

# COLLEGIATE RANGE BIGHORN SHEEP HERD MANAGEMENT PLAN

DATA ANALYSIS UNIT RBS-12

GAME MANAGEMENT UNITS  
S11, S17, S66, and S76



Prepared By:  
Jamin Grigg, Julie Mao, Kevin Blecha  
Colorado Parks and Wildlife

*Approved Date, Year by the Colorado Parks and Wildlife Commission*



## EXECUTIVE SUMMARY

GMUs: S-11 (Collegiate North), S-17 (Collegiate South), S-66 (Mt Elbert), S-76 (Holy Cross)

Tier Status: 1 ( $\geq 100$  animals for  $\geq 90\%$  of the years since 1986; native population comprised of one or more interconnected herds that have received few ( $\leq 50$  animals total) if any supplemental releases of Rocky Mountain bighorn sheep in the past (George et al. 2009))

Land Ownership: USFS 84%, Private 12%, BLM 2%, Other 2%

Post-hunt 2018 Age and Sex Ratio Estimate: 50 rams:100 ewes, 25 lambs:100 ewes

Post-hunt 2018 Population Estimate: 375; Recommended Objective 350-400

3-yr Average Age of Harvested Rams: 2016-2018 Estimate 6.8 years; Recommended Objective 6-8

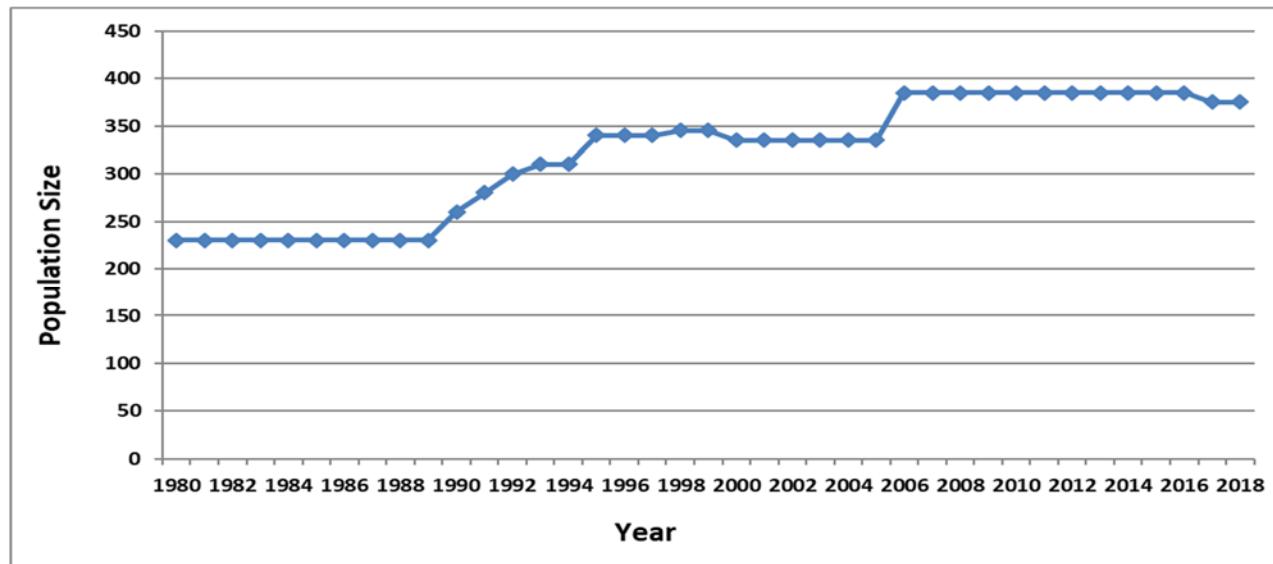


Figure 1. RBS-12 post-hunt population estimates from 1980-2018.

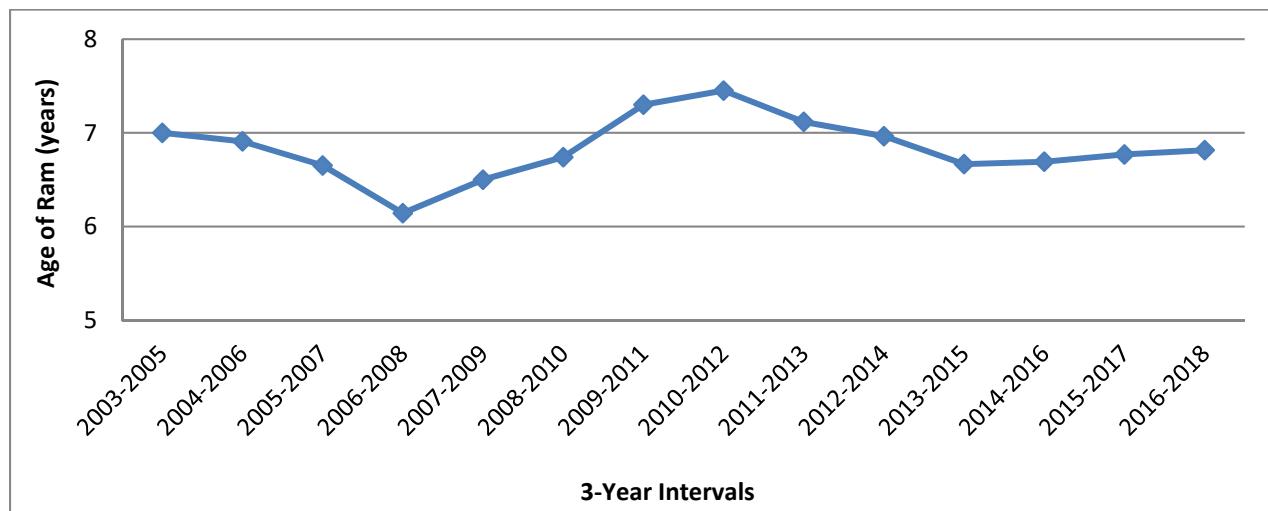


Figure 2. Three-year average age of rams harvested in RBS-12 from 2003-2018.

## BACKGROUND & ISSUE SUMMARY

Rocky Mountain bighorn sheep Data Analysis Unit (DAU) RBS-12 consists of Game Management Units (GMUs) S-11 (Collegiate North), S-17 (Collegiate South), S-66 (Mt Elbert), and S-76 (Holy Cross). The DAU is 1,317 mi<sup>2</sup> and includes portions of Chaffee, Eagle, Gunnison, Lake, and Pitkin counties. The RBS-12 sheep herd is indigenous, meeting the criteria for Tier 1 designation (George et al. 2009). The 2018 post-hunt population estimate for RBS-12 is approximately 375 animals. Habitat in this DAU is abundant and anecdotally in good condition, although due to high elevations and heavy annual snowfall available winter forage is likely a limiting factor for this population. Bighorns generally summer on the alpine reaches of the high elevation peaks in this DAU, and while some animals descend to lower elevations in winter, others spend the entire year on alpine range.

The first official hunting season for bighorn rams in RBS-12 occurred in 1953, when 10 licenses were issued, and increasing to 30 licenses issued by 1955 (Bear and Jones 1973). Current hunting license allocations include 6 rifle ram tags and 2 rifle ewe tags for each of S-11, S-17, and S-66. Beginning in 2020, 2 archery ram licenses have been added for S-66. There currently are no licenses allocated for S-76. The 3-year average age of ram harvested in the DAU has been at or above 6 years of age for the last 10+ years (Figure 2).

## MANAGEMENT OBJECTIVES

To solicit input for this herd management plan, we sent the plan to federal partners and interest groups for review, as well as the wild sheep/domestic sheep working group. We also posted the plan on the CPW website for a 30-day comment period. The following represent our preferred alternatives:

**Population size:** The current population estimate in RBS-12 is stable at approximately 375 animals. Key limiting factors for this population include winter range carrying capacity and the potential for disease outbreaks. Considering bighorn distribution, winter range capability, population density/density dependence, and the potential risks of contact with domestic livestock, we selected the following management objective: *Population target 400 bighorns (range 350-400)*

**Ram and Ewe Harvest Objective:** *Maintain a 3-yr average age of rams harvested of 6-8 years old.* This alternative maintains the current harvest regime in the DAU. Moderate ram license increases may be possible based on population performance. This alternative should provide a quality experience, moderate levels of crowding, and diverse age-classes of rams. **Ewe harvest:** *Maintain ewe harvest as a population management tool and for hunter opportunity.* This is currently how we manage ewe harvest within the DAU.

**Strategies for obtaining objectives and addressing issues:** Both of the preferred alternatives are consistent with our current management in RBS-12. Therefore, a change in harvest management is not expected with this plan. The most significant issue for RBS-12 is the potential for new respiratory pathogens or strains to be introduced from other wild sheep herds or from domestic livestock, particularly sheep and goats (George et al. 2009). There are currently two active domestic sheep summer grazing allotments along the northern boundary of this DAU, along with numerous hobby livestock operations, and the potential for interaction is a continual threat.

## TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	i
INTRODUCTION AND PURPOSE .....	5
DESCRIPTION OF DAU.....	6
Location, Boundaries, Land Management, and Physiography .....	6
DAU HERD HISTORY .....	8
Introduction and historic population monitoring .....	8
Translocations (to and from the DAU) .....	10
Hunting and harvest history .....	11
CURRENT HERD BIOLOGY & MANAGEMENT ISSUES .....	13
Available habitat and bighorn densities.....	13
Disease and interactions with domestic livestock .....	Error! Bookmark not defined.
Recreational impacts.....	19
Mountain Goat/Bighorn Interactions.....	20
Hunter Harvest Objectives and Management.....	20
Ewe Hunting .....	20
Ram Hunting .....	21
ISSUE SOLICITATION PROCESS.....	22
30-Day Comment Period .....	22
MANAGEMENT RECOMMENDATIONS AND FUTURE NEEDS .....	22
Herd Management .....	22
Domestic Sheep and the Potential for Disease Transmission ..	Error! Bookmark not defined.
Population objective range .....	23
Preferred Alternative: Population target 400 sheep (range 350-400) .....	23
Alternative 2: Population target 300 sheep (range 250-300) .....	23

Alternative 3: Population target 500 sheep (range 450-500) .....	23
Ram and Ewe Harvest Objective Alternatives.....	23
Preferred alternative: Maintain a 3-year average age of 6-8 for hunter harvested rams. .....	24
Preferred alternative: Maintain ewe harvest as a population management tool as well as to allow for hunter opportunity. ....	24
Alternative 2: Maintain a 3-yr average age of rams harvested of 5-7 years old. ....	24
Alternative 3: Maintain a 3-yr average age of rams harvested of 7-9 years old. ....	24
Strategies for Achieving Objectives.....	25
Strategies for Addressing Management Concerns.....	25
LITERATURE CITED .....	25
APPENDIX A: Colorado Wool Growers Association Comment Letter.....	29

## INTRODUCTION AND PURPOSE

Colorado Parks and Wildlife (CPW) manages big game for the use, benefit, and enjoyment of the people of the state in accordance with the CPW's Strategic Plan (2010-2020), with bighorn sheep management directed under the Colorado Bighorn Sheep Management Plan (George et al. 2009). Bighorn sheep management is also determined by mandates from the Colorado Parks and Wildlife Commission (PWC) and the Colorado Legislature. Colorado's wildlife species require careful and increasingly intensive management to accommodate the many and varied public demands and growing human impacts. The CPW uses a "Management by Objective" approach to manage the state's big game populations (Figure 3).

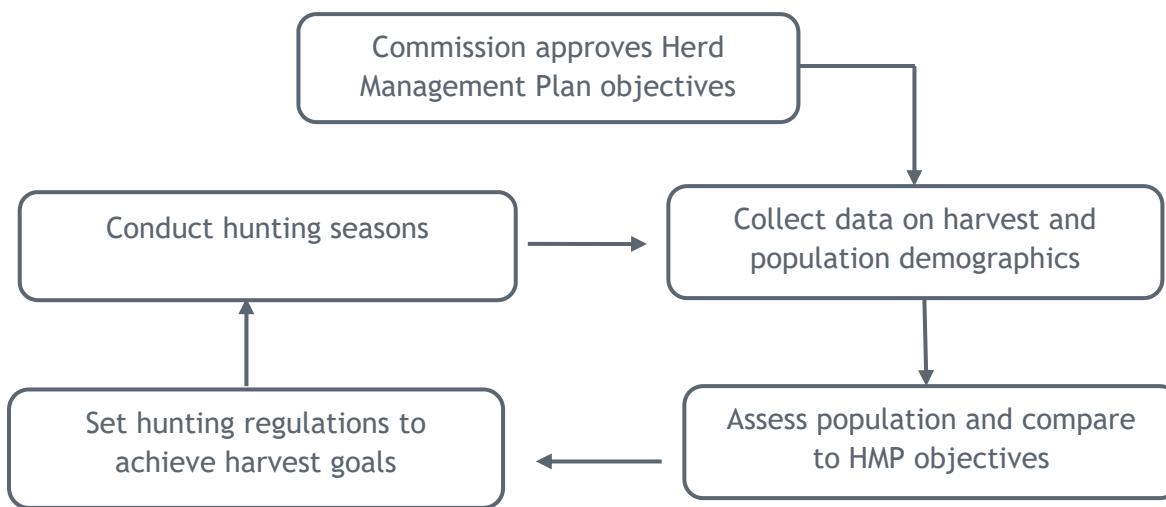


Figure 3. Management by Objective process used by Colorado Parks and Wildlife to manage big game populations by Data Analysis Unit.

With the Management by Objective approach, big game populations are managed to achieve the population objective established for a Data Analysis Unit (DAU). A DAU is the geographic area that includes the year-round range of a big game herd. A DAU includes the area where most of the animals in a herd are born, live, and die. DAU boundaries are delineated to minimize interchange of animals between adjacent DAUs. A DAU may be divided into several Game Management Units (GMUs) to distribute hunters and harvest within a DAU.

Management decisions within a DAU are based on a herd management plan. The primary purpose of a herd management plan is to establish population and sex ratio (i.e., the number of males per 100 females) objectives for the DAU. The herd management plan also describes the strategies and techniques that will be used to reach these objectives. During the herd management planning process, public input is solicited and collected through questionnaires, public meetings, and comments to CPW staff and the PWC. The intentions of the CPW are integrated with the concerns and ideas of various stakeholders including the United States Forest Service (USFS), the Bureau of Land Management (BLM), city and county governments, hunters, guides and outfitters, private landowners, local chambers of commerce and the public. In preparing a herd management plan, agency personnel attempt to balance the biological capabilities of the herd and its habitat with the public's demand for wildlife

recreational opportunities. Herd management plans are approved by the PWC and are reviewed and updated every 10 years.

The herd management plan serves as the basis for the annual herd management cycle. In this cycle, the size and composition of the herd is assessed and compared to the objectives defined in the herd management plan. Removal goals are set. Based on these goals, specific removal strategies are made for the coming year to either maintain the population or move it towards the established objectives (e.g., license numbers and allocation are set, translocation plans are made). Hunting seasons and/or translocations are then conducted and evaluated. The annual management cycle then begins again (Figure 3).

The purpose of this herd management plan is to set population and harvest objectives for the Collegiate Range bighorn sheep herd (RBS-12; GMUs S11, S17, S66, S76). The herd management plan will be in place from 2020-2030 with the expectation that it will be reviewed and updated in 2030.

## DESCRIPTION OF DAU

### Location, Boundaries, Land Management, and Physiography

Rocky Mountain bighorn sheep Data Analysis Unit (DAU) RBS-12 consists of Game Management Units (GMUs) S-11 (Collegiate North), S-17 (Collegiate South), S-66 (Mt Elbert), and S-76 (Holy Cross). The DAU is 1,317 mi<sup>2</sup> and includes portions of Chaffee, Eagle, Gunnison, Lake, and Pitkin counties. Municipalities include Poncha Springs, Buena Vista, Leadville, and Aspen. The bighorn population in the DAU utilizes primarily public lands, which represent the majority of the DAU (88%). It is bounded on the north by the Holy Cross Wilderness area, West Grouse Creek, and USFS Trail 2129 and USFS Rd 733, on the east by US 24 and 285, on the south by US 50, and on the west by the Gunnison-Chaffee Co. line, Middle Willow Creek, Willow Creek, Taylor River, North Fork of Taylor River, USFS Trail 761, USFS 123, Lost Man Creek, over ridge from Lost Man Creek to South Fork Fryingpan River and Fryingpan River (Figure 4). Elevations in the DAU range from 14,439 ft at Mount Elbert, the highest point in Colorado, to approximately 7,500 ft at the intersections of US highways 50 and 285 near Poncha Springs. The 30-year average precipitation for the DAU is 17 in, which falls primarily as winter-spring snow fall and summer rains. Topography in the DAU is generally steep and consists primarily of high-elevation alpine summer habitats and lower-elevation winter range areas.

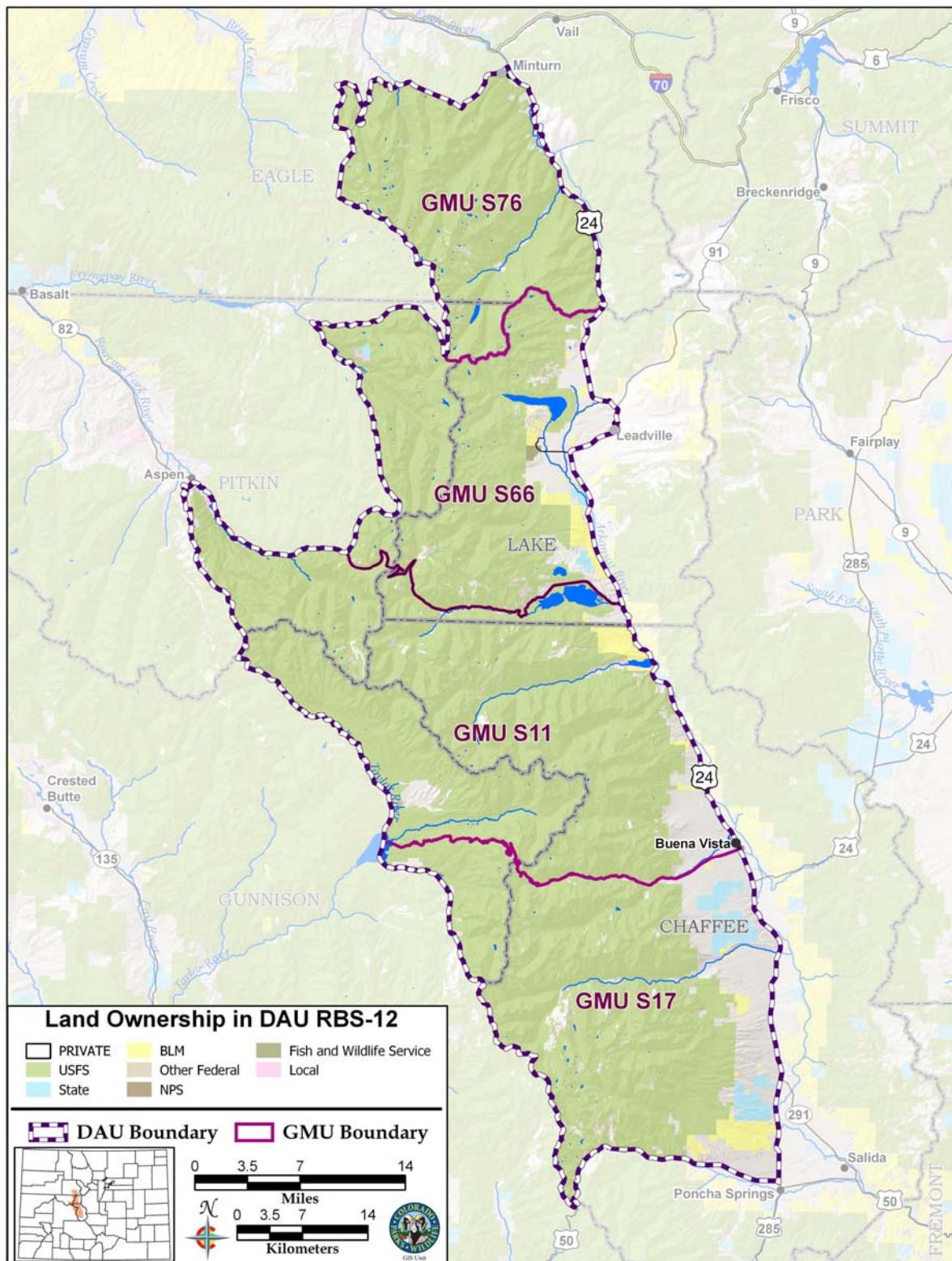


Figure 4. RBS-12 geography and landownership.

## DAU HERD HISTORY

### Historic and current population monitoring

The RBS-12 bighorn sheep herd is indigenous to the region, and one of the highly valued native populations in Colorado. Due to the inherent difficulties with estimating the population size of high-elevation mountain sheep populations, it's not exactly known how many sheep historically inhabited the RBS-12 geographic area, though it appears that the current population size is as high as has ever been recorded. Estimates have ranged from approximately 300 animals in the 1950s to perhaps fewer than 100 animals during the 1970s (Bear and Jones 1973). However, since accurate aerial surveys were difficult to obtain during those decades, the precision of historic estimates is unknown. Estimates of the population size have increased from 225 bighorns in the 1980's to the current estimate of approximately 375 animals (Figure 5). Approximately 125 bighorns inhabit primarily the alpine portion of each of the S-11, S17, and S-66 GMUs, ranging from Monarch Pass to north of Leadville. There are accounts that a small population of wild sheep existed historically in the Holy Cross Wilderness in S-76 (Bear and Jones 1973), and that remains the case today.

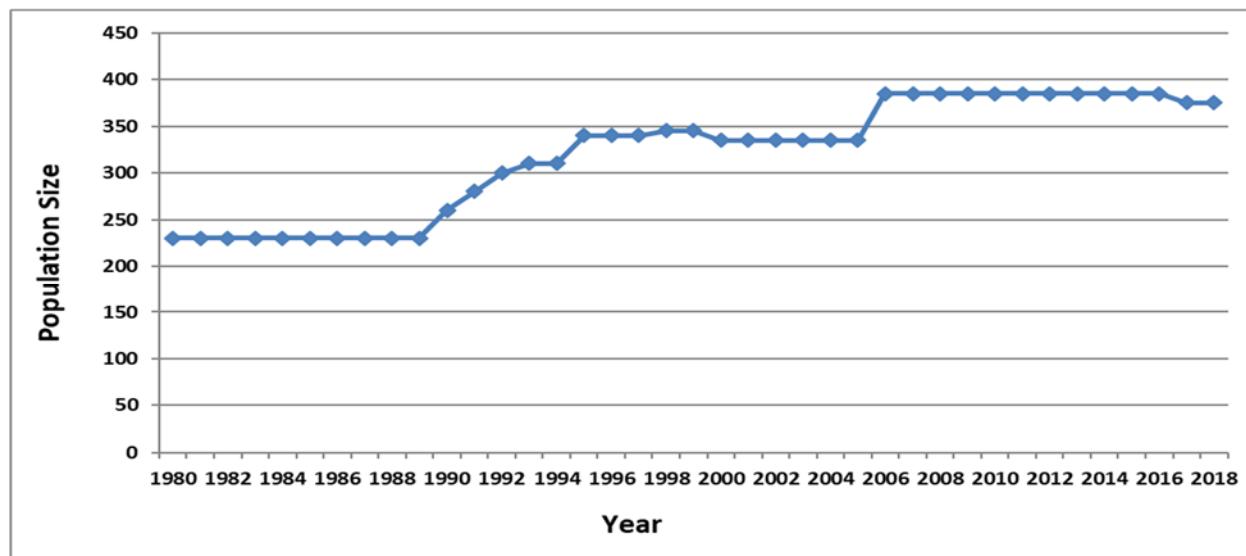


Figure 5. RBS-12 post-hunt population estimates from 1980-2018.

Summer ratios generally average approximately 50 lambs:100 ewes and 50 rams:100 ewes. Inventory data for this DAU is collected through a helicopter survey conducted during summer (July/Aug) months in the DAU, as well as hunter reports. From these surveys, we report the total number of sheep observed and the ratio of lambs to ewe and rams to ewes (Table 1). When determining the productivity of a bighorn sheep herd, the preferred method is to collect ratios in the winter months. Several years ago, we tried to fly this DAU in the winter

months and due to high elevations, high winds and difficult terrain, we deemed winter inventory flights to be too dangerous to collect.

Table 1. Population surveys conducted in GMUs S-11, S-17, and S-66 since biological year 2010.

GMU S-11					
Year	Ewes	Lambs	Rams	Total	Date of Survey
2010	25	15	9	49	7/18/2010
2011	48	14	11	73	7/19/2011
2012	27	4	9	40	8/15/2012
2013	22	15	6	43	7/22/2013
2014	53	22	7	82	8/9/2014
2017	13	4	7	24	8/8/2017
2018	30	20	20	70	9/1/2018
2019	20	7	17	44	9/1/2019

GMU S-17					
Year	Ewes	Lambs	Rams	Total	Date of Survey
2010	45	19	10	74	7/19/2010
2011	33	11	21	65	7/18/2011
2012	77	34	12	123	8/15/2012
2013	54	19	20	93	7/22/2013
2014	4	3	3	10	8/9/2014
2015	32	13	16	61	8/10/2015
2016	10	4	3	17	12/15/2016
2017	15	8	20	43	8/8/2017
2018	50	20	30	100	9/1/2018
2019	32	14	19	65	9/1/2019

GMU S-66					
Year	Ewes	Lambs	Rams	Total	Date of Survey
2010	56	36	11	103	7/18/2010
2011	32	21	4	57	7/21/2011
2012	55	32	1	88	8/15/2012
2013	12	3	3	18	7/23/2013
2014	48	28	13	89	8/9/2014
2015	49	24	9	82	8/10/2015
2017	63	29	14	106	8/5/2017
2018	60	30	30	120	9/1/2018
2019	55	21	22	98	9/1/2019

### Translocations (to and from the DAU)

Throughout much of the 1980s and early 1990s, the RBS-12 DAU was used as a source population for transplants around Colorado. One small transplant of sheep into the DAU occurred in 1992. Another 15 sheep were transplanted into the Holy Cross Wilderness in S76 in 1999; however, it's believed very few if any of the sheep from that transplant survived. Most of the sheep in the DAU are native (Table 2).

Table 2. Historic transplants of bighorn sheep into and out of DAU RBS-12.

Date	Capture Location	Release Site	Ram	Ewe	Yrlg	Lamb	Total
2/12/80	S17 Chalk Crk	S48 Carrizo Canyon	4	9	0	7	20
4/8/80	S11 Cottonwood Crk	GMU 70 Sawpit	1	11	0	8	20
4/2/82	S11 Cottonwood Crk	S60 Shelf Rd	2	11	0	6	19
3/13/84	S11 Cottonwood Crk	S10 Trickle Mtn	1	11	0	8	20
3/6/85	S11 Cottonwood Crk	S36 Blue Crk	2	10	0	8	20
3/31/85	S11 Cottonwood Crk	S10 Saguache	1	11	0	8	20
3/14/86	S11 Cottonwood Crk	S61 Purgatoire	2	10	0	8	20
2/19/87	S11 Cottonwood Crk	S8 Mt Blanca	4	7	0	9	20
2/2/90	S11 Cottonwood Crk	S59 Derby Crk	3	0	0	0	3
2/20/90	S11 Cottonwood Crk	Oregon	0	6	0	3	9
2/20/90	S11 Cottonwood Crk	S14 Clinetop Mesa	1	7	3	10	21
2/20/90	S11 Cottonwood Crk	S38 Apishapa	4	0	0	0	4
1/21/92	S34 Rampart	S17 North Fork	3	7	0	11	21
4/8/99	S46 Dome Rock	S76 Holy Cross Wilderness	3	12	0	0	15

## Hunting and harvest history

The RBS-12 population currently appears to be stable near 375 animals. Traditionally, hunting licenses have been issued conservatively for several reasons. The first is to maintain a quality experience for hunters who draw licenses. In 2018, 40,993 hunters applied for 298 bighorn sheep licenses in Colorado. Hunters often wait for more than 10 years to draw licenses with the expectation of a high-quality hunting experience. More licenses may contribute to hunter crowding and diminish the experience, particularly if sheep tend to concentrate in a few small geographic areas. The second reason for conservative license allocation is the threat of stochastic events outside of the influence of management. Pneumonia epidemics, in particular, have led to large-scale population declines which are typically followed by lengthy periods of low lamb recruitment. The frequency, intensity, and duration of any future disease events will impact bighorn sheep hunting opportunities in RBS-12. Another reason for conservative license allocation is that we have historically lacked sufficient population monitoring data for meeting suggested off-take rates to maintain a maximum sustained yield.

The first official hunting season for bighorn rams in RBS-12 occurred in 1953, beginning with 10 licenses and increasing to 30 licenses by 1955 (Bear and Jones 1973). Current hunting license allocations consists of 6 rifle ram licenses and 2 rifle ewe licenses for each of S-11, S-17, and S-66 (Table 3). Beginning in 2020, 2 ram archery licenses are also allocated for S-66. No hunting licenses are currently allocated for S-76 due to its small population size. The average age of ram harvested in the DAU has fluctuated between 6-8 years of age over the past 10+ years (Figure 7). Hunter success rates have averaged 53% for ram rifle licenses since 2003 (Figure 8).

Table 3. 2019 Hunting license allocation in RBS-12.

<i>GMU</i>	<i>Rifle Ram</i>	<i>Rifle Ewe</i>	<i>Archery Ram</i>
S-11	6	2	0
S-17	6	2	0
S-66	6	2	2
<i>DAU Total</i>	<i>18</i>	<i>6</i>	<i>2</i>

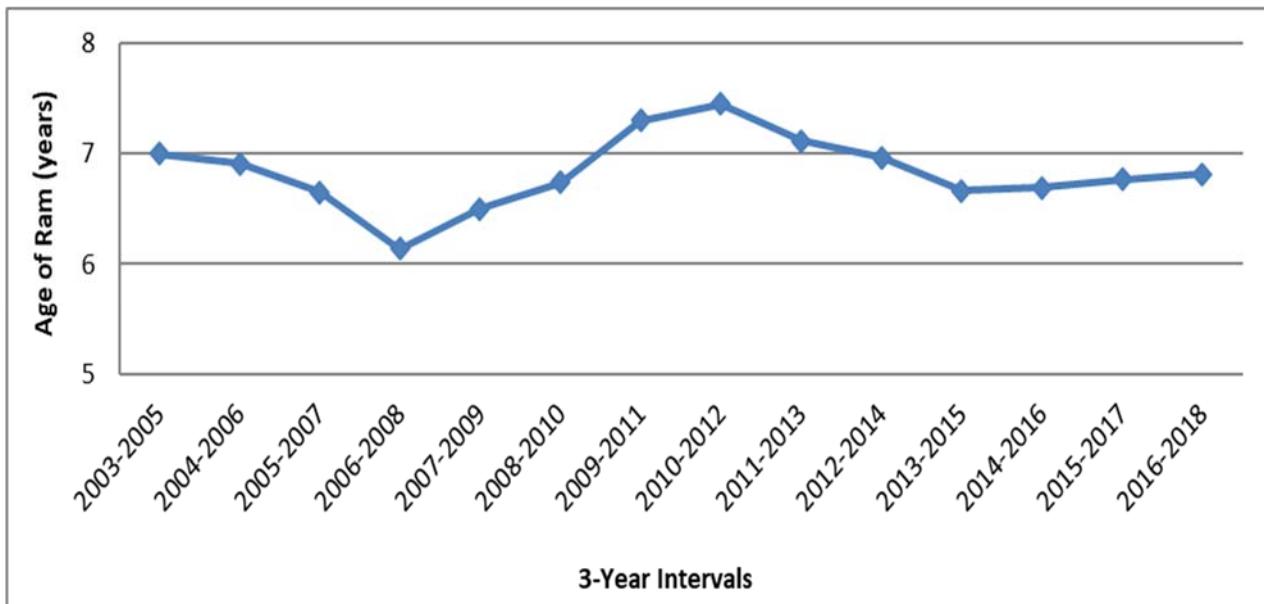


Figure 7. Three-year average age of rams harvested in RBS-12 from 2003-2018.

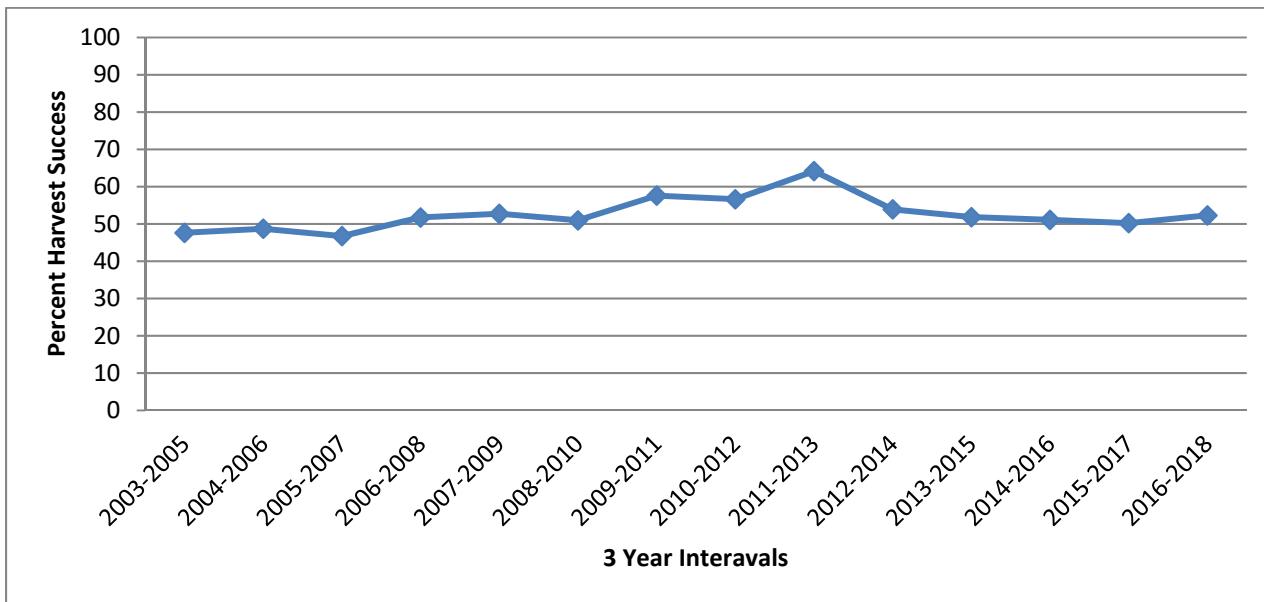


Figure 8. Three-year average harvest success of rams harvested in RBS-12 from 2003-2018.

## CURRENT HERD BIOLOGY & MANAGEMENT ISSUES

### Available habitat and bighorn densities

Approximately 43% of the RBS-12 DAU is classified as bighorn sheep habitat, with 39% of the DAU being designated as summer range, but only 9% being designated as winter range, and only 9% being suitable lambing habitats (Figures 9, 10, and 11). Only 3% (36 mi<sup>2</sup>; 23,126 acres) of the DAU is classified as severe winter range, meaning only 3% of the habitat is available to bighorns during the worst 2 winters out of 10. It is during these winters that available forage could be a limiting factor for the population. Given the current post-hunt 2018 population estimate of 375 animals, densities of sheep on winter range likely approach 10.4 sheep/mi<sup>2</sup> during severe winters. These densities are similar or even higher than documented winter densities currently observed in other high elevation, alpine bighorn populations in Colorado, which range from 3.2 sheep/mi<sup>2</sup> in the San Juan herds (RBS-21 and RBS-22) to 7.0 sheep/mi<sup>2</sup> in the Georgetown herd (RBS-03). Research conducted on Ram Mountain in Alberta, Canada documented a population crash when local bighorn population exceeded a density of 16.0 bighorn/mi<sup>2</sup>, (Jorgenson et al 1997, Festa-Bianchet 2003). This decline apparently was not disease related, which suggests that it occurred in response to some undetermined density dependent factor(s). Unfortunately, few other density studies have been performed on bighorns and none have been done in Colorado. Though densities of sheep in the Ram Mountain studies exceed current documented densities in RBS-12, the Ram Mountain studies demonstrate the importance of maintaining a population density below carrying capacity.

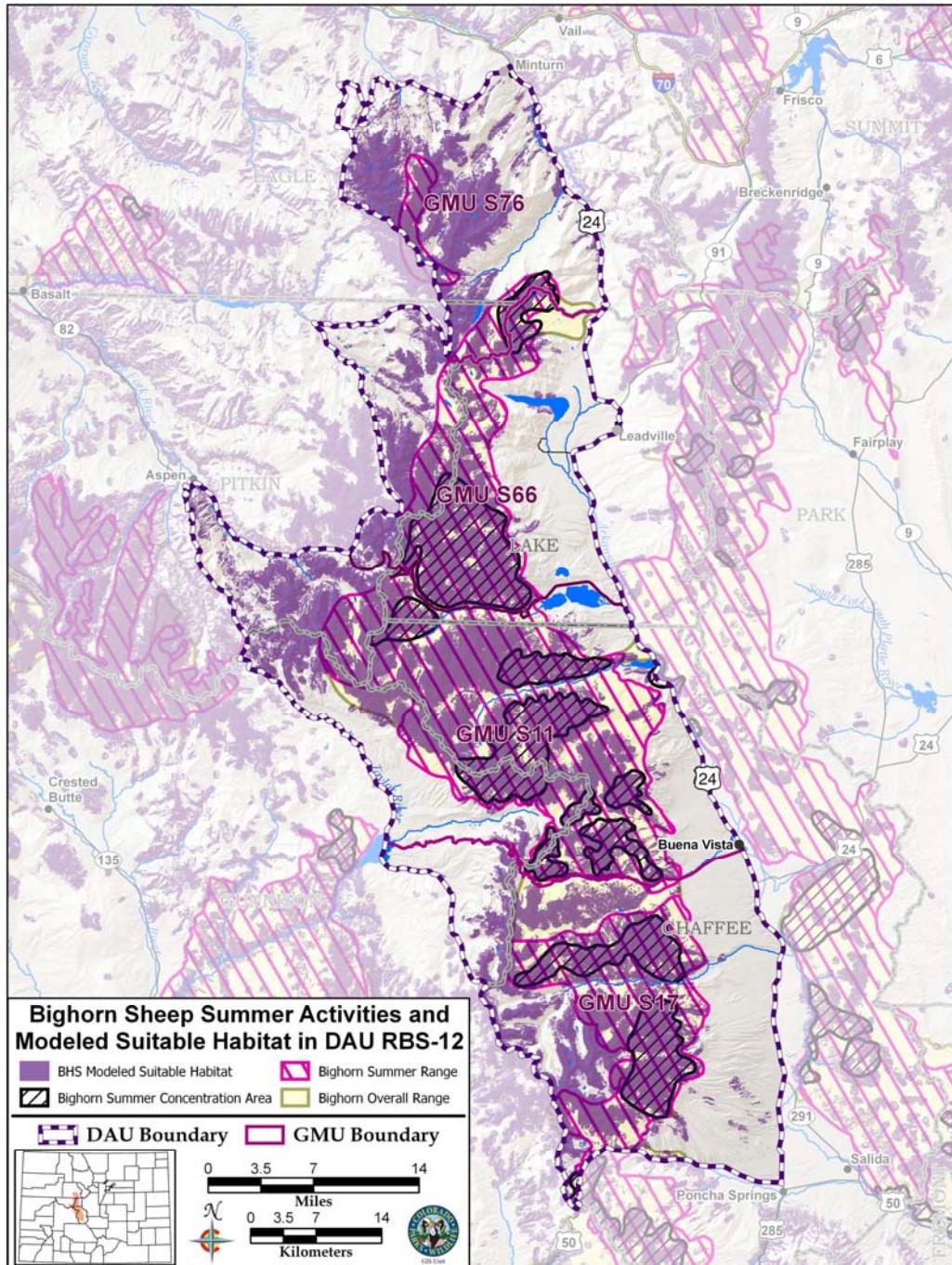


Figure 9. Overall range, summer range, and summer concentration areas for bighorn sheep in RBS-12.

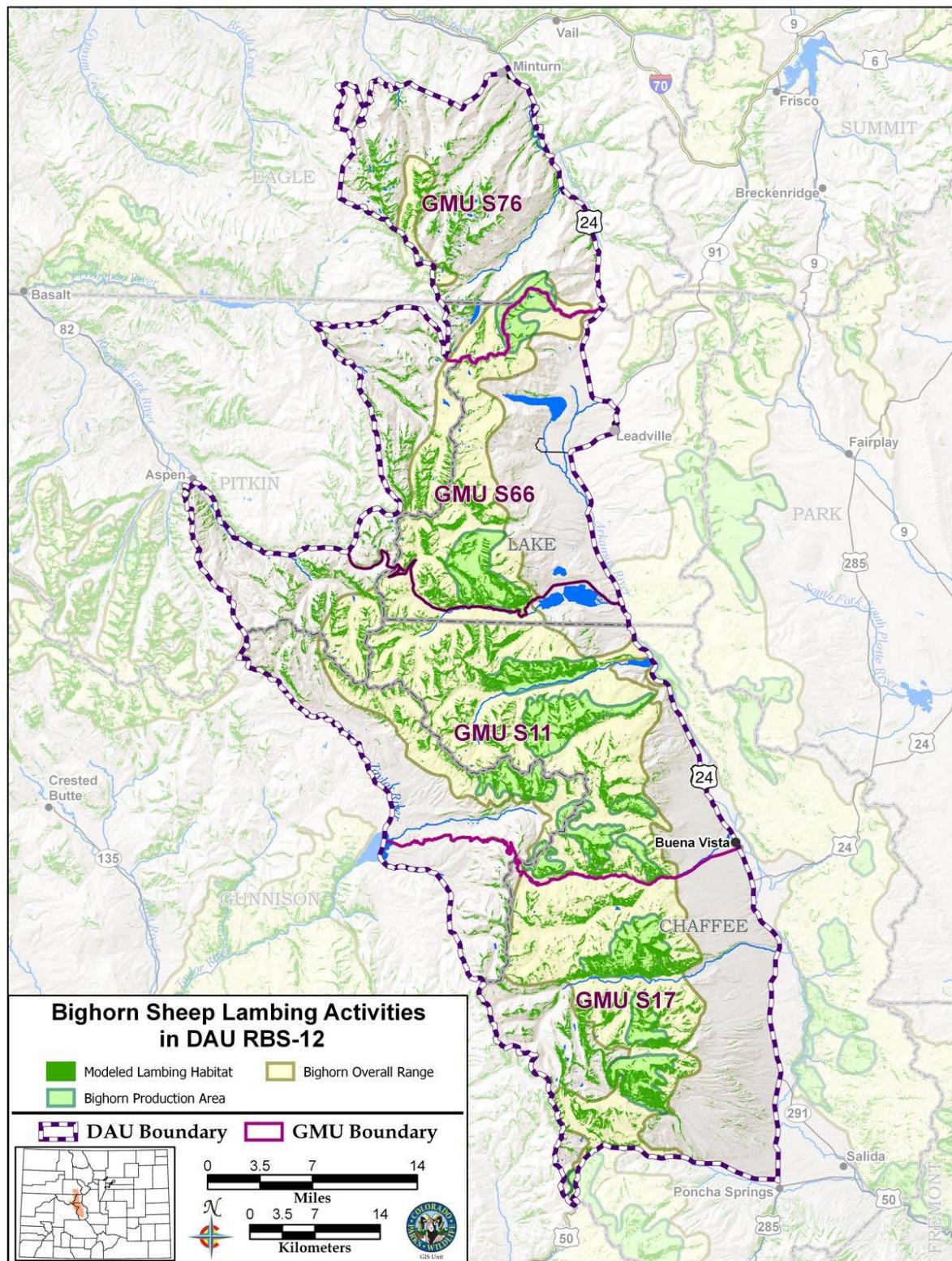


Figure 10. Lamb production areas for bighorn sheep in RBS-12.

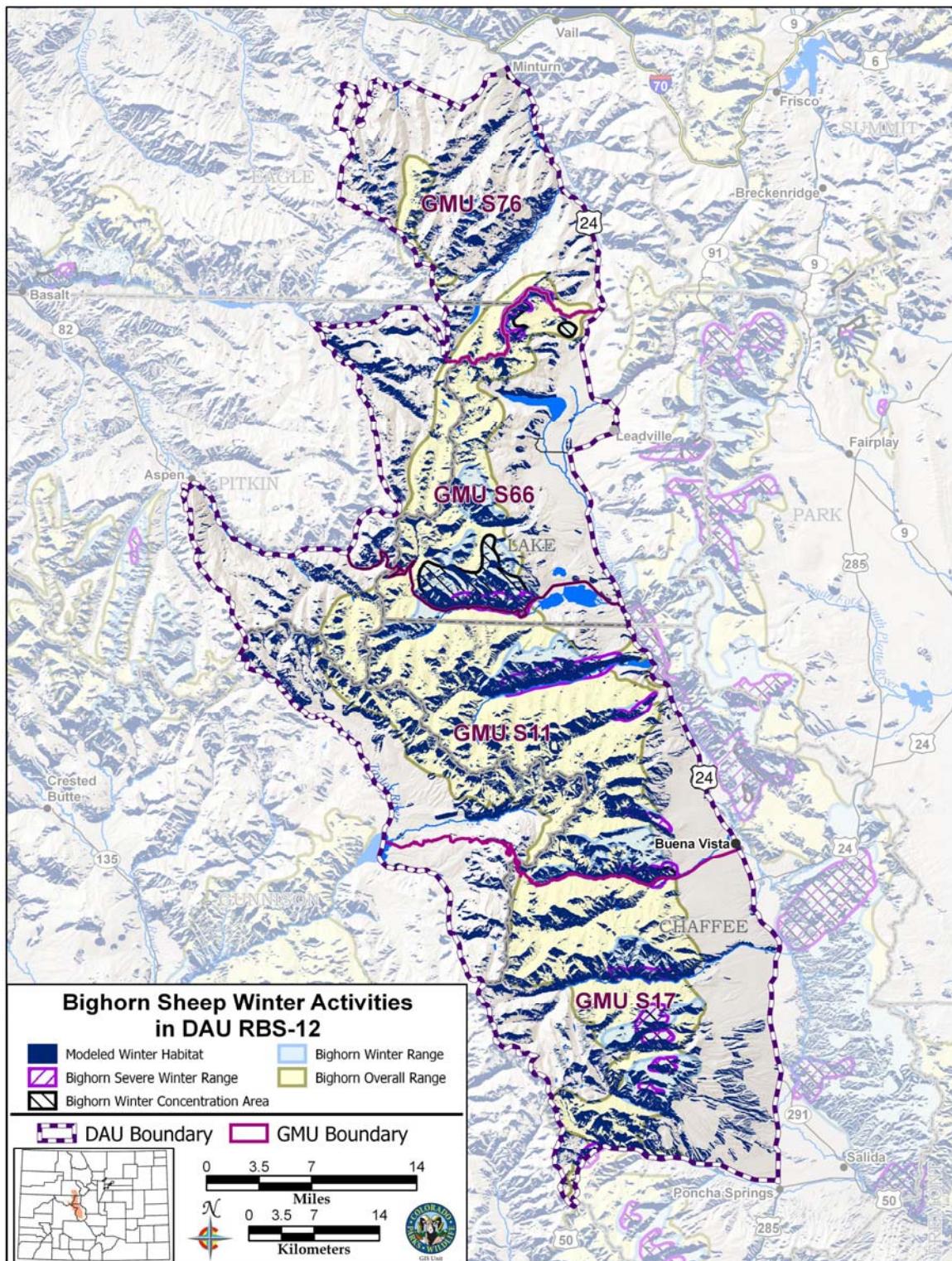


Figure 11. Overall range, winter range, severe winter range, and winter concentration areas for bighorn sheep in RBS-12.

### Respiratory disease

Bighorn sheep are unique among Colorado's big game species with respect to the influence that infectious diseases have on population performance and species abundance. The susceptibility of bighorn sheep to pathogens originally introduced by domestic livestock is regarded as the primary factor limiting bighorn sheep populations in Colorado. Respiratory disease is by far the most important health problem in contemporary bighorn populations. In addition to initial all-age die offs, pneumonia epidemics in bighorn sheep can lead to long-term reductions in lamb survival and recruitment resulting in stagnant or declining populations over many years (George et al. 2009). Interaction between bighorn sheep and domestic sheep and goats is a significant management issue for bighorn populations in Colorado and elsewhere, which is corroborated in the existing literature (Beecham et al. 2007, Schommer and Woolever 2008, George et al. 2009, Lawrence 2010, WAFWA 2010, Wehausen et al. 2011, Grigg et al. 2017).

Native North American wild sheep species are quite susceptible to polymicrobial-induced pneumonia, the generic term for respiratory disease caused by bacteria in the family *Pasteurellaceae* (Miller 2001) and *Mycoplasma ovipneumoniae* (Cassirer et al 2018). Some strains of these bacteria carried by domestic livestock are particularly pathogenic in bighorns (reviewed by Miller 2001, US Department of Agriculture [USDA] 2006, George et al. 2008, Wolfe et al. 2010).

There are two active domestic sheep grazing allotments along the northern boundary of RBS-12 (Figure 12), as well as numerous hobby sheep and goat livestock operations within the DAU. In the Sugarloaf Peak allotment, 1,300 domestic sheep graze annually from June 25-September 30, while 800 domestic sheep graze the Meadow-Vail allotment annually from June 13-September 25. As such, the potential for contact between wild and domestic sheep continues to exist within this DAU; therefore, on-going and future management actions should focus on maintaining effective separation between the species (WAFWA 2010). Pioneering bighorn sheep, particularly young rams, are most likely to co-mingle with domestic sheep and goat livestock. Conversely, stray domestic sheep are also likely to associate with wild sheep groups if they are separated from their primary band. Sheep, wild and domestic, are highly gregarious by nature and are likely to interact with other sheep as they encounter one another.

In addition to the potential for pathogen introduction via interactions with domestic livestock, some respiratory pathogens likely are already endemic in bighorn bands residing in RBS-12 and adjacent ranges. The Almont/Taylor River bighorn herd that occupies range west of S-11 and S-17 has a long history of chronic respiratory disease problems and could be a source of pathogens were immigration or range overlap to occur. A recent flare-up of respiratory disease in the Granite herd that winters east of S-11 (Grigg et al. 2017) also could be a source of pathogens. Managing bighorn abundance in RBS-12 as prescribed should help minimize the potential for interaction with neighboring bighorn herds that could be an added source of pathogens.

The potential for pathogen introduction from mountain goats also could contribute to respiratory disease risk in RBS-12, as discussed separately below.

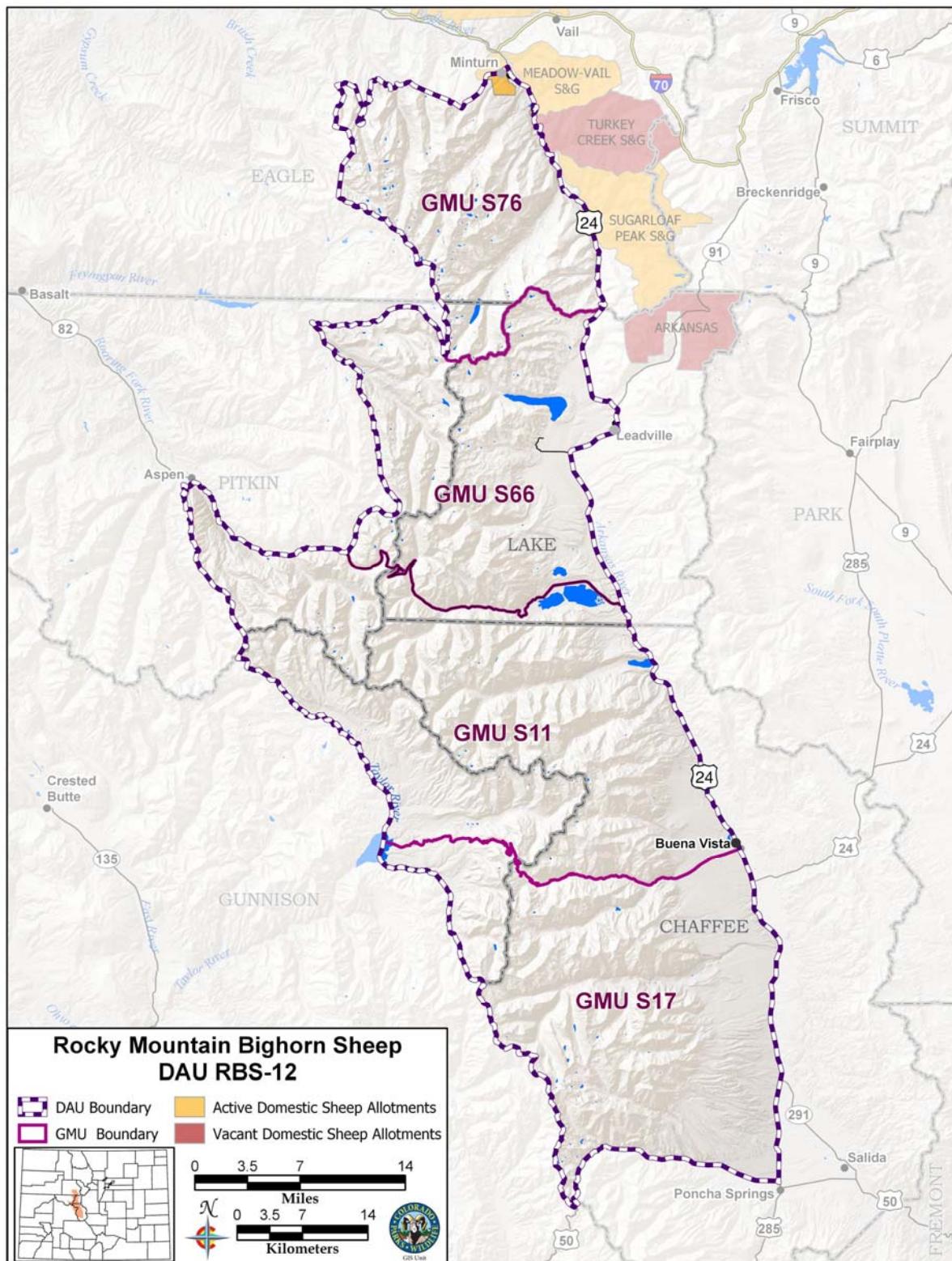


Figure 12. Active and inactive domestic sheep grazing allotments in proximity to RBS-12.

## Recreational impacts

Perpetually-increasing recreational use from hikers, backpackers, mountain bikers, and backcountry skiers is another primary concern for bighorn sheep in RBS-12. Recreation is a driving economic force in local communities and occurs throughout the year. These communities continue to grow, resulting in rising demands for recreational opportunities, higher impacts on natural resources, and potential increases in habitat fragmentation. Quality wildlife habitat includes food, water, shelter, space, and connectivity, which is imperative to maintaining healthy wildlife populations. Large blocks of contiguous habitat are most likely to promote the long-term viability of a species. Habitat becomes fragmented as land use changes break the landscape into smaller more distinct “patches.” These patches may not provide fundamental habitat requirements resulting in a diminished carrying capacity for the species across the landscape. Wildlife living within fragmented habitat is more vulnerable to stochastic population declines stemming from disease, increased rates of predation, or habitat loss or modifications. Fragmentation often leads to diminished immigration and emigration rates that are vital for promoting genetic diversity, range expansion, and recolonization in the event of localized extirpation. Most wildlife managers agree, with support from the scientific literature, that recreation has the potential to impact wildlife distribution and abundance (Joslin and Youmans 1999, Valdez and Krausman 1999, Papouchis 2001, Taylor and Knight 2003, Keller and Bender 2007, Naylor et al. 2008, Goldstein et al 2010, Courtemanch 2014). The “zone of influence” of recreational activities for wildlife may extend for some distance beyond the actual activity and will vary depending on habitat composition, topography, and a species’ tolerance of human disturbance.

Bighorn sheep inhabit open country and are particularly vulnerable to disturbance from recreation. For example, sheep will often flee at the sight of humans on a distant ridge, even when they are a considerable distance away (Holl and Bleich 1983, Courtemanch 2014). Ewes with young lambs are particularly flighty and every effort should be made to document and protect lambing and nursery areas from excessive disturbance. In a previous section density-dependent influences were discussed; human activity, including recreation, may perpetuate higher densities of bighorn sheep in areas where they seek refuge from disturbance resulting in unintended impacts on the population. During aerial surveys in the summer and fall, it is standard to see large numbers of hikers on each of the high peaks in RBS-12, while bighorns generally avoid the human intrusion in those areas. It's currently estimated that approximately 340,000 people climb Colorado's 58 14ers each year, more than a dozen of which occur in RBS-12. These peaks draw high levels of recreational interest, increasing potential negative or unintended impacts, such as higher level of disturbance on alpine bighorn sheep populations in RBS-12 and elsewhere by users.

Winter range is also crucial for bighorn sheep across Colorado. The needs of wildlife in the winter should be carefully considered during all land-use and recreational planning. Disturbance from recreation is typically unnecessary and additive during the winter months when bighorn are already on a downward starvation curve. Some bighorn populations have no choice but to habituate to human activities during the winter; however, activities such as snowmobiling, dog walking (i.e. dogs off-leash harassing wildlife), and backcountry skiing all have significant potential to disturb and displace wintering sheep (Graham 1980, MacArthur et al. 1982, Etchberger et al. 1989, Courtemanch 2014).

Recreation has the potential to limit the overall range of bighorn and discourage use of suitable habitats that are consumed by human activities. CPW biologists intend to continue

working with federal agencies, Non-Governmental Organization's (NGO's), and local jurisdictions in the future to ensure that recreational activities are not detrimental to bighorn sheep in RBS-12.

### Mountain Goat/Bighorn Interactions

Mountain goats were first introduced into Colorado in 1948 with the intent of establishing populations that would support controlled hunting (Hibbs 1966). Subsequent translocations occurred in several areas around the state during the next 25 years. Mountain goats provide unique wildlife viewing and hunting opportunities and have proven to be extremely effective at pioneering into new areas. Issues related to sympatric bighorn and mountain goat populations are comprehensively discussed in the Colorado Bighorn Sheep Management Plan (2009). Management concerns include the potential for pathogen introduction and the potential for resource competition within a given habitat once mountain goat populations become established, thereby potentially reducing bighorn population vigor.

A sizable mountain goat population of approximately a combined 400 goats currently exist in GMUs G-1, G-2, G-3, G-13, G-14, and G-17 along the Continental Divide. These units generally overlap with the RBS-12 bighorn population, likely resulting in a competition for resources, especially during crucial winter months.

### Hunter Harvest Objectives and Management

#### Ewe Hunting

Increasing densities of bighorn create unique management ramifications, specifically regarding disease and the potential for increased susceptibility to disease and disease transmission. Bighorns, particularly ewe groups, are often slow to pioneer into vacant habitat, and therefore tend to congregate in the same places year after year. As the population grows, densities increase in these traditional use areas, which may lead to localized habitat degradation, reduced animal body condition and vigor, and subsequent increased vulnerability to disease.

Wild sheep studies conducted on Ram Mountain in Alberta, Canada, offer some valuable insight into the role density plays in bighorn population dynamics. Results from these studies indicated that lamb mass and winter survival decreased as population density increased (Portier et al. 1998), that yearling female survival was negatively affected by density, and that age at first reproduction was also negatively correlated with population size (Jorgenson et al. 1997). Establishing conservative ewe harvest may reduce intraspecific competition, increase juvenile survival, lower age at first reproduction, provide hunter opportunity, increase hunter attained herd information, encourage use of new habitats/dispersal, and possibly reduce the risk and severity of disease outbreaks.

Recommendations for ewe harvest are presented in the Colorado Bighorn Sheep Management Plan (George et al 2009). These recommendations should provide managers with the general framework for establishing ewe hunting seasons across the state (Table 3). In the plan, off-take rates revolve around a population objective and observed winter lamb:ewe ratios. Healthy bighorn sheep populations (i.e., high winter lamb:ewe ratios and adult survival) can sustain relatively high levels of annual female harvest. For example, in a population that is at objective with an observed winter lamb:ewe ratio of 25:100, the recommendation is for an off take of <12% of the prehunt ewe population. In a population of 375 sheep with a

ram:ewe:lamb ratio of 50:100:25, that would equate to a harvest of ~25 ewes. In RBS-12, we currently lack sufficient data to recommend this level of harvest. However, managers will consider additional ewe hunting opportunity and strategies in the future if the population continues to be stable-increasing. Consideration will be given so that ewes in sub-herds that are most accessible to hunters are not overharvested, and that impacts are minimized on social structure and “legacy” movement patterns. Ewe seasons and ram seasons may overlap but the hunting of ewes should not interfere with the quality of the hunt experienced by ram hunters. In the absence of a specified population objective, managers will adapt harvest on an annual basis based on the best available data and information available, and whether the herd is at, or exceeds the expected population size objective.

Table 4. Recommended ewe removal rates via hunting and translocations from Colorado's Bighorn Sheep Management Plan.

<i>Estimated Population in Relationship to Objective</i>	<i>Observed Winter Lamb:Ewe Ratio</i>	<i>Ewe Removal or Harvest Rate as a Percentage of Total Population</i>	<i>Comments</i>
$\geq 25\%$ below	NA	No ewe removals	<i>Exceptions allowed for disease management</i>
<Objective, but within 25%	$\geq 40:100$	Up to 5% of total post hunt population $\geq 1$ year old	Or up to 12% of pre hunt ewe population
At Objective	$\geq 40:100$	5-10% of total post hunt population $\geq 1$ year old	Or 12-24% of pre hunt ewe population
	20-39:100	<5% of total post hunt population $\geq 1$ year old	Or <12% of pre hunt ewe population
	<20:100	No ewe removals	<i>Exceptions allowed for disease management</i>
Over Objective		$\geq 10\%$ of total post hunt population $>1$ year old	$\geq 24\%$ of pre hunt ewe population

#### Ram Hunting

Several strategies are outlined in Colorado's bighorn sheep management plan regarding ram harvest (George et al 2009). Ram harvest rates of 2-5% of the post-hunt population and/or 4-10% of the total post-hunt ram numbers are recommended, as long as winter lamb:ewe ratios exceed 20:100. Similar to ewe hunting, ram licenses will be driven by winter lamb:ewe ratios, sheep densities on winter ranges, and average age of harvested animals. Using a 2018 post-hunt population estimate of 375, and assuming a winter lamb:ewe ratio greater than 20:100 (preferably higher) across the DAU, RBS-12 can hypothetically sustain a harvest of between 8 and 20 rams, which is congruent with current ram harvest in the DAU. Opportunities for increasing licenses in this DAU will be considered in the future depending on population performance.

Ram hunting opportunity will be provided in RBS-12 as long as population performance allows. Ram hunting will be focused on providing a quality hunting experience, and to a lesser extent population management. Ram hunting will not be used to manage for a specified male:female ratio; however, biologists will manage ram hunting in accordance with the alternative selected during this planning process.

## ISSUE SOLICITATION PROCESS

### Stakeholder Input and 30-Day Comment Period

The draft plan was posted on the CPW website for a 30-day comment period. It was also sent to county commissioners, federal land management agencies, special interest groups, and the Wild Sheep/Domestic Sheep Working Group for review.

## MANAGEMENT RECOMMENDATIONS AND FUTURE NEEDS

### Herd Management

DAU RBS-12 will be managed as a primary (Tier 1) core population. Primary core populations are defined as those that are large ( $\geq 100$  for  $\geq 90\%$  of the years since 1986), native populations comprised of one or more interconnected herds that have received few (i.e.  $\leq 50$  animals total) if any supplemental releases in the past. RBS-12 meets those criteria.

The management strategy for the bighorn sheep herd in RBS-12 is to maintain the population at a stable level and reduce the potential for catastrophic disease outbreaks causing mortality and suppressed lamb recruitment. Currently, CPW's primary management tools are hunting, habitat manipulations and improvements, and disease monitoring.

### Reducing the Risk of Pathogen Transmission from Livestock

Regarding livestock and disease transmission, the following management goal is established in Colorado's statewide management plan (George et al. 2009):

- *CPW will strive to prevent introductions of infectious or parasitic diseases from domestic livestock that could adversely impact bighorn population performance and viability. CPW will work cooperatively with the USFS, BLM and private landowners to minimize the potential for bighorn sheep to contact domestic livestock whenever practicable.*

To this end, Colorado Parks and Wildlife advocates strict adherence to recommendations presented in the Western Association of Fish and Wildlife Agencies (WAFWA), *Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat* (2010) and U.S. Animal Health Association's, *Recommendations on best management practices for domestic sheep grazing on public land ranges shared with bighorn sheep* (2009). These types of recommendations and Best Management Practices (BMP's) are only effective if consistently implemented and rigorously enforced. WAFWA managers emphasize the goal of "effective

*separation,*" which they define as "spatial and/or temporal separation between wild sheep and domestic sheep or goats resulting in, at most, minimal risk of potential association and subsequent transmission of respiratory disease between animal groups."

### Population objective range

The current population estimate in RBS-12 is stable at approximately 375 animals. Current ewe harvest in RBS-12 provides opportunity, but is not expected to control population growth within the DAU. Therefore, the key limiting factor in past and current population growth is attributed to winter range carrying capacity, and the potential for disease transmission following contact with domestic livestock. Considering bighorn distribution, winter range capability, population density/density dependence, and the potential risks of contact with domestic livestock, the following management objective was selected:

#### *Preferred Alternative: Population target 400 sheep (range 350-400)*

- This alternative will:
  - Maintain the current density of bighorn sheep across modeled winter ranges, index density if and when the model is refined. Density on winter ranges should not exceed 1.0 bighorn/mi<sup>2</sup>
  - Encourage managers to respond with increased ewe licenses if densities exceed winter range capacity
  - Encourage managers to consider non-lethal harassment, targeted hunting licenses, or managed culling if individual or small groups of bighorn expand their range into novel areas where the risk of contact with domestic livestock or wild sheep or goat herds of concern is considered too high
  - Assume that the risk of contact with domestic livestock is maintained at the current level
  - Allow for current watchable wildlife opportunities to be maintained

#### *Alternative 2: Population target 350 sheep (range 300-350)*

This alternative would result in a decrease from the current population and represents an available winter range density of 0.5 sheep/mi<sup>2</sup>.

#### *Alternative 3: Population target 450 sheep (range 400-450)*

This alternative would result in an increase from the current population and represents an available winter range density of 1.0 sheep/mi<sup>2</sup>.

### Ram and Ewe Harvest Objective Alternatives

Ram and ewe hunting will continue throughout RBS-12 as long as population performance allows. Hunter crowding, hunter experience, age of harvested rams, and maintaining watchable wildlife opportunities are all factors that are to be considered when discussing bighorn harvest management. The harvest management objectives in this DAU will focus on average age of harvested ram and allows for ewe harvest to manage population size and winter range densities.

*Preferred alternative: Maintain a 3-year average age of 6-8 for hunter harvested rams.*

- This alternative will essentially maintain the current harvest regime in the DAU. Moderate ram license increases may be possible based on population performance. This alternative should provide a quality experience, moderate levels of crowding, and diverse age-classes of rams.

*Preferred alternative: Maintain ewe harvest as a population management tool as well as to allow for hunter opportunity.*

- This alternative allows for ewe harvest depending on population performance and winter range densities.

*Alternative 2: Maintain a 3-yr average age of rams harvested of 5-7 years old.*

Under this alternative, ram license allocation may increase which is expected to decrease the age of harvested rams. Similarly, the horn size of the harvested rams would likely decrease.

*Alternative 3: Maintain a 3-yr average age of rams harvested of 7-9 years old.*

Under this alternative, ram license allocation would likely decrease but average age of ram harvested and horn size would increase.

## Strategies for Achieving Objectives

The selected preferred alternatives are supported by the current management for both rams and ewes within RBS-12. Therefore, it is not expected that significant changes will be needed to achieve the preferred alternatives.

## Strategies for Addressing Management Concerns

In this plan, we have identified four significant issues to managing bighorn sheep in RBS-12, which include habitat limitations, disease transmission, recreational impacts, and the potential for bighorn sheep/mountain goat competition. Here are our strategies to address these issues:

- CPW will manage ram harvest to maintain an average age of ram harvested between 6-8 years of age.
- CPW will manage ewe harvest to keep the population within the objective range.
- CPW will manage hunting licenses for mountain goats overlapping with RBS-12 to ensure the continued conservation of the bighorn sheep population.
- CPW will actively comment on land use proposals that involve domestic grazing and recreation, and to the extent possible, will align comments with the conservation of bighorn sheep.
- CPW will continue to pursue potential habitat improvement projects that could benefit bighorn sheep in RBS-12.

## LITERATURE CITED

Bear, G. D. and G. W. Jones, 1973. *History and distribution of bighorn sheep in Colorado*. Colorado Division of Wildlife Game Research Report. 232pp.

Beecham, J. J. Jr., C. P. Collins, and T. D. Reynolds. 2007. *Rocky Mountain Bighorn Sheep (Ovis canadensis): a technical conservation assessment*. USDA Forest Service, Rocky Mountain Region. <http://www.fs.fed.us/r2/projects/scp/assessments/rockymountainbighornsheep.pdf>

Cassirer, E.F., Manlove, K.R., Almberg, E.S., Lamath, P.L., Cox, M., Wolff, P., Rough, A., Shannon, J., Robinson, J., Harris, R.B., Gonzales, B.J., Plowright, R.K., Hudson, P.J., Cross, P.C., Dobson, A., Besser, T.E. 2018. Pneumonia in bighorn sheep: risk and resilience. *Journal of Wildlife Management* 82: 32-45.

Courtemanch, A. 2014. *Seasonal Habitat Selection and Impacts of Backcountry Recreation on a Formerly Migratory Bighorn Sheep Population in Northwest Wyoming, USA*. Master's Thesis. University of Wyoming.

Etchberger, R. C., P. R. Krausman, and R. Mazaika. 1989. Mountain sheep habitat characteristics in the Pusch Ridge Wilderness, Arizona. *Journal of Wildlife Management* 53:902-907.

George, J. L., D. J. Martin, P. M. Lukacs, and M. W. Miller. 2008. Epidemic Pasteurellosis in a Bighorn Sheep Population Coinciding with the Appearance of a Domestic Sheep. *Journal of Wildlife Diseases*. 44: 388-403.

George, J. L., L. Wolfe, and M. Miller. 2008. Bighorn sheep capture and translocation guidelines. Colorado Division of Wildlife. Unpublished report. 48 pp.

George, J. L., R. Kahn, M. W. Miller, and B. Watkins. 2009. Colorado Bighorn Sheep Management Plan 2009-2019. Colorado Division of Wildlife Special Report. 88pp.

Ghormley, R. 2010. Final Supplement to the Forest Plan Biological Evaluation and Conservation Assessment for Rocky Mountain Bighorn Sheep Rio Grande National Forest. San Luis Valley Public Lands Center. March 1, 2010.

Goldstein, M.I., A.J. Poe, L.H. Suring, R.M Nielson, T.L. McDonald. 2010. Brown Bear Den Habitat and Winter Recreation in South-Central Alaska. *Journal of Wildlife Management*. 74(1):35-42.

Graham, H. 1980. The impacts of modern man. Pages 288-309 in G. Monston and L. Sumner, editors. *The desert bighorn: its life history, ecology, and management*. University of Arizona Press, Tucson, AZ.

Grigg, J.L., L.L. Wolfe, K.A. Fox, H.J. Killion, J. Jennings-Gaines, M.W. Miller, and B.P. Dreher. 2017. Assessing Timing and Causes of Neonatal Lamb Losses in a Bighorn Sheep *Ovis canadensis canadensis* Herd via Use of Vaginal Implant Transmitters. *Journal of Wildlife Diseases*. 53: 596-601.

Hibbs, L. D., 1966. A literature review on mountain goat ecology. State of Colorado, Game, Fish and Parks Commission, Denver, Colorado. State Publication GFP-R-S-8.

Holl, S. A. and V. C. Bleich. 1983. San Gabriel bighorn sheep. USFS, San Bernardino NF Administrative Report.

Japuntich, R. 2011. Personal Communication. Bureau of Land Management, Gunnison Field Office.

Johnston, B. C.. 2001. Ecological types of the Gunnison Basin. USDA Forest Service Tech. Rep. R2-RR-2001-01. 858pp.

Jorgenson, J. T., M. Festa-Bianchet, J. Gaillard, and W. D. Wishart. 1997. Effects of age, sex, disease, and density on survival of bighorn sheep. *Ecology*78(4): 1019-1032.

Joslin, G., and H. Youmans, coordinators. 1999. Effects of recreation on Rocky Mountain wildlife: A Review for Montana. Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society. 307 pp.

Keller, B.J. and L.C. Bender. 2007. *Bighorn Sheep Response to Road-Related Disturbances in Rocky Mountain National Park, Colorado.* The Journal of Wildlife Management. 71(7):2329-2337

Lawrence, P.K., S. Shanthalasingam, R. P. Dassanayake, R. Subramaniam, C.N. Herndon, D.P. Knowles, F.R. Rurangirwa, W.J. Foreyt, G. Wayman, A.M. Marciel, S.K. Highlander, and S. Srikuamran. 2010. *Transmission of Mannheimia Haemolytica from Domestic Sheep (Ovis Aries) to Bighorn Sheep (Ovis Canadensis): Unequivocal Demonstration with Green Fluorescent Protein-tagged Organisms.* Journal of Wildlife Diseases 46(3), pp.706-717.

MacArthur, R. A., V. Geist, and R. H. Johnston. 1982. *Cardiac and behavioral responses of mountain sheep to human disturbance.* Journal of Wildlife Management 46:351-358.

Miller, M. W. 2001. *Pasteurellosis.* In *Infectious Diseases of Wild Mammals, 3<sup>rd</sup> edition,* E. S. Williams and I. K. Barker (eds.). Iowa State University Press, Ames, Iowa, pp. 330-339.

Moser, C. A. 1962. *The Bighorn Sheep of Colorado.* The Colorado Game and Fish Department. 49pp.

Memorandum of Understanding (MOU). 2009. *Memorandum of Understanding for Management of Domestic Sheep and Bighorn Sheep.* Forest Service Agreement No. 09-MU-11020000-006. BLM Agreement No. BLM-MOU-CO-482.

Naylor, L.M., M.J. Wisdom, R.G. Anthony. 2008. *Behavioral Responses of North American Elk to Recreational Activity.* Journal of Wildlife Management. (73)3: 328-338.

Orear, L. 1917. *The Battle of the Crags, told to Leslie Orear; When the Shadow of Death Swept from the Sky Above the Lofty Peaks.* Outing magazine. 552-558.

Portier, C., M. Festa-Bianchet, J. Gaillard, J. T. Jorgenson, and N. G. Yoccoz. 1998. *Effects of density and weather on survival of bighorn sheep lambs (Ovis canadensis).* J. Zool. 245: 271-278

Schommer, T. J. and M. M. Woolever. 2008. *A Review of Disease Related Conflicts Between Domestic Sheep and Goats and Bighorn Sheep.* Gen. Tech. Rep. RMRS-GTR-209 Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 17pp.

Taylor, A.R. and R.L. Knight. 2003. *Wildlife Responses to Recreation and Associated Visitor Perceptions.* Ecological Applications. 13(4): 951-963.

United States Department of Agriculture (USDA). 2006. *Risk Analysis of Disease Transmission Between Domestic Sheep and Bighorn Sheep on the Payette National Forest.* Forest Service. Intermountain Region. Payette National Forest. 800 West Lakeside Avenue P.O. Box 1026 McCall, ID 83638.

Valdez R., and P.R. Krausman (editors). 1999. *Mountain Sheep of North America.* University of Arizona Press, Tucson. 353 pp.

Wallace, H. 1940. *Rocky Mountain Sheep Study*. Colo. Fed. Aid Rept. Jan.-Dec.: 1-29.

Wehausen, J. D., S. T. Kelley, and R. R. Ramey II. 2011. Domestic sheep, bighorn sheep, and respiratory disease: a review of the experimental evidence. *California Fish and Game* 97(1):7-24.

Western Association of Fish and Wildlife Agencies (WAFWA) Wild Sheep Working Group. 2010. *Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat*. July 21, 2010. 29 pp. <http://www.wafwa.org/html/wswg.shtml>.

Wolfe, L. L., B. Diamond, T. R. Spraker, M. A. Sirochman, D. P. Walsh, C. M. Machin, D. J. Bade, and M. W. Miller. 2010. A bighorn sheep die-off in southern Colorado involving a Pasteurellaceae strain that may have originated from syntopic cattle. *Journal of Wildlife Diseases* 46 (4): 1262-1268.

U.S. Animal Health Association. 2009. *Recommendations on best management practices for domestic sheep grazing on public land ranges shared with bighorn sheep*. USAHA Joint Working Group Committee on Wildlife Diseases & Committee on Sheep & Goats. 8 pp.

USDI Bureau of Land Management. 1992. *Instruction Memorandum 92-264. Guidelines for Domestic Sheep Management in Bighorn Sheep Habitats*. USDI-BLM, Washington, DC. 3 pp.

USDI Bureau of Land Management. 1998. *Instruction Memorandum 98-140. Revised Guidelines for Management of Domestic Sheep and Goats in Native Wild Sheep Habitats*. USDI-BLM, Washington, DC. 6 pp.

USDI Bureau of Land Management. 2011. *Instruction Memorandum ID-2011-004, 2011. Separation Response Plans for Bighorn Sheep, Domestic Sheep and Goats*. USDI-BLM, Idaho State Office, Boise, ID. 4 pp.

## APPENDIX A: Colorado Wool Growers Association Comment Letter



PO Box 292 ° Delta, CO 81416-0292 ° (970) 874-1433 ° (970) 874-4170 fax  
cwgawool@aol.com ° coloradosheep.org

Colorado Parks & Wildlife  
Jamin.grigg@state.co.us

November 14, 2019

Re: Collegiate Range Bighorn Sheep Herd Management Plan – DAU RBS – 12

The Colorado Wool Growers Association (CWGA) appreciates the opportunity to provide comments on the Collegiate Range Bighorn Sheep Herd Management Plan. The CWGA supports the Preferred Alternative: Population target 400 sheep (range 350-400).

RBS-12 is a stable and huntable bighorn population. Since at least 1980, the population has been increasing in a complex and crowded environment that includes domestic sheep grazing. The herd management plan singles out domestic livestock grazing and pathogen transmission as a significant factor in bighorn herd health, yet the plan fails to acknowledge the most recent and significant scientific research that has identified *Mycoplasma ovipneumoniae* (*M. ovi*) in other wildlife species. Livestock and wildlife have comingled on our western rangelands for more than a century. The concept that domestic sheep introduced a novel pathogen to bighorns when the West was settled seems likely but is purely speculative, and ignores that fact that other wildlife species can serve as disease reservoirs.

The Mycoplasmas: Molecular biology, Pathogenicity, and Strategies for Control textbook states: “assumptions about restricted host range of mycoplasmas, based on the host from which they were first or frequently isolated, are usually made in the context of nearly complete absence of representative sampling of the vast majority of potential hosts.”

Winter habitat, fragmented habitat, population density, and intense recreational pressure appear to play a much larger role in bighorn herd health than does livestock grazing.

The CWGA supports taking reasonable steps to minimize potential contact, but we do not support managing for “zero risk”. We support educational efforts (*Reducing Interactions Between Bighorn & Domestic Sheep brochure*) to inform both small and large sheep farms and ranches of efforts they need to take to minimize contact, but we do not support telling sheep owners that they need to stop raising sheep or change to other species of livestock.

Respectfully,

*Ernie Etchart*

President