SOUTH DAKOTA BIGHORN SHEEP MANAGEMENT PLAN, 2018–2027

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

WILDLIFE DIVISION REPORT 2018–02

JULY 2018

This document is for general, strategic guidance for the South Dakota Department of Game, Fish and Parks (SDGFP) and serves to identify what we strive to accomplish related to bighorn sheep management. By itself this document is of little value; the value is in its implementation. This process will emphasize working cooperatively with interested publics in both the planning process and the regular program activities related to bighorn sheep management. This plan will be used by Department staff and Commission on an annual basis and will be formally evaluated at least every ten years. Plan updates and changes, however, may occur more frequently as needed.

ACKNOWLEDGEMENTS

This plan is a product of substantial discussion and input from many wildlife professionals and the South Dakota public sector. In addition, those comments and suggestions received from private landowners, hunters, and those who recognize the value of bighorn sheep and their associated habitats were also considered.

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All text and data contained within this document are subject to revision for corrections, updates, and data analyses.

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LIST OF ACRONYMS

ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
BGNG	Buffalo Gap National Grasslands
BHNF	Black Hills National Forest
BLM	Bureau of Land Management
CSP	Custer State Park
M	Meter
MOU	Memorandum of Understanding
M. ovi	*Mycoplasma ovipneumoniae*
NPS	National Park Service
OSPRA	Oglala Sioux Parks and Recreation Authority
SDGFP	South Dakota Department of Game, Fish and Parks
SDSU	South Dakota State University
USFS	United States Forest Service
WAFWA	Western Associate of Fish and Wildlife Agencies
WSWG	Wild Sheep Working Group
YDS	Yards

EXECUTIVE SUMMARY

Mountain sheep, also known as bighorn sheep in some geographic areas, embody wildness as they are legendary in their ability to negotiate precipitous terrain and survive in some of the most desolate areas of North America. Bighorn sheep were numerous on the prairies of western South Dakota and the Black Hills before their extirpation in the late 1890s. United States Senator Peter Norbeck orchestrated their reintroduction in the early 1920s and this began a conservation success story where bighorns once again occupied their native habitats.

This management plan provides important historical background and relevant biological information for the sustainable management of bighorn sheep. Current bighorn sheep survey methodology and relevant biological literature are presented, along with a thorough discussion of objectives and strategies to guide management of this important resource into the future. This plan is intended to guide managers and biologists over the next ten years, but should be considered a working document that will be amended as new biological and social data provide opportunities to improve management of bighorn sheep resources in South Dakota.

Unfortunately since their successful reintroduction in the early 1920s, bighorn populations have fluctuated greatly over time in western South Dakota. Respiratory disease largely caused by bacteria remains the most prominent factor impacting bighorn sheep restoration in North America. Several herds have been decimated by pneumonia die-offs and trapping and translocation efforts have either restored or helped maintain bighorn populations in South Dakota. Disease research and advancements in methodologies may provide important tools for managers to maintain healthy populations of this species into the future.

For the management of bighorn sheep the following objectives have been identified: 1) management and monitoring of disease pathogens in bighorn sheep herds across South Dakota; 2) annually determine status of bighorn sheep populations; 3) bi-annually review and formulate bighorn sheep management objectives; use harvest strategies to manage the population with the available resource; 4) maintain, manage, and protect existing bighorn sheep habitat and augment populations to either maintain or start new herds in vacant habitat in South Dakota; 5) continue to use science-based research, habitat inventories, and surveys to answer questions related to bighorn sheep ecology and public attitudes towards bighorn sheep management; and 6) the SDGFP will inform and educate the public on bighorn sheep ecology, management, research, and provide viewing opportunities.

The "*South Dakota Bighorn Sheep Management Plan, 2018-2027*" will serve as the guiding document for decision making and implementation of actions to ensure bighorn sheep populations and their habitats are managed appropriately. South Dakota Department of Game, Fish, and Parks (SDGFP) will work closely with United States Forest Service (USFS), National Park Service (NPS), private landowners, and sportsmen and women to overcome the challenges and take advantage of opportunities regarding the future management of bighorn sheep in South Dakota.

INTRODUCTION AND HISTORICAL BACKGROUND

Mountain sheep (*Ovis canadensis*) embody wildness as they are legendary in their ability to negotiate precipitous terrain and survive in some of the most desolate areas of North America. Their native range occurred from the alpine mountains of western Canada south to the lower desert elevations of the southwestern United States and northern Mexico (Figure 1). Bighorn sheep were likely common in the Black Hills and badlands of South Dakota before European settlement (Beecham et al. 2007). Prince Maximillian of Wied described seeing bighorns on the western prairies of the Dakotas. In 1833, Maximillian further reported the Hidatsas Indians, a Siouan or Crow tribe, went on a hunting expedition to the Black Hills and other mountainous regions and killed 100 or more in one hunting season (Witte and Gallagher 2012). Naturalist Ernest Thompson Seton estimated mountain sheep numbers in the contiguous United States at roughly two million before their decline (Seton 1929). In South Dakota, Seton noted that bighorn sheep were "practically cleared out of the Black Hills by about 1887, though a few lingered on till 1899 when the last one was killed" (Seton 1929).

After extirpation, the reintroduction of Rocky Mountain bighorn sheep (*O. c. canadensis*) began in the early 1900s with United States Senator Peter Norbeck. After helping to create Custer State Park (CSP), he orchestrated the restoration and reintroduction of many imperiled native species. In 1922, Peter Norbeck worked with Alberta Canada to obtain eight Rocky Mountain bighorns for release into CSP within the Black Hills (Table 1). This herd grew and maintained a population until their demise for unknown reasons in the late 1950s. Without bighorn sheep once again, South Dakota began a series of translocations in the 1960s to reintroduce bighorns in sheep habitat. Translocation efforts have continued as populations have fluctuated over time and the most recent efforts included bighorns from Alberta being released in the Deadwood area of the Black Hills, and from Badlands National Park to Custer State Park (Table 1).

North American mountain sheep belong to the order Artiodactyla, family Bovidae, and tribe Caprini; all true sheep belong to the *Ovis* genera of hoofed animals, or ungulates (Valdez and Krausman 1999). Physical characteristics and habitat preference separate mountain sheep into 3 primary groupings: 1) Moufloniforms with representatives such as the European mouflon (*O. musimom*), 2) Argaliforms with representatives such as the argali (*O. ammon*) from Central Asia, and the 3) Pachyceriforms which include North American Dall's (*O. dalli*), Stone's (*O. dalli stonei*), and bighorn sheep, as well as Siberian snow sheep (*O. nivicola*; Valdez and Krausman 1999). Thinhorn (Dall's and Stone's sheep) and bighorn are distinctively different phenotypically but this would not prevent interbreeding if their ranges overlapped (Geist 1971).

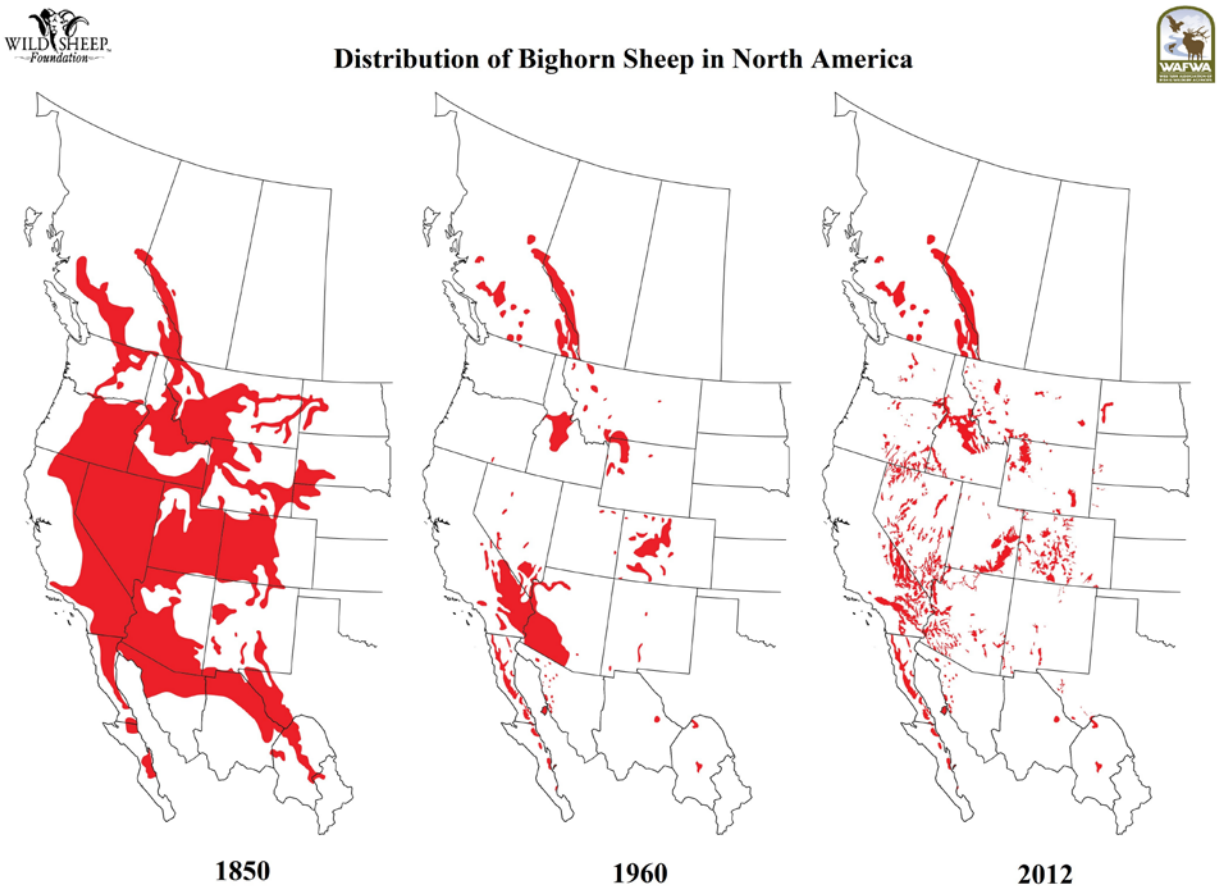

Figure 1. Distribution of bighorn sheep across North America and change in occupied habitats from 1850 through 2012. Map courtesy of the Western Association of Fish and Wildlife Agencies Wild Sheep Working Group 2014.

Table 1. History of bighorn sheep translocations in South Dakota, 1922-2018.

Year	Number Translocated	Capture Location	Release Location
1922	8	Alberta, Canada	Custer State Park, Black Hills, South Dakota
1961	12	Alberta, Canada	Slim Buttes, South Dakota
1964	22	Pikes Peak, Colorado	Badlands National Park, South Dakota
1965	22	Whiskey Mountain, Wyoming	Custer State Park, Black Hills, South Dakota
1974	26	Custer State Park, South Dakota	Colorado
1980	6	Custer State Park, South Dakota	Nebraska
1981	6	Custer State Park, South Dakota	Nebraska
1982	4	Custer State Park, South Dakota	Nebraska
1991	26	Georgetown, Colorado	Spring Creek Canyon, Black Hills, South Dakota
1992	5	Badlands National Park, South Dakota	Spring Creek Canyon, Black Hills, South Dakota
1999	20	Alberta, Canada	Custer State Park, Black Hills, South Dakota
2001	20	Spring Creek Canyon, Black Hills, South Dakota	Hell Canyon- Moved Over to Elk Mountain, Black Hills, South Dakota
2004	7	Wheeler Peak, New Mexico	Elk Mountain, Black Hills, South Dakota
2004	23	Wheeler Peak, New Mexico	Badlands National Park, South Dakota
2014	20	Rocky Boy Reservation, Montana	Hell Canyon, Black Hills, South Dakota
2014	20	Rocky Boy Reservation, Montana	Oglala Sioux Reservation, South Dakota
2015	26	Alberta, Canada	Deadwood, Black Hills, South Dakota
2018	12	Badlands National Park, South Dakota	Custer State Park, Black Hills, South Dakota
Totals	297		

DESCRIPTION, BEHAVIOR, AND VITAL RATES

Male and female bighorn sheep are distinctively different, particularly at older age classes. Males are larger in size and have much larger horns than females (Figure 2). As bighorns age the differences in weight between males and females is noticeable, as two year old males are typically 18% heavier and at six years old males can be as much as 65% heavier (Festa-Bianchet et al. 1996). Horns of bighorn sheep grow annually as keratin is deposited on bone horn-cores that are attached to frontal bones of the skull (Figure 2). The general pattern of horn growth is relatively consistent among mountain sheep populations and is independent of gender; however, individual growth can vary considerably due to genetics and environmental conditions (Valdez and Krausman 1999). Size of horns can vary considerably across the bighorn range, and in South Dakota there can be considerable differences in horn size between individuals from different areas (Figure 3). Geist (1971) hypothesized that greater annual horn growth occurs in high-quality or expanding populations that exhibit rapid population growth, early maturation, and high milk production compared to low-quality populations that are stable or declining.

Figure 2. Larger male bighorn on the left compared with smaller ewe on the right. Note the larger horns of the male compared to the female. Horns of bighorn sheep grow annually as keratin is deposited on bone horn-cores that are attached to frontal bones of the skull.

Figure 3. Comparison of horn size of mature ram from Badlands National Park on the prairie of western South Dakota with a ram from Custer State Park of the Black Hills, South Dakota. Both are similar in age and are impressive rams but the male from Badlands is considerably larger and is estimated to score nearly 40 points higher in the Boone and Crockett scoring system.

Bighorns reach puberty as early as 18 months of age (Woodgerd 1964, Geist 1971) but full sexual maturity is not reached until later (Valdez and Krausman 1999). In expanding populations ewes can breed at 1.5 years of age but most females do not produce young until they are 2.5–3 years of age. Males typically do not breed until they are much older than 2.5 years of age (Valdez and Krausman 1999); however, a 2.5 year old male was observed breeding ewes in a reintroduced population in the Hell Canyon area of the Black Hills, South Dakota (Chad Lehman, SDGFP, personal observation). This young male was the only ram in the area and the majority of ewes produced lambs the following spring (SDGFP, unpublished data).

Breeding typically peaks from mid-November to mid-December (Honess and Frost 1942, Wishart 1958, Geist 1971). Timing of the rut may vary according to latitude, and some Rocky Mountain and California bighorns can breed as early as October (Buechner 1960, Blood 1963). Before the rut commences males interact in order to determine dominance and fights between males occur in the form of horn clashes (Figure 4, Geist 1971, Shackleton 1973). Breeding usually occurs on ewe winter range (Blood 1963, Geist 1971), and observations in the Black Hills indicate males typically seek out and move to those areas during the rut (SDGFP, unpublished data). Pregnancy rates in bighorn populations are typically high (>90%; Hass 1989, Jorgenson 1992) and high rates have been documented in South Dakota (Parr 2015, SDGFP unpublished data). Gestation following breeding is usually 175-180 days and mountain sheep in northern ranges typically give birth in May and June (Geist 1971). Most ewes give birth to single young but twinning can occur (Buechner 1960).

Figure 4. Horn clash among 2 males in Custer State Park before the rut occurs from mid-November through mid-December.

Most parturition occurs in May for the Deadwood, Rapid City and CSP herds (Smith et al. 2014, SDGFP unpublished data). Young follow their mothers shortly after birth making them a "follower" species (Lent 1974). Lamb survival following parturition can vary considerably. Survival for the first year of life is typically lower and much more variable than adult survival, as is typical of ungulates (Gaillard et al. 2000). In South Dakota, lamb survival for the Elk Mountain herd was 0.45 (SE=0.09) at 26 weeks of age, whereas annual survival for the Rapid City herd was 0.02 (95% CI = 0.01–0.07; Smith et al. 2014). Pneumonia was the primary cause of mortality for lambs in the Rapid City herd whereas predation was the primary known cause of mortality in the Elk Mountain herd (Smith et al. 2014, Parr 2015). *Mycoplasma ovipneumoniae* (*M. ovi.* hereafter) is hypothesized as a bacteria pathogen leading to subsequent pneumonia and death in bighorn sheep. Following severe epidemics, surviving ewes continue to produce lambs but lamb survival can remain poor due to peak mortality caused by pneumonia from 6–11 weeks of age (Woodard et al. 1974, Cassirer et al. 2001, Cassirer and Sinclair 2007, Smith et al. 2014). Pneumonia death can continue to persist in lambs several years after the initial outbreak and can contribute to greater than 90% annual mortality in lambs (Cassirer et al. 2013, Smith et al. 2014).

Annual survival of adult ewes was 0.81 (95% CI 5 0.72–0.87) for the Rapid City herd (Smith et al. 2015), similar to annual survival of adult ewes in the Elk Mountain herd (0.88, SE = 0.05; Parr 2015). Annual ram survival was 0.85 (SE = 0.10) for the Elk Mountain herd (Parr 2015). Predation and pneumonia are the primary causes of mortality for adults depending upon the herd in the Black Hills (Parr 2015, Smith et al. 2015). Data pertaining to survival of yearlings is minimal, but it appears to be similar to older age classes (SDGFP, unpublished data).

Bighorn sheep management is typically focused on harvest of males and may include restrictions that horns meet a minimum size requirement (Hebert and Evans 1991, Hengeveld and Festa-Bianchet 2011). However, harvest of ewes up to 12% can be implemented to slow or stabilize population growth in populations with low probabilities of pneumonia die-offs (Jorgenson et al. 1993). Harvest of ewes may have the ability to increase horn size in males at younger ages in some populations (Jorgenson et al. 1993). It was hypothesized that ewe removals likely lowered competition in nursery herds, allowing young rams to grow faster during their first 2 years of life; further, less competition for resources was more pronounced among 4 year olds than among 5 year olds (Jorgenson et al. 1993). Most harvest management decisions take into account the following items (as suggested by the Western Association of Fish and Wildlife Agencies [WAFWA] Wild Sheep Working Group [WSWG] 2014): 1) population size and trend, 2) lamb recruitment (lamb:ewe ratios), 3) some index to the number or availability of rams in the population (ram:ewe ratios, the number of mature rams estimated or seen during surveys, average age of harvested rams), and 4) trends in hunter success or hunter effort, or both, from recent hunting seasons.

For the management of bighorn sheep it is recommended to close a season when <75 sheep are observed during surveys for 3 consecutive survey periods (British Columbia Ministry of Forests, Lands, and Natural Resource Operations, Policies and Procedures, 2017). Further, it is recommended opening a season on bighorn sheep when 3 criteria are met: 1) ≥75 sheep are observed during surveys for 3 consecutive survey periods, 2) observe a ram:ewe ratio of ≥30 rams/100 ewes for 3 consecutive surveys, and 3) observe a lamb:ewe ratio of ≥30 lambs/100 ewes for 3 consecutive surveys (Montana Game, Fish, and Parks 2010, British Columbia Ministry of Forests, Lands, and Natural Resource Operations, Policies and Procedures, 2017). Generally, ram harvest will be set at 10% of the available rams in a herd for management units in South Dakota. However, harvest could be set above 10% of the available rams in a herd during disease events or under additional special circumstances depending upon sex and age ratios and population size (Table 2).

Carrying capacity of South Dakota's bighorn ranges is currently unknown; however we can use the decision support table in Table 3 to guide management of ewes to reduce the probability of disease transmission and provide for higher quality habitat. Research evaluating ewe harvest suggests a harvest of 7% of the preseason population, 10% of the total winter population, or 12% of the summer population of ewes is needed to stabilize a herd under normal conditions (Jorgenson et al. 1993). It is assumed a harvest rate of 10% or more is needed to reduce the size of individual herds that are stable or growing. The basic premise behind the ewe harvest decision support table is to stabilize or decrease the number of ewes in herds where there is a high threat of disease transmission to other herds, or a threat to habitat degradation due to overpopulation. Translocation of excess ewes should always be considered prior to the implementation of harvest.

Table 2. Decision support table to guide harvest of bighorn rams in South Dakota.

Guiding Factors
[a]Ram harvest will occur when: 1) ≥75 sheep are observed during surveys for 3 consecutive survey periods, 2) observe a ram:ewe ratio of ≥30 rams/100 ewes is observed for 3 consecutive surveys, and 3) observe a lamb:ewe ratio of ≥30 lambs/100 ewes is observed for 3 consecutive surveys
⬇
Survey of available rams in population
⬇
Ram harvest will be set at 10% of the available rams in a herd. However, harvest could be set above 10% of the available rams in a herd during disease events or under additional special circumstances depending upon sex and age ratios and population size.

[a]General guidelines to follow in setting harvest; however, special circumstances may exist where seasons may be closed or opened where these requirements may not be met.

Table 3. Decision support table to guide harvest of bighorn ewes in South Dakota[1].

Guiding Factors	No Harvest	Maintenance Harvest	Reduction Harvest
Lamb to ewe ratio (three-year trend) of lambs >4 months of age	Decreasing, stable or increasing	Stable	Stable or increasing
Threat for disease transmission to other herds	Low to moderate	Moderate	Moderate to high
Three-year population trend	Decreasing, stable or increasing	Stable	Stable or increasing
Habitat degradation	Low	Moderate	High
Body condition	Moderate to good	Poor to good	Poor to good
Management action	⬇	⬇	⬇
Targeted harvest percent of adult ewe population	0%	5-9%	10-15%

[1]Translocation of excess ewes should always be considered prior to the implementation of harvest.

HABITAT SELECTION AND RANGE

Bighorn sheep live in a variety of habitats including open grasslands, alpine, subalpine, rock outcrops, cliffs, talus slopes, deciduous forests, and disturbed or undisturbed conifer forests (Blood 1961, Demarchi 1965, Pallister 1974, Van Dyke 1978, Risenhoover and Bailey 1985, Dale 1987). Bighorn sheep need resources that contain adequate amounts of forage, escape terrain, lambing and loafing areas, water, and movement corridors (Brewer et al. 2013). Bighorns are thought to need precipitous terrain, or steep rocky areas, especially for lambing and escape terrain (Blood 1961, Adams et al. 1982). Escape terrain has been described as any habitat such as cliffs and steep hillsides (Geist 1971). Typically bighorns stay within 875 yds (800 m) of escape terrain during the entire year (Pallister 1974). Bighorns can use a wide variety of habitats with varying slope, and in Oregon they used slopes ranging from 6–100% (Van Dyke 1978). In Hell Canyon area of South Dakota, sheep used slopes with an average of ~28% (Lehman et al. 2017).

Vegetation change due to overgrazing by domestic livestock or shrub invasion can make previously occupied bighorn sheep range unsuitable from the standpoint of forage quality and quantity (Risenhoover and Bailey 1985, Etchberger et al. 1989). Forage production and quality are factors that can regulate bighorn populations (Stelfox 1976). Ensuring adequate bighorn sheep habitat can be a significant challenge for managers, particularly in the Black Hills where ponderosa pine (*Pinus ponderosa*) can regenerate quickly leading to increased tree density and loss of open areas (Shepperd and Battaglia 2002, Battaglia et al. 2008). Specific habitat resources important to bighorn sheep typically include slopes >50%, close to escape terrain (350 yds [<320 m]), and minimal overstory canopy cover (<5%) or lack of dense tree vegetation (Geist 1971, Tilton and Willard 1982, McCarty and Bailey 1994, Sweanor et al. 1996, Johnson and Swift 2000). Bighorn sheep primarily forage on grasses and forbs, and quantifying the amount of herbaceous biomass at foraging sites is needed for subsequent monitoring (Chapman and Feldhamer 1982, Lehman et al. 2017). A foraging study of the Hell Canyon bighorn herd in the Black Hills found the availability of grasses and forbs was greater than for shrubs at foraging sites (Lehman et al. 2017). Further, at foraging sites, sheep selected for areas close to escape terrain and for open areas providing good visibility (Figure 5; Zimmerman 2008, Lehman et al. 2017).

Figure 5. Typical post-lambing habitat has open areas for increased visibility and availability of grasses and forbs for foraging but needs to be near escape terrain if needed to elude predators. Photo provided by Dennie Mann.

Diets of bighorn sheep are typically comprised of grasses, forbs, and shrubs but can vary markedly depending upon gender and geographic location (Valdez and Krausman 1999, Schroeder et al. 2010). Most bighorn sheep migrate seasonally over an altitudinal gradient (Geist 1971), which can influence their diet seasonally and geographically. Shrub availability at foraging sites was greater for some bighorn populations that exhibit altitudinal migrations (Risenhoover and Bailey 1985, Greene et al. 2012). Most bighorn herds in the Black Hills do not

exhibit spatial or altitudinal migrating behavior, which may explain why foraging availability of grasses and forbs was greater than for shrubs (Lehman et al. 2017). Regardless, bighorns have been described as eating a diversity of plant species as they seem to eat almost every plant available to them at one time or another (Ellis 1941).

The occupied range of bighorn sheep in South Dakota includes 6 distinct herds in 2017 (Figure 6). The easternmost herd occurs on the western prairies in and around Badlands National Park. On the eastern front range of the Black Hills there are 2 herds including the Rapid City and CSP herds. The furthest north is the Deadwood herd, and the Hell Canyon and Elk Mountain herds can be found in the western Black Hills (Figure 6). Bighorns may move between herds primarily through males moving during the rut trying to find ewes in new areas (Borg et al. 2017).

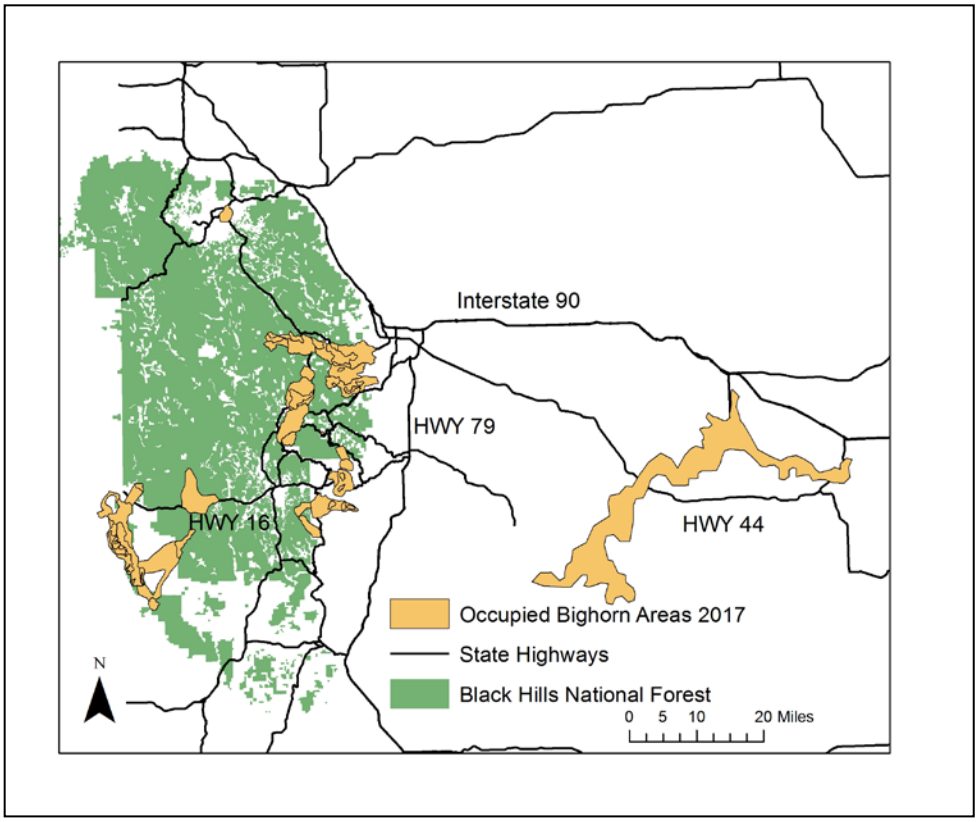

Figure 6. Bighorn sheep occupied habitats in South Dakota, 2017. Their primary range includes the Black Hills and Badlands areas of western South Dakota.

SURVEYS AND MONITORING – CURRENT STATUS

Bighorn sheep are surveyed using ground counts to obtain minimum counts, lamb:ewe ratios, ram:ewe ratios, and using radio-telemetry with mark-resight techniques to estimate population size. Bighorn sheep abundance estimates are generated for the Elk Mountain herd using Poisson log-normal mark-resight (Table 4). Ground counts are used to estimate the minimum number of sheep for herds in the Badlands and Black Hills (Table 5). Ratio data includes lamb:ewe and ram:ewe for each herd (Table 6). Bighorn sheep are classified as lambs, ewes, and rams using body form and horn size; rams are further classified into categories I, II, III, and

IV (Figure 7, Table 7). Ages provided in Figure 7 may not reflect what is observed in South Dakota due to genetic and size differences of wild sheep found in South Dakota.

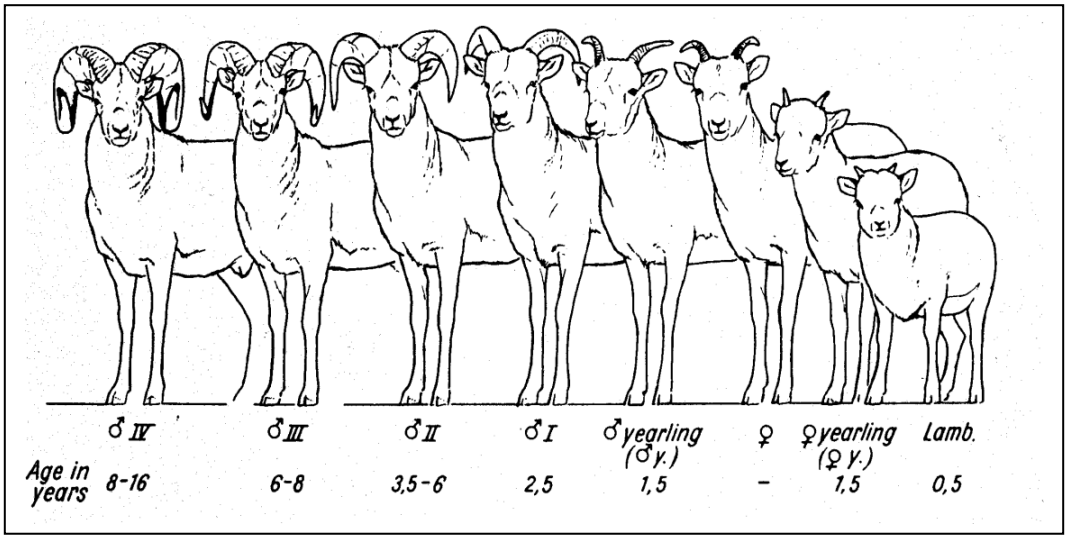

Figure 7. Bighorn sheep age and gender characteristics. Note that animals form a cline in body and horn size, and the adult female is very similar in external appearance to the yearling ram. The above drawing is taken from Geist 1968 and uses several physical characteristics in determining classification.

Table 4. Survey information estimating abundance using radio-marked bighorn sheep at Elk Mountain in the Black Hills, South Dakota, 2013-2017.

Year	Population Estimate	95% Confidence Interval	Method[a]
2013	104	75-144	Log-normal Mark-Resight
2014	111	71-180	Log-normal Mark-Resight
2015	158	78-327	Log-normal Mark-Resight
2016	159	81-312	Log-normal Mark-Resight
2017	134	69-262	Log-normal Mark-Resight

[a]A Poisson log-normal mark-resight estimator was used to estimate population size from radio-marked bighorn sheep.

Table 5. Survey data from ground counts in the Badlands and Black Hills, South Dakota, 2007-2017.

Year	Badlands	Custer State Park	Rapid City	Elk Mountain	Hell Canyon	Deadwood	Method[a]
2007	89	35	81	NA	NA	NA	Ground
2008	97	35	84	54	NA	NA	Ground
2009	67	37	100	52	NA	NA	Ground
2010	64	29	98	48	NA	NA	Ground
2011	86	26	72	75	NA	NA	Ground
2012	110	25	68	87	NA	NA	Ground
2013	85	26	65	70	20	NA	Ground
2014	85	25	56	57	25	NA	Ground
2015	151	25	55	46	47	26	Ground
2016	147	26	55	70	34	24	Ground
2017	191	29	45	67	41	18	Ground

[a]Ground counts represent the minimum number of sheep estimated for each population.

Table 6. Ratio data for bighorn sheep in the Badlands and Black Hills, South Dakota, 2007-2017.

Lamb:Ewe Ratios							
Year	Badlands	Custer State Park	Rapid City	Elk Mountain	Hell Canyon	Deadwood	Method[a]
2007	0.77	0.07	0.10	NA	NA	NA	Ground
2008	0.66	0.07	0.28	0.51	NA	NA	Ground
2009	0.48	0.06	0.32	0.42	NA	NA	Ground
2010	0.48	0.00	0.17	0.47	NA	NA	Ground
2011	0.48	0.00	0.06	0.60	NA	NA	Ground
2012	0.50	0.33	0.06	0.54	NA	NA	Ground
2013	0.47	0.50	0.14	0.63	0.27	NA	Ground
2014	0.47	0.28	0.19	0.22	0.75	NA	Ground
2015	0.44	0.21	0.11	0.63	0.44	0.81	Ground
2016	0.38	0.82	0.22	0.72	0.67	0.17	Ground
2017	0.39	0.25	0.21	1.10	0.45	0.06	Ground
Ram:Ewe Ratios							
Year	Badlands	Custer State Park	Rapid City	Elk Mountain	Hell Canyon	Deadwood	Method[a]
2007	0.46	0.53	0.78	NA	NA	NA	Ground
2008	0.34	0.53	0.54	0.03	NA	NA	Ground
2009	0.24	0.53	0.41	0.58	NA	NA	Ground
2010	1.09	0.43	0.29	1.35	NA	NA	Ground
2011	0.48	0.50	0.41	0.90	NA	NA	Ground
2012	0.44	0.50	0.38	0.81	NA	NA	Ground
2013	0.51	0.88	0.35	0.96	0.07	NA	Ground
2014	0.51	0.32	0.32	0.89	0.33	NA	Ground
2015	0.31	0.57	0.34	0.79	0.30	0.05	Ground
2016	0.31	0.55	0.31	1.08	1.17	0.17	Ground
2017	0.62	0.56	0.41	1.10	0.60	0.06	Ground

[a]Ground counts using the maximum number of ewes, lambs, and rams counted for the given year. Counts provide ratio data of sheep estimated for each population.

Table 7. Class III and IV rams observed during fall surveys in South Dakota, 2007-2017.

Numbers of Class III and Class IV rams observed during fall surveys				
Year	Rapid City	CSP	Elk Mountain	Hell Canyon
2007	23	7	NA	NA
2008	22	7	0	NA
2009	21	6	12	NA
2010	18	6	17	NA
2011	12	6	17	NA
2012	16	4	19	NA
2013	13	4	17	NA
2014	10	6	16	NA
2015	8	7	16	NA
2016	4	4	19	3
2017	4	5	23	7

BIGHORN SHEEP HUNTING – HISTORICAL HARVEST AND LICENSES

The first season for bighorn sheep since their reintroduction was held in 1979 in CSP with 4 licenses being offered (Table 8). The most licenses ever offered in a season was 6; since 2013, there has been 3 licenses offered to hunters each year. In 2016, the Black Hills population estimate was approximately 300, and a harvest of 3 males was 1.0% of the population. An auction license raising money for the bighorn sheep research and management program was made available in 2013. SDGFP administrative rule 41:06:56:03 states that one bighorn sheep license may be issued for sale by auction pursuant to the procedures established in § 41:06:56:11, valid for 1 ram. Revenue generated from the auction tag is used for management and research purposes (Table 9). The season dates as of 2018 occur from September 1– December 31 in 2 hunting units (Figure 8). In 2018, there were 2 hunting units open including BHS-BH2, which is Custer County west of Highway 79, excluding fenced portions of Custer State Park, Wind Cave National Park and Jewel Cave National Monument. The BHS-BH3 unit includes a portion of Pennington County east of the Cheyenne River and a portion of Jackson County north of the White River, excluding Badlands National Park. Hunters must attend an orientation which briefs hunters on information related to bighorn sheep biology, management, and hunting regulations before the season is initiated. A mandatory check of harvested bighorn sheep is required within 24 hours of harvest.

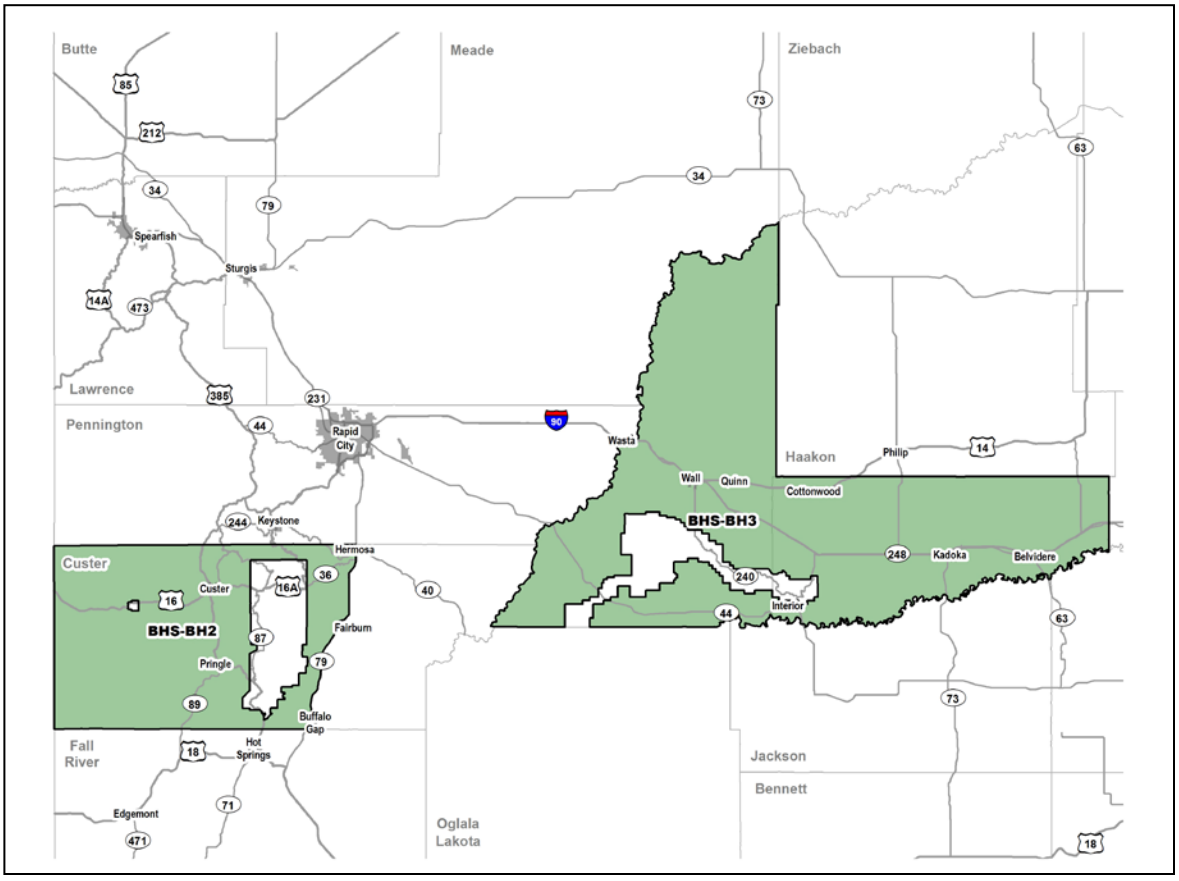

Figure 8. Bighorn Sheep Hunting Units Map (BHS-BH2- Custer County, and BHS-BH3-Badlands Area) for South Dakota in 2018.

Table 8. Historical harvest of bighorn sheep in the Black Hills, South Dakota, 1979-2017.

Year	Licenses Issued	Total Harvest	Male	Female	Unknown	Unit
1979	4	4	4	0	0	Custer State Park
1980	5	5	5	0	0	Custer State Park
1981	6	6	6	0	0	Custer State Park
1982	6	6	6	0	0	Custer State Park
1983	6	6	6	0	0	Custer State Park
1984	6	6	6	0	0	Custer State Park
1985	3	3	3	0	0	Custer State Park
1986	3	3	3	0	0	Custer State Park
1987	3	3	3	0	0	Custer State Park
1988	2	2	2	0	0	Custer State Park
1989	2	2	2	0	0	Custer State Park
1990	2	2	2	0	0	Custer State Park
1991	2	2	2	0	0	Custer State Park
1992	2	2	2	0	0	Custer State Park
1993	3	3	3	0	0	Custer State Park
1994	3	3	3	0	0	Custer State Park
1995	4	4	4	0	0	Custer State Park
1996	4	4	4	0	0	Custer State Park
1997	4	4	4	0	0	Custer State Park
1998	4	4	4	0	0	Custer State Park
1999	4	4	4	0	0	Custer State Park
2000	6	6	6	0	0	4- Custer State Park, 2- Rapid City Herd
2001	5	5	5	0	0	3- Custer State Park, 2- Rapid City Herd
2002	4	4	4	0	0	2- Custer State Park, 2- Rapid City Herd
2003	4	4	4	0	0	2- Custer State Park, 2- Rapid City Herd
2004	6	6	6	0	0	3- Custer State Park, 3- Rapid City Herd
2005	3	3	3	0	0	Rapid City Herd
2006	3	3	3	0	0	Rapid City Herd
2007	4	4	4	0	0	Rapid City Herd
2008	5	5	5	0	0	4- Rapid City, 1- Elk Mountain
2009	5	5	5	0	0	4-Rapid City, 1-Elk Mountain
2010	5	5	5	0	0	4-Rapid City, 1-Elk Mountain
2011	3	3	3	0	0	2-Rapid City, 1-Elk Mountain
2012	2	2	2	0	0	1-Rapid City, 1-Elk Mountain
2013	3	3	3	0	0	2-Rapid City, 1-Elk Mountain
2014	3	3	3	0	0	1-Rapid City, 2-Elk Mountain
2015	3	3	3	0	0	1-Rapid City, 2-Elk Mountain
2016	3	3	3	0	0	1-Rapid City, 2-Elk Mountain
2017	3	3	3	0	0	1-Rapid City, 2-Elk Mountain
Total	151	151	151	0	0	

Table 9. Expenditures of bighorn sheep auction tag revenue, 2013-2018.

2013		
4292 License	$102,000.00	Revenue from auction license
2014		
4292 License	$80,000.00	Revenue from auction license
5204 Contractual	-$20,212.71	SDSU disease research; Montana helicopter capture and transplant project
5205 Supplies	-$4,918.28	Radio collars and supplies for Montana capture and transplant project
2015		
4292 License	$78,000.00	Revenue from auction license
4599 Sale of Skull	$1,600.00	Revenue from sale of skull
5203 Travel	-$6,335.78	Travel costs to Alberta for sheep capture and transplant into Deadwood area
5204 Contractual	-$25,384.12	Disease lab fees, vet fees, consulting fees, etc. for Deadwood area transplan
5205 Supplies	-$93,139.20	Radio collars, lab supplies, misc. supplies for Deadwood area transplant
2016		
4292 License	$79,500.00	Revenue from auction license
4599 Sale of Skull	$12,250.00	Revenue from sale of skull
4894 Donation	$5,000.00	Revenue from conservation partner donation
5204 Contractual	-$1,944.78	Disease lab fees, etc.
5205 Supplies	-$45,686.72	Elk Mountain water project, radio collars for SDSU research project
2017		
4292 License	$71,000.00	Revenue from auction license
4599 Sale of Skull	$6,600.00	Revenue from sale of skull
4894 Donation	$22,000.00	Revenue from conservation partner donation
5204 Contractual	-$3,576.92	Disease lab fees, etc.
5205 Supplies	-$40,933.75	Elk Mountain water project
2018		
4292 License	$90,200.00	Revenue from auction license
4894 Donation	$8,000.00	Revenue from conservation partner donation
5204 Contractual	-$6,110.00	Badlands capture for CSP transplant
5205 Supplies	$0.00	

POTENTIAL REINTRODUCTION AREAS AND HUNTING UNITS

Habitat Suitability Modeling to Identify Potential Sites

Several factors such as public access, proximity to domestic sheep and goats, and habitat suitability are evaluated to identify potential bighorn sheep reintroduction sites. Using ArcGIS software, a habitat suitability model was developed in the Black Hills using 2 layers: 1) canopy cover and 2) steepness of slope. If slopes were ≥40% and canopy cover was ≤20% it would be considered more suitable than other habitats (Figure 9). Additionally, a habitat suitability model was also developed for prairie habitats west of the Missouri River using slopes ≥40% (Figure 10).

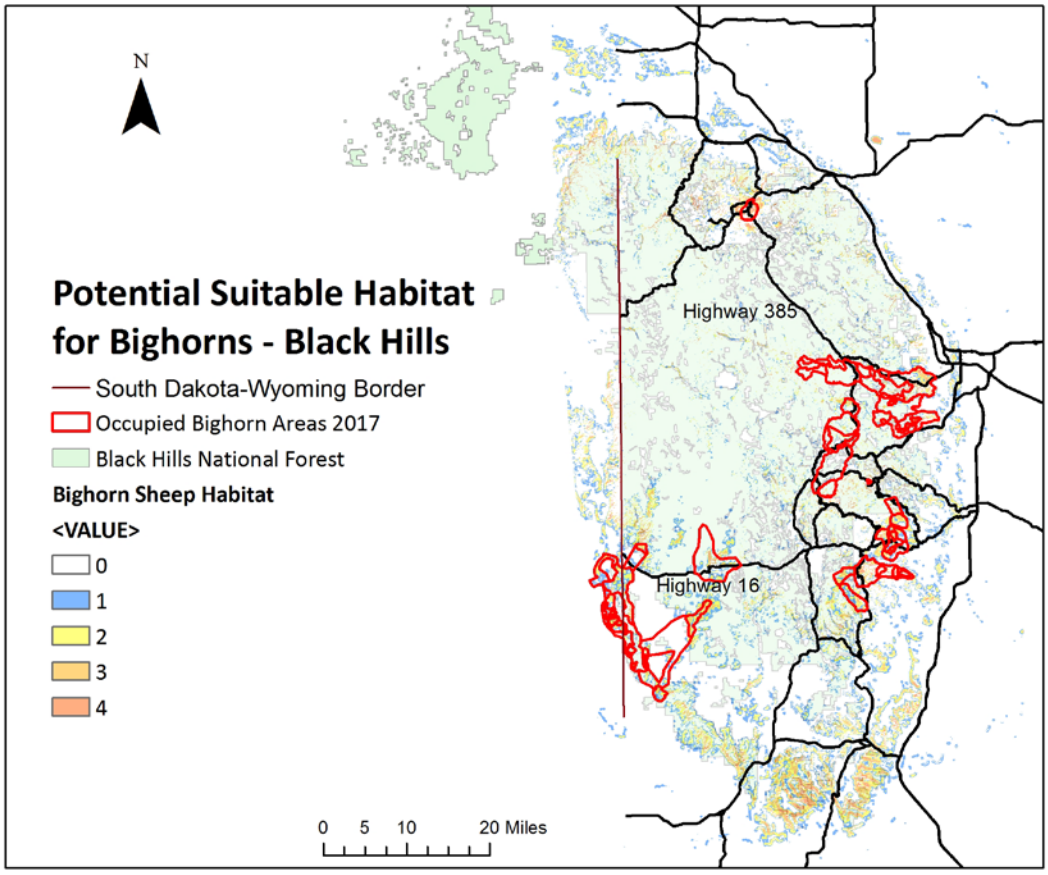

Figure 9. Potential suitable habitat for bighorn sheep in the Black Hills using steepness of slope and canopy cover to evaluate potential reintroduction areas. Suitability ranges from 0 or little habitat suitability to most suitable with orange and red colors at 3 and 4.

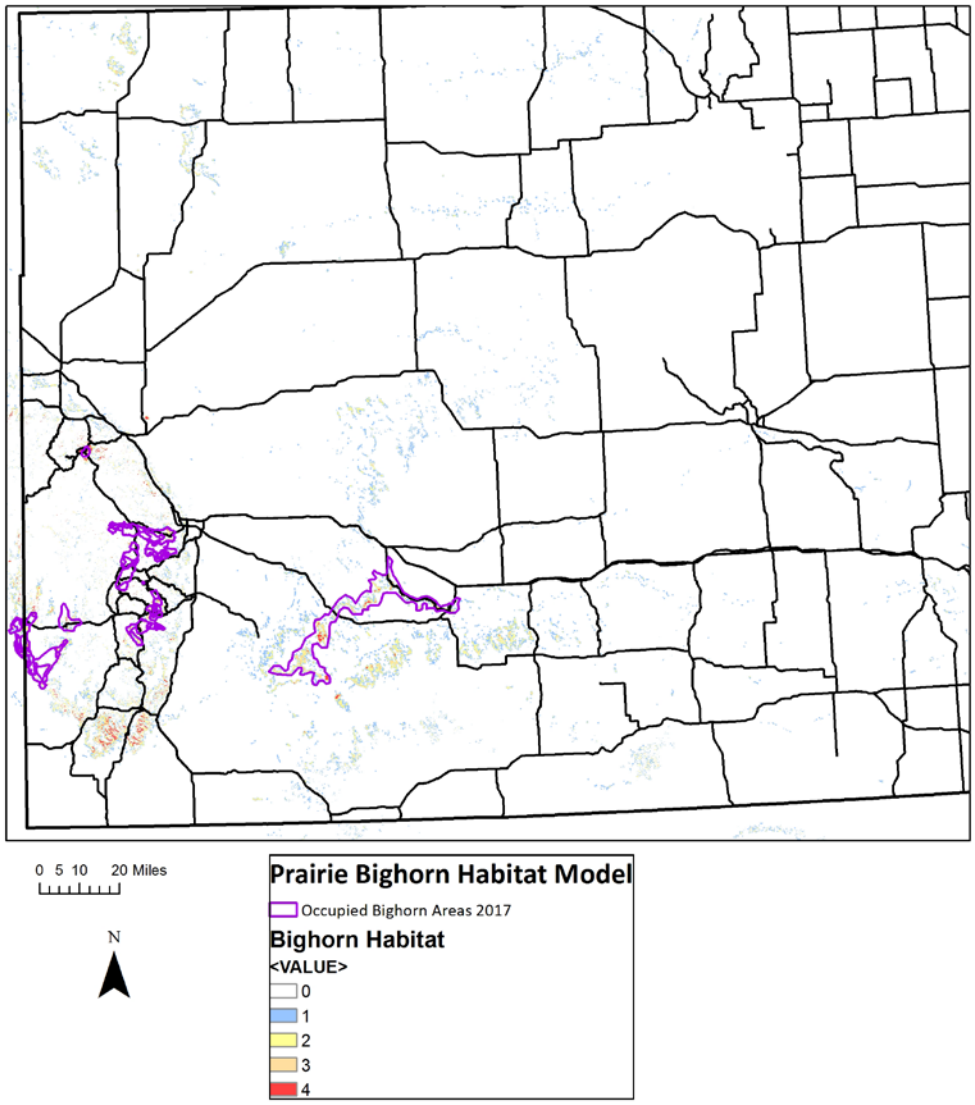

Figure 10. Potential suitable habitat for bighorn sheep in prairie habitats west of the Missouri River using steepness of slope to evaluate potential reintroduction areas. Suitability ranges from 0 or little habitat suitability to most suitable with orange and red colors at 3 and 4.

Angostura Reintroduction Site

Just south of Hot Springs, this area could potentially encompass 2 sub-herds, one each on Horse Trap Mountain and Flagpole Mountain (Figure 11). Suitable habitat is estimated to be about 18,600 acres on Horse Trap Mountain and 15,700 acres on Flagpole Mountain. Habitat and forage quality assessments need to be completed and issues such as range overlap with domestic sheep and goats and public access need to be evaluated prior to establishing these herds.

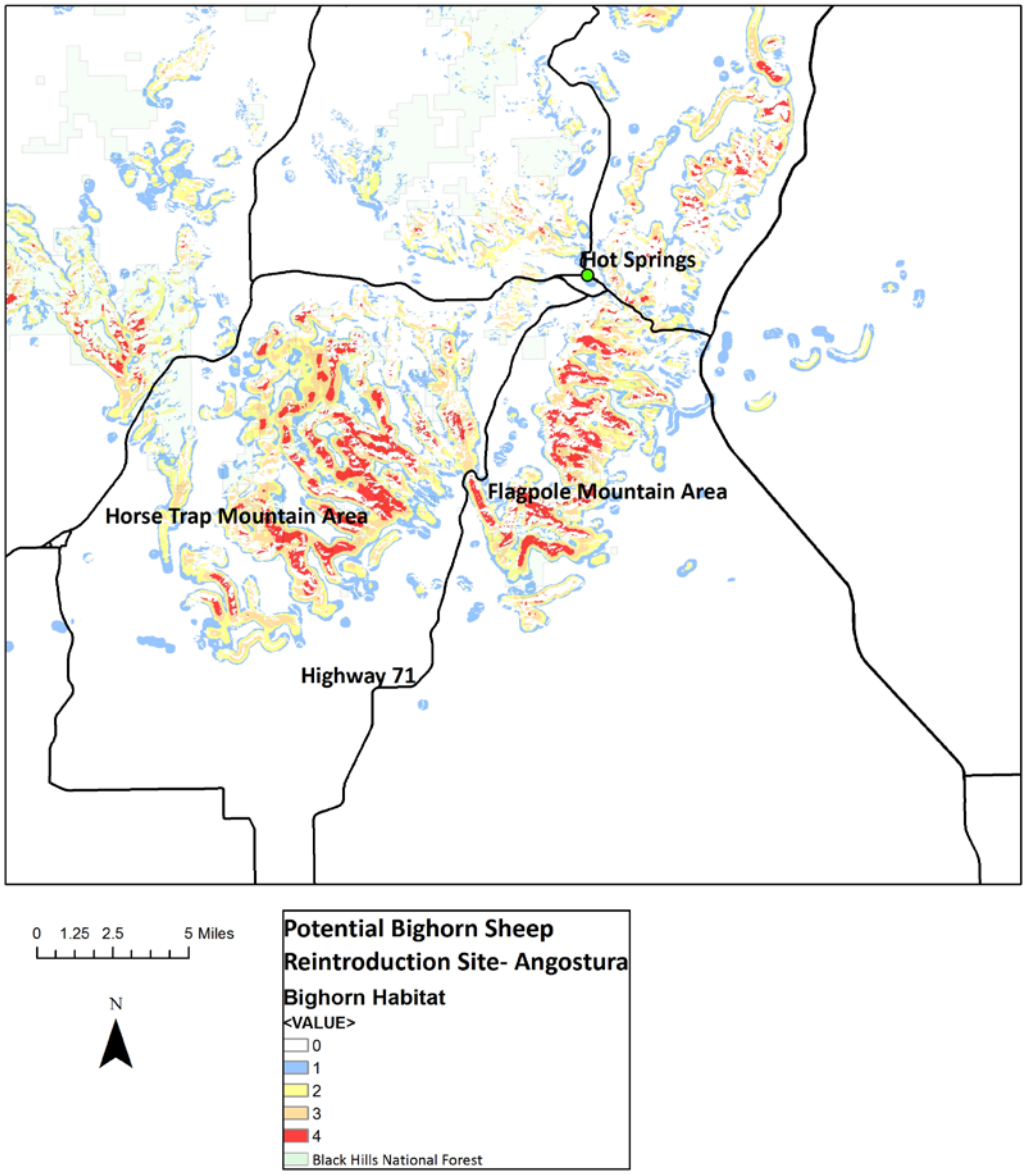

Figure 11. Horse Trap and Flagpole Mountain areas are potential sites for reintroductions of bighorn sheep in the Southern Black Hills, South Dakota. Issues such as forage quality assessments, public access, and range overlap with domestic sheep and goats need to be evaluated prior to reintroductions.

Hell Canyon Hunting Unit

The bighorn sheep herd in the Hell Canyon area continues to increase and in the near future a separate season could occur for this population. A new hunting unit could occur west of Highway 79 but east of the revised Elk Mountain Unit (Figure 12). Telemetry observations indicate Elk Mountain and Hell Canyon bighorns are separate herds with no documented movement of marked animals between areas. The creation of a new Hell Canyon unit would provide additional future hunting opportunities for bighorn sheep.

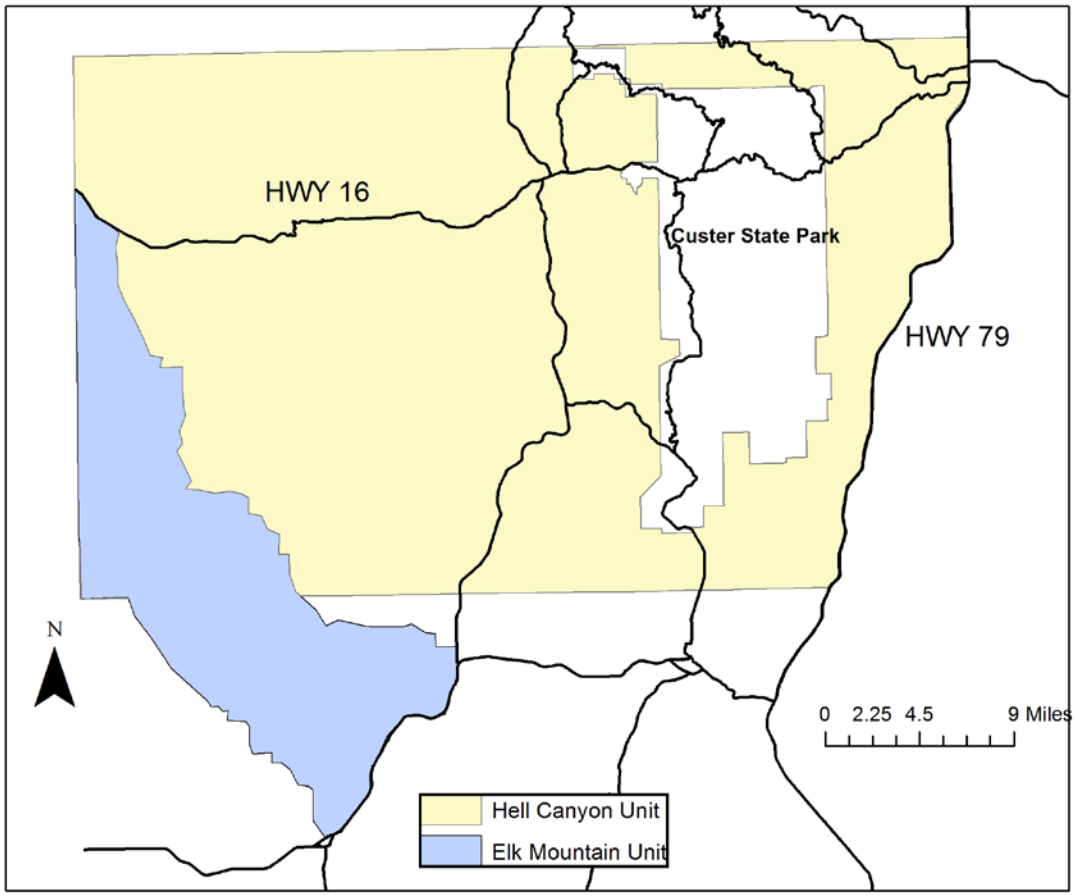

Figure 12. Potential Hell Canyon and Elk Mountain units after the Hell Canyon herd increases to a sufficient population size. Using radiotelemetry, movements of bighorn sheep between Elk Mountain and Hell Canyon will continue to be monitored, but as of 2017 these bighorn populations appear to be separate herds.

CHALLENGES AND OPPORTUNITIES

Disease

Respiratory disease largely caused by bacteria (including *Mannheimia haemolytica* and *M. ovi.*) remains the most prominent negative factor impacting bighorn sheep restoration in North America. A host of other diseases can inflict bighorn sheep such as infectious keratoconjunjunctivitis, contagious ecthyma, partuberculosis (Johne's disease), sinus tumors, lungworm, and hemorrhagic disease (Forrester and Littell 1976, Williams et al. 1979, Jessup 1985, Noon et al. 2002, Goldstein et al. 2005, Jansen et al. 2007, Fox et al. 2015). Bighorn sheep can be hosts for internal and ectoparasites as well (Couey 1950, Buechner 1960, Worley and Seesee, 1992, Hoar et al. 1996). However, bacteria pathogens causing pneumonia has been the dominant mortality factor impacting bighorns in South Dakota and across the west (Besser et al. 2013, Smith et al. 2014, Werdel 2017).

Several *M. ovi* strains have been documented to occur in bighorn sheep, domestic sheep and goats, and mountain goats across the bighorn sheep range. Pneumonia deaths related to *M. ovi* and other forms of bacteria have been the primary mortality factor limiting 3 bighorn sheep herds in the Black Hills (T. Haffley, SDGFP, personal communication, Smith et al. 2014, Werdel 2017) and throughout the west (Tom Besser, Washington State University, personal communication). Bighorns in CSP suffered an all-age pneumonia die-off in 2004–05 with an estimated loss of 90% of the herd (G. Brundige, SDGFP, personal communication). Additionally, losses due to pneumonia have occurred in the Rapid City herd since 2009, but have killed a smaller percentage of the entire herd compared to the CSP die-off with losses occurring for adults and lambs (Smith et al. 2014). Pneumonia deaths were 57.9% of all mortalities in the Deadwood herd of the northern Black Hills, 2016–17 (Werdel 2017). Evidence from deoxyribonucleic acid strain typing may suggest this disease was introduced into bighorn sheep populations from contact with domestic sheep or goats. Separation of domestic sheep and goats from wild sheep populations should be recognized as the most important step in maintaining healthy populations and assessing new areas for potential reintroductions. The WAFWA WSWG defines "effective separation" as spatial or temporal separation between wild sheep and domestic sheep or goats to minimize the transmission of diseases between species (WSWG 2012).

Collaborative field research with South Dakota State University (SDSU) and SDGFP being conducted from 2016–2017 shows promise for potentially minimizing the negative effects of pneumonia for lamb recruitment (SDSU and SDGFP, unpublished data); preliminary analysis of removal of bighorns that are actively shedding the *M. ovi*. pathogen indicate significantly higher survival in lambs after shedders have been removed (SDSU and SDGFP, unpublished data). This may have significant management implications for the future management of bighorn sheep in South Dakota and throughout the west. Sorting out the causes of pneumonia has important implications for the management of the species (Besser et al. 2013), and future testing and removal of *M. ovi*. shedding bighorn sheep could be a viable management alternative to allow for the recovery of populations that are experiencing die-offs; however, such management will

be time consuming for staff and will also be expensive for disease testing as all the sheep in a herd need to be captured, then radio-marked and tested for shedding status to be effective.

To potentially increase separation between domestic sheep and goats and wild bighorn sheep SDGFP can enter into an agreement with private landowners where SDGFP will provide assistance with domestic sheep and goat fencing. SDGFP will cover 100% of costs for fence materials and installation. The cooperating landowners agree to maintain a secondary fence and all other fences associated with the domestic sheep or goat herds for the life of the agreement or until possession of the domestic herd has ended. The cooperating landowners would need to allow SDGFPs, or its designee, to access the property to inspect the condition of the fence during the terms of the agreement. Cooperating landowners are responsible for all fence maintenance for the duration of the agreement.

Habitat

Wild sheep are one of the most widely distributed ungulates in the world and extensive montane and grassland habitats allowed them to spread throughout most of western North America into a variety of habitats (Valdez and Krausman 1999, Beecham et al. 2007). Certainly in areas such as the Badlands of South Dakota there are plentiful grasslands for foraging habitat. The Black Hills provides patchy habitat where suitable precipitous escape terrain exists in the form of rock outcroppings and canyon walls. The Black Hills dominant vegetation community of ponderosa pine provides managers some challenges in providing optimal conditions for their survival and reproduction. The Black Hills is characterized by a dominant ponderosa pine vegetation community that regenerates seedlings at a fast rate (Shepperd and Battaglia 2002); a dense understory providing greater lateral cover creates conditions where there could be poor visual detection of predators. However, wildfires and mountain pine beetle (MPB;*Dendroctonus ponderosae* Hopkins) epidemics have created natural disturbances with significant tree mortality in some areas potentially enhancing their habitat. Wildfires and MPB disturbance has occurred in areas with steep rugged terrain, or areas with rugged granite outcroppings, and such a disturbance may have provided improved conditions to enhance bighorn sheep vital rates. Removal of dense ponderosa pine stands immediately adjacent to or in areas with escape terrain may improve the ability of bighorns to visually detect predators. Further, foraging habitat may have improved due to the removal of the overstory. Collaborating with the Black Hills National Forest (BHNF), Bureau of Land Management (BLM), NPS, and private landowners to prevent future pine regeneration in areas with escape terrain and rugged precipitous habitat would be important. In areas identified as bighorn habitat in this document it would be important to implement programs such as mechanical thinning of pine regeneration, or prescribed burning to maintain the open conditions necessary for their enhanced survival and recruitment.

Public Access

Access to bighorn sheep populations for hunting and viewing opportunities is a priority goal of SDGFP. Most bighorn sheep herds within the Black Hills and the Badlands areas are relatively accessible to the public and provide many recreational opportunities. Some areas being

evaluated for potential reintroductions (i.e., Angostura Reintroduction Site) is a challenge because substantial parcels of public habitat are surrounded by private land with little or no public access. The SDGFP will work with adjacent private landowners to find reasonable solutions to access issues such as establishing public access agreements.

Sheep-Vehicle Collisions

Vehicle collisions of sheep along roads have been documented to occur in almost every herd in South Dakota. For instance along highway 16 west of Custer near Jewel Cave National Park SDGFP documented 4 sheep (2 were radio-collared) being hit and killed by vehicles from May 2015 through November 2016. Vehicle collisions in Hell Canyon had the same amount of cause-specific mortality as puma predation (n = 2) and both causes of mortality represent the majority of losses of sheep in this herd. In an effort to reduce vehicle collisions signs have been posted in areas where sheep cross at higher rates (Figure 14). Research has been conducted on the standard deer warning sign in the United States (i.e., a diamond-shaped panel with a black deer symbol on a yellow background, sometimes accompanied by text signs that indicate the length of the road section to which the sign applies) to determine its effectiveness in reducing collisions. The effectiveness of standard deer warning signs in Kansas was compared before and after sign installation (Meyer 2006). After taking all available accident data before sign installation and other road and landscape factors into consideration, there was no evidence that the presence of the deer warning signs had resulted in fewer collisions (Meyer 2006). Further, additional research indicated that simple warning signs did not reduce vehicle speeds and collisions for deer and camels (Al-Ghamdi and AlGadhi 2004, Rogers 2004). Certainly, such signs can warn motorists of potential animals being a hazard on roadways. Future research may provide more insights into what mitigation factors may reduce vehicle collisions for wildlife.

Figure 13. Warning sign posted along major highway in South Dakota in an effort to warn motorists of potential bighorn sheep along roadways.

Viewability

Providing and promoting viewing opportunities is a priority goal of SDGFP. Opportunities exist where tourism viewsheds such as CSP, Rapid City, Badlands National Park, and Deadwood provide the public a unique setting to observe mountain sheep behavior as a quality experience. However, additional viewing opportunities could be created as populations are established in other areas of South Dakota. Habitat creation with natural movements of wild sheep may provide future additional opportunities to view sheep. Future reintroductions of sheep may also provide additional viewing opportunities.

Tribal Bighorn Sheep Management

South Dakota has nine Indian reservations, including the Cheyenne River, Crow Creek, Flandreau Santee, Lower Brule, Pine Ridge, Rosebud, Sisseton Wahpeton, Standing Rock, and Yankton (Figure 15). Each is managed by a respective Native American tribe under tribal sovereignty and their respective tribal councils. Most tribes have a wildlife department that conducts various wildlife population surveys and makes hunting recommendations to the tribal councils. South Dakota Indian reservations contain a diverse mixture of landscape features and associated habitats. As a result, bighorn sheep and other wildlife species thrive on these tribal lands, benefiting both wildlife watchers and hunters.

SDGFP and some tribes are currently in the process of developing Memorandum of Understandings (MOU's). The purpose of these MOU's is to formalize cooperative efforts between tribes and SDGFP where mutual interest exists to conduct collaborative operations. Collaborative operations between the parties may include, but not be limited to the following: conducting and sharing wildlife surveys, developing big game and small game harvest season recommendations, communicating wildlife and fisheries resource management concerns, and conducting predator/nuisance animal control activities in an effort to safeguard domestic livestock operations.

The Pine Ridge Indian Reservation is currently the only reservation with a population of bighorn sheep. Bighorn sheep primarily inhabit the south unit of Badlands National Park within the boundaries of the reservation however, bighorns do occur on tribal and deeded lands as well. Currently it is estimated that there is a minimum of 60 bighorn sheep in the Pine Ridge herd. This herd is considered part of the overall population of bighorn sheep in South Dakota and SDGFP collaborates with the Oglala Sioux Parks and Recreation Authority (OSPRA) to manage the Pine Ridge herd. SDGFP worked with OSPRA in the winter of 2014 to translocate 20 bighorn sheep from the Rocky Boy Indian Reservation near Havre, MT to Pine Ridge. Recently SDGFP assisted OSPRA with a helicopter aerial survey to estimate the bighorn sheep population on Pine Ridge. SDGFP will continue to offer assistance to OSPRA to cooperatively manage bighorn sheep in South Dakota.

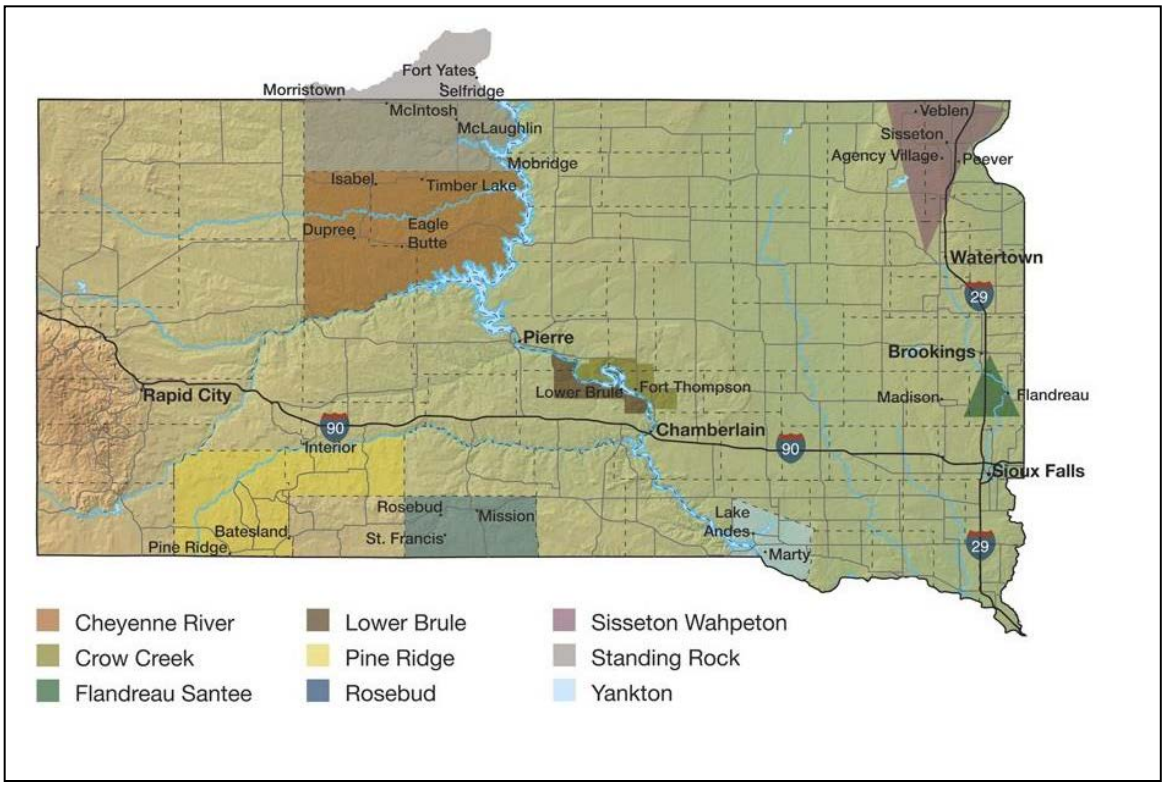

Figure 14. South Dakota has nine Indian reservations, including the Cheyenne River, Crow Creek, Flandreau Santee, Lower Brule, Pine Ridge, Rosebud, Sisseton Wahpeton, Standing Rock, and Yankton.

Guiding Principles

The following statements have guided the development of the bighorn sheep management goals and objectives (Table 10) and reflect the collective values of the SDGFP in relation to management of bighorn sheep in South Dakota:

- that wildlife, including bighorn sheep, contributes significantly to the quality of life in South Dakota and therefore must be sustained for future generations.
- that recreational hunting is a legitimate use of bighorn sheep, and must be encouraged and preserved.
- that the collaboration among various agencies, including NPS, USFS, BLM, Tribes, and the State, is critical for the future of bighorn sheep and their habitats in South Dakota, and is deserving of recognition and respect.
- that reasonable regulations are necessary for equitable distribution of the benefits of wildlife, including bighorn sheep, and to promote ethical and safe behavior.
- that the future of wildlife, including bighorn sheep, depends on a public that appreciates, understands, and supports wildlife and in the public's right to participate in decisions related to wildlife issues.

GOALS, OBJECTIVES & STRATEGIES

The goal for bighorn sheep management in South Dakota is to maximize user opportunity while maintaining populations consistent with ecological, social, aesthetic, and economic values of the people of South Dakota and our visitors.

Objectives and Strategies

Objective 1. Management and monitoring of disease pathogens in bighorn sheep herds across South Dakota.

Strategy A. Continue to inventory and document domestic sheep and goats in areas adjacent to wild bighorn herds.

Strategy B. Work with conservation organizations to develop cooperative programs to discourage domestic sheep and goat ownership in areas adjacent to wild bighorn herds.

Strategy C. Continue to educate the public about bighorn sheep disease and the risk that domestic sheep and goats pose to wild sheep.

Strategy D. Continue to offer assistance to owners of domestic sheep and goats in an effort to minimize the risk of disease transmission to wild sheep.

Strategy E. Manage and monitor bighorn sheep disease events and attempt to mitigate losses of bighorns through disease mitigation management when feasible; implement testing and removal of bighorns that are identified as shedders of *M. ovi.* in populations that are experiencing pneumonia die-offs in an attempt to recover these populations at a faster rate.

Strategy F. Through trap-and-transfer augment established populations recovering from disease events that are at critically low population levels once *M. ovi.* are no longer detected.

Strategy G. Implement Department policy (Appendix 1) for the lethal take of bighorn sheep when associated with domestic sheep or goats.

Objective 2. Monitor the status of bighorn sheep populations.

Strategy A. Annually conduct surveys including ground and hunter harvest. Males will be classified during surveys according to body and horn size (Geist 1968).

Strategy B. Where feasible, conduct aerial surveys and obtain abundance estimates utilizing mark-resight or other methodologies.

Strategy C. Supplement survey data with research findings when available.

Objective 3. Bi-annually review and set bighorn sheep management objectives; use harvest strategies to provide the public with the available resource.

Strategy A. Bi-annually review bighorn harvest strategies, license allocation, and unit boundaries and develop 2-year recommendations based on available biological data, public input, and staff recommendations.

Strategy B. Generally, ram harvest will be set at 10% of the available rams in a herd (Table 2). Harvest could be above 10% of the available rams in the herd during disease events or under additional special circumstances depending upon sex and age ratios and population size. We will take into account: 1) population size and trend, 2) lamb recruitment (lamb:ewe ratios), 3) some index to the number or availability of rams in the population (ram:ewe ratios, the number of mature rams estimated or seen during surveys, average age of harvested rams), and 4) trends in hunter success or hunter effort, or both, from recent hunting seasons.

Strategy C. When feasible, use subunits and create new units to maximize hunting opportunities, distribute hunters, and minimize hunter conflicts. For the management of bighorn sheep a season will be closed when <75 sheep

are observed during surveys for 3 consecutive survey periods (i.e., years). A season may get opened or reopened when 3 criteria are met: 1) ≥75 sheep are observed during surveys for 3 consecutive survey periods (i.e., years), 2) observed a ram:ewe ratio of ≥30 rams/100 ewes for 3 consecutive surveys, and 3) observed a lamb:ewe ratio of ≥30 lambs/100 ewes for 3 consecutive surveys.

Strategy D. Maintain high hunter success rates (>90%) and/or high hunter satisfaction in all units.

Strategy E. Ewe harvest can be implemented depending upon guiding factors found in the decision support table (Table 3). Translocation of excess ewes should always be considered prior to the implementation of sport harvest.

Objective 4. Maintain, manage, and protect existing bighorn sheep habitat and augment populations to either maintain or establish herds in vacant habitat in South Dakota.

Strategy A. Maintain existing partnerships with the USFS, BLM, NPS, private landowners, and other state, local, and private conservation partners to support programs and practices encouraging proper bighorn sheep habitat management on public and private lands.

Strategy B. Continue to support and utilize SDGFPs forest service liaison position in USFS planning processes to assure bighorn sheep habitat needs are considered.

Strategy C. Through trap-and-transfer augment established populations that are at critically low population levels or create new populations in vacant habitat.

Strategy D. Avoid disturbance during critically sensitive parturition and nursery periods. Parturition for ewes can occur from April 15-June 15. Nursery groups can be raising lambs in sensitive areas during May 1- August 31.

Objective 5. Continue to use science-based research, habitat inventories, and surveys to answer questions related to bighorn sheep ecology and public attitudes towards bighorn sheep management.

Strategy A. Annually evaluate and prioritize research/survey needs for bighorn sheep. Develop research/survey proposals and seek funding opportunities.

Strategy B. Use research/survey findings to guide bighorn sheep management where available and feasible.

Objective 6. The SDGFP will inform and educate the public on bighorn sheep ecology, management, research, and provide viewing opportunities.

Strategy A. By March 2018, provide an electronic copy of the "South Dakota Bighorn Sheep Management Plan 2018–2027" on the department's website. Printed copies will be available upon request.

Strategy B. Use all available media to educate and inform the public regarding bighorn sheep status, ecology, and harvest. Work with the South Dakota Animal Industry Board and the public to discuss potential risks to bighorn sheep from domestic sheep and goats in South Dakota.

Strategy C. Brief bighorn sheep hunters annually to provide them useful information on habits, ecology, and sound management of bighorn sheep.

Strategy D: Promote viewability of bighorn sheep for the enjoyment of the public. Opportunities exist where tourism viewsheds such as CSP, Rapid City, and Deadwood provide the public a unique setting to observe their behavior as a quality experience.

Table 10. Implementation schedule and primary responsibility, 2018-2022.

Goals, Objectives & Strategies	2018	2019	2020	2021	2022	Primary Responsibility
GOAL: Goal for bighorn sheep management in South Dakota is to maximize user opportunity while maintaining populations consistent with ecological, social, aesthetic, and economic values of the people of South Dakota and our visitors.						
OBJECTIVE 1: Management and monitoring of disease pathogens in bighorn sheep herds across South Dakota.						
Strategies						
Strategy A: Continue to inventory and document domestic sheep and goats in areas adjacent to wild bighorn herds.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Game Survey Coordinator
Strategy B: Work with conservation organizations to develop cooperative programs to discourage domestic sheep and goat ownership in areas adjacent to wild bighorn herds.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Regional Program Managers
Strategy C: Continue to educate the public about bighorn sheep disease and the risk that domestic sheep and goats pose to wild sheep.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Regional Program Managers
Strategy D: Continue to offer assistance to owners of domestic sheep and goats in an effort to minimize the risk of disease transmission to wild sheep.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Regional Program Managers
Strategy E: Manage and monitor bighorn sheep disease events and attempt to mitigate losses of bighorns through disease mitigation management when feasible; implement testing and removal of bighorns that are identified as shedders of *M. ovi.* in populations that are experiencing pneumonia die-offs in an attempt to recover these populations at a faster rate.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Regional Program Managers
Strategy F: Through trap-and-transfer augment established populations recovering from disease events that are at critically low population levels once *M. ovi.* are no longer detected.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Regional Program Managers
Strategy G: Implement Department policy (Appendix 1) for the lethal take of bighorn sheep when associated with domestic sheep or goats.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Regional Program Managers

OBJECTIVE 2: Monitor the status of bighorn sheep populations.						
Strategies						
Strategy A: Annually conduct surveys including ground and hunter harvest. Males will be classified during surveys according to body and horn size (Geist 1968).	✓	✓	✓	✓	✓	Senior Biologists Regional Program Managers Regional Staff
Strategy B: Where feasible, conduct aerial survey and obtain abundance estimates utilizing mark-resight or other methodologies.	✓	✓	✓	✓	✓	Senior Biologists Regional Program Managers Regional Staff
Strategy C. Supplement survey data with research findings when available.	✓	✓	✓	✓	✓	Senior Biologists Regional Program Managers Administration
OBJECTIVE 3: Bi-annually review and set bighorn sheep management objectives; use harvest strategies to manage the population with the available resource.						
Strategies						
Strategy A: Bi-annually review bighorn harvest strategies, license allocation, and unit boundaries and develop 2-year recommendations based on available biological data, public input, and staff recommendations.		✓		✓		Senior Biologists Regional Program Managers Administration
Strategy B: Generally, ram harvest will be set at 10% of the available rams in a herd (Table 2). Harvest could be above 10% of the available rams in the herd during disease events or under additional special circumstances depending upon sex and ageratios and population size. We will take into account: 1) population size and trend, 2) lamb recruitment (lamb:ewe ratios), 3) some index to the number or availability of rams in the population (ram:ewe ratios, the number of mature rams estimated or seen during surveys, average age of harvested rams), and 4) trends in hunter success or hunter effort, or both, from recent hunting seasons.	✓	✓	✓	✓	✓	Senior Biologists Regional Program Managers Administration
Strategy C: When feasible, use subunits and create new units to maximize hunting opportunities, distribute hunters, and minimize		✓		✓		Senior Biologists Regional Program Managers

hunter conflicts. For the management of bighorn sheep a season will be closed when <75 sheep are observed during surveys for 3 consecutive survey periods (i.e., years). A season may get opened or reopened when 3 criteria are met: 1) ≥75 sheep are observed during surveys for 3 consecutive survey periods (i.e., years), 2) observed a ram:ewe ratio of ≥30 rams/100 ewes for 3 consecutive surveys, and 3) observed a lamb:ewe ratio of ≥30 lambs/100 ewes for 3 consecutive surveys.						Administration
Strategy D: Maintain high hunter success rates (>90%) and/or high hunter satisfaction in all units.	✓	✓	✓	✓	✓	Regional Program Managers Administration
Strategy E: Ewe harvest can be implemented depending upon guiding factors found in the decision support table (Table 3). Translocation of excess ewes should always be considered prior to the implementation of sport harvest.		✓		✓		Regional Program Managers Administration
OBJECTIVE 4: Maintain, manage, and protect existing bighorn sheep habitat and augment populations to maintain healthy populations in South Dakota.						
Strategies						
Strategy A: Maintain existing partnerships with the USFS, BLM, NPS, private landowners, and other state, local, and private conservation partners to support programs and practices encouraging proper bighorn sheep habitat management on public and private lands.	✓	✓	✓	✓	✓	Regional Staff Senior Biologists Game Survey Coordinator Habitat Staff USFS–SDGFP liaison
Strategy B: Continue to support and utilize SDGFP's forest service liaison position in USFS planning processes to assure bighorn sheep habitat needs are considered.	✓	✓	✓	✓	✓	Administration USFS–SDGFP liaison
Strategy C: Through trap-and-transfer augment established populations that are at critically low population levels or create new populations in vacant habitat.	✓	✓	✓	✓	✓	Administration Regional Staff Senior Biologists
Strategy D: Avoid disturbance during critically sensitive parturition and nursery periods. Parturition for ewes can occur from April 15-June 15. Nursery groups can be raising lambs in sensitive areas during May 1-August 31.	✓	✓	✓	✓	✓	Administration Regional Staff Senior Biologists

OBJECTIVE 5: Continue to use science-based research, habitat inventories, and surveys to answer questions related to bighorn sheep ecology and public attitudes towards bighorn sheep management.						
Strategies						
Strategy A: Annually evaluate and prioritize research/survey needs. Develop research/survey proposals and seek funding opportunities.	✓	✓	✓	✓	✓	Administration Regional Staff Senior Biologists
Strategy B: Use research/survey findings to guide bighorn sheep management where available and feasible.	✓	✓	✓	✓	✓	Administration Regional Staff Senior Biologists
OBJECTIVE 6: The SDGFP will inform and educate the public on bighorn sheep ecology, management, research, and provide viewing opportunities.						
Strategies						
Strategy A: By March 2018, provide an electronic copy of the "South Dakota Bighorn Sheep Action Plan 2018–2027" on the department's website. Printed copies will be available upon request.	✓					Communications Staff
Strategy B: Use all available media to educate and inform the public regarding bighorn sheep status, ecology, and harvest. Work with the South Dakota Animal Industry Board and the public to discuss potential risks to bighorn sheep from domestic sheep and goats in South Dakota.	✓	✓	✓	✓	✓	Communication Staff Administration Regional Staff Senior Biologists
Strategy C: Brief bighorn sheep hunters annually to provide them useful information on habits, ecology, and sound management of bighorn sheep.	✓	✓	✓	✓	✓	Wildlife Manager Regional Staff
Strategy D: Promote viewability of bighorn sheep for the enjoyment of the public. Opportunities exist where tourism viewsheds such as CSP, Rapid City, and Deadwood provide the public a unique setting to observe their behavior as a quality experience.	✓	✓	✓	✓	✓	Wildlife Manager Regional Staff

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Appendix 1. Department policy for the lethal take of bighorn sheep when associated with domestic sheep or goats.

LETHAL TAKE OF BIGHORN SHEEP WHEN ASSOCIATED WITH DOMESTIC SHEEP OR GOATS

PURPOSE STATEMENT

To provide direction to Department staff in dealing with bighorn sheep that have known or suspected contact with domestic sheep or goats. To prevent the spread of diseases from domestic sheep and goats back to wild bighorn sheep herds.

BACKGROUND

There is scientific evidence that the bacterium *Mycoplasma ovipneumoniae* (*M. ovi*) predisposes bighorn sheep to pneumonia. Once a bighorn sheep is infected with *M. ovi*, bacteria that normally live in its nose, throat, or gut can descend into the lungs and cause pneumonia. Therefore, ultimately, many different bacteria cause pneumonia, but most of these bacteria are usually harmless and would not cause disease without M. ovi first predisposing bighorn sheep to lung infections. Disease is the number one limiting factor to bighorn sheep population growth in South Dakota. Domestic sheep and goats can pass pathogens, including M. ovi, to bighorn sheep that cause pneumonia which can kill as much as 75-100%of a bighorn sheep herd.

POLICY REQUIREMENTS

It is the policy of the South Dakota Department of Game, Fish and Parks that bighorn sheep observed in close proximity to or have known or suspected contact with domestic sheep or goats are to be captured or killed as soon as feasible. It is recommended that live capture be attempted first and the animal used for disease research purposes. If live collection is not practical, then lethal means should be used. If lethal removal is accomplished via gunshot, the shot should be to the head to swiftly dispatch the animal and prevent damage to respiratory organs to facilitate sample collection for disease testing.

Whenever possible, proper collection will be made of samples to include, but not be limited to, blood (both serum and anticoagulant), nasal and throat swabs, and the entire thoracic contents to include trachea, lungs, and heart as required to supplement ongoing research and management projects.