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# South Dakota SURVEY REPORT

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## Elk Population Status Update

*2018 Biennial Report*

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**SOUTH DAKOTA DEPARTMENT OF GAME, FISH AND PARKS  
PIERRE, SOUTH DAKOTA**

**WILDLIFE SURVEY REPORT**

**May 2018**

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## **INTRODUCTION**

Native to South Dakota, elk (*Cervus elaphus*) are the largest hunted member of the deer family (Cervidae) residing in the state. Extirpated in the late 1800s, the re-establishment of elk in South Dakota is a wildlife management success story. Today several thousand elk roam free, primarily in the Black Hills forested region along with several smaller herds occupying prairie and/or agriculture landscapes. Public demand for elk hunting opportunities is strong, with approximately 17,530 hunters applying for 3,029 available elk licenses at recent peak population levels in 2005.

Elk hunting seasons in South Dakota provide an important recreational opportunity for resident sportsmen and women, and also provide a means to manage elk populations. The current over-riding goal for elk management is to “manage elk populations and habitats consistent with ecological, social, aesthetic, and economic values of South Dakota citizens while addressing the concerns and issues of both residents and visitors of South Dakota” (South Dakota Game, Fish and Parks 2015). More specific information on elk management objectives, strategies, and research in South Dakota can be found in the South Dakota Elk Management Plan at <https://gfp.sd.gov/UserDocs/nav/ElkPlanApril2015Final.pdf>.

The following report provides a statewide overview of elk surveys and assessments conducted by the South Dakota Department of Game, Fish, and Parks (SDGFP) and an update on the population status of elk in the Black Hills.

## **POPULATION SURVEYS AND ASSESSMENTS**

### **Population Assessments**

The majority of elk herds in South Dakota occur within the Black Hills. The current Black Hills population objective (excluding Custer State Park and Wind Cave National Park) is 7,000 wintering elk, but may range from 6,000 to 8,000 depending on habitat conditions (SDGFP 2015). The current population objective for Custer State Park (CSP) is 800 wintering elk, with a range from 700-900 depending on habitat conditions. These goals were developed after thorough analyses of elk population data, available habitat resources on public land, private land depredation issues, and substantial input from a wide variety of publics with an interest in elk management in South Dakota.

The primary surveys and data assessments used to evaluate elk population abundance and trends in the Black Hills include the following: 1) hunting season evaluations (harvest surveys, harvest age structure), 2) herd composition surveys, 3) aerial sightability surveys, 4) survival monitoring, and 5) population modeling.

Survey data are lacking for most prairie units and elk densities are primarily managed to abate substantial agricultural damages on private property while at the same time to provide

recreational hunting opportunity. In 2018, however, an aerial sightability survey was conducted in Harding County in preparation for the inaugural hunting season of prairie elk management Unit 35 in 2018.

### **Hunting Season Evaluations**

Elk hunting licenses in South Dakota are limited in all management units and issued through a lottery draw system. For all elk hunting units and seasons (excluding CSP), up to 50% of elk licenses allocated in each management unit are available to those who qualify for landowner/operator preference. Based on current South Dakota Administrative Rules (ARSD), the 2017 hunting seasons in the Black Hills began with the archery season open September 1-30 (ARSD 41:06:43). The firearm season for “any elk” licenses ran Oct 1-31 (ARSD 41:06:26:01). Antlerless firearm hunting seasons were October 16-31, Dec 1-15, and/or Dec 16-31. Contingency licenses are made available for Black Hills units after the harvest seasons have been set if weather and range conditions necessitate a reduction to the grazing pressure on the landscape. Hunting seasons in CSP (ARSD 41:06:27, 41:06:28, 41:06:47, 41:06:48) are similar but may vary depending on Park objectives. Prairie elk hunting seasons (ARSD 41:06:59) vary and are a collaborative effort between SDGFP and private landowners to manage elk populations in agricultural settings.

There are currently eight elk management units in the Black Hills (Units H1, H2, H3, H4, H5, H7, H9, and CSP; Figure 1). Several of these units are further subdivided by area and season date for purposes of antlerless harvest management. In addition, there are currently four prairie elk management units open (Units 09, 11, 15, 27), one closed unit (Unit 30), and one new unit in 2018 (Unit 35).

Management objective directions (increase, maintain, or decrease) are set every two years when season recommendations are brought forward to the SDGFP commission (Figure 1). Elk management objectives for each management unit are based on elk population assessments, habitat conditions, and social considerations. Management objectives on the prairie can vary substantially between areas.

### **Harvest Surveys**

All elk hunters, regardless of hunting success or participation, are currently surveyed to assess overall harvest and hunter success. In addition, all successful hunters are required to check-in any harvested elk to a SDGFP representative within 24 hours (ARSD 41:06:04:19). Hunter survey cards are emailed and/or mailed to all elk license holders to obtain information on the number of hunting recreation days, gender 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.

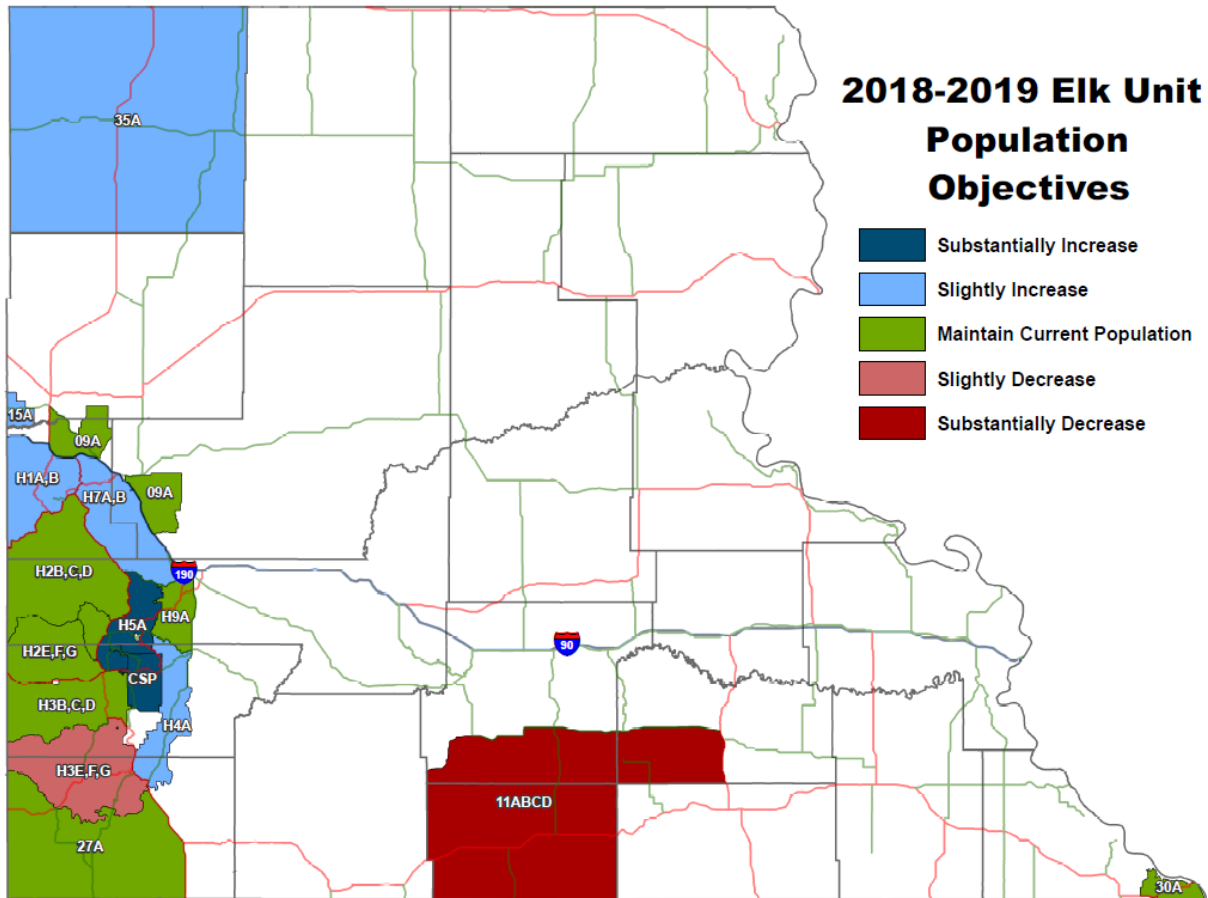


Figure 1. Population objective directions for elk units in South Dakota, 2018-2019.

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 estimating harvest statistics. The minimum acceptable response rate has been established at 85%. Confidence intervals are calculated to monitor precision and accuracy. Harvest information specific to each season, unit, and license type are published annually (Huxoll 2017).

Over the past 10 years, peak elk harvest rates occurred in 2016 and 2017 at 1,087 and 1,049, respectively (Figure 2). Significant increases in antlerless license types and subsequent cow harvest were obtained during these years to meet population management objectives (Figures 2 and 3). The availability of “any elk” license types has remained relatively stable since 2010 (Figure 3). From 2000 to 2017, the average number of “any elk” and antlerless elk licenses sold each year has been 678 and 893, respectively.

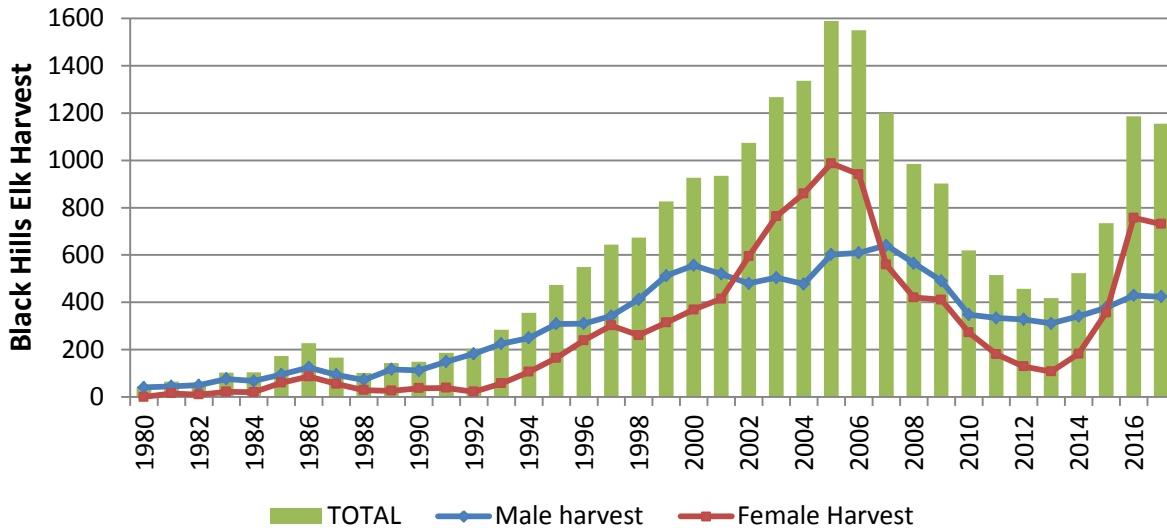


Figure 2. Harvest of elk from all hunting seasons in the Black Hills, 1980 – 2017.

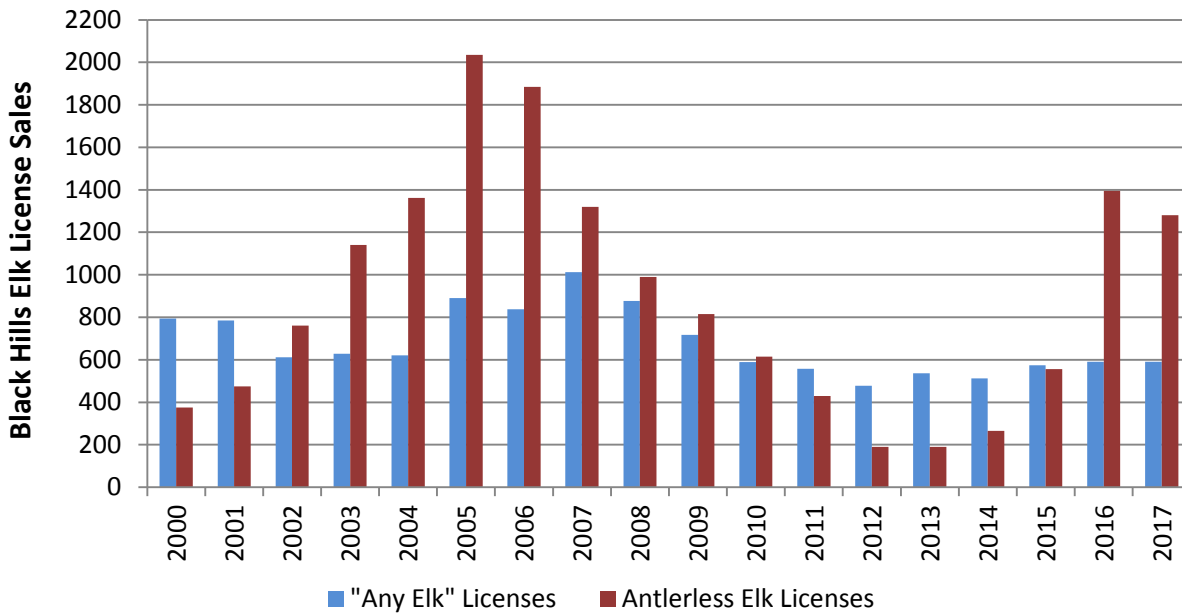


Figure 3. Total Black Hills elk license sales (firearm and archery) for antlerless and “any elk” license types, 2000-2017.

Public demand for firearm elk hunting licenses in the Black Hills is high, with over 12,000 hunters applying for approximately 1,500 licenses in 2017 (Table 1). Hunters spend an average of four to six days pursuing elk in the firearm season. Harvest rates vary across each hunting



unit, but Unit 2 has higher elk densities and elk harvest rates than all other hunting units combined (Figure 4).

Firearm hunter success rates in the Black Hills have been 52-73% over that past 10 years. The Elk Management Plan Objective (SDGFP 2015; Objective 3, Strategy B) is to manage for a minimum of 60% hunter success for hunters with an “any elk” Black Hills and CSP firearm license type. Firearm hunters with “any elk” licenses experienced success rates of 78% in 2017, thus meeting and exceeding the minimum thresholds established in the Elk Management Plan. Harvest success can vary substantially between years and units, but firearm hunter success in the Black Hills has been increasing the past five years in most hunting units (Figure 5).

Table 1. Black Hills Firearm elk harvest, 2008-2017 (Huxoll 2017).

Year	# Apps 1 <sup>st</sup> Choice	Licenses Sold	Bulls Harvest	Cows Harvest	Total Harvest	Success Rate	Avg. Days Hunted	Average Satisfaction
2008	13,083	1,675	473	390	863	52%	6.57	4.62
2009	12,915	1,366	404	379	783	57%	6.38	4.7
2010	12,197	1,059	300	260	560	53%	6.64	4.47
2011	11,031	866	299	173	472	55%	6.8	4.64
2012	9,665	570	291	125	416	73%	6.37	5.3
2013	11,274	620	272	103	374	60%	6.63	4.65
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	5.5

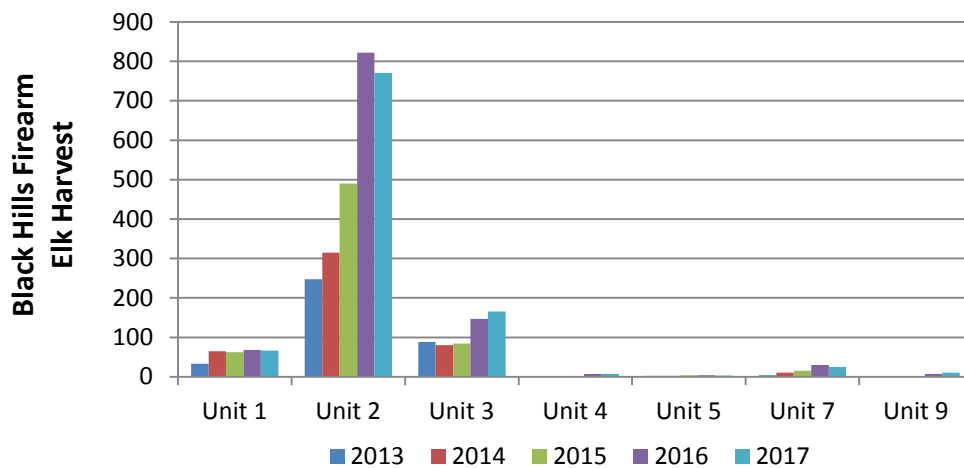


Figure 4. Black Hills firearm elk harvest for each elk hunting unit, 2013-2017.

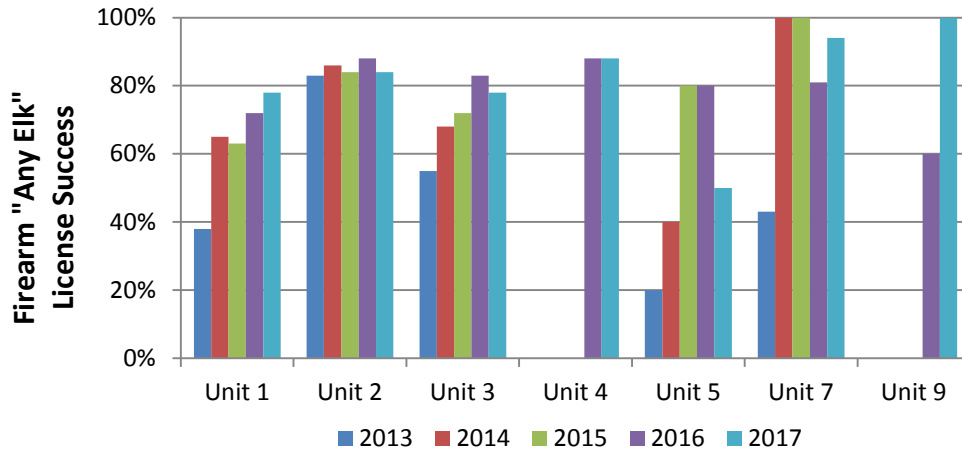


Figure 5. Black Hills firearm “any elk” license harvest success for each elk hunting unit, 2013-2017.

Nearly 4,900 hunters applied for 269 Black Hills Archery Elk licenses in 2017 (Table 2). Overall archery success rates have declined from a recent high of 40% in 2014 to 26% in the 2017 season. This decrease is reflective of a substantial increase of archery antlerless licenses available following the adoption of the South Dakota Elk Management Plan in 2015 and subsequent guidelines on elk license allocations. Over that past 10 years, harvest success of archery hunters with antlerless licenses averaged 15%, whereas success of hunters with “any elk” licenses averaged 39%. Cow harvest for the past two years has been over 40% of the total harvest, which is significantly higher than the years prior to 2016 when the cow harvest rate averaged 18% of the total harvest (Table 2). The Black Hills Unit 2 maintains the highest numbers of elk, ultimately producing higher archery harvest rates in this unit compared to all other Black Hills elk units combined (Figure 6).

Table 2. Archery elk harvest in the Black Hills, 2008-2017 (Huxoll 2017).

Year	# Apps 1 <sup>st</sup> Choice	Licenses Sold	Bull Harvest	Cow Harvest	Total Harvest	Success	Avg. Days Hunted	Average Satisfaction
2008	3,660	202	47	9	56	28%	10.87	5.31
2009	3,826	185	52	9	61	33%	10.29	5.52
2010	3,761	144	34	6	40	28%	11.88	5.16
2011	3,486	126	24	8	32	25%	11.42	5.01
2012	3,228	97	33	4	38	39%	11.94	5.34
2013	3,952	107	33	3	36	34%	11.97	5.59
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	5.4
2017	4,892	269	50	20	70	26%	11.29	5.6

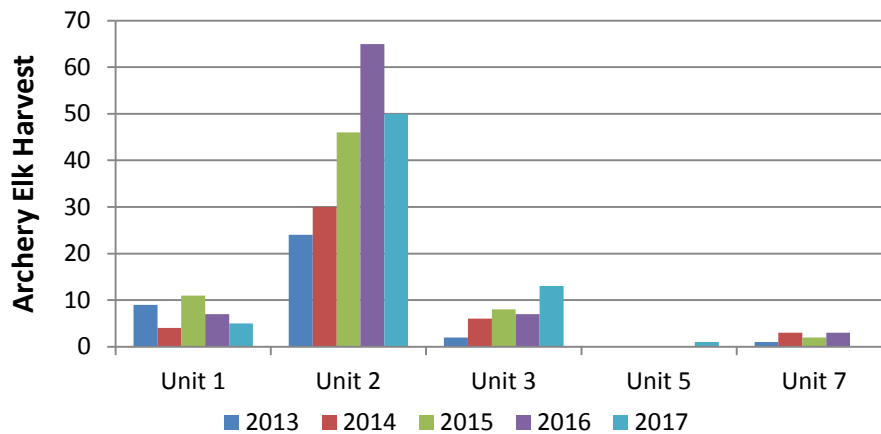


Figure 6. Black Hills Archery elk harvest, 2013-2017.

The 2017 elk season in Custer State Park began with the CSP archery season which was open September 1-30 (ARSD 41:06:28). The “any elk” CSP firearm season was open September 16 – October 1 (ARSD 41:06:27). The antlerless CSP firearm season was open October 7-15 for unit CU1, October 21-29 for unit CU2, and December 2-10 for Unit CU3 (ARSD 41:06:27). There were an additional three antlerless seasons with 10 licenses each scheduled for December of 2017 and January of 2018 in the southern portion of the Park, but these were canceled due to a fire that burned significant portions of the Park. In 2017, CSP hunters with an “any elk” firearm license averaged 88% success for the nine licenses issued, while CSP archery license holders averaged 33% success for the three licenses issued (Table 3).

Table 3. Elk harvest in Custer State Park, 2015-2017 (Huxoll 2017).

Hunting Season	Year	Applications	Licenses	Bull Harvest	Cow Harvest	Success	Avg. Days Hunted	Average Satisfaction
Archery	2015	3600	4	3	0	75%	16.3	6.5
	2016	3707	3	1	0	33%	15	6
	2017	3704	3	1	0	33%	9.7	5.7
Firearm "Any Elk"	2015	9136	8	8	0	100%	1.9	6.88
	2016	8958	9	8	0	89%	2.8	6.56
	2017	8828	9	8	0	88%	2.3	6.71
Firearm Antlerless Elk	2011-15	Closed	-	-	-	-	-	-
	2016	3138	20	0	18	90%	2.2	6.2
	2017	3436	29	1	24	86%	2.1	5.83

The Prairie Elk season dates vary based on the movement of elk and the management objectives within each unit, but start as early as July and some contain a late season in December (ARSD 41:06:49). In 2016 and 2017 there was an increase in the number of licenses sold (the majority of the increase reflects an increase in antlerless licenses in Units 09A and 11D), therefore increasing the total harvest. Overall success rates have remained relatively consistent through the years (Table 4).

Table 4. Prairie Firearm Elk harvest, 2008-2017 (Huxoll 2017).

Year	Licenses Sold	Bull Harvest	Cow Harvest	Total Harvest	Success	Avg. Days Hunted	Average Satisfaction
2008	76	18	17	35	46%	7.46	4.29
2009	133	29	22	51	38%	5.31	4.17
2010	134	24	27	51	38%	3.92	4.00
2011	128	20	15	35	27%	4.03	4.02
2012	97	26	20	46	47%	5.22	4.72
2013	96	18	13	30	32%	4.81	4.15
2014	92	33	25	59	64%	3.73	5.31
2015	98	29	25	54	55%	4.59	5.34
2016	148	32	27	60	40%	4.76	4.68
2017	149	41	34	75	50%	6.43	4.81

### Harvest Age Structure

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 bottom 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.

The South Dakota Elk Management Plan (SDGFP 2015; Objective 3, Strategy C) establishes a harvest age threshold as follows: “manage combined Black Hills elk management units for an average minimum bull harvest age structure of 30% bulls 4+ years or older, and manage CSP for a minimum of 60% bulls 4+ or older”. In 2017, 1,104 usable teeth were returned from hunters. Of the 359 Black Hills firearm and archery bull teeth visually inspected, 32% were assessed to be 4+ years of age or older (Figure 7). Further assessment by analyses of cementum annuli increased this percentage substantially; therefore regardless of method, the minimum thresholds identified in the Elk Management Plan were met. Discrepancies between methods of tooth aging will be cause for further evaluation of this objective and process in future years. In CSP, 100% of bull elk were aged as 4+ years or older based on cementum annuli analyses. Elk harvest ages in the Black Hills have been very similar the past three years (Figure 7). The 20-year average for Black Hills unit bulls harvested in the firearms and archery seasons combined is 4% calves, 8% yearlings, 55% 2-3 year olds, and 34% 4+ year olds.

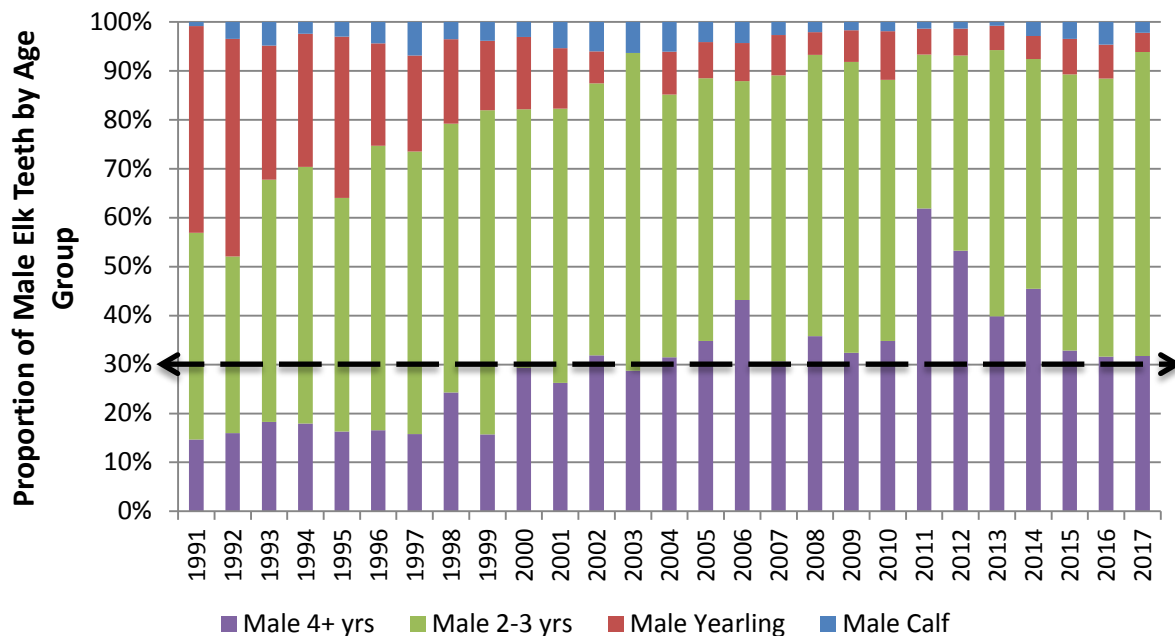


Figure 7. Age distribution of hunter harvested bull elk in the firearm and archery seasons within the Black Hills (excluding CSP), 1991-2017. The 30% minimum threshold for bull harvest in the 4+ age category is identified by the horizontal line.

## CWD Testing of Harvested Elk

The first documentation of Chronic Wasting Disease (CWD) in free-roaming wildlife in South Dakota was in 2001 in a white-tailed deer in Fall River County. The first free-roaming elk that tested positive for CWD was found in 2002 within Wind Cave National Park (WICA). Since 2002, CWD has been found in a total of 188 elk from a sampling effort of over 7,000 elk in and around the Black Hills (126 CWD positive elk were collected from within WICA). A voluntary testing program is in place for hunters to submit samples from harvested elk and receive CWD test results. In the past two years, just over 1,000 elk have been tested with 69 returning positive for CWD (49 positive CWD results are from WICA). The locations of these CWD positive elk are focused in and around WICA, but have recently expanded into the Jasper Burn area near Jewel Cave (Figure 8). Recent research conducted in Colorado suggests that in areas of high CWD prevalence, CWD can reduce survival rates of cow elk and decrease elk population growth (Monello et al. 2014). The long-term impacts of CWD on elk populations in South Dakota are concerning but remain largely unknown.

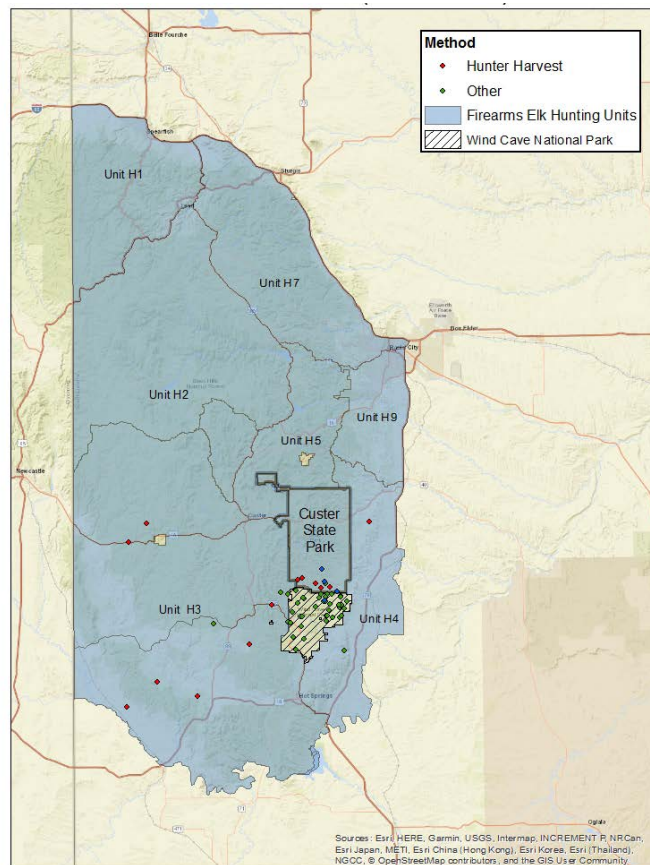


Figure 8. Map of CWD positive elk collected from hunter harvest or other collection methods, 2017-2018.

## 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. Spatial and temporal data are also recorded for each observation in order 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. From 2011 to 2016, SDGFP staff collected adequate samples in both months in order to evaluate monthly impacts on ratio datasets. Upon conclusion of data collection and analyses, the survey protocol was changed to be exclusively in August in order to minimize monthly variability and avoid interference with archery hunting seasons. Evaluations of bull ratios suggested that bulls were less observable in August than September surveys, and on average 5 bulls:100 cows less were counted. Therefore, a model correction factor of 5 bulls:100 cows is used to adjust current Black Hills August counts.

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 (Simpson 2015).

In 2017, 1,511 elk were classified throughout the Black Hills and 367 in CSP during the fall herd composition survey. Age and sex ratios, along with binomial (95%) confidence intervals were calculated for each Black Hills and CSP statistic. Herd composition in the Black Hills was 26 bulls:100 cows (95% CI: 23-29) and 46 calves:100 cows (95% CI: 43-49, Figures 9 and 10). The long-term 15-year bull ratio is 27 bulls:100 cows, while the 3-year average (2015-17) that is used in modeling predictions of future populations is 25 bulls:100 cows. The long-term 15-year fall recruitment average is 49 calves:100 cows, while the 3-year average is 47 calves:100 cows. In CSP, herd composition was 58 calves:100 cows (95% CI: 46-72) and 26 bulls:100 cows (95% CI: 19-35) in 2017 (Figures 9 and 10).

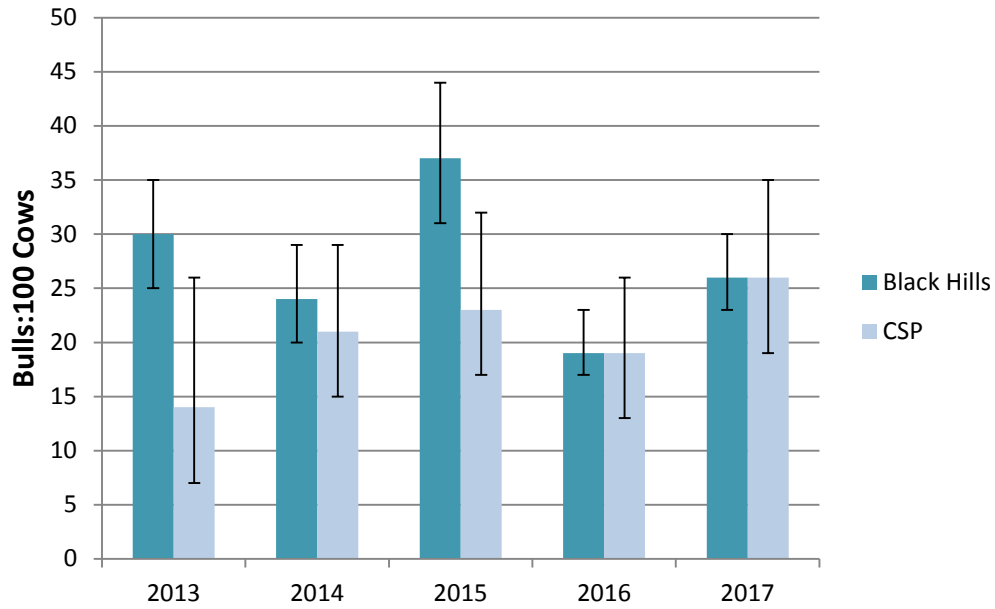


Figure 9. Fall sex ratios of elk (with 95% error bars) in the Black Hills and CSP, 2013-2017.

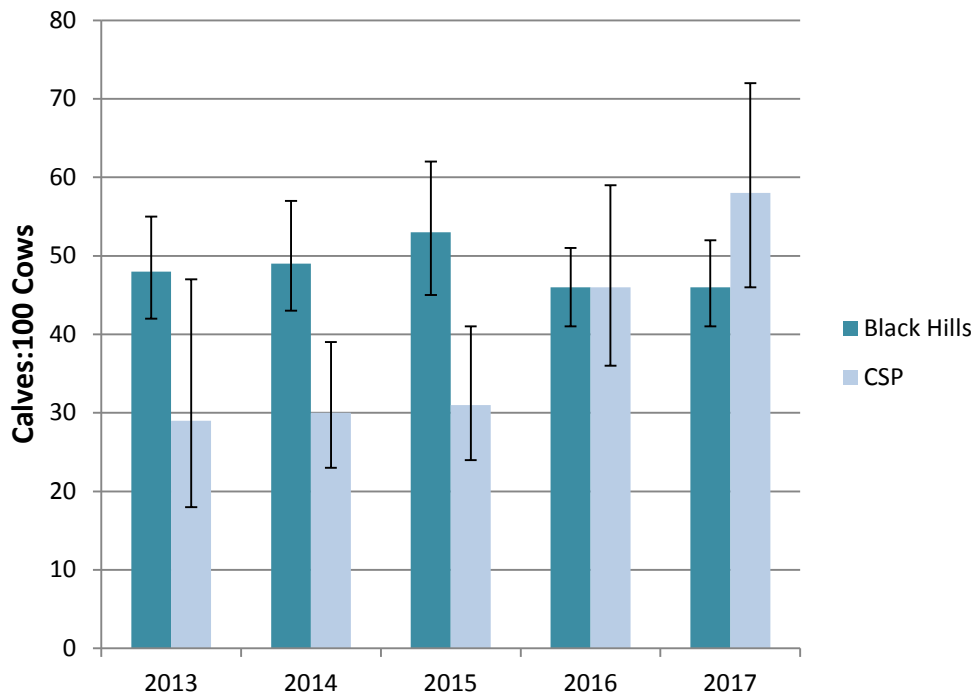


Figure 10. Fall age ratios of elk (with 95% error bars) in the Black Hills and CSP, 2013-2017.



## Survival Monitoring

Obtaining knowledge of calf and adult elk survival rates is critical to understanding population dynamics and trends of elk in the Black Hills. Annual rates of change within an elk population are influenced primarily by adult survival and the number of calves that reach one year of age. Previous data from elk research conducted in the Black Hills (Simpson 2015) are used to estimate annual calf survival (0.75, 95% CI = 0.56-0.84), while increased efforts to obtain statistically and biologically valid survival estimates of adult cows in the Black Hills have been occurring since 2015. Currently, SDGFP maintains a sample of at least 100 radio collared adult cow elk in the Black Hills. As of March 2018, there were 118 cows being monitored approximately once monthly to assess annual survival rates and harvest mortality. Additional adult cow elk will be captured and collared annually to maintain adequate sample sizes.

Within the Black Hills, adult cows are captured via helicopter dart gunning and chemically immobilized using a combination of butorphanol, azaperone, and medetomidine (BAM; ZooPharm, Laramie, WY). Immobilized animals are fitted with a VHF radio collar, and blood sampled to evaluate pregnancy status during the winter months. Pregnancy rates of captured cow elk have been 83% and 77% in January of 2016 and 2017, respectively. In addition, cow elk blood samples were tested for brucellosis in 2018 and all test results were negative.

Monitoring for a live/dead signal occurs within 12-16 days post-capture and all mortalities (<16 days post capture) are labeled as capture-related mortalities, with the exception of vehicle mortalities. Monitoring then occurs one time each month between the 1<sup>st</sup> -15<sup>th</sup> for each collared individual. All mortalities are investigated to verify death of the animal via physical evidence. In most cases, cause-specific mortality is not identifiable with the exception of vehicle collisions and hunter harvest. Hunter harvest is a very important metric used in population modeling and collar reporting by hunters is a vital step in obtaining the most accurate and precise data possible. The annual survival rate of adult cows in the Black Hills for 2015, 2016, and 2017 was 87% (SE = 0.04), 77% (SE = 0.04) and 70% (SE = 0.04), respectively, and includes harvest and non-harvest related mortality events. Survival rates are calculated using a staggered-entry known fate analysis. Annual survival and harvest rates are then used in a spreadsheet population model, resulting in abundance estimates and an annual rate of change of the population. Population models are heavily data driven and reliable abundance and trend estimates require statistically valid survival estimates.

## Aerial Sightability Surveys

In 2009, efforts began to develop an elk aerial sightability model specific to the Black Hills of South Dakota (Jarding 2010, Phillips 2011, SDGFP unpublished). The resulting model estimated elk sightability as  $\mu = 0.1446 - 0.0361(\% \text{ visual obstruction}) + 0.1001(\text{group size}) + 0.0158(\% \text{ snow cover})$  and is currently used to correct for elk missed during the aerial survey work in the Black Hills.

Aerial surveys of the entire Black Hills have been completed in 2013 and 2016. In 2016, elk surveys within the Black Hills were conducted February 1 – February 22 and were flown using three R-44 helicopters, each carrying two observers and a pilot. A total of 195 survey hours were flown in South Dakota. The Black Hills (including WICA and CSP) was divided into 253 subunits and 100% of these subunits were flown (Figure 11). 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 sampling, 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 12).

A total of 6,356 elk were counted in 2016 in the Black Hills hunting units excluding CSP and WICA National Park (Figure 11). The Program R “sightability model package” was used to formulate the corrected population estimate and 95% confidence interval using the Wong variance estimator. The 2016 sightability model winter estimate of elk in the Black Hills (excluding CSP and WICA) was 7,185 (95% CI: 6,692 – 9,068) elk.

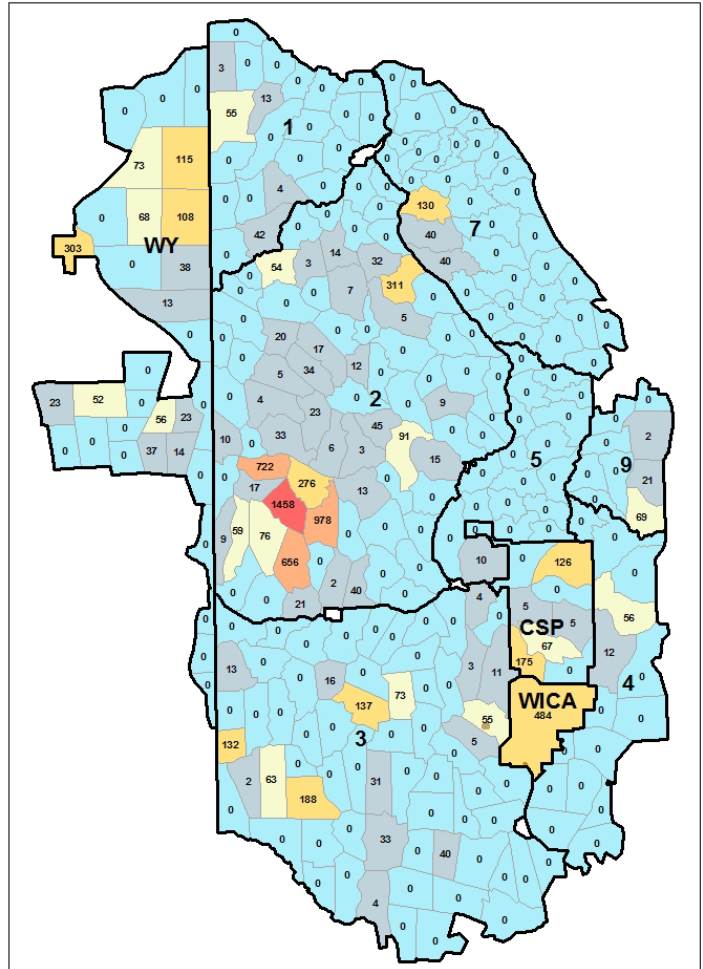


Figure 11. Aerial sightability subunits and raw count data, 2016.



Figure 12. Photo of elk herd during aerial sightability survey, 2016.

Within CSP, 378 elk were counted and the model adjusted 2016 estimate was 455 (95% CI: 404 – 733). Crews counted 484 elk in WICA, with a model adjusted estimate of 699 (95% CI: 566 – 1,269) elk.

Aerial surveys provide great information on the wintering distribution of elk in the Black Hills (Figure 11). The Black Hills population objective (excluding CSP and WICA) is 7,000 wintering elk, ranging from 6,000 to 8,000 depending on habitat conditions (SDGFP 2015). Assessing elk unit densities during the fall hunting seasons is accomplished by distributing the Black Hills winter estimate into each elk unit using previous years' average harvest proportions. 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.

Future aerial surveys will be conducted again at the 100% coverage level. Because of time and expenses required to accomplish this task, however, complete aerial surveys will only be conducted every three to four years (SDGFP 2015). The next survey of the Black Hills will be in Jan-Feb of 2020. Population estimates from aerial surveys will be compared with modeled population projections to validate modeling efforts in years without surveys.

A sightability survey was conducted in January 2018 in Harding County covering 100% of the primary elk habitat (Figure 13). A total of 43 elk were counted and the Program R "sightability model package" was used to formulate the corrected population and 95% confidence interval using the Wong variance estimator. The 2017 sightability model winter estimate of elk in Harding County was 52 (95% CI: 45 – 125) elk. A few small herds of elk were observed and reported by the public during the survey period, but outside of the designated survey area. SDGFP acknowledges that some areas with elk were likely not surveyed and additional elk occur in this prairie unit. Prairie Unit 35A was established by the SDGFP commission in 2018 and the inaugural season will be held in the fall of 2018.

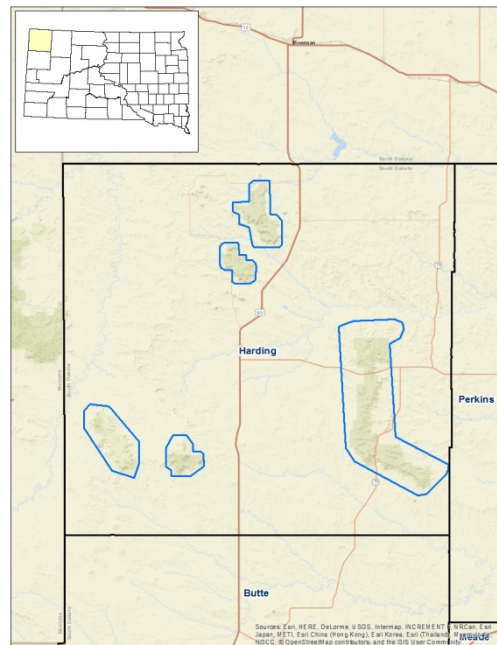


Figure 13. Harding County map of elk sightability survey, 2017.

## Population Modeling

Aerial sightability surveys of elk in the Black Hills are not conducted on an annual basis; therefore population abundance and rate of change estimates are modeled during years when aerial estimates are not available. Aerial surveys in 2016 provided data to estimate the total population size of elk wintering in the Black Hills ( $N = 7,185$ , 95% CI = 6,692 – 9,068; excludes Custer State Park and Wind Cave National Park), and the approximate distribution of winter elk herds. Population projections are used to estimate current population levels and are formulated using a spreadsheet model incorporating 3-year pooled fall herd composition ratios (2015-2017), survival, and hunter harvest estimates. The average fall age and sex ratio data obtained in 2015-17 estimated a 47 calf:100 cow recruitment ratio and a 25 bull:100 cow sex ratio. A conservative overwinter calf survival (80%, SE = 0.05) is used to adjust the estimated number of calves that are recruited into the population between October and May. Annual survival estimates for adults are quantified separately between sexes (2017 females = 70%, SE = 0.05; males = 60%, SE = 0.08), and those estimates are calculated from current or previous radio-collared elk in the Black Hills. Confidence intervals for the Black Hills hunting unit population estimate are developed using Markov Chain Monte Carlo (MCMC) simulation methods in Program R, incorporating standard errors for all input variables. To predict how different tag recommendations may impact growth rates, change in harvest is assumed to be additive, and the potential number of animals removed from the population was derived from the previous 5-year average success rate for each tag type.

Future aerial surveys of elk in CSP will be completed in conjunction with surveys of the entire Black Hills, therefore population and rate of change estimates are modeled during years when aerial estimates are not available. Aerial surveys in 2016 provided data to estimate the total population size of 455 elk in CSP (95% CI: 404 – 733). The aerial survey abundance data are used to estimate population status through time using a Lefkovitch matrix projection model in Program R. 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 were used to estimate future abundance. Confidence intervals for annual abundance estimates are developed using Monte Carlo simulation methods in Program R, which fully accounts for uncertainty in all input variables. To predict how different tag recommendations may impact growth rates, change in harvest is assumed to be additive, and various harvest simulations are conducted to ensure CSP is maintaining the elk population objective.

## SUMMARY

The South Dakota Game, Fish, and Parks conducts several surveys and assessments to better understand elk population abundance and trends in the Black Hills. SDGFP establishes hunting unit objectives to manage elk densities towards the overall population objective of 6,000 to 8,000 wintering elk in the Black Hills and 700 to 900 wintering elk in Custer State Park, all dependent upon habitat conditions (SDGFP 2015). Surveys are completed annually or periodically to assess harvest, herd composition, reproduction, survival, and abundance.

Hunter surveys and mandatory elk check-ins are conducted annually to estimate harvest, hunter success and satisfaction, and harvested elk age structure. Minimum harvest success thresholds for hunters with “any elk” licenses in the Black Hills and CSP were established in the South Dakota Elk Management Plan (SDGFP 2015); both success thresholds are being met and exceeded. In addition, minimum harvest age thresholds established in the Elk Management Plan were also exceeded the past few years.

Annual herd composition surveys provide critical information on fall recruitment and bull to cow ratios of the elk herd. Over the past three years, calf-to-cow and bull-to-cow ratios in the Black Hills have averaged 47 calves:100 cows and 25 bulls:100 cows, respectively. Annual capture and radio-collaring efforts provide an opportunity to gather important data on pregnancy rates; monitoring of radio collared adult cow elk survival provides insights on the impacts of antlerless harvest rates and population trends. Annual cow survival rates have been presumably impacted by recent increases in antlerless licenses, decreasing from 87% in 2015 to 70% in 2017.

Sightability surveys are completed every three to four years and provide periodic abundance estimates of wintering elk herds, and important “anchor points” to population models. Aerial surveys completed in the winter of 2015/2016 resulted in an elk estimate of approximately 7,200 in the Black Hills and 450 in CSP. Population models projected the Black Hills elk population to remain stable for the winter of 2016/2017, and decrease to approximately 6,900 in the winter of 2017/2018. Assuming future elk population demographics are similar to current observations, elk abundance is projected to remain relatively stable at current harvest rates.

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