

BIGHORN SHEEP MANAGEMENT PLAN

DATA ANALYSIS UNIT RBS-8 Pikes Peak/Dome Rock/Beaver Creek Herd

GAME MANAGEMENT UNITS S5, S6, S46

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DAU RBS-8 (Pikes Peak Bighorn Sheep) EXECUTIVE SUMMARY

GMUs: S5, S6, S46. **Tier Status:** 1 (large, native population with no historic supplementation)
Land Ownership: 47% Private, 25% USFS, 14% BLM, 7% State, 3% CDOW, 2% City, 1% NPS, 1% County
Posthunt Population: **Previous Objective** 350 (S-6) 75 (S-46) **2009 Estimate** 110 **Recommended Obj.** 240 (225-275)
Posthunt Sex Ratio: **Previous Objective** 80 (S-6) 35 (S-46) **2009 Estimate** 53 **2009 Modeled** 50 **Recommended Obj.** 50 (45-55)

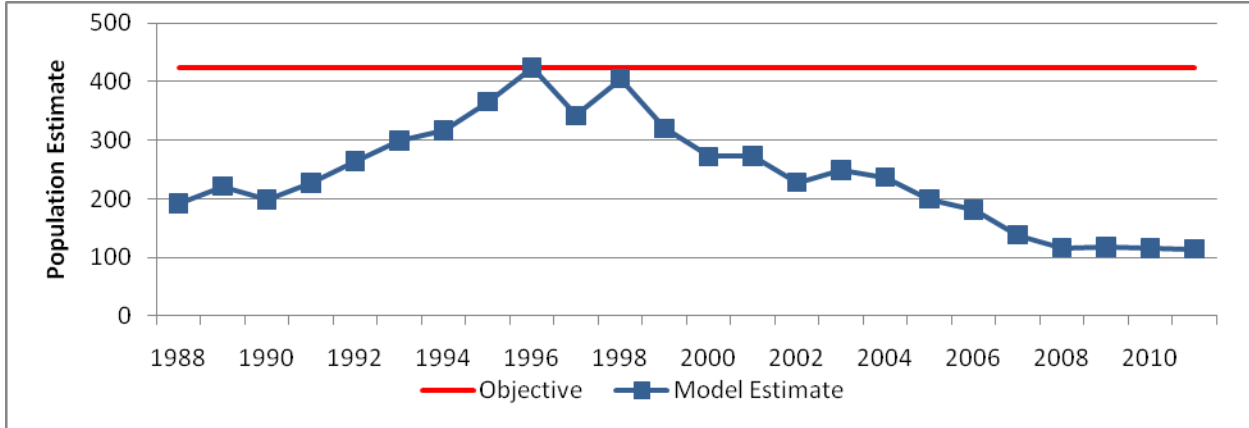


Figure 1. RBS-8 bighorn posthunt modeled population estimate and objective range from 1988 to 2011 (projected).

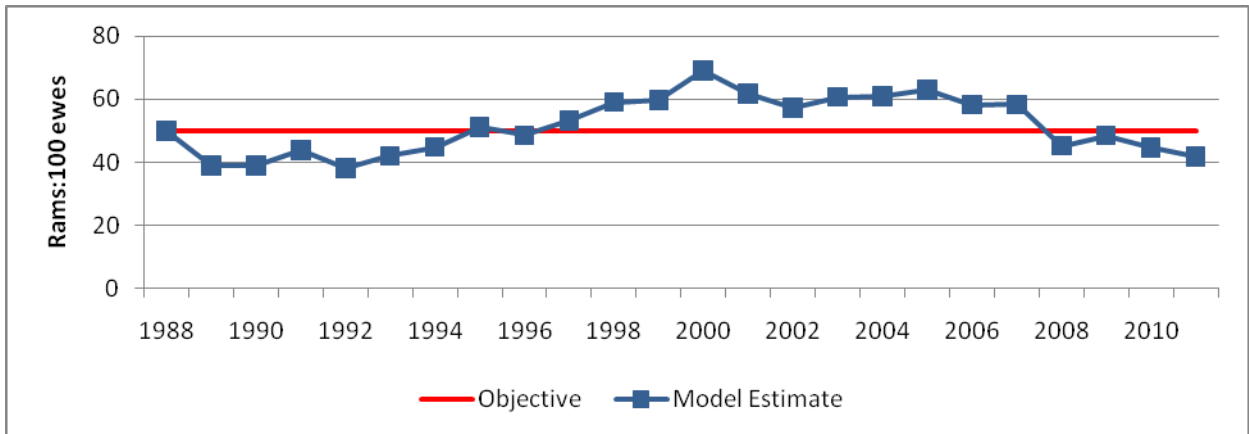


Figure 2. RBS-8 bighorn posthunt modeled sex ratio estimate and objective range from 1988 to 2011 (projected).

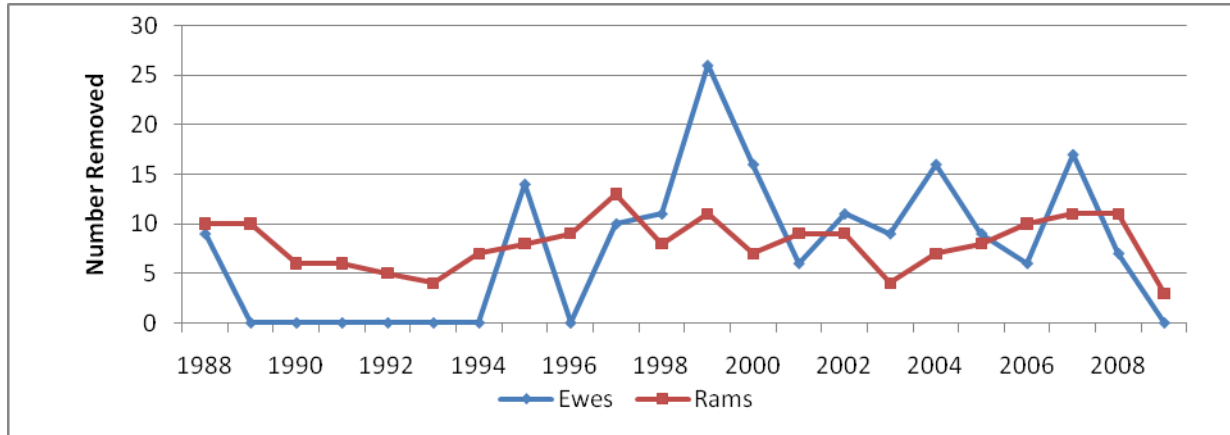


Figure 3. RBS-8 ram and ewe removals via harvest and translocations from 1988 to 2009.

Background Information

The Pikes Peak/Dome Rock/Beaver Creek herd (Rocky Mountain Bighorn Sheep Data Analysis Unit RBS-8) was once thought to be one of the largest herds in Colorado. It is a native herd and is valued for its recreational opportunities including hunting and wildlife viewing, especially on Pikes Peak. It is designated as a Tier 1 population.

RBS-8 consists of Game Management Units S-5 (Beaver Creek), S-6 (Pikes Peak), and S-46 (Dome Rock). It encompasses 521 squares miles in El Paso, Teller, and Fremont counties. The nearest municipalities include Colorado Springs, Woodland Park, and Canon City. Most of S-6 is comprised of US Forest Service land but also includes a high percentage of private property. There is a high percentage of private property in both S-5 and S-46, as well. In S-5, much of the land is managed by the Bureau of Land Management, while in S-46, a high percentage is managed by the state. Most of the sheep in the herd are found in S-6 and S-46. Occasionally the Colorado Division of Wildlife receives reports of sheep in S-5 but the population is thought to number less than 10. Only S-6 and S-46 are currently open to hunting.

Population numbers in the DAU have fluctuated from 30-40 animals in the early 1950's to a modeled estimate of 425 in the mid-1990's. Over the last decade, the population has declined from around 300 animals to 110-120 in 2009. Disease has been implicated as a possible cause of the recent decline. The current population objective for the herd is 425 animals (350 in S-6 and 75 in S-46) and the sex ratio objective is 80 rams per 100 ewes in S-6 and 35 rams per 100 ewes in S-46. The current population objective and the sex ratio objective in S-6 appear too high to be supported.

Threats to the population include disease outbreaks following interaction with domestic animals, human recreation, habitat loss due to human development, and forest encroachment.

Population Objective Alternatives

This DAU plan presents three population objective alternatives. All three alternatives represent a decrease from the current objective. Alternative 1 is for a population of 240 (range 215-265) and the population would need to double (increase by 100%) from its current size to reach this objective. Alternative 2 is for a population of 195 (range 175-215). The population would need to increase by 65% to reach this objective. Alternative 3 is for a population of 300 (range 270-330). The population would need to increase by 2.5 times (250%) to reach this objective.

Sex Ratio Objective Alternatives

The DAU plan presents three sex ratio objective alternatives. Alternative 1 is a sex ratio of 50 rams per 100 ewes (range 45-55). This is the long-term average summer sex ratio for the herd. Alternative 2 is a sex ratio of 60 rams per 100 ewes (range 55-65). For 2007 and 2008, the two-year average postseason sex ratio was 60. Alternative 3 is a sex ratio of 75 rams per 100 ewes (range 70-80). The sex ratio would have to increase by 25% to achieve this sex ratio.

Preferred Alternatives

The CDOW recommends Population Objective Alternative 1: 240 (215-265) bighorn. Based on historic data, the range appears to be biologically realistic for current conditions on Pikes Peak. Additionally, the population size of 240 is expected to reduce the probability of catastrophic disease epidemics. This alternative is expected to provide a higher number of sheep than currently exist in 2010, including both ewes and rams, available for harvest. This alternative would also provide wildlife viewers on Pikes Peak with ample viewing opportunities.

The CDOW recommends Sex Ratio Objective Alternative 1: target 50 (45-55) rams per 100 ewes. This objective encompasses the long-term sex ratio for the herd suggesting this is a realistic and biologically appropriate objective. Additionally, at this objective, we expect to be able to maintain a similar number of ram licenses in RBS-8 to the proportion of licenses (relative to the posthunt population size) currently available.

This DAU plan was approved by the Colorado Wildlife Commission on January 5, 2011

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INTRODUCTION AND PURPOSE

The Colorado Division of Wildlife (CDOW) manages big game for the use, benefit, and enjoyment of the people of the state in accordance with the CDOW's Strategic Plan (2010-2020), and for bighorn sheep, with the Colorado Bighorn Sheep Management Plan (George et al. 2009). Bighorn sheep management is also determined by mandates from the Colorado Wildlife Commission 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 CDOW uses a "Management by Objective" approach to manage the state's big game populations (Figure 4).

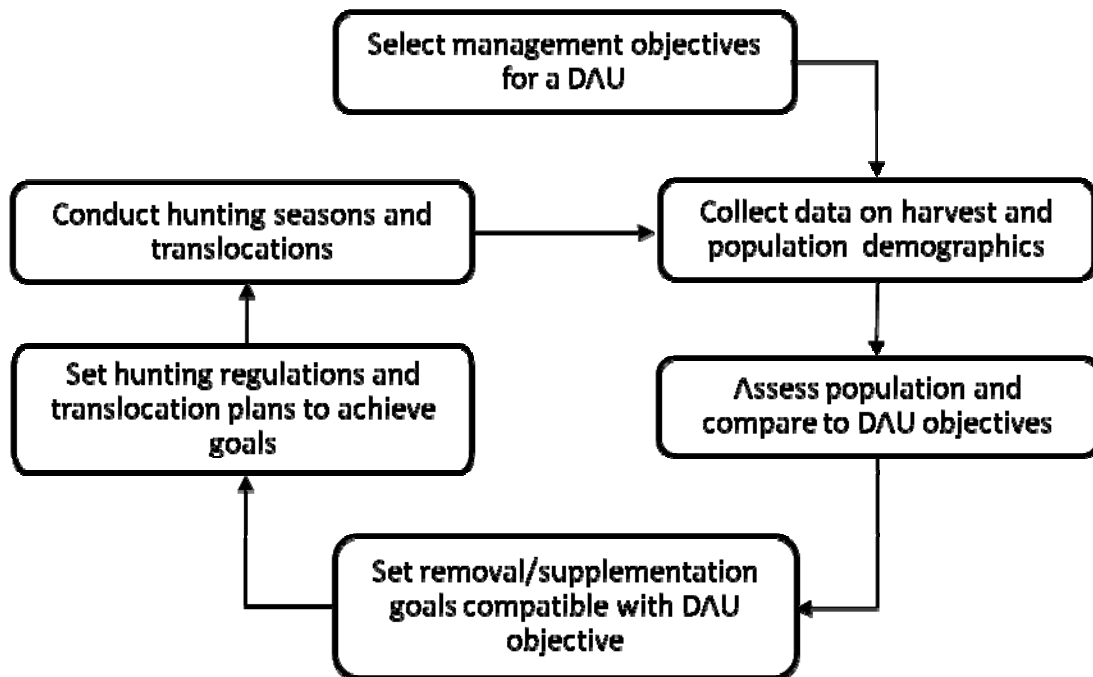


Figure 4. Management by Objective process used by the Colorado Division of Wildlife to manage big game populations by Data Analysis Unit.

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 the majority 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) in order to distribute hunters and harvest within a DAU.

Management decisions within a DAU are based on a DAU plan. The primary purpose of a DAU plan is to establish population and sex ratio (i.e., the number of males per 100 females)

objectives for the DAU. The DAU plan also describes the strategies and techniques that will be used to reach these objectives. During the DAU planning process, public input is solicited and collected through questionnaires, public meetings, and comments to CDOW staff and the Colorado Wildlife Commission. The intentions of the CDOW 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 general public. In preparing a DAU plan, agency personnel attempt to balance the biological capabilities of the herd and its habitat with the public's demand for wildlife recreational opportunities. DAU plans are approved by the Colorado Wildlife Commission and are reviewed and updated every 10 years.

The DAU 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 DAU 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 4).

The purpose of this DAU plan is to set population and sex ratio objectives for the Pikes Peak/Dome Rock/Beaver Creek bighorn sheep herd (RBS-8). The DAU plan will be in place from 2010-2020 with the expectation that it will be reviewed and updated in 2020.

DESCRIPTION OF DAU

Location, Boundaries, and Land Management

The Bighorn Sheep DAU RBS-8 includes GMUs S-5, S-6, and S-46 (Figure 5). The DAU encompasses 521 square miles. S-6 is the largest GMU in the DAU at 226 square miles. S-5 is the second largest at 222 square miles followed by S-46 at 73 square miles. The primary landownership/management types in the DAU are private (47%), US Forest Service (USFS, 25%), Bureau of Land Management (BLM, 14%), State Land Board (SLB, 6%), and Colorado Division of Wildlife (CDOW, 3%). The remaining 5% of land is divided amongst properties owned by the City of Colorado Springs, El Paso and Teller Counties, the National Park Service, and Colorado State Parks (Figure 6).

S-6 is located in Teller and El Paso counties. It is bounded on the north by US highway 24; on the west by Colorado highway 67; on the south by Gold Camp Road (Forest Service Road 370); and on the east by US highway 115. The Pike National Forest makes up 48% (108 mi²) of S-6. Private entities own most (42% or 94 mi²) of the remaining land in the GMU. The City of Colorado Springs owns 5% (11 mi²) of the property in the GMU and the remaining 5% (14 mi²) of property is divided between the BLM, Teller and El Paso Counties, Colorado State Parks, CDOW, and the SLB.

S-5 is located in Fremont, Teller, and El Paso counties. It is bounded on the north by Gold Camp Road (Forest Service Road 370) and Rock Creek; on the west by Colorado highway 67; on the south by US highway 50; and on the east by US highway 115. The highest percentage of land in the GMU is owned by private entities (47% or 104 mi²). The BLM (29% or 63 mi²) and the SLB (12% or 27 mi²) manage the next highest percentage of land in the GMU. The remaining land is managed by the USFS (9% or 20 mi²) and the CDOW (2% or 7 mi²).

S-46 is located solely in Teller County. More than half (61% or 45 mi²) of the GMU is in private ownership. Dome Rock State Wildlife Area (CDOW) and Mueller State Park comprise 15% (11 mi²) and 11% (8 mi²) of the GMU, respectively. The remaining 13% (10 mi²) of the GMU is managed by the BLM, National Park Service, and SLB.

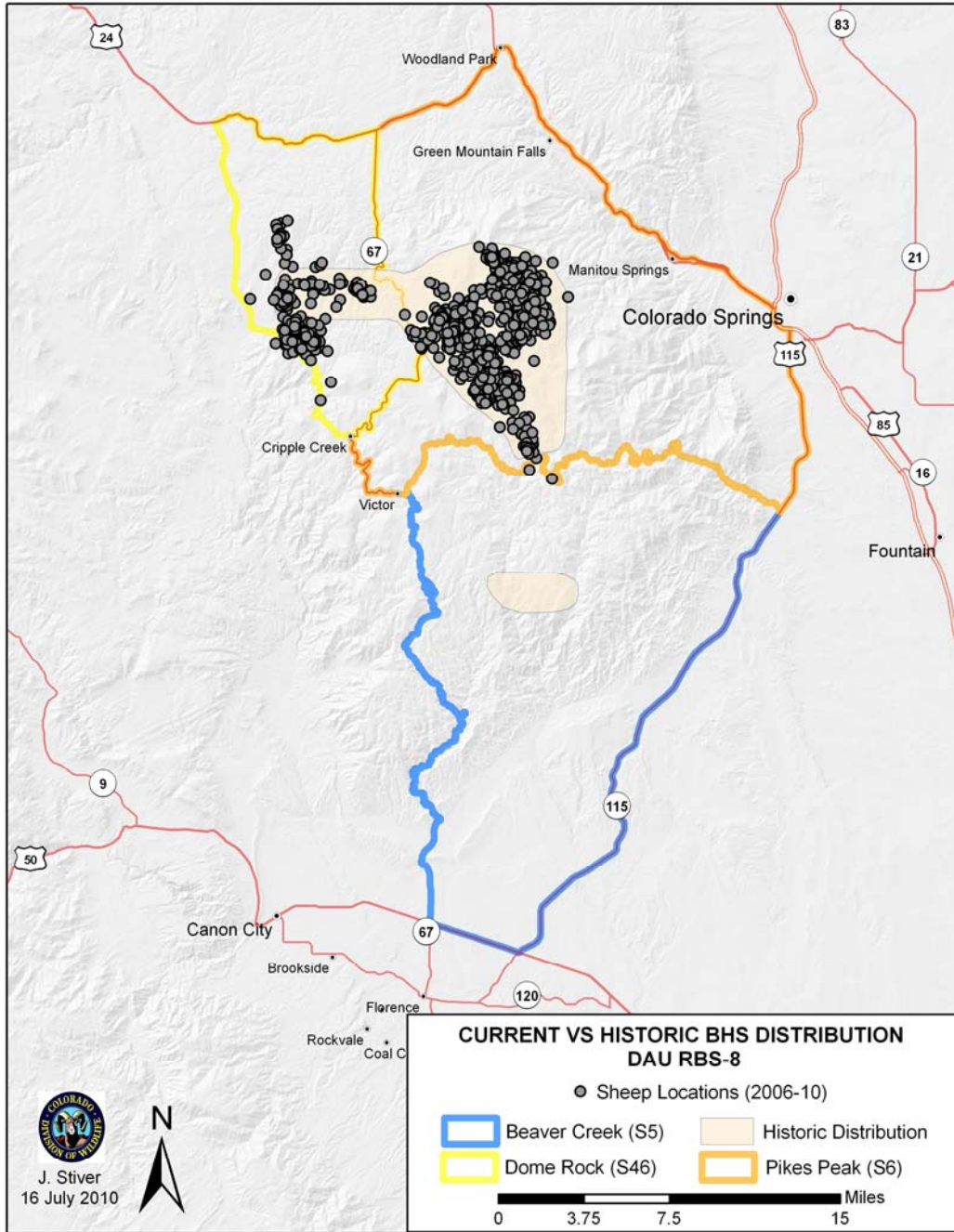


Figure 5. Sheep distribution and geographic location of bighorn sheep Data Analysis Unit (DAU) RBS-8 and Game Management Units (GMU) S5, S6, & S46. Historic sheep distribution from Bear and Jones 1973.

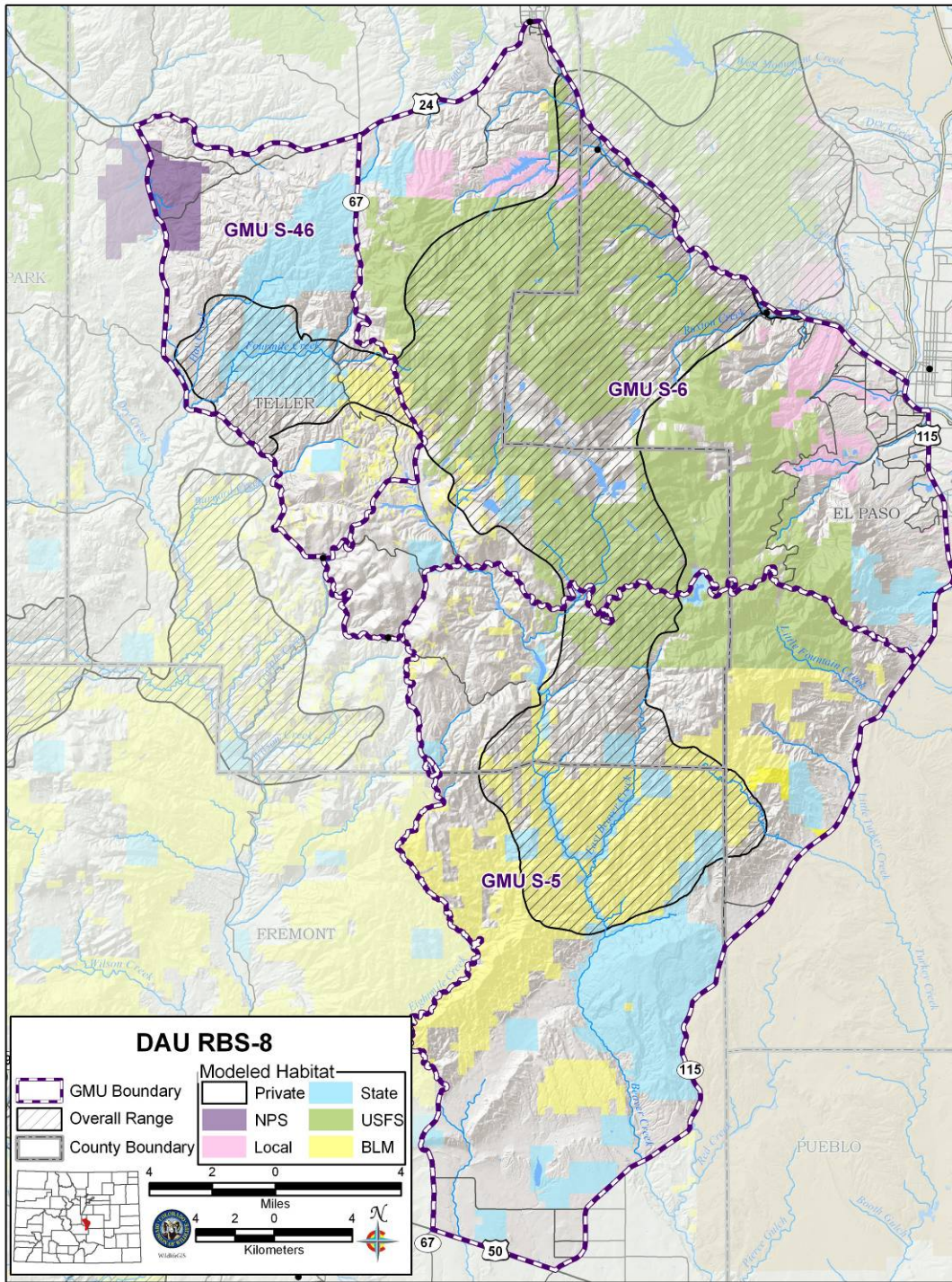


Figure 6. Land ownership in bighorn sheep DAU RBS-8.

General Physiography

Climate

Elevations in the DAU range from approximately 5,250 feet in the southern part of S-5 to 14,110 feet at the summit of Pikes Peak in S-6. Like many locations in Colorado, weather conditions in RBS-8 vary depending on elevation, with increasingly severe conditions occurring at higher elevations. Data collected from weather stations within the DAU suggest that July is the warmest month while December and January are the coldest months. The highest average snowfall occurs in March and April but snow is possible at the higher elevations throughout the year. Precipitation amounts vary across the DAU. From 1988-2009, the average annual precipitation recorded at northwest corner of S-46 was 15 inches at 8,440 feet (Florissant Fossil Beds National Monument weather station). From 1959-2009, the average precipitation was 23 inches at 9,050 feet on the northeastern of Pikes Peak (S-6; Ruxton Park weather station). Snow fall averaged 57 inches and 139 inches at the Florissant Fossil Beds and Ruxton Park, respectively.

Weather on Pikes Peak is characteristic of high elevation peaks throughout Colorado. During the summer, conditions are relatively mild during the morning hours but thunderstorms often form during the afternoon. Snow and freezing temperatures are possible throughout the year. During the winter and spring, strong winds (>100 knots) are common at the summit.

Vegetation

Above timberline (>11,500 feet), the vegetation communities are typical of alpine bedrock, scree, and tundra. However, some meadow complexes occur within the alpine on Pikes Peak. Subalpine communities comprised of spruce-fir, bristle cone and lodgepole pine, and aspen forests occur between 10,500 and 11,500 feet. Below 10,500, much of the DAU is dominated by ponderosa pine and aspen forests, although some areas contain wet meadow complexes. Pinon-juniper forests occur below 7,000 feet.

BIGHORN SHEEP POPULATION HISTORY

Historic Occurrence and Distribution

The Pikes Peak herd is native. Bear and Jones (1973) reported documented sightings by early explorers and travelers on Pikes Peak. These historic sightings presumably included Dome Rock in S-46 and Beaver Creek in S-5. However, Colley (in Bear and Jones 1973) reported that sheep use in S-46 increased between 1966 and 1972. A map of sheep distribution produced by Bear and Jones (1973) showed overlapping sheep summer and winter range on the eastern, western, and southern sides of Pikes Peak, along Fourmile Creek in S-46, and west of Crown Point in S-5 (Figure 5).

Translocations (to and from the DAU)

Bighorn sheep from both Pikes Peak and Dome Rock have been used as source populations for transplants dating back to the 1970's (Table 1). The most recent transplant occurred in 1999 when 15 sheep were captured at Dome Rock for a transplant to the Holy Cross Wilderness. We have no documented evidence that sheep in RBS-8 have been supplemented by sheep from other populations.

Table 1. RBS-8 bighorn sheep capture and release sites, 1970-2010.

Date	Capture Location	Release Site	Rams	Ewes	Yrlg	Lambs	Total
1/8/1970	Pikes Peak	Lower Lake Fork (Sapinero)	1	3	1	1	6
9/23/1970	Pikes Peak	Taylor River	0	1	0	0	1
9/23/1970	Pikes Peak	Lake Fork	1	1	0	0	2
1974	Pikes Peak	CSU	0	0	0	0	7
3/8/1977	Pikes Peak	Dillon Mesa (Soap Creek)	1	12	0	6	19
3/3/1978	Pikes Peak	Buffalo Peaks	2	5	0	1	8
3/28/1978	Pikes Peak	Buffalo Peaks	1	3	0	0	4
1/23/1988	Pikes Peak	Cedar Springs Gulch (Texas Creek)	3	9	0	8	20
3/10/1995	Dome Rock	Deep Creek	0	14	1	5	20
3/18/1997	Dome Rock	Dinosaur	2	11	0	8	21
4/8/1999	Dome Rock	Holy Cross Wilderness	2	11	2	0	15

Population History and Past Inventory Methods

The first reported count of bighorn sheep in the Pikes Peak herd was conducted in 1948, when a total of 29 animals were observed on Sheep Mountain (Bear and Jones 1973). Jones conducted a more comprehensive survey of Pikes Peak in 1949 and reported observing 205 sheep. In subsequent surveys, Jones reported observing 147 sheep in 1951 and 297 sheep in 1952. Periodic ground and aerial surveys were conducted on Pikes Peak through 1970 (Table 2).

In 1988, the Colorado Division of Wildlife initiated coordinated one-day counts of sheep on Pikes Peak. Counts were conducted in all but three years from 1988 through 2006 (Table 3). The goal of the counts was to enumerate the minimum number of sheep in the herd and to estimate age and sex ratios. The counts included 12 established walking routes where observers were asked to count, classify, and spatially document sheep observed along the counts. Spatial and temporal data were collected in an attempt to minimize duplicate sightings. The routes were devised to encompass most of the summer habitat on Pikes Peak.

Dense habitat and rugged terrain in S-46 has made population inventory from both the ground and air difficult. In October 1970, biologists counted 83 sheep in Fourmile area from a helicopter but reported it as only a partial count due to the amount of cover in the area (Bear and Jones 1973). A winter bait site was established in the Dome Rock State Wildlife Area in 1997 for sheep capture and treatments. A survey of sheep at the site was conducted in conjunction

with baiting operations and this survey provides the best known estimates of sheep in S-46 (Table 4).

Colley (*in* Bear and Jones 1973) reported that the number of sheep S-5 was less than 20 in the late 1960's. However, historic accounts suggest that sheep numbers were much higher in the early 1900's. The Canterbury family from Howard, Colorado, hunted sheep in S-5 for sustenance and routinely observed 250 animals in Beaver Creek around 1915-1916. However, by 1937, the Canterbury's found less than 10 animals in the GMU (K. Woodruff, pers. comm.).

Division personnel periodically receive reports of sheep sightings in S-5. However, only six sheep have been observed during the only formal surveys conducted recently in S-5. Three rams each were observed in the unit during ground surveys in the summers of 1999 and 2008, respectively. The Colorado Division of Wildlife also surveyed the DAU from a helicopter during the winters of 2008-9 and 2009-10. No sheep were observed from the helicopter in either survey.

Table 2. Bighorn sheep counts, Pikes Peak, 1948-1970 (reproduced from Table 17; page 80 *in* Bear and Jones 1973).

Date	Type of Survey ^a	Bighorns Counted					Total	Remarks
		Ewes	Lambs	Yearlings	Rams	Unclassified		
1948	G	6	3	2	18	-	29	Sheep Mtn.
1949	G	90	43	34	38	-	205	Pikes Peak
1950	G	78	39	29	45	-	192	Pikes Peak
1951	G	43	34	18	52	-	147	Pikes Peak
1952	G	103	97	52	46	-	297	Pikes Peak
1953	G	2	2	0	6	-	10	Pikes Peak
8-26-55	G	-	-	-	8	-	8	Pikes Peak
8-27-56	G	16	9	7	11	-	43	Pikes Peak
1964	A	-	-	-	-	109	109	Pikes Peak
1966	A	-	-	-	-	127	127	Pikes Peak
1966	G	158	63	8	65	40	334	Accumulation of all year long
1968	A	-	-	-	-	154	154	Pikes Peak
6-15-67	A	-	-	-	48	-	48	Sheep Mtn. – may be duplications
1969	A	118	46	-	49	11	224	Pikes Peak
1970	A	-	-	-	-	107	107	Only partial count

^aG=ground; A=aerial

Table 3. Total sheep, age, and sex ratios recorded during one-day coordinated ground counts, Pikes Peak, 1988-2006. From 2007-9, the Colorado Division of Wildlife began estimating population size from mark-resight data (see current population estimate).

Date	Total	Lambs/100 Ewes	Rams/100 Ewes	Comments
7/21/1988	134	47	52	
7/19/1989	142	69	80	
7/22/1991	113	49	64	
7/20/1992	98	55	79	
7/19/1993	156	33	78	
7/18/1994	201	52	65	
7/17/1995	58	22	155	Snow and fog
7/15/1996	253	60	130	
7/20/1998	235	47	95	
7/19/1999	334	75	38	
7/17/2000	256	57	31	
7/16/2001	116	20	75	
7/14/2003	131	53	122	
7/19/2004	132	59	91	
7/2005	113	30	108	Poor sighting conditions
7/17/2006	189	34	83	

Table 4. S-46 bighorn sheep inventory, 1997-2008. Data from 1997-2007 were collected from the bait site. Data in 2008 were collected during a ground count.

Year	Maximum # of Sheep on Bait	Lambs/100 Ewes	Rams/100 Ewes
1997	76	40	20
1998	--	--	--
1999	65	33	30
2000	62	44	50
2001	66	38	28
2002	59	32	58
2003	68	29	33
2004	79	34	34
2005	55	25	13
2006*	10	0	25
2007	--	--	--
2008	24	38	13

*Trap Data Only

Hunting and Harvest History

Bighorn sheep hunting was closed by the Legislature in the state of Colorado in 1887. The season was then reinstated in 1953 and Pikes Peak was included in the list of hunting areas. Records indicate that six sheep were harvested on Pikes Peak the same year hunting was reinstated (Table 5). Since its inception, the hunting season on Pikes Peak has been strictly a rifle season. Hunters were required to harvest rams that were $\frac{1}{2}$ curl or larger from 1953-1957 and 1960-1964 and $\frac{3}{4}$ curl or larger from 1958-1959 and 1965-1970 (Bear and Jones 1973). Currently, hunters are required to take a $\frac{1}{2}$ curl or larger ram. From 1953 to 1970, 152 licenses were offered on Pikes Peak with a harvest of 74 rams and a success rate of 47% (Bear and Jones 1973). The number of licenses in S-6 has varied over the years with a low of 4 ram licenses in 1959-1960 and a high of 15 ram licenses in 1967-1969 and 1975 (Table 5). From 1976 to 2008, both ewe and ram licenses were offered and harvest success has varied over the years for both sexes (Table 5). In 2007 and 2008, results from a population estimation study indicated that the Pikes Peak bighorn sheep herd was much smaller than previous estimates (see Current Population Estimate and Proposed Inventory Methods). Based on the results from the study, ewe hunting was suspended on Pikes Peak (starting with the 2009 season) and ram licenses have reduced accordingly.

In 1984, S-46 was established as an archery only sheep hunting unit. From 1984 to 1997, ram licenses were available and starting in 1998, both ram and ewe licenses were offered (Table 6). The hunting season in the past has been held from mid to late November to capitalize on sheep wintering in S-46 from Pikes Peak. Harvest success has varied over the years. Interestingly, from 1990 to 1997, hunters had 100% success on the two archery licenses offered in the unit. Beginning in 2009, the S-46 license was expanded to include archery-only licenses valid for both S-6 and S-46 to provide hunters with additional access to sheep during the rut. In November, many of the rams in S-46 are in rural housing areas, making them difficult to access. As with S-6, ewe licenses were suspended in S-46 in 2009 due to low population size.

Bighorn sheep hunting was initiated in Beaver Creek in 1958 and seasons ran through 1961 (Bear and Jones 1973). As with the Pikes Peak licenses, curl sizes were restricted to $\frac{3}{4}$ curl or better in 1958-1959 and $\frac{1}{2}$ curl or better from 1960-1961. Two rams total were harvested in 1958 & 1959 and three rams total were harvested in 1960-1961. No licenses were issued again in Beaver Creek until 1973, when the unit was opened to archery hunting. The first rams to be harvested (n=2) were taken in 1974 after the unit was reopened to hunting. The unit was closed again to hunting following the 1998 season due to low population size and poor harvest success (Table 7).

Table 5. Estimated posthunt population, licenses offered, harvest rates & success, and the number of hunters in S-6, 1953-2010.

Year	Post Hunt Pop.	# of Licenses			# Harvested			# of Hunters				% Success			
		ram	ewe	E/S*	ram	ewe	total	ram	ewe	E/S*	total	ram	ewe	E/S*	total
1953		10			6		6	6			6	60%			60%
1954		6			1		1	1			1	17%			17%
1955		7			1		1	1			1	14%			14%
1956		7			3		3	3			3	43%			43%
1957		5			3		3	3			3	60%			60%
1958		6			2		2	2			2	33%			33%
1959		4			2		2	2			2	50%			50%
1960		4			2		2	2			2	50%			50%
1961		6			4		4	4			4	67%			67%
1962		6			2		2	2			2	33%			33%
1963		6			4		4	4			4	67%			67%
1964		8			7		7	7			7	88%			88%
1965		8			4		4	4			4	50%			50%
1966		12			5		5	5			5	42%			42%
1967		15			8		8	8			8	53%			53%
1968		15			8		8	8			8	53%			53%
1969		15			9		9	9			9	60%			60%
1970		12			3		3	3			3	40%			40%
1975		15			2		2	15			15	13%			13%
1976				15	5	3	8			15	15			53%	53%
1977				15	4	0	4			15	15			27%	27%
1978				15	5	6	11			15	15			73%	73%
1979				15	3	3	6			15	15			40%	40%
1980		10	5		10	5	15	10	5		15	100%	100%		100%
1981		10	5		1	4	5	10	5		15	10%	80%		33%
1982		10	5		4	0	4	10	5		15	40%	0%		27%
1983		10	5		3	5	8	10	5		15	30%	100%		53%
1984		9	5		6	3	9	10	5		15	60%	60%		60%
1985		5	10		3	2	5	6	3		9	50%	67%		56%
1986	250	10	5		6	2	8	10	5		15	60%	40%		53%
1987	250	10	9		4	5	9	10	9		19	40%	56%		47%
1988	200	10	9		6	9	15	10	9		19	60%	100%		79%
1989	200	10	9		9	6	15	10	8		18	90%	75%		83%
1990	225	5	9		5	5	10	5	7		12	100%	71%		83%
1991	225	5	9		4	5	9	5	8		13	80%	63%		69%
1992	250	5	9		3	5	8	5	8		13	60%	63%		62%
1993	220	5	9		2	5	7	5	9		14	40%	56%		50%
1994	250	5	9		5	5	10	5	7		12	100%	71%		83%
1995	250	8	9		6	3	9	8	8		16	75%	38%		56%
1996	300	8	9		7	5	12	8	8		16	88%	63%		75%
1997	300	10	16		8	11	19	10	16		26	80%	69%		73%
1998	300	10	20		7	9	16	10	18		28	70%	50%		57%
1999	350	9	18		8	14	22	9	17		26	89%	82%		85%
2000	350	10	26		6	14	20	10	24		34	60%	58%		59%

Table 5. cont.

Year	Post Hunt Pop.	# of Licenses			# Harvested			# of Hunters				% Success			
		ram	ewe	E/S*	ram	ewe	total	ram	ewe	E/S*	total	ram	ewe	E/S*	total
2001	350	10	26		9	6	15	10	21		31	90%	29%		48%
2002	350	10	26		8	11	19	10	21		31	80%	52%		61%
2003	350	10	26		3	9	12	10	18		28	30%	50%		43%
2004	350	11	27		6	15	21	11	23		34	55%	65%		62%
2005	300	10	26		6	7	13	8	16		24	75%	44%		54%
2006	300	12	26		9	6		12	21		33	75%	29%		45%
2007**	185	12	21		4	2		9	15		24	44%	13%		25%
2008**	170	10	10		7	3		10	6		16	70%	50%		63%
2009**	110	7	0		2	0	2	7			7	29%			29%
2010		4	0		NA	NA	NA	NA							

**Population estimate derived from summer mark-resight data

Table 6. Posthunt population, licenses offered, harvest number & success, and number of hunters in S-46, 1984-2010.

Year	Posthunt Pop.	# of Licenses			# Harvested			# of Hunters			% Success		
		ram	ewe	total	ram	ewe	total	ram	ewe	total	ram	ewe	total
1984		2		2	0		0	2		2	0%		0%
1985		2		2	0		0	2		2	0%		0%
1986	55	2		2	1		1	2		2	50%		50%
1987	55	2		2	1		1	2		2	50%		50%
1988	55	2		2	1		1	2		2	50%		50%
1989	55	2		2	1		1	2		2	50%		50%
1990	125	2		2	1		1	1		1	100%		100%
1991	125	2		2	2		2	2		2	100%		100%
1992	65	2		2	2		2	2		2	100%		100%
1993	65	2		2	2		2	2		2	100%		100%
1994	65	2		2	2		2	2		2	100%		100%
1995	70	2		2	2		2	2		2	100%		100%
1996	90	2		2	2		2	2		2	100%		100%
1997	90	2		2	2		2	2		2	100%		100%
1998	90	2	2	4	1	2	3	2	2	4	50%	100%	75%
1999	75	2	1	3	0	0	0	2	1	3	0%	0%	0%
2000	75	2	4	6	1	2	3	2	3	5	50%	67%	60%
2001	75	2	4	6	0	0	0	1	3	4	0%	0%	0%
2002	75	2	4	6	1	0	1	2	3	5	50%	0%	20%
2003	75	2	4	6	1	0	1	2	2	4	50%	0%	25%
2004	85	2	2	4	1	1	2	1	1	2	100%	100%	100%
2005	85	2	4	6	2	2	4	2	4	6	100%	50%	67%
2006	85	2	2	4	1	0	1	2	2	4	50%	0%	25%
2007	35	2	2	4	1	0	1	2	2	4	50%	0%	25%
2008	30	1	1	2	1	1	2	1	0	1	100%	0%	50%
2009	25	1		1	0		0	1	0	1	0%		0%
2010	25	1		1	N/A		N/A	N/A		N/A	0%		0%

Table 7. Estimated posthunt population, licenses offered, harvest rates & success, and number of hunters in S-5, 1973-1998. Only ram licenses were offered.

Year	Posthunt Pop.	# of Licenses	# Harvested	# of Hunters	% Success
1973		3	0	3	0
1974		2	2	2	100
1975		10	0	10	0
1976		3	0	3	0
1977		6	5	6	83
1978		6	5	6	83
1979		8	1	8	13
1980		8	4	8	50
1981		8	3	8	38
1982		8	3	8	38
1983		8	2	7	29
1984		6	3	6	50
1985		6	1	5	40
1986	70	6	0	6	0
1987	70	6	4	6	67
1988	80	6	3	6	50
1989	80	6	3	5	60
1990	80	6	3	6	50
1991	80	6	3	6	50
1992	70	6	2	6	33
1993	80	6	2	6	33
1994	80	6	0	6	0
1995	80	6	1	6	17
1996	80	6	0	6	0
1997	80	6	0	5	0
1998	30	6	0	5	0

Disease History

Bighorn sheep on Pikes Peak and the Dome Rock State Wildlife Area have been subjected to a number of disease related declines. The first recorded declines occurred in 1952-1953 when the population was thought to drop from 300 sheep down to 30-40 animals (Bear and Jones 1973). Domestic sheep were present on private lands adjacent to Pikes Peak during this time period and following the declines, the Colorado Division of Wildlife purchased the private land which became the Pikes Peak State Wildlife Area. Another decline occurred in the 1970's when the population was thought to decrease by approximately 50%.

Beginning in 1972, researchers began research on the Pikes Peak sheep herd to test the efficacy of anthelmintics for the treatment of lungworm (*Protostrongylus* spp.), which they partially

believed to be the cause of low lamb recruitment. The researchers studied the following anthelmintics: cambendazole, diethylcarbamazine, and fenbendazol. During the study, lamb recruitment improved, which the researchers attributed to the treatments (Schmidt et al. 1979). Based on these results, the CDOW continued treating sheep for lungworm on Pikes Peak through 1990, primarily with fenbendazol.

Between 1972 and 1975, lambs exhibiting respiratory symptoms consistent with infection were culled and collected for necropsy. All of the collected lambs contained strains of *Pasteurella* pneumonia and heavy lungworm loads. *Mycoplasma* spp. and parainfluenza 3 (PI3) were found but in small amounts (Schmidt et al. 1974, Schoonveld et al. 1974, Schmidt et al. 1975, Schoonveld et al. 1975, and Schmidt et al. 1976). Findings also showed transplacental transmission of lungworm in the lambs taken in the summer of 1972 (Schoonveld et al. 1976). In addition to lungworm treatments in S-6, sheep were treated annually for lungworm at Dome Rock from the early 1990's through 2007. In 1995, animals captured at the Dome Rock bait site tested positive for exposure to parainfluenza 3 (PI3).

BIGHORN SHEEP DISTRIBUTION

Current Distribution and Herd Descriptions

Current overall sheep range for S-6 (the Pikes Peak herd) includes the alpine areas above 10,000 feet in elevation on and surrounding Pikes Peak. Known wintering areas include Cathedral Park, Sheep Mountain/Bison Reservoir, Oil Creek/Pancake Rocks Trail, and on the alpine of Pikes Peak. Sheep sign found in the summer of 2005 indicates sheep use on Almagre Mountain to the southeast of Pikes Peak. Concentration areas for the Dome Rock herd (S-46) include Fourmile Creek, areas around Dome Rock, Cripple Creek Mountain Estates, and Lost Canyon. Concentration areas for Pikes Peak (S-6) include, Sheep Mountain, Sentinel Point, Bison Reservoir, the sheep viewing area on the Pikes Peak Highway, Bottomless Pit, East and West Forks of Beaver Creek, South Slope/Boehmer Reservoir (Reservoir #2), and Sachett Mountain.

Known lambing areas for sheep in S-6 include Oil Creek and the rugged terrain to the northeast of Bison Reservoir (Sheep Mountain and Beaver Ridge), the east face of Pikes Peak (Bottomless Pit), the alpine of North French Creek, and the Crater. Some sheep have also lambed north of Boehmer Reservoir (Reservoir #2). In S-46 lambing areas include Dome Rock, along Fourmile Creek, and Lost Canyon.

The current distribution of sheep in RBS-8 differs little from the distribution outlined by Bear and Jones (1973) with a few exceptions (Figure 5). In S-6, Bear and Jones (1973) suggested that sheep use was limited above 13,500 ft. However, sheep have been located near the summit of Pikes Peak at 14,110 ft. Bear and Jones (1973) also outline sheep use in areas north of Sentinel Point near the Craggs Trail but between December 2006 and July 2010 no radio-collared sheep have been located in that area. The distribution of sheep in S-46 appears to be larger now than what was outlined in Bear and Jones (1973).

Interactions with other DAUs

Two DAUs border RBS-8: RBS-18 (Shelf Road) and RBS-14 (Rampart Range). Data gathered from radio-collared sheep in both RBS-8 and RBS-14 suggest that individuals in RBS-8 currently have limited, if any, interaction with sheep from other DAUs. Any interactions would likely occur along the boundaries between the DAUs. In 2008, a hunter reported harvesting a radio-collared sheep along Teller County Road 1, which forms the boundary between RBS-8 and RBS-18, and numerous locations of collared rams have been recorded along the road. Sheep also have been occasionally spotted on Highway 24, the boundary between RBS-8 and RBS-14.

One caveat to these observations is that the most likely dispersers in a bighorn sheep herd are young rams. All but one of the radio-collared bighorn sheep in RBS-14 are ewes. Therefore, it is possible that rams are moving from RBS-14 to RBS-8, but the movements have yet to be detected.

Summary of Available Movement and Distribution Data

In December 2006, the Colorado Division of Wildlife initiated a population demographic study of sheep on Pikes Peak and Dome Rock. During the course of the study, the Division has captured, radio-collared, and monitored 32 ewes and 18 rams. As of July 2010, we have collected over 2,400 locations.

Based on these locations, we have delineated movement patterns of four different groups of ewes within the DAU (Figure 7). The first group of ewes, all captured at Dome Rock SWA, generally spend the winter on the Dome Rock SWA and surrounding areas. However, they cross Highway 67 during the summer and spend the summer around Oil Creek, West Beaver Creek and Sentinel Point. They return to Dome Rock in mid- to late-September. The exact route of the migration corridor between Pikes Peak and Dome Rock is uncertain, but believed to exist along Oil Creek.

A second group of ewes spends both the summer and winter in the ridges above Oil Creek and the West Fork of Beaver Creek. The ewes from Dome Rock and Oil Creek are typically found together during the summer but split into two different groups during the winter. A third group of ewes have been located around Sheep Mountain, Bison Reservoir, and Bull Park on the south side of Pikes Peak. This group has also been located on the ridge between the East and West Forks of Beaver Creek and in North French Creek on the northeast side of Pikes Peak. The fourth group of ewes is found on the east face of Pikes Peak in North French Creek and from the Bottomless Pit to Sachett Mountain. Locations of ewes from Sheep Mountain and the east face of Pikes Peak overlap in North French Creek.

Unlike the ewes, the rams do not appear to form groups with distinctive movement patterns. Rams are found at Dome Rock and the surrounding housing developments throughout the year. Rams captured at Dome Rock have also been located near the summit of Pikes Peak. Besides Dome Rock, year-round seasonal ram locations are concentrated in the area between the Pikes

Peak summit and Sachett Mountain, Sheep Mountain, and Oil Creek. Rams also spend the winter in the Cathedral Park area west of the Gold Camp Road (Forest Service Road 370).

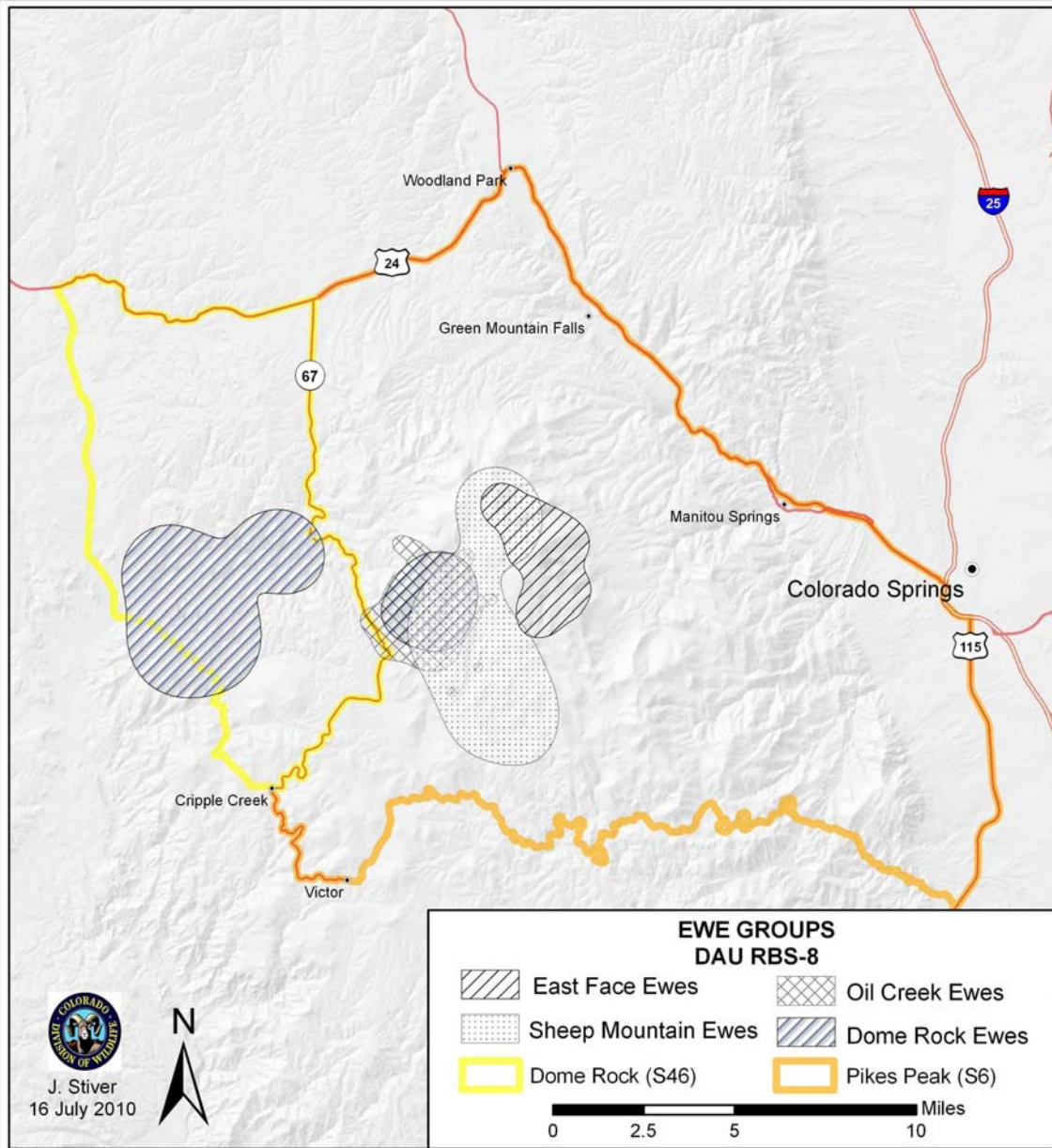


Figure 7. Range of four groups of ewes found in the Pikes Peak/Dome Rock Herd. Ewes from Dome Rock summer in S-6 and spend the spring, fall, and winter in S-46.

Delineation and Use of Available Habitat

The amount of available bighorn sheep habitat in DAU RBS-8 was estimated through a spatial analysis as outlined in the Colorado Bighorn Sheep Management Plan (George et al. 2009). This analysis identified the areas which were topographically suitable as bighorn sheep habitat and then removed areas that were known to be unsuitable due to vegetative characteristics.

Bighorn sheep escape terrain was defined as those areas with slopes greater than or equal to 60% (i.e., approximately 27 degrees). All areas within 300m of escape terrain were considered topographically suitable habitat. Areas within 500m of escape terrain were also included if escape terrain occurred on at least 2 sides. Areas that contained unsuitable vegetation (e.g., spruce fir containing areas) were removed from the topographically suitable area in order to estimate the amount of suitable bighorn habitat. Using this definition, DAU RBS-8 contains 827 km² of suitable habitat (Figure 8). This spatial analysis is very useful for generating a map of the areas that may be suitable for use by bighorn and for calculating the amount of habitat that may be available to them. However, this is an overestimate of the actual suitable bighorn habitat as not all of the area identified as suitable habitat is actually available for use by bighorn. Much of the area designated as suitable bighorn habitat actually contains vegetation that limits bighorn use, but that could not be mapped due to limitations in the spatial model.

Lambing and wintering habitat was delineated separately from available habitat with a spatial analysis of telemetry locations obtained from the 50 individual sheep radio-collared between 2006 and 2009. We used 90% kernel estimators to define both winter and lambing habitat. Winter habitat was estimated based on 347 locations gathered from 17 rams and 30 ewes. Winter locations were collected in December, January, and February. Lambing habitat was defined separately for S-6 and S-46 to avoid overestimating available habitat. The boundary between the two appears is used primarily as a corridor of movement during the summer and fall. Lambing habitat was delineated from collared ewe locations gathered in the months of May, June, and July between May 2007 and May 2010. For S-46, 233 locations were gathered from nine ewes, and for Pikes Peak, 350 locations were gathered from 31 ewes. Some ewes used both Dome Rock and Pikes Peak during the lambing period and were thus included in both areas.

Winter habitat was estimated to include 246 km² of land in both S-6 and S-46 (Figure 9). Lambing habitat in Dome Rock encompasses 29 km² of land while lambing habitat on Pikes Peak includes 57 km² of land (Figure 9).

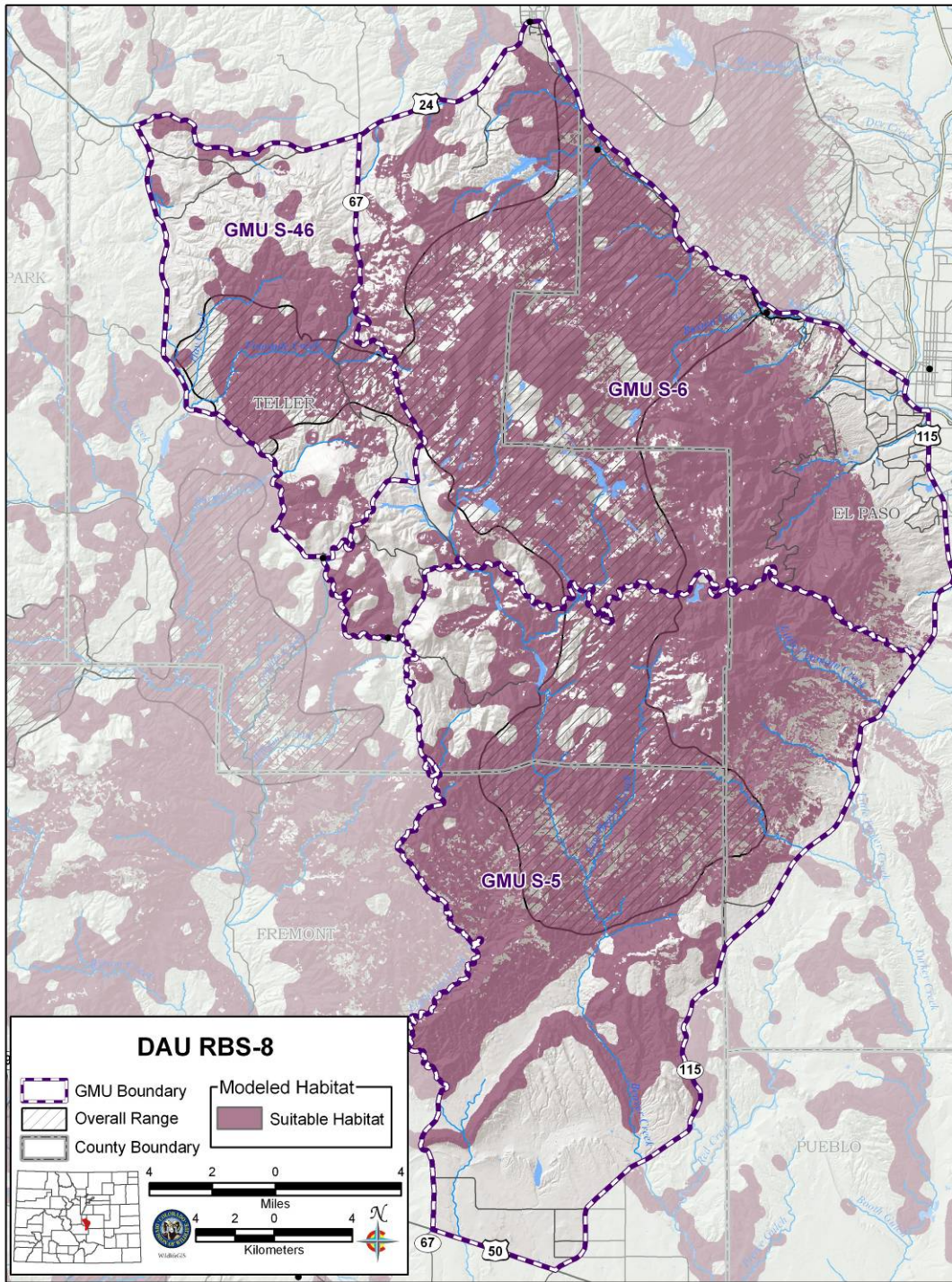


Figure 8. Modeled available bighorn sheep habitat in DAU RBS-8. Some of the modeled area is not suitable habitat due to vegetation characteristics.

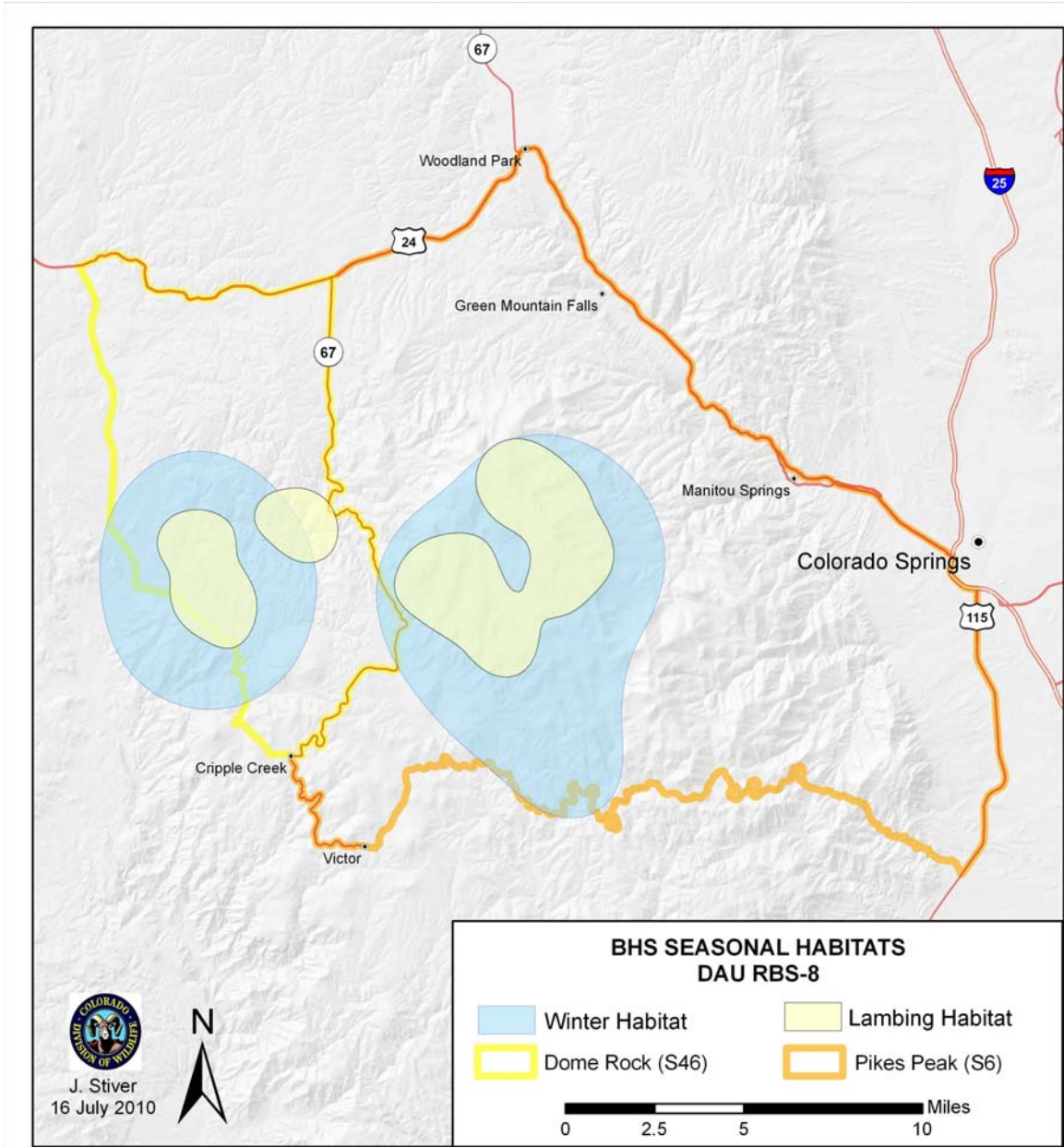


Figure 9 . Winter and lambing bighorn sheep habitats in DAU RBS-8.

CURRENT POPULATION ESTIMATE AND PROPOSED INVENTORY METHODS

Current Population Estimate and Inventory Methods

The current combined population estimate for the Pikes Peak and Dome Rock sheep herds is approximately 110 animals. This estimate is based off data gathered during the study of bighorn sheep initiated by the Colorado Division of Wildlife in December 2006. One goal of the study was to derive a population estimate with mark-resight methodology. The mark-resight estimate was generated by comparing the ratio of marked to unmarked animals resighted during a sampling period (Thompson et al. 1998). In this study, the sampling period was a series of ground counts conducted along nine established routes on Pikes Peak. The counts were conducted on seven different days in 2007 and six days each in 2008 and 2009. Observers recorded the number of marked (i.e., radio-collared) and unmarked sheep observed along the routes. Population estimates were derived for the summers of 2007-2009 (Table 8). Bowden's estimator (Bowden & Kufeld 1995) implemented in NOREMARK software (White 1996) was used to generate a mark-resight estimate for each year.

Table 8. Mark-resight population estimates for the Pikes Peak/Dome Rock herd, 2007-2009.

Year	Collared Animals		Estimate (95% Confidence Interval)			
	Ewes	Rams	Ewes	Rams	Lambs*	Total
2007	19	7	92 (83-103)	50 (43-59)	42	184
2008	22	11	85 (71-104)	42 (34-51)	36	163
2009	27	14	60 (54-67)	32 (25-41)	15	107

*Lamb numbers were estimated from lamb:ewe ratios collected during summer counts.

In addition to the summer counts, we have monitored annual adult survival and lamb:ewe:ram ratios on Pikes Peak and Dome Rock. Survival rates were generated by monitoring mortality rates of radio-collared individuals. Between December 2006 and December 2009, the rates have averaged 0.89 for rams and 0.90 for ewes (Table 9). Lamb:ewe ratios were estimated following helicopter classification flights conducted in April 2009 and March 2010. In 2009, we estimated the overall lamb:ewe:ram ratio to be 25.6:100:46.1, and in 2010, the ratio was 27.3:100:77.3. In both years, the lamb:ewe ratio was higher for sheep at Dome Rock than for sheep on Pikes Peak. In 2009, the ratio for Dome Rock was 50.0 lambs per 100 ewes versus 14.3 lambs per 100 ewes on Pikes Peak. In 2010, the ratio was 60.0 lambs per 100 ewes for Dome Rock versus 18.8 lambs per 100 ewes for Pikes Peak. These data have been incorporated into a population model which will be used to project changes in population size and sex ratios in the herd. The model is currently estimating a 2009 posthunt population of 118 animals.

Table 9. Annual survival rates for ewes and rams in the Pikes Peak/Dome Rock herd, December 2006-April 2010.

Time Period	Ram estimate	Ewe estimate
12/06-12/07	0.875 ± 0.11	0.889 ± 0.07
12/07-12/08	0.808 ± 0.12	0.913 ± 0.06
12/08-12/09	1.00 ± 0.00	0.889 ± 0.06
3 year average	0.894	0.897

Proposed Future Inventory Methods

We plan on monitoring sheep in RBS-8 through four different inventory methods. First, we will continue summer counts on Pikes Peak to maintain the long-term dataset that started in 1988. From summer counts, we will derive a minimum count of sheep as well as age and sex ratio data (i.e., lamb:ewe:ram ratios). Our second inventory method will be winter (Dec.-Jan.) helicopter surveys. From these surveys, we will also derive age and sex ratios. Age ratios collected during winter helicopter surveys will provide a measure of annual recruitment since lambs have passed the period when pneumonia caused mortality has likely occurred (George et al. 2009). Third, since a high percentage of sheep in RBS-8 are fitted with radio-collars with mortality sensors, we will continue to monitor adult survival through both ground and aerial telemetry. Fourth, we plan on repeating a mark-resight population estimate every 3-5 years. Additional sheep will need to be radio-collared to produce a mark-resight estimate, so funding might be necessary to complete future estimates.

MANAGEMENT ISSUES

Habitat Quality, Quantity, and Potential for Improvement

Habitat quality does not appear to be limiting sheep numbers in S-6 and S-46. Bear and Jones (1973) list a variety of forage types that have been identified in S-6. Forbs include western yarrow (*Achillea* spp.), wild onion (*Allium* spp.), pussytoes (*Antennaria* spp.), sandwort (*Arenaria* spp.), thistle (*Cirsium* spp.), buckwheat (*Eriogonum* spp.), sorrel (*Oxyria* spp.), cinquefoil (*Potentilla* spp.), stonecrop (*Sedum* spp.), false strawberry (*Sibbaldia* spp.), and clover (*Trifolium* spp.). Grasses include wheatgrass (*Agropyron* spp.), sedge (*Carex* spp.), sheep fescue (*Festuca ovian*), rush (*Juncus* spp.), bluegrass (*Poa* spp.) and spikes trisetum (*Trisetum spicatum*). Habitat in S-46 and some of the lower elevation areas in S-6 can best be characterized as a high mountain shrub community with pinion/juniper, ponderosa pine (*Pinus ponderosa*), mountain mahogany (*Cercocarpus ledifolius*) and willow (*Salix* spp.) bottoms. Some of these areas are heavily forested so sheep habitat could be improved through the removal of trees in Dome Rock SWA and along Highway 67. However, together, GMU S-6 and S-46 contain a sufficient amount of escape terrain, lambing, and winter habitat to sustain a larger number of sheep than is currently found on the mountain.

Competition with domestic livestock is minimal within the DAU. Dome Rock SWA is leased for cattle grazing for one month in the spring, but this is unlikely to negatively impact sheep habitat. Interspecific forage competition between elk and deer is also believed to be minimal.

Development and Fragmentation Impacts

A number of rural housing developments occur in RBS-8 and bighorn sheep are routinely found within or near the developments. These are primarily small acreage subdivisions such as Cripple Creek Mountain Estates, Lost Canyon Estates, Rainbow Valley, Ranch Resorts, and Colorado Mountain Estates. Some of the lots in these subdivisions are currently vacant but could be developed in the future.

Currently, the primary concern for bighorn sheep within the developments is interaction with domestic animals, which could result in increased mortality (e.g., dogs chasing sheep) or disease transmission (see *Diseases and Parasites*). For example, in March 2010, one radio-collared bighorn ewe was found dead near a housing development adjacent to Dome Rock SWA. Based on the evidence at the site, it appeared the sheep had died from a fall following a pursuit by domestic dogs.

No new housing developments are slated for completion within occupied sheep range in RBS-8. However, other types of developments might be proposed for the unit. For example, in 2008, an article published in the Rocky Mountain News suggested that there might be interest in opening a ski resort on Pikes Peak (Phillips 2008). Given the popularity of Pikes Peak and proximity of the mountain to Colorado Springs, development will remain a possibility in the area. The CDOW will continue to provide comments with regards to potential affects to bighorn sheep through the land use commenting process as plans for developments arise.

Recreational Impacts

Pikes Peak has some of the highest number of visitors annually of any mountain in the United States (City of Colorado Springs 2009). Visitors can reach the summit of Pikes Peak by car, train, or two main hiking trails, with around 15,000 people attempting to summit by foot annually. The main hiking trail, the Barr Trail, is located along the eastern face of Pikes Peak and crosses an area heavily used by bighorn sheep (CDOW, unpublished). Sheep use near the Craggs Trail, the other major hiking trail, is almost nonexistent although sheep historically used the area around the trail (Bear and Jones 1973; T. Sharp, pers. comm.). Human use peaks during the summer so potential impacts from recreation are highest immediately following the lambing season.

The City of Colorado Springs owns a 9,275 acre property on the south side of Pikes Peak (the South Slope Watershed) that has been closed to public access for over 100 years (AECOM 2010). The Watershed is managed by Colorado Springs Utilities (CSU) as a municipal water source for Colorado Springs. The Watershed is used by bighorn sheep year-round and includes both lambing and wintering habitat (CDOW, unpublished). In 2010, the Colorado Springs City

Council voted to allow the opening of the South Slope Watershed to recreational use. Currently, the proposed recreational uses include hiking, hunting, horseback riding, mountain biking, reservoir fishing, wildlife/nature viewing/photography, picnicking, and non-motorized boating. Prior to the Council's decision, the CDOW was asked to comment on the potential impacts to wildlife, especially bighorn sheep, which could occur if the Watershed was opened for public recreation. Based on data provided by CDOW, trails were recommended only outside of core lambing and wintering areas (AECOM 2010). Also, a closure was recommended for the one spur trail nearest bighorn sheep habitat. It is unknown whether bighorn sheep will be impacted by the increased recreation (and associated mitigation) on the Watershed. One concern is that recreationists will leave designated trails within the Watershed to access other areas of Pikes Peak which are currently difficult to reach through other access points. The CDOW will continue to monitor sheep use within and around the Watershed and collaborate with CSU to mitigate potential impacts to the sheep.

Recreational impacts to sheep in either S-5 or S-46 are likely minimal. Recreational use in Dome Rock SWA is limited to horseback riding and hiking, with sportsmen comprising the majority of recreational users. There are also seasonal closures on some trails. Access into Beaver Creek is limited by the rugged terrain in the canyon.

Diseases and Parasites

Bighorn sheep are unique among Colorado's big game species with respect to the influence infectious diseases have on population performance and species abundance. Bighorn sheep managers generally agree that bacterial pneumonia is the main reason for Rocky Mountain bighorn sheep population declines across much of the west in recent decades. For example, during the winter of 2009-2010 alone, nine bighorn sheep herds from five different western states experienced disease-related declines (K. Hurley, pers. comm.). There are a number of strains of pneumonia-causing bacteria commonly carried by domestic livestock that are highly pathogenic to bighorns, and introduction of a pathogenic strain or another novel pathogen into bighorn populations can cause all-age die-offs and lead to low lamb recruitment. In some instances, low lamb recruitment can last for a decade or more. Once introduced, these pathogenic bacterial strains can persist in survivors of the initial epidemic. These infected survivors may, therefore, serve as a source of infection for other animals in the same herd and for other herds and populations through natural movements and translocations. The susceptibility of bighorn sheep to pathogens originally introduced by domestic livestock is regarded as the primary factor limiting Rocky Mountain bighorn populations in Colorado. Moreover, the continued presence of introduced pathogens appears to have played an important role in preventing statewide bighorn numbers from rebounding to some approximation of historical levels. Based on the substantial volume of literature, one of the most important aspects of bighorn sheep management is to keep them separated from domestic livestock (George et al. 2009).

Besides historic outbreaks (see *Disease History*), disease has been implicated as a possible cause of the recent decline in population size in S-6 and S-46. In the summer and fall of 2007, three

dead lambs were found on Pikes Peak and pneumonia was the purported cause of death in all three cases. Many of the sheep (n=50) captured for the Pikes Peak Population Estimation and Demographic study were tested for a variety of diseases. In S-6, sheep showed evidence of exposure to parainfluenza 3 (PI3) every year and the data suggest the infection rate increased in 2008 and 2009 (Figure 10). In 2008, 9 of 10 (90%) of sheep sampled for *Pasteurella* spp. tested positive for β -hemolytic (i.e., potentially pathogenic) isolates (Figures 11 and 12). No samples revealed evidence of *Mycoplasma* spp., however, one individual sheep indicated exposure to bovine respiratory syncytial virus (BRSV). Data from sheep captured in S-46 in 2007 suggest that the herd was recently infected with PI3 (Figure 13).

RBS-8 is currently experiencing low lamb recruitment, especially in alpine areas, which might also indicate the presence of pathogenic bacterial strains in the population. For example, on Pikes Peak, the lamb to ewe ratio was 14.3 lambs per 100 ewes in the winter of 2008-9 and 18.8 lambs per 100 ewes in the winter of 2009-10. By contrast, over the same time period, the herd nearest to Pikes Peak, the Rampart herd, averaged 33 lambs per 100 ewes.

RBS-8 does not overlap with any active domestic sheep allotments so large scale domestic sheep grazing is an unlikely source of disease exposure for the herd. However, numerous private property owners maintain hobby animals, including sheep, goats and llamas, near Pikes Peak and Dome Rock which could pose a threat of disease transmission to the herd.

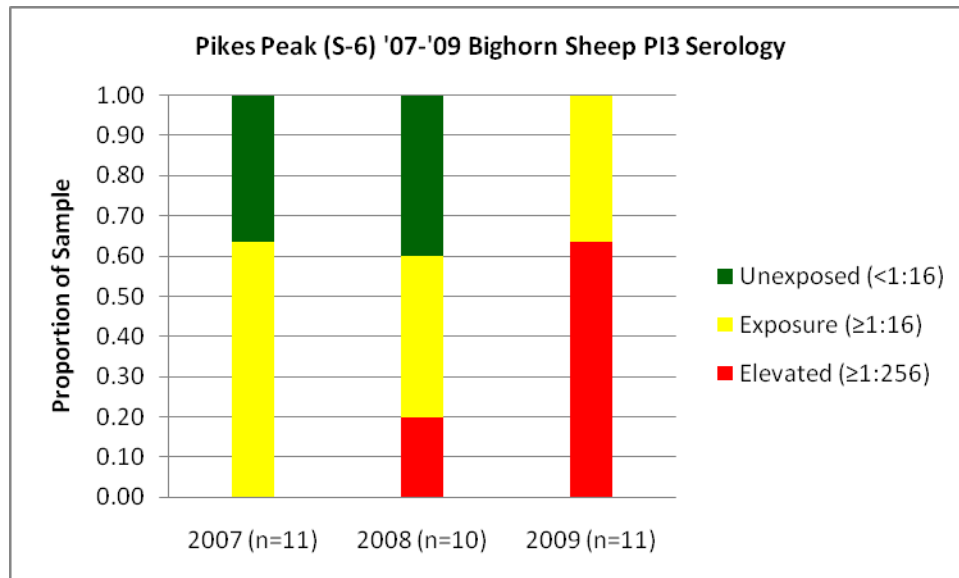


Figure 10. S-6 Parainfluenza (PI3) Serology. Titers greater than 1:16 to less than 1:256 represent exposure and titers equal or greater than 1:256 represent recent active infection (George et al. 2009).

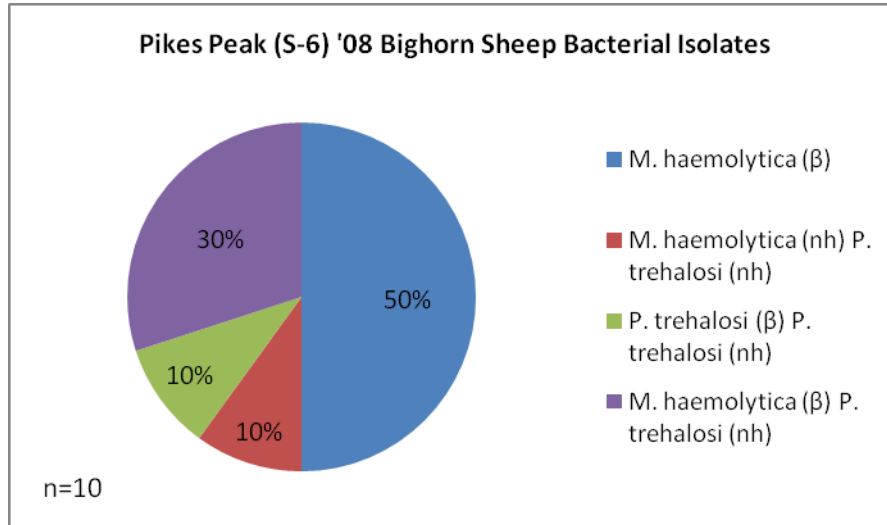


Figure 11. S-6 Bacterial Culture Isolates. β = beta hemolysis; nh = nonhomolytic.

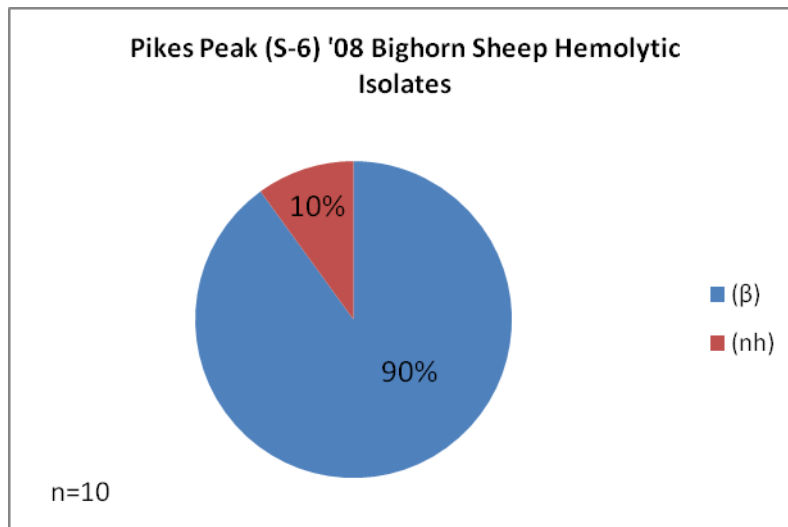


Figure 12. S-6 Bacterial Culture Isolates (Hemolytic). β = beta hemolysis; nh = nonhomolytic.

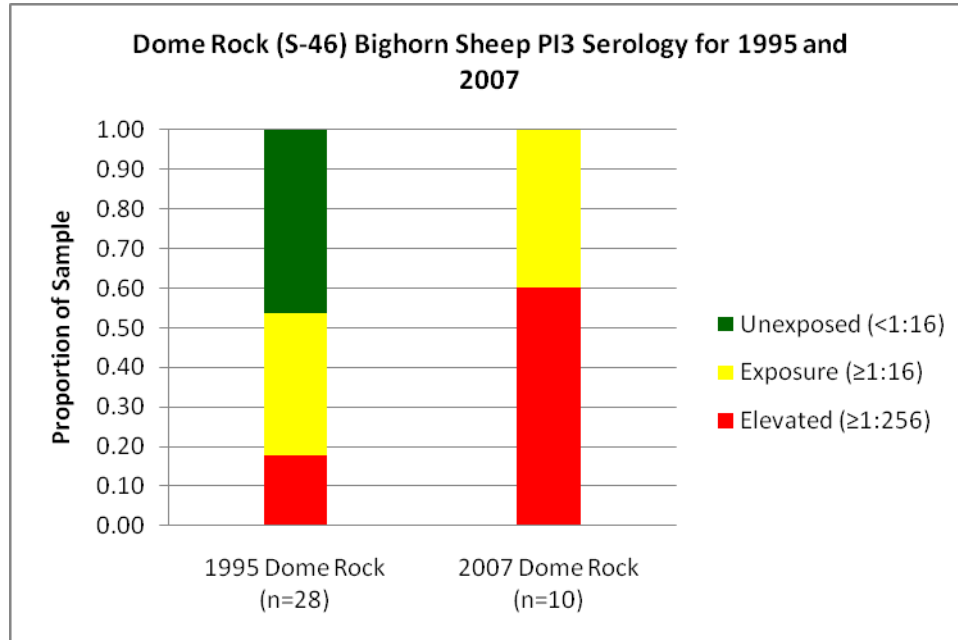


Figure 13. S-46 Parainfluenza (PI3) Serology. Titers greater than 1:16 to less than 1:256 represent exposure and titers equal or greater than 1:256 represent recent active infection (George et al. 2009).

Predation

From December 2006-June 2010, two of 32 radio-collared ewes (6.3%) and three of 18 radio-collared rams (16.7%) are known to have died from mountain lion predation in S-6 and S-46. Mountain lion predation has accounted for 50% (3 of 6 deaths) of ram mortality and 25% (2 of 8 deaths) of ewe mortality (Figure 14). Mountain lion predation appears to be a more important source of mortality in RBS-8 than in RBS-3 (Georgetown) where only one of 71 sheep died due to mountain lion predation during a three year study (Huwer 2010). Lion predation might be a significant source of mortality in other Colorado bighorn sheep populations, however (George et al. 2009).

Mountain lion predation has been shown to decrease survival rates in some bighorn sheep herds (Festa-Bianchet et al. 2006; George et al. 2009). Between 2006 and 2009, adult survival rates (Table 9) for sheep in RBS-8 were slightly lower than for a similar three-year period in Georgetown, RBS-3 (Huwer 2010). Annual survival rates averaged approximately 90% for both ewes and rams in RBS-8 whereas 95% of ewes and 98% of rams survived annually in RBS-3. Annual adult survival rates in RBS-8 were similar to rates other bighorn sheep populations in Alberta and Montana (Enk et al. 2001, Festa-Bianchet et al. 2006, Jokinen et al. 2007).

Mountain lion predation is unlikely to have caused the recent population decline in RBS-8 given the observed low lamb recruitment rates and disease prevalence. However, predation on adult animals could inhibit a recovery (George et al. 2009). Therefore, it might be necessary to consider predator management strategies in the future if both lamb recruitment and disease problems are mitigated and the population fails to increase. Habitat management might be the most effective and socially acceptable way to decrease predation rates on adults. Specifically, forest thinning might open escape terrain in areas that currently have limited visibility. Mountain lion hunting is also allowed throughout RBS-8. If predator management becomes necessary, the CDOW will follow the guidelines and recommendations found in the Colorado Bighorn Sheep Management Plan (George et al. 2009).

The effect of predation on lamb survival in RBS-8 is currently unknown. Lambs are vulnerable to a larger suite of predatory species than adults. Golden eagles, mountain lions, bobcats, and coyotes, which all occur in RBS-8, could prey on lambs (George et al. 2009). Additional research would be necessary to quantify predation rates on lambs in RBS-8.

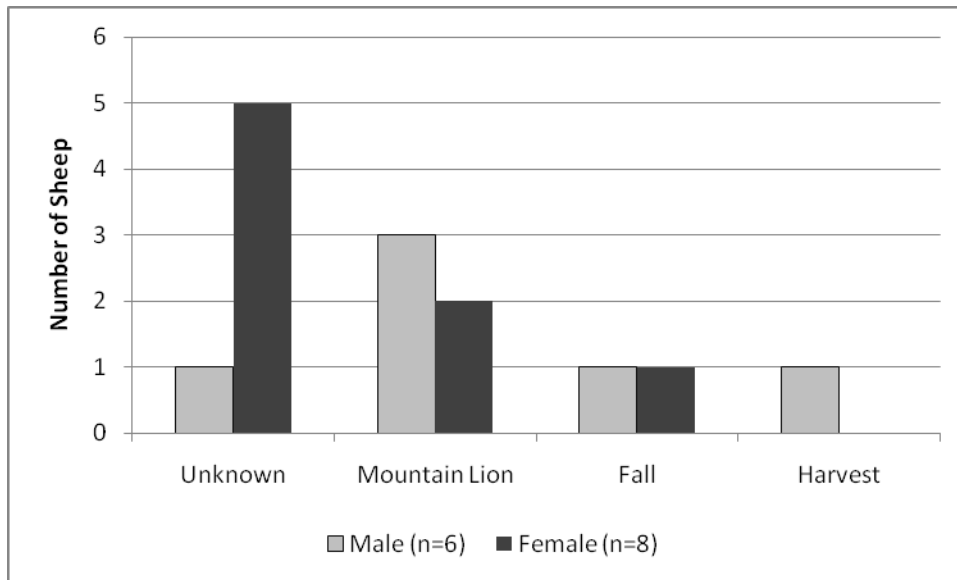


Figure 14. Cause of mortality for radio-collared bighorn sheep that have died since the initiation of the Pikes Peak Population Estimation and Demographics Study.

Illegal Kill

Although the potential exists for bighorn sheep to be illegally killed in RBS-8, the occurrence of violations is likely very low due to the high visibility of sheep in the unit (T. Sharp, pers. comm.).

Other

Bighorn sheep regularly cross Highway 67 in Teller County when moving between S-6 and S-46. They also feed along the highway. Although no radio-collared sheep has yet to be killed along highways during the Pikes Peak Demographic and Population Study, a ewe was hit by a car on the highway in August 2008. Therefore, vehicular collisions are a potential source of mortality in RBS-8.

MANAGEMENT RECOMMENDATIONS AND FUTURE NEEDS

Population Status

RBS-8 will be managed as a primary (Tier 1) core population. Primary core populations are defined as those that are large (≥ 100 animals for $\geq 90\%$ of the years since 1986), native populations comprised of one or more interconnected herds that have received few (i.e., ≤ 50 animals total) if any supplemental releases in the past. RBS-8 meets all criteria for a primary (Tier 1) core population.

Habitat Improvement and Protection

Bighorn sheep in RBS-8 could benefit from both habitat improvement and protection. Like many other places in Colorado, fire suppression has resulted in the encroachment of trees and shrubs into bighorn sheep habitat. This is especially true in RBS-8. Tree encroachment limits the availability of suitable forage as well as escape terrain since bighorn sheep prefer areas with high visibility for predator avoidance. Tree removals, through either mechanical methods or burning, could greatly improve bighorn sheep habitat in RBS-8. Specifically, in S-46, tree removals might be beneficial in the Dome Rock SWA. In S-6 and S-46 tree removals along Oil Creek might be important for bighorn sheep migration. Currently, the migration corridor between S-6 and S-46 is unknown, but it is suspected to occur along Oil Creek. The CDOW hopes to identify this corridor by placing GPS collars on ewes in S-46 in the winter of 2010-2011. Once the migration corridor is identified, habitat along the corridor should be evaluated to determine whether tree removals will be beneficial to bighorn sheep. In most areas, the CDOW will have to work with both the USFS and private land owners when planning tree removals.

S-5 is almost entirely forested which is a possible cause of the paucity of sheep in the unit. Removal of trees through mechanical means would prove difficult in the unit due to rugged terrain. Trees could be removed through burning. However, there are a number of houses on the eastern side of the unit which could be threatened by an uncontrolled fire. Therefore, habitat improvement in S-5 is unlikely in the near future. If habitat conditions in S-5 do improve, the CDOW should consider moving sheep from Dome Rock or Pikes Peak into the area to expand the herd.

Given both the recreational and developmental pressures that sheep in RBS-8 are currently experiencing, habitat protection might be critical to improving sheep numbers in the DAU. The

CDOW should evaluate the impact that any future developments will have on the bighorn sheep population and provide feedback to land management agencies before developments are initiated. The CDOW will also continue monitoring bighorn sheep in the South Slope Watershed to determine what, if any, effect recreational development in the watershed is having on bighorn sheep.

Diseases and Parasites

Disease transmission

The CDOW should work with private land owners, especially in rural areas of Teller Co., to prevent or mitigate interaction between domestic hobby animals and bighorn sheep. During routine law enforcement and research activities, the CDOW will spatially document the presence of hobby animals within bighorn range. When hobby animals are found within bighorn range, the CDOW will provide information to the landowner on the threats of domestic livestock to bighorn sheep and possible ways to reduce the potential for negative impacts to bighorn sheep.

Disease monitoring and research

The CDOW will continue monitoring bighorn sheep for diseases and parasites in RBS-8 based on guidelines and advice from the CDOW Wildlife Health Lab. Samples for disease testing will be obtained for sheep during capture operations or opportunistically from harvested sheep or from sheep found dead within the DAU. Additionally, during aerial or ground surveys, the CDOW will monitor survival and look for signs of illness in the population. As vaccines or other treatment options become available, the CDOW will evaluate ways to deliver the therapies to the population.

Since most areas of Pikes Peak are accessible on foot or from a helicopter, sheep in RBS-8 provide a unique opportunity for research on an alpine herd. The CDOW may consider using the herd for future research projects, especially if the projects have the potential to contribute to the development of effective treatment options.

Other

Ewe removals

Ewe hunting and translocations were suspended in RBS-8 following the recent population decline, based on the recommendations in the Colorado Bighorn Sheep Management Plan (George et al. 2009). We do not anticipate reopening the ewe hunting season until the population nears objective which could result after disease and lamb recruitment issues have been effectively addressed. Bighorn sheep appear to be more susceptible to disease outbreaks at higher densities (George et al. 2009). Additionally, rams might grow larger horns in lower density populations (Jorgenson et al. 1993, 1998). Therefore, ewe removals could maintain this

objective while providing for unique hunting opportunities. Hunting would be the preferred removal method for ewes.

Watchable Wildlife

Many visitors to Pikes Peak have the opportunity to observe segments of the bighorn sheep herd, primarily along the Pikes Peak Highway and Cog Railroad. On the South Slope Watershed property, recreationists have the potential to view bighorn sheep from the dam at Boehmer Reservoir. These are or could be valuable watchable wildlife experiences for many individuals. However, visitors have the potential to disturb sheep if they approach individuals, especially if they have dogs. The CDOW will work with the City of Colorado Springs to mitigate potential impacts visitors might have on sheep while balancing the public's interest in a valuable viewing opportunity.

PUBLIC INPUT IN DAU PLANNING PROCESS

Public input on the management of this herd was collected through a public meeting and through verbal and written comments. The public meeting was held in Colorado Springs on 28 July 2010. The meeting was advertised in newspapers, on the CDOW website, and through personal notification of groups or individuals known to be interested. The meeting was attended by the local District Wildlife Manager, the Terrestrial Biologist and the Senior Terrestrial Biologist and two members of the public. The public attendees represented the Rocky Mountain Bighorn Society (RMBS) and the Colorado Bowhunters Association (CBA). Since only two members of the public attended the meeting, discussions focused on the methods used by CDOW to develop population and sex ratio alternatives, including results from ongoing research in the area. We also discussed the advantages/disadvantages of different alternatives. Verbal comments were collected at the meeting and the members of RMBS and CBA were encouraged to provide written comments to the plan.

Comments were also solicited in response to the Draft DAU plan which was placed on the CDOW's website from 10 August 2010 through 11 September 2010 (31 days). A link to this website was sent to interested parties, including the USFS, Colorado Springs Utilities, and RMBS. Every hunter who applied for an S-6 or S-46 bighorn sheep license in 2010 was also mailed a postcard with information detailing how they could access the Draft DAU plan and where to provide comments. From these contacts, we received written comments from two members of the public, RMBS, the USFS, and Colorado Springs Utilities.

In summary, comments were generally in support of the preferred alternatives outlined by the CDOW (population objective=240; sex ratio objective=50). We received a letter from RMBS outlining their arguments for supporting the preferred alternatives (see Appendix). Other individuals thought that the current population (350 for S-6 and 75 for S-46) and sex ratio objectives (80 for S-6 and 35 for S-46) were too high and thus supported a decrease in the objectives but did not specify which alternative they preferred. The representative from the CBA supported a sex ratio of 50 rams per 100 ewes because the sex ratio was realistic for the herd and

provided for a higher percentage of females in the population. One member of the public supported the DAU plan but commented that the CDOW should work towards negotiating public access through areas of private property on the southwest portion of Pikes Peak. Comments from both USFS and Colorado Springs Utilities were primarily editorial.

HARVEST OBJECTIVES AND MANAGEMENT

Posthunt Population Objective

The posthunt population objective should be established at a level that allows for a self-sustaining herd while providing quality hunting and wildlife viewing opportunities. It is difficult to estimate this ideal population level for RBS-8; however, we can base a population objective on research from other bighorn sheep populations and the population performance of this herd at various population levels in the past.

At high population densities, lamb recruitment is lower and the body and horn size of individual sheep decrease due to competition among individuals for resources. Additionally, several studies have suggested that disease caused mortality is higher in densely populated herds compared to less densely populated herds (Jorgenson et al. 1993; Portier et al. 1998).

The optimum number of bighorn for RBS-8 is unknown and will change with habitat conditions. The herd grew from an estimated posthunt population size of about 200 in 1988 to over 400 in the mid-1990's. This number appeared to be too high for the population to sustain as the population declined throughout late-1990's and 2000's to a low of approximately 110 in 2009 (Figure 1).

If density was the only factor determining herd productivity in bighorn sheep, we would expect the Pikes Peak/Dome Rock herd to have high lamb recruitment at the low densities currently observed in the population. However, lamb recruitment has been low in the previous two years, which is consistent with the suggestion that disease was a factor in the recent population decline (George et al 2009). Regardless of the cause of low lamb recruitment, the herd should be able to sustain a higher density than is presently found in the population.

The current posthunt population objective is 350 for S-6 and 75 for S-46. These objectives were set in 2000 and are apparently unreasonably high for the herd since the population has neared that objective in only one year between 1988 and 2010. For this DAU plan, we propose three alternative combined posthunt population objectives for the two GMUs since they represent a single herd.

Alternative 1: Posthunt population target 240 (range 215-265)

This alternative is near the average modeled posthunt population from 1988-2009 (average=254 sheep). Additionally, Jorgenson et al. (1993) found that a stable population of alpine bighorn sheep in Alberta supported a density of 1.14 adult ewes per km² and 0.46 yearlings per km². There is approximately 86.8 km² of lambing habitat on Pikes Peak and Dome Rock which would equate to about 100 adult ewes (86.8 km²*1.14 adult ewes/km²) and 40 yearlings (86.8*0.46). Assuming a sex ratio of 50 rams per 100 ewes and recruitment of 30-50 lambs per 100 ewes, the total population would equate to 220-240 sheep. The population would need to double to reach this objective.

Alternative 2: Posthunt population target 195 (range 175-215)

The mark-resight estimate from 2007 fell within the range of this alternative (184 animals) suggesting this is an achievable objective. This objective is also ½ of the highest modeled population size over any given 4 year time period between 1988 and 2010. The highest average was 384 animals which occurred from 1995-1998 (~390/2=195). The population would have to increase by 65% to reach this target.

Alternative 3: Posthunt population target 300 (range 270-330)

Historic estimates place the population size of S-6 and S-46 at 300 animals. Model estimates suggest that the population was this high as late as 1999. If the current disease issues and low lamb recruitment can be effectively addressed, the population might return to this level. The population would have to increase 250% to reach this target.

Posthunt Sex Ratio Objective

The posthunt sex ratio objective (rams per 100 ewes) is set at a level that provides the public with the desired level and quality of recreational opportunities. Higher sex ratios equate to higher numbers, ages, and horn sizes of the rams in the herd. These rams are highly valued by hunters and wildlife viewers. However, maintaining a high ram to ewe ratio necessitates a lower ram harvest, so hunting opportunity is lower at higher sex ratios. Historically, this population has been managed for hunting opportunity.

The best data available for ram to ewe ratios in RBS-8 come from the summer ground counts conducted on Pikes Peak beginning in 1988. The average ram to ewe ratio over the time period between 1988 and 2009 is 50 rams per 100 ewes. The only data available for posthunt ratios comes from the winter helicopter classifications conducted in 2009 and 2010. The ram to ewe ratios were 46 and 77 rams per 100 ewes, respectively, for the two years. It is doubtful that the ram to ewe ratio varied that much over the two years. The difference is likely due to the small sample size obtained during the classification (which resulted for the low overall population

size). Over the two years, the average ratio was 61 rams per 100 ewes. The current population objective is 80 rams:100 ewes for S-6 and 35 ram:100 ewes for S-46.

Alternative 1: Posthunt sex ratio target 50 rams per 100 ewes (range 45-55)

This is a biologically realistic sex ratio for the DAU. Based on data from the mark-resight estimate, the population is currently at this sex ratio. This alternative is also the long term average for the population. Ram licenses are sought after for the unit with 141 individuals applying for four rifle licenses in S-6 in 2010. A sex ratio of 50 will allow us to maintain a similar harvest on rams (proportional to the posthunt population).

Alternative 2: Posthunt sex ratio target 60 rams per 100 ewes (range 55-65)

This alternative would not require a change from estimated sex ratio from the 2009 and 2010 post season classification surveys. However, since there is currently no ewe harvest in the population, a short-term decrease in ram licenses might be necessary in the future to maintain this sex ratio. Once the population reaches this sex ratio, the number of rams and size of rams available for harvest would be expected to increase.

Alternative 3: Posthunt sex ratio target 75 rams per 100 ewes (ranges 70-80)

This alternative would require a 25% increase in the current posthunt sex ratio. Ram licenses might have to be dropped to achieve this objective, which would decrease hunting opportunity. However, if the sex ratio neared this objective, the number of rams available for harvest would increase.

Preferred Alternatives

Preferred Population Objective Alternative

The CDOW recommends Population Objective Alternative 1: 240 (215-265) bighorn. The preferred population objective of 240 was derived based on comparable densities from well-studied stable alpine sheep herd that is similar to RBS-8. Additionally, the range is realistic because it includes the estimated average population size for S-6 and S-46 over the last 22 years. A population size of 240 is expected to be low enough to reduce the probability of catastrophic disease epidemics. This alternative is expected to provide a higher number of sheep, including both ewes and rams, available for harvest. This alternative would also provide wildlife viewers on Pikes Peak with ample viewing opportunities.

Alternative 2 is also sufficiently low to reduce the probability of catastrophic disease epidemics. Additionally, the objective should be attainable since the population was within the range within the last four years. However, the amount of available habitat in both S-6 and S-46 can likely sustain a higher number of sheep than 195. Alternative 3 would provide a higher number of

sheep for harvest and viewing opportunities. The herd has also reached 300 individuals within the last 15 years. However, this population size might be too high to prevent a catastrophic disease epidemic. Additionally, the habitat might be unable to support the population at this level.

Preferred Sex Ratio Objective Alternative

The CDOW recommends Sex Ratio Objective Alternative 1: target 50 (45-55) rams per 100 ewes. This objective balances recreational opportunities for hunters with a realistic and biologically appropriate objective for the herd since it encompasses the long-term sex ratio. Additionally, at this objective, we expect to be able to maintain a similar number of ram licenses in RBS-8 to the numbers currently available. However, the number and size of rams available for harvest will be lower compared to the levels expected at higher sex ratios.

Alternative 2 is a biologically feasible option that provides the potential for better quality rams. However, ram licenses will need to be decreased in the near term to achieve this objective which would result in decreased hunter opportunity. Alternative 3 would result in the oldest and largest rams for hunters and wildlife viewers. However, it would reduce hunting opportunity, especially in terms of the number of licenses that could be given in the unit.

Other Management Considerations

Ewe Harvest

We will follow the guidelines laid out in the Colorado Bighorn Sheep Management Plan when considering the need for ewe removals in the future (George et al. 2009). While the population is greater than 25% below objective, there will be no ewe harvest in the population unless needed for disease management or other special conditions. However, if the population approaches objective, harvest will be the primary method of ewe removal unless circumstances (i.e., catastrophic die-off) necessitate the use of other methods to reduce ewe numbers. Ewe harvest rates will be based on the population model, and three-year average harvest success rates will be used to calculate hunting license numbers. As a check for the model, the following rates will be used when initially setting harvest objectives: 1) If the population is below but within 25% of objective and the observed winter lamb:ewe ratio is $\geq 40:100$, we would recommend a harvest objective of up to 5% of the total posthunt population (≥ 1 years old). 2) If the population is at objective, the recommended harvest objective would be determined by the observed winter lamb:ewe ratio (Table 10). 3) If the population is over objective, we would recommend a ewe season with a harvest objective of $\geq 10\%$ of the total posthunt population > 1 year old. These rates will be adjusted accordingly if removals are not producing desired changes in the population numbers.

Table 10. Guidelines for ewe harvest if RBS-8 approaches the population objective (George et al. 2009).

Observed Winter Lamb:Ewe Ratio	Ewe Removal or Harvest Rate as a Percentage of Total Population	Alternatives
≥40:100	5-10% of total posthunt population ≥1 year old	Or 12-24% of pre hunt ewe population
20-39:100	<5% of total posthunt population ≥1 year old	Or <12% of pre hunt ewe population
<20:100	No ewe removals	Exceptions allowed for disease management

Methods of Take, Season Structure, and Timing

Two 15-day rifle seasons are currently offered in S6. The first season starts the Tuesday after Labor Day. There is a two-day break between the close of the first season and the start of the second. There is currently an archery-only season offered in S6 and S46 that runs from November 10-30. We anticipate retaining this season structure for the duration of the DAU plan unless special conditions necessitate a change.

Closures and Special Restrictions

The CDOW and Colorado Springs Utilities are currently discussing options for allowing sheep hunters access to the South Slope Watershed. Should hunting access be allowed on the Watershed, hunters would be required to abide by regulations set by the CDOW and Colorado Springs Utilities for accessing the South Slope Watershed.

Maximum Allowable Off-take (harvest and translocation)

Maximum allowable off-take through harvest and translocation will be determined by guidelines outlined in the Colorado Bighorn Sheep Management Plan (George et al. 2009). Exceptions will be made for disease management or other special conditions. Harvest will be the preferred method of off-take but translocations might be considered if the population is above objective and disease issues can be resolved. Harvest objectives for ewes are defined above. For rams, the recommended harvest will be based on the population model. As a check for the model, removal rates should be 2-5% of the posthunt population and/or 4-10% of the total posthunt ram numbers. If the population exceeds the sex ratio or population objective, the removal objective should be 5% of the total population or 10% of the ram population until the objective is met. Removal objectives might be decreased while the population remains below objective or if winter lamb:ewe ratios remain low (<20:100). As with ewe harvest, these rates could be adjusted if ram removals are not producing desired changes in the sex ratio or population size.

Beaver Creek (S-5)

Given the paucity of animals in S-5 and challenges associated with improving habitat in the unit, we do not anticipate opening the unit to hunting in the foreseeable future. The CDOW plans on periodically surveying the unit for bighorn sheep and also encourages the public to inform us of sheep sightings in the unit. If the unit appears to be sustaining a higher number of sheep (>40), the CDOW will consider reopening the unit to hunting.

LITERATURE CITED

- AECOM. 2010. Plan for recreational uses on municipal watershed lands. Report prepared for Colorado Springs Utilities. 88 pp.
- Bear, G. D. and G. W. Jones. 1973. History and distribution of bighorn sheep in Colorado. Colorado Division of Wildlife Report. Ft. Collins, CO. 232 pp.
- Bowden, D. C., and R. C. Kufeld. 1995. Generalized mark-sight population size estimation applied to Colorado moose. *Journal of Wildlife Management*. 54:840-851.
- City of Colorado Springs. 2009. Pikes Peak America's Mountain. Available online: <http://www.springsgov.com/SectionIndex.aspx?SectionID=18>. Accessed 21 July 2010.
- Enk, T. A., H. D. Picton, and J. S. Williams. 2001. Factors limiting a bighorn sheep population in Montana following a dieoff. *Northwest Science*. 75:280-291.
- Festa-Bianchet, M., T. Coulson, J. Gaillard, J. T. Hogg, and F. Pelletier. 2006. Stochastic predation events and population persistence in bighorn sheep. *Proceedings of the Royal Society of London—Part B*. 273: 1537-1543.
- George, J. L., R. Kahn, M. W. Miller, and B. Watkins. 2009. Colorado bighorn sheep management plan: 2009-2010. Colorado Division of Wildlife, Denver, CO. Special Report 81. 88 pp.
- Huwer, S. 2010. Bighorn sheep management plan: Data analysis unit RBS-3, Georgetown Herd. Colorado Division of Wildlife. Denver, CO. 40 pp.
- Jokinen, M., D. Dorge, and P. Jones. 2007. Bighorn sheep survival and demography in the Yarrow - Castle region of Alberta, Canada. Technical Report, T - 2007 - 003, produced by Alberta Conservation Association, Blairmore, Alberta, Canada. 60pp. + App.
- Jorgenson, J. T., M. Festa-Bianchet, and W. D. Wishart. 1993. Harvesting bighorn ewes, consequences for population size and trophy ram production. *Journal of Wildlife Management*. 57:429-435
- Jorgenson, J. T., M. Festa-Bianchet, and W. D. Wishart. 1998. Effects of population density on horn development in bighorn rams. *Journal of Wildlife Management*. 62:1011-1020.
- Phillips, D. 2008. Pikes Peak ski resort proposed. *Rocky Mountain News*. 22 February 2008. <http://www.rockymountainnews.com/news/2008/feb/22/pikes-peak-ski-resort-proposed/>
- Portier, C., M. Festa-Bianchet, J. M. Gaillard, J. T. Jorgenson, and N. G. Yoccoz. 1998. Effects of density and weather on survival of bighorn sheep lambs (*Ovis canadensis*). *Journal of Zoology*. 245:271-278.
- Schmidt, R. L., C. P. Hibler, T. R. Spraker, and W. H. Rutherford. 1979. An evaluation of drug treatment for lungworm in bighorn sheep. *Journal of Wildlife Management*. 43:461-467.

- Schmidt, R. L., P. Neil, C. P. Hibler, T. R. Spraker, R. Davies, J. DeMartini, F. E. Latson, J. Ellenberger, J. G. Wegryzn, L. R. Clum, and J. Hurlock. 1976. Investigation of Spontaneous Diseases of Bighorn Sheep. Game Research Report, Federal Aid Projects, Job Project Report, Project W-41-R-25. Colorado Division of Wildlife. Ft. Collins, CO. pp.75-114.
- Schmidt, R. L., J. Rodgers, J. Morris, P. Neil, and T. Spraker. 1975. Trapping, Marking, and Collecting Bighorn Lambs Game Research Report, Federal Aid Projects, Job Project Report, Project W-41-R-24. Colorado Division of Wildlife. Ft. Collins, CO. pp. 41-44.
- Schmidt, R. L., G. G. Schoonveld, and W. H. Rutherford. 1974. Collection of Bighorn Lambs. Research Report, Federal Aid Projects, Job Project Report, Project W-41-R-23. Colorado Division of Wildlife. Ft. Collins, CO. pp. 107-109.
- Schoonveld, G. G., R. L. Schmidt, R. E. Keiss, C. P. Hibler, T. R. Spraker, L. H. Lauerman, R. E. Lange, J. Metzger, F. E. Latson, L. R. Clum, and J. G. Wegryzn. 1975. Spontaneous Diseases of Bighorn Sheep. Game Research Report, Federal Aid Projects, Job Project Report, Project W-41R-24. Colorado Division of Wildlife. Ft. Collins, CO. Colorado Division of Wildlife, pp 59-96.
- Schoonveld, G. G., R. L. Schmidt, W. H Rutherford, R. E. Keiss, C. P. Hibler, G. C. Solomon, L. H. Lauerman, T. R. Spraker, R. E. Lange, J. Metzger, G. Heideman. 1974. Spontaneous Diseases of Bighorn Sheep. Game Research Report, Federal Aid Projects, Job Project Report, Project W-41-R-23. Colorado Division of Wildlife. Ft. Collins, CO. pp. 111-189.
- Thompson, W. L., G. C. White, and G. Gowan. 1998. Monitoring vertebrate populations. Academic Press, Inc. San Diego, California, USA.
- White, G. C. 1996. NOREMARK: population estimation from mark-resighting surveys. Wildlife Society Bulletin. 24:50-53.

APPENDIX

Public outreach: Press Release

DOW Seeks Input on Bighorn Sheep Management

COLORADO SPRINGS, Colo. - The Colorado Division of Wildlife will hold a public meeting in Colorado Springs to gather input on bighorn sheep management on Pikes Peak, Dome Rock, and Beaver Creek.

The meeting is scheduled for Wed., July 28, at 6 p.m. at the DOW office in Colorado Springs at 4255 Sinton Rd.


"Talking to the public is one of the tools we use for developing our long-term goals for wildlife management," said DOW biologist Julie Stiver. "Public input is important in our decision-making process," she added.

Stiver is developing bighorn sheep management plans for Game Management Units S-5, S-6, & S-46.

Hunters, outfitters, business owners, landowners, and the general public all have a vested interest in the management of big game populations.

"Everyone has a voice in this process," Stiver explained. Items under consideration include sheep population size and the ideal number of rams per 100 ewes. How these objectives are met will be factored in the number of hunting licenses issued.

Persons who cannot attend the meetings, but would like to provide input, should contact Stiver at (719) 227-5225.

Figure 15. Letter from the Rocky Mountain Bighorn Society (2 pages).

Rocky Mountain Bighorn Society
P.O. Box 8320, Denver, CO 80201-8320
www.bighornsheep.org

August 25, 2010

Julie Stiver, Terrestrial Biologist SE Region
Colorado Division of Wildlife
4255 Sinton Road
Colorado Springs, CO 80907

Julie

On behalf of the Rocky Mountain Bighorn Society (RMBS), I want to thank you for giving our membership the opportunity to review the Bighorn Sheep Management Plan that takes into consideration units S5, S6 and S46 (Pikes Peak Herd).

As you know, the RMBS is very interested in the welfare, health and expansion of our Bighorn herds throughout Colorado. Based on the conversations we've had and the proposal/options you have put together, the RMBS Board of Directors and Membership were able to have a productive conversation on what the RMBS collectively believes are the right management decisions for this very visible herd.

The recommendations of the RMBS are:

- Manage the Pikes Peak DAU to an overall herd size of 240 animals. We believe this is the appropriate number given no major changes to current habitat conditions. If S5 (Beaver Creek) received extensive habitat improvements than we would likely endorse a higher herd size but realize the effort and cost associated with such a project is all but prohibitive. We also based our decision on scientific data cited in your plan and a belief that stressing the habitat's ability in order to sustain a higher population could cause continued (significant) fluctuations in the overall size and health of this particular herd. In essence, we are seeking a population size that can better withstand disease and variable climatic conditions and remain relatively stable.
- Manage the Pikes Peak DAU to a sex ratio of 50 rams:100 ewes. The RMBS believes we should manage herds differently throughout the state to meet hunter demands. Whether that is from a trophy perspective where a hunter should expect to see a significant number of class IV rams to an opportunity situation where more folks get to experience the thrill and challenge of a Bighorn hunt, we believe there should be herds managed for these different desires. The RMBS believes the Pikes Peak DAU should be managed as an "opportunity" herd in regards to hunting. By managing to this ratio, the herd can continue to provide hunter opportunity while still achieving growth in overall herd size. In addition, once the herd size objective is reached, the hunter opportunities can be expanded to provide more potential hunters the chance to participate in a Bighorn hunt while still maintaining a quality experience.

A non-profit organization formed in 1975 to support the sound management of bighorn sheep and their habitat. Your personal or corporate contributions fund valuable resource and educational projects that enhance the well-being of Colorado bighorns.



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If you have questions, please feel free to contact me for further discussion. We look forward to the approval of this management plan and appreciate the quality of effort clearly put into the proposal.

Sincerely,

A handwritten signature in black ink, appearing to read 'R. Ong', with a long horizontal flourish extending to the right.

Robert Ong, President
Rocky Mountain Bighorn Society

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