

BIGHORN SHEEP MANAGEMENT PLAN

DATA ANALYSIS UNIT RBS-3 Georgetown Herd

**GAME MANAGEMENT UNIT
S32**

Prepared for:
Colorado Division of Wildlife

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DAU RBS-3 (Georgetown Bighorn Sheep) EXECUTIVE SUMMARY

GMUs: S32
Land Ownership: 46% Private, 36% USFS, 11% City/County, 5 % State, 2% DOW, 1% BLM
Posthunt Population: **Previous Objective** 250-350 **2008 Estimate** 370 **Current Objective** 250 - 350
Posthunt Sex Ratio: **Previous Objective** 60-80 **2008 Observed** 88 **2008 Modeled** 89 **Current Object.** 60-80

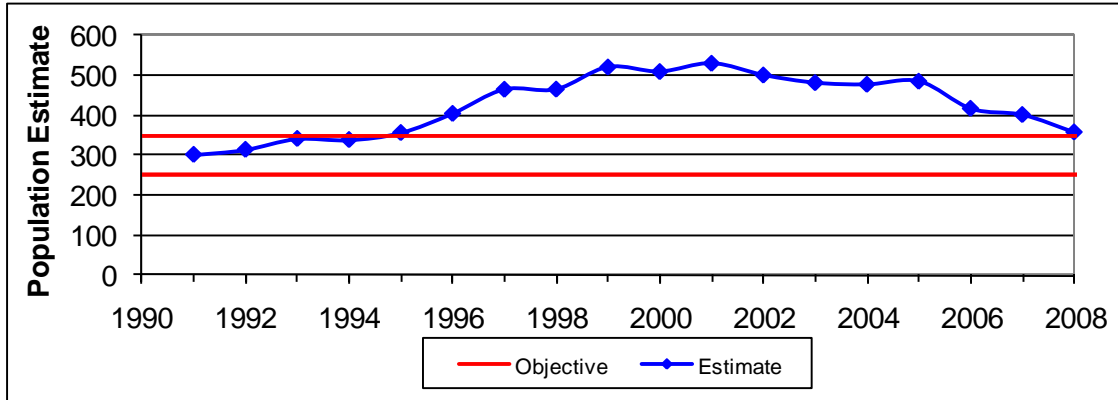


Figure 1: RBS-3 bighorn posthunt population estimate and objective range from 1991 to 2008.

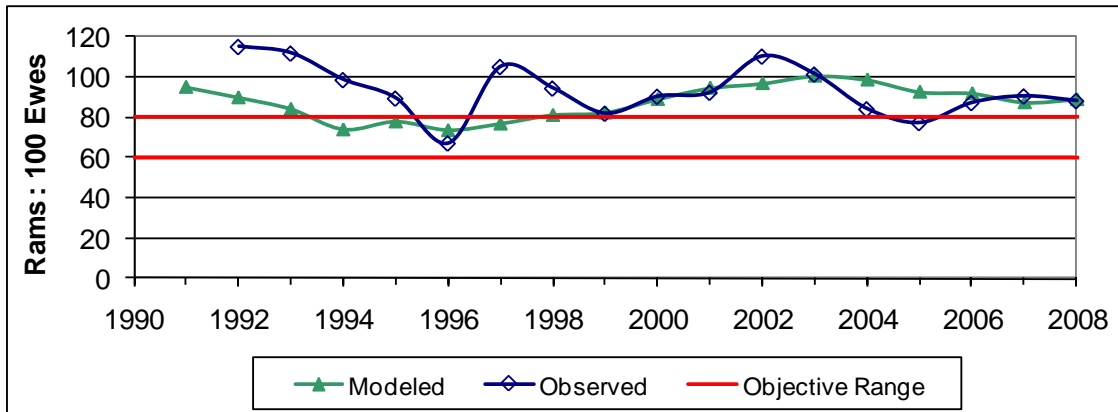


Figure 2: Observed, modeled and objective range of posthunt sex ratios for RBS-3 from 1991 to 2008.

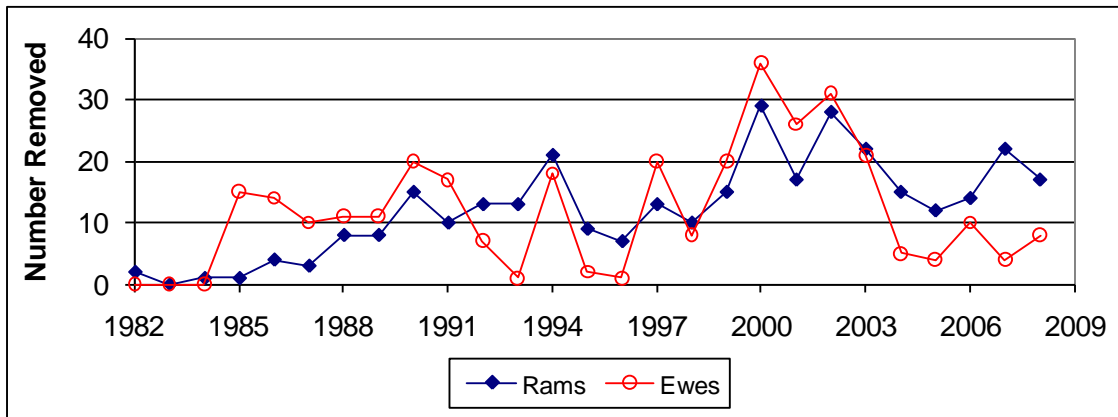


Figure 3: RBS-3 ram and ewe removals via harvest and translocation from bioyear 1982 to 2008.

Background Information

The Georgetown Bighorn Sheep herd (Rocky Mountain Bighorn Sheep Data Analysis Unit 1 - DAU RBS-3) is one of the largest herds in Colorado. It is also one of the most highly valued for the opportunities it provides for hunting, wildlife viewing, and photography and as a source of bighorns for reintroductions and herd supplementations throughout Colorado and other states.

DAU RBS-3 consists of Game Management Unit (GMU) S32 plus an un hunted area to the east. It encompasses 425 square miles (1100 square kilometers) in Jefferson, Gilpin, Clear Creek, and Boulder Counties. Municipalities include Golden, Idaho Springs, Dumont, Downieville, Empire, Georgetown, Silver Plume, and Black Hawk. Most of the western half of the DAU is comprised of Forest Service land, while most of the eastern half is owned privately or by cities and counties.

The Georgetown bighorn sheep herd is indigenous. Population numbers have fluctuated from less than 50 in 1945 to over 500 in 2001. Over the last decade, management actions (i.e., regulated hunting and translocations) have been taken to bring the population back down towards the objective, which is currently 250-350 bighorn. The 2008 population estimate is 370 bighorn. The current sex ratio objective is 60 – 80 rams per 100 ewes, with the current ratio estimated at 89 rams per 100 ewes. This ratio has been above objective for a decade, and ram hunting license numbers have been set to manage this ratio down towards objective.

Potential threats to this herd include disease epidemics following contact with domestic livestock and habitat fragmentation and degradation resulting from human development, recreation, forest encroachment into bighorn habitat, and pine beetle infestation.

Population Objective Alternatives

This DAU plan presents 3 population objective alternatives. Alternative 1 is equal to the current objective, 250 – 350 bighorn. Alternative 1 would call for a 5 – 32% decrease in the population. Alternative 2, 300 – 400 bighorn, is a slight increase from the current population objective to account for the extended range of the herd. A 5% decrease in the population would be required to reach the midpoint of the objective. Alternative 3, 350 – 400 bighorn is an increase from the current objective. Alternative 3 would, call for the herd to be allowed to increase slightly in number.

Sex Ratio Objective Alternatives

This DAU plan presents 3 sex ratio objective alternatives. Alternative 1, 40 – 60 rams per 100 ewes, is a decrease from the current objective and would require a 33 - 55% reduction from the current the sex ratio. This range is probably lower than naturally occurring sex ratios in bighorn herds. Alternative 2, 60 – 80 rams per 100 ewes, is the same as the current sex ratio objective. This range is thought to be at the lower end of natural sex ratio of bighorn herds. This alternative would call for a 10 – 33% decrease in the ram to ewe ratio. Alternative 3, 80 – 100 rams per 100 ewes is an increase from the current objective. Under this alternative, the sex ratio would be allowed to increase slightly from its current level.

Preferred Alternatives

The CDOW recommends Population Objective Alternative 1, 250 – 350 bighorn. This alternative represents no change from the current population objective. Alternative 1 calls for a population numbering approximately ½ of that estimated in 2001, when the herd was at its highest level since settlement. This population range is expected to be low enough to reduce the probability of catastrophic disease epidemics and allow for healthy individual animals and improved recruitment rates. As a result, this is expected to result in higher numbers and larger bighorn available for take by hunters, than the other 2 alternatives. Although Alternative 1 will provide fewer bighorn for viewing than the other alternatives, it is expected to result in increased quality of the viewing experience by resulting in a healthier herd, with less disease, higher proportions of lambs and higher probability of long term stability. Wildlife viewers and photographers are currently happy with the viewing opportunities. Given the distribution and movement patterns of this herd (i.e., a large proportion of the herd use low elevation range that is easily accessible to recreationalists during a large part of the year), viewing and photography opportunities are expected to remain high under Alternative 1. In summary, Alternative 1 is expected to optimize long-term herd health, as well as hunting, viewing and photography opportunities. If substantial habitat improvements occur, or if the range of the herd is expanded the population objective will need to be increased.

The CDOW recommends Sex Ratio Objective Alternative 2. This recommendation is based on public input and field staff evaluation of recreational opportunity, conflicts and current herd levels. This alternative is the same as the current objective range and is thought to be the most biologically appropriate. Also, hunters, wildlife viewers and photographers have all expressed satisfaction with the current sex ratio objective and the opportunity in terms of quantity and quality of bighorn it results in.

This DAU plan was approved by the Colorado Wildlife Commission on March 11, 2010.

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INTRODUCTION AND PURPOSE

The Colorado Division of Wildlife (CDOW) manages bighorn sheep for the use, benefit and enjoyment of the people of the state in accordance with the CDOW’s Strategic Plan, the Colorado Bighorn Sheep Management Plan (George et al. 2009) and mandates from the Colorado Wildlife Commission and the Colorado Legislature. Colorado’s wildlife resources 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).

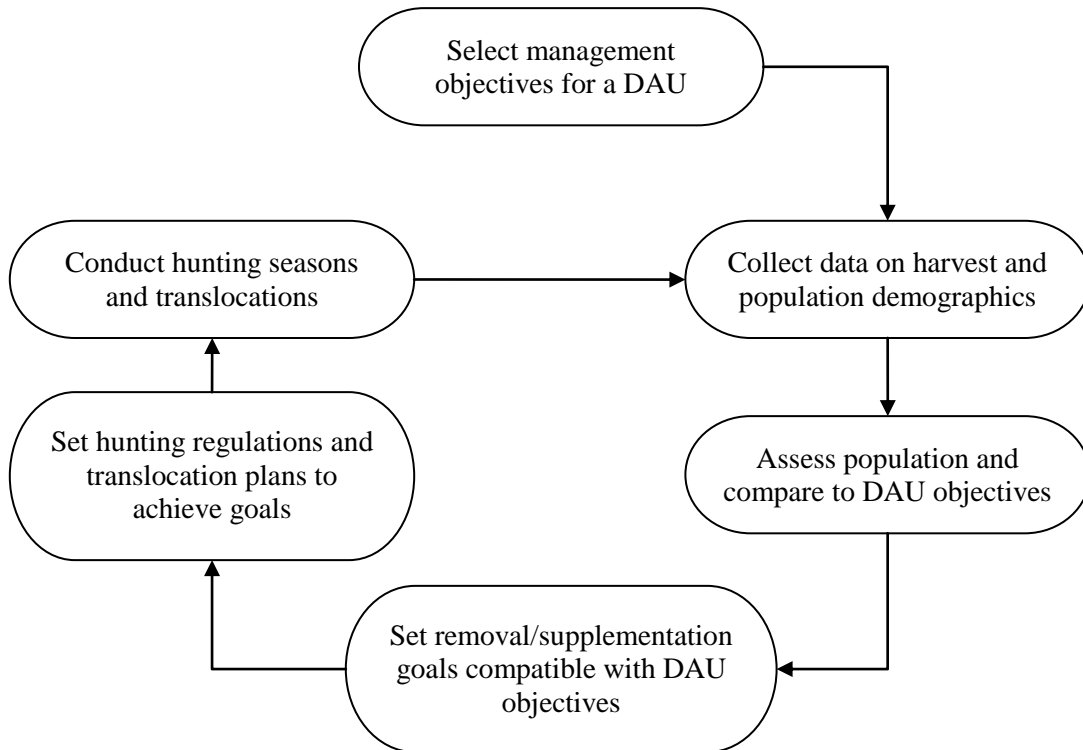


Figure 4: Management by Objective process used by the Colorado Division of Wildlife to manage big game populations by Data Analysis Unit.

In this approach, big game populations are managed to achieve population objectives 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 herd composition (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 then set. Based on these goals specific removal strategies are made for the coming year to either maintain the population or move it toward the objectives. (e.g., license numbers and allocation are set, translocation plans are made). Hunting seasons and translocations are then conducted and evaluated. The annual management cycle then begins again (Figure 4).

DESCRIPTION OF DAU

Location

Bighorn sheep DAU RBS-3 consists of GMU S32. It encompasses 425 square miles (1100 square kilometers) in Jefferson, Gilpin, Clear Creek, and Boulder Counties. The DAU is bounded on the south by Interstate 70; on the west by the Continental Divide; on the north and east by USFS road 149 (Rollins Pass Road), Highway 119, and Highway 72. Bighorn sheep DAU RBS-3 overlaps parts of Big Game GMUs 38 and 39. Clear Creek is the main drainage. Municipalities include Golden, Idaho Springs, Dumont, Downieville, Empire, Georgetown, Silver Plume, and Black Hawk (Figure 5). GMU S32 was expanded to the north and east in 2009 during the implementation of the Statewide Bighorn Sheep Management Plan (George et al. 2009). The previous northern and eastern boundary of the GMU was the Clear Creek / Gilpin county line from the junction of Highways 6 and 119 to the Continental Divide.

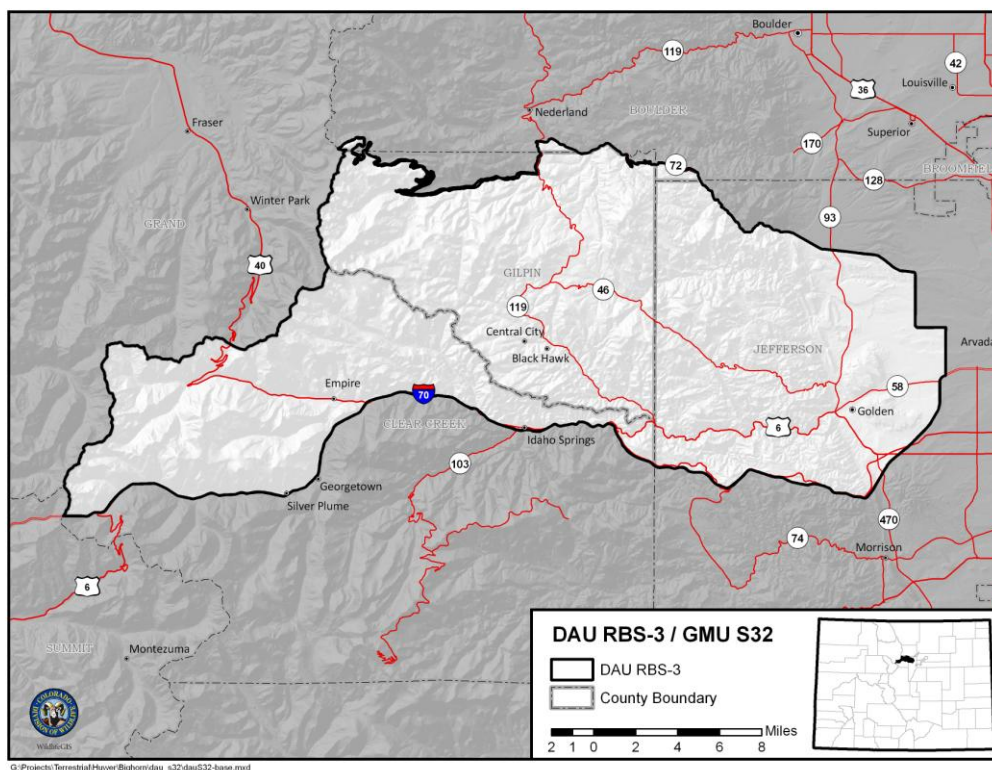


Figure 5: Geographic location of bighorn sheep Data Analysis Unit (DAU) RBS-3 and Game Management Unit (GMU) S32.

Physiography

Climate

The climate varies greatly from east to west across the DAU, depending on elevation. The eastern portion has comparatively warm summer temperatures and mild winters. The western portion is much colder with snow covering timbered areas and north facing slopes from November through May. Much of the DAU has relatively mild winters and is influenced by Chinook winds. These warm down slope winds melt snow quickly. Snow seldom stays for more than a few days on south-facing slopes below 9,000 feet. Alpine ridges usually stay open due to wind.

Vegetation

Vegetation is diverse depending on elevation and climate. Foothills shrubs occur up to approximately 7,500 feet. Species include mountain mahogany, juniper and currants. Mountain riparian communities are found along streams, wetlands and irrigation ditches from 5,600 to 11,000 feet. Willows, chokecherries, alders and narrowleaf cottonwoods are common species. Ponderosa pine dominated communities are found up to 8,500 feet with Douglas fir covering many north-facing slopes in the foothills. There are some agricultural fields, mainly hay and pasture, found in suitable areas up to 9,000 feet. The DAU contains subalpine forests from 8,500 feet up to timberline at approximately 11,600 feet. Within the subalpine forest zone, lodgepole pine intermixed with aspen dominates

up through 10,500 feet. Spruce/fir subalpine forest interspersed with meadows is dominant up to timberline. Stands of limber and bristlecone pine also occur at higher elevations. Alpine tundra, alpine willows, and rock dominate above timberline.

Land Management

DAU RBS-3 encompasses 425 square miles. Approximately 46% (195 mi²) is private land, 36% (152 mi²) is National Forest land (including 6% (27 mi²) of Wilderness), 8% (33 mi²) is County Open Space, 5% (20 mi²) is State Land, 3% (12 mi²) is City Open Space, 2% (10 mi²) is Division of Wildlife land, and 1% (3 mi²) is BLM. Most of the National Forest is located in the western ½ of the DAU (Figure 6).

Only 130 square miles of this DAU is occupied by bighorn sheep. Of this occupied range, approximately 63% (82 mi²) is National Forest land, (including 9% (12 mi²) of Wilderness), 27% (35 mi²) is private land, 5% (7 mi²) is Jefferson County Open Space, 2% (3 mi²) is Clear Creek County Open Space, 1% (1 mi²) is City Open Spaces, 1% (1 mi²) is Division of Wildlife land, 0.5% (0.6 mi²) is State Land, and 0.5% (0.5 mi²) is BLM.

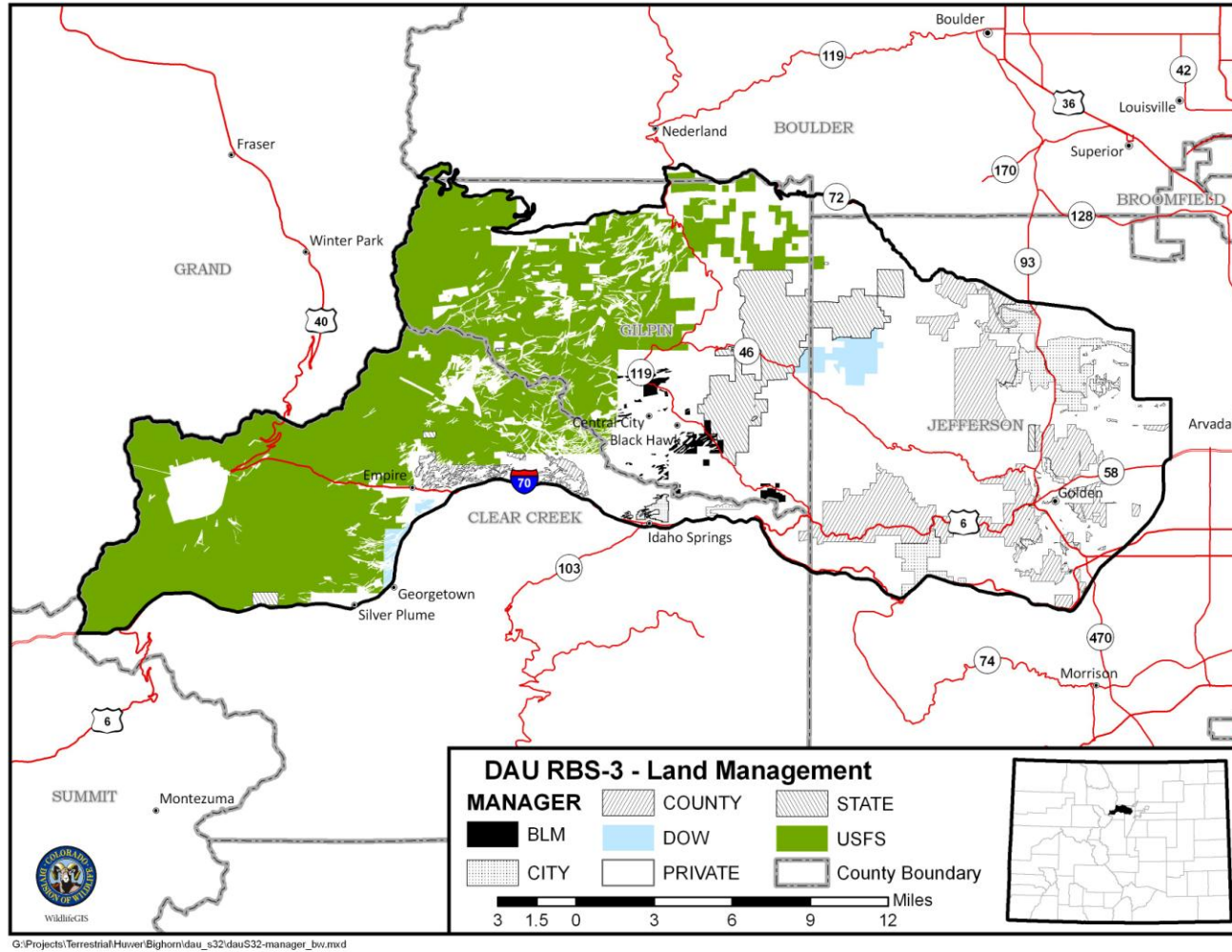


Figure 6: Land ownership in bighorn sheep DAU RBS-3.

Habitat Resources

The amount of available bighorn sheep habitat in DAU RBS-3 was estimated through a spatial analysis as outlined in the Colorado Bighorn Sheep Management Plan (George et al. 2009). This analysis identified the areas 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-3 contains 685 km² (i.e., 264 mi²) of suitable bighorn habitat. 330 km² (i.e., 128 mi²) of this occurs within the currently occupied overall range of the herd (Figure 7). 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.

The amount of suitable winter range was estimated as suitable habitat with a southerly aspect. DAU RBS-3 contains 325 km² (i.e., 126 mi²) of suitable winter range. 150 km² (i.e., 48 mi²) of this occurs within the currently occupied range of the herd (Figure 8)

Lambing habitat was defined as suitable habitat in patches of at least 2 ha in size with slopes $\geq 60\%$ and southerly, easterly or westerly aspects. DAU RBS-3 contains 135 km² (i.e., 52 mi²) of suitable winter range. Of this, 79 km² (i.e., 30 mi²) of lambing habitat is within the currently occupied range (Figure 9).

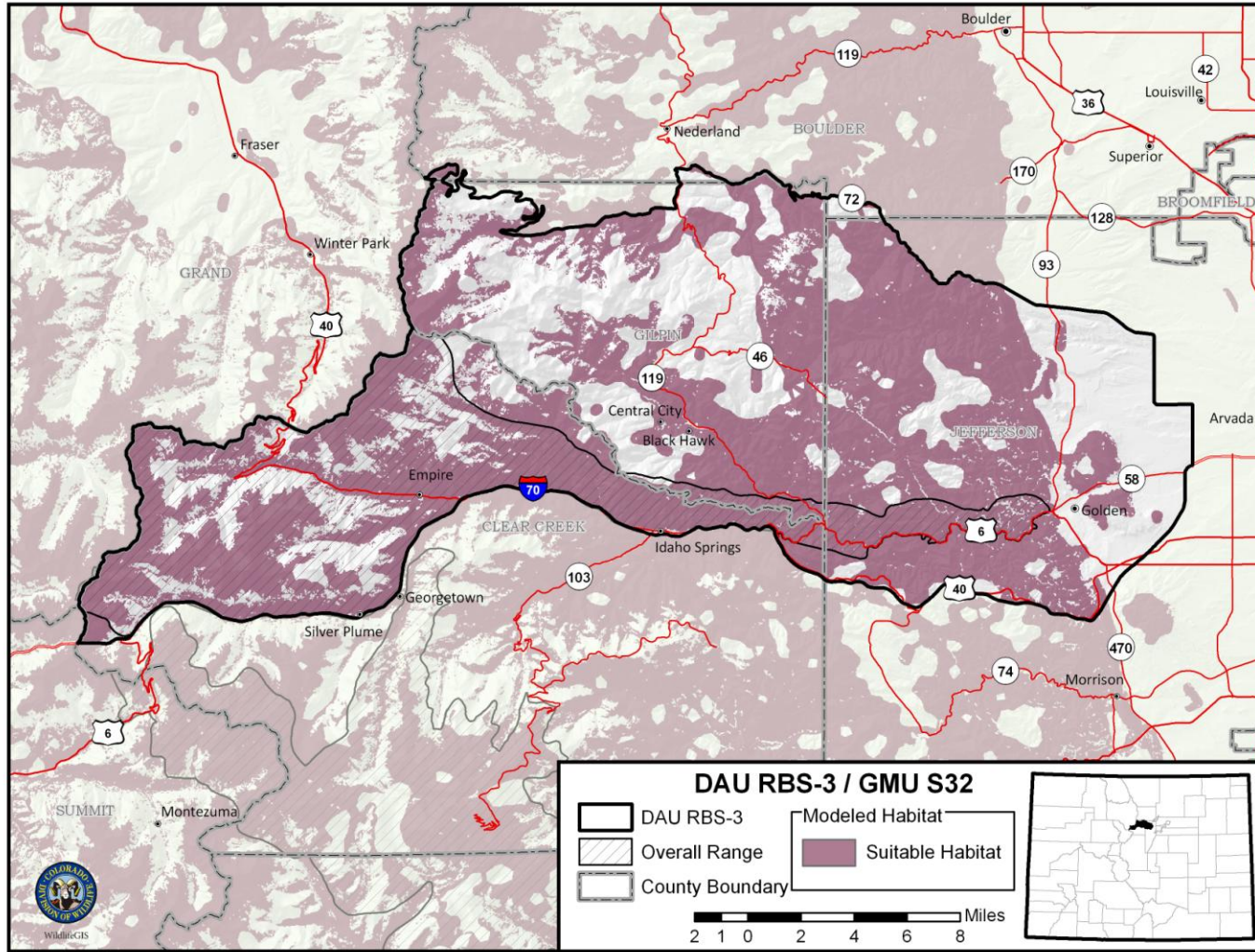


Figure 7: Modeled suitable bighorn sheep habitat and occupied range in DAU RBS-3. Some of the modeled area is not suitable habitat due to vegetation characteristics.

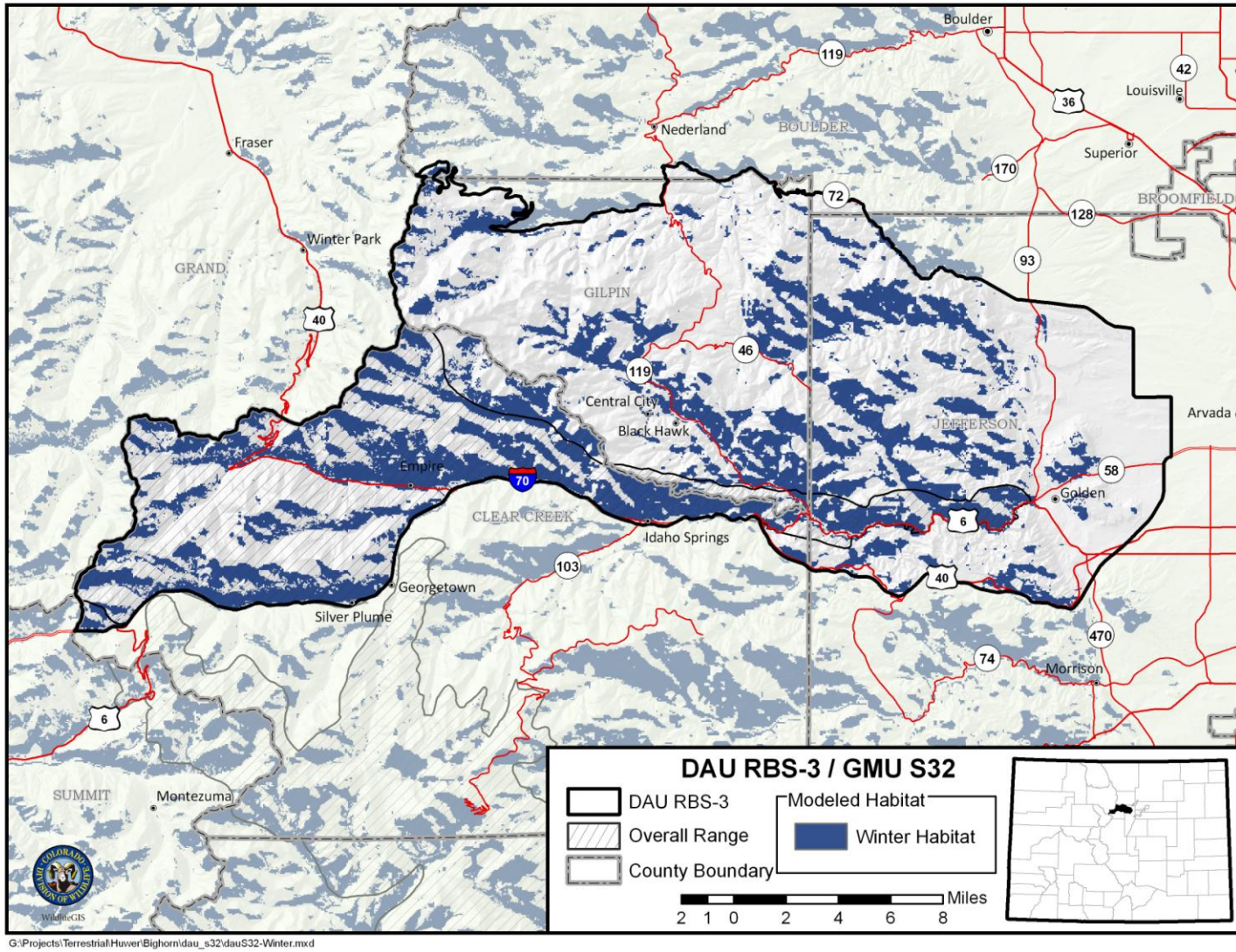


Figure 8: Modeled bighorn sheep winter habitat and occupied range in DAU RBS-3.

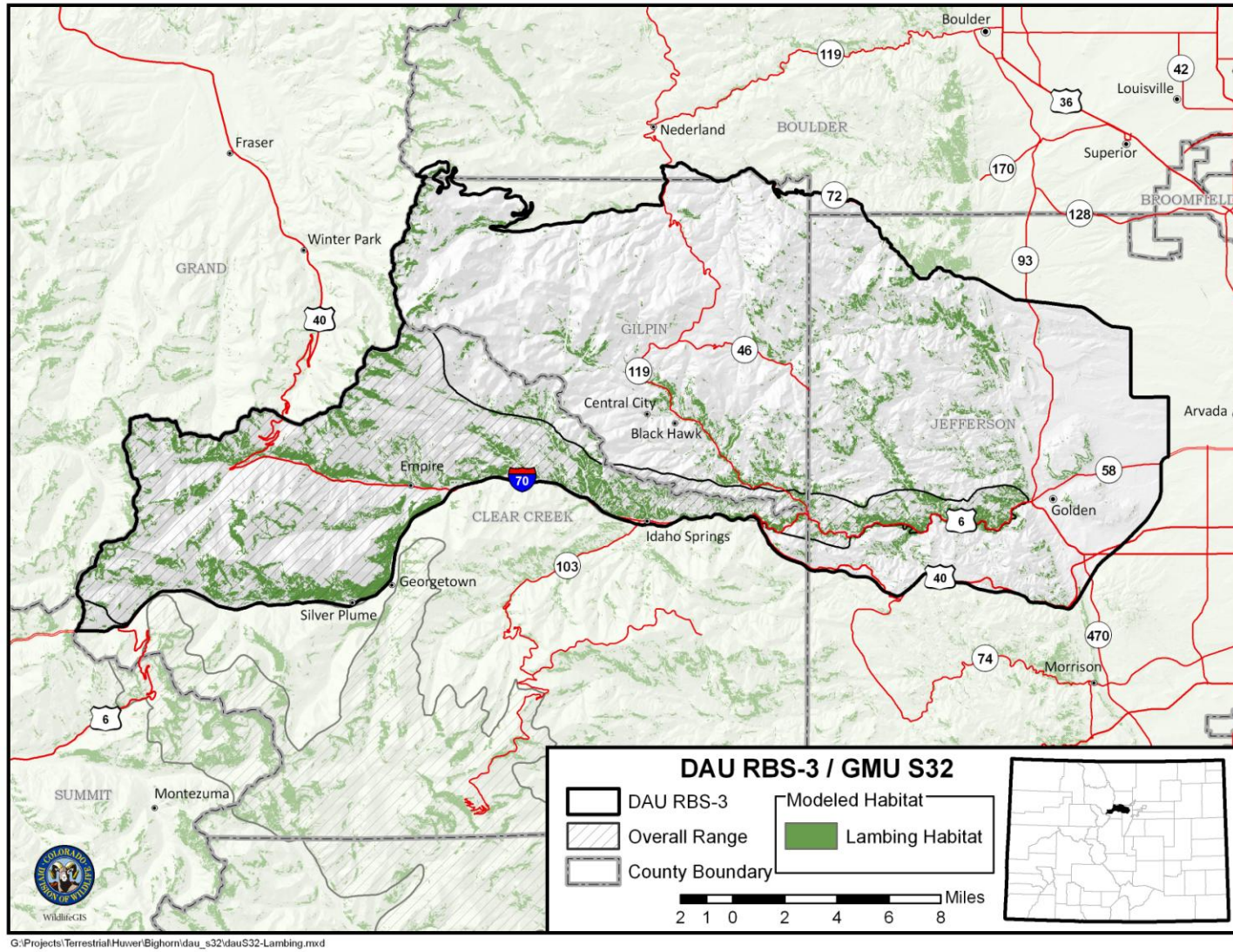


Figure 9: Modeled bighorn sheep lambing habitat and occupied range in DAU RBS-3.

BIGHORN SHEEP POPULATION HISTORY

Population History

The Georgetown bighorn sheep herd is an indigenous herd. Bighorn sheep have been present in the area for the span of recorded history. Population numbers have fluctuated over the last 60 years from less than 50 bighorn sheep to over 500.

Bear and Jones (1973) reported that there were few bighorn sheep in the area prior to the release of 33 and 14 bighorns in 1946 and 1949, respectively (see Translocations Section). In 1949, White (1951) estimated a population of 65 bighorn sheep. The population increased to 135 bighorn sheep by the mid 1950s (Moser 1962) and continued to grow through the 1950s before declining (Bear and Jones 1973). Although the cause of this decline is unknown, it coincided with die-offs in other herds caused by “the lungworm-pneumonia complex.” The population remained low through the 1960s and 1970s. Lynch and Hector estimated the population in 1971 at 75 bighorn sheep. The population began to increase in the early 1980s and then increased dramatically by the late-1980s. The population continued to grow through the 1990s, despite offtake by hunters and translocations, reaching a high of approximately 530 bighorn sheep in 2001. Management actions to control the population and fair to low lamb recruitment brought the population down to approximately 370 bighorn in 2008 (Figure 10). These management actions included removing bighorn sheep through trapping and transplanting (see Translocations section) and increasing hunter harvest (see Harvest section).

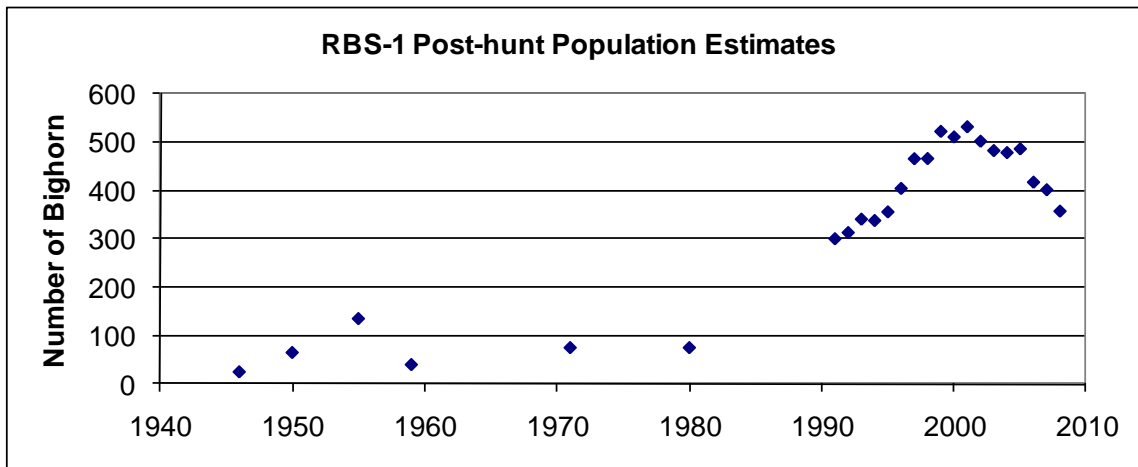


Figure 10: Population estimates for DAU RBS-3 from 1940 to 2008.

The population estimates for 1991 to 2008 were derived from computer models, which incorporate estimates of mortality, population size, sex ratio at birth, observed age ratios, hunter harvest, translocations, and vehicle collision mortality (Figure 11). See the *Inventory Methods* and *Population Estimation* sections for more details. The population is modeled from 1991 to 2008 because this is the time period for which the necessary data is available.

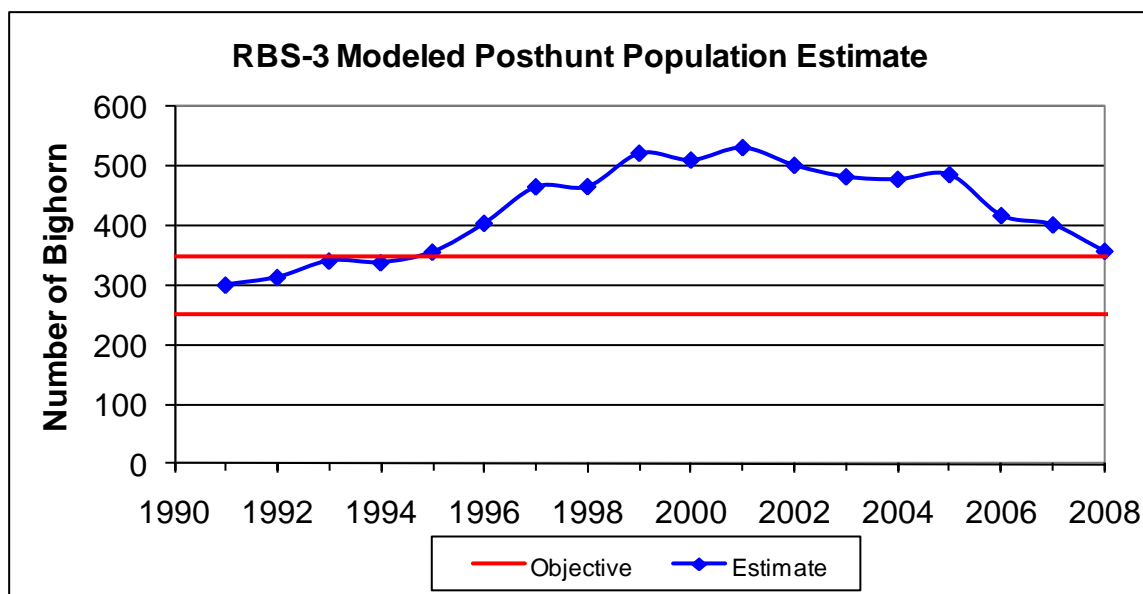


Figure 11: Modeled annual population estimates and objective range for DAU RBS-3 from 1991 to 2008.

Estimating population numbers of wild animals over large geographic areas is a difficult and approximate science. The CDOW recognizes the difficulties of estimating the size of bighorn populations as a challenge in managing populations and attempts to maximize the accuracy of these estimates by using the latest technology and inventory methodology available. As better information and techniques become available (e.g., new estimates of survival/mortality, wounding loss, sex ratios, density, or new modeling techniques and software) they are evaluated and used where appropriate. The population estimate presented in this document should, therefore, not be considered a completely accurate enumeration of the animals in the DAU.

Distribution

Immediately prior to the herd supplementations of bighorn in 1946 and 1949, the herd was described as few bighorn occupying the Georgetown Empire area. The Georgetown bighorn sheep herd in 1973 was described by Bear and Jones (1973) as wintering north of Interstate 70 from Lawson west to Bard and Robeson Peaks. At that time sheep summered in this wintering area as well as to the north along the Continental Divide from Colorado Mines Peak north to James Peak and to the west of the winter range in a triangle between Mt Bethel to Bard Peak to Red Mountain. Since 1973 the herd has expanded its range to the east and west. Currently, bighorn sheep in DAU RBS-3 occur north of Clear Creek and Interstate 70 between the City of Golden and the Continental Divide and south of Clear Creek between Tunnels 2 and 6 in Clear Creek Canyon. In the eastern portion of the range, bighorn sheep only occur within a mile of Clear Creek; the western portion of the range extends north to James Peak (Figure 12). During the summer, bighorn sheep are found throughout this area. During winter, bighorn use shifts to low elevation areas, south and west facing slopes and windblown alpine ridges depending on snow depths.

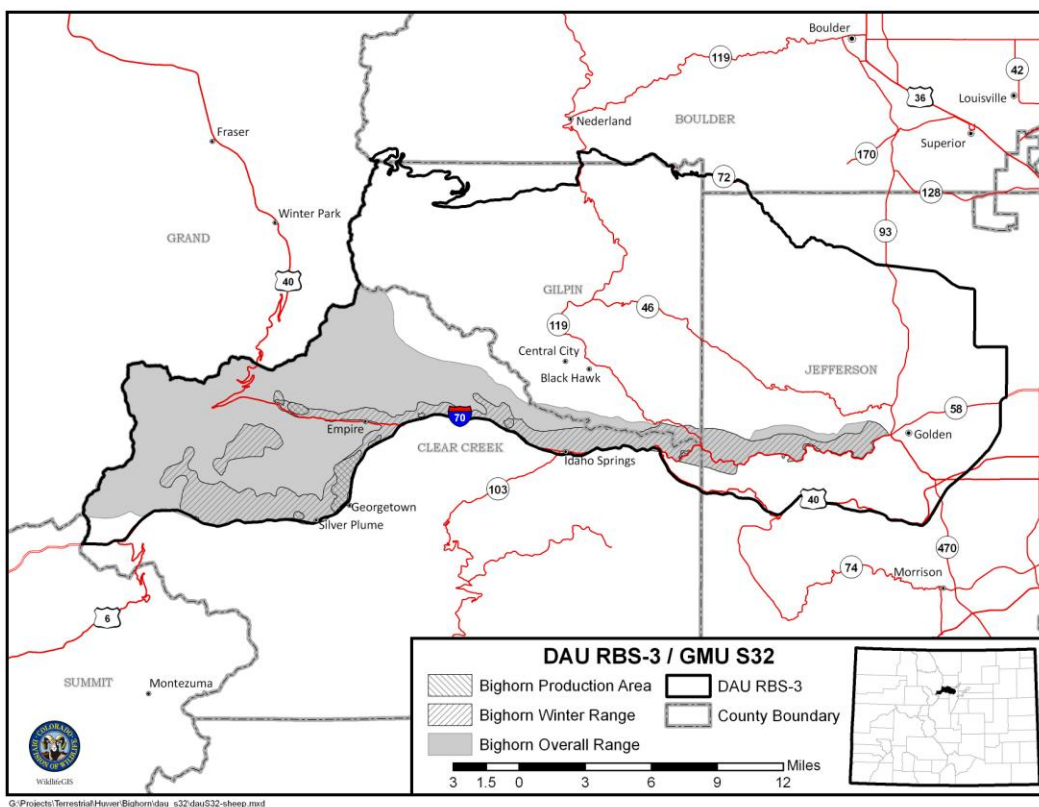


Figure 12: Distribution of bighorn sheep in DAU RBS-1.

Movement

Interaction of Subherds within the DAU

Several loosely defined and overlapping subherds can be described within this DAU. The **Eastern** subherd occurs primarily from Golden to the junction of Highways 6 and 119. This subherd’s range shifts to the west in the summer and to the east towards Golden in the winter. The **Idaho Springs East** subherd occupies the area from the junction of Highways 6 and 119 to Idaho Springs, shifting to the west in summer and to the east in winter. The **Dumont** subherd ranges from the twin tunnels east of Idaho Springs to Lawson. The **Empire** subherd winters mostly in the low elevation areas from Dumont to Empire and summers on the alpine along the Continental Divide from Berthoud Pass to James Peak. The **Douglas Mountain** subherd moves between Dumont and Georgetown north of I-70. The **Georgetown** subherd uses the area from the junction of I-70 and US Highway 40 to the west and moves up in elevation to occupy the alpine areas from Republican Mountain to Silver Plume Mountain. The **Western** subherd occupies the area south of US Highway 40, north of I-70 and east of the Continental Divide. They use both the alpine and low elevation areas throughout this area.

There is connectivity throughout the DAU. The Eastern subherd interacts with the Idaho Springs subherd. The Idaho Springs subherd interacts with the Eastern, Dumont, Empire,

and Douglas Mountain subherds. The Empire subherd interacts with the Idaho Springs, Dumont, Douglas Mountain subherds. The Georgetown subherd interacts with the Douglas Mountain and Western Subherds and the Western subherd interacts with the Douglas Mountain and Georgetown subherd.

Interaction with other DAUs

Interchange between the Georgetown herd and other herds via occasional long-range dispersal is known to occur. For example, in the early 1990s, a ram that had been ear tagged as a lamb in Georgetown was harvested by a hunter in the Kenosha Mountains. However, beyond these occasional dispersal movements, there appears to be little interaction between the Georgetown herd and other bighorn sheep herds. The nearest herd is the Mount Evans herd. The ranges of these 2 herds are separated by only ½ mile near Georgetown and less than a mile near the Eisenhower Tunnel. These 2 herds are separated by Clear Creek, Interstate 70, and the town of Georgetown. There have been several studies and management activities over years through which collars and ear tags have been placed on bighorn sheep from the Georgetown and Mt Evans herds. No marked bighorn sheep has ever been observed to cross the boundary between the 2 herds. Evidence for the lack of movement from the Mt Evans herd into the Georgetown herd is provided by the fact that Johnne's disease occurs in the Mount Evans herd, but has never been identified in the Georgetown herd.

Interchange with other herds is probably very infrequent due to the distances that separate the Georgetown herd from any other. Due to the physiography of the area, after the Mount Evans herd, interchange is most likely with the St Vrain herd to the north. These 2 herds are separated by contiguous suitable bighorn sheep summer habitat, some (if not all) of which was historically occupied by bighorn. In July 2006, the signal from a radio collared ewe from the Georgetown herd was located near Jasper Lake in Boulder County (no visual). This is 9 miles north of the currently mapped range of the Georgetown herd and 12 miles south of that of the St Vrain herd. At the same time, 2 additional signals from radio collared ewes from the Georgetown herd were located near Rollins Pass. This is 6 miles north of the currently mapped range of the Georgetown herd and 14 miles south of that of the St Vrain herd. All three of these ewes returned to the Georgetown herd and were never again found outside of its mapped boundaries. The ewe that moved to Jasper lake was killed in a collision with a vehicle in May of 2007 (i.e., before her movement to summer range). The 2 ewes that moved to Rollins Pass were alive for 2 summers following their movement, but did not leave DAU RBS-3 during either of those years.

Although the Gore herd is only 11 miles from that of the Georgetown herd, interchange between these 2 herds is very unlikely given the non-contiguous nature of suitable bighorn habitat between the 2 herds.

Herd Management History

Inventory Methods

Coordinated summer ground surveys have taken place each July in DAU RBS-3 since 1988 (Table 1). During these surveys, teams of observers simultaneously search for bighorn sheep along specified routes. Since 1992, coordinated fall ground surveys have also taken place during the breeding season each November/December (Table 2). Total counts are higher during the winter survey because the bighorn sheep are more concentrated and accessible for counting. Ram: ewe ratios during the summer surveys are highly variable due to the spatial separation of rams and ewes during the surveys. The ram: ewe ratios are more reliable during the winter surveys when rams and ewes are together. The observed number of rams per 100 ewes during the winter survey has ranged from 67 to 115. The modeled posthunt sex ratio has ranged from 72 to 106 rams per 100 ewes (Figure 13). Fall lamb to ewe ratios are a commonly used measure of herd recruitment. Since 1992, in DAU RBS-3, they have ranged from 6 to 68 lambs per 100 ewes (Figure 14). Lamb to ewe ratios fluctuate from year to year, however, the steady decrease observed between 2001 and 2006 and low recruitment since, is a cause for concern.

Table 1: Results of the DAU RBS-3 summer coordinated ground surveys from 1988 to 2008. From 1988 to 2005, one survey was conducted each year. In 2006 and 2007, 7 surveys were conducted. In 2008, 6 surveys were completed; the totals for all surveys are shown for each year. The highest number of unduplicated bighorn seen on a single day in each year is shown in the “1 Day” column.

Year	Ewe	Lamb	Yearling	Ram	Unclass	Total	1 Day	L: E	R: E
1988	36	21	5	36	14	112	112	0.58	1.00
1989	27	3	5	24	12	71	71	0.11	0.89
1990	50	20	11	33	25	114	114	0.40	0.66
1991	91	31		22		144	144	0.34	0.24
1992	92	35	12	32	19	190	190	0.38	0.35
1993	26	24	4	42	20	116	116	0.92	1.62
1994	44	13	8	56	12	133	133	0.30	1.27
1995	78	29	1	48	40	194	194	0.37	0.62
1996	104	60	13	41	30	256	256	0.58	0.39
1997	43	32	5	63	26	169	169	0.74	1.47
1998	35	24	16	45	69	189	189	0.69	1.29
1999	69	30	20	35	30	185	185	0.43	0.51
2000	68	48	9	89	18	232	232	0.71	1.31
2001	82	32	18	65	7	204	204	0.39	0.79
2002	107	56	14	39	38	254	254	0.52	0.36
2003	43	28	60	35	56	189	189	0.65	0.81
2004	66	17	8	63	14	168	168	0.26	0.95
2005	70	33	9	83	18	213	213	0.47	1.19
2006	358	96	53	427	82	1004	225	0.27	1.19
2007	348	150	19	365	29	883	208	0.43	1.05
2008	390	124	41	242	76	873	165	0.32	0.62

Table 2: Results of the Georgetown bighorn sheep fall coordinated ground surveys from 1992 to 2008. From 1992 to 2006, one survey was conducted each year. In 2007 and 2008, 4 and 3 surveys were conducted, respectively; the totals for all surveys are shown. The highest number of unduplicated bighorn seen on a single day in each year is shown in the “1 Day” column.

Year	Ewe	Lamb	Yearling	Ram	Unclass	Total	1 Day	L: E	R: E
1992	86	51	19	99	4	259	259	0.59	1.15
1993	76	40	24	85	2	228	228	0.53	1.12
1994	77	12	17	76	0	182	182	0.16	0.99
1995	67	35	6	60	6	174	174	0.52	0.90
1996	101	42	14	68	7	232	232	0.42	0.67
1997	115	56	13	121	0	305	305	0.49	1.05
1998	73	26	21	69	13	206	206	0.36	0.95
1999	145	69	50	119	9	392	392	0.48	0.82
2000	84	57	17	76	27	261	261	0.68	0.90
2001	106	70	30	98	13	317	317	0.66	0.92
2002	87	39	17	96	12	251	251	0.45	1.10
2003	69	24	7	70	5	175	175	0.35	1.01
2004	108	27	21	91	8	255	255	0.25	0.84
2005	71	17	9	55	1	153	153	0.24	0.77
2006	93	6	7	81	3	190	190	0.06	0.87
2007	341	78	31	309	18	779	230	0.23	0.91
2008	257	38	25	227	6	553	221	0.15	0.88

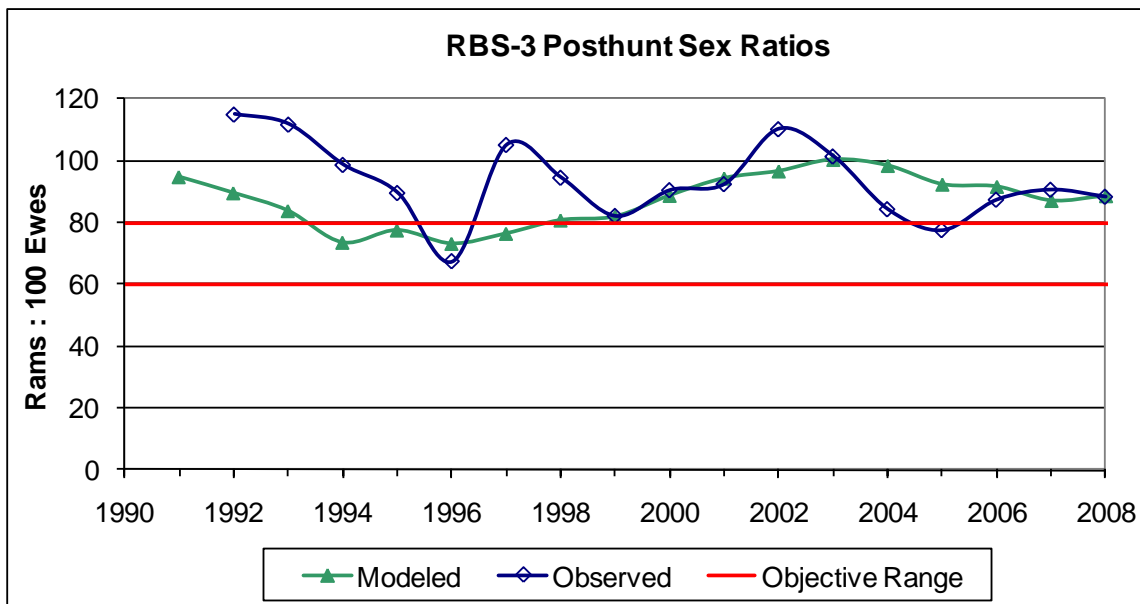


Figure 13: Observed, modeled and objective range of posthunt rams per 100 ewes in DAU RBS-3 from 1991 to 2008.

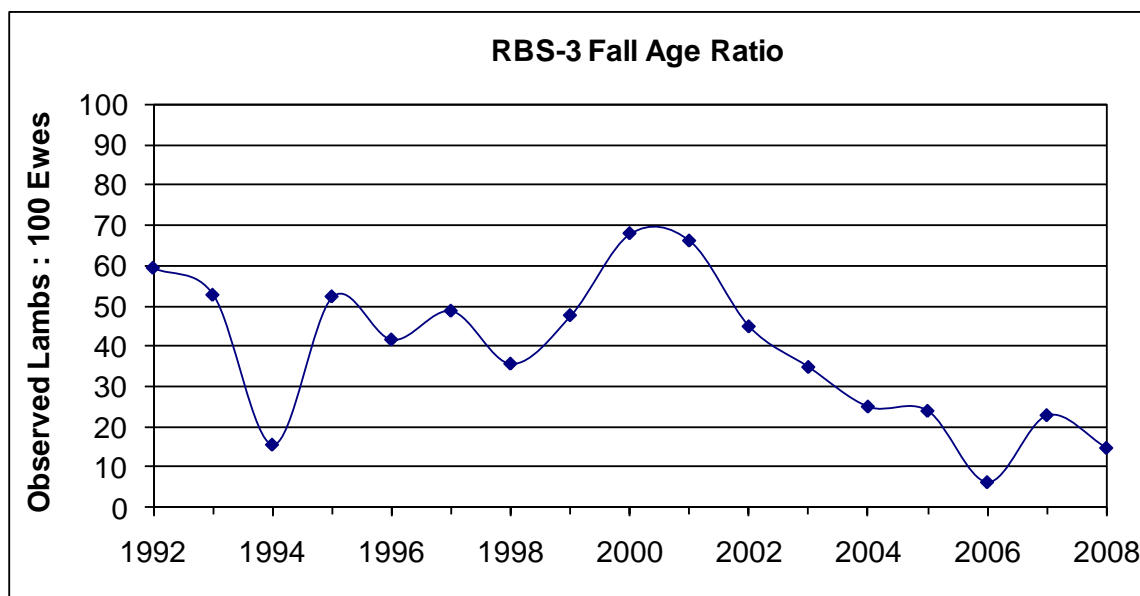


Figure 14: Observed lambs per 100 ewes during the fall survey in DAU RBS-3 from 1992 to 2008.

Population Estimation

From 2006-2008, mark-resight methodology was used to estimate the adult population size of this herd in July of each year. During the 3 capture seasons 73 (48 ewes, 25 rams) adult bighorn sheep were collared. In July 2006, 6 resight surveys were completed during which 35 ewes and 14 rams were collared. Bowden's estimator was used to calculate a population estimate of 185 adult ewes (95% CI of 154 – 222) and 194 adult rams (95% CI of 144 – 261). The ram to ewe ratio from this estimate was 1.05. In July 2007, 7 resight surveys were completed during which 33 ewes and 18 rams were collared. Bowden's estimator was used to calculate a population estimate of 229 adult ewes (95% CI of 175 – 300) and 216 adult rams (95% CI of 154 – 303). The ram to ewe ratio from this estimate was 0.94. In July 2008, 5 resight surveys were completed during which 33 ewes and 16 rams were collared. Bowden's estimator was used to calculate a population estimate of 185 adult ewes (95% CI of 150 – 229) and 157 adult rams (95% CI of 101 – 245). The ram to ewe ratio from this estimate was 0.85. These population estimates were used in population models to estimate the size of the posthunt population (see the *Population History* section). These July (pre-hunt) population estimates are higher than the posthunt population described in the *Population History* section due to losses of sheep between July and December through hunter harvest, vehicle collisions, and other mortalities. Lambs account for the majority of the other mortalities between July and December.

Translocations

Two supplemental translocations into the Georgetown herd have occurred. Thirty-three bighorn sheep (3 rams, 20 ewes, 3 yearlings, and 7 lambs) from the Tarryall herd were released on Douglas Mountain near Georgetown on October 29, 1946. Fourteen more bighorn sheep (2 rams, 8 ewes, 2 yearlings, and 2 lambs) from the Tarryall herd were released in the same area on March 3, 1949 (Bear and Jones 1973).

In 1985, bighorn sheep captured near Georgetown were moved to the junction of Highways 6 and 119 to extend the range of the Georgetown herd. By 1986 the herd had grown large enough to allow for the removal of excess bighorn sheep for reintroductions and herd supplementations throughout Colorado and other states. Bighorns from the Georgetown herd have gone to Nevada, South Dakota, Utah, Glenwood Canyon, Spanish Peaks, Big Thompson Canyon, Dinosaur National Monument, Browns Canyon, Durango and Ouray. From 1986 to 2003, a total of 280 bighorn sheep (54 rams, 153 ewes, and 73 lambs) were removed from the herd for translocation (Table 3).

Table 3: Number of bighorn sheep translocated from the Georgetown herd from 1986 to 2003.

Year	Ram	Ewe	Yearling	Lamb	Total	To
1986	1	15		3	19	Junction of Hwys 119 and 6
1987	2	14		8	24	White River
1988	2	10		8	20	Spanish Peaks
1989	3	11		12	26	Nevada
1990	2	11		7	20	Black Canyon
1991	8	19		0	27	South Dakota
1992	6	16		0	22	SW Colorado
1994	1	5	9	7	22	Nevada
1997	10	17		1	28	Utah
1998	3	11	2	8	24	Browns Canyon, Colopaxi
2000	7	13		7	27	Dinosaur National Monument
2000	5	13		4	22	Big Thompson Canyon
2001	2	15		11	28	Animas Canyon near Durango
2002	3	17		7	31	Rock Creek (Gunnison)
2003	5	2		0	7	Animas Canyon near Durango
Total	55	168		76	299	

Hunting Season Structure, License Numbers and Timing

Unregulated market hunting, along with habitat losses and introduced diseases, contributed to reductions in bighorn numbers in the 1860s and 1870s. In response to declining bighorn populations, the Colorado legislature placed a moratorium on bighorn sheep hunting in 1885 (George et al. 2009). By 1953, many of the herds in the state had recovered and several areas were reopened to hunting, including DAU RBS-3. Hunting occurred in DAU RBS-3 from 1953 through 1970, except in 1959. In 1971, the hunting season in this unit was closed. Hunting was reinstated in 1982 with an archery ram only season.

As the bighorn sheep population grew, ewe seasons were added and modified in order to control the size of the population and ram seasons were added and modified in order to control the herd demographics. In 1990, an archery ewe season was added. Trapping and transplanting efforts that removed more ewes than rams (see Translocations section) combined with low ram harvest rates resulted in unnaturally high ram to ewe ratios. Concern over the stress that high ram to ewe ratios could cause the herd led managers to increase the number of archery ram licenses and add a rifle ram season in 1992. This succeeded in reducing the ram to ewe ratio. In 1997, in response to complaints from

archers about overcrowding, the number of archery ram licenses was reduced in order to improve the quality of the archery hunting experience. Continued population growth led to the addition of a ewe rifle season in 1997 (Table 4).

From 1953 to 1970, there was 1 hunting season in this herd during which hunters could use any method of take. When hunting was reestablished in 1982, there were 2 archery seasons. In 1989, 1 more archery season was added. In 1992, the number of seasons was increased to 4 with the addition of a rifle season. In 2000, another rifle season was added for a total of 5 seasons (Table 5). The total number of hunting days has increased with the number of seasons, from a low of 9 in 1954 to a high of 68 days since 2005 (Table 4). The total number of licenses offered grew from 10 in 1982 to a high of 92 in 2003. License numbers were decreased to 46 in 2004 in response to 2 years of low lamb recruitment and suspected mortality caused by an unusual snow event in March 2003. Licenses were increased from 2006-2008 in order to bring the population size down towards objective (Table 4).

Curl restrictions

Minimum curl restrictions have been used in Colorado to direct ram harvest towards the desired age classes. Restrictions in DAU RBS-3 have followed statewide restrictions in most years and have included $\frac{1}{2}$ curl, $\frac{3}{4}$ curl, and full curl (Table 4). In 1993, the ram to ewe ratio was high with young rams accounting for a large proportion of the ram population. In order to reduce the ram to ewe ratio while maintaining the quality of rams for viewing and hunting, licenses with a slot curl restriction were introduced in GMU S32. From 1993 to 2001, 2 types of licenses were issued each year in GMU S32. One type required that harvested rams be at least a $\frac{1}{2}$ curl. The other type of license required that a harvested ram be at least a $\frac{1}{2}$ curl but not exceed $\frac{3}{4}$ curl. From 1993 to 1996, both types of licenses were issued during both the archery and rifle seasons. From 1997 to 2001, the slot restriction licenses were only issued during rifle seasons.

Nonresident licenses

Prior to 1985, only residents of Colorado were eligible to draw bighorn sheep licenses. From 1985 to 1988, 20% of the licenses were made available to non-resident hunters. Since 1989, 10% of statewide licenses have been offered to non-resident hunters annually.

Season Timing

Hunting seasons have occurred in August, September and October, except in 1958 when the hunting season was held in November. Currently, hunting seasons occur between August 1 and the deer and elk regular rifle seasons (i.e., early October). Archery seasons have always been held prior to rifle seasons (Table 5). Ewes have been hunted as early as August 3 (during the first archery season in 2002). However, since 2005, ewes have not been hunted prior to September 1 due to concerns that harvesting of ewes in August may result in the orphaning of lambs that are not yet independent. Since 2005, therefore, no ewe licenses have been issued during the first 2 archery season.

Hunting unit boundaries

The southern and western boundaries of the hunting unit has remained consistent since 1953, however, the eastern and northern boundaries have changed several times. In 1953, hunting was allowed west of Empire only; at that time the unit did not have a unit number designation. In 1963 and 1964, hunting was allowed throughout the current bighorn sheep GMU 32, although it was called Unit 17 at the time. In 1966 and 1967, hunting was only allowed as far east as Idaho springs and as far north as St Mary's Glacier. In 1969 and 1970, there were 2 hunting units, unit 17 was from US Highway 40 north and east to Idaho Springs and unit 32 was from US Highway 40 south and west to the continental divide. There were 2 licenses available in each unit. From 1971 to 1981 no hunting occurred in this herd. Since 1982, the hunting unit has been called GMU S32, the size of which steadily increased until 1987. In 1982, hunting was allowed only from Empire north to Mt Flora and west to the continental divide except for a 1/2 mile closures along US Highway 40 and Interstate 70 to the FS boundary near Bakerville. In 1983, the eastern boundary was moved east to Dumont. In 1987, the eastern boundary was moved east to current boundary of the junction of Highways 6 and 119. In 1989, the northern boundary was extended to James Peak and the closures around the highways were change to ¼ mile throughout the unit. In 2009, the unit was expanded to the north and east to the current boundaries.

Harvest

Hunters have harvested 0 - 45 bighorn annually in DAU RBS-3 (Table 6). From 1953 to 1970 success rates ranged from 0 to 50% (Figure 15). From 1982 to 2007, success rates for ewe hunters have ranged from 0% to 67% for archery and from 25% to 53% for rifle hunters (Figure 16). From 1982 to 2007, success rates have ranged from 0% to 64% for archery ram hunters and from 50 to 100% for rifle ram hunters (Figure 17).

Anecdotal evidence suggests that the average age of rams harvested and the size of their horns probably decreased during the 1980s. Since 1988, the average length of harvested ram horns has decreased slightly (Figure 18).

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Table 4: Licenses offered and ram curl restrictions in DAU RBS-3 from 1953 to 2008.

Year	Rifle			Archery			Total			Curl Restriction
	Ram	Ewe	Total	Ram	Ewe	Total	Ram	Ewe	Total	
1953							10		10	1/2
1954							10		10	1/2
1955							10		10	1/2
1956							5		5	1/2
1957							15		15	1/2
1958							14		14	3/4
1959							no hunt		no hunt	no hunt
1960							4		4	1/2
1961							8		8	1/2
1962							8		8	1/2
1963							6		6	1/2
1964							6		6	1/2
1965							6		6	1/2
1966							12		12	3/4
1967							12		12	3/4
1968							12		12	3/4
1969							12		12	3/4
1970							4		4	Full
1982				10		10	10		10	1/2
1983				10		10	10		10	1/2
1984				10		10	10		10	1/2
1985				10		10	10		10	1/2
1986				10		10	10		10	1/2
1987				10		10	10		10	1/2
1988				10		10	10		10	1/2
1989				18		18	18		18	1/2
1990				18	3	21	18	3	21	1/2
1991				21	3	24	21	3	24	1/2
1992	6		6	30	3	33	36	3	39	1/2
1993	6		6	30	3	33	36	3	39	1/2; 1/2 - 3/4
1994	6		6	30	3	33	36	3	39	1/2; 1/2 - 3/4
1995	6		6	30	3	33	36	3	39	1/2; 1/2 - 3/4
1996	6		6	30	2	32	36	2	38	1/2; 1/2 - 3/4
1997	6	10	16	21	11	32	27	21	48	1/2; 1/2 - 3/4
1998	8	10	18	21	10	31	29	20	49	1/2; 1/2 - 3/4
1999	8	10	18	21	10	31	29	20	49	1/2; 1/2 - 3/4
2000	15	30	45	23	16	39	38	46	84	1/2; 1/2 - 3/4
2001	15	30	45	21	15	36	36	45	81	1/2; 1/2 - 3/4
2002	18	30	48	23	15	38	41	45	86	1/2
2003	15	35	50	24	15	39	39	50	89	1/2
2004	9	15	24	14	7	21	23	22	45	1/2
2005	10	15	25	15	7	22	25	22	47	1/2
2006	13	17	30	18	7	25	31	24	55	1/2
2007	20	16	36	24	7	31	44	23	67	1/2
2008	20	24	44	24	12	36	44	36	80	1/2

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Table 5: Archery (A) and rifle (R) season dates and lengths in DAU RBS-3 from 1953 to 2008.

Yr	Season Start Date					Season End Date					Season Length				
	A 1	A 2	A 3	R 1	R 2	A 1	A 2	A 3	R 1	R 2	A 1	A 2	A 3	R 1	R 2
53				9/3					9/13					10	
54				9/11					9/20					9	
55				9/3					9/12					9	
56				9/1					9/10					9	
57				8/31					9/16					16	
58				11/15					11/24					9	
59				None					None						
60				8/27					9/12					16	
61				8/26					9/11					16	
62				8/18					9/4					17	
63				8/24					9/8					15	
64				8/22					9/28					37	
65				8/28					9/20					23	
66				8/28					9/19					22	
67				8/26					9/13					18	
68				8/17					9/9					23	
69				8/16					9/8					23	
70				8/15					9/6					22	
82	8/21	9/22				9/7	10/12				17	20			
83	8/20	9/10				9/6	9/25				17	15			
84	8/18	9/4				9/4	9/25				17	21			
85	8/17	9/7				9/3	10/8				17	31			
86	8/16	9/6				9/2	10/7				17	31			
87	8/15	9/5				8/30	10/6				15	31			
88	8/13	9/10				9/5	10/9				23	29			
89	8/12	8/30	9/20			8/27	9/17	10/8			15	18	18		
90	8/13	8/30	9/20			8/27	9/15	10/11			14	16	21		
91	8/12	8/29	9/20			8/26	9/15	10/11			14	17	21		
92	8/10	8/27	9/16	10/1		8/24	9/13	9/30	10/7		14	17	14	6	
93	8/9	8/26	9/15	10/4		8/23	9/13	10/1	10/8		14	18	16	4	
94	8/8	8/25	9/14	10/3		8/22	9/1	9/30	10/7		14	7	16	4	
95	8/7	8/24	9/13	10/2		8/21	9/11	9/29	10/6		14	18	16	4	
96	8/12	8/29	9/18	10/7		8/26	9/16	10/4	10/11		14	18	16	4	
97	8/9	8/26	9/12	10/1		8/24	9/10	9/28	10/10		15	15	16	9	
98	8/8	8/25	9/11	9/30		8/23	9/9	9/27	10/9		15	15	16	9	
99	8/7	8/24	9/10	9/29		8/22	9/8	9/26	10/8		15	15	16	9	
00	8/5	8/22	9/8	9/27	10/7	8/20	9/6	9/24	10/6	10/13	15	15	16	9	6
01	8/4	8/21	9/7	9/26	10/6	8/19	9/5	9/23	10/5	10/12	15	15	16	9	6
02	8/3	8/20	9/6	9/25	10/5	8/18	9/4	9/22	10/4	10/11	15	15	16	9	6
03	8/2	8/19	9/5	9/24	10/4	8/17	9/3	9/21	10/3	10/10	15	15	16	9	6
04	8/2	8/19	9/4	9/22	10/2	8/17	9/3	9/19	10/1	10/8	15	15	15	9	6
05	8/1	8/18	9/3	9/21	10/1	8/16	9/2	9/18	9/30	10/10	15	15	15	9	9
06	8/1	8/18	9/3	9/21	10/1	8/16	9/2	9/18	9/30	10/10	15	15	15	9	9
07	8/1	8/18	9/4	9/21	10/2	8/16	9/2	9/19	9/30	10/11	15	15	15	9	9
08	8/1	8/18	9/4	9/21	10/1	8/16	9/2	9/19	9/30	10/10	15	15	15	9	9

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Table 6: Bighorn sheep harvest in DAU RBS-3 from 1953 to 2008.

Year	Rifle			Archery			Total		
	Ram	Ewe	Total	Ram	Ewe	Total	Ram	Ewe	Total
1953							3		3
1954							4		4
1955							5		5
1956							2		2
1957							5		5
1958							2		2
1959							No Hunt	No Hunt	No Hunt
1960							0		0
1961							2		2
1962							1		1
1963							3		3
1964							3		3
1965							0		0
1966							2		2
1967							3		3
1968							2		2
1969							1		1
1970							0		0
1982				2		2	2		2
1983				0		0	0		0
1984				1		1	1		1
1985				0		0	0		0
1986				2		2	2		2
1987				1		1	1		1
1988				5		5	5		5
1989				6		6	6		6
1990				7	1	8	7	1	8
1991				4	1	5	4	1	5
1992	6		6	6	2	8	12	2	14
1993	4		4	9	1	10	13	1	14
1994	6		6	5	1	6	11	1	12
1995	4		4	5	2	7	9	2	11
1996	3		3	4	1	5	7	1	8
1997	5	4	9	5	5	10	10	9	19
1998	5	4	9	5	4	9	10	8	18
1999	5	4	9	5	3	8	10	7	17
2000	13	16	29	9	7	16	22	23	45
2001	10	10	20	5	1	6	15	11	26
2002	15	11	26	10	3	13	25	14	39
2003	11	12	23	6	7	13	17	19	36
2004	5	4	9	10	1	11	15	5	20
2005	9	4	13	3	0	3	12	4	16
2006	10	8	18	4	2	6	14	10	24
2007	16	4	20	6	0	6	22	4	26
2008	14	7	21	3	1	4	17	8	25

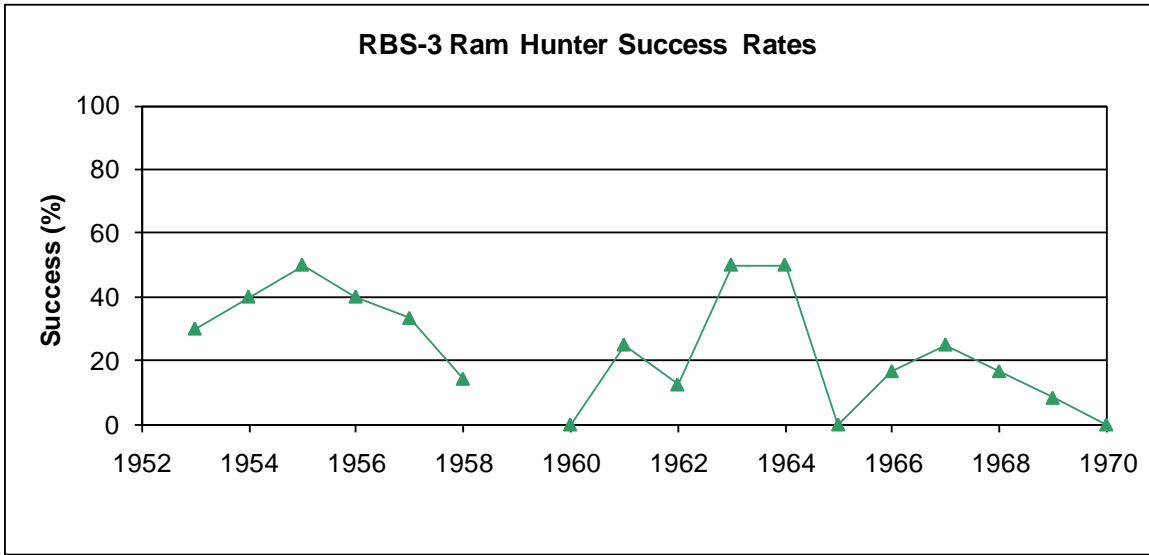


Figure 15: Hunter success rates in DAU RBS-3 from 1952 to 1970, calculated as number of bighorn harvested divided by the number of licenses issued.

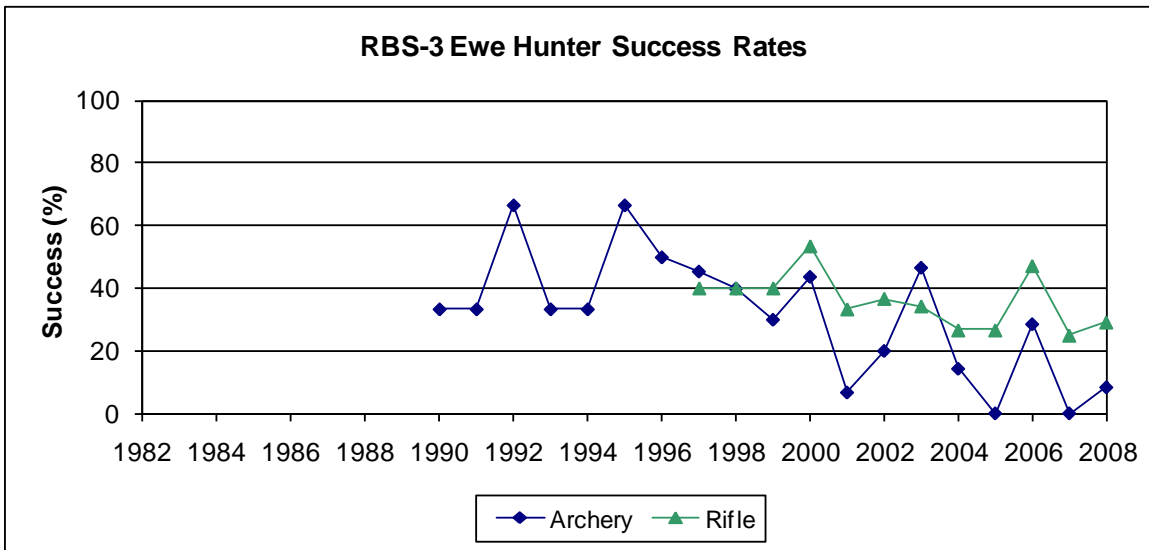


Figure 16: Archery and rifle ewe hunter success rates in GMU S32 calculated as number of bighorn harvested divided by the number of licenses issued.

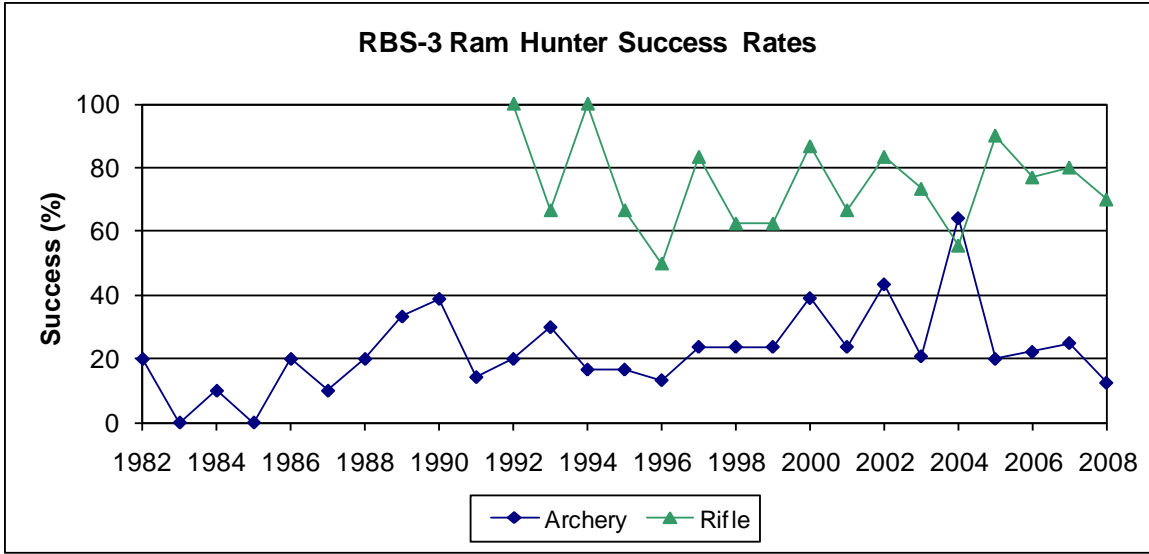


Figure 17: Archery and rifle ram hunter success rates in GMU S32 calculated as number of bighorn harvested divided by the number of licenses issued.

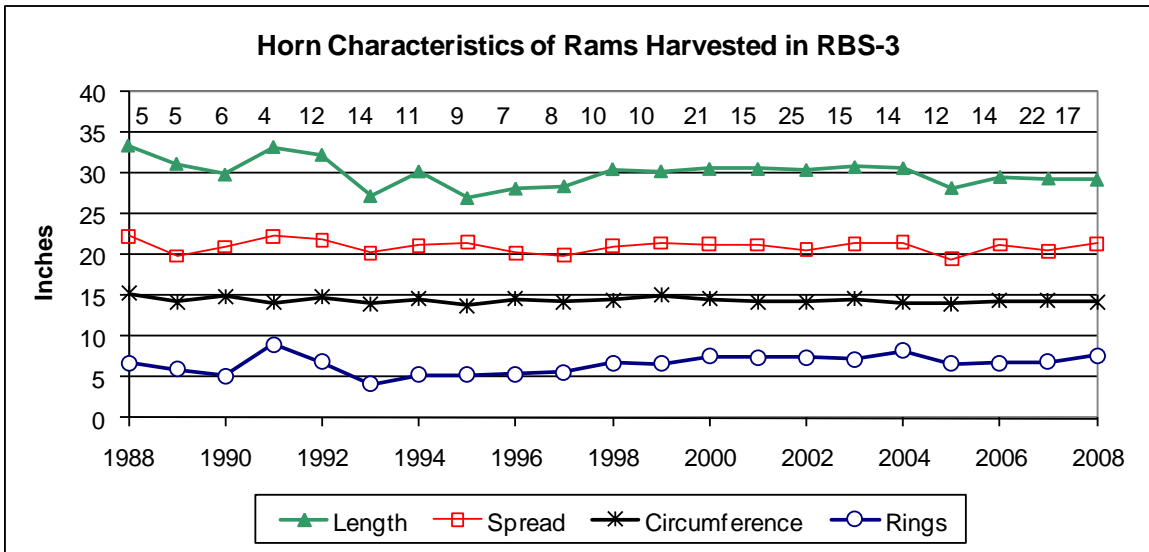


Figure 18: Average length, spread, circumference and number of rings, of horns of rams harvested in GMU S32 from 1988 to 2007. The number of harvested rams measured each year is shown across the top of the chart.

MANAGEMENT ISSUES

Habitat Quality

There was a habitat evaluation of the bighorn sheep range near Georgetown and Empire conducted in 1967 (Hibbs and Woodward 1969). The authors described most of the winter range as no better than fair and stated that, “the bighorn sheep utilize the steep hillsides next to the highway. These hillsides are characterized by rocky outcroppings and loose shale slides. The overstory consists of a few scattered ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*). The major shrubs which make up

the understory are fringed sagebrush (*Artemisia frigida*), mountain mahogany (*Cercocarpus montanus*), rabbitbrush (*Chrysothamnus sp.*) and skunkbrush (*Rhus trilobata*). The principal grasses are blue grama (*Bouteloua gracilis*), mountain muhly (*Muhlenbergia Montana*), Indian ricegrass (*Oryzopsis hymenoides*) and sleepy grass (*Stipa robusta*).” Currently the forage in the winter concentration areas appears to be over utilized by bighorn and is probably in worse condition than in the 1967 study. In addition, some native vegetation has been replaced by the noxious weeds oriental clematis (*Clematis orientalis L.*) throughout the DAU and by cheat grass (*Bromus tectorum*) at lower elevations. Water is thought to be adequate throughout the range.

Fire suppression over the last 100 years has resulted in the encroachment of shrubs and trees into bighorn sheep habitat. Tree and shrub encroachment has resulted in habitat loss and fragmentation by deterring bighorn sheep from using otherwise suitable habitat and by decreased the amount of forage available in the areas they do use. Habitat quality and quantity could be increased by the removal of trees in many areas of DAU RBS-3. Habitat quality could also be improved through the removal of noxious weeds, especially oriental clematis throughout the DAU.

Much of the lodgepole pine stands in the western half of the DAU have been infested with the mountain pine beetle (*Dendroctonus ponderosae*). This infestation began on the western slope in 1996 and spread eastward into the DAU in the early 2000s. This infestation is expected to continue its eastward expansion, resulting in the death of the majority of the mature lodgepole pines in the area by 2013 (Colorado State Forest Service 2008). Dead trees are expected to remain standing for several years before they begin to come down.

The large-scale mortality of lodgepole pine trees will result in changes to bighorn sheep habitat quality and quantity in the DAU over the next 20 years. Initially, lodgepole mortality may increase the openness of the terrain and allow bighorn to use areas from which they are currently excluded due to visual obstruction. This would decrease habitat fragmentation and increase habitat quality and quantity. The long-term overall effect this will have on bighorn sheep is unknown. The effects of fallen dead trees and vegetation succession following lodgepole mortality on bighorn habitat will vary within the DAU depending on the physiography of specific sites. For example, areas of regenerating aspen stands will exclude sheep due to visual obstruction, whereas areas that come back with few trees and shrubs will likely be higher quality bighorn habitat than the current condition.

Impacts of Human Development

Several major highways and heavily used roads run through the range of the Georgetown herd including Interstate 70, US Highways 6 and 40, State Highway 119, and the Central City Parkway. Many of these roads bisect traditional movement corridors and, therefore, fragment habitat. This is evidenced by the large number of sheep killed in vehicle collisions each year (see Vehicle Caused Mortality section).

In addition to habitat fragmentation resulting from major roads, habitat loss and fragmentation through development of commercial and residential sites and associated infrastructure (e.g., smaller roads, pedestrian paths, etc) are ongoing threats to this herd. Twenty-seven percent of the occupied bighorn range in DAU RBS-3 is privately owned. The fragmentation of DAU RBS-3 will continue to increase as more of this private land is developed for human use. Most of the herd range within Jefferson County is owned by Jefferson County Open Space and has remained relatively unfragmented. Most of bighorn sheep range in Clear Creek County east of Empire is privately owned and highly fragmented. Even the Forest Service lands in this portion of the DAU are highly fragmented by private inholdings. The Arapaho National Forest comprises most of the western half of the DAU. Except for the area adjacent to major highways, the Forest Service land along the Continental Divide and west of Empire is largely unfragmented.

Human Recreation Impacts

Due to its proximity to many large human population centers, DAU RBS-3 sustains a very large amount of recreational use. Hiking, camping, off road vehicle use, angling, hunting, wildlife viewing and wildlife photography are primary uses. In addition to the major roadways that impact this DAU, hiking, biking, and off-road vehicle trails permeate into nearly every corner of DAU RBS-3. The amount of recreational use continues to increase as do the miles of hiking, biking and off-road vehicle trails. The disturbance caused by human recreation within this DAU is exacerbated by dogs that often accompany people recreating in bighorn sheep habitat (MacArthur 1982).

Vehicle Caused Mortality

Bighorn sheep mortality resulting from collisions with vehicles is substantial in DAU RBS-3, although the exact number killed each year is unknown. Prior to 2006, records of road killed bighorn sheep are sporadic. Since 2006, a concerted effort has been made to record as much information as possible on each reported vehicle caused bighorn mortality in DAU RBS-3 and to necropsy as many as possible. From 1991 through 2008, 113 vehicle collision cause mortalities have been recorded, with 41 of these recorded from 2006 - 2008. These represent the minimum number of bighorn sheep killed. Most of the bighorn sheep killed in vehicle collisions are never reported by the parties involved. Animals that die acutely and remain near the road are sometimes found and reported by Colorado State Patrol, the Colorado Department of Transportation, the DOW or by members of the public. Animals that are injured, but able to move more than a short distance from the road before dieing from their injuries are usually not found or reported.

Radio-collar information can be used to estimate the number of bighorn sheep that are killed via vehicles collisions but never found. From 2006 to 2008, 9 radio collared bighorn sheep were killed in vehicle collisions, 4 of these (i.e., 44%) were reported as vehicle killed. The other 5 (i.e., 56%) were not reported and were only found during regular telemetry searching. These were determined to have been killed in vehicle collisions through inspection of the carcasses. In other words, the radio collared bighorns reported as vehicle killed accounted for only 44% of the radio collared bighorn sheep actually killed by vehicles.

Bighorn are killed on the major roads throughout the DAU (Table 7). There are 3 occasions during which sheep are most vulnerable to being killed in collisions with vehicles. First, Highways 40, 6 and 119, the Central City parkway all bisect traditional bighorn movement corridors; this may be especially true during the breeding season. Bighorn are vulnerable when following these traditional movement corridors. Second, bighorn sheep are drawn to all of the major roadways in the DAU in the winter by the minerals that are applied to the roads to reduce ice. Third, bighorn traditionally make seasonal movements down in elevation in the spring to take advantage of the spring green-up which begins first at the lower elevations. Because roads run through most of the low elevation habitats in DAU RBS-3, bighorn sheep moving down in elevation to take advantage of the spring green-up are also vulnerable to vehicle collisions. The most vehicle cause mortalities occur in April, May, and November (Figure 19).

Table 7: Number of vehicle caused mortalities on each major road in DAU RBS-3 from 1991 to 2008 and from 2006 to 2008 only.

Road	1991-2008	2006-2008
Interstate 70	52	21
Highway 6	26	14
Highway 40	15	4
Highway 119	12	1
Central City Parkway	3	1
Unknown	3	
Other	2	
Total	113	41

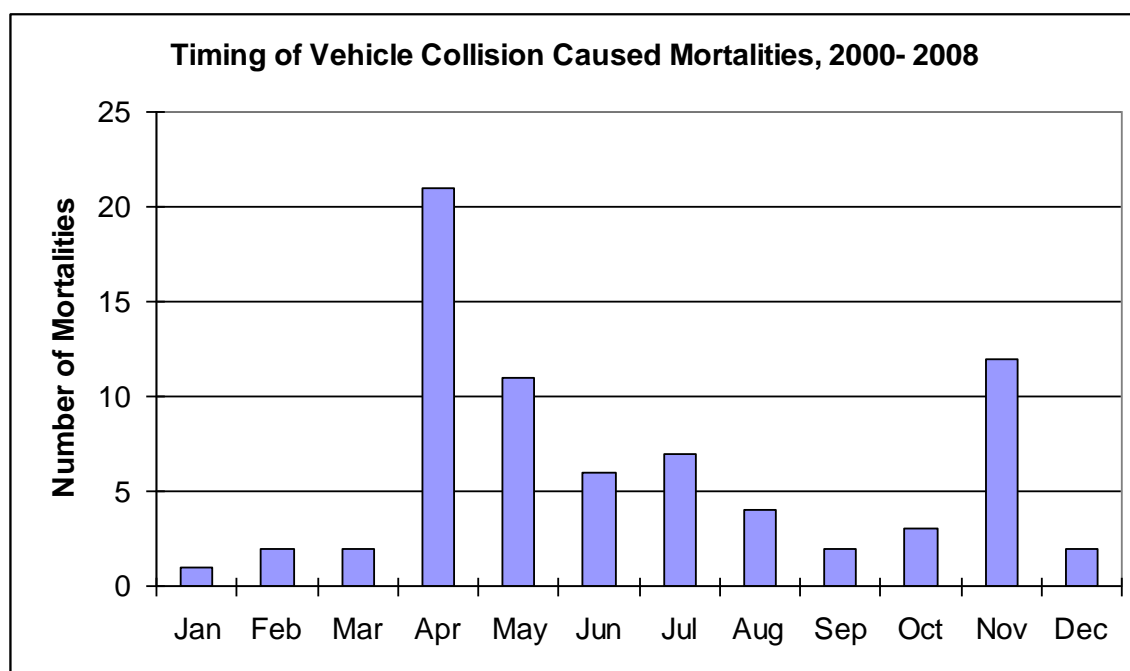


Figure 19: Temporal summary of vehicle collision caused mortalities in DAU RBS-3 from 2000 to 2008.

Diseases and Parasites

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. 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. 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 sheep 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 a 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).

The decline in the Georgetown herd in the late 1950s was probably the result of a pneumonia epidemic. Since then, there have been no documented epidemics in this herd. Bighorn were treated to control lungworm from 1977 through 1994 in an effort to prevent a pneumonia epidemic and increase lamb survival. This was done by adding antihelminthic medications to apple pulp at bighorn sheep baiting areas. This practice was stopped in response to doubts of their effectiveness and due to concerns that it concentrated bighorn sheep, thereby increasing the probability of disease transmission. There were also concerns that consistent baiting over many years may alter herd distribution and migration patterns.

Disease samples from this herd from 1984 to 1995 were analyzed by Dr Terry Spraker of Colorado State University's College of Veterinary Medicine and Biomedical Sciences. He reported that the average maximum sustained serum cortisol levels recorded during this sampling was indicative of a herd experiencing moderate stress levels. He also reported that Parainfluenza-3-virus (PI3) was present in all sampling years. Bovine Respiratory Syncytial Virus (BRSV) on the other hand was not found in this herd until 1994 although it had been tested for in previous years. *Pasteurellaceae* were routinely isolated from this herd throughout this time period. Numerous animals were also tested for bluetongue/epizootic hemorrhagic disease, bovine progressive pneumonia, *Brucella abortus* and *Brucella ovis*, all were negative.

In 2002, Dr Rob Roy Ramey II of the Denver Museum of Nature and Science collected 37 nasal and oral swab samples. Several potentially pathogenic *Pasteurellaceae* were isolated from these samples.

Disease surveillance was conducted in this herd from 2005 to 2008 in order to characterize the potential pathogens present in the herd. There was serologic evidence of exposure and active infection to both BRSV and PI3. In addition, bacterial cultures isolated potentially pathogenic (beta hemolytic) *Pasteurellaceae*, including strains of *Mannheimia (Pasteurella) haemolytica* and to a lesser extent *Bibersteinia (Pasteurella) trehalosi*. Pneumonia has been implicated in the low lamb survival of recent years. From 2006 – 2008, 8 bighorn lambs carcasses were necropsied: pneumonia was determined to be the cause of death in 6 of these, 1 lamb was killed in a collision with a vehicle when only 1 to 2 weeks old, the cause of death for the remaining lamb was either disease or predation by domestic dogs.

Nearly all of the Forest Service lands above 10,000 feet in this DAU were included in domestic sheep grazing allotments, which were actively grazed from the early 1900s until 1968 - 1970, depending on the specific allotment. Cattle and horse grazing allotments occupied most of the Forest Service lands in this DAU east of Lawson and Alice. Cattle and horses were present on individual allotments until 1980, 1985 and 2005. Currently, there are no active grazing allotments on Forest Service land within DAU RBS-3.

Clear Creek and Jefferson counties are aware of the potential hazards of domestic sheep and goats to bighorn and have agreed not to allow grazing by domestics for weed control on their open space properties within bighorn occupied range. In addition, the keeping of domestic sheep is not permitted in Clear Creek County within 1 mile of bighorn sheep range, and any domestic sheep within the county must be kept behind a double buffer fence to prevent direct contact with bighorn. There are no such regulations in Jefferson and Gilpin Counties. Twenty-seven percent of the occupied habitat in DAU RBS-3 is privately owned. It is exceedingly difficult to detect and mitigate the presence of a small number of domestic livestock on private property. The biggest threat to the overall health of this herd is the possibility of the introduction of a disease to the herd from contact with domestic or hobby sheep or goats on private property.

Interspecific competition

There are currently no active domestic sheep or cattle grazing allotments on Forest Service lands within this DAU. Mountain goats were introduced into the Mount Evans area (G4) in 1961. Mountain goats dispersed in the 1970's to the west side of Guanella Pass into what is now G7. Mountain goat numbers were adequate by 1979 to create the G7 mountain goat hunting unit with 3 licenses. The G7 herd grew to over 470 animals by 1999 and expanded its range to the north and south along the Continental Divide. Mountain goats were first observed in DAU RBS-3 in the mid 1980s. Concerns were raised that the expansion of mountain goats into the range of the Georgetown bighorn sheep herd could cause declines in the Georgetown bighorn sheep herd through interspecific competition or disease transmission. Although Johnne's disease has not been found in G7 mountain goats, it has been identified in mountain goats and bighorn sheep in the adjacent Mount Evans herds. In response to these concerns and other consideration, G15 was created in 2002 with the purpose of controlling the number of mountain goats in this area and their expansion to the north. This goat unit straddles the Continental Divide between Interstate 70 (at the Eisenhower tunnel) and Berthoud Pass.

The goal for G15 was to keep the number of mountain goats in this area below 40. Currently the number of mountain goats in G15 is estimated at 40, with a majority of these spending most of their time west of the Continental Divide, outside of DAU RBS-3. Spatial overlap between these 2 species in DAU RBS-3 is limited, but does occur along the Continental Divide, most notably between Berthoud Pass and Vasquez Peak. Currently, competition between the 2 species appears to be minimal, however, if spatial overlap of the species increases, or if mountain goat populations increase, or if Johnne's disease appears in the herd, the G15 mountain goats could have detrimental effects on DAU RBS-3 bighorn (George et al. 2009).

Elk occur year round within bighorn sheep use areas in this DAU especially on the alpine. Competition between elk and bighorn sheep is probable on the alpine, but has never been studied. Mule deer are also present within this DAU and their numbers and range have been expanding in recent years. Mule deer are present at highest densities on portions of low elevation bighorn sheep range. Although there is limited dietary overlap between deer and bighorn sheep, the high densities of deer in some portions of bighorn occupied range could be limiting to bighorn populations through competition for forage.

Predation

The effect of predation on the DAU RBS-3 bighorn sheep population is mostly unknown; however, predation is probably a very minor source of bighorn mortality, especially of adult mortality. Mountain lions, coyotes, and bobcats all inhabit the DAU RBS-3 bighorn sheep range and it is likely that each accounts for some bighorn mortality. From 2006 – 2008, 71 adult bighorn were radio collared. Twenty of these bighorn have died, of these only 1 was depredated. This was a ewe that was killed by a mountain lion.

Illegal Kill

The extent and effects of illegal take of bighorns in DAU RBS-3 is largely unknown. There are known cases of illegal take, but the impacts on the population are probably minor.

Watchable Wildlife

The Georgetown sheep herd has special value to the people of Colorado because it is one of the most easily viewed herds in the state. Throughout the year, sheep from this herd can be seen feeding and resting along the rocky south facing slopes of the I-70 and Highway 6 corridors - within the sight of millions of people each year.

Opportunities to watch bighorns attract thousands of Colorado people to the Georgetown area each year. Some travelers stop briefly along the highway to snap a photo, but others plan family outings around the opportunity to watch and learn about the sheep. The Georgetown Viewing Area, built by the Colorado Division of Wildlife (with several partners), opened in 1990 in part to provide a safe place for highway travelers to view the sheep. Permanently mounted binoculars and interpretive signage help make the viewing experience a positive and rewarding one. An additional smaller viewing station in the town of Empire offers travelers on Hwy 40 the chance to view the sheep.

During November and December, when rut activities are easily seen from the Viewing Area, the Division of Wildlife staffs the station with trained volunteer naturalists to help visitors find and learn about the sheep. Volunteers host about 1,000 visitors from all over the world each year. The average stay is about 20 minutes, though some visitors have stayed over an hour, and more than one has left the station to pick up family at local ski areas, and returned to the Viewing Area to show them the sheep. Beginning in 2006, the DOW began partnering with the Town of Georgetown to host an annual Georgetown Bighorn Sheep Festival the second Saturday in November. This festival aims to increase public awareness and appreciation of wildlife, especially bighorn sheep, to attract new constituents for the DOW, and to promote rural economic diversification opportunities that rely on the conservation of quality wildlife habitat. Participation in the festival has increased each year, and in 2009 the Town of Georgetown chose to expand it to two consecutive days.

In addition to providing public education and recreation, wildlife viewing opportunities at Georgetown – and in communities like it – can result in positive economic impacts to the local communities. The results of local and national surveys completed in 2006, suggest that the total economic impact of wildlife viewing in Colorado is estimated to be \$1.22 billion, close to the total economic impact of both hunting and fishing combined (\$1.8 billion) (BBC 2008). Wildlife viewing recreation continues to attract a growing number of participants nationwide (US Fish and Wildlife Service 2006).

PUBLIC INPUT IN DAU PLANNING PROCESS

Public input on the management of this herd was collected through 2 public meetings and verbal and written comments. The first public meeting was held in Georgetown on June 30, 2008, the other held in Denver on July 7, 2008. These meetings were both advertised in newspapers, on the CDOW website, through a mailing to each person that had applied for a hunting license in GMU S32 during the 2 previous years and through personal notification of groups or individuals known to be interested. The Georgetown meeting was attended by CDOW personnel (the Area Wildlife Manager, the Public Information Officer, the local District Wildlife Manager, and the Terrestrial Biologist) and one member of the public. The Denver meeting was attended by CDOW personnel (the Regional Manager, the Assistant Regional Manager, the Area Wildlife Manager, the Senior Terrestrial Biologist, the Public Information Officer, the Terrestrial Biologist and 3 District Wildlife Managers), a wildlife biologist from the USFS and 8 members of the public. Verbal and written comments were collected at these meetings.

Comments were also solicited during the scoping phase of the DAU planning process and in response to a draft DAU plan. This plan was placed on the CDOW's website from March 3 to April 5, 2009 (34 days). A link to this website was sent to interested parties and to everyone who had attended one of the public meetings or who had submitted comments during the scoping phase.

In summary, many people commented that the herd should be managed to ensure the conservation of this herd and the species as a whole, although opinions on how this

should be done differed. We received comments suggesting that management efforts be increased in the following areas: 1) reducing the possibility of contact between bighorn sheep and domestic sheep and goats -2 comments; 2) improving bighorn habitat in the DAU-3 comments; 3) reducing the number of bighorn killed in collisions with vehicles-3 comments; 4) reducing the impacts of recreation to sheep during late winter and lambing-1 comment. Some people suggested expanding the range of the herd to the north and west or relocating sheep from Georgetown to other areas.

There were several people who registered opposition to any hunting of this herd specifically and bighorn sheep in general. Members of the hunting public suggested expanding the current hunting unit to the east; the Colorado Bowhunters Association suggested the creation of a new archery only hunting unit east of the current GMU 32. Some hunters suggested management focus on trophy quality, while others wanted to increase hunting opportunity. One person suggested changing the curl restriction to a $\frac{3}{4}$ minimum. Many people commented on the importance of this herd to wildlife viewing opportunities.

Three people commented on the population objective alternatives, 2 of these supported alternative #2 (300 – 400 bighorn), 1 person favored a population objective between alternative #2 and #3 (375 – 425). Only 3 people commented on the sex ratio objective, all 3 supported alternative #2 (60 – 80 Rams: 100 Ewes).

MANAGEMENT RECOMMENDATIONS AND FUTURE NEEDS

Prevention of contact between bighorn sheep and domestic livestock

The DOW should continue to work with the Forest Service and City and County governments to prevent the introduction of domestic sheep and goats near bighorn sheep range. The DOW should also remain vigilant in identifying and mitigating the impacts of domestic livestock on private property. When domestic livestock are found within bighorn range, information will be provided 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.

Population management throughout herd

The management strategy for the Georgetown herd is to maintain the population at a moderate level in order to reduce the probability of catastrophic disease cause mortality (see Diseases and Parasites section). Currently, the DOW's primary management tool to control this herd's population size is hunting. However, the eastern segment of the herd is largely unhunted. Hunting opportunities in this area are very limited due to land ownership, physiography, and the fact that the bighorn only use a very narrow band of habitat adjacent to Highway 6. Unmanaged population growth in this segment of the herd is particularly concerning due to: 1) the proximity of bighorn occupied range to human habitation and the associated risk of contact between domestic sheep or goats and bighorn; 2) the juxtaposition of Highways 6 and 119 and occupied bighorn range

resulting in several vehicle caused bighorn mortalities each year and an unknown amount of damage to vehicles; and 3) the lower lamb recruitment rates observed in this segment of the population as compared to the western portion of the population. Lamb recruitment rates are an indication of herd health, from 2006 to 2008, lamb recruitment east of Fall River road, was only 74% of that west of Fall River road. Several studies on other herds have shown decreased lamb recruitment at high sheep densities (Jorgenson and Wishart 1993; Portier et al. 1998). This low lamb recruitment increases concerns over high bighorn densities in the area.

The DOW should work with land owners to explore the possibility of allowing bighorn hunting and other population management techniques in this area.

Habitat improvement recommendations

Native vegetation has been replaced by the noxious weeds throughout the unit, most notably by oriental clematis (*Clematis orientalis L.*) throughout the DAU and by cheat grass (*Bromus tectorum*) at lower elevations. Where possible, noxious weeds should be removed or prevented from spreading.

Fire suppression over the last 100 years has lead to tree and shrub encroachment into bighorn sheep range, causing habitat loss and fragmentation. The DOW should work with land managers to use prescribed burns or forest thinning in order to reduce the visual obstruction in bighorn sheep range and improve forage quality. These efforts should concentrate on winter range, which is limiting this herd's population potential. The DOW should also work with the US Forest Service and other emergency response agencies to allow naturally occurring fires to continue were possible.

Critical habitat protection

Clear Creek County owns approximately 1600 acres north of Interstate 70 between Fall River Road and the Town of Empire. This area is commonly known as the "Sheep Keep" and is managed for the benefit of bighorn sheep. The property is utilized by the Georgetown bighorn sheep herd as overall range, winter range, winter concentration area, production area and movement corridor. It is of vital importance in maintaining connectivity between the eastern and western portions of the herd. This area is highly fragmented by private property. The DOW has been working with Clear Creek County to identify management strategies for this property that will maximize the benefit of this area to bighorn sheep. This cooperative relationship should be continued and expanded where possible.

There are several restricted movement corridors that are vital to maintaining connectivity within the herd. The DOW should pursue acquisition of or conservation easements on properties within these movement corridors to ensure genetic diversity throughout the herd and to protect traditional bighorn sheep movement patterns.

Reduction in Vehicle Caused Mortality

Vehicle caused mortality is estimated at approximately 8% of the population per year (see Vehicle Caused Mortality section). Efforts should be made to identify possible strategies to reduce vehicle caused bighorn sheep mortalities. As part of their normal annual movement patterns bighorn cross US Highway 40 east of Empire, State Highway 119 and US Highway 6 near their junction and the Central City Parkway between mile markers 0 and 2. Efforts should be made to identify ways to reduce vehicle caused mortalities at these locations. Possible approaches include constructing wildlife overpasses, encouraging bighorns to cross at the safest possible locations (e.g., via fencing), and altering driver behavior (e.g., via signs, slowing vehicles or warning systems which are activated when wildlife are on the road). Bighorns are also killed in vehicle collisions in areas where they are attracted to the shoulders of roads but do not cross. Possible mitigation in these areas include using different de-icing substances on the roads, modifying roadside vegetation, discouraging bighorn from approaching roadways, erecting barriers in certain locations, and altering driver behavior.

Use as a source herd for translocations

The Georgetown herd served as a source for bighorn sheep translocations from 1986 to 2003. During this time 280 bighorn sheep from this herd were used for bighorn reintroductions and herd supplementations throughout Colorado and to other states. The Georgetown herd is over its population objective, so removal of bighorn sheep via transplants would be beneficial to the herd. However, no bighorn sheep have been transplanted from this herd in recent years due to: 1) concerns over the role that disease may be playing in the observed the low lamb recruitment; 2) lack of suitable release sights; 3) a preference to allow removal via hunting.

Need for range extension translocations

The Georgetown herd is slowly extending its summer range to the north along the Continental Divide. There is ample suitable unoccupied bighorn habitat, especially summer habitat to the north and west of the currently occupied range. Some of this habitat is of high quality. However, range extensions into these areas are not being pursued due to the proximity of these areas to other bighorn sheep herds or to domestic livestock, particularly domestic sheep and goats. Range extensions into these areas would increase the possibility of bighorn sheep from this herd contacting other bighorn sheep or domestic livestock, increasing the probability of the introduction of novel pathogens into the Georgetown herd.

Research needs

Lamb recruitment has been low in recent years. A study was initiated in 2005 in order to identify the possible causes. Studies should be continued in order to identify possible management strategies that could be used to improve lamb recruitment. Monitoring of lamb recruitment should continue in order to identify any changes.

MANAGEMENT OBJECTIVES

Posthunt Population Objective

The posthunt population objective should be established at a level that allows for a healthy, self-sustaining herd while providing quality hunting and wildlife viewing opportunities. It is difficult to estimate this ideal population level for this herd; however, we can base a population objective on basic wildlife population management theory and the population performance of this herd at various population levels in the past.

Many studies on various species have shown that animal populations are most productive and individual animals are healthiest at approximately half the maximum number of animals that the habitat can sustain. At high population densities, the health of individual animals, the body and horn size of individual animals and recruitment of young animals into the population decrease due to competition among individuals for resources. Several studies in bighorn sheep specifically have suggested that disease caused mortality is higher in densely populated herds than in less densely populated herds and have shown decreased lamb recruitment at high sheep densities (Jorgenson and Wishart 1993; Portier et al. 1998).

The optimum number of bighorn for this DAU is unknown and changes with habitat condition. The Georgetown herd grew dramatically from the mid 1980s to early 2000s, reaching an estimated posthunt high of 550 bighorn sheep in 2001 (Figure 11). This was thought to be too many bighorn for the area to sustain. This high population density may have been responsible for the steady decrease in lamb recruitment from 68 lambs per 100 ewes in 2001 to 6 lambs per 100 ewes in 2006. In other words, the poor lamb recruitment seen in the Georgetown herd in recent years may be the result of density-dependence affecting lamb survival through increased susceptibility to disease.

If this is the case, the reduction in the number of the sheep in the herd since 2001 should result in increased herd productivity. Currently, lamb recruitment is lower than desired. This could be because: 1) the population density is still too high; 2) lamb recruitment is lagging behind the population reductions due to the slow recovery of habitat conditions; 3) the causes of the observed low lamb recruitment are unrelated to population densities.

The current population objective is 250 to 350 bighorn sheep. This objective was established in 1993. At that time there were few sheep east of Idaho Springs. Since 1993, the range of the herd has extended eastward to Golden and the number of sheep east of Fall River Road (20% of the herd's occupied range) has increased.

Alternative 1: 250 – 350 Bighorn Sheep

This alternative would require no change to the current population objective. It does not take into account that the area occupied by the herd has increased since the current objective was established. This alternative would call for a 5 – 32% decrease in the population. The mid-point of this range is approximately ½ of the maximum number of bighorn sheep estimated to have existed in this herd.

Alternative 2: 300 – 400 Bighorn Sheep

This alternative is a slight increase from the current population objective to account for the extended range of the herd. This objective, therefore, strives for the same bighorn density as the current objective. The 2008 population estimate is within this objective range. A 5% decrease in the population would be required to reach the midpoint of the objective. This mid-point is approximately 2/3 of the maximum number of bighorn sheep estimated to have existed in this herd.

Alternative 3: 350 – 450 Bighorn Sheep

The 2008 posthunt population estimate is within this objective range, below the midpoint. The alternative would, therefore, require the population to be maintained at the current population level or be allowed to increase slightly to the midpoint. The mid-point of this range is approximately 3/4 of the maximum number of sheep estimated to have existed in this herd.

Posthunt Sex Ratio Objective

The posthunt sex ratio objective should be set at a level that provides for the long-term health of the herd while providing the public with the desired level and quality of recreational opportunities. The higher the sex ratio of a herd is, the higher the number, age, and horn size of the rams in the herd. These rams are highly valued by wildlife viewers, photographers and hunters. However, fewer rams can be harvested if high ram to ewe ratios are to be maintained, so hunting opportunity is lower at higher sex ratios. Also, the higher the ram to ewe ratio is, the lower the reproductive potential of the herd. That is because the higher the number of rams at a given population size, the lower the number of ewes and, therefore, the lower the number of potential lambs. Another consideration when setting sex ratio objectives is that at very high sex ratios the stress levels of ewes during the breeding season are thought to increase, possibly leading to detrimental effects on recruitment. Finally, high sex ratios may lead to increased extra range movements by rams thereby increasing the probability of contact between bighorn and domestic sheep or bighorn from other herds and the related risks of disease transmission.

It is difficult to estimate the “natural” range of sex ratios of bighorn sheep herds. However, given the slightly higher mortality rates of adult rams than ewes, it is thought to be below parity. Since posthunt coordinated surveys have been conducted in this herd (1991), the modeled sex ratio has fluctuated from approximately 70 to 105 rams per 100 ewes. The current posthunt sex ratio objective is 60 to 80 rams per 100 ewes. The sex ratio has been above that objective for almost a decade, partially due to the number of ewes removed from the herd through translocations between 1985 and 2001. The number of ram hunting licenses offered over the past several years has been high in order to bring the sex ratio down to objective. The current sex ratio estimate is 89 rams per 100 ewes.

Under the current management scenario, the herd is expected to reach the midpoint of the current objective range within the next couple years. When this is achieved the number of ram licenses offered will be reduced in order to maintain the sex ratio at the midpoint of the alternative range. Both hunters and wildlife viewers have indicated that they are

satisfied with the current sex ratio of the herd. Both groups report high success in finding older age class rams.

Alternative 1: 40 – 60 Rams per 100 Ewes

This alternative is a decrease from the current objective and would require a 33 - 55% reduction in the sex ratio. This range is probably lower than naturally occurring sex ratios in bighorn herds. This alternative would allow for the highest number of bighorn ram licenses, but would reduce the number, average age and horn size of rams available for viewing and harvest.

Alternative 2: 60 – 80 Rams per 100 Ewes

This is the current sex ratio objective. This range is thought to be at the lower end of natural sex ratio of bighorn herds. The current sex ratio is above this range, so the adoption of this alternative would call for a 10 – 33% decrease in the ram to ewe ratio. Compared to the other alternatives, this alternative would result in intermediate herd reproductive potential; number of ram licenses; number of rams; average ram age; and horn size.

Alternative 3: 80 – 100 Rams per 100 Ewes

This alternative is an increase from the current objective. The current sex ratio of the Georgetown herd is slightly below the midpoint of this range, so under this alternative, the sex ratio would be allowed to increase slightly from its current level. This range is probably at the upper end of naturally occurring sex ratios in bighorn herds. This alternative may, therefore, lead to increased ewe stress levels due to the high proportion of rams competing for mating opportunities during the breeding season. Compared to the other 2 alternatives, Alternative 3 would result in a herd with the lowest reproductive potential, the lowest numbers of ram licenses, and the greatest ram age and horn size.

PREFERRED ALTERNATIVES

Preferred Population Objective Alternative

The CDOW recommends Population Objective Alternative 1, 250 – 350 bighorn. This alternative represents no change from the current population objective. Alternative 1 calls for a population approximately ½ of that estimated in 2001, when the herd was at its highest numbers since settlement. This population level is expected to be low enough to reduce the probability of catastrophic disease epidemics, allow for healthy individual animals and improved recruitment rates. As a result, this is expected to result in higher numbers and larger bighorn available for take by hunters, than the other 2 alternatives. Although Alternative 1 will provide fewer bighorn for viewing than the other alternatives, it is expected to result in increased quality of the viewing experience by resulting in a healthier herd with less disease, higher proportions of lambs, larger rams and higher probability of long term stability. Wildlife viewers and photographers are currently happy with the viewing opportunities. Given the distribution and movement patterns of this herd (i.e., a large proportion of the herd use low elevation range that is easily accessible to recreationalists during a large part of the year), viewing and

photography opportunities are expected to remain high under Alternative 1. In summary, Alternative 1 is expected to optimize long-term herd health, as well as hunting, viewing and photography opportunities. The population could be managed toward the lower end of the range in order to allow habitat to recover. If lamb recruitment rates improve and can be maintained, the herd could be managed toward the upper end of the range.

Alternatives 2 and 3 would provide larger numbers of sheep for wildlife viewing than Alternative 1. However, there are indications (i.e., low lamb recruitment, reduction in the size of harvested ram horns, winter range condition) that these population ranges are too high for the currently available habitat to support. If this is the case, these alternatives would be expected to lead to poor lamb recruitment, as seen at this population level over the last few years. The result of poor lamb recruitment would be fewer bighorn available for take by hunters. Alternatives 2 and 3 may, therefore, result in lower hunter opportunity than Alternative 1 and in lower quality of viewing opportunity.

Preferred Sex Ratio Objective Alternative

The CDOW recommends Sex Ratio Objective Alternative 2, 60 – 80 rams per 100 ewes. This recommendation is based on public input and field staff evaluation of recreational opportunity, conflicts and current herd levels. This alternative is the same as the current objective range. This range is thought to be the most biologically appropriate. Also, hunters, wildlife viewers and photographers have expressed satisfaction with the current sex ratio objective and the resulting opportunity in terms of quantity and quality of bighorn. However, some hunters have expressed a desire for larger horned rams.

Although alternative 1 is considered a biologically feasible option, and would provide the largest number of ram hunting licenses, it would reduce the age and size of rams available to hunters, viewers and photographers. Comments from the public indicate that this is undesirable.

Alternative 3 would result in the oldest, and largest rams for hunters and wildlife viewers, however, it would reduce the hunting opportunity and may lead to increased stress on ewes during the breeding season.

Management Implications

Under each of the population objective alternatives, the number of hunting licenses issued in the coming years is expected to decrease when the population objective is reached. High harvest has been desirable for the past 10-15 years because the population was over objective and was being managed downward. Once the population objective is achieved, the number of licenses issued will need to be decreased in order to maintain the population at objective.

In addition to population size and sex ratio, bighorn distribution needs to be considered. Currently, approximately 25% of the herd is located east of Fall River Road. Most of the occupied bighorn habitat in this area is privately owned or owned by Jefferson County Open space. The ability to manage the bighorn population in this area through hunting is, therefore, dependant on permission to hunt on private and county properties. The

population west of Fall River Road, where most of the harvest occurs, should not be over harvested to compensate for the limited harvest in the east in pursuit of a population objective. At least $\frac{3}{4}$ of the population should continue to occur west of Fall River Road. The CDOW should work with private land owners and Jefferson County in order to manage the portion of the herd east of Fall River Road.

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