

1. **Species:** Rocky Mountain Bighorn Sheep (*Ovis Canadensis canadensis*)
2. **Status:** Table 1 summarizes the current status of this species or subspecies by various ranking entity and defines the meaning of the status.

<b>Entity</b>	<b>Status</b>	<b>Status Definition</b>
NatureServe	G4	<i>Species is Secure</i> At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
CNHP	S4	<i>Species is Apparently Secure</i> At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
Colorado State List Status	SGCN, Tier 2	Species of Greatest Conservation Need
USDA Forest Service	R2 Sensitive	Region 2 Regional Forester’s Sensitive Species
USDI FWS <sup>b</sup>	N/A	N/A
USDI FWS Critical Habitat	N/A	N/A
<sup>a</sup> Colorado Natural Heritage Program.		
<sup>b</sup> US Department of Interior Fish and Wildlife Service.		

The 2012 U.S. Forest Service Planning Rule defines Species of Conservation Concern (SCC) as “a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best available scientific information indicates substantial concern about the species’ capability to persist over the long-term in the plan area” (36 CFR 219.9). This overview was developed to summarize information relating to this species’ consideration to be listed as a SCC on the Rio Grande National Forest, and to aid in the development of plan components and monitoring objectives.

### 3. Taxonomy

Genus/species *Ovis canadensis canadensis* is accepted as valid (ITIS 2015).

### 4. Distribution, abundance, and population trend on the planning unit [12.53.2,3,4]:

Rocky Mountain bighorn sheep are native to the Rio Grande National Forest and surrounding area and have occupied suitable mountainous habitat since pre-settlement times. Although it is difficult to estimate how many bighorn sheep occurred on the Forest historically, the available information suggests that they were quite common and widespread. By the late 1800’s, however, the number of bighorns decreased drastically in association with human settlement and were nearly extirpated on the Forest by the early 1900’s.

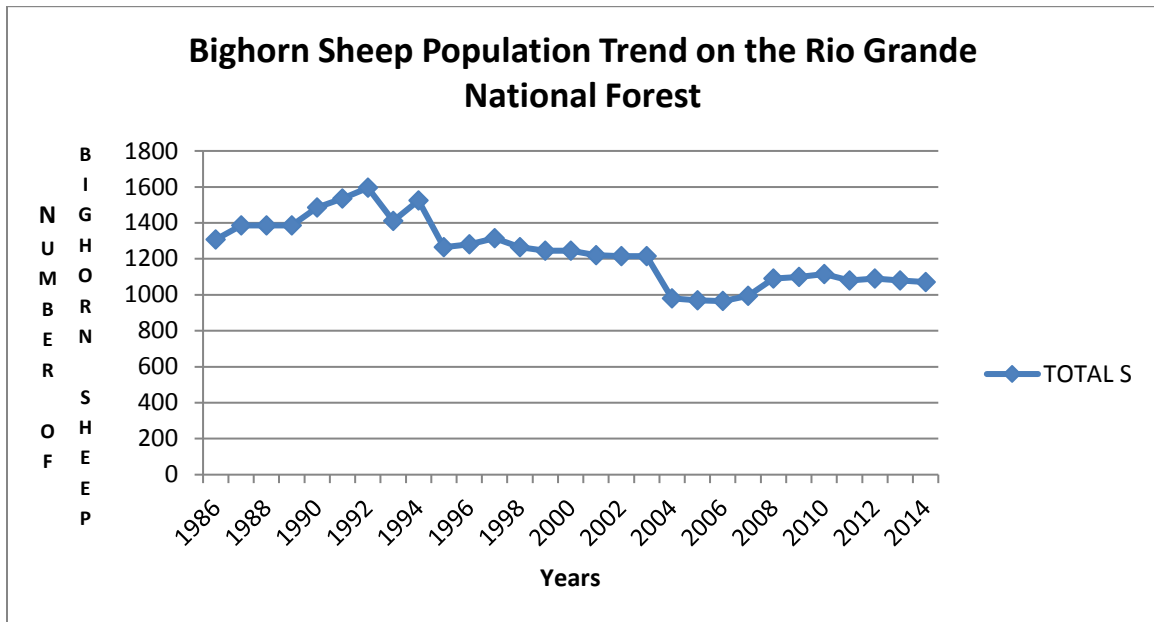
As of July 2015, there are 11 bighorn sheep herds that occur or partially occur on the Rio Grande National Forest that support approximately 1,070 individuals (2014 Herd Statistics, Colorado Parks & Wildlife 2015). Two herds that border or minimally overlap the Forest (S68 Cotopaxi and S16 Cimarrona Peak) are not included in these statistics. The first data available in 1986 estimated these herds at approximately 1,308 individuals. This population estimate rose to 1,595 individuals in 1995, dropped to a low of 965 in 2006 following several disease epizootic events, and risen again to the current estimate of 1,070 as of 2014. The current population estimate represents about a 33% decline from previous highs and a 10% increase from the previous low. It should be recognized that population estimates of local bighorn herds in an inexact science, and population models do not currently exist for bighorn sheep in Colorado to assist with these efforts.

**Table 2. Known Occurrence Frequency within the Planning Area**

<b>Known Occurrences</b>	Numerous
<b>Year Last Observed</b>	2015

Although bighorn populations on the Rio Grande National Forest have undergone periodic fluctuations, the general population trend has followed that of herds elsewhere in Colorado. Many local bighorn herds as they exist today are small remnants that persisted in the most productive or isolated portions of their ranges. There is ample unoccupied habitat available for herd expansion but only four of the 11 herds contain 100 individuals or more, which is considered by several authorities to be a minimal size for viability (Smith et al. 1991, Singer et al. 2001, New Mexico Department of Game and Fish 2005).

**Table 3. Population Trend of Rocky Mountain Bighorn Sheep Within and Overlapping the Planning Area**



## **5. Brief description of natural history and key ecological functions [basis for other 12.53 components]:**

Rocky Mountain bighorn sheep are characterized by low reproductive rates, long life spans, and populations adapted to live near carrying capacity in relatively stable environments (Geist 1971).

Bighorn sheep are a sexually dimorphic species with ewes that may weigh 190 pounds and rams may weigh greater than 300 pounds. Large-horned, older rams do much of the breeding, though younger rams will breed opportunistically (Hogg and Forbes 1997). Rams may breed several ewes; however, they are not territorial nor do they form harems, but rather are serial polygynists. Ewes generally first breed at 2.5 years and give birth to one lamb after a gestation period of 180 days. Although twins have been documented in both wild and captive bighorn sheep it occurs infrequently (Eccles and Shackleton 1979).

In the southern Rocky Mountains, bighorn sheep generally breed from late October through late December with the peak breeding season occurring from about mid-November to mid-December (Beecham et al. 2007). Most lambs are born from late April through early June, with few lambs born after mid-June. Bighorn sheep generally have a life span of 10-14 years, although exceptions as old as 18 years have been reported (Geist 1971). Mortality tends to be high the first year, low from ages 2-8, and then increases after age nine (Lawson and Johnson 1983).

Bighorn sheep are social animals that live in groups most of the year. Ewe groups (comprised of adult ewes, yearling ewes, lambs, and young rams) generally are larger than ram groups especially during late spring and early summer when nursery bands may contain 25-100 animals (Lange 1978). Mature rams generally remain solitary or in bachelor groups except during the pre-rut and rut periods (November- January), when rams and ewes gather on the same range.

Bighorn sheep eat a wide variety of plants with diets vary seasonally and throughout their geographic range (Cooperrider and Hansen 1982, Rominger et al. 1988). Succulent vegetation in summer and snow and ice in winter help bighorns to survive for long periods without freestanding water. Forbs generally dominate the diet, followed by grasses, and lastly browse (Krausman and Shackleton 2000). However, some low-elevation Rocky Mountain bighorn sheep populations have diets dominated by the leaves of browse species, particularly true mountain-mahogany (Rominger et al. 1988). Bighorn sheep also use mineral licks, especially during summer when green, potassium-rich forage is consumed.

Unlike other ungulates in which young disperse to new areas, bighorn sheep pass knowledge of home ranges and migration routes from one generation to the next. Therefore, bighorn sheep do not typically re-colonize ranges where they have been extirpated. Translocations are generally required to establish new populations (Singer and Gudorf 1999).

Climate, elevation, and latitude influence the vegetative structure and composition in bighorn sheep habitat. Within individual home ranges, different habitats meet the specific requirements of wild sheep, including foraging, resting, mating, lambing, thermal cover, and predator avoidance (Risenhoover and Bailey 1985). Seasonal use of different slopes and aspects results in a mosaic of plant communities and phenological patterns which provide foraging and security opportunities for bighorn sheep (Valdez and Krausman 1999).

Warm temperatures on south-facing slopes result in earlier green-up, marking the transition from winter range to spring range. During the spring green-up, mineral licks appear to be an important component of bighorn sheep habitats where soils are derived from granitic materials. As

temperatures continue to rise during late spring and early summer, bighorn sheep make greater use of north, east, and west-facing slopes at higher elevations for foraging. Alpine meadows and high elevation plateaus are important summer foraging areas for many Rocky Mountain sheep populations (Shannon et al. 1975). The elevation and aspect preferred by bighorn sheep varies according to forage succulence and ambient temperature.

While bighorns feed in open areas, they are rarely found more than 0.25 miles (400 m) from escape cover, where they have an advantage over most predators (Oldemeyer et al. 1971, Krausman and Leopold 1986, Krausman and Bowyer 2003). Bighorn sheep rely on keen vision to detect predators, and on rapid mobility on steep terrain as the principal means of avoiding predators (Geist 1971). Thus, open, steep terrain is the defining component of bighorn sheep habitat (Risenhoover et al. 1988, Krausman and Shackleton 2000). Talus slopes, rock outcrops, and cliffs provide habitat for resting, lambing, and escape cover. Adult male sheep are known to move farther away from security cover than females. Young rams in particular have a propensity to wander great distances from escape cover, particularly during the breeding season (Schommer and Woolever 2001).

Escape terrain is critical for ewes during lambing, even to the extent that they will sacrifice access to high quality forage for security (Cook 1990, Bleich et al. 1997). Both ewes and lambs are vulnerable to predation immediately prior to and for one to two days after parturition. Adult female bighorns exhibit strong fidelity to parturition sites and often use the same lambing grounds year after year. In the Rocky Mountains, lambing areas are usually on or very close to wintering areas (Geist 1971).

Key elements of winter ranges for bighorn sheep include low snow depth and wind-swept areas with sufficient forage and adjacent escape terrain for eluding predators (Krausman and Bowyer 2003). Wind, cold temperatures, and heavy snow accumulation are likely limiting factors for Rocky Mountain bighorn sheep in some areas. Stelfox (1975) suggested that the critical snow depth for Rocky Mountain bighorn lambs was 12-17 inches (30 to 44 cm), 13-19 inches (32 to 48 cm) for yearlings and adult females, and 14-21 inches (36 to 54 cm) for adult males. Consequently, most bighorn winter ranges occur on steep south, southwest, or southeast-facing slopes where maximum heat gain reduces cold stress and snow cover, and increases the availability of forage (Geist 1971, Krausman and Bowyer 2003). In some areas, bighorn sheep may remain at or move to high elevation, wind-swept ridges to avoid heavy snow depths at lower elevations (Geist 1971, Geist and Petocz 1977). Snow quality and the proximity of security cover are other factors influencing sheep use of winter ranges.

## **6. Overview of ecological conditions for recovery, conservation, and viability [12.53 7, 9?, 10, 11, 12]:**

An extensive conservation assessment for bighorn sheep was completed recently for the Rio Grande National Forest with details available regarding the ecological conditions for recovery, conservation, and viability (USDA Forest Service 2010).

Local habitat relationships and ecological needs for bighorn sheep are similar to that described elsewhere for Colorado. Most local bighorn sheep populations occur in steep, mountainous terrain in the alpine and subalpine zones. Most herds display elevational migrations which vary by season although some herds remain in the alpine zone throughout the year. There is ample unoccupied habitat for herd expansion on the Forest, but most herds experience limited growth due to past disease events. Information from the local bighorn sheep conservation assessment

indicates that the key ecological conditions for recovery, conservation, and viability of bighorn sheep herds on the Forest includes:

- Effective separation from domestic sheep and, in the Sangre de Cristo Range, the potential inclusion of recreational pack goats. Effective separation is defined by science-based estimates of bighorn sheep core herd range and movements across the landscape in relationship to domestic sheep areas, and managing potential contact rates to an acceptable level ensure a minimal risk of disease transmission.
- Re-establishment of a meta-population structure where genetic interchange can occur between herds at a landscape scale, including adjacent Forest Service and BLM units.
- Within individual home ranges, habitat components that meet the foraging, resting, mating, lambing, thermal cover, and predator avoidance requirements.
- Ecological processes, such as wildfire, that help maintain adequate forage resources in the core herd home range, particularly in close proximity (~ 500 meters) of escape terrain.
- Adequate seclusion on important lambing and winter range areas. Management of human disturbances spatially and temporally near these key ecological condition areas.

## 7. Threats and Risk Factors

The 2010 Bighorn Sheep Conservation Assessment for the Rio Grande National Forest evaluated all known threats and risk factors mentioned for the Southern Rocky Mountains in the R2 Species Conservation Assessment (Beecham et al.2007) in relationship to our local bighorn sheep herds and management context. The outcome of this evaluation is summarized below for the Rio Grande National Forest.

- Disease Epizootics: In Colorado, the susceptibility of bighorn sheep to pathogens introduced by domestic sheep is regarded as the primary factor limiting bighorn sheep populations (George et al. 2009). Respiratory illness due to comingling with domestic sheep is also considered the primary limiting factor for most local bighorn sheep populations (USDA Forest Service 2010). Currently, 9 of 11 herds on the Rio Grande National Forest have been documented to have or been exposed to respiratory illness resulting in *Pasteurella* related pneumonia, with four herds suffering all-age die-offs. Other diseases documented in bighorn herds on the Forest include *Mycoplasma ovipneumoniae*, PI3, and bovine respiratory syncytial virus (BSRV, see Appendix A).
- Habitat Quality and Quantity: Habitat conditions are not considered a primary limiting factor for any bighorn sheep herd on the Rio Grande National Forest and appear adequate to support existing or expanding herd populations. For a few units, certain areas have possibly moved away from desired conditions for bighorn sheep due to succession of vegetation related to fire suppression activities. In these cases, habitat conditions could possibly be improved by implementing prescribed fire or mechanical treatments. In some units, large and/or increasing elk populations are a possible concern because they have the potential to influence habitat and forage conditions for bighorn sheep. Although perhaps important to some local herds, disruption of access to trace mineral supplies is not considered a limiting factor to Colorado bighorn sheep populations (Ramey and Carpenter 2007 *in* George et al. 2009). One emerging habitat phenomenon involves the extensive mortality of conifer trees in the subalpine spruce-fir zone. The Rocky Mountain subalpine spruce-fir forest vegetation type provides a common interface with the alpine tundra and montane grassland habitats that most bighorn sheep herds occupy. A current spruce beetle outbreak has led to extensive mortality of mature Engelmann spruce trees in this interface, and the dense forest cover once considered a barrier to most bighorn sheep movement now supports very little, if any, canopy cover. What these open

forest conditions mean to bighorn sheep habitat ecology and movements has not yet been studied.

- Herd Size and Loss of Genetic Diversity: In pre-settlement times, it is likely that most of Colorado's bighorn populations existed as large metapopulations that interacted over large areas and maintained high genetic diversity. Currently, large-scale movements and herd interactions have been greatly restricted because most extant populations occur as small, isolated herds separated by landscape habitat fragmentation factors such as roads, towns, urban home-sites, and other human developments. There is speculation that the recent open canopy conditions due to the spruce beetle outbreak may facilitate greater movements across the landscape, which may be a positive factor for greater genetic exchange but perhaps a negative factor for higher contact rates with domestic sheep allotments.
- Human Disturbance, Development and Habitat Fragmentation: Human disturbances, development, and habitat fragmentation are not considered a primary limiting factor for any bighorn sheep herd on the Rio Grande National Forest. In some units, recreation or other potential human disturbances warrant further site-specific evaluations for possible influences on local bighorn herds (e.g. recreation and recreational pack goats in S9-Sangre de Cristo). However, development off National Forest Systems land combined with highways, roads, and other human infrastructure is a concern in some areas, particularly where bighorn highways intersect core herd home range or disrupt movements to resource needs such as water (e.g. S30 Conejos Canyon). Fragmentation on non-federal lands combined with small herd size and the presence and continued risk of transmitted diseases are primary factors limiting the restoration of large, interconnected herds on Forest and between adjacent public land management units.
- Competition: Competition with domestic and wild ungulates can potentially influence bighorn sheep. From a forage perspective, bighorn sheep have the most dietary overlap with domestic sheep, cattle, and elk and less overlap with species such as mule deer. On Trickle Mountain (S10), the average year-round dietary overlap with pronghorn antelope was also fairly high at 45%. The Trickle Mountain study did not include domestic sheep, which had been removed at the time but are known to have the highest dietary overlap and utilize many of the same habitats as bighorn sheep. In regards to livestock, the study found that although bighorns and cattle have a high dietary overlap, the impact of cattle was limited to only about 5% of the critical bighorn sheep range because cattle primarily remained close to water and used areas with less slope. However, other researchers have reported that cattle were serious dietary competitors with bighorn where their habitats overlapped, and also compete through spatial displacement (several authors *in* Beecham et al. 2007). The impact on bighorns due to an apparent social intolerance of cattle has resulted in displacement from traditional range areas and disruption of the lamb-rearing season (Taylor 2001, Beecham et al. 2007). On the Rio Grande National Forest, however, there is usually minimal range overlap between cattle and bighorn sheep and any potential forage competition from livestock most likely involves domestic sheep.

In regards to native ungulates, potential competition with elk is the primary concern for local bighorn herds on the Rio Grande National Forest. Elk can have greater negative effects on bighorn sheep because they are much larger, have a broader dietary overlap with bighorn sheep than other wild ungulates, and can gather in large herds on traditional bighorn habitat summer range in the alpine zone (George et al. 2009). On Trickle Mountain, the year-round dietary overlap between elk and bighorn sheep averaged 68% and increased to as high as 76% during the spring (Bailey and Cooperrider 1982). The potential impacts of alpine elk on several local bighorn sheep is currently of concern.

- Harvest: Current harvest rates in most herds in Colorado involve less than three percent of the estimated post-hunt herd size and primarily involve rams. These numbers are considered small enough that in most cases hunting is unlikely to have much effect on bighorn sheep populations. All herds on the Rio Grande National Forest have been hunted, some since the season re-opened in 1953. Hunts have primarily involved ram licenses although one unit has and continues to support a few ewe licenses (S9-Sangre de Cristo). Hunting is not considered a primary limiting factor for any bighorn sheep herd on the Rio Grande National Forest. On one unit (S10-Trickle Mountain), the possible influences of hunting may warrant further consideration because of the small herd size caused by an extensive die-off due to a disease outbreak. The 2010 conservation assessment also suggests that some currently suppressed herds (e.g. S36-Bellows Creek) should be allowed to increase to at least the lower thresholds of a population size considered in the literature to possibly be viable (e.g. 60-65 individuals) prior to reestablishing a hunting season. Unit S36 was reopened with one ram tag for the 2014 rifle season despite having a population estimate of 50 individuals. The CPW considers bighorns from this unit, S53 (Bristol Head) and S22 (San Luis Peak) to be one larger population that can withstand additional hunting pressure.
- Predation: Common predators of bighorn sheep in Colorado include mountain lion, coyote, black bear, and domestic dogs. Additional predators of lambs include bobcats, golden eagles, and red fox. For most Rocky Mountain bighorn sheep populations in Colorado, there is little evidence that lion predation is limiting bighorn sheep numbers. However, lion predation has been found to be a significant source of Rocky Mountain bighorn sheep mortality in individual field studies and in some cases numerous losses can be attributable to a single lion (Viera 2007 in George et al. 2009). Predation is not considered a primary limiting factor for any bighorn sheep herd on the Rio Grande National Forest. On one local unit (S10-Trickle Mountain), the possible influences of predation may warrant further consideration because of the small herd size caused by an extensive die-off due to a disease outbreak. However, the Colorado Division of Wildlife does not consider predation to be a limiting factor in this unit (B. Weinmeister, pers. comm. 2009).
- Interagency and Cross-Boundary Management Coordination: The core herd home range and/or summer source habitat for several bighorn sheep herds on the Rio Grande National Forest are shared with adjacent Forest Service units and/or Bureau of Land Management (BLM) units. In some cases, domestic sheep allotment permittees are also shared between the land management agencies. Coordination and consistency of management approaches regarding risk of contact with domestic sheep, monitoring, permit administration, and communication remains a significant barrier to bighorn sheep management across the landscapes that support their long-term viability and population persistence. The need for cross-boundary cooperation regarding bighorn sheep management is highlighted by the fact that several local Game Management Units have recently been combined by CPW into Data Analysis Units (DAU) involving connected populations that extend beyond the Forest boundary. Examples include DAU RBS-20 (Weminuche Herd, shared with the San Juan NF), RBS-22 (Central San Juan Herd, shared with the GMUG National Forest and Gunnison BLM), and RBS-24 (South San Juan Herd, shared with the San Juan NF, the San Luis Valley BLM, and the State Land Board).

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## **9. Map of Modeled Habitat and Known Occurrences**

There is currently no single map that models the habitat for all 11 local bighorn sheep herd in regards to their overall range (summer source habitat) and known occurrences ( i.e. core herd home range). Furthermore, individual bighorn sheep are known to frequently leave their core herd home range and wander on exploratory movements (forays) presumably through mapped summer source habitat. Currently, potential forays have been modeled for only four of the 11 herds that occur on the Rio Grande National Forest.

The map in Figure 1 displays bighorn sheep game management units (GMUs) and general occupied range based on the 2009 Colorado Bighorn Sheep Management Plan (George et. al. 2009). Bighorn sheep herds associated with the Rio Grande National Forest are narrated in the text box.



## Appendix A. Disease History of Bighorn Sheep Herds on the Rio Grande National Forest as of August 2015.

Herd Name/Unit	Herd Size	USFS Units	Disease Status
Huerfano S-8	80	Rio Grande-Conejos Peak Pike San Isabel	No historic disease testing. Anecdotal information suggests historic disease influence but herd appears to be doing well.
Sangre de Cristo S-9	250	Rio Grande-Saguache Pike San Isabel	Historic <i>Pasteurella</i> >20 years ago. Herd appears to be doing well.
Trickle Mountain S-10	35	Rio Grande-Saguache	Disease event and all-age die off 1990s. <i>Pasteurella multocoda</i> , BSRV, and PI3 detected. No herd recovery to date.
Sheep Mountain S-15	200	Rio Grande -Divide San Juan	No known disease or testing. Herd appears to be doing well.
San Luis Peak S-22	60	Rio Grande-Divide Gunnison	<i>Pasteurella</i> potentially present. Signs of disease related lamb recruitment and growth.
Alamosa Canyon S-29	50	Rio Grande-Conejos Peak	Disease event and all-age die-off 1990s. <i>Mycoplasma ovipneumoniae</i> , <i>Mannheimia haemolytica</i> , leukotoxin, PI3, BSRV detected.
Conejos River S-30	75	Rio Grande-Conejos Peak	<i>Pasteurella</i> present, same as S29
Lake Fork/Pole Mtn S-33	135	Rio Grande-Divide Gunnison	Historic <i>Pasteurella</i> >20 years. Herd appears to be doing well.
Bellows Creek S-36	50	Rio Grande-Divide	Presumed <i>Pasteurella</i> related outbreak and all-age die off 1990s. Signs of disease related lamb recruitment and growth.
Bristol Head S-53	115	Rio Grande-Divide	<i>Pasteurella</i> Potentially Present and Suspected
Carnero/Natural Arch S-55	20	Rio Grande-Divide/Saguache	All-age die-off 1990's attributed to <i>Pasteurella</i> ; no disease testing to date. <i>No herd recovery to date.</i>
<b>Total</b>	<b>1,070</b>		