BIGHORN SHEEP MANAGEMENT IN NEW MEXICO

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GENERAL BACKGROUND

The New Mexico Department of Game and Fish (NMDGF) is a New Mexico state agency that is responsible for maintaining wildlife and fish in the state. Its mission is to conserve, regulate, propagate, and protect the wildlife and fish within the state of New Mexico using a flexible management system that ensures sustainability for public food supply, recreation, and safety. NMDGF manages bighorn sheep and their habitats on behalf of all New Mexicans to conserve and protect bighorn for their intrinsic and ecological values, and to provide for their beneficial use and enjoyment across a diversity of interests and activities including education, hunting, photography, and wildlife viewing. This document is intended to provide a general description of the statewide management of bighorn sheep in New Mexico.

BIGHORN SHEEP TAXONOMY, LIFE HISTORY, AND NATURAL HISTORY IN NORTH AMERICA

Bighorn sheep (*Ovis canadensis*) are even-toed ungulates taxonomically classified in a hierarchical structure beginning most broadly under the Order *Artiodactyla* and Suborder *Ruminantia*, ruminants that obtain nutrients from plants through a specialized foregut; ruminants eructate and rechew cud to further break down rough plant material in preparation for digestion. The Family *Bovidae* includes antelope, cattle, sheep, goats, and their allies, in which all members have a four-chambered stomach and at least one pair of horns. The *Caprinae* Subfamily is made up of sheep and goats, animals especially adapted to montane environments. Both sexes within *Caprinae* have horns, which grow throughout an animal's life. Horn morphology is sexually dimorphic – males and females express both horn size and structure differently, with males possessing larger head ornaments. The Genus *Ovis* contains all sheep, which includes seven recognized species, including bighorn sheep.

Bighorn sheep are named for the large, curved horns worn by males of the species which tend to garner significant interest among hunters and wildlife enthusiasts. Societal interest in large horns (as well as large antlers and pronghorns) is not a new phenomenon, as evidenced by regalia and petroglyphs found across many Indigenous cultures. Horns are hollow structures made of a sheath of keratin that overlies a bony core, a modified protrusion extending from the frontal plate of the skull. Horns grow throughout the life of both males (rams) and females (ewes) with growth rate the most rapid the first 7 to 8 years of an animal's life. Maximum horn size is typically achieved between 7 and 10 years of age, with growth rate slowing as an animal ages. Ewe horn size is similar to that of yearling males, generally between 10 to 13 inches at maturity with a base circumference between three to six inches. Mature ram horns can measure up to 40 inches long with a base circumference between 13 and 18 inches.

Horn size is a function of age, nutrition, and genetics. They are a heritable product of sexual selection that offers reproductive advantages. Horns are referred to as "honest indicators" of an individual's fitness because horn size signals metabolic efficiency and an individual's ability to access high quality forage. Nutritional access is determined by social order; thus, the older, more dominant rams tend to have greater access to better nutrition which is then reflected in the quality, or size, of their horns. Horn size dictates a ram's ability to compete for breeding access to ewes and subsequently, their ability to pass on their genes to the next generation. It may also serve as an indirect measure of habitat quality and a given landscape's ability to support a population.

Bighorn occupy and are adapted to some of the most rugged, seasonally variable environments in North America, and possess a suite of adaptations to support survival in extreme conditions. Bighorn have a short tail and a stocky, muscular build with short, powerful legs. Their coats are coarse and can range in color from light brown to gray or dark brown. Both rams and ewes possess a distinctive white rump patch and white muzzle. Their eyes are large and widely spaced, with horizontal pupils that provide a wide field of vision which is critical for predator detection. Bighorn sheep are unguligrade animals meaning they walk on the tips of their toes which helps them move swiftly across their environments. They have cloven hooves coupled with rough-textured soles that provide support and traction adapted for traversing rough, rocky terrain.

Bighorn are dietary generalists, with vegetation consumption varying seasonally and spatially. Native forbs, grasses, and shrubs are preferred; cacti are an important food source in harsh environments. Due to the low processing rate of their digestive system, bighorn do best with highly nutritious forage. Selection is generally determined by the most nutritious plants available seasonally. Their diets can therefore be adversely affected when range conditions are suboptimal and forage quality, quantity, and diversity is low. Bighorn also use mineral licks, especially during summer when green, potassium-rich forage may cause an imbalance in the potassium-sodium ratio of the intracellular fluids.

Bighorn sheep are social ungulates and are typically found in groups, heterogeneously scattered in a range of group sizes throughout occupied habitat. Rams and ewes sexually segregate across the landscape for most of the year but coalesce during the rut, or breeding season. Bighorn sheep participate in a polygynous mating system, in which a small number of dominant rams breed the majority of ewes. Ewes reach sexual maturity around 2 years old. Although young rams reach sexual maturity within the same period, they are less likely to gain the opportunity to breed until they are older, larger, and able to compete with mature, dominant rams.

Ewes generally give birth to one lamb each year following a roughly 180-day gestation period. Ewes will break off from the social group to drop their lambs in isolation before returning several days later with lamb at heel. Lambs weigh between 8 and 10 pounds at birth, and generally have a fuzzy, dark-gray coat, and stand upon slightly disproportionate, long, skinny legs. Bighorn lambs are precocial, readily capable of traversing their mountain environments soon after birth. Ewes form nursery groups with their lambs, also joined by yearling ewes and rams. Young rams typically remain with their maternal ewe until about 2 years of age, after which they depart and join a bachelor herd or may even foray long distances. Bighorn sheep generally have a life span of 10-14 years in the wild, although exceptions as old as 18 years have been recorded. Multifactorial mortality tends to be highest in the first year, relatively low from ages 2-8, and then increases after age 9.

Several subspecies of bighorn sheep are found throughout North America including Rocky Mountain bighorn (*O.c. canadensis*), Sierra Nevada bighorn (*O.c. sierrae*), Nelson's desert bighorn (*O.c. nelsoni)*, and Mexican desert bighorn (*O.c. mexicana*), among others. Historically, both Rocky Mountain bighorn and Mexican desert bighorn occupied New Mexico. Both subspecies are similar in morphology, behavior, and reproductive strategies, but several key differences distinguish between the two.

Rocky Mountain bighorn typically occupy mountain regions at elevations between 5,000-13,000 feet in alpine, subalpine, and rugged terrain, usually near areas with water and meadows. Desert bighorn occupy arid country in the American southwest, often at elevations below 6,000 feet. Desert bighorn are adapted to dry climates with limited water resources and sparse vegetation.

In terms of body size, Rocky Mountain bighorn sheep are generally larger, with mature rams weighing between 180-300+ pounds, while ewes typically weigh between 120-200 pounds. Rocky Mountain sheep have thicker pelage built to withstand cold, snowy conditions. Desert bighorn are smaller and leaner compared to their Rocky Mountain counterparts, with rams weighing between 110-200+ pounds and ewes between 75-125 pounds. Desert sheep also have shorter pelage adapted for heat dissipation in hot and dry conditions. Rocky Mountain rams have thick, curling horns that can exceed a full 360° curl, a reflection of genetics and access to more abundant forage and mineral resources compared to desert sheep. Desert rams tend to have slightly smaller and narrower horns relative to Rocky Mountain bighorn. This reduced horn mass is likely a result of the arid, resource-limited environments where lower forage quality and extreme temperatures constrain growth. Horn morphology is not only a key biological trait but also a useful management tool. It is possible to estimate age of animals via horn annuli – a "ring" that is formed annually when growth is slowed or stopped. And, as mentioned earlier, horn size can be an indicator of the environmental conditions on the landscape where that individual resides.

Reproductive phenology also slightly differs across subspecies, primarily as a functional response to environmental conditions. Rocky Mountain ewes tend to give birth in spring to late summer to take advantage of seasonal vegetation growth. Conversely, desert ewes often give birth in late winter through early spring, timed to periods when desert vegetation thrives after rain events. While the lambing period of Rocky Mountain bighorn is generally locally synchronized between April and July, desert sheep populations are known to produce lamb crops anywhere from December to August, reflecting the greater seasonal variation of the desert environments they occupy.

Bighorn sheep historically thrived in a dynamic natural metapopulation structure supported by landscape-scale connectivity and relatively frequent demographic exchange between populations across much of North America (Figure 1). Bighorn sheep populations declined, and their distribution significantly reduced, as westward expansion of European settlement encroached through much of their range. Unregulated market hunting, habitat loss and modification, and introduction of domestic livestock and thus exposure to novel bacterial pathogens contributed to the rapid decline of bighorn range and abundance in the 19th and 20th centuries. Modern restoration campaigns across state jurisdictions have resulted in re-establishment of bighorn within historical ranges. Recovery of bighorn sheep has largely resulted from human-mediated capture and translocations to assist bighorn recolonization of vacant, suitable habitat. Over 100 years of collaborative efforts have resulted in largely successful restoration of bighorn populations throughout their ancestral range in North America.

Modern human impacts, however, have resulted in habitat fragmentation which has disrupted the historical metapopulation functionality. Today, many established bighorn populations persist in fragmented, demographically and genetically vulnerable networks of isolated populations that necessitate active management. Applied strategies to effectively manage bighorn include annual inventory and monitoring to assess population performance, regular disease surveillance, understanding and managing local-scale predator-prey dynamics, conducting captures and translocations, protection and enhancement of bighorn habitat, and prescribing regulated harvest opportunities. Used collectively, these integrated strategies allow wildlife managers to make science-based decisions to effectively manage for self-sustaining free-ranging bighorn populations into the future. For more information on the status of bighorn sheep throughout North America, visit https://wafwa.org/publications/wswg-publications/.

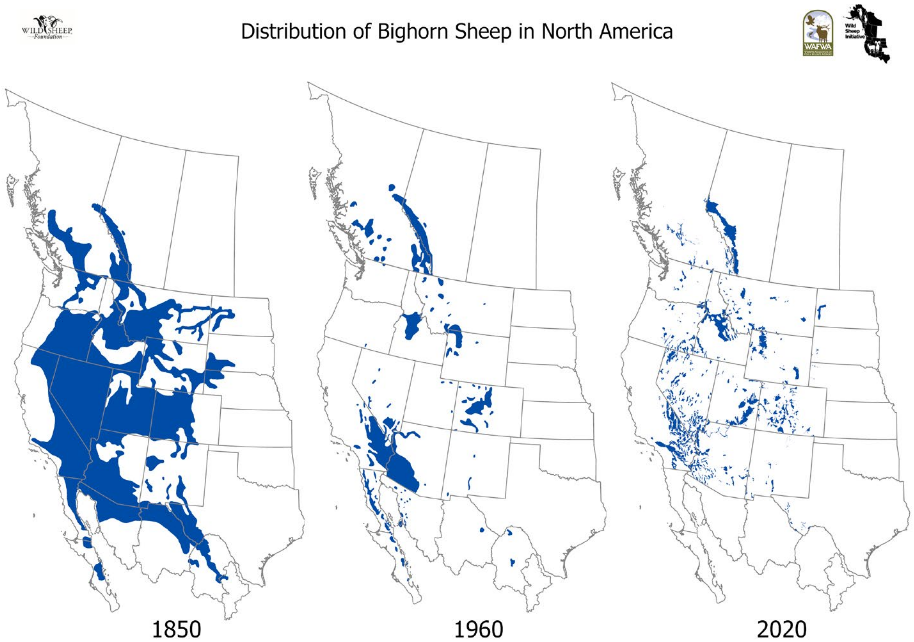
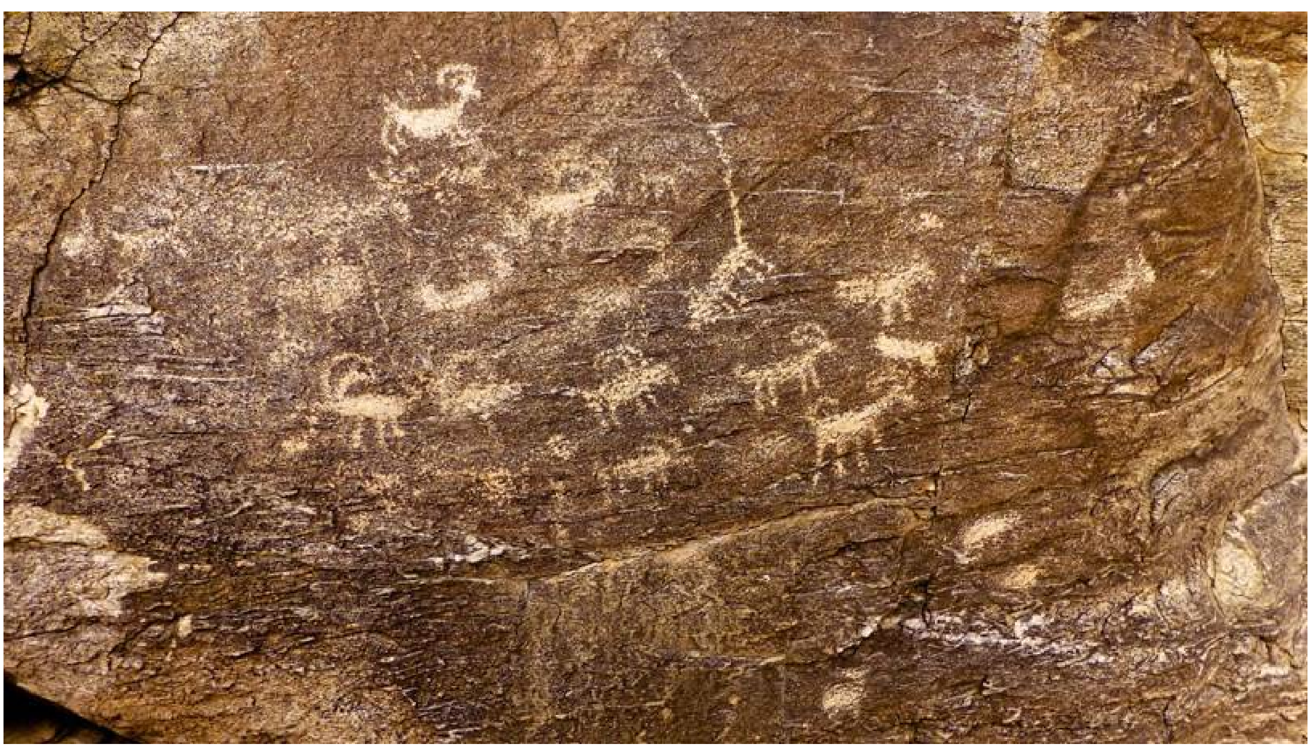


Figure 1. Estimated distribution of bighorn sheep (blue polygons) in North America in 1850, demonstrating "pristine" conditions, the subsequent range contraction due to human influence by 1960, and the metapopulation format in which they exist circa 2020. Image available from the Western Association of Fish and Wildlife Agencies (WAFWA) Wild Sheep Initiative (WSI), https://wafwa.org/initiatives/wsi/.



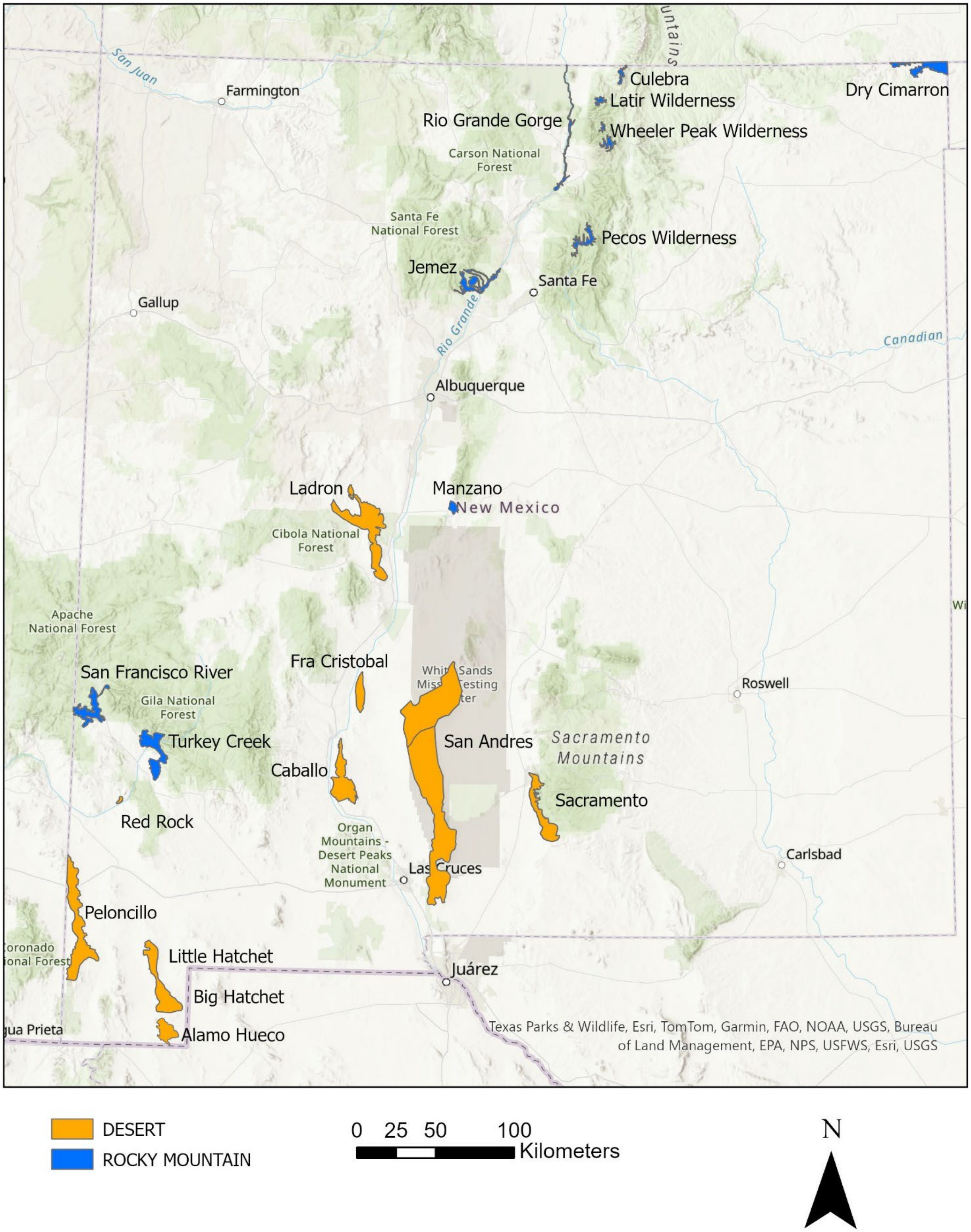
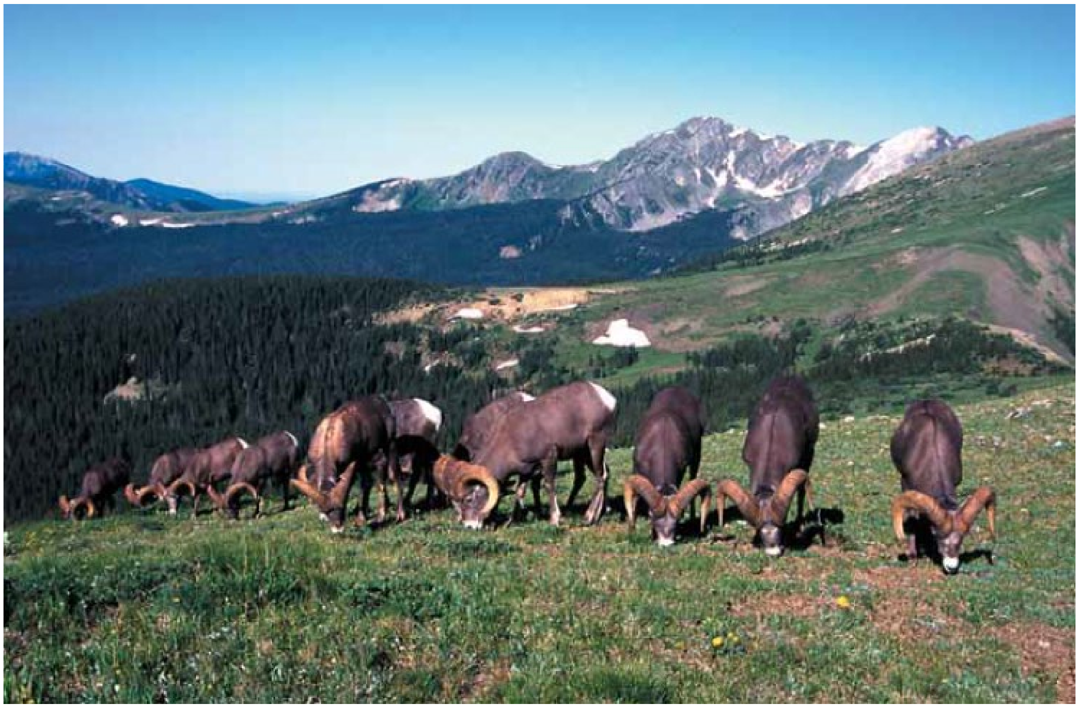


Figure 2. The current (circa 2025) estimated occupied range of Rocky Mountain bighorn sheep populations (blue polygons) and desert bighorn sheep populations (orange polygons) in New Mexico.

NATURAL HISTORY AND CURRENT STATUS OF ROCKY MOUNTAIN BIGHORN IN NEW MEXICO

In pristine conditions, Rocky Mountain bighorn sheep occupied the mountainous northern regions of New Mexico. Rocky Mountain bighorn were never widespread in New Mexico, but evidence confirms they occupied at least four ranges including the Wheeler Peak-Truchas Peak-Santa Fe Baldy portions of the Sangre de Cristo mountains, White Rock Canyon east-southeast of modern-day Bandelier National Monument, and the Manzano-Los Pinos mountains in the central part of the state. It is hypothesized that pre-Columbian Rocky Mountain bighorn populations in New Mexico also occupied other suitable areas nearby, but probably not in as great abundance.



Rocky mountain bighorn declined in the 20th century primarily due to unregulated harvest, disease exposure from and competition with domestic livestock, and loss of habitat. They were thought to have been extirpated from New Mexico by 1900. In his 1931 report on the mammals of New Mexico, Bureau of Biological Survey Senior Biologist Vernon Bailey lamented on the destruction of Rocky Mountain bighorn in the state but suspected that with proper protection they could return through the mountains from Colorado. While formal protection was not granted, restoration of this iconic subspecies was initiated by the state in the early and mid-20th century. In 1932, six bighorn sheep were translocated from Canada into the Pecos Wilderness; this reintroduction was unsuccessful. Rocky Mountain bighorn were reestablished in 1940 when a small number of bighorn were collected in Banff National Park, Canada, and released in the Sandia mountains near Albuquerque. Although it is now defunct, the Sandia population, along with bighorn from Canada, served as the primary source populations to reestablish Rocky Mountain herds elsewhere in New Mexico and translocations periodically continue. A captive breeding population was briefly maintained at Fort Wingate Army Depot near Gallup, NM, but that effort ultimately ended due to escapes and losses of bighorn. Today, Rocky Mountain bighorn are sourced from existing, free-ranging populations.

As of 2024, Rocky Mountain bighorn exist in 11 discrete populations in the northern and southwestern portions of the state (Figure 2) with an estimated abundance of 1,675 (1,505-1,845) (Figure 3). Rocky mountain bighorn have been restored to many historical habitats since their extirpation in the early 20th century. Additional locales continue to be considered as potential future release site(s) to further restore free-ranging populations.

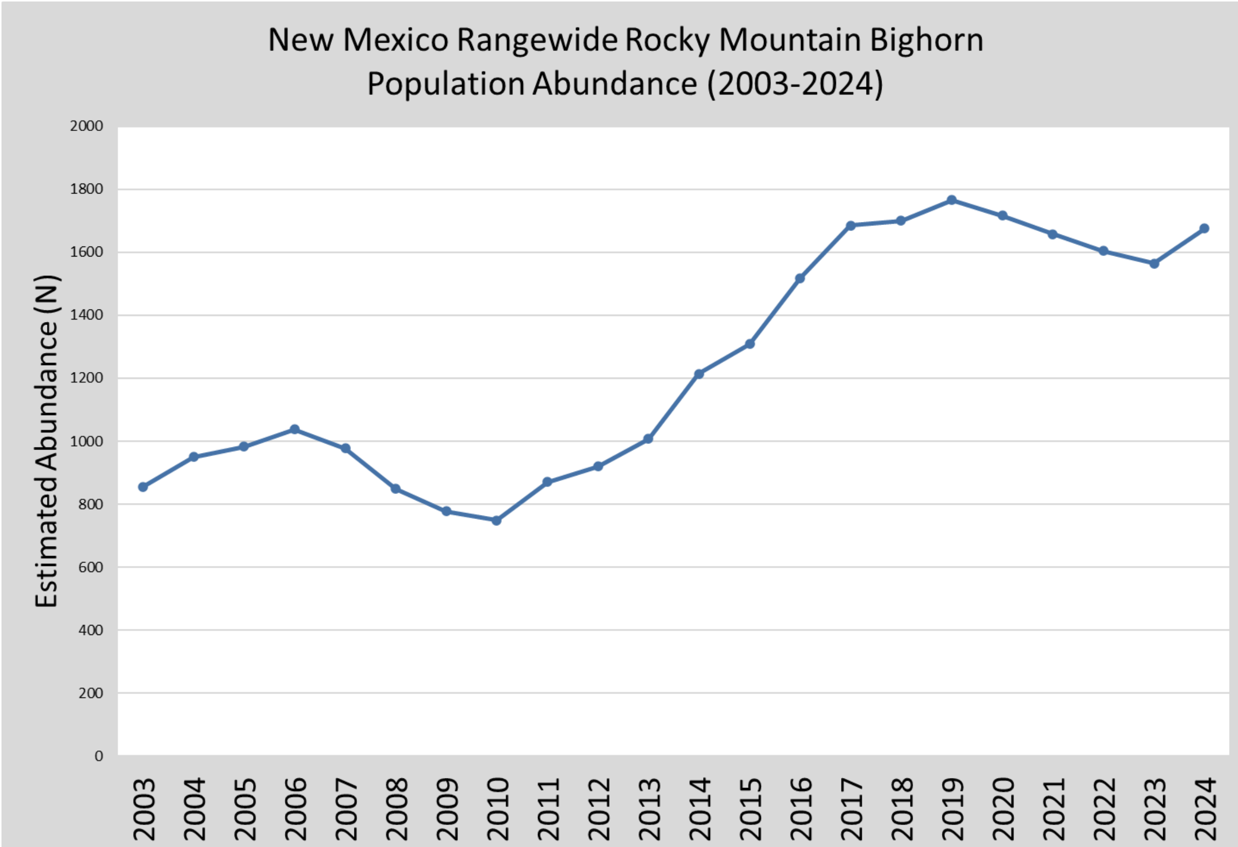


Figure 3. Rangewide estimated abundance (N) of Rocky Mountain bighorn sheep in New Mexico, 2003-2024.

NATURAL HISTORY OF DESERT BIGHORN IN NEW MEXICO

Desert bighorn sheep occurred in most arid mountain ranges across central and southern New Mexico with ethnographic, ethnobiological, and zooarcheological evidence suggesting their occupation in at least 14 mountain ranges prior to European arrival. Like their Rocky Mountain counterparts, desert bighorn also experienced a reduction in distribution and abundance due to unregulated harvest, disease exposure from and competition with domestic livestock, and loss of habitat. The decline roughly followed a geographic north-south trend that correlates with the progressive movement of human settlement and their associated domestic livestock. Large flocks of domestic sheep were estimated in total at 3 million animals by 1820. Between 1860 and 1900, large cattle operations controlled the open range and desert grasslands rapidly shifted to desert shrub. Most cattle companies disbanded, while homesteaders and other land operators opted to raise domestic goats and sheep. Bighorn hunting was prohibited in 1890, but illegal unregulated market hunting continued to be a primary cause of mortality in some areas. State game refuges were established in the Hatchet and Guadalupe mountains during the mid-1920s under the assumption that if bighorn were protected from illegal harvest, they would increase and recolonize former occupied range. Livestock were not excluded from these areas, however, and severe overgrazing limited forage availability for bighorn. While desert bighorn sheep were not entirely extirpated from New Mexico, these various pressures nearly brought them to extinction within the state in the early 20th century. Vernon Bailey's 1931 report stated that "…[desert] sheep are so accessible to the neighboring settlements and so easily hunted that their range has been greatly reduced." Bailey went on to describe his doubts that, at the time, any bighorn occurred within the limits of

New Mexico beyond the Hatchet, Guadalupe, and San Andres mountains. Existence of so few desert sheep prompted the establishment of the San Andres National Wildlife Refuge in 1941. By 1946, only two small, remnant populations of desert bighorn existed, relegated to ancestral ranges in the San Andres and Big Hatchet mountains. The propagation of a captive desert bighorn herd at the Red Rock Wildlife Area began in 1972, which included founding stock from Kofa, Arizona and Sonora, Mexico. In 1980, the State Game Commission added desert bighorn to the state list of endangered wildlife. Efforts to restore desert bighorn to vacant habitat began in 1979 (see: Captures and Translocations). The 1,500-acre Red Rock captive breeding facility has served as a source population to periodically augment demographics and genetics of existing free-ranging populations and to establish new populations in unoccupied suitable habitat. This program, in tandem with other applied management actions, has proven successful; in 2011 the state-wide desert bighorn sheep population met the biological criteria to be de-listed. However, substantial suitable vacant range remains in the state and full restoration remains an overarching goal. Red Rock continues to be the primary source herd for the majority of transplants to augment and reestablish desert bighorn herds in southern New Mexico, though some translocations occur from established desert herds as well.

Desert sheep abundance is estimated to be 1,088 (950-1,225) as of 2024 (Figure 4). Desert bighorn persist in 9 discrete populations in the south central and southwestern portions of the state, plus the one captive herd at the Red Rock Wildlife Area north of Lordsburg, NM (Figure 2).

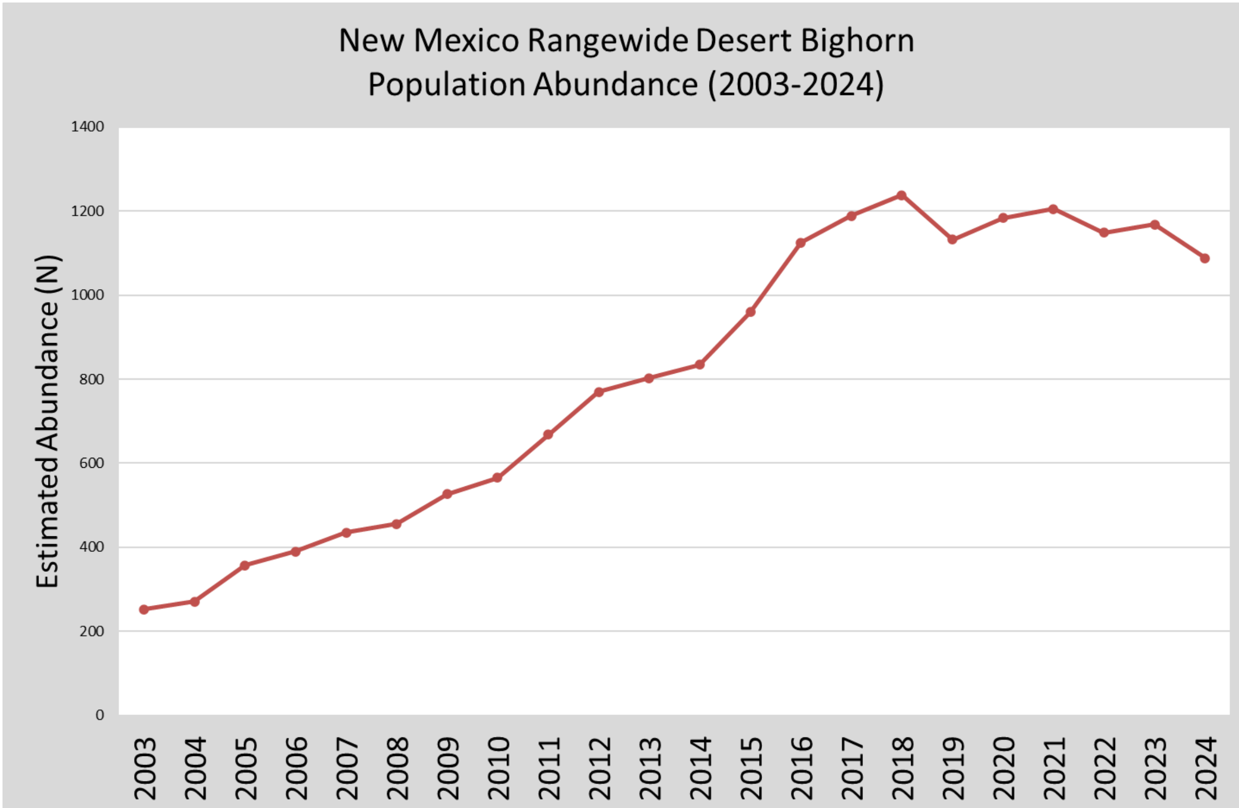


Figure 4. Rangewide estimated abundance (N) of desert bighorn sheep in New Mexico, 2003-2024.

ELEMENTS OF BIGHORN SHEEP MANAGEMENT IN NEW MEXICO

Management of both Rocky Mountain and desert bighorn relies on several key elements that contribute holistically to NMDGF's Bighorn Program including annual inventory and monitoring of bighorn populations, disease surveillance, mountain lion (*Puma concolor*) management, captures and translocations, habitat conservation and enhancement, and regulated harvest all being essential to the conservation and management of bighorn sheep in New Mexico. A detailed description of each program element follows.

1.1 ANNUAL INVENTORY AND MONITORING

Performing regular surveys is essential for effectively managing bighorn populations that are relatively low in abundance and persist in a metapopulation structure. Annually surveying populations allows NMDGF to make sound management recommendations regarding regulated harvest, capture and translocations needs, and habitat conservation and enhancement. The annual survey cycle begins in May at the Red Rock Wildlife Area. Ground surveys of the confined desert bighorn population are conducted to determine whether and how many surplus desert sheep are available for capture and release (note that this number is not included in the rangewide estimated abundance of free-ranging populations). NMDGF staff annually conducts aerial surveys for the 9 desert bighorn populations and both aerial and ground surveys for the 11 Rocky Mountain bighorn populations.

Helicopter surveys are traditionally the most effective and efficient method for collecting population abundance data for bighorn. In New Mexico, both air- and ground-based surveys are used to gather minimum abundance, demographic information, age ratios, and productivity and recruitment indices. Helicopter surveys consist of two observers, a primary observer in the front left seat and a secondary in the rear left seat. Surveys in high elevation ranges where aircraft size and power may predicate lower weight capacity are often conducted with a single observe in the front left seat. Surveys are initiated at first light, generally from the closest airport. Surveys spatially cover the entire known occupied range, unless terminated by high winds. Upon sighting bighorn sheep, an immediate assessment of the riskiness of the associated habitat to the bighorn sheep needs to be made and care must be taken not to force bighorn into precipitous terrain. Group counts and classifications are made as quickly as possible and can be expedited by quickly getting consensus on the group total, then having the primary observer classify rams and the secondary observer classify lambs and yearling females and deriving adult ewes via subtraction. Bighorn sheep can be classified into multiple categories based on sex and age. Ewes are classified as adults and yearlings, with juveniles < 1 year old classified as lambs. Rams in New Mexico are placed into 4 classes based on horn size: Class I rams are yearlings, Class II rams are 2-3 years old, Class III rams are generally 4-7 years old and maintain mostly sharp points to the tips of the horns, and Class IV rams are typically ≥8 years old and often have broomed, or worn/blunted, horn tips. The most recent survey summaries at the time of this writing were completed for the 2024 survey cycle.

Minimum count surveys have been effective for managing populations and the data collected is useful as an annual index of population performance for bighorn sheep in New Mexico. These are not considered a population size estimate, so data should be interpreted with caution. Modern methods are in development that will yield corrected estimates which allow managers to elicit population trends over time. NMDGF intends to employ a hybrid double-observer sightability (HDOS) model to periodically derive corrected estimates for bighorn populations. A survey cycle will be developed to produce corrected estimates on a 3- to 5-year basis for each bighorn population. This cycle will ultimately inform the preceding capture efforts prior to application of aerial HDOS survey methods. This method requires a sufficient number of marked animals on the landscape to meet model assumptions; animals are typically marked by attaching ear tags and Global Positioning System (GPS) collars through aerial- and ground-based capture efforts. Captures are performed annually, and locations of capture are determined by data needs per population, as assessed by NMDGF biologists.

GPS and Geographic Information System (GIS) technology and equipment are regularly used to monitor space use across bighorn populations. In addition to space use, GPS collars provide data on (1) annual and seasonal home ranges, revealing how individuals use the landscape across varying seasons, different habitat types, as well as topographic and environmental conditions, (2) habitat affinities, which allows inference of preferred vegetation types and terrain features, (3) movement corridors and barriers to movement that can facilitate or impede demographic and genetic exchange between populations, as well as to provide (4) cause-specific mortality and annual survival of individuals across populations. These data provide NMDGF staff and partners with necessary information to guide more informative surveys, inform necessary management intervention(s) to reduce problematic predation that threatens population persistence, and efforts to enhance habitat. They are also crucial for detecting dispersal events, identifying natural barriers to movement, signaling behavioral changes in space use, and assessing functional connectivity of landscapes.

While spatial data is important for monitoring potential connectivity across populations, demographic exchange alone does not necessarily result in successful breeding. In a fragmented metapopulation context, patchily distributed populations that have also experienced historical genetic bottlenecks may be especially susceptible to negative genetic consequences; smaller population sizes experience more rapid genetic decay (i.e., loss of genetic diversity) compared to large, continuous populations, and are therefore more susceptible to maladaptive genetic mutations. Further exacerbating the genetic/genomic situation is the polygynous mating system bighorn sheep participate in, where a small fraction of mature males breed a majority of females in a population. Genetic and genomic monitoring may be used to assess genetic summary statistics (genetic diversity, allelic richness, heterozygosity, etc.), population genetic structure (the difference in ancestry within and among groups), detect genetic bottlenecks, inbreeding, and loss of fitness/adaptive variation, and evaluate whether demographic exchange (movements tracked via GPS collars) results in genetic exchange (successful breeding between populations or subpopulations). Characterizing genetic and genomic variation also allows managers to infer or confirm connective corridors and barriers as well as guide management activities based on predicted genetic outcomes.

Maintenance of resilient, spatially connected bighorn sheep populations requires an integrated annual inventory and monitoring approach. The three data sources described herein allow for science-based decisions that optimize the long-term persistence of bighorn sheep populations. In the absence of functional connectivity, translocations have proven useful as a management tool to augment demographic and genetic diversity and to improve the fitness potential and resilience of recipient populations (see: Captures and Translocations).

1.2 RESEARCH PERTAINING TO INVENTORY AND MONITORING IN NEW MEXICO

Ruhl, C. Q., J. W. Cain III, F. Abadi, and J. D. Hennig. In review. Estimating abundance of desert bighorn sheep with double-observer sightability modeling with residual heterogeneity.

ABSTRACT – Accurate abundance estimates are critical for informed management of wildlife populations. In New Mexico, minimum counts from aerial surveys are the primary basis for management decisions of desert bighorn sheep (*Ovis canadensis mexicana*); therefore, there is need to assess the applicability of methods that account for imperfect detection. Common survey methods for large mammals (i.e., sightability, double-observer, and double-observer sightability (DOS) models) are known to result in biased estimates, but the presence of radio-collared individuals within a population allows for the estimation of residual heterogeneity. Consequently, we explored the applicability of hybrid double-observer sightability approaches that account for residual heterogeneity when estimating abundance of desert bighorn sheep in the Fra Cristobal Mountains of New Mexico. We collected double-observer sightability data for 168 desert bighorn groups across 3 surveys between December 2016 and November 2017, and compared abundance estimates under five modeling methods: a standard sightability model (M_S), a standard double-observer sightability model (M_{DS}), a hybrid double-observer sightability model incorporating a recapture type heterogeneity parameter (M_R), a hybrid double-observer sightability model incorporating a mark-type heterogeneity parameter (M_H), and a Lincoln-Petersen estimator. Standard sightability models produced greater abundance estimates than all double-observer sightability models but were less precise. The M_R model was the best supported of the heterogeneity models and resulted in the greatest abundance estimates of all DOS models. The M_R models produced an average detection probability of p = 0.724 (95% CI = 0.684−0.764) and abundance estimates of 301 (95% CI = 271−392), 292 (95% CI = 273−352), and 337 (95% CI = 276-480) for the December 2016, May 2017, and November 2017 surveys, respectively. Across all model types, group behavior (moving vs. stationary) and group size were the variables that most influenced detection, followed by drainage terrain and proportion of obscuring vegetation cover. Lincoln-Peterson estimates were greater than all DOS models and similarly precise, but the requirement to permanently maintain a subset of animals with radio collars, and inability to incorporate information from factors influencing detection probability reduces their reliability. Estimates from the M_R and M_H models had greater precision than M_S models and accounted for more bias than the M_{DS} model. Further, because residual heterogeneity models offer enhanced capabilities in estimating visibility bias, flexibility in their accommodation of radio-collar data, and adaptability to unique survey occasions, they present a viable and robust option for estimating desert bighorn sheep abundance.

Bangs, P.D., P.R. Krausman, K.E. Kunkel, and Z.D. Parsons. 2005. Habitat use by female desert bighorn sheep in the Fra Cristobal Mountains, New Mexico, USA. European Journal of Wildlife Research 51: 77-83.

ABSTRACT – Mexican desert bighorn sheep (*Ovis canadensis mexicana*) populations have declined since the 1980s, and restoration efforts are necessary to establish viable populations. Mexican desert bighorn sheep were translocated to the Fra Cristobal Mountains of south-central New Mexico in 1995. We described seasonal habitats used by female desert bighorn sheep by comparing characteristics of radiolocations with random locations within their home range. We developed a geographic information system to derive aspect, distance to steep slopes, elevation, slope, substrate associations, terrain ruggedness, and visibility. We developed seasonal logistic regression models that incorporated distance to 60% slope patches, ruggedness, slope, substrate, and visibility. Habitat characteristics at bighorn sheep locations were similar among seasons. Bighorn sheep locations were on steeper and more rugged terrain, closer to topography with a 60% slope, and had lower visibility than random locations. Based on our description of habitat selection by sheep, managers in New Mexico may need to reassess the amount of escape habitat in restoration areas to prioritize translocations and plan to manage predators.

Hedrick, P.W., and J.D. Wehausen. 2014. Desert bighorn sheep: changes in genetic variation over time and the impact of merging populations. Journal of Fish and Wildlife Management 5 (1): 3-13.

ABSTRACT – Founder effects, genetic bottlenecks, and genetic drift in general can lead to low levels of genetic diversity, which can influence the persistence of populations. We examine genetic variation in two populations of desert bighorn sheep *Ovis canadensis* from New Mexico and Mexico to measure change over time and evaluate the impact of introducing individuals from on population into the other. Over about three generations, the amount of genetic variation in the New Mexico population increased. In contrast, over about two generations the amount of genetic variation in the Mexico population decreased by a great extent compared with an estimate from another Mexican population from which it is primarily descended. The potential reasons for these changes are discussed. In addition, although both populations have low genetic variation, introduction of Mexican rams into the New Mexico population might increase the amount of genetic variation in the New Mexico population. Overall, it appears that management to increase genetic variation might require substantial detailed monitoring and evaluation of ancestry from the different sources and fitness components.

2.1 DISEASE SURVEILLANCE AND MANAGEMENT

Bighorn sheep are susceptible to a variety of pathogens, most of which can be traced back through domestic livestock sources. A variety of bacteria, viruses, and parasites can be possessed with little effect on bighorn sheep while some can cause widespread die-offs and population declines. Control and eradication of pathogens in free-ranging wildlife populations is often not realistic, as logistical and economic problems are prohibitive. Prevention is the most effective form of disease management in wildlife populations. Among the many pathogens bighorn can be exposed to and affected by, the most concerning are pneumonia-related epidemics that can result in large, rapid fluctuations in population abundance. Domestic sheep and goats are the most common originating sources of respiratory disease spread in wild sheep populations. Contact between wild sheep can also facilitate spread when individuals from one exposed population contact those in a naïve herd.

Mycoplasma ovipneumoniae (*M. ovi*) is a bacterium commonly found in the sinuses of otherwise healthy domestic sheep and goats that can be transmitted via nose-to-nose contact with wild sheep – a common phenomenon when occupied wild sheep habitat occurs in juxtaposition to domestic flocks. Clinical signs include coughing, nasal discharge, lethargy, labored/open-mouthed breathing, and poor body condition. While domestic sheep and goats often possess an immune response in which the bacteria do not manifest in disease, *M. ovi* makes wild sheep highly susceptible to pneumonia that can result in high mortality rates and can lead to entire herd die-offs or, at a minimum, depressed population productivity. As infection continues to be passed on by individuals throughout a herd (sometimes by "chronic carriers" – individuals that harbor and shed the pathogen after initial infection), long-term suppression of lamb survival and recruitment can occur, limiting population growth, persistence, and resilience; this can ultimately lead to local extinction of bighorn populations.

Pneumonia continues to be a significant limiting factor in the distribution and abundance of wild sheep and is currently recognized as one of, if not the greatest challenge facing bighorn sheep conservation. New Mexico bighorn populations are no exception. Since restoration efforts began, several past die-offs have occurred in New Mexico bighorn populations either speculated or confirmed as having been associated with pneumonia, including in the San Francisco River and Latir populations. NMDGF began widespread disease surveillance for *M. ovi* in 2016-2017, and at the time of writing, five of the nine desert bighorn populations have been recently exposed to *M. ovi* while five of the eleven Rocky Mountain populations have been recently exposed (Table 1). The northernmost high-elevation Rocky Mountain sheep populations have recently been exposed (excluding the Pecos herd) as well as the low-elevation Rio Grande Gorge population. The suspected transmission routes were either from contact with domestic sheep or goats or wild-sheep to wild-sheep contact from an exposed population to a naïve population. The Pecos population lies within the alpine chain of Rocky Mountain bighorn distribution and is under the most immediate threat of exposure. The Jemez, Dry Cimarron, Manzanos, San Francisco River, and Turkey Creek Rocky Mountain populations are relatively isolated from the others and have not been recently exposed to *M. ovi*. None of the southwestern "Bootheel" desert sheep populations have been recently exposed (including the Red Rock captive breeding facility), while all the "Interior" desert sheep populations have been. It is a management priority for NMDGF to prevent exposure to the remaining naïve populations.

Table 1. *Mycoplasma ovipneumaniae* (*M. ovi*) exposure status (+ = exposed, - = naïve) for Rocky Mountain bighorn and desert bighorn populations in New Mexico circa 2024. Populations are listed in descending fashion as they geographically occur from North to South for each subspecies.

Population	*M. ovi* Status
Rocky Mountain Populations	
Dry Cimarron	-
Culebras	+
Latir	+
Wheeler Peak	+
Red River	+
Rio Grande Gorge	+
Pecos	-
Jemez	-
Manzanos	-
San Francisco River	-
Turkey Creek	-
Desert Populations	
Ladrons	+
Fra Cristobals	+
San Andres	+
Caballos	+
Sacramentos	+
Red Rock (captive breeding pop'n)	-
Peloncillos	-
Little Hatchets	-
Big Hatchets	-
Alamo Hueco	-

Since 2016, nasal swabs and blood samples have been collected from all captured bighorn sheep and tested for *M. ovi* and other diseases. Beginning in 2019, hunters have been requested to participate in voluntary sample collection and submission, which has been successful in increasing surveillance in additional herds. (see: Regulated Harvest). This program has increased in success over time and participation now totals nearly 100% annually for ram hunters. NMDGF will continue to systematically collect samples from captured bighorn, hunter harvested bighorn, as well as from opportunistically encountered mortalities as a regular element of disease surveillance. To reduce disease spread, captures and translocations will occur between two naïve populations or two exposed populations, while considering *M. ovi* strain-types and their associated virulence (see: Captures and Translocations). NMDGF staff will continue to work with partners and stakeholders to maintain separation and prevent contact between wild sheep and domestic sheep and goats on the landscape. When bighorn are confirmed to have come in contact with domestic sheep or goats, NMDGF will assess the individual circumstances surrounding the exposure event and proceed accordingly, prioritizing the health and protection of the greater bighorn population.

Other parasites and diseases can also adversely affect bighorn sheep. Many of these diseases have been documented in New Mexico bighorn sheep. These include psoroptic scabies, lungworms, bluetongue virus, contagious ecthyma, and chronic sinusitis, among others.

Psoroptic scabies, or psoroptic mange, is a contagious skin condition caused by the mite *Psoroptes ovis* that feeds on a host's body fluids. This leads to intense itching, causing pelage to loosen and slough off, and extensive lesions to develop in the ears and around the head. Weight loss, loss of hearing and balance, and potentially death through secondary bacterial infections or environmental stress may follow. This disease can affect bighorn at the population level and has been implicated in the historic decline of desert bighorn sheep in the American west. In New Mexico, scabies appeared in 1978, reducing the San Andres desert bighorn population from 200 to 75 individuals within one year. Preventing contact with infested domestic animals and monitoring for clinical signs, especially in translocated or augmented herds, is critical.

Lungworms (*Protostrongylus* spp., *Muellerius capillaris*) are parasitic nematodes commonly found in the lungs of bighorn sheep, especially in northern latitudes. Lungworms block airways, result in dissemination of bacteria, or reduce immunological response. They are often associated with respiratory illness and pneumonia. Infected animals serve as reservoirs, with transmission facilitated by intermediate gastropod hosts. Habitat monitoring and minimizing contact with domestic livestock can help reduce exposure.

Bluetongue virus (BTV) is a vector-borne noncontagious viral hemorrhagic disease transmitted by biting gnats (*Culicoides* spp.). The gnat is prevalent when conditions are warm and moist, breeding in shallow water contaminated by fecal material. Clinical signs include swelling of the face and tongue, ulceration of nasal and oral cavities, tissue death in the mouth and tongue, and may cause abortions. BTV is often subclinical (asymptomatic), but outbreaks can cause mortality. BTV was responsible for killing 22% and 15% of the herd at Red Rock in 1980 and 1991, respectively, and may have been responsible for another decline in 2000. Risk reduction involves surveillance during active vector seasons and limiting overlap with domestic livestock.

Contagious ecthyma is a parapox virus that produces proliferative lesions on the lips, nostrils, anus, genitalia, and hooves of bighorn sheep. While this disease can cause mortality, mostly in juveniles, bighorn generally recover 2 to 4 weeks after the onset of symptoms. It is transmitted through direct contact and via contaminated surfaces. Risk reduction involves reducing overlap with domestic livestock and, because the virus is zoonotic, handling infected individuals with caution.

Chronic sinusitis is a bacterial infection that produces deterioration of bone in sinuses and horn cores. It is initiated by the deterioration of nasal bot fly (*Oestrus ovis*) larvae that hatch in the sinuses of bighorn sheep. Clinical signs include nasal discharge, facial swelling, and weight loss. Although it is not typically a population-level threat, it has contributed to the decline of some bighorn populations in other western states. It does not appear to be common in New Mexico.

2.2 RESEARCH PERTAINING TO DISEASE SURVEILLANCE AND MANAGEMENT IN NEW MEXICO

Manlove, K., A. Roug, K. Sinclair, L. E. Ricci, K. R. Hersey, C. Martinez, M. A. Martinez, K. Mower, T. P. Ortega, E. M. Rominger, C. Q. Ruhl, N. M. Tatman, and J. Taylor. 2022. Bighorn sheep show similar in-host responses to the same pathogen strain in two contrasting environments. Ecology and Evolution. 12(7). 10.1002/ece3.9109.

ABSTRACT – Ecological context-the biotic and abiotic environment, along with its influence on population mixing dynamics and individual susceptibility-is thought to have major bearing on epidemic outcomes. However, direct comparisons of wildlife disease events in contrasting ecological contexts are often confounded by concurrent differences in host genetics, exposure histories, or pathogen strains. Here, we compare disease dynamics of a *Mycoplasma ovipneumoniae* spillover event that affected bighorn sheep populations in two contrasting ecological contexts. One event occurred on the herd's home range near the Rio Grande Gorge in New Mexico, while the other occurred in a captive facility at Hardware Ranch in Utah. While data collection regimens varied, general patterns of antibody signal strength and symptom emergence were conserved between the two sites. Symptoms appeared in the captive setting an average of 12.9 days postexposure, average time to seroconversion was 24.9 days, and clinical signs peaked at approximately 36 days postinfection. These patterns were consistent with serological testing and subsequent declines in symptom intensity in the free-ranging herd. At the captive site, older animals exhibited more severe declines in body condition and loin thickness, higher symptom burdens, and slower antibody response to the pathogen than younger animals. Younger animals were more likely than older animals to clear infection by the time of sampling at both sites. The patterns presented here suggest that environment may not be a major determinant of epidemiological outcomes in the bighorn sheep-*M. ovipneumoniae* system, elevating the possibility that host- or pathogen-factors may be responsible for observed variation.

Padilla, C. J., C. Q. Ruhl, J. W. Cain III, and M. E. Gompper. 2024. Effects of Mycoplasma ovipneumoniae, abundance, and climate conditions on bighorn sheep lamb:ewe ratios in New Mexico. *Ecosphere* 15(12): e70095. https://doi.org/10.1002/ecs2.70095.

ABSTRACT – Mycoplasma ovipneumoniae is a primary causative agent responsible for initiating polymicrobial pneumonia in bighorn sheep (Ovis canadensis). Infections of bighorn sheep populations are typically characterized by initial all-age epizootics followed by long-term periods of repressed juvenile (lamb) survival.

Populations of bighorn sheep in New Mexico, USA, were thought to be free of this pathogen prior to 2017 but recent infection of multiple herds raised concerns regarding impacts on population size and juvenile:female ratios. Using aerial survey, survival, and disease sampling data in an exploratory framework, we (1) characterize age-related differences in M. ovipneumoniae prevalence and seroprevalence, (2) quantify differences in lamb:ewe ratios pre- and post-M. ovipneumoniae detection, and (3) investigate differences in survival between previously exposed and naïve individuals. From 2007 to 2022, we sampled 466 bighorn sheep across 19 populations in New Mexico for M. ovipneumoniae exposure. While the timing of initial herd infections varied across populations, one population sustained active infections for over 15 years. We found reduced juvenile:female ratios post M. ovipneumoniae exposure for both desert (O. c. mexicana) and Rocky Mountain (O. c. canadensis) bighorn sheep populations. Post-exposure ratio declines ranged from 20% to 69%. Evaluation of population size and environmental condition effects on juvenile:female ratios indicated varying impacts for each subspecies. Notably, population size was negatively related to Rocky Mountain juvenile:female ratios only after populations were exposed to M. ovipneumoniae. Additionally, climatic conditions in the previous lambing season and pre-parturition time frame were associated with juvenile:female ratios for Rocky Mountain populations, while juvenile:female ratios of desert bighorn appeared to only be affected by pre-parturition climatic conditions. Kaplan–Meier survival estimation of previously exposed, but putatively recovered, individuals (n = 31) and naïve individuals (n = 70) revealed lower (75%; 95% CI: 62%–93%) but not statistically significant (p = 0.2) 1-year survival rates for individuals that were seropositive but not actively infected, when compared to seronegative individuals (88%; 95% CI: 81%–97%). These results collectively suggest that following M. ovipneumoniae introduction, bighorn sheep populations in New Mexico could be limited by lamb survival.

Boyce, W.M., and M.E. Weisenberger. 2005. The rise and fall of psoroptic scabies in bighorn sheep in the San Andres Mountains, New Mexico. Journal of Wildlife Diseases 41(3): 525-531.

ABSTRACT – Between 1978 and 1997, a combination of psoroptic scabies (*Psoroptes* spp.), mountain lion (*Puma concolor*) predation, and periodic drought reduced a population of native desert bighorn sheep (*Ovis canadensis*) in the San Andres Mountains (SAM), New Mexico, from >200 individuals to a single ewe. In 1999, this ewe was captured, ensured to be *Psoroptes*-free, and released back into the SAM. Eleven radiocollared rams were translocated from the Red Rock Wildlife Area (RRWA) in New Mexico to the SAM range and monitored through 2002 to determine whether *Psoroptes* spp. mites were still in the environment. None of these sentinel rams acquired scabies during this period, and no additional native sheep were found to be present in the range. In 2002, 51 desert bighorn sheep were translocated into the SAM from the Kofa National Wildlife Refuge in Arizona (n = 20) and the RRWA in New Mexico (n = 31). Twenty-one bighorn sheep have died in the SAM since that time, but *Psoroptes* spp. mites have not been detected on any of these animals, nor have they been found on mule deer (*Odocoileus hemionus*) sampled since 2000. We conclude that psoroptic scabies is no longer present in the San Andres bighorn sheep population and that psoroptic scabies poses a minimal to nonexistent threat to the persistence of this population at this time.

3.1 MOUNTAIN LION MANAGEMENT

Predator control can be a useful management tool when ungulate populations are below carrying capacity and when predation is a limiting factor. It is recommended as a management tool to protect rare species. Although many predators kill bighorn sheep, mountain lions are currently considered the primary proximate cause of mortality for many bighorn sheep populations. In a literature review of mountain lion predation on bighorn sheep, Rominger (2017) described three primary reasons that explains increased mountain lion predation on bighorn sheep: (1) Mountain lions occupy habitats where they were historically absent or rare because of the expansion of their primary prey, mule deer (*Odocoileus hemionus*), following conversion of fire-maintained grasslands to shrublands in the late 19th century, (2) the extirpation of competitors such as wolves (*Canis lupus*) and grizzly bears (*Ursos arctos horribilus*) during this same time period that may have excluded lions from certain areas, and (3) termination of >70 years of intense predator control. Collectively, these circumstances have resulted in unsustainable mountain lion predation on bighorn sheep, particularly desert bighorn in some circumstances. In southern New Mexico, mule deer are often the primary prey source for mountain lions. As mule deer populations fluctuate and decline, mountain lions are capable of prey-switching; declines in bighorn sheep therefore do not result in mountain lion declines. Southern New Mexico is also occupied by elk (*Cervus canadensis*) and javelina (*Dicotyles tajacu*) as well as introduced domestic livestock and exotic ungulates including African oryx (*Oryx gazella*), Persian ibex (*Capra aegagrus*), and aoudad (*Ammotragus lervia*), whose presence may support maintenance of greater mountain lion abundance than what might have naturally occurred.

Predation can be a significant mortality factor in small, isolated populations; a common structure of bighorn sheep populations, particularly those that have been reintroduced. Since monitoring of desert bighorn populations began, mountain lion predation has been a principal limiting factor for desert bighorn population abundance and growth in New Mexico. In fact, mountain lion predation has been documented as contributing to ~85% of all known cause, non-hunter related mortality of collared desert bighorn in New Mexico.

Lethal removal of mountain lions has been demonstrated to promote population growth and significantly reduce the risk of extinction for small, struggling populations of bighorn sheep. The Department regularly applies this management action for desert bighorn populations, where demographics warrant active intervention. Not all circumstances prompt lion management, particularly with many populations that are near carrying capacity or with a sufficient number of ewes to buffer against the negative impacts of lion predation (i.e., most of New Mexico's Rocky Mountain bighorn herds). These actions continue to improve survival rates and aid in the overall success of bighorn restoration, promoting bighorn expansion into vacant habitat and to occupy their ecological role on the landscape as an important native species.

3.2 RESEARCH PERTAINING TO MOUNTAIN LION MANAGEMENT IN NEW MEXICO

Rominger, E. M. 2017. The Gordian knot of mountain lion predation and bighorn sheep. Journal of Wildlife Management. 82: 19-31. 10.1002/jwmg.21396.

ABSTRACT – The objective of this review is to generate a synthesis of research conducted on predation of bighorn sheep (*Ovis canadensis*) and to suggest directions for future research relative to current knowledge gaps and a novel hypothesis. This review is primarily based on literature from the last 60 years on desert bighorn sheep (*O.*

c. nelsoni), Rocky Mountain bighorn sheep (*O. c. canadensis*), and mountain lion (*Puma concolor*) predation. Although, many predators kill bighorn sheep, only mountain lions are currently considered to be the primary proximate cause of mortality for many bighorn sheep populations. The ultimate cause of this phenomenon has vexed wildlife managers for >40 years. There are 3 primary reasons for increased predation on bighorn sheep by mountain lions. First, there is an increased presence of mountain lions in habitats where they were historically absent or rare because of the expansion of mule deer (*Odocoileus hemionus*) following the extensive conversion of fire-maintained grasslands to shrublands in the late-1800s. Second, is the extirpation of the 2 dominant apex carnivores (wolves [*Canis lupus*] and grizzly bears [*Ursus arctos*]) during this same time period and a hypothesized numerical response of mountain lions to those extirpations. Finally, the response of mountain lions to the cessation of >70 years of intensive predator control has often resulted in unsustainable mountain lion-bighorn sheep ratios, especially for desert bighorn sheep. Additionally, the effect of mountain lion predation is exacerbated by declines in bighorn sheep that do not result in declines in mountain lions because of their ability to prey switch to mule deer, elk (*Cervus canadensis*), or domestic cattle; kleptoparasitism of mountain lions kills, by ursids and canids, resulting in higher kill rates for mountain lions; and a possible ecological trap where adaptations derived over evolutionary time are no longer adaptive because of human-induced changes in the sympatric apex predator guild. Control of mountain lions, when mountain lion-ungulate ratios are high, might be required to protect small or endangered bighorn sheep populations, and to produce bighorn sheep for restoration efforts.

Rominger, E. M., and E. J. Goldstein. 2005. Synopsis of a 5 year mountain lion control effort on endangered desert bighorn sheep recovery (abstract only). Desert Bighorn Council Transactions 48:67.

ABSTRACT – Desert bighorn sheep (Ovis canadensis mexicana) have been listed as a state-endangered species in New Mexico since 1980. Approximately 85% of all known-cause non-hunter killed radiocollared individuals have been killed by mountain lions between 1992-2004. In 2001, a mountain lion removal program was implemented in several desert bighorn sheep mountain ranges in New Mexico. As a preliminary evaluation of the effectiveness of mountain lion removal to protect desert bighorn sheep, we used program MARK to compare mortality rates of desert bighorn sheep in the Peloncillo Mountains in SW New Mexico following two bighorn sheep releases. We used a known-fate model framework, considering several models and ranking them using Akaike's Information Criterion (AICc) model selection. Sex was the most important factor in explaining survival rates. In 1997, 24 radiocollared desert bighorn sheep were released from the Red Rock captive breeding facility to the Peloncillo Mountains with no mountain lion removal prior to release. The management strategy was offending mountain lion removal only. The mortality rate from mountain lions during the 16 months post-release was 0.29 for the herd, 0.0 for rams, and 0.55 for females. Eight of 12 ewes were killed by mountain lions, with mountain lions taken at 3 of the kills and a 4th mountain lion pursued from another kill. In contrast, in 2003, 30 radiocollared desert bighorn sheep were released into the Peloncillo Mountains from Red Rock following two years of mountain lion control in which seven mountain lions were removed. The mortality rate from mountain lions during the 16 months post-release was 0.10 for the herd, 0.0 for rams, and 0.15 for females. Three of 21 ewes were killed by mountain lions, but after the removal of one mountain lion, bighorn sheep mortalities from mountain lion predation ceased. Mortalities occurred during a six-week period when there was no field technician monitoring the bighorn sheep herd. In the Peloncillo

Mountains, 100% of the mountain lion kills were ewes during these periods. This is in contrast to other mountain ranges in New Mexico where mountain lions killed both rams and ewes. In desert bighorn sheep herds where mountain lion predation is a known predominant mortality factor, we recommend range-wide removal of mountain lions for six months prior to a bighorn sheep release. This should be followed with intensive bighorn sheep monitoring to enable rapid detection and removal of mountain lions until the herd has grown large enough to sustain predation without annual population numbers declining.

Rominger, E. M., F. S. Winslow, E. J. Goldstein, D. W. Weybright, and W. C. Dunn. 2005. Cascading effects of subsidized mountain lion populations in the Chihuahuan desert (abstract only). Desert Bighorn Council Transactions 48:65.

ABSTRACT – The primary proximate cause of mortality in 4 recently extinct or nearly extinct desert bighorn sheep (*Ovis canadensis mexicana*) populations in New Mexico has been mountain lion (Puma concolor) predation. This has occurred in habitats with native ungulate densities hypothesized to be insufficient to maintain resident mountain lion populations. Mountain lions in the Chihuahuan desert ecosystem are a subsidized predator, with domestic livestock the principal subsidy. We hypothesize that the ability to prey switch from native ungulate prey to domestic livestock or exotic wild ungulates may result in an artificially high density of mountain lions. Livestock prey reduces the probability of starvation in mountain lions when native ungulate populations decline to low numbers. This may result in an inversely density dependent mortality rate in desert bighorn sheep populations. The high proportion of cattle in the diets of mountain lions in Arizona (Cunningham et al. 1999) is the basis for this hypothesis. Similar data on the proportion of cattle in mountain lion diets in New Mexico are lacking. However considerable livestock predation is reported and a high percentage of mountain lions harvested in the Chihuahuan desert are pursued from livestock kills. The potential cascading effects of a subsidized predator include population level impacts on alternate prey. In much of the Chihuahuan desert, mule deer (*Odocoileus hemionus*) populations have declined drastically and lion predation has become an additive mortality factor. Another native mammal, porcupine (*Erethizon dorsatum*), was reported to be relatively common less than 30 years ago but appears to have been nearly extirpated from southwestern New Mexico. Empirical data correlates the substantial decline of porcupines with a hypothesized increase in mountain lions in southwestern New Mexico during this time period. Evidence implicating mountain lion predation in the decline of porcupines is lacking in New Mexico. However, the near extirpation of porcupines by mountain lions in a Nevada mountain range (Sweitzer et al. 1997) suggests that this may have occurred in southwestern New Mexico. Numbers of mountain lions harvested, in an effort to protect state endangered desert bighorn sheep, suggest that historical sport harvest in the Chihuahuan desert is an ineffective method for reducing subsidized mountain lion populations.

4.1 CAPTURES AND TRANSLOCATIONS

Historically, bighorn sheep occupied a vast and nearly continuous range across the mountainous and desert regions of western North America. Under pristine conditions, bighorn populations functioned as a natural metapopulation – groups of spatially separated populations connected by a gradient of occasional demographic and genetic exchange. Populations were linked by intact movement corridors, enabling seasonal migrations and dispersal events between neighboring groups. Rams would often foray and occasionally ewes moved between herds, promoting demographic and genetic diversity. When local extinctions would occur – often because of predation, environmental stress, disease, or natural stochastic events – recolonization from nearby populations was common, provisioning long-term resilience and stability at both the broad and local scales.

Modern bighorn metapopulations are heavily influenced by human-induced landscape changes and anthropogenic pressures leading to significant alterations in their natural dynamics. Urban development, highways, fences, agriculture, and resource extraction have created fragmented habitats, isolating populations and reducing or eliminating natural connective corridors. Movement between populations is now rare or even impossible in some areas, limiting natural demographic exchange and precluding genetic rescue in small, isolated populations. Disease transmission, particularly because of contact with domestic sheep and goats, has introduced pathogens that can cause large-scale die-offs and these negative effects can be intensified in small, isolated, and genetically more uniform populations. Bighorn management in a modern context now requires some degree of human-mediated translocation to simulate connectivity between populations. Captures and translocations are now a common tool in bighorn sheep management for restoring extirpated populations as well as augmenting the demographics and genetics of existing herds.

For over 80 years, NMDGF has utilized captures and translocations to restore bighorn populations. In New Mexico, this practice began in the 1940s, when a small cohort of Rocky Mountain bighorn were collected in Banff National Park, Canada and released in the northern Sandia mountains east of Albuquerque. Since 1940, 578 Rocky Mountain bighorn have been captured and translocated within New Mexico as well as transfered to Arizona, Utah, and South Dakota (Appendix A).

Restoration of New Mexico's desert bighorn sheep began in the 1970s. Very low numbers across two remnant desert bighorn populations (San Andres and Big Hatchets) caused concern for the availability of animals for translocation. In 1972, a captive breeding facility was established at the Red Rock Wildlife Area in southwestern New Mexico, in cooperation with the Bureau of Land Management (BLM). A total of 18 bighorn, 13 mixed stock from the San Andres mountains in New Mexico and five pregnant ewes imported from Sonora, Mexico, were collected and released into the high fence facility. The first translocation of desert bighorn in New Mexico occurred in 1979, when 12 sheep were released in the Big Hatchets. This captive breeding facility continues to be maintained today. The desert bighorn confined within this 1,500-acre high fence area serves as a source population to periodically augment demographics and genetics of existing free-ranging populations and to establish new herds. To prevent overcrowding and reduce pressure on forage and water resources, NMDGF aims to maintain a population of ~60-70 bighorn, with at least 20-25 adult ewes. When abundance exceeds 70 bighorn, surplus animals are removed and strategically released in free-ranging herds. Since the establishment of the Red Rock captive breeding facility, 776 desert bighorn have been captured and released within the state, with the most recent occurring in 2023 (Appendix B).

Captures and translocations continue to be a core component of New Mexico's bighorn management program. While most ancestral range is now occupied by Rocky Mountain bighorn, suitable habitat elsewhere remains under consideration for introduction efforts. Further, it has been the aim of NMDGF's desert bighorn program to restore sheep to all historical habitats that are presently unoccupied. Potential release sites continue to be considered and assessed for both subspecies by NMDGF staff. Evaluation criteria for potential release sites includes, but is not limited to, consideration of topography (more specifically, escape terrain), plant communities, forage and water availability, competition, and land use status, among others. NMDGF will continue to build upon previous assessments when selecting sites for potential establishment of new bighorn populations.

Recent debate has brought into question the validity of the Mexican desert subspecies delineation as opposed to phylogenetically grouping them with Nelson's desert sheep. Recent genetic and genomic research has confirmed that *O.c. nelsoni* and *O.c. mexicana* represent distinct ancient lineages, and it is undesirable for these two subspecies to overlap and potentially hybridize, which could lead to loss of genetic diversity and local adaptation. The Department therefore recommends managing New Mexico's desert bighorn populations as *O. c. mexicana.* This exemplifies the importance of genetic assessment coupled with capture and translocation efforts.

In fact, integrating genetic assessment with capture and translocation efforts can improve long-term demographic and genetic outcomes. Characterizing genetic metrics such as inbreeding coefficients and mean kinship allows for informed selection of source and recipient populations that will maximize the genetic benefits to a population. Genetic monitoring can also be used to assess the efficacy of translocations, beyond simple survival and dispersal success informed by GPS collar data. Lab analyses can reveal whether translocated or naturally dispersing individuals are contributing genetically to recipient populations, inform ideal cohort sizes and timing of interventions, and whether a translocation plan guided by genetic statistics may help to ensure bighorn population viability and resilience in the face of habitat fragmentation and environmental change. Disease exposure, particularly of *M. ovi.*, is a limiting factor and must also be considered when deciding if, when, and where to move bighorn. NMDGF will continue to consider and assess the utility of this integrated approach towards advancing bighorn management.

4.2 RESEARCH PERTAINING TO CAPTURES AND TRANSLOCATIONS IN NEW MEXICO

Bleich, V.C., and D.W. Lutz. 2024. Wild sheep capture and handling guidelines. Second edition. Western Association of Fish and Wildlife Agencies, Boise, Idaho, USA.

The capture of wildlife has its roots in providing nutrients for human consumption, whether through the domestication of wild animals or for more immediate use as a source of protein (Drew 2020). Over the millennia, methods of capturing wildlife have evolved in terms of their utility and efficacy. Recent history has seen massive improvements in capture and handling techniques, especially for wildlife conservation or wildlife research. Such has been the case with North American wild sheep (*Ovis canadensis, Ovis dalli*). Capture and handling of wild sheep for any purpose requires extensive planning, is labor-intensive, and extremely costly (Bleich 1990). Some wildlife agencies have developed "in house" guidelines or recommendations for the capture, handling, sampling, treatment, or translocation of wildlife in general (e.g., Jessup and Clark 1980, 1982; Jessup et al. 1986), and some agencies eventually developed guidelines for wild sheep (e.g., George et al. 2008, WGFD 2022). With minor exceptions (e.g., Wilson et al. 1975, Remington and Fuller 1989), however, few recommendations specific to the capture of North American wild sheep were available. With this realization and at the urging of wild sheep biologists from throughout North America, Foster (2005) developed and published a set of guidelines to address that shortcoming. Those recommendations have been in use for more than 20 years. The concept and initial draft of these revised guidelines were initiated in 2019 by the then current Chair of the WAFWA Wild Sheep Working Group (now the Wild Sheep Initiative), who assigned two wildlife veterinarians to create the framework and sections necessary to build on and update Foster's (2005) document.

Montoya, B. 1973. Bighorn sheep capture techniques. Desert Bighorn Council Transactions. 17:155-163.

ABSTRACT – Bighorn sheep capture techniques developed or utilized by the New Mexico Department of Game and Fish are discussed. Equipment, including drugs and drug dosages, capture guns and helicopters, is discussed in some detail. Instruction on the care and handling of capture sheep, and recommendations for bighorn capture programs also are presented.

Gilad, O., X.B. Wu, and F. Armstrong. 2013. Assessing the feasibility for reintroducing desert bighorn sheep to Guadalupe Mountains National Park: habitat, migration corridors, and challenges. Applied Geography 41: 96-104.

ABSTRACT – Desert bighorn sheep were once part of the Guadalupe Mountains ecosystem but were extirpated in the 1930s due to disease transmittance from domestic sheep and goats, habitat loss, and unregulated hunting. The Guadalupe Mountains (Texas) are now managed by the National Parks Service which wishes to restore native species to their historical range. A habitat suitability study is an important step in restoring desert bighorn sheep to the mountains since restoration efforts are labor intensive and costly. This study uses Geographic Information System (GIS) modeling to identify suitable areas within the park for bighorn sheep and evaluate possible migration corridors between the park and a nearby mountain range (Sierra Diablo) that currently supports more than 400 bighorn sheep. Landscape analysis was conducted to compare the spatial attributes of the habitat areas in the Guadalupe Mountains to those in the Sierra Diablo Mountain Range and assess habitat quality. Our results found 79.95 km^2 of suitable habitat for desert bighorn sheep in Guadalupe Mountains National Park which exceeds the established size to support a minimum viable population size of bighorn sheep (100–125 individuals). Landscape analysis indicated a larger area of optimal habitat at the park with larger mean patch size, lower edge density, and shorter mean nearest neighbor distance than in the Sierra Diablo mountain range. The Sierra Diablo was found to have a larger area of suitable habitat which may indicate that the park may be able to support a smaller population if water development mirrors that of the Sierra Diablo. Several migration corridors were identified between the park and areas with a viable population of bighorn sheep and this connectivity is important for migration and gene flow. Considerations should be given to water development, non-native, competitor species (Barbary sheep) and predators (mountain lions).

Hedrick, P.W. 2013. Conservation genetics and the persistence and translocation of small populations: bighorn sheep populations as examples. Animal Conservation 17(2): 106-114.

ABSTRACT – Understanding and evaluating the factors that influence the persistence of small populations and establishment of new populations are basic goals of conservation biology. Genetic effects due to genetic drift and inbreeding can have important impacts on the success of new populations. Many bighorn sheep populations in western North America have had low numbers and many have gone extinct. Here, the possible effects of genetic drift and inbreeding are evaluated in three populations of desert bighorn sheep initiated in the 1970s from translocations. One of these has no molecular genetic data but has substantial demographic data (Aravaipa Canyon), one has both extensive demographic data and some molecular genetic data (Red Rock), and one has limited demographic data and some molecular genetic data (Tiburon Island). Overall, either from theoretical pedigree analysis and population genetic estimates from demographic history (Aravaipa, Tiburon) or from molecular data (Red Rock, Tiburon), it appears that the levels of genetic drift and inbreeding are substantial in all of these populations. This impact was larger when higher variance in male reproductive success was assumed. In other words, it appears that genetic factors are and will be important in the establishment and persistence of these populations. These examples in long-term monitored bighorn sheep populations are relevant to many endangered species in similar situations where demographic data are available but there is little or no historical molecular genetic data.

5.1 HABITAT CONSERVATION AND ENHANCEMENT

Bighorn sheep rely on visual cues to detect predators and rapid mobility on steep terrain to escape from them. Thus, open, steep terrain is a defining component of suitable bighorn habitat. Escape terrain (slopes >60%) is particularly important for ewe-lamb groups due to the high vulnerability of lambs to predation soon after birth. Other habitat requirements of bighorn sheep include quality and abundance of forage and availability of surface water and trace minerals.

Suitable bighorn sheep habitat in New Mexico, as in most of the American west, has been reduced due to encroachment of woody vegetation primarily as a consequence of fire suppression and extensive livestock grazing. Fire suppression over the past 100+ years has allowed shrubs, pinyon pine (*Pinus* spp.), juniper (*Juniperus* spp.), and oaks (*Quercus* spp.) to encroach into open habitat.

Although fire suppression policies of land management agencies have contributed to the lack of fires, livestock grazing has also been a contributor to the absence of fire. Over-intense grazing regimes can reduce fine fuel loads so that fires cannot carry through these more open habitats, facilitating successional stage advancement. Increased woody vegetation decreases visibility within habitats and provides additional cover for predators.

Habitats that have reached advanced seral stages can therefore result in heightened levels of predation on bighorn or behavioral exclusion entirely, reducing the ability of bighorn populations to remain viable.

A key management action in New Mexico, therefore, is the reduction of woody vegetation cover, especially pinyon-juniper encroachment, in desert bighorn and low elevation Rocky Mountain bighorn ranges. Removal of woody vegetation is accomplished using hand manipulation, mechanized manipulation, and/or prescribed fire. These actions can help restore visibility, promote natural fire regimes, and provide access to critical resources. Other key threats include habitat fragmentation, water availability, and human disturbance. In some instances, removal of woody vegetation can free up excess ground water and indirectly increase water availability. Development and maintenance of water catchment units (WCUs) can also provide surface water access, benefiting a suite of species. In cases where bighorn have limited access to minerals, NMDGF staff distribute mineral blocks to ensure bighorn are able to meet sodium requirements during critical seasons. Both WCUs and periodically providing supplemental minerals may also induce more uniform space use and draw bighorn away from areas where human-bighorn conflict occurs. The latter has primarily occurred in the Pecos Wilderness Rocky Mountain bighorn population with mixed results.

Habitat conservation and restoration are foundational to the long-term success of bighorn sheep recovery in New Mexico. Effective conservation and management of bighorn sheep in New Mexico requires protection, enhancement, and restoration of critical habitat. Rocky Mountain bighorn and desert bighorn have different habitat requirements but experience similar threats to the places they inhabit. To ensure habitat integrity for bighorn in New Mexico, collaborative land management is essential. NMDGF routinely collaborates with other land management agencies including the United States Forest Service (USFS), BLM, New Mexico State Land Office (SLO), Tribal partners, private landowners, and non-governmental organizations (NGOs). Use of GPS-collar data leads to characterization of habitat use which can ultimately inform management efforts directed at priority areas.

5.2 RESEARCH PERTAINING TO HABITAT CONSERVATION AND ENHANCEMENT IN NEW MEXICO

Dunn, W.C. 1996. Evaluating bighorn habitat: a landscape approach. Technical Note 395. U.S. Bureau of Land Management Papers. 9.

ABSTRACT – This technical note describes a method that incorporates a landscape approach with the use of Geographic Information Systems (GIS) to measure habitat and impacts for Rocky Mountain and desert bighorn sheep and to rank potential transplant sites. A landscape approach, in which habitat is viewed from a large-scale perspective as an assemblage of patches, is used because: (1) bighorn habitat is naturally patchy due to the affinity of bighorn for terrain that is both open and mountainous; (2) fragmentations (i.e., increased patchiness) often is the most severe consequence of human disturbance; and (3) the proximity and distribution of neighboring bighorn ranges may be critical factors in determining genetic and demographic support for small bighorn populations. Potential suitability (the inherent capability to support bighorn sheep) and current suitability (the effect of impacts) is determined for each study area [in New Mexico]. Habitat components measured in alpine habitat include total habitat, escape terrain, and escape terrain contiguity in both summer and winter ranges. Habitat components measured in low-elevation habitat include total habitat, escape terrain, escape terrain contiguity, and water availability.

Karsch, R. C., J. W. Cain III, E. M. Rominger, and E. J. Goldstein. 2016. Desert bighorn sheep lambing habitat: parturition, nursery, and predations sites. Journal of Wildlife Management. 80: 1069-1080. https://doi.org/10.1002/jwmg.21092.

ABSTRACT – Fitness of female ungulates is determined by neonate survival and lifetime reproductive success. Therefore, adult female ungulates should adopt behaviors and habitat selection patterns that enhance survival of neonates during parturition and lactation. Parturition site location may play an important role in neonatal mortality of desert bighorn sheep (*Ovis canadensis mexicana*) when lambs are especially vulnerable to predation, but parturition sites are rarely documented for this species. Our objectives were to assess environmental characteristics at desert bighorn parturition, lamb nursery, and predation sites and to assess differences in habitat characteristics between parturition sites and nursery group sites, and predation sites and nursery group sites. We used vaginal implant transmitters (VITs) to identify parturition sites and capture neonates. We then compared elevation, slope, terrain ruggedness, and visibility at parturition, nursery, and lamb predation sites with paired random sites and compared characteristics of parturition sites and lamb predation sites to those of nursery sites. When compared to random sites, odds of a site being a parturition site were highest at intermediate slopes and decreased with increasing female visibility. Odds of a site being a predation site increased with decreasing visibility. When compared to nursery group sites, odds of a site being a parturition site had a quadratic relationship with elevation and slope, with odds being highest at intermediate elevations and intermediate slopes. When we compared predation sites to nursery sites, odds of a site being a predation were highest at low elevation areas with high visibility and high elevation areas with low visibility likely because of differences in hunting strategies of coyote (*Canis latrans*) and puma (*Puma concolor*). Parturition sites were lower in elevation and slope than nursery sites. Understanding selection of parturition sites by adult females and how habitat characteristics at these sites differ from those at predation and nursery sites can provide insight into strategies employed by female desert bighorn sheep and other species during and after parturition to promote neonate survival.

6.1 REGULATED HARVEST

Hunting provides physical, mental, spiritual, and nutritional benefits, among many others, to those who choose to participate in this outdoor activity. It is a critical component for conserving and managing wildlife populations. Regulated harvest is a cornerstone of science-based management that plays a vital role in effective wildlife management and population monitoring. Prescriptive harvests, for example male-only or age-based quotas, can influence reproductive success and overall population dynamics in a desirable direction. Hunter harvests provide the opportunity for wildlife managers to determine age-at-harvest, obtain an index of nutritional condition, and collect biological samples, such as blood for disease screening and tissue for genetic/genomic analyses. These samples contribute data towards long-term population monitoring that can influence adaptive management strategies.

New Mexico offers some of the world's premier bighorn hunting opportunities. Due to their life history traits and natural history of decline and recovery, bighorn populations are neither as widespread nor as abundant as other big game species found in New Mexico. Bighorn harvest is therefore very limited. While bighorn hunting opportunities are highly coveted throughout both New Mexico and North America, demand always exceeds supply. Because bighorn possess a slow-paced life history and often persist in small, isolated populations, great care must be taken when defining harvest goals and strategies. Bighorn hunting is a highly regulated activity in New Mexico that is authorized under the authority of the New Mexico State Game Commission (SGC) and Title 19 Chapter 31 Part 17 (19.31.17) of the New Mexico Administrative Code (NMAC).

The SGC is a seven-member citizen's body that sets the Department's overall direction and priorities. Within this framework, NMDGF is responsible for periodically reviewing hunting rules for each big game species. Species' rules are governing documents that establish hunting regulations, bag limits, weapon types, and season structure. The bighorn sheep rule opens for review on a four-year cycle, during which NMDGF proposes recommended changes, as necessary, based on the best available data, population status, hunter harvest, and management objectives. NMDGF seeks public comment and may modify recommendations based on public feedback. Recommendations are presented to the SGC who provide feedback on program directions and ultimately votes on adoption of the rule for the next four years. During this process, the SGC considers relevant data presented as well as public input brought forth during the open comment period.

NMDGF aims to provide and promote annual quality bighorn hunting opportunities at biologically sustainable levels. To this end, NMDGF primarily prescribes a conservative male-only harvest regime. The exception to this rule are ewe hunts, which are established to maintain stable populations where capture and translocation of bighorn is neither logistically nor economically feasible (i.e., designated wilderness areas), populations are at or near carrying capacity, and/or the threat of disease spread is high.

In consideration of the most recent and best available data for a given population, a suite of metrics is used to guide tag allocation for ram harvest. The metrics that guide license determination for rams are the average number across the following metrics: 2.5% of total minimum count, 2.5% of total estimate, 10% of total rams observed, 10% of total ram estimate, 25% of Class III and Class IV rams observed, and 25% of Class III and Class

IV ram estimate. The estimate terms are derived by multiplying the observed count by a correction factor that is independently determined for each population under the assumption that surveys are imperfect and individuals in a given population are inevitably missed due to a suite of factors that limit visibility. Other criteria, including age and sex ratios, are also factored in when determining annual tag quotas. Lamb to ewe ratios provide a metric of productivity within a population. A lamb:ewe ratio range between 20-40:100 is generally desirable for maintaining a stable to increasing population. Consistent lamb:ewe ratios <20:100 can result in declining population abundance over time.

A commonly prescribed male:female ratio for social ungulates is 20:100 in the presence of regulated harvest. This is considered biologically “safe”, because enough males remain on the landscape to meet breeding requirements while having no impact on population productivity. NMDGF considers a desirable ram:ewe ratio range to be between 20-40:100 as this objective retains additional rams for breeding, ensures maintenance of age structure diversity among the male segment of the population, and improves hunting and viewing opportunities. A ram ratio <20:100 may reduce harvest opportunities and can pose problems for reproductive phenology, productivity, and recruitment within a population.

Age-at-harvest is another factor that influences annual harvest allocation. Age is estimated by assessment of the horn annuli when hunters bring their ram harvest in for sealing and measurement. Bighorn rams tend to achieve maximum horn growth between age 7 and 8. An average-age-at-harvest objective above 7 years old is desirable as it is indicative of older age class rams (Class III and Class IV rams) within a given population, a feature that is of interest to many bighorn hunters. This also supports harvest of males that are likely past their peak breeding years, which results in removal of a mature competitor from the landscape, freeing up resources, and affording subordinate males breeding opportunities which may promote genetic diversity. Other aspects considered in the tag allocation process include population density/disease threats, hunter access, historical hunter success, and hunter satisfaction. Horn restrictions do not apply, and the bag limit is defined as any ram.

Presently, 10 of the 11 Rocky Mountain and 8 of the 9 desert bighorn sheep populations provide annual recreational hunting opportunities (Table 2). NMDGF delineates hunt boundaries by Game Management Units (GMUs), spatial subdivisions influenced by geographic features and road infrastructure used to manage big game species throughout New Mexico. Bighorn hunts are spatially distributed across 12 GMUs and 6 GMUs for Rocky Mountain bighorn and desert bighorn, respectively (Figure 5).

NMDGF implements a random draw system for awarding hunting tags to applicants. This contrasts with many other western state agencies that employ a preference point or modified preference point system that creates differential odds favoring applicants who have accrued preference points or purchased bonus points over time. In New Mexico, all applicants have the same odds of drawing a hunting tag for any game species regardless of how many times they may have applied in the past. However, state law requires allocation of 84% of tags to New Mexico residents, 10% to residents and non-residents applying with a New Mexico registered outfitter, and 6% to non-resident applicants sans a registered New Mexico outfitter.

Under rare circumstances bighorn populations may predominantly occur on private lands with limited public access. In these cases, NMDGF may enter into a contractual agreement with the private landowner(s) to secure public hunting opportunities. These agreements allow hunter access onto private property occupied by bighorn sheep. Specific terms of a hunt agreement may vary but often include the authorization of private tags for the landowner to use or sell at their discretion. Due to the limited tags available, the allocation of these tags typically cycles annually between the public draw and private use or sale. For example, if a population has two ram tags allocated for the license year, the hunt agreement may stipulate that one tag goes to the private landowner every other year while the other tag remains in the public draw.

Rocky Mountain and desert bighorn ram tags obtained through the draw are considered “once-in-a-lifetime” tags. Hunters are eligible to draw one of each subspecies within their lifetime. Hunters who have drawn a Rocky Mountain bighorn tag remain eligible to apply for the public draw for a desert bighorn ram or vice versa. Ewe hunts, on the other hand, are not “once-in-a-lifetime”, and individuals who have previously drawn a ram or ewe license are still eligible to apply for this hunt.

New Mexico also offers two enhancement auction tags (one Rocky Mountain, one desert) and two enhancement raffle tags (one Rocky Mountain, one desert). Auction tags are sold at auction to the highest bidder via a third-party partner; most of the proceeds from the sale of each auction tag comes back to NMDGF and is spent directly on the Bighorn Sheep Management Program. The drawing for the two raffle tags is also

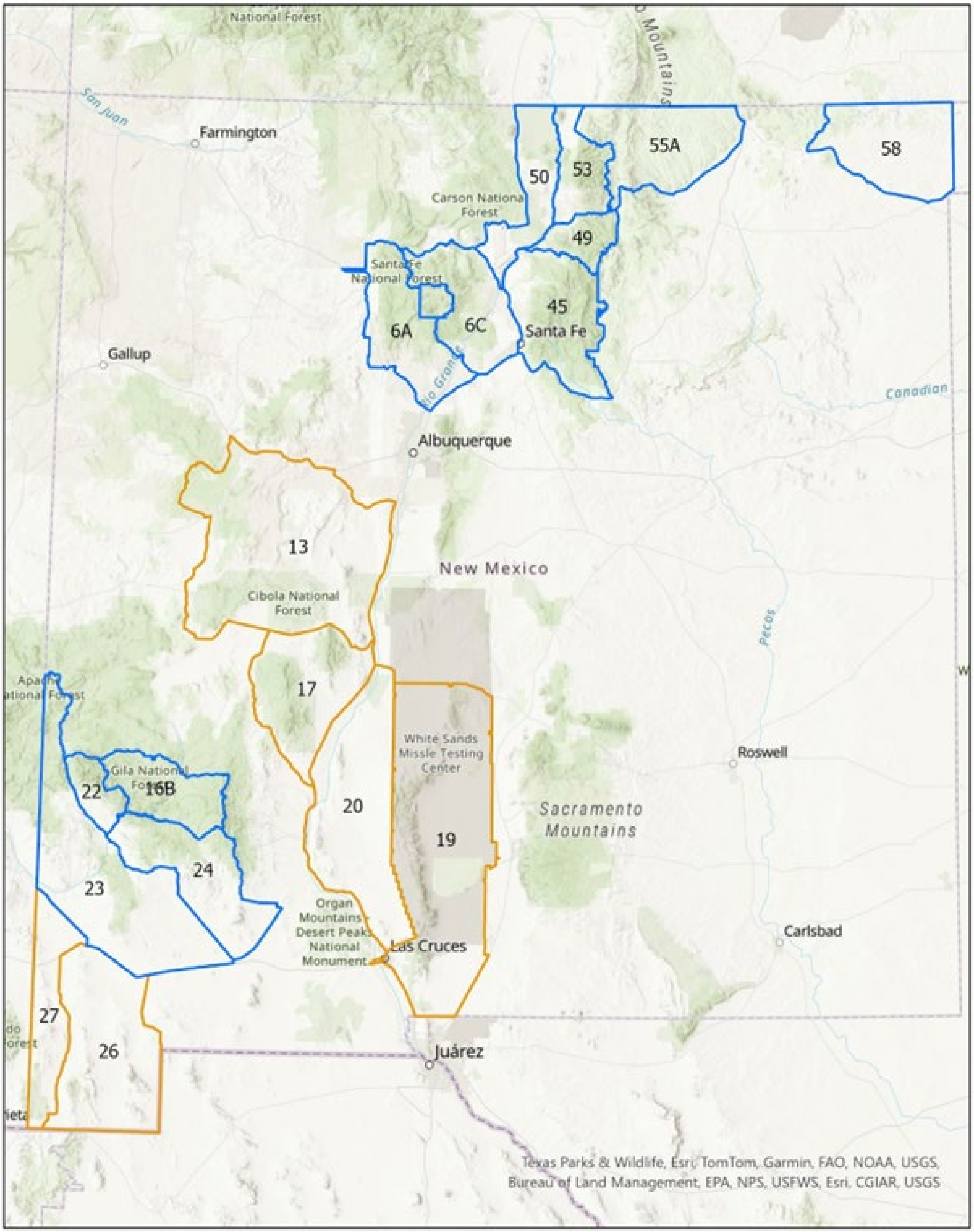


Figure 5. New Mexico Department of Game & Fish Game Management Units (GMUS) for Rocky Mountain bighorn sheep (GMUs indicated by blue boundaries), and desert bighorn sheep (GMUs indicated by the orange boundaries).

administered by a third party, where individual raffle tickets are sold, usually for $20 each. One winner is drawn for each subspecies, allowing a wide audience to purchase tickets and have the chance of winning a special hunt. Additional information on rules for this program can be found in 19.31.17 NMAC. Since the inception of the bighorn enhancement program in 2000, the Department has raised over $11.3 million. The funds generated from this program are required to be spent directly on bighorn sheep, contributing to advancing bighorn conservation and management efforts in New Mexico. Bighorn restoration and management is costly, and the enhancement program generates revenue far above what would be generated by draw license sales. The program continues to allow the Department to implement many projects that otherwise would not be possible. Many other western states offer similar opportunities and have comparable success. The Wild Sheep Foundation (WSF) produces annual fiscal reports that document funds allocated to state projects and the revenue generated from enhancement license sales as well as conservation impacts that highlight how grant-in-aid funding are directly contributing to bighorn conservation and management. Undoubtedly, these programs have led to the numeric increase of bighorn across their native range, subsequently increasing recreational opportunities to both view and hunt bighorn sheep.

Regulated harvest programs and hunting opportunities are considered a result of successful, sound conservation and management practices. Hunting bighorn in New Mexico is a rare privilege and in part a celebration of these successful conservation efforts; quantifying the size of harvested rams not only honors the individual animal itself but also supports science-based strategies aimed at sustaining healthy populations and in turn producing large, mature sheep. Specifically, horn size of harvested rams coupled with average age-at-harvest provides a feedback loop for wildlife managers to recommend biologically relevant harvest quotas. Changes in average age and horn size can signal shifts in population performance and inform of any necessary adjustments to tag recommendations.

In New Mexico, the five-year (2020-2024) average-age-at-harvest for Rocky Mountain bighorn is 9 years old, ranging from 7 (Culebras) to 10 (Latir and Jemez); the five-year average-age-at-harvest for desert bighorn is also 9 years old, ranging from 8 in three populations to 9 in five populations during the same time period (Table 2). The five-year average ram score for Rocky Mountain bighorn is 170 5/6, ranging from 163 6/8 (Culebras) to 199 (Jemez); the five-year average ram score for desert bighorn is 162 3/5, ranging between 146 3/4 (Fra Cristobals) to 169 4/8 (Ladrons). The five-year harvest success rate is 96% for Rocky Mountain rams, 99% for desert rams, 63% for Rocky Mountain ewes (any weapon), and 60% for Rocky Mountain ewes (archery only). Note that several discrete populations are spatially grouped together within the same GMU and are thus consolidated for any harvest assessment. These include the Wheeler Peak/Red River, San Francisco River/Turkey Creek, and Big Hatchet/Alamo Hueco populations. More information on harvest, including details of ram scores, can be found on the Department's harvest report webpage.

Table 2. Game Management Units (GMUs), the five-year average-age-at harvest per population (5-yr Avg. Age), the five-year average ram score per population (5-yr Avg. Score), and the weighted average of both categories across all herds for Rocky Mountain and desert bighorn sheep populations in New Mexico, 2020-2024. Italics indicate populations that are currently not open to hunting.

Population	GMU(s)	5-yr Avg. Age	5-yr Avg. Score
Rocky Mountain Populations			
Dry Cimarron	58	8	178 1/5
Culebras	50	7 [A]	163 6/8[A]
Latir	53 & 55	10	173 5/6
Wheeler Peak/Red River	53	8	167 ¼
Rio Grande Gorge	49, 50, & 53	8	173 8/9
Pecos	45	9	165 ¼
Jemez	6A & 6C	10[B]	199[B]
Manzanos	*x*	*x*	*x*
San Francisco River/Turkey Creek	16B, 22, 23, 24	9	174 ¾
Weighted Average	-	9	170 5/6
Desert Populations			
Ladrons	13 & 17	9	169 4/8
Fra Cristobals	20 North	8	146 3/4
San Andres	19	9	168
Caballos	20 South	8	160 2/9
Sacramentos	*x*	*x*	*x*
Peloncillos	27	9	166
Little Hatchets	26	9[C]	161 1/3[C]
Big Hatchets/Alamo Hueco	26	8[C]	163 4/9[C]
Weighted Average		9	162 3/5

[A] Four-year average. The one Culebras hunter did not harvest in 2024.

[B] One-year average. Inaugural hunt season was 2024.

[C] Hatchets were split in 2023. Averages are derived from combined Hatchet score averages (2020-2022) with the averages of the Little Hatchets (2023-2024) and Big Hatchets (2023-2024), respectively.

New Mexico regularly produces some of the largest Rocky Mountain and desert bighorn ram scores in North America. Over twenty 180" desert bighorn rams have been harvested in the state, well over the 165" minimum score for entry criteria set by the Boone & Crockett Club (B&C). To date, New Mexico's largest desert ram was harvested in the Ladrons in 2013, producing and official B&C score of 195 3/8" (Table 3). For Rocky Mountain bighorn, notably, in 2024, two rams exceeding 200" were harvested out of the Jemez Rocky Mountain bighorn population in its inaugural hunt season. The first ram recorded an official B&C score of 208 1/8" and the second an official B&C score of 202" (Table 3). These rams are now the first and second largest Rocky Mountain bighorn sheep ever harvested in New Mexico. The official B&C score of 208 1/8 places New Mexico's largest harvested ram in the Top 5 for Rocky Mountain bighorn (including "deadhead" pickups), and top 3 for harvested Rocky Mountain bighorn in North America.

Table 3. The top ten Rocky Mountain bighorn and desert bighorn rams harvested in New Mexico through the 2024-2025 hunt season. Each row contains the harvest year, harvest population, estimated age of the ram (determined via assessment of horn annuli), and ram score (inches). The '**' indicate the score is an official Boone & Crockett or Pope & Young score.

	Rocky Mountain Bighorn				Desert Bighorn			
Rank	**Year**	**Population**	**Age**	**Score**	**Year**	**Population**	**Age**	**Score**
1	2024	Jemez	10	208 1/8**	2013	Ladrons	13	195 3/8**
2	2024	Jemez	10.5	202**	2012	Ladrons	11	191 0/8**
3	2017	Pecos	13	197 2/8**	2006	Peloncillos	7	188 2/8**
4	2019	Wheeler Peak	10	196 4/8**	2017	Ladrons	11	188 0/8**
5	2003	Wheeler Peak	7	195 2/8**	2014	Peloncillos	12	187 3/8**
6	2002	Wheeler Peak	8	195 0/8**	2012	Big Hatchets	9	187 1/8**
7	2017	Rio Grande Gorge	7	192 7/8	2016	Ladrons	9	186 6/8**
8	2023	San Francisco River	10.5	192 3/4	2019	San Andres	11	186 6 /8
9	2017	Wheeler Peak	11	191 6/8**	2021	Ladrons	10.5	185 3/8
10	2016	Rio Grande Gorge	8	191 2/8**	2019	Ladrons	12	185 1/8

7.1 BIGHORN RESEARCH

Research is essential towards bighorn sheep conservation and management, providing data on population trends, habitat and space use, predator-prey dynamics, genetics, and disease, among other features. Information helps managers design effective strategies for actions such as captures and translocations, habitat conservation and enhancement, disease mitigation, predator management, and harvest recommendations to maintain healthy and resilient bighorn populations. Additionally, independent jurisdictions and organizations can learn more and leverage resources when they collaborate. NMDGF biologists actively participate in committees and working groups to continue to inform science-based management approaches for the benefit of bighorn sheep in the state. By grounding decisions in science, research ensures that conservation efforts are adaptive, targeted, and sustainable. Decades of selected research associated with New Mexico bighorn can be found in Appendix C.

8.1 HERD STATUS AND HUNT FORECAST

ROCKY MOUNTAIN BIGHORN

Pecos – GMU 45

BIOLOGY – *Population estimate: 350-400*
The Pecos herd is the largest of the Rocky Mountain bighorn herds and inhabits alpine terrain in the rugged Sangre de Cristo mountain range, an area that boasts one of the highest concentrations of peaks exceeding 12,000 feet in elevation in New Mexico. Initial restoration efforts began with a translocation effort from Canada in 1932, but no bighorn sheep survived past the mid-1930s. Pecos was effectively reestablished in 1965-1966 with bighorn sheep from Banff National Park, Alberta, Canada, and the now defunct Sandia population. The population is considered stable at 350-400 individuals and is likely limited by winter range as sheep are restricted to small wind-blown terrain when winter snow accumulates. Bighorn regularly encounter outdoor recreationalists and are often not wary of humans, though this shifts during the hunting season. The Pecos population had been the primary source herd for Rocky Mountain bighorn restoration efforts in New Mexico. A consistent biennial removal of nearly a quarter of the ewe population was recommended to maintain a productive population below carrying capacity. Prescriptive annual ewe harvests, as conducted in several other western states and provinces, have been used in recent years to achieve this objective.

HUNTING – *Type: Alpine (>12,000 ft), Difficulty: High, Trophy Potential: High*
The Pecos herd consistently boasts plentiful, quality bighorn hunting opportunities. Sheep reside primarily on Forest Service lands, but access is difficult as the trails commonly used to travel into their habitat average 5-10 miles in high elevations. Both ram and ewe licenses are available for the Pecos herd at the time of writing.

Wheeler – GMU 53

BIOLOGY – *Population estimate: 175-225*
The Wheeler bighorn population is one of the most iconic in New Mexico and well-known across the west. It occupies the region surrounding Wheeler Peak, the highest natural point in New Mexico at 13,167 feet. The herd is co-managed with Taos Pueblo as some bighorn habitat is on Taos tribal lands and sheep move between the two jurisdictions. Bighorn are also found near Red River and Questa Mine and are considered distinct subpopulations within the greater Wheeler population. The population has declined slightly since 2022 because of respiratory disease exposure in the primary Wheeler Peak range. The effects of disease continue to be monitored.

HUNTING – *Type: Alpine (>12,000 ft), Difficulty: High, Trophy Potential: High*
This herd inhabits rough high-elevation alpine terrain and hunters should be prepared to hike extensively during their hunt. Bighorn also occur in and may quickly transition onto Taos Pueblo where there is no public hunting access. Hunters may observe bighorn coughing or displaying other respiratory symptoms as the herd continues to recover from disease exposure, however this respiratory disease is not transferable to humans.

Jemez – GMUs 6A & 6C

BIOLOGY – *Population estimate: 225-300*

This population was reestablished in 2014 when Rocky Mountain bighorn from Wheeler Peak were captured and released in Cochiti Canyon following the Las Conchas fire. Since its reintroduction, this population has increased in abundance and expanded its range. Bighorn primarily occupy USFS and BLM land, but can be found throughout the Dome Wilderness, Bandelier National Monument, Pueblo de Cochiti, and have recently been observed as far east as White Rock, NM. The herd is currently doing very well with an estimated 225-300 bighorn and the population continues to increase.

HUNTING – *Type: Low elevation/canyon, Difficulty: Medium, Trophy Potential: High*

The 2024-2025 season was the inaugural hunt for the Jemez bighorn population and produced the two largest bighorn rams to ever be harvested in New Mexico. The first ram recorded an official B&C score of 208 1/8" and the second an official B&C score of 202". While public access is good, care should be taken to become familiar with land boundaries, as bighorn may move onto property that cannot be hunted (Bandelier National Monument or Pueblo de Cochiti). There is some uncertainty on the level of difficulty hunters should expect which could range from easy to difficult, however trophy potential is high, and considered the best potential in New Mexico as well as across western North America.

Rio Grande Gorge – GMUs 49, 50, & 53

BIOLOGY – *Population estimate: 225-275*

The Rio Grande Gorge bighorn sheep population, near Taos, NM, is another iconic herd in New Mexico due to its proximity to human activity and the excellent wildlife viewing opportunities it offers. It was reestablished in 2007 with bighorn relocated from the Pecos Wilderness. This population occupies an eroded chasm along the Rio Grande, and bighorn consistently move between the upper canyon rim and the lower river corridor. Population abundance has declined slightly since 2020 because of respiratory disease, but the population is currently considered stable. The effects of disease continue to be monitored. This herd is co-managed with Taos Pueblo as some bighorn habitat is on Taos tribal lands and sheep move between the two jurisdictions.

HUNTING – *Type: Low elevation/canyon, Difficulty: Medium, Trophy Potential: High*

Public land (BLM and Forest Service) along the rim of the Rio Grande Gorge is accessible. Bighorn also occur in and may quickly transition to the less accessible habitat within the gorge corridor or onto property that cannot be hunted (Taos Pueblo, Orilla Verde, Wild River, or private lands). This herd has significant spatial overlap with human activity, and as a result these bighorn are sometimes less wary of people. Hunters may observe bighorn coughing or displaying other respiratory symptoms as the herd continues to recover from disease exposure, however this respiratory disease is not transferable to humans.

Culebras – GMU 55

BIOLOGY – *Population estimate: 55-75*

The Culebra bighorn sheep population resides in a small section of alpine stretching from Big Costilla Peak north to State Line Peak on the New Mexico-Colorado border. This population most likely resulted from Colorado bighorn naturally moving into and repopulating this area. Due to the small size of the range, the population is small, but stable. The alpine portion of this range is 100% privately owned by Turner Enterprises operated by the Vermejo Ranch and the Rio Costilla Cooperative Livestock Association (RCCLA).

HUNTING – *Type: Alpine (>12,000 ft), Difficulty: High, Trophy Potential: High*

Due to its smaller population size the Culebras sometimes gets overlooked by applicants. The smaller population corresponds with the small range size compared to other alpine herds which serves to concentrate hunting efforts. This hunt takes place entirely on private land and land managers coordinate directly with hunters to minimize conflict.

Latir – GMUs 53 & 55

BIOLOGY – *Population estimate: 65-80*

The Latir population was briefly reestablished in 1978 with stock translocated from the Pecos Wilderness. The population crashed after exposure to 115 domestic sheep authorized under a USFS grazing allotment. The die-off was caused by pneumonia attributed to contact with domestic sheep. The USFS converted the domestic sheep grazing allotment to cattle in 2000. In 2001, 56 bighorn sheep were translocated to the Latir Wilderness, and the population has remained stable to increasing since. This population is found within the alpine of Latir Peak Wilderness with the ridgeline connecting Virsylvia Peak, Venado Peak and Latir Mesa comprising the core bighorn range. The RCCLA also manages a small portion of the Latir habitat.

HUNTING – *Type: Alpine (>12,000 ft), Difficulty: High, Trophy Potential: High*

Due to its smaller population size, Latir sometimes gets overlooked by applicants. The smaller population corresponds with the small range size compared to other alpine herds which serves to concentrate both bighorn abundance and hunting efforts. Fewer hunters on the landscape minimizes the potential for hunter overlap.

Dry Cimarron – GMU 58

BIOLOGY – *Population estimate: 155-175*

Pictographs and petroglyphs found in southeastern Colorado suggest that bighorn may have been present historically in extreme northeastern New Mexico. In 1980, Colorado Division of Wildlife (today Colorado Parks and Wildlife) translocated 20 Rocky Mountain bighorn sheep to the Carrizo Sheep Unit, just north of Dry Cimarron. Bighorn rams were occasionally sighted in the Dry Cimarron area following this release. While transient sheep were occasionally observed, the Dry Cimarron was never naturally reestablished by these bighorn. It did become successfully reestablished by NMDGF in 2007-2008 with bighorn translocated from both Pecos Wilderness and Wheeler Peak. Today, bighorn are known to move between New Mexico, Colorado, and Oklahoma. Bighorn here are commonly found grazing irrigated meadows on private parcels.

HUNTING – *Type: Low elevation, Difficulty: Low, Trophy Potential: Medium/High*

Bighorn occur primarily on private land in this unit. Three ranches collectively provide the core habitat for this population and grant access to any public hunters that draw these tags. The longer hunt period provides flexibility for all parties to coordinate access.

San Francisco River/Turkey Creek – GMUs 16B, 22, 23, & 24

BIOLOGY – *Population estimate: 80-120*

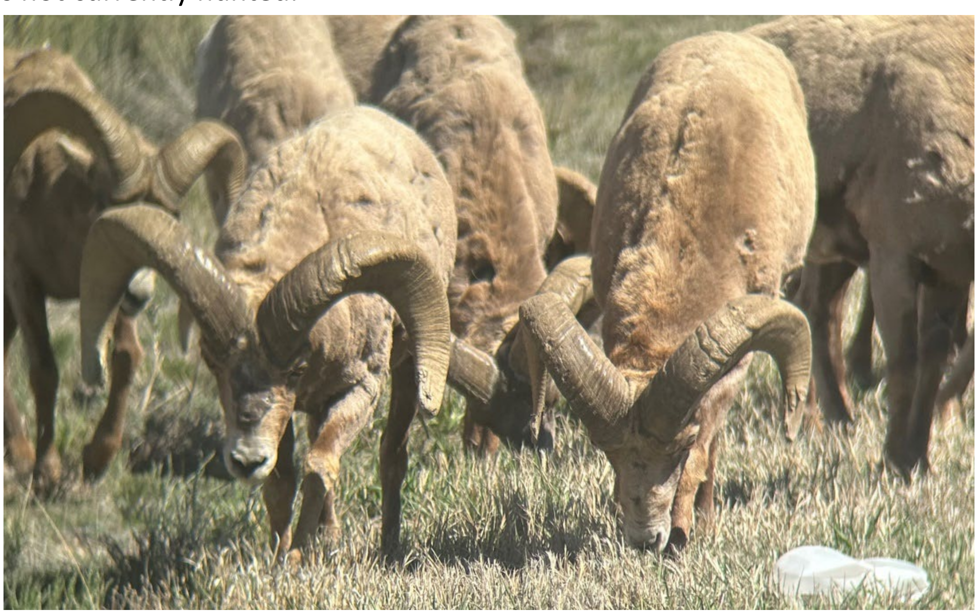
Although no specimens exist from the historical population, desert bighorn sheep are assumed to be the subspecies historically present until the mid-1800s. However, in 1964-1965 Rocky Mountain bighorn were sourced from Banff National Park, Alberta, Canada and the now defunct Sandia population and released in this area. The population grew to an estimated 140-170 but suffered a die-off in the early 1990s, likely caused by disease. The population has gradually increased since then and remains relatively smaller but stable today. Bighorn occur sporadically across the San Francisco River/Turkey Creek ranges. Core use areas include Sundial Mountain, the San Francisco River corridor, Watson Mountain along the Gila River, and Hells Half Acre. NMDGF regularly works with the Arizona Game and Fish Department (AZGFD) to monitor this interstate population as bighorn can easily move between jurisdictions.

HUNTING – *Type: Low elevation/canyon, Difficulty: High, Trophy Potential: High*
Bighorn are found in pockets throughout this range and do not tend to be found in the same places throughout the year. Hunters should prepare to be mobile and look for bighorn in rough terrain throughout this range. A recent ram harvested in this herd was very large and had gone undetected for years. In addition to bighorn counted in New Mexico during helicopter surveys, rams from neighboring Arizona have been known to venture into these units and may be present at any time.

Manzanos – GMU 14*

BIOLOGY – *Population estimate: 50-70*
The Manzano population was established in 1977-1978 with Rocky Mountain bighorn collected from the Pecos Wilderness. Abundance has fluctuated over time but the population has remained relatively small. Train strikes have been a primary cause of bighorn sheep mortality in the Manzano population, possibly limiting abundance and distribution. NMDGF continues to work with railway managers to reduce this threat. Bighorn primarily reside on private property in the Sand Canyon and Abo Canyon drainages in the southern portion of the Manzano mountains. Bighorn are also drawn to nearby mining activity to access trace minerals. The population is considered stable between 50-70 sheep.

HUNTING – *Type: Low elevation/canyon, Difficulty: Medium/High, Trophy Potential: Medium/High*
*This population is not currently hunted.



DESERT BIGHORN

Red Rock Wildlife Area

BIOLOGY – *Population estimate: 102*

Since 1972, NMDGF has maintained a confined desert bighorn population to propagate for subsequent releases into the wild. Red Rock resembles free-ranging desert conditions, with canyons, springs, and steep slopes contained within five pastures totaling ~1,500 acres north of Lordsburg, NM. Confinement increases vulnerability to predation, disease, inbreeding, and harassment of ewes by rams. To offset these risks, the property is regularly monitored by an independent contractor who maintains fences, floodgates, and WCUs and checks for predator sign within and immediately surrounding the pastures. This contractor is approved to trap and remove predators as needed. Despite population growth, the Red Rock population has less genetic diversity than most wild bighorn populations. When surplus animals (>70) exist, the Department captures and relocates bighorn from the enclosure to not only benefit free-ranging populations, but also to relax pressure on resources within the high fence area. The 2025 census resulted in a count of 102 bighorn, thus, a capture and relocation project is warranted.

Ladrons – GMUs 13 & 17

BIOLOGY – *Population estimate: 125-175*

The Ladron population was established in 1992 with bighorn sourced from Red Rock Wildlife Area. Ladron bighorn utilized the areas extending from Mesa Lucero to Yellow Mountain and the Rio Salado drainage between Riley, NM and the Silver Creek Area on the Sevilleta National Wildlife Refuge with primary use occurring on most lower-elevation habitat in the Ladron Mountains. Bighorn still occupy these areas, however the current core range extends from Ladron Peak south to “M” Mountain. Recent expansion has occurred south of State Highway 60 into the Chupadera mountains, corresponding to increases in WCU establishment by the BLM.

HUNTING – *Type: Desert mountain, Difficulty: Medium/High, Trophy Potential: High*

The Ladrons herd has produced some of the largest desert bighorn rams ever harvested in both New Mexico and the world. Bighorn are found in several pockets of habitat throughout this range: Polvadera Mountains, Chupadera Mountains, Riley Springs, and “M” Mountain. Hunters can access most of these areas easily but should be aware that hunting is not allowed on Sevilleta National Wildlife Refuge. Hunters who are picky should scout all of these habitats , as large rams or small bands of sheep can easily be missed in this expansive landscape.

Fra Cristobal – GMU 20 North

BIOLOGY – *Population estimate: 130-180*

The Fra Cristobal population was established in 1995 on the Armendaris Ranch. This population is managed in cooperation with Turner Enterprises Inc. The population has fluctuated over time and has slightly declined in recent years, likely as a result of multiple contributing factors. There is likely some exchange between the San Andres, Caballos, and Fra Cristobal bighorn populations. Horn size of harvested rams in this herd is generally smaller than other desert herds across the state. NMDGF and Turner Enterprises continue to partner to improve population performance of this herd.

HUNTING – *Type: Desert mountain, Difficulty: Medium, Trophy Potential: Low/Medium*
This hunt occurs in cooperation with the Armendaris Ranch under a hunt agreement, therefore access is coordinated with ranch staff. Land access for tagholders is good and hunt competition is low. Rams harvested here tend to have smaller horn size. Road access around the mountain is better than most desert bighorn ranges.

Caballos – GMU 20 South
BIOLOGY – *Population estimate: 210-240*
The Caballos population, near Elephant Butte, NM, was reestablished in 2009 with bighorn translocated from the Red Rock Wildlife Area. Bighorn primarily occupy BLM land on this 32 mile north-south mountain range. The mountains are unusual and unique in New Mexico due to the variety and scope of their exposed rocks. No perennial streams flow through this range, although the Rio Grande is close to the north, west, and south margins. Since the initial release, this population has increased and now rivals the San Andres population in abundance levels.

HUNTING – *Type: Desert mountain, Difficulty: Medium/High, Trophy Potential: Medium/High*
The number of mature (Class III and Class IV) rams has been observed to be increasing in recent years. Hunters have had success finding bighorn from Red House Mountain to Palomas Gap and the rugged intervening hill country between these two areas. Hunters should be prepared to look for sheep throughout a large landscape and relocate to where sheep are found.

San Andres – GMU 19
BIOLOGY – *Population estimate: 180-220*
The San Andres is one of two remnant desert bighorn populations that survived western expansion. As the largest and most contiguous desert bighorn range in New Mexico, the San Andres mountains are considered critical to desert bighorn recovery and conservation. The range extends 75 miles north to south, but only 12 miles wide at its greatest width. Gypsum deposits windswept and washed from these mountains are the main source of the dunes in White Sands National Park (WSNP). This population has a long history of cyclic increases and decreases. It was afforded protection in 1941 with the establishment of the San Andres National Wildlife Refuge (SANWR), increased to approximately 140 bighorn, but declined to around 70 by 1955 due to drought conditions and reduced forage by cattle and mule deer. It stabilized around 200 bighorn in the mid-1970s but rapidly declined due to psoroptic scabies; by 1979 only an estimated 75 bighorn remained. Disease, drought conditions, and mountain lion predation continued to plague this population for the next two decades. With only a single remaining ewe by 1997, this population nearly became extinct. Between 1999 and 2005, 5 translocation events occurred. The population is now considered scabies-free and, since 2010, abundance has been considered stable to increasing. This population is managed in cooperation with the SANWR, the White Sands Missile Range (WSMR), WSNP, and the BLM.

HUNTING – *Type: Desert mountain, Difficulty: High, Trophy Potential: Medium/High*
Because San Andres bighorn reside primarily within WSMR, hunts are administered in collaboration with the military. The San Andres mountain range is extensive and highly complex, but hunters typically receive some guidance from WSMR personnel or NMDGF escorts. The trophy outlook is typically high, but this can be impacted by ram distribution and accessibility. Hunters should be aware that, while parts of the range appear accessible, hunters must be off range each night because WSMR is an active military training facility. This results in some locations being logistically inaccessible and can limit hunt areas.

Sacramentos – GMU 34*
BIOLOGY – *Population estimate: 40-45*
The Sacramentos population occurs near Alamogordo, NM. Since its reintroduction in 2018, this population has remained relatively stagnant, slightly fluctuating over time but numbering no greater than 45 bighorn. Bighorn primarily occupy USFS managed land, and occasionally BLM and U.S. Army property. They tend to remain on the western edge of the Sacramento mountains, which forms a series of dramatic escarpments leading up to a high ridge made up almost entirely of limestone. Aoudad also occupy this range and, because of their similarity in appearance, bighorn ewes and some yearling rams have been illegally harvested by aoudad hunters. To combat this, the WSF and the local New Mexico chapter introduced the BE SURE educational campaign in 2024. This effort provides guidance on field identification of the two species and has

included posting signs around the access points to the Sacramento Mountain range directing aoudad hunters to be aware and know the difference between aoudad and bighorn. For more information on the BE SURE campaign, visit https://www.wildsheepfoundation.org/field-identification-desert-bighorn-aoudad.

HUNTING – *Type: Desert mountain, Difficulty: Medium/High, Trophy Potential: Medium*
*This population is not currently hunted.

Little Hatchets – GMU 26 (west of NM 81)
BIOLOGY – *Population estimate: 90-110*
The Little Hatchets population is the north segment of the greater remnant Big Hatchet population. The Little Hatchets range trends north and south between Hachita Valley to the east and Playas Valley to the west. It has historically maintained a lower abundance compared to the Big Hatchets but has begun to slightly increase in recent years. Inter-mountain movement between the Little Hatchets and Big Hatchets can occur, functioning as a metapopulation. Recent increase in ram abundance is attributed to movement of males from the Big Hatchets north into the Little Hatchets.

HUNTING – *Type: Desert mountain, Difficulty: Low/Medium, Trophy Potential: Medium/High*
The Little Hatchets may be the most accessible desert bighorn range but still provides a true mountain hunt. Hunters should be sure to focus scouting efforts throughout the extent of this range. In previous years, hunters who drew GMU 26 tended to prefer to hunt the Little Hatchets, and harvest was spatially disproportionate. The 2023-2027 Bighorn Rule established the Little Hatchets as a distinct hunt (GMU west of NM 81) for the first time. This change was made to better manage the sheep populations through regulated harvest and to provide an improved hunting experience by distributing hunters more evenly across the landscape. Bighorn can primarily be found on BLM land in the Little Hatchets.

Big Hatchets/Alamo Huecos – GMU 26 (east of NM 81)
BIOLOGY – *Population estimate: 125-195*
The second of two remnant populations, surviving bighorn occupied the Dog Mountains south of the Alamo Huecos in the late 1800s into the early 1900s near the United States-Mexico international border. Today, this herd occurs in two distinct subgroups in the Big Hatchet and Alamo Huecos mountains. The Big Hatchets are one of the most visually stunning desert ranges in New Mexico. This range is a visually complex fault block composed of limestone, shale, and sandstone running 18 miles long in a northwest by southeast fashion, and only about 8 miles at its greatest width. The Alamo Huecos, a 15 mile long range, received bighorn in 1986 but the population was considered extirpated by 2003. Bighorn were again released in the Alamo Huecos in 2021 and 2023 and abundance is increasing. Collar data has revealed contemporary movement unidirectionally from the Alamo Huecos to the Big Hatchets. Transient bighorn, presumably from the Big Hatchets, were observed during the time the Alamo Huecos population was considered defunct, indicating movement from the Big Hatchets to the Alamo Huecos is not unprecedented. Demographic exchange between these two subgroups should help bolster the population over time.

HUNTING – *Type: Desert mountain, Difficulty: High, Trophy Potential: Medium/High*

This area is very remote and vast, and the hunt is difficult. The incredible habitat allows rams to slip by hunters undetected each year, so trophy potential is high. In previous years, hunters who drew GMU 26 tended to prefer to hunt the Little Hatchets, and harvest was spatially disproportionate. The 2023-2027 Bighorn Rule established the Big Hatchets as a distinct hunt (GMU east of NM 81) for the first time. This change was made to better manage the sheep populations through regulated harvest and to provide an improved hunting experience by distributing hunters more evenly across the landscape. Bighorn can primarily be found on BLM land in the Big Hatchets and primarily on private property and some BLM land in the Alamo Huecos. There is no paved road access or developed recreation sites.

Peloncillos – GMU 27

BIOLOGY – *Population estimate: 40-60*

The Peloncillos population was established in 1981 with bighorn originating from Red Rock Wildlife Area and the Kofa National Wildlife Refuge/Plomosa Mountains in Arizona. At one time, it was one of the largest desert herds in New Mexico. It has fluctuated greatly over time and has declined more rapidly in recent years. The exact mechanism influencing this decline is not well understood, but it is hypothesized that degraded habitat and elevated predation levels are the primary factors contributing to this decline.

HUNTING – *Type: Desert mountain, Difficulty: Medium/High, Trophy Potential: Low/Medium*

The topography is somewhat diverse, with some very steep areas neighbored by rolling hills. Located south and west of Lordsburg, this bighorn habitat is bisected by several highways and I-10. Some movement of sheep between AZ and NM makes this a unique desert herd that may experience fluctuations. This herd appears to have declined from a few years ago. NMDGF deployed additional radio collars in this herd in autumn 2023 to enhance monitoring of this population. Mature rams are present, but that trophy potential is not as high as in recent years.

APPENDIX A. Capture and translocation history of Rocky Mountain bighorn sheep in New Mexico conducted by NMDGF, 1940-2017. This table displays the capture/release year, source population, release population, and the total number of bighorn captured and released.

Year	Source Population	Release Population	Total Bighorn
1940	Banff NP, Canada	Sandias	3
1941	Banff NP, Canada	Sandias	3
1942	Banff NP, Canada	Sandias	3
1964	Sandias	San Francisco River, Gila NF	16
1964	Banff NP, Canada	Turkey Creek, Gila, NF	10
1965	Sandias	San Francisco River, Gila NF	2
1965	Banff NP, Canada	Pecos Wilderness	15
1966	Sandias	Pecos Wilderness	9
1968	Banff NP, Canada	Wheeler Peak	10
1970	Dubois, WY	Sandias	1
1970	Dubois, WY	Wheeler Peak	19
1977	Pecos Wilderness	Manzanos	16
1978	Pecos Wilderness	Cimarron Canyon	5
1978	Waterton Lakes, Canada	Ft. Wingate	7
1978	Pecos Wilderness	Latir Wilderness	20
1978	Pecos Wilderness	Manzanos	16
1993	Pecos Wilderness	Wheeler Peak	33
1998	Pecos Wilderness	San Francisco River, Gila NF	4
1998	Pecos Wilderness	Manzanos	23
1998	Pecos Wilderness	Turkey Creek, Gila NF	5
1999	Cimarron Canyon	Manzanos	1
2001	Pecos Wilderness	Latir Wilderness	56
2003	Pecos Wilderness	Arizona	11
2003	Wheeler Peak	Arizona	16
2004	Pecos Wilderness	San Francisco River, Gila NF	14
2004	Wheeler Peak	South Dakota	30
2005	Latir Wilderness	Turkey Creek, Gila NF	5
2005	Pecos Wilderness	Arizona	29
2006	Wheeler Peak	Turkey Creek, Gila NF	25
2007	Pecos Wilderness	Dry Cimarron	34
2007	Pecos Wilderness	Rio Grande Gorge	25
2008	Wheeler Peak	Dry Cimarron	27
2008	Wheeler Peak	Turkey Creek, Gila NF	8
2009	Turkey Creek	Manzanos	1
2012	Wheeler Peak	Manzanos	31
2014	Wheeler Peak	Jemez	45
2016	Red River	Jemez	3
2017	Red River	Jemez	33

APPENDIX B. Capture and translocation history of desert bighorn sheep in New Mexico conducted by NMDGF, 1979-2023. This table displays the capture/release year, source population, release population, and the total number of bighorn captured and released.

Year	Source Population	Release Population	Total Bighorn
1979	Red Rock	Big Hatchets	12
1981	Red Rock	Peloncillos	10
1981	Kofa, AZ	Peloncillos	10
1981	Red Rock	Peloncillos	2
1982	Kofa, AZ	Peloncillos	4
1982	Kofa, AZ	Peloncillos	10
1982	Red Rock	Big Hatchets	18
1986	Red Rock	Alamo Huecos	21
1991	Red Rock	Peloncillos	6
1992	Red Rock	Sierra Ladron	23
1993	Red Rock	Sierra Ladron	8
1993	Red Rock	Peloncillos	11
1995	Red Rock	Fra Cristobals	37
1997	Red Rock	Peloncillos	24
1997	Red Rock	Big Hatchets	6
1997	Red Rock	Fra Cristobals	7
1997	Red Rock	Sierra Ladron	8
1999	Red Rock	Little Hatchets	3
1999	Red Rock	Alamo Huecos	3
1999	Red Rock	Peloncillos	12
1999	Red Rock	Sierra Ladron	3
1999	Red Rock	San Andres	6
2001	Red Rock	San Andres	5
2002	Red Rock	San Andres	31
2002	Kofa, AZ	San Andres	20
2003	Red Rock	Peloncillos	33
2005	Red Rock	Little Hatchet	28
2005	Kofa, AZ	San Andres	30
2006	Red Rock	Big Hatchets	36
2009	Red Rock	Caballos	18
2009	Red Rock	Ladrons	5
2009	Red Rock	Peloncillos	5
2011	Mexico	Red Rock	10
2011	Red Rock/Fra Cristobals	Peloncillos	26
2011	Red Rock/Fra Cristobals	Big Hatchets	15
2012	Red Rock	Ladrons	6
2014	Fra Cristobals	Big Hatchets	40
2014	Red Rock	Big Hatchets	26
2016	Red Rock	Peloncillos	11

2017	Fra Cristobals	Ladrons	22
2018	Red Rock	Peloncillos	33
2018	San Andres	Sacramentos	34
2020	Caballos	Sacramentos	24
2021	Red Rock	Alamo Huecos	46
2023	Red Rock	Alamo Huecos	28

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BIGHORN SHEEP MANAGEMENT

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