairie elk season hunting unit boundary changes in South Dakota, 1995-2020.

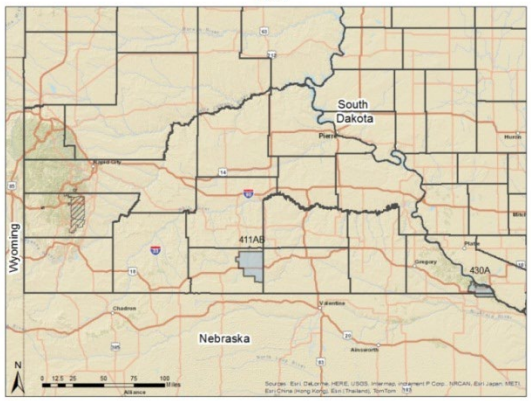
1995



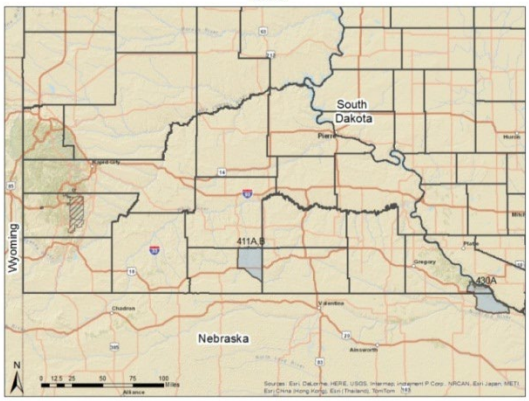
1996



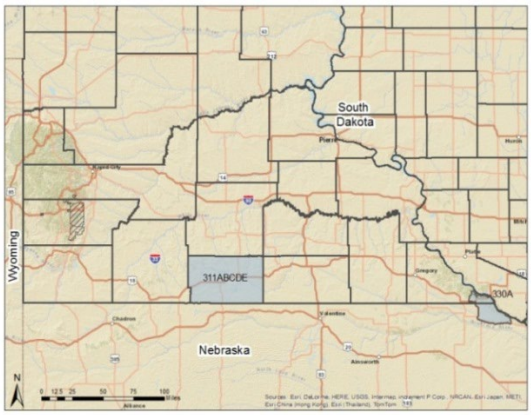
1998



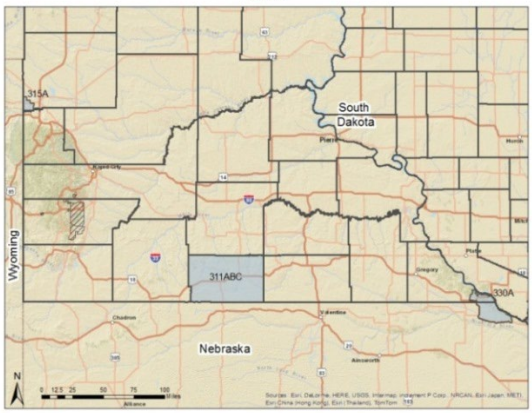
2000



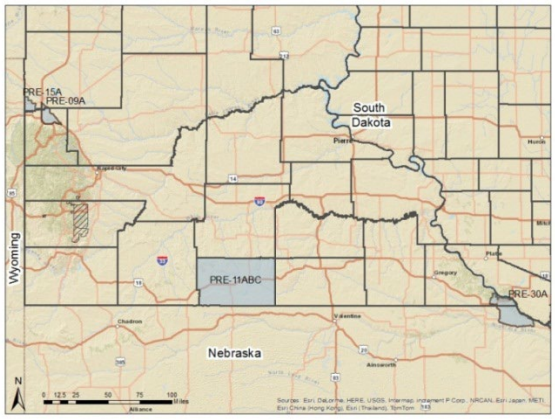
2001



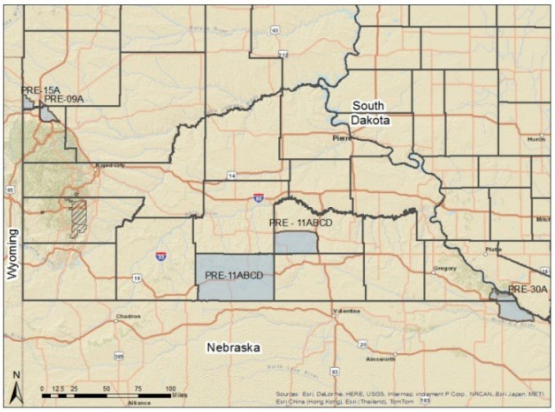
2004



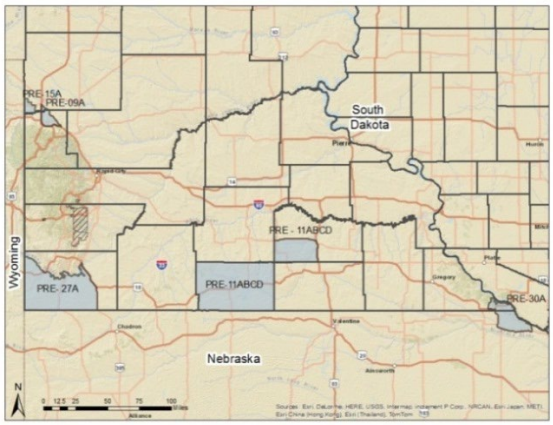
2009



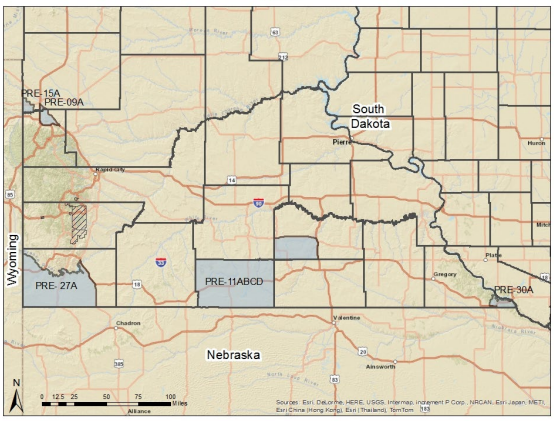
2011



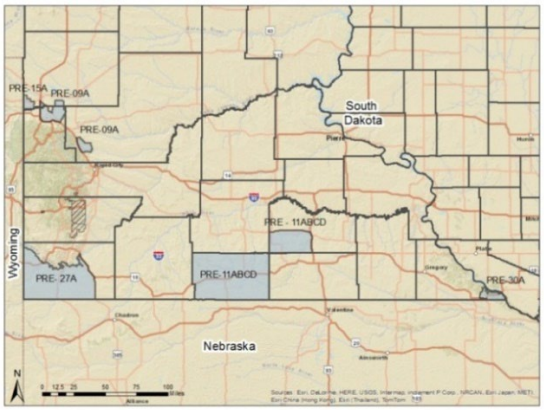
2012



2013



2014



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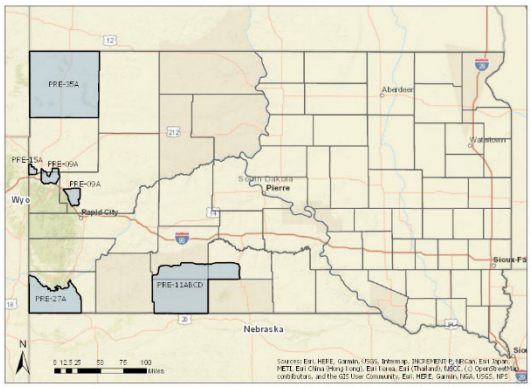

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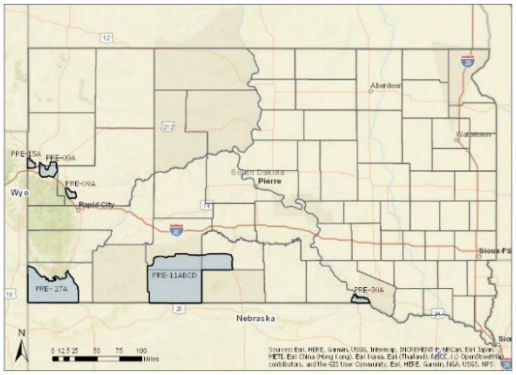

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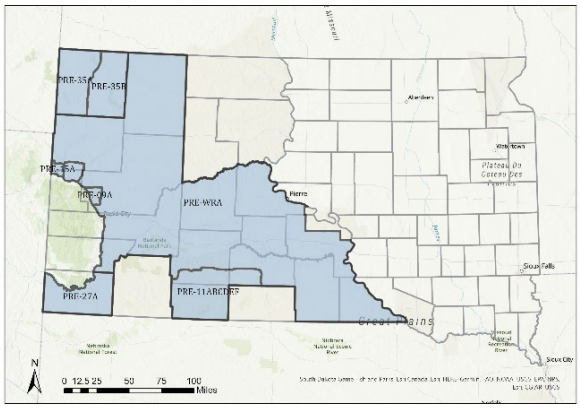


Appendix 5. Aerial surveys completed in the Black Hills of South Dakota, 1955-2020.

Year	Area Surveyed	Time of Year	Survey methods	Model Used	Estimate within management unit	Upper	Lower	Area Surveyed (SqMi) or units size if area not provided	Density Estimate for survey area (elk/SqMi)	Extrapolated elk population estimate for Black Hills
1955-1956	CSP and surrounding area	January	Fly 1/4 mile belt transects 300 feet AGL. Determine detection by using ground located elk groups and determine if they were missed by the census party. 6 groups ground located, 3 missed by aerial group for a -50% error.	50% detection	500 total (21 outside park)					
1956-1957	CSP and surrounding area	January	Fly 1/4 mile belt transects 300 feet AGL. Determine detection by using ground located elk groups and determine if they were missed by the census party. 3 groups ground located, 1 missed by aerial group for a -60% error.	30% detection	300 total (0 outside the park)					
1985-1986	Butte Co., Northeast hills, Unit 1, Unit 2, Unit 3, and Unit 4	Winter	Survey with National Guard helicopter, on the ground observations, track counts, and additional fall harvest data.	Winter census using track counts and both aircraft and on-the-ground observations. No methodology of flights presented.	940					890

Year	Area Surveyed	Time of Year	Survey methods	Model Used	Estimate within management unit	Upper	Lower	Area Surveyed (SqMi) or units size if area not provided	Density Estimate for survey area (elk/SqMi)	Extrapolated elk population estimate for Black Hills
1992-1993	2/3 of Wind Cave (Block 1 and 3)	September	September sightability flights with drive counts to determine existing population	Idaho Elk Sightability Model	241(+/-55) in Block 1&3 on first model run and 302(+/-57) in Bloc 1&3 on second model run					
1992-1993	1A	February	Fly subunits predicted to have elk present (23 were flown of 42 total) (5 out of the 23 subunits flown had elk present)	Idaho Elk Sightability Model	131 (+/- 24) (106 observed)	155	107	266	0.49	
1993-1994	1A	January	Fly subunits predicted to have elk present (9 were flown of 42 total) (5 out of the 9 subunits flown had elk present)	Idaho Elk Sightability Model	208 (+/- 58) (139 observed)	266	150	266	0.78	
1995-1996	3A	Winter	Fly subunits predicted to have elk present (30 classified as high (2) and low density (28) and all high density were flown and 17 of low density were flown of 42 total) (6 out of the 19 subunits flown had elk present)	Idaho Elk Sightability Model	378 (258 observed)	500	256	838	0.45	
1996-1997	2A	Winter	Fly subunits predicted to have elk present (40 flown of 128 total) (21 of these subunits had elk)	Idaho Elk Sightability Model	585 (529 observed)	618	552	883	0.66	
1997-1998	2A	January	Fly subunits predicted to have elk present (64 flown of 128 total) (18 of these subunits had elk)	Idaho Elk Sightability Model	251 (+/- 27) (215 observed)	278	224	883	0.28	
Year	**Area Surveyed**	**Time of Year**	**Survey methods**	**Model Used**	**Estimate within management unit**	**Upper**	**Lower**	**Area Surveyed (SqMi) or units size**	**Density Estimate for survey**	**Extrapolated elk population estimate for Black Hills**

								if area not provided	**area (elk/SqMi)**	
2012-2013	Unit 1 and 2	February	Complete coverage of Unit 1 and partial coverage of Unit 2 (17 of 55 subunits) 300 AGL and transects 650-1000 feet apart	Black Hills Sightability Model	Unit 1 estimate of 169 (+/- 13) (159 observed) Unit 2 estimate of 3135 (+/- 1816) (969 observed)			Unit 1 was 266 SqMi (entire unit) and Unit 2 was 300 of 883 SqMi covered	Unit 1 = 0.64 & Unit 2 = 3.55	
2013-2014	Entire Black Hills	February	Complete coverage of Black Hills, 300 AGL and transects 650-1000 feet apart	Black Hills Sightability Model	Unit 1 = 277 Unit 2 = 3819 Unit 3 = 698 Unit 4 = 65 Unit 5 = 13 Unit 7 = 205 Unit 9 = 0 CSP = 506 WCNP = 484			3045	1.99	6067 (95% CI: 5794 to 7115) (includes parks)

Year	**Area Surveyed**	**Time of Year**	**Survey methods**	**Model Used**	**Estimate within management unit**	**Upper**	**Lower**	**Area Surveyed (SqMi) or units size if area not provided**	**Density Estimate for survey area (elk/SqMi)**	**Extrapolated elk population estimate for Black Hills**

2019-2020	Entire Black Hills	February	Complete coverage of Black Hills, 3,000 AGL and transects 650-1000 feet apart	Black Hills Sightability Model	Unit 1=177 Unit 2-3406 Unit 3=2072 Unit 4=394 Unit 5=17 Unit 7=380 Unit 9=3 CSP=457		3045	2.13	6483 (95% CI 6098 to 7958 (excludes park)

Appendix 6. Aerial helicopter transect surveys with complete coverage, spaced 500-800 meters apart, and 300 feet above ground level in Custer State Park, South Dakota, from 1947 to 2013. Surveys from 1947 to February 2011 assumed 90% detection of elk and a Poisson Mark-Resight model was used from September 2011 to 2013.

Year	Time of Year	Density (elk/SqMi)	Estimate (95% CI)
1947-48	January	5.4	603
1978-79	February	3.5	393
1979	September	1	114
1979-80	February	3.6	399
1980	September	1.6	173
1980-81	February	2.9	317
1981	September	1.7	190
1981-82	February	4.7	521
1982	September	2	216
1982-83	February	5.1	571
1983	September	1.8	202
1983-84	February	4.8	537
1984	September	1.5	171
1984-85	February	3.1	347
1985	September	2.5	279
1985-86	February	2.2	265
1986	September	1.1	264
1986-87	February	1.5	166
1987	September	1.8	199
1987-88	February	2.7	299
1988	September	2.1	237
1988-89	February	2.3	259
1989	September	1.7	187
1989-90	February	4	446
1990	September	0.5	56
1990-91	February	3.1	341
1991	September	1.5	166
1991-92	February	5.2	581
1992	September	2.4	263
1992-93	February	7.5	829
1993	September	4.3	477

Year	Time of Year	Density (elk/SqMi)	Estimate (95% CI)
1993-94	February	7.9	879
1994	September	2.9	316
1994-95	February	7.2	796
1995	September	2.7	297
1995-96	February	10.1	1,126
1996	September	3.6	397
1996-97	February	8.1	897
1997	September	3.9	427
1997-98	February	7.7	856
1998	September	3.7	413
1998-99	February	10	1,106
1999	September	4.1	458
1999-2000	February	9.6	1,068
2000	September	2.8	312
2000-01	February	9.3	1,030
2001	September	2.1	236
2001-02	February	9.8	1,088
2002	September	4.3	472
2002-03	February	9.3	1,030
2003	September	3.8	426
2003-04	February	8.9	985
2004	September	2.8	313
2004-05	February	8.6	950
2005	September	1.8	199
2005-06	February	6.5	718
2006	September	1	113
2006-07	February	5	560
2007	September	2.2	528
2007-08	February	4.7	527
2008	September	1.5	165
2008-09	February	3.7	408
2009	September	1.5	167
2009-10	February	2	222
2010	September	0.7	83
2010-11	February	2.1	228

Year	Time of Year	Density (elk/SqMi)	Estimate (95% CI)
2011	September	1.2	128 (107-192)
2011-12	February	1.1	125 (124-154)
2012	September	1.3	139 (99-111)
2012-13	March	4.6	508 (501-718)
2013	September	3.6	396 (324-512)

Appendix 7. Herd composition results from September aerial helicopter transect surveys with complete coverage, spaced 500-800 meters apart, and 300 feet above ground level in Custer State Park, South Dakota, from 1979 to 2013.

Year	calves:100 cows	bulls:100 cows
1979	37	-
1980	32	11
1981	36	32
1982	35	17
1983	33	17
1984	46	22
1985	35	17
1986	-	-
1987	32	23
1988	29	7
1989	27	21
1990	46	30
1991	53	26
1992	55	34
1993	60	40
1994	51	26
1995	47	16
1996	37	19
1997	-	-
1998	37	15
1999	28	24
2000	39	34
2001	38	35
2002	33	23
2003	37	32
2004	35	30
2005	33	34
2006	42	50
2007	21	64
2008	17	59
2009	19	29
2010	15	96
2011	13	43
2012	29	33
2013	26	21

Appendix 8. South Dakota Elk Stakeholders Group Charter.

Management Stakeholder Group

Purpose – The SD Game, Fish and Parks (GFP) 'Elk Management Stakeholder Group' is a diverse group of citizen stakeholders who have been asked to assist Department of Game, Fish and Parks Staff and the Game, Fish and Parks Commission in conducting a review of the broad range of issues affecting elk management in South Dakota. The Elk Management Stakeholder Group will assist GFP Staff and the GFP Commission by offering insight, ideas, and alternatives that could be considered in regard to the Department and Commission positions on various elk management goals, strategies, challenges and related recreational opportunities.

Objectives – The basic objectives of the Elk Management Stakeholder Group are to:

- Provide an additional link between the GFP Staff and the GFP Commission and the citizens we serve;
- Identify challenges and opportunities and develop ideas and suggestions regarding the range of issues affecting the management of elk and associated recreation in South Dakota; and
- Promote communication, increased awareness and mutual understanding between and among the Stakeholder Group members regarding the diversity of elk management challenges.

Scope of Authority – The Stakeholder Group will function in an advisory capacity only and will provide a discussion forum for members to share their personal perspective and the perspective of the group or organization they may represent on a diversity of issues related to elk management. Members who serve on the Stakeholder Group do so solely in a volunteer capacity. The Stakeholder Group is granted no authority over rule-making or rule enforcement on public or private land, has no budgetary authority or authority over personnel management, nor is it granted any authority over any state or federal agency or non-governmental organization. The Stakeholder Group was assembled as an additional citizen participation opportunity but is not designed to supplant or curtail any other type of citizen participation or public involvement opportunities that may be further utilized by GFP.

Organizational Structure and Stakeholder Group Membership - The Stakeholder Group is comprised of a diverse group of citizen stakeholders who may represent a broad range of public interests in the management of elk in South Dakota. Participants will attend 2 to 3 structured meetings to hear GFP Staff presentations and offer their

ideas and perspectives on elk management topics. The Stakeholder Group meetings will be facilitated by GFP staff or a third party facilitator hired by GFP.

Stakeholder Group Member Roles and Responsibilities – Working Group members will:

- Make a commitment to attend the scheduled Stakeholder Group meetings;
- Offer their thoughts and ideas and communicate with others in a respectful manner while maintaining an open mind with regard to the views and perspectives of other Working Group members, and;
- Serve as a sounding board and provide feedback and ideas to GFP Staff and the GFP Commission.

GFP Staff Roles and Responsibilities – GFP Staff will:

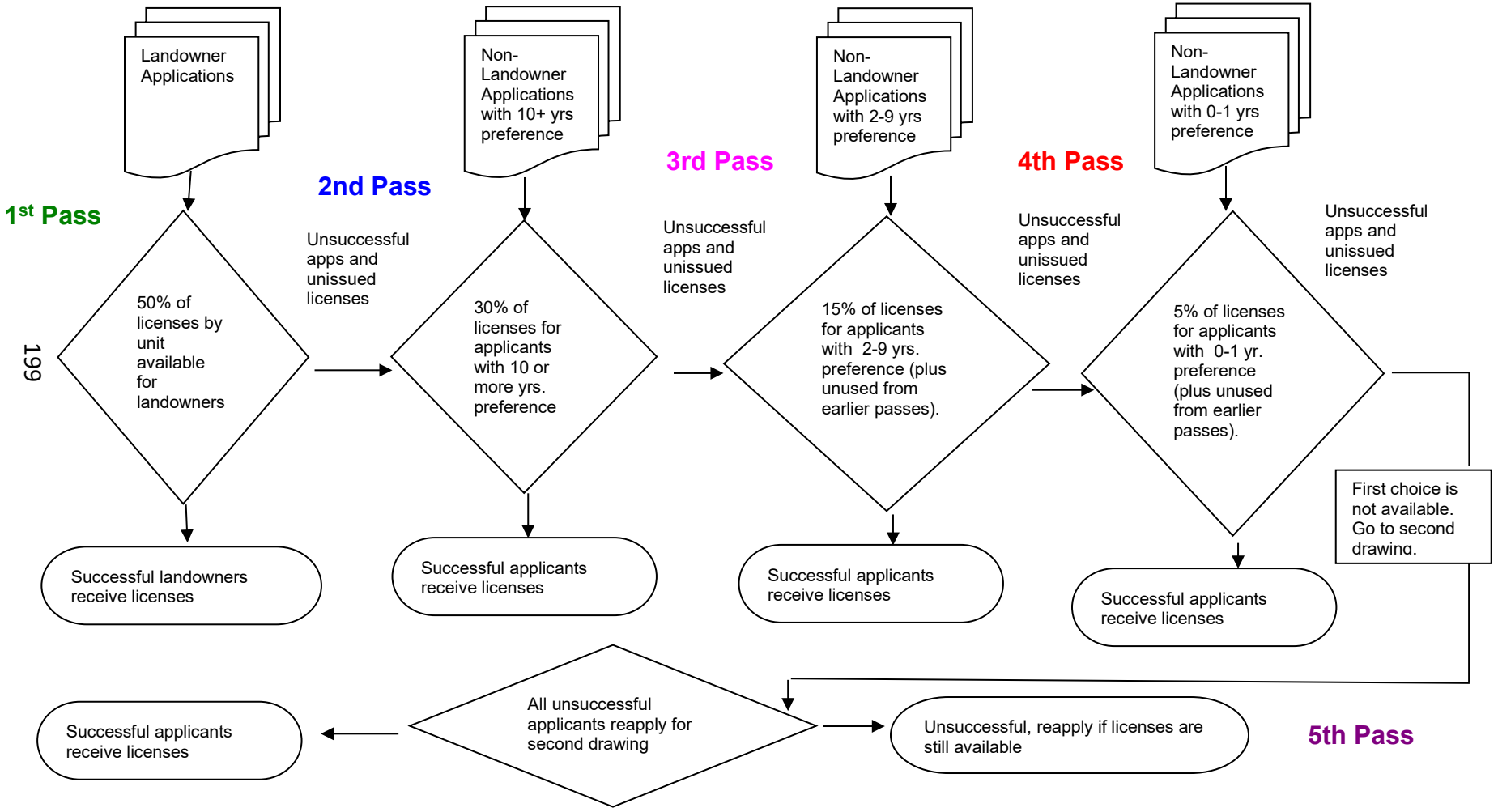
- Provide a diversity of information regarding elk management to the Stakeholder Group;
- Serve the role of facilitator for the meetings, including keeping order, achieving the meeting agenda and providing a comfortable working atmosphere for Working Group members to share ideas and opinions;
- Schedule and arrange meeting room facilities, including providing all necessary communication related to the meetings;
- Listen attentively and respectfully to all viewpoints; and
- Gather meeting notes and make them available to the public via the GFP website.

Meeting Guidelines and Communication – The purpose of the Elk Management Stakeholder Group is to provide a forum to promote understanding of elk management issues and challenges from diverse perspectives, therefore voting or other similar methods will not be used to formulate final group consensus on issues discussed.

- Additional Open House meetings, citizen surveys or other public involvement techniques may be used as a means to share information and gather additional public input on any proposed changes in elk management.
- Stakeholder Group members are encouraged to discuss and communicate with others about specific elk management issues discussed at the Stakeholder Group meetings.

Travel Expenditures – Travel expenses (lodging, per diem and vehicle mileage) for Stakeholder Group members will be reimbursed in accordance with State Reimbursement Rules for those members who are not reimbursed by another organization or agency.

Appendix 9. Elk license drawing process for Black Hills and Prairie seasons.



Appendix 10. Elk license drawing process for Custer State Park.