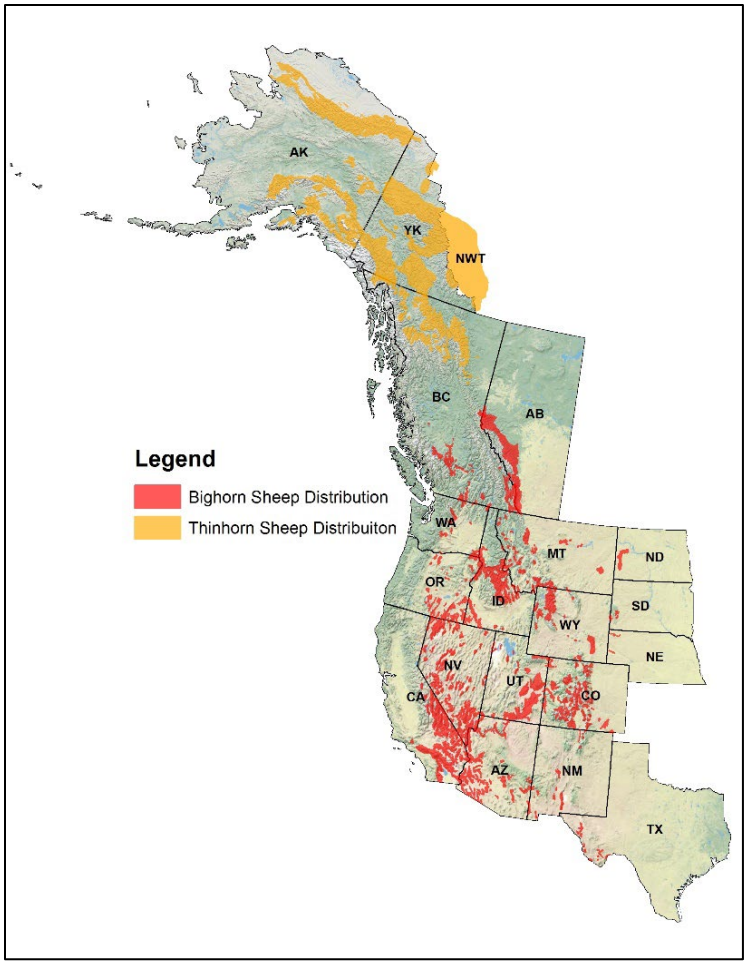
2023 RANGE-WIDE STATUS OF BIGHORN AND THINHORN SHEEP IN NORTH AMERICA

Wild Sheep Initiative. Western Association of Fish and Wildlife Agencies (ver. 06282023)

Abstract: The purpose of this document is to provide a general overview of the current bighorn and thinhorn sheep population status and general abundance trends throughout their range in North America. The information reported is the harvest and population estimates after the 2022 hunting season. The Wild Sheep Initiative (WSI) consists of representatives from 20 state, territorial, and provincial agencies that comprise the Western Association of Fish and Wildlife Agencies (WAFWA).

The WSI's mission is to provide a collaborative approach to finding solutions to improve wild sheep conservation and management. The general population status and trajectory of wild sheep populations is commonly requested by stakeholders including agency leadership, NGOs, hunters, and the public at large. To provide a quick snapshot of the status of these species, the WSI assembled this information by having each agency representative provide the current population status, and harvest information (Tables 1 – 3) and disease status/management for their respective jurisdiction. All states and provinces use very different methods to survey and estimate population size and harvest. Some have more rigorous processes than others, based on available resources and management needs within their jurisdictions. Wild sheep populations are below agency goals in most jurisdictions, due to a variety of factors of which disease, primarily pneumonia, harsh winter conditions, and climate are perhaps the most important. Wildlife managers, veterinarians, and researchers have been tirelessly seeking solutions to population decline with some success.



Wild Sheep Initiative

WAFWA
Western Association of Fish & Wildlife Agencies

Bighorn sheep (Rocky Mountain and California BHS – Table 1 and Desert BHS – Table 2) populations are generally stable with a recent downward trend across most jurisdictions (Figure 1), however, British Columbia is reporting significant declines in California BHS populations through the past 5 years.

Thinhorn sheep population status data is incomplete. In Alaska managers estimate that Dall's sheep have been stable with a recent dramatic, sharp decline due to extraordinary harsh winter conditions. In British Columbia, Dall's sheep have been stable, but estimates were increased in 2019 as a result of new genetic information that expanded the range of that subspecies to include areas previously identified as Stone's sheep (Table 3, Figure 2). Stone's sheep estimates from British Columbia show a similar trend over the past 23 years with a modest decline in 2020 (Table 3, Figure 2).

Table 1. Range-wide estimates of 2022 bighorn sheep (Rocky Mountain and California BHS combined) population size, number of hunting licenses issued, and number of rams and ewes harvested. ***Click on a state/province/territory name to go directly to that jurisdiction.***

	Estimated Population	Ram Licenses	Ram Harvest	Ewe Licenses	Ewe Harvest
Alberta	6,000	2,420[1]	n/a	n/a	n/a
Arizona	1,300	20	18	n/a	n/a
British Columbia[2]	4,250	179	n/a	7	n/a
California	n/a	n/a	n/a	n/a	n/a
Colorado	7,485	253	175	91	n/a
Idaho	3,140	94	71	0	n/a
Montana	4,748	111[3]	115[4]	87	n/a
Nebraska	278	2	2	0	0
Nevada	2,100	58	50	0	0
New Mexico	1,710	30	27	58	22
North Dakota	467	5	5	0	n/a
Oregon	5,500	79[5]	71	22	8
South Dakota	390	11	11	0	0
Utah	1,447	65	64	5	4
Washington	n/a	n/a	n/a	n/a	n/a
Wyoming	6,390	187	150	20	11

[1]*Alberta – Ram licenses includes licenses allocated to outfitters, and general and special (limited entry hunt) licenses sold to Alberta residents.*

[2]*British Columbia – data listed under licenses includes only the numbers of available draws/permits issued in Limited Entry Hunt Zones*

[3]*Limited entry hunt units only*

[4]*Montana – includes limited and unlimited hunting district ram harvest*

[5]*Includes controlled hunts, 1 auction tag, and 1 raffle tag.*

n/a – not available

Table 2. Range-wide estimation of 2022 Desert bighorn sheep population size, licenses issued, and rams harvested provided by member agencies of WAFWA. Click on a state/province/territory name to go directly to that jurisdiction.

	Estimated Population	Ram Licenses	Ram Harvest	Ewe Licenses	Ewe Harvest
Arizona	5,600	120	117	n/a	n/a
California	5,000	30	n/a	n/a	n/a
Colorado	500	15	14	0	0
Nevada	8,200	294[1]	231	90	41
New Mexico	1,148	28	28	0	0
Texas	785	10	n/a	0	0
Utah	3,009	80	75	0	0

[1] Total ram tags including management ram hunt for one-horn ram

n/a – not available

Table 3. Range-wide estimation of 2022 Thinhorn sheep (Dall's sheep and Stone's sheep) population size, licenses issued, and rams harvested provided by member agencies of WAFWA. Click on a state/province/territory name to go directly to that jurisdiction.

	Estimated Population	Ram Licenses	Ram Harvest	Ewe Licenses	Ewe Harvest
Dall's sheep					
Alaska	Decline	4,147	424	0	0
British Columbia[1]	700	46	n/a	0	0
NW Territories	n/a	n/a	n/a	n/a	n/a
Yukon	22,500	n/a	n/a	n/a	n/a
Stone's sheep			n/a		
British Columbia	12,300	112	n/a	0	0
Yukon	100	n/a	n/a	n/a	n/a

[1]*British Columbia – data listed under licenses includes only the numbers of available draws/permits issued in Limited Entry Hunt Zones*

n/a – not available

Figure 1. Bighorn sheep population trend throughout North America, 2000 – 2022.

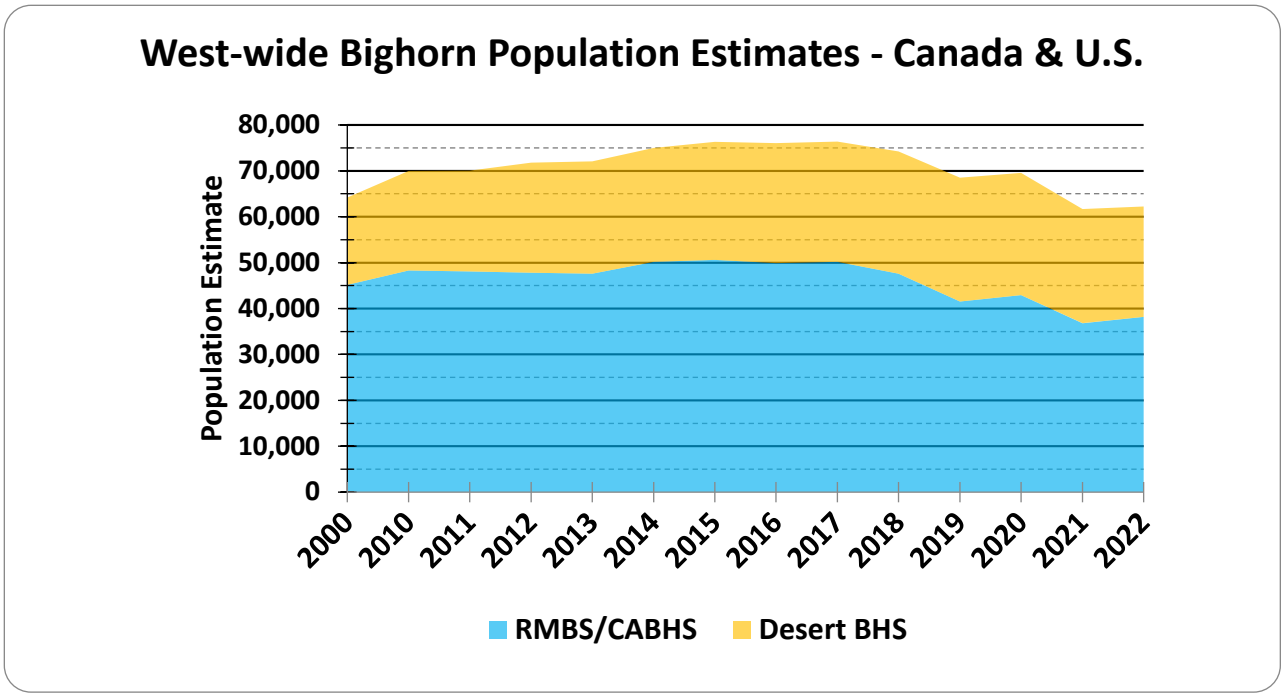
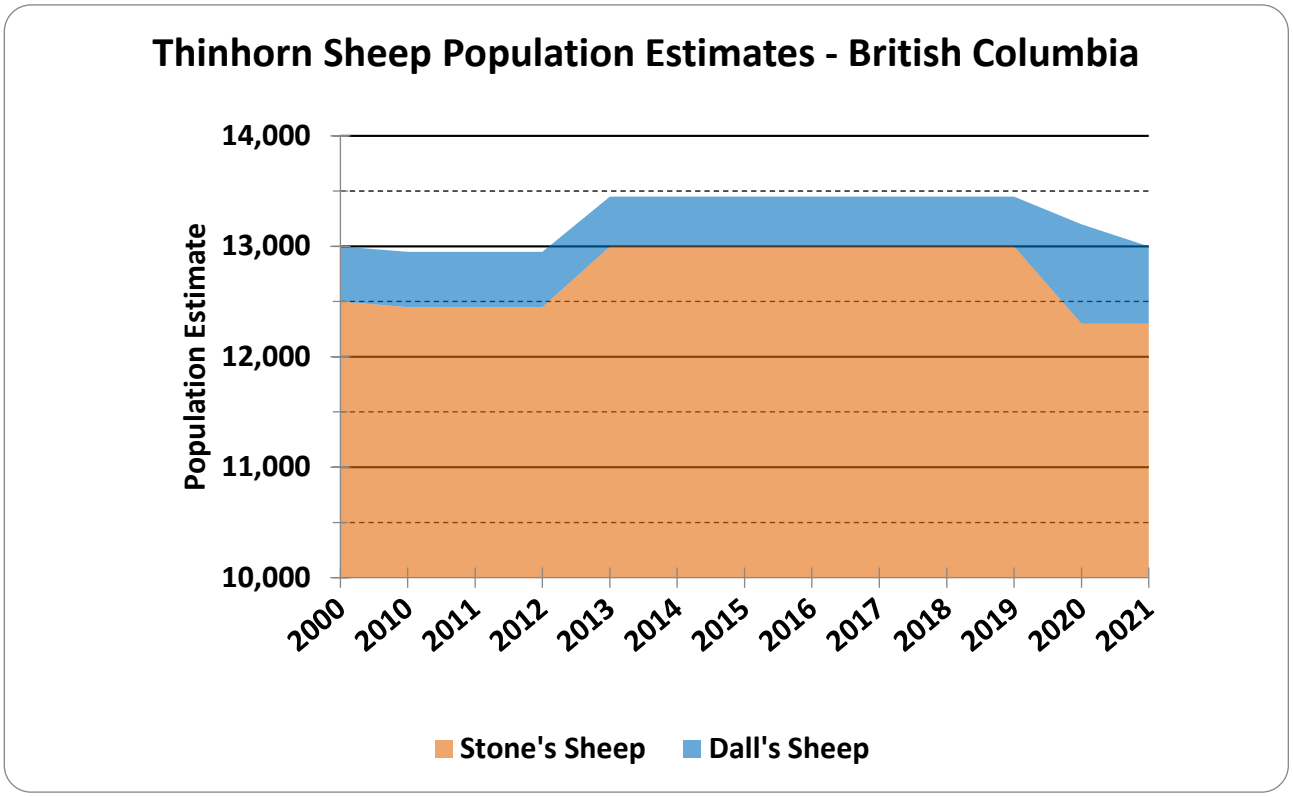


Figure 2. Thinhorn sheep population trend in British Columbia and Yukon, 2000 – 2021.



As sheep numbers decline, license availability and harvest follow suit. It is clear Dall's sheep provides the majority of wild sheep hunting opportunity based on license issuance (on average >60%). On average, bighorn sheep, desert bighorn sheep and Stone's sheep account for 35%, 5%, and 1% of wild sheep hunting licenses available, respectively (Figure 3). Interestingly, on average bighorn sheep and Dall's sheep provide about an equal amount of harvest at 35% and 38%, respectively. And on average desert bighorn sheep and Stone's sheep account for 16% and 11%, respectively (Figure 4).

Figure 3. Thinhorn and bighorn ram licenses across Canada and U.S., 2000 – 2021.

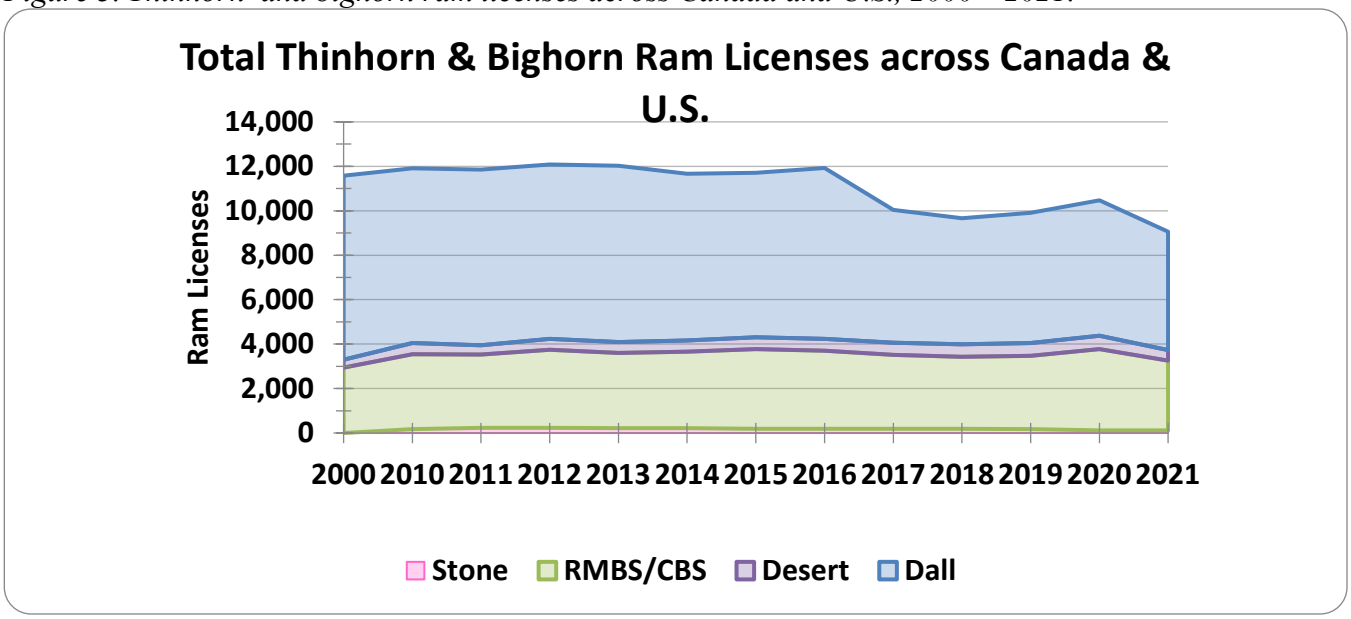
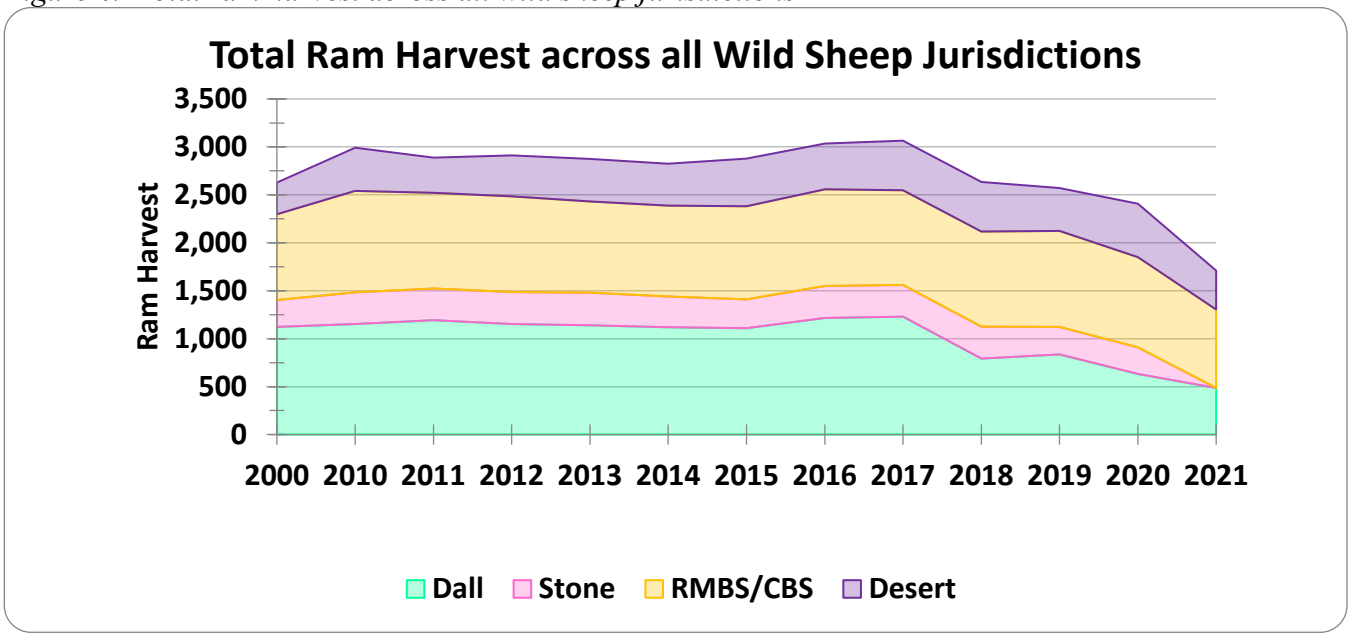


Figure 4. Total ram harvest across all wild sheep jurisdictions



State/Provincial Status Reports

Alaska
Not Available

Alberta

Rocky Mountain Bighorn Sheep (RMBHS)

Populations

There are an estimated 9,000 RMBHS in Alberta (2022), of which 6,000 occur on provincial lands and 3,000 in federal National Parks. This estimate is based on minimum aerial survey counts every 2-5 years of known winter ranges. Overall, the provincial population has been stable to slightly decreasing since 2000.

Licenses and Harvest

To be legal for harvest, rams must meet or exceed a 4/5 curl ('Trophy Sheep') or full curl requirement ("Full-curl Trophy Sheep"). In 2022, there were 55 special licenses available to Alberta residents through a limited entry draw / lottery system, as well as 125 outfitter allocations. In addition, 2240 resident Albertans purchased a general license to hunt rams. This license provides an "over the counter" hunting opportunity (with 1 license/hunter and an unlimited number of licenses available).

In 2022, 92 rams were harvested by resident hunters, down from an average of 121 from 2015-2022. Overall, 154 rams were harvested in 2022 by all licensed hunters (resident, non-residents, non-resident aliens), consistent with past years.

Hunter success is typically 5% for resident hunters and approximately 40-50% for hunters accompanied by an outfitter. The ram harvest rate averages about 2.6% of the estimated population on provincial lands. Harvest in some sheep management areas exceeds 50-70% of available legal rams annually, with 70-90%+ of rams harvested the first year they become legal. Approximately, 30% of rams are legal by age - 65% by age 6, 85% by age 7 and 95% by age 8. The percentage of legal rams observed in aerial surveys in many areas has consistently been low (1-3%) the last 5 years or more.

Ewes, or male bighorn sheep < 1 year of age, can be hunted under a special license (limited entry hunt) in 27 non-trophy areas. These areas include 14 of a possible 31 wildlife management units (WMUs) with bighorn sheep. A total of 179 non-trophy sheep licenses were available in 2022, down slightly from the 2015-2022 average of 189. The non-trophy harvest rate averages about 1% of the estimated population on provincial lands.

Disease

Prior to February 2023, there had not been a known pneumonia outbreak in Alberta since 2000. In February 2023, 9 rams were found dead in the Sheep River Provincial Park west of Black Diamond in southern Alberta. An additional 7 rams were observed coughing and were culled by wildlife managers to prevent transmission to a nearby group of 95 bighorn ewes and young animals. A total of 13 of the 15 dead bighorn rams were PCR tested for Mycoplasma spp.; all were positive. Of the seven animals then sequenced for *Mycoplasma ovipneumoniae* (M. ovi), 5 were positive and 2 results are pending. A subset of bighorns in the adjacent herd of 95 were subsequently tested for *Mycoplasma* spp. and all 42 were negative. Eight young rams in this herd were also radio-collared to track their movements.

Anne Hubbs, Alberta Environment and Parks

Arizona

Arizona has Rocky Mountain bighorn sheep and two sub-species of desert bighorn sheep, with the Nelson's (*Ovis canadensis nelsoni*) bighorn sheep occupying the northern areas of Arizona and the Mexican (*Ovis canadensis mexicana*) bighorn sheep occupying the central and southern habitat areas of the state.

Through aggressive translocation and augmentation efforts over the past couple of decades, Arizona has reached record high population numbers and distribution through native bighorn sheep range after experiencing the same type of near-extirpation wildlife events that many western states witnessed in the early years of the twentieth century.

Since 1955, Arizona Game and Fish Department (Department) has captured and released ~1,397 desert bighorn sheep within and outside of the state establishing new herd units and augmenting existing herd units within identified native habitat. During this long-term effort, the Department has worked collaboratively with the Utah Division of Wildlife Resources to acquire desert bighorn sheep for conservation efforts. Arizona has also been the source population for augmentations in multiple locations within Colorado, New Mexico, Texas, and Utah, assisting with those state agencies management objectives.

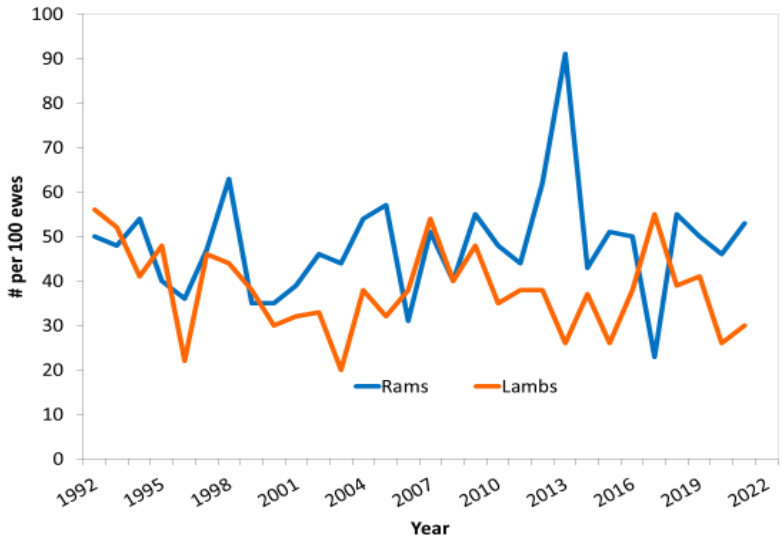
Since 1979, the Department has released ~154 Rocky Mountain bighorn sheep within the state establishing new herd units and/or augmenting existing herd units and has worked collaboratively with Colorado and New Mexico to acquire bighorn sheep in the past. Recently, the Department collaborated again with the Utah Division of Wildlife Resources and supplied 27 Rocky Mountain bighorn sheep for release on Antelope Island, Utah.

Rocky Mountain Bighorn Sheep

Populations

Rocky Mountain bighorn sheep populations throughout Arizona have increased since the late 2000s, primarily as a result of translocations of "nuisance or at-risk" bighorn sheep within private land and mining operations in the eastern portion of the state. Several new herd groups have been established in Arizona native range, as well as providing a source population for other western state agencies to further conservation and recovery efforts. The current Rocky Mountain bighorn sheep population is estimated at 1,300 bighorn sheep.

Figure 1. Historic Survey Ram and Lamb Ratios from Survey Data – Rocky Mountain Bighorn Sheep.



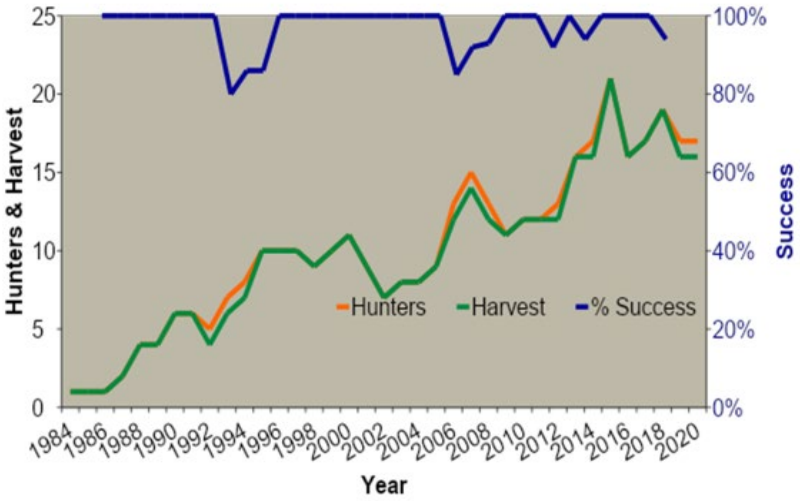
Licenses and Harvest

The number of hunt permit-tag licenses offered, as established within the Department's Hunt Guidelines, is set at 15-25% of the estimated number of Class III (age 6-8 years old) and Class IV (age 8+ years old) rams determined through survey observations and population modeling.

During the 2022 hunt season, 20 "Any-Ram" hunt permit-tags were offered. There was a total of 4,665 first choice applicants in the hunt draw process, which is a hybrid, bonus-point type draw system. Eighteen (18) mature rams were harvested, plus one (1) additional ram was taken under the Commissioner's Special-Tag statewide permit. The average age of the Rocky Mountain bighorn sheep rams harvested during the 2022 seasons was 8 years old with an average score of 172.

The Arizona Game and Fish Commission has approved 19 "Any-Ram" permit-tags for Rocky Mountain bighorn sheep for the 2023 hunt seasons, plus one (1) Commissioner's Special Tag.

Figure 2. Rocky Mountain Bighorn Sheep Hunt Data.



Disease and Herd Health

Biological samples are taken during capture efforts (includes collaring for population monitoring and/or translocations) in the following Rocky Mountain bighorn sheep management unit(s) (Table 1).

Table 1 – Percentage of bighorn sheep testing positive for diseases or pathogens.

GMU	Actual Samples Taken	BTV	EHD	BRSV	BVDV	PI-3	movi ELISA	Movi PCR
Morenci **1/27**	27	70	37	0	0	0	0	0

Test and Remove

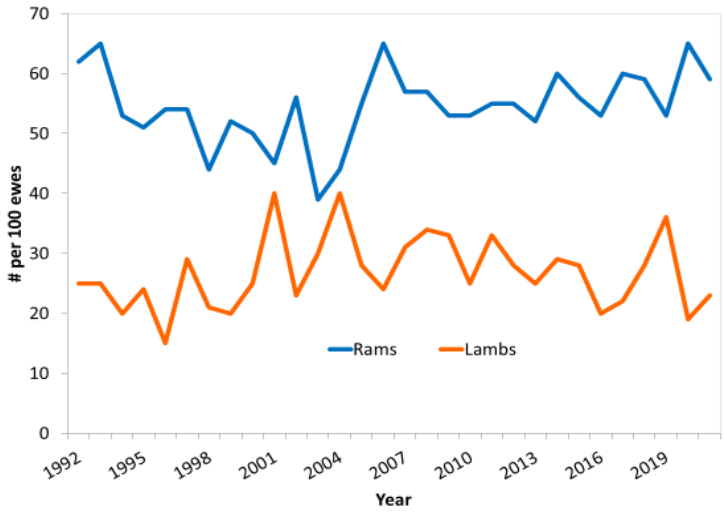
No test and remove efforts have been implemented to date. However, this management tool will be considered in response to any documented disease outbreaks in populations that may be conducive and receptive to a test and remove effort.

Desert Bighorn Sheep

Populations

Desert bighorn sheep populations throughout Arizona have shown variability in population estimates as management units are typically only surveyed once every three years in most occupied habitat. Overall, populations have increased on a statewide status. Currently, the statewide population is estimated to be approaching 5,600 bighorn sheep. A large portion of the documented increase is in the Kofa Mountains and adjacent mountain ranges in western Arizona. The Kofa National Wildlife Refuge population has increased from a total estimated population of 404 in 2012 to an estimated 941 bighorn sheep based on the 2021 aerial survey.

Figure 3. Historic Ram and Lamb Ratios from Survey Data – Desert Bighorn Sheep.



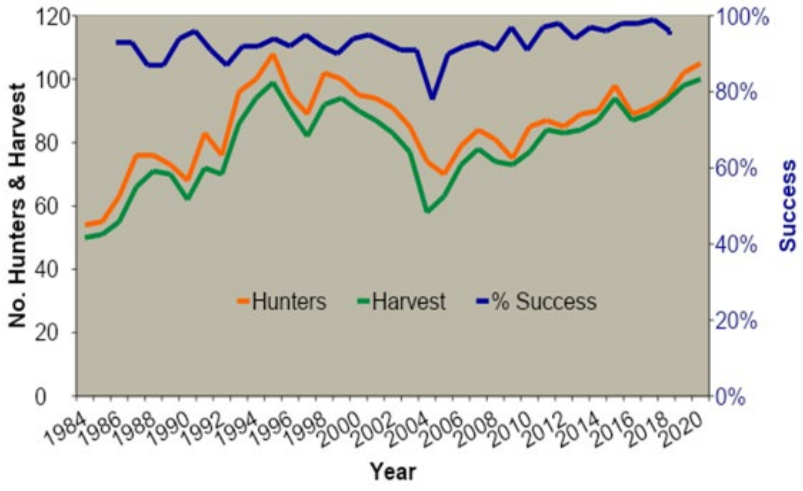
Licenses and Harvest

The number of hunt permit-tag licenses offered, as established in the Department's Hunt Guidelines, is set at 15-25% of the estimated number of Class III (age 6-8 years old) and Class IV (age 8+ years old) rams determined through survey observations and population modeling.

During the 2022 hunt season, 120 "Any-Ram" hunt permit-tags were offered. There was a total of 20,450 first choice applicants in the hunt draw process, which is a hybrid, bonus-point type draw system. There were 117 desert bighorn sheep rams harvested in 2022 regular seasons, plus two (2) additional rams taken under the Commissioner's Special-Tag permits. The average age of the desert bighorn sheep rams harvested during the 2022 seasons was 7.5 years old with an average score of 160.

The Arizona Game and Fish Commission has approved 137 "Any-Ram" permit-tags for desert bighorn sheep for the 2023 hunt seasons, plus two (2) Commissioner's Special Tags.

Figure 4. Desert Bighorn Sheep Hunt Data.



Disease and Herd Health

Biological samples (nasal swabs) were collected during the mandatory check-out process from hunter harvested bighorn sheep (N=51) and strain typing is pending for those samples testing positive for pneumonia. Preliminary positive samples were from management units 15C, 15D, 39W, 44B, and 46B.

Biological samples were taken during capture efforts (includes collaring for population monitoring and/or translocations) in the following desert bighorn sheep management units (Table 2).

Table 2 – Percentage of bighorn sheep testing positive for diseases and pathogens.

GMU	Actual Samples Taken	BTV	EHD	BRSV	BVDV	PI-3		M.ovi ELISA	M.ovi PCR
16A	26	42	15	50	0	27		42	4
16B	4	100	100	0	0	0		100	75
40A	9	33	100	11	0	0		44	33
43B	33	33	52	45	0	12		73	21
24A	9	100	100	0	0	25		0	0

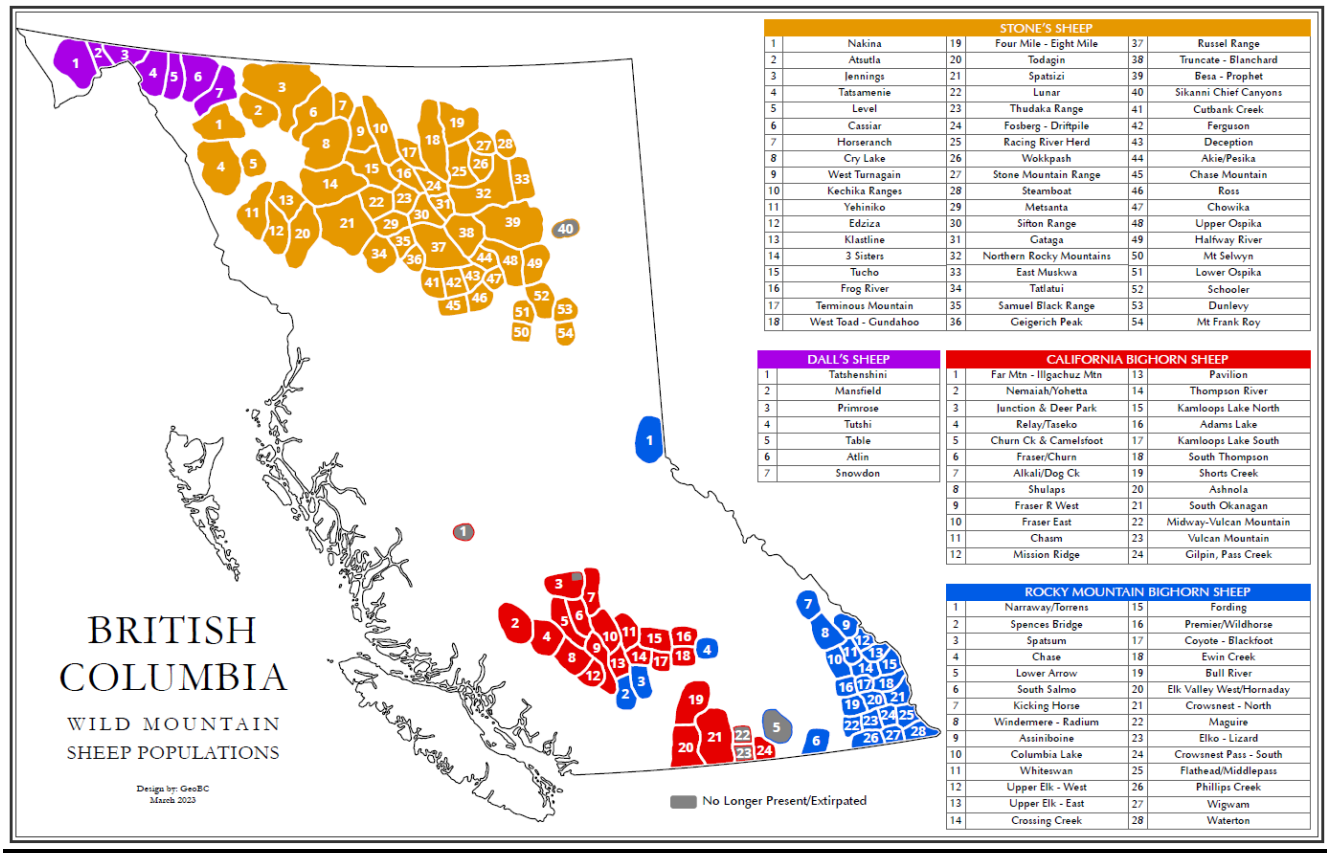
Test and Remove

No test and remove efforts have been implemented to date. However, this management tool will be considered in response to any documented disease outbreaks in populations that may be conducive and receptive to a test and remove effort.

- *Dustin Darveau, Senior Terrestrial Wildlife Specialist*

British Columbia

British Columbia has 4 native subspecies of wild sheep (Thinhorns: Dall's and Stone's; Bighorns: Rocky Mountain and California).



STONE'S SHEEP					
1	Nakina	19	Four Mile - Eight Mile	37	Russel Range
2	Atsutla	20	Todagin	38	Truncate - Blanchard
3	Jennings	21	Spatsizi	39	Besa - Prophet
4	Tatsamenie	22	Lunar	40	Sikanni Chief Canyons
5	Level	23	Thudaka Range	41	Cutbank Creek
6	Cassiar	24	Fosberg - Driftpile	42	Ferguson
7	Horseranch	25	Racing River Herd	43	Deception
8	Cry Lake	26	Wokkpash	44	Akie/Pesika
9	West Turnagain	27	Stone Mountain Range	45	Chase Mountain
10	Kechika Ranges	28	Steamboat	46	Ross
11	Yehiniko	29	Metsanta	47	Chowika
12	Edziza	30	Sifton Range	48	Upper Ospika
13	Klastline	31	Gataga	49	Halfway River
14	3 Sisters	32	Northern Rocky Mountains	50	Mt Selwyn
15	Tucho	33	East Muskwa	51	Lower Ospika
16	Frog River	34	Tatlatui	52	Schooler
17	Terminous Mountain	35	Samuel Black Range	53	Dunlevy
18	West Toad - Gundahoo	36	Geigerich Peak	54	Mt Frank Roy

DALL'S SHEEP	
1	Tatshenshini
2	Mansfield
3	Primrose
4	Tutshi
5	Table
6	Atlin
7	Snowdon

CALIFORNIA BIGHORN SHEEP			
1	Far Mtn - Illgachuz Mtn	13	Pavilion
2	Nemaiah/Yohetta	14	Thompson River
3	Junction & Deer Park	15	Kamloops Lake North
4	Relay/Taseko	16	Adams Lake
5	Churn Ck & Camelsfoot	17	Kamloops Lake South
6	Fraser/Churn	18	South Thompson
7	Alkali/Dog Ck	19	Shorts Creek
8	Shulaps	20	Ashnola
9	Fraser R West	21	South Okanagan
10	Fraser East	22	Midway-Vulcan Mountain
11	Chasm	23	Vulcan Mountain
12	Mission Ridge	24	Gilpin, Pass Creek

ROCKY MOUNTAIN BIGHORN SHEEP			
1	Narraway/Torrens	15	Fording
2	Spences Bridge	16	Premier/Wildhorse
3	Spatsum	17	Coyote - Blackfoot
4	Chase	18	Ewin Creek
5	Lower Arrow	19	Bull River
6	South Salmo	20	Elk Valley West/Hornaday
7	Kicking Horse	21	Crowsnest - North
8	Windermere - Radium	22	Maguire
9	Assiniboine	23	Elko - Lizard
10	Columbia Lake	24	Crowsnest Pass - South
11	Whiteswan	25	Flathead/Middlepass
12	Upper Elk - West	26	Phillips Creek
13	Upper Elk - East	27	Wigwam
14	Crossing Creek	28	Waterton

Harvest management for all species includes a combination of over-the-counter licenses for General Open Season (GOS) areas and Limited Entry Hunting Zone (LEH) draw-only hunting areas. The province currently only issues a general, non-specific sheep hunting species tag, so we are unable to report out on specific numbers of licenses sold for each of the subspecies' hunting opportunities; the information reported for licenses sold shown in Tables 1-3 in the Introduction represents the number of subspecies specific draw permits issued in the 2022/23 hunt year (Figure 1).

Figure 1. Numbers of sheep licenses sold annually in British Columbia, by hunter residency type.

Rocky Mountain & California Bighorn Sheep

British Columbia uses a combination of GOS and LEH to manage hunter harvest in both California and Rocky Mountain Bighorn Sheep populations, and has recently made changes to both GOS and LEH opportunities in an attempt to mitigate population declines and address localized harvest pressure.

B.C. is reporting significant declines in California BHS populations through the past 5 years as a result of disease and health related losses from M. ovi, Psoroptes & Blue-tongue. Affected populations include sheep in Regions 3 (Thompson), 5 (Cariboo) & 8 (Okanagan). The 2022 provincial population estimate across all regions for California BHS was ~2,000 sheep.

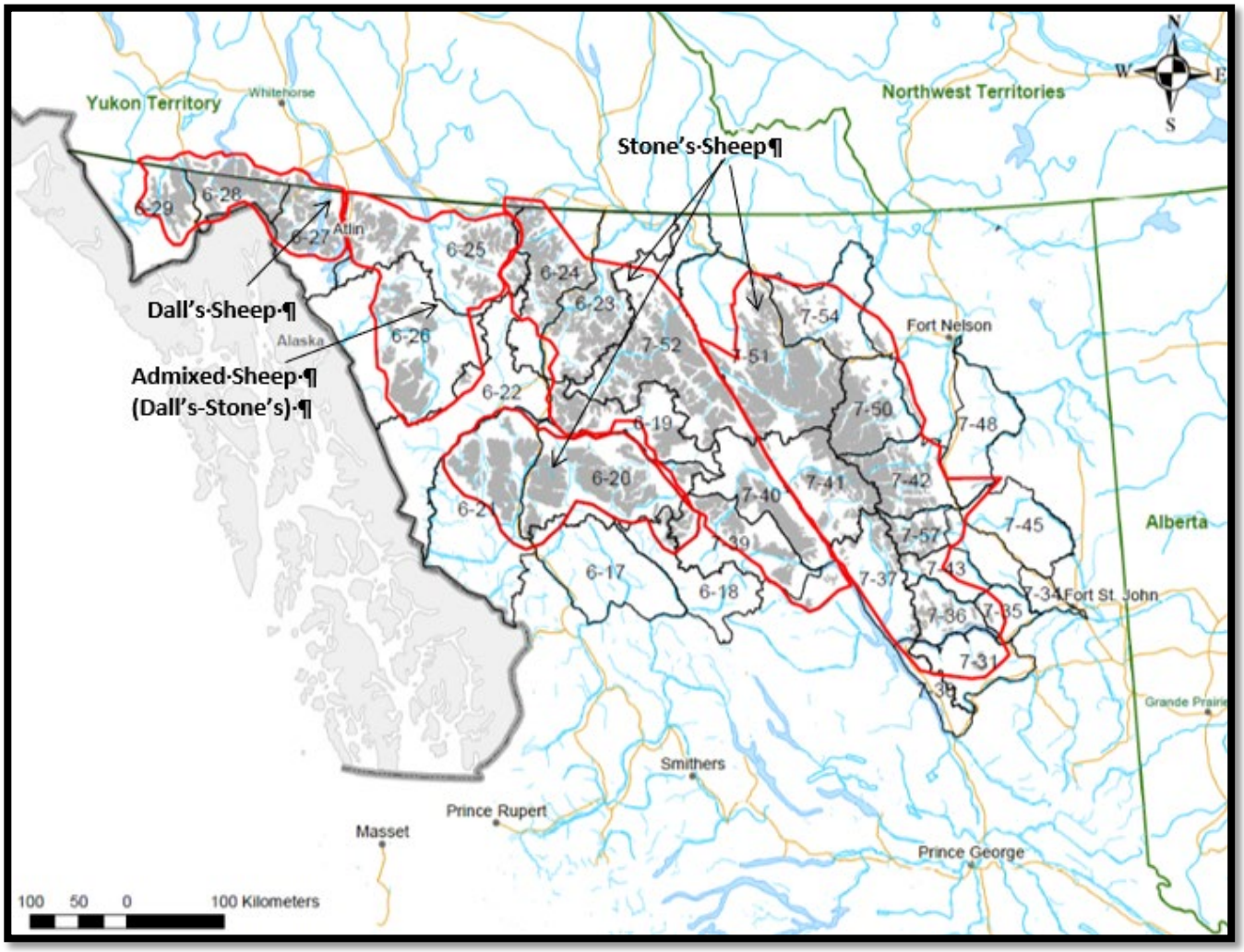
Rocky Mountain sheep have also declined to some degree in the Thompson region over the past decade, to ~400 RMBHS in 2022. Region 4 (Kootenays) populations have shown mixed outcomes with several populations declining below management objectives and some others showing slight improvements in populations over recent years. In March of 2021, the Kootenays released their regional Bighorn sheep management plan (https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/wildlife-wildlife-habitat/sheep/kootenay_bighorn_sheep_management_plan.pdf), that included a regional estimate of ~1800 RMBHS.

The continent's most northern population of RMBHS, is a cross-jurisdictional population located in Region 7 (Peace) and Alberta. Inventory information has confirmed that this population has steadily declined since 2015. The B.C. portion of this meta-population has also declined to <75 sheep, as a result of severe weather events and predation effects; hunter harvest is currently managed through general open season and it increased to a 10% harvest rate in 2022. As such, the region is currently considering changes to hunting regulations in order to reduce the harvest rate to more sustainable levels (i.e., potentially moving to an LEH delivery). The total provincial population estimate is ~2,250 RMBHS.

Thinhorn Sheep

The Province recently drafted a Stewardship Framework for Thinhorn Sheep in B.C. This document incorporates recent genetic information, applying it across traditional Wildlife Management Unit boundaries; from this, 5 large Thinhorn sheep genetic population groups have been identified (Figure 2).

Figure 2. Current Stone's and Dall's sheep distribution.



Dall's Sheep

Recent genetic information has confirmed that the range of Dall's sheep in B.C. is larger than previously thought. B.C. provided revisions to the previous estimates provided to the WAFWA WSI data records to reflect this new information (i.e., we reassigned sheep previously included as Stone's into the Dall's category). The 2022 total estimated number of Dall's sheep in B.C. is ~700, with the new geographic distribution being identified as all populations west of the centerline of the Teslin and Taku watersheds. Approximately 75% of all Dall's sheep range in B.C. has been inventoried over the past decade.

Hunts for Dall's sheep in B.C. are predominantly managed through LEH draw hunts (for white sheep), however, some of the newly defined areas immediately west of Teslin Lake that contain Fannin or dark-phased Dall's phenotypes, continue to be managed through GOS. A review of all sheep license sales suggests that hunts for sheep in B.C. continue to increase, despite reduced numbers of LEHs being issued and this supports the general conclusion that those who receive an LEH draw are more likely to attend

and hunt that opportunity today than they were in the early 2000's (Figure 3).

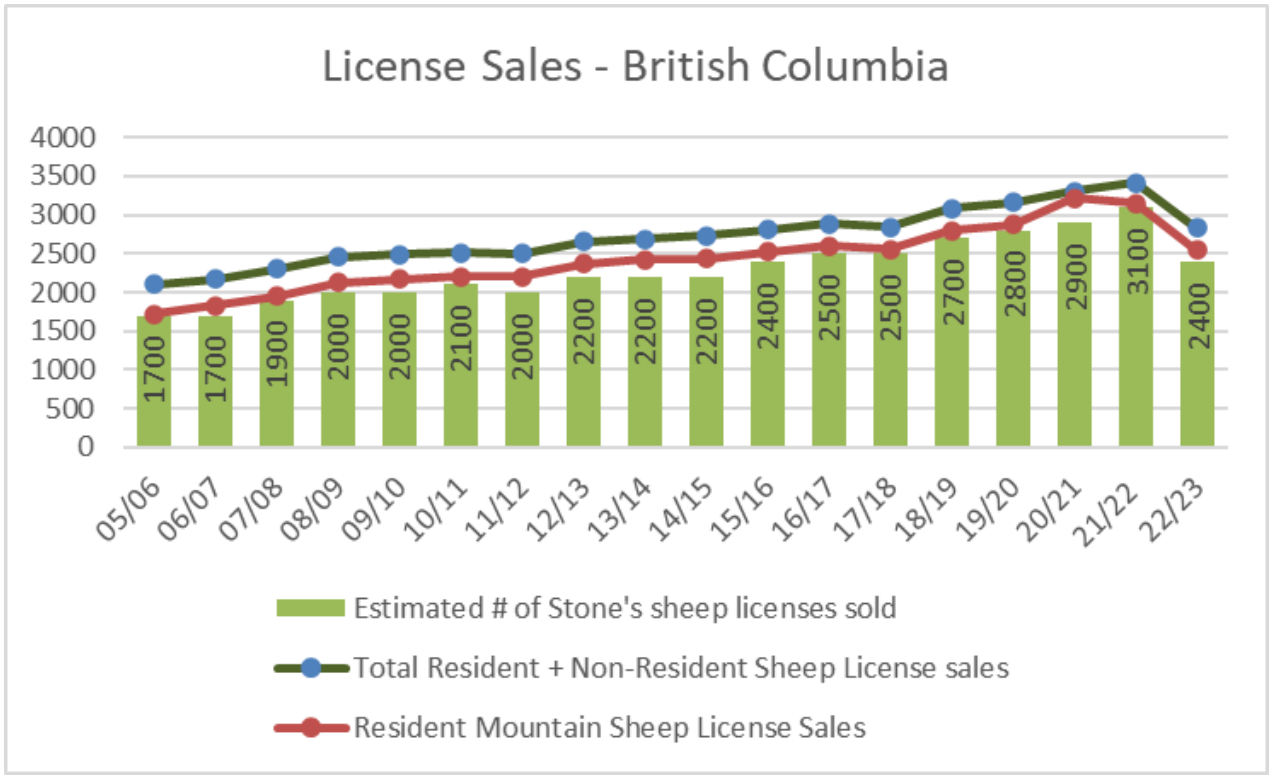
Figure 3. Dall's sheep license sales, 2006-2023.

Stone's Sheep

Genetic information has confirmed that the distribution of Stone's sheep in B.C. is smaller than previously thought. B.C. has provided revisions to past estimates provided to the WAFWA WSI data records to reflect this new information (i.e., we reassigned sheep previously included as Stone's into the Dall's category) and the new geographic distribution is identified as all Thinhorn sheep populations east of the centerline of the Teslin and Taku watersheds. The 2022 total estimated number of Stone's sheep in B.C. is ~12,300, however only about 35% of known Stone's sheep range has had population level inventory work completed in it over the past decade.

Hunting for Stone's sheep provides the bulk of the hunting opportunity in B.C. with most areas managed through GOS; some smaller specific hunt areas overlapping provincial park areas are managed through LEH and there is one archery-only GOS hunting area. A review of all sheep license sales suggests that hunts for sheep in B.C. continue to increase, despite reduced numbers of LEHs being issued for other subspecies of sheep, supporting the general sense that the number of hunters pursuing Stone's sheep has increased since the early 2000's. An estimate of sheep license sales focused on Stone's sheep hunting opportunity was generated by rounding-down the result of subtracting the total number of LEH permits issued from the total number of sheep licenses sold; while the specific numbers may not be accurate, the trend very likely is (Figure 4).

Figure 4. Approximate number of Stone's sheep license sales, 2006-2023.



NOTE: The estimated numbers of Stone's Sheep licenses shown in the graph are generated as a rough estimation for discussion purposes only.

Bill Jex, British Columbia Ministry of Forests, Fish and Wildlife Branch

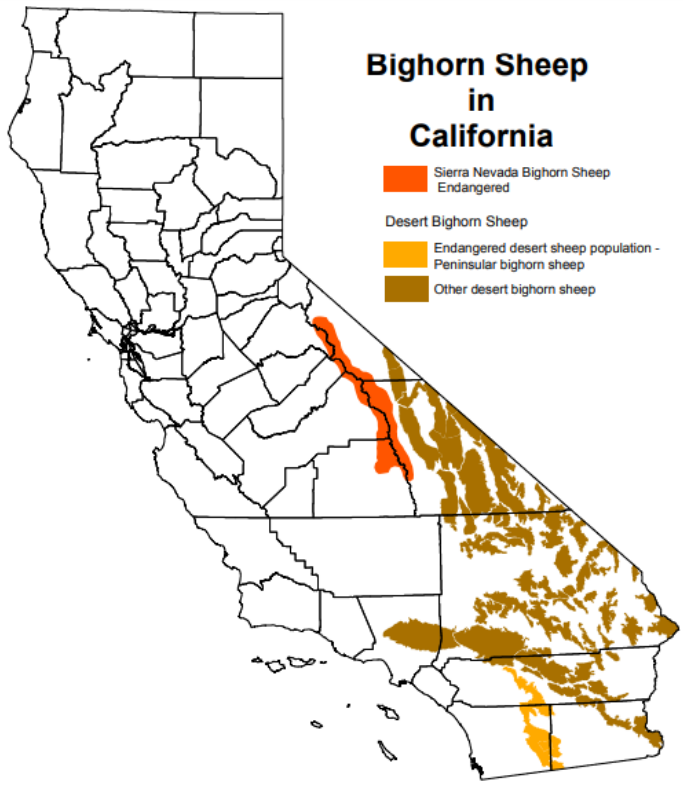
California

Desert bighorn sheep

Populations

California's desert bighorn sheep metapopulation consists of 64 herd units spread across the state's southern mountain ranges. This metapopulation is managed in two distinct segments. The bighorn sheep in the peninsular ranges in the southwestern section of the metapopulation are considered a federally endangered distinct population segment and are therefore managed by a recovery plan drafted under the U.S. Fish & Wildlife Service (Figure 1). All other desert bighorn sheep populations in the State are not considered endangered but have fully protected status except for individual bighorn sheep subject to sport hunting.

Figure 1. Bighorn sheep in California. The desert and Sierra Nevada subspecies are found in California. The desert subspecies is managed in two distinct population segments as seen above.



California's population was estimated at 5,000 desert bighorn sheep, though expert opinion suggests a decrease of ~10% (500 bighorn, such that 4,500 remain) over the past three years, attributed to impacts of drought and disease on recruitment. Among the populations in the 10 hunt zones (where population monitoring was most intensive outside of the peninsular ranges), population recruitment and overall health remained variable. The population in the Marble Mountains in the central Mojave was strikingly estimated to have zero percent recruitment during the last two years. However, data suggests the population on Old Dad Mountain in the central Mojave maintained healthy recruitment levels throughout the drought. Fortunately, heavy monsoonal moisture in the summer and fall of 2022, as well as significant to historic rainfall in the winter of 2023, has substantially decreased the drought severity throughout bighorn range. We anticipate higher levels of recruitment among most bighorn populations this season.

Licenses and Harvest

Per California Fish & Game Code, hunting of bighorn sheep in California is limited to rams. The California Fish & Game Commission may not adopt regulations authorizing the hunting in a single year of more than 15 percent of the mature rams (Class III or IV) in a single management unit. Hunts usually have a near 100% success rate except in the high-altitude White Mountain Hunt Zone 7. The 2023/2024 hunt season consists of 26 hunt tags (Figure 2).

ZONE 1 - MARBLE/CLIPPER MOUNTAINS - GENERAL METHOD - RAM	1
ZONE 2 - OLD DAD AND KELSO PEAK MOUNTAINS - GENERAL METHOD - RAM	1
ZONE 3 - CLARK AND KINGSTON MOUNTAIN RANGES - GENERAL METHOD - RAM	4
ZONE 4 - OROCOPIA MOUNTAINS - GENERAL METHOD - RAM	1
ZONE 7 - WHITE MOUNTAINS - GENERAL METHOD - RAM	6
ZONE 8 - SOUTH BRISTOL MOUNTAINS - GENERAL METHOD - RAM	2
ZONE 9 - CADY MOUNTAINS - GENERAL METHOD - RAM	2
ZONE 10 - NEWBERRY, RODMAN AND ORD MOUNTAINS - RAM	6

Figure 2. Number of general hunt tags offered in each hunt zone for the 2023/2024 hunt season. 23 general tags, as well as 3 special fundraising tags are offered for the season.

Disease and Herd Health

Mycoplasma ovipneumoniae poses a significant threat to desert bighorn herds in California. Antibodies to the pathogen have been found in individuals from every herd unit tested in the State. Over the past decade, all age-class die-offs have been detected in the Old Dad, San Gorgonio, and South Bristol herds. Carcasses from the Old Dad herd sampled during the die-off tested positive for *Mycoplasma.* Carcasses from the San Gorgonio and South Bristol herds during their respective die-offs did not test positive for *Mycoplasma*; it is possible that the pneumonia in those herds was caused by a different, as-yet undetermined pathogen. No test and remove efforts have taken place in California.

Connectivity

Historically, California's desert bighorn sheep formed one large metapopulation. Three freeways (I-15, 40, and 10) have divided this metapopulation into six fragments as clearly shown by both genetic and movement data. Re-establishing genetic connectivity remains one of the top priorities for California's desert bighorn sheep program. Construction is planned to start this year on three wildlife overcrossings traversing I-15 and a planned high speed rail line, designed specifically to benefit the species.

Danielle Glass, Environmental Scientist-California Department of Fish & Wildlife

Colorado

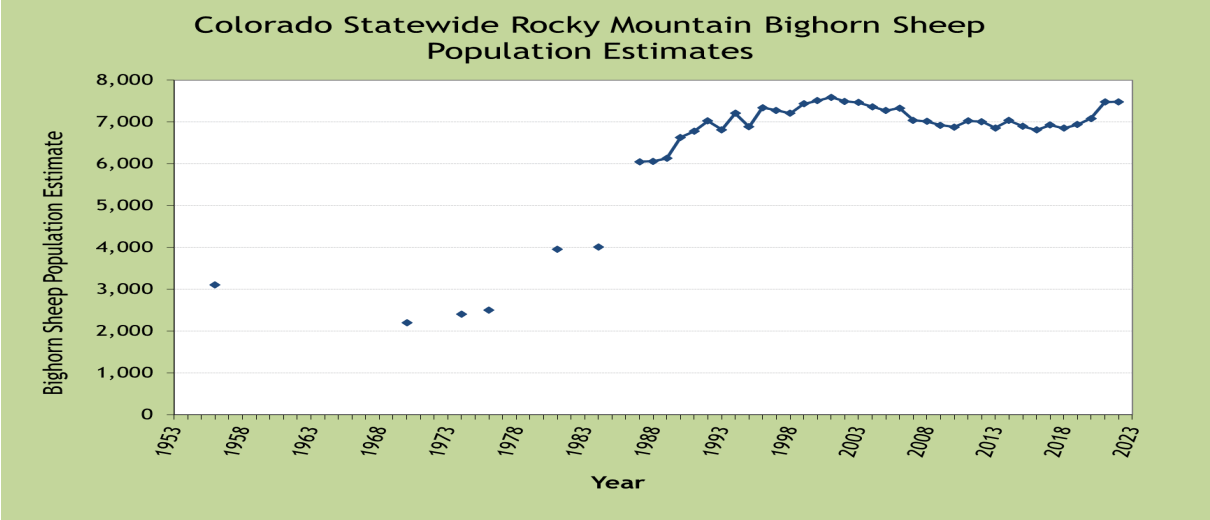
Rocky Mountain Bighorn Sheep

Populations

The Colorado statewide post-hunt 2022 Rocky Mountain bighorn sheep (RMBHS) population estimate is 7,500, which is near our contemporary peak population size (Figure 1). The statewide population has averaged 7,200 over the last 25 years. Approximately 6,800 RMBH occur in hunted populations and 700 in unhunted populations which are primarily in Rocky Mountain National Park.

From 1945 to present, Colorado conducted approximately 150 translocations of 2,500 RMBHS. Most of these occurred during the 1980's and 1990's. Approximately 55% of current herds resulting from reintroductions. These transplants continue to this day but at a much lower rate because there are very few locations remaining that have both suitable habitat for bighorn sheep and that do not have domestic sheep or goats nearby.

Figure 1. Rocky Mountain bighorn sheep population estimates.



Licenses and Harvest

Colorado has 39 designated RMBHS populations with 70 hunted Game Management Units (GMUs) shown in red in Figure 2.

For 2023, we have an increased from 347 to 351 (+4) RMBHS licenses statewide. Ram and either-sex licenses recommendations are the same at 253. Ewe licenses went from 94 to 98 (+4). Ram harvest rate averages about 2.3% of hunted population size while female harvest rate is less than 1% (Figure 3).

Figure 2. Colorado Rocky Mountain (red) and desert bighorn sheep (blue) game management units.

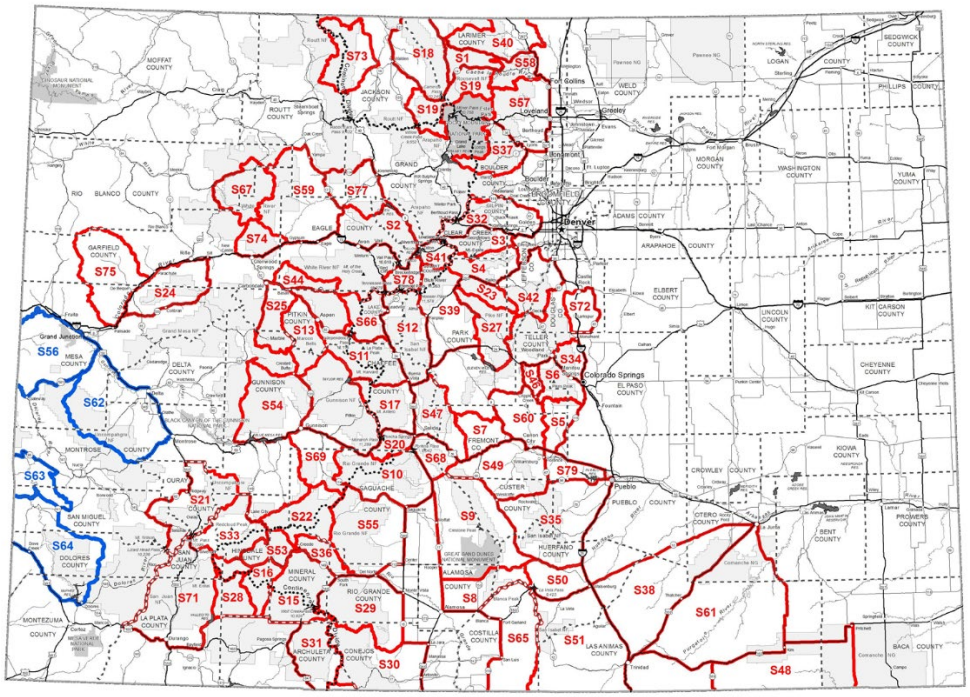
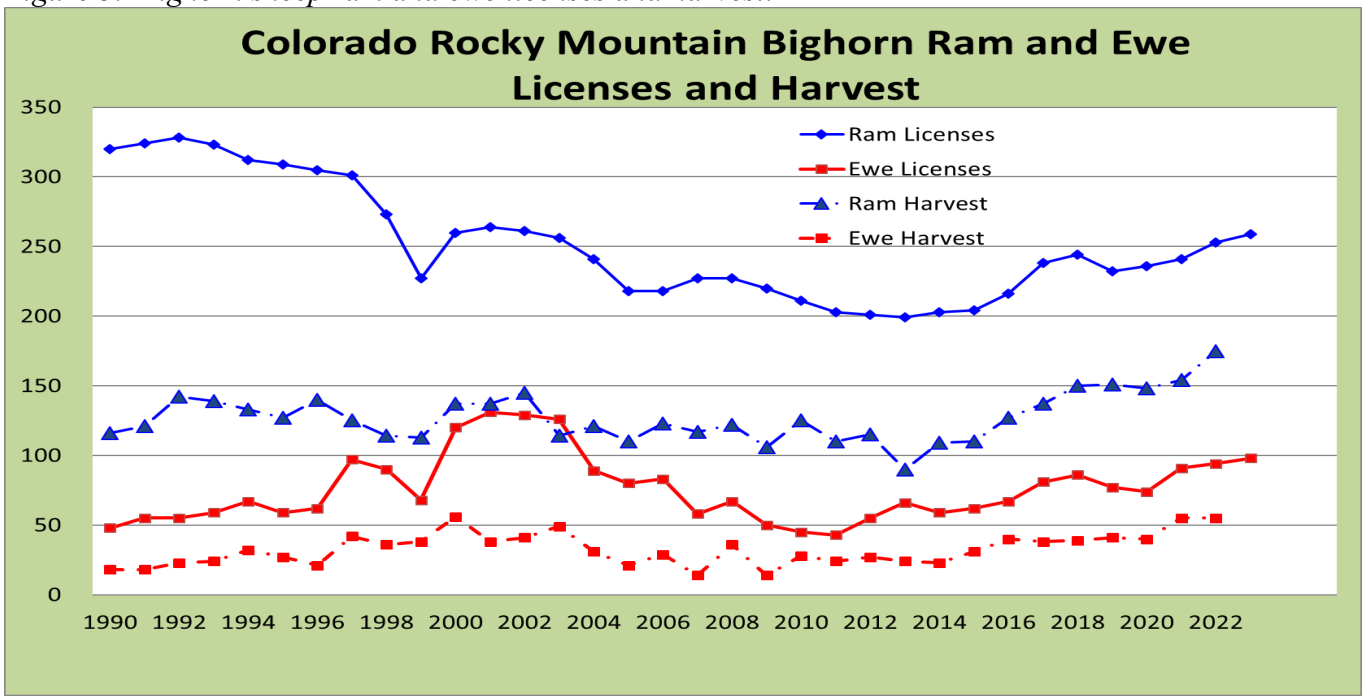


Figure 3. Bighorn sheep ram and ewe licenses and harvest.



Desert bighorn sheep

Between 1979 and 2001, Colorado conducted 12 transplant operations and translocated 218 desert bighorn sheep from Arizona, Nevada, and Utah. As a result of these significant and expensive transplant efforts, Colorado has 2 desert bighorn sheep herds, in 4 game management units (GMUs) shown in blue in Figure 2.

The 2022 DBHS population estimate is 500, down from 550 in 2021 (Figure 4). Ram licenses for 2023 will be the same as 2022 at 15. No ewe licenses have been offered yet for DBHS (Figure 5).

Figure 4. Desert bighorn sheep population estimates.

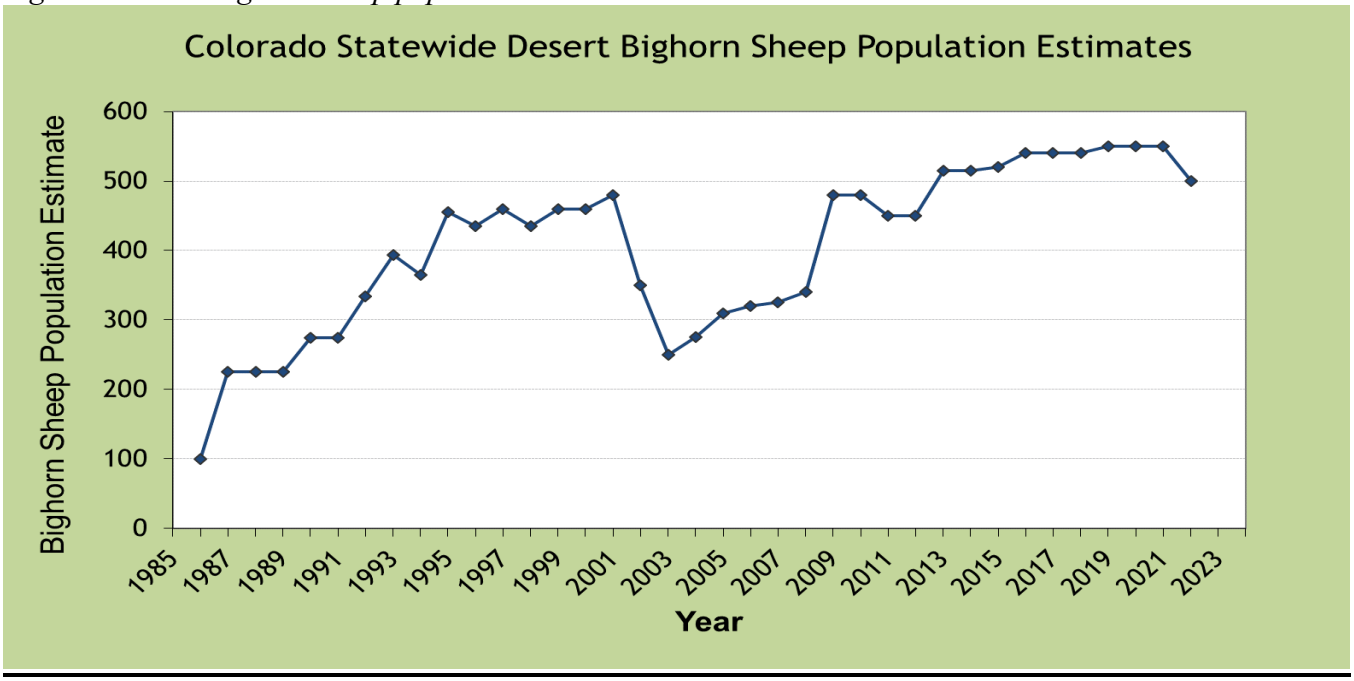
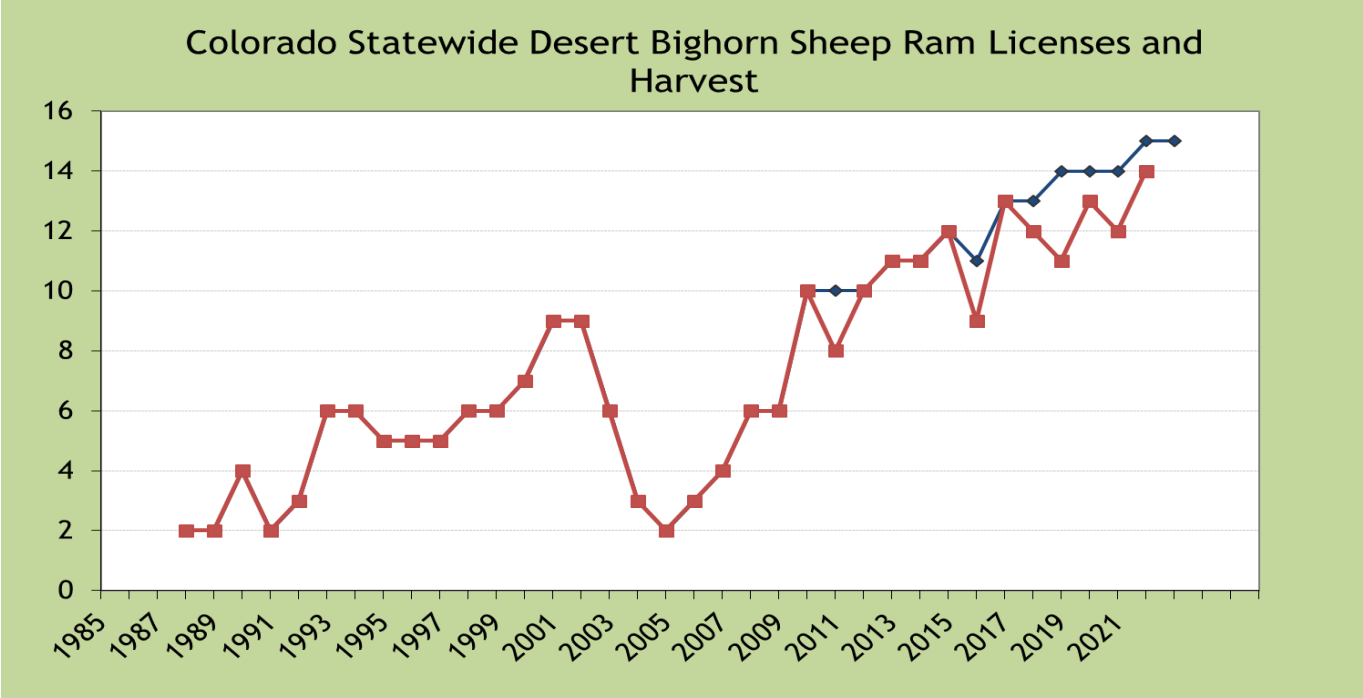


Figure 5. Desert bighorn sheep ram licenses and harvest.



Disease and Herd Health

In 2022, the CPW wildlife health program received 45 submissions of lungs and/or heads from free-ranging

Colorado bighorn sheep mortalities, submitted for lower and upper respiratory disease surveillance. We performed specific (PCR) testing for pathogens including Mycoplasma ovipneumoniae, leukotoxigenic Pasteurellaceae, and Pasteurella multocida. Respiratory disease was determined to be the cause of death for bighorns in two herds: S32 (Georgetown) and S37 (Saint Vrain). The most significant respiratory disease detected was an all-age mortality event in the S32 (Georgetown) herd that occurred during winter 2021/2022. Live bighorns were observed coughing and with nasal discharge. Necropsy of deceased bighorns demonstrated bronchopneumonia, with variable concurrence of upper respiratory disease (including sinus tumor) and detection of leukotoxigenic Pasteurellaceae, Mycoplasma ovipneumoniae, and Pasteurella multocida. Chronic upper respiratory disease (sinus tumor) was detected in several Colorado bighorn herds in 2022 including S32 (Georgetown), S20 (Marshall Pass), S12 (Buffalo Peaks), S62 DBHS (Dominguez), and S54 (Dillon Mesa West Elks). Between 2020 and 2022, CPW sampled approximately 123 live free-ranging bighorn sheep from 8 population units. Sampling approaches were tailored to the individual project and included both serology and swab-based diagnostics. Mycoplasma ovipneumoniae, leukotoxigenic Pasteurellaceae, and Pasteurella multocida were detected in various combinations among the sampled populations. No new pathogens were documented through live sampling efforts. Limited strain typing was performed for pathogens detected in Colorado bighorns although a goal of the CPW wildlife health program is to expand strain typing capabilities through new diagnostic approaches.

Test and Remove

No current test and remove programs were conducted in Colorado in 2022.

-Andy Holland, Karen Fox, and Mary Wood- Colorado Parks and Wildlife

Idaho

In Idaho, bighorn sheep exist in both small, isolated populations and in interconnected metapopulations (Figure 1). For management purposes, these populations and metapopulations have been divided into 21 Population Management Units (PMUs). Currently, an estimated 3,400 bighorn sheep occupy about 15.5% of the state. Historical and recent data indicate most PMUs can sustain higher populations of bighorn sheep and overall management direction will be to increase population levels where feasible. To attain this goal, IDFG will write an annual action plan to describe in more detail planned activities to address management directions and strategies.

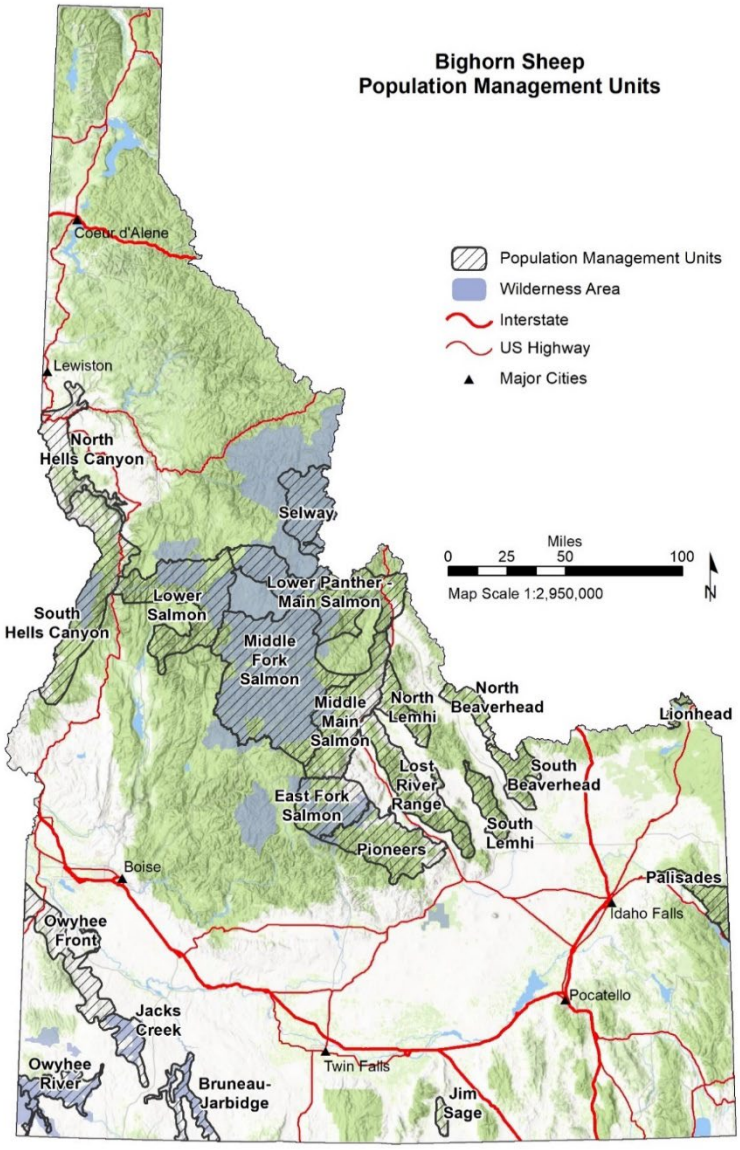


Figure 1. Current distribution of bighorn sheep in Idaho, as defined by Population Management Units (PMU).

Populations

Rocky Mountain bighorn sheep (approximately 2,950 animals – Figure 2) occur in 16 PMUs in central and southeastern Idaho. Eighteen out-of-state translocations and 17 in-state translocations were conducted between 1975 and 2005 to restore Rocky Mountain bighorn sheep populations to historically occupied habitat. Translocations have successfully expanded the distribution of bighorn sheep, but most of the largest populations are still native Rocky Mountain bighorn sheep that were never extirpated in the Salmon River drainage. In south-central and southwestern Idaho about 450 California bighorn sheep (Figure 2) occur in 5 PMUs. Bighorn sheep were completely extirpated from this part of the state, and current populations are the result of 11 translocations from outside Idaho and 18 in-state translocations between 1963 and 2004.

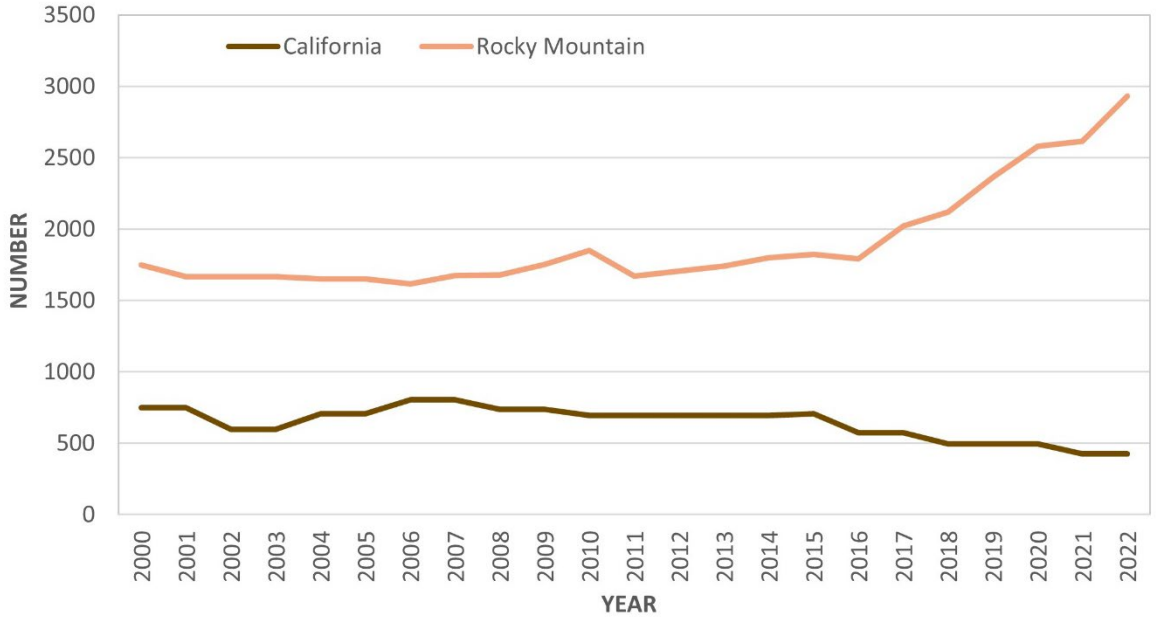


Figure 2. Statewide population estimates of California bighorn sheep and Rocky Mountain bighorn sheep in Idaho, 2000–2022. Statewide estimates are based on the most recent survey in each population management unit which may, or may not, reflect the year of the estimate.

Harvest Management

Over the last 85 years, ram tags and harvest have varied considerably with changes in populations (Figure 3). Disease-related die-offs that have impacted large portions of Idaho's bighorn sheep populations typically resulted in large reductions in tag levels, followed by slow increases in tags when populations recovered.

Beginning with the 1991–95 bighorn sheep management plan, hunting was not recommended unless a population was estimated at >100 animals. However, a 100-animal minimum may preclude legitimate ram-only harvest opportunities in some smaller populations where habitat carrying capacity prevents achieving minimum population size or risk of catastrophic, all-age die-off is high.

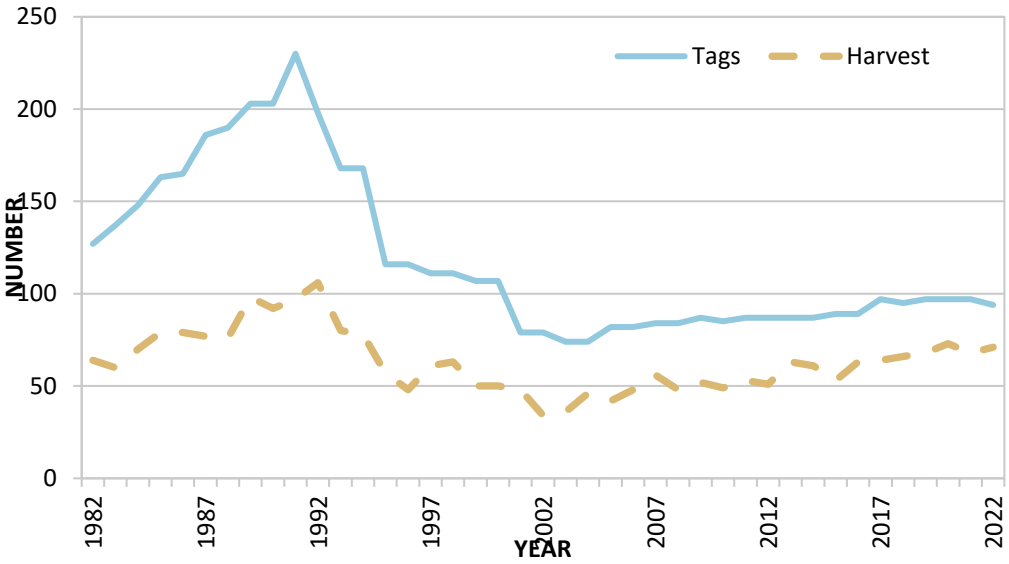


Figure 3. Bighorn sheep tags (issued) and harvest 1980–2020, Idaho.

In Idaho, harvest was restricted to ¾-curl or larger rams from 1970–1983 and ¾-curl or larger rams or rams >4 years old (≥3 annual growth rings on horns) from 1984–2006. In 2007, regulations were changed to allow harvest of any ram. Data gathered since 1994 indicate this change had no effect on the average age of harvested rams in Idaho.

Since 1991, management direction is to set tag levels so that harvest is ≤20% of class III and IV rams (¾-curl or larger) observed during the most recent survey for each hunt area. This conservative harvest strategy ensures adequate mature rams for harvest and biological-behavioral requirements (social dominance hierarchy, genetics, mature male:female ratios, etc.).

Current timing of bighorn sheep seasons avoids hunting during the breeding season. Most bighorn sheep seasons start 30 August and continue until 8 October for California bighorns and until 13 October for Rocky Mountain bighorns. Some late-season hunts exist; for example, some hunts for Rocky Mountain bighorns extend through 31 October.

Reduction of ewe numbers may be necessary when sheep numbers have increased above population objectives, including when habitat degradation is possible due to overpopulation or bighorn sheep move into habitat with an increased risk of contact with domestic sheep and goats. Removal of ewes can be accomplished through capture and translocation (in-state or to other jurisdictions) or regulated harvest. Ewe removal is generally not recommended when populations are below habitat carrying capacity, newly reintroduced, or suppressed by a mortality factor (e.g., disease). There is currently no ewe harvest in Idaho.

All bighorn sheep hunting in Idaho is allocated via a controlled hunt (random drawing) system. Currently, nonresidents are limited to ≤10% of all bighorn sheep tags and not more than 1 nonresident tag can be issued for controlled hunts with ≤10 tags (≤10% to nonresidents in hunts with >10 tags). Chances of obtaining a bighorn tag generally declined over time as interest and demand have increased, particularly for nonresidents (Figure 4).

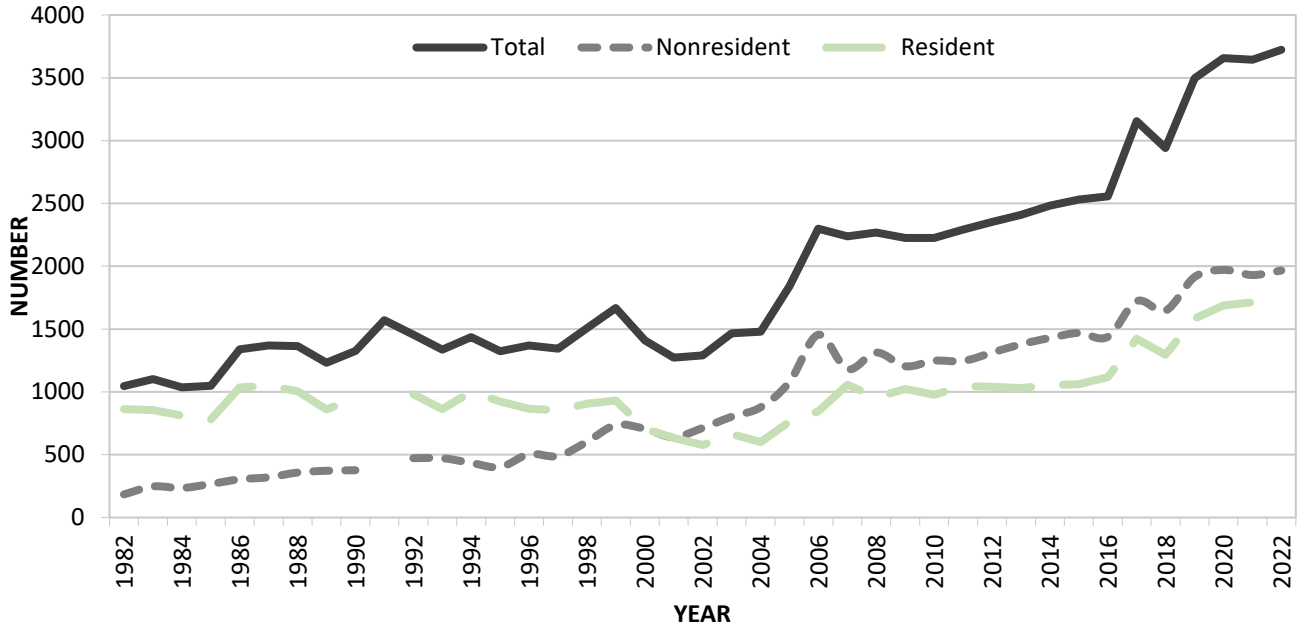


Figure 4. Resident, nonresident, and total number of applicants for bighorn sheep tags 1980–2020, Idaho.

Disease and Herd Health

Population health is an essential component of bighorn sheep restoration and management. Historically disease was an important factor contributing to declines and extirpation of bighorn sheep in much of their range and disease continues to limit bighorn sheep numbers today. Not only does disease affect populations directly, risk of disease transmission also affects where and how IDFG manages for bighorn sheep in Idaho.

The primary limiting factor for Idaho bighorn sheep populations is disease, although other factors including habitat, genetics, climate change, predation, and hunting can also be important. The disease that has the most widespread and severe impacts on bighorn sheep population abundance is a microbiologically complex pneumonia triggered by the bacterium *Mycoplasma ovipneumoniae (Movi)* (Figure 5).

The most recent die-off was first detected in the Bruneau-Jarbidge PMU (California bighorn sheep) in 2017. The population has decreased from 150 bighorn sheep counted in 2010 to 26 bighorn sheep counted in 2021.

IDFG is currently conducting test and remove research/adaptive management to clear Movi from multiple infected bighorn sheep populations. This includes testing and removing infected sheep in the Lower Salmon, Lower Panther-Main Salmon, and the South Beaverhead PMUs. We are gathering baseline data in other populations and evaluating the North and South Hells Canyon PMUs post Movi clearance.

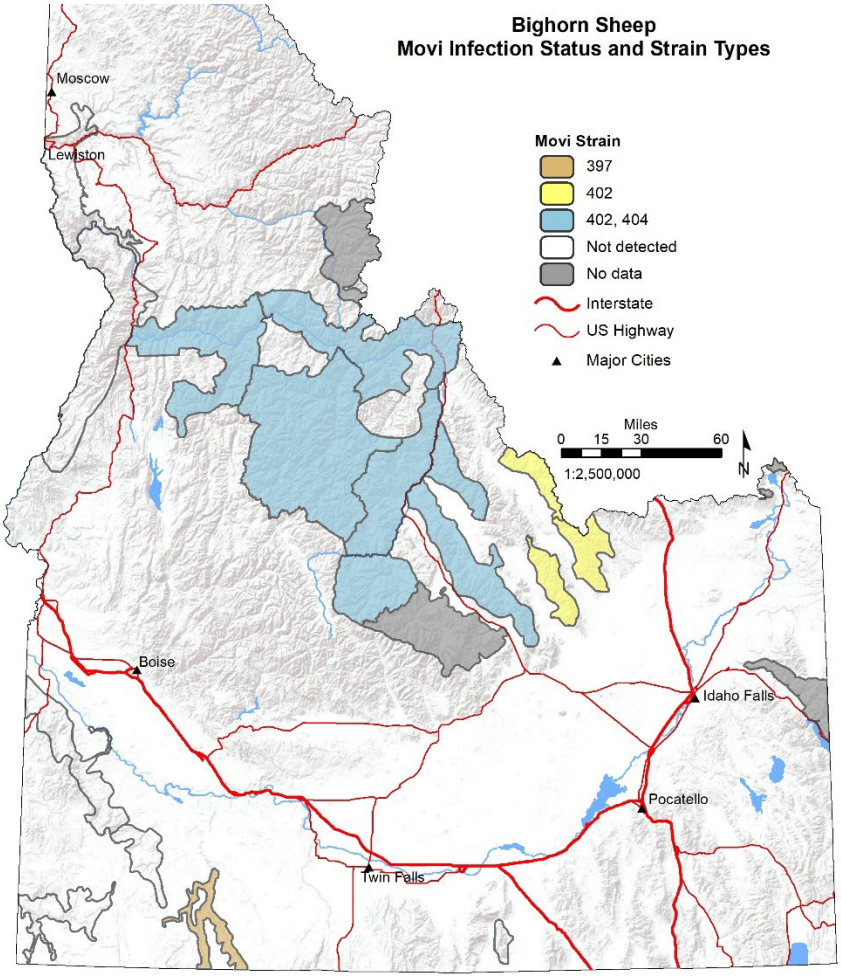


Figure 5. Mycoplasma ovipneumoniae (Movi) infection status and current distribution of multi-locus sequence strain types in Idaho bighorn sheep.

Hollie Miyasaki, Idaho Department of Fish and Game

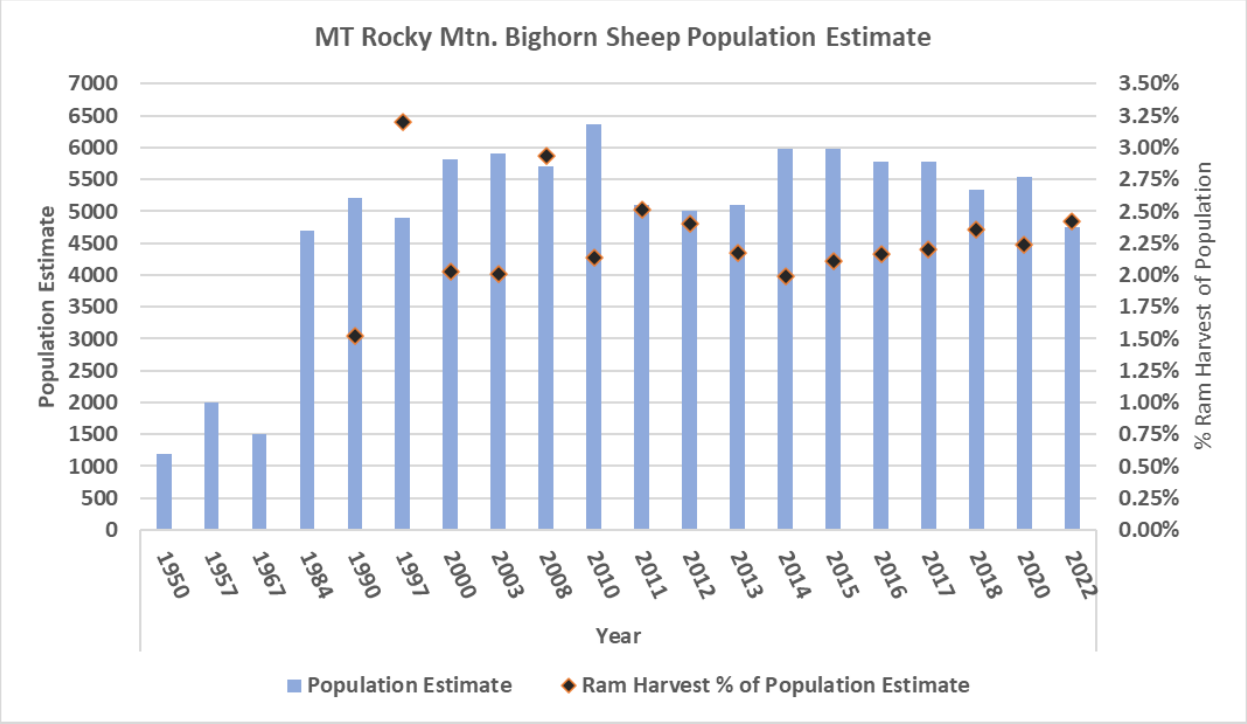
Montana

Rocky Mountain Bighorn Sheep

Populations

Similar to many areas, Rocky Mountain bighorn sheep (RMBHS) in Montana suffered widespread populations reductions during the late 19th and early 20th centuries. After various conservation measures were put in place in the early part of the 20th century, RMBHS populations stabilized with estimates by 1950 at approximately 1,200 sheep throughout the state. Around that same time and continuing over the next several decades, significant translocation efforts and other conservation measures were completed to help improve population levels and increase distribution. To date, approximately 3,000 RMBHS have been translocated in MT (including out of state transplants), which continue to occur, albeit on a limited basis for a variety of reasons. Current statewide RMBHS population estimates are at just under 4,800 sheep (See Figure 1). The long-term average (1984 to present) estimated state population is approximately a little over 5,400 sheep.

Figure 1. *Population estimates are derived via professional biologist data and judgement and not a rigorous statistical enumeration process. Prior to 2010, statewide population estimates include all known wild sheep within the boundaries of the state (including Glacier National Park). The 2010/2011 reduction correlates strongly with multiple disease die-offs during that period and only includes sheep within state jurisdiction. Population estimates from 2018 forward include only sheep managed under state of MT jurisdiction and are completed every two years.*



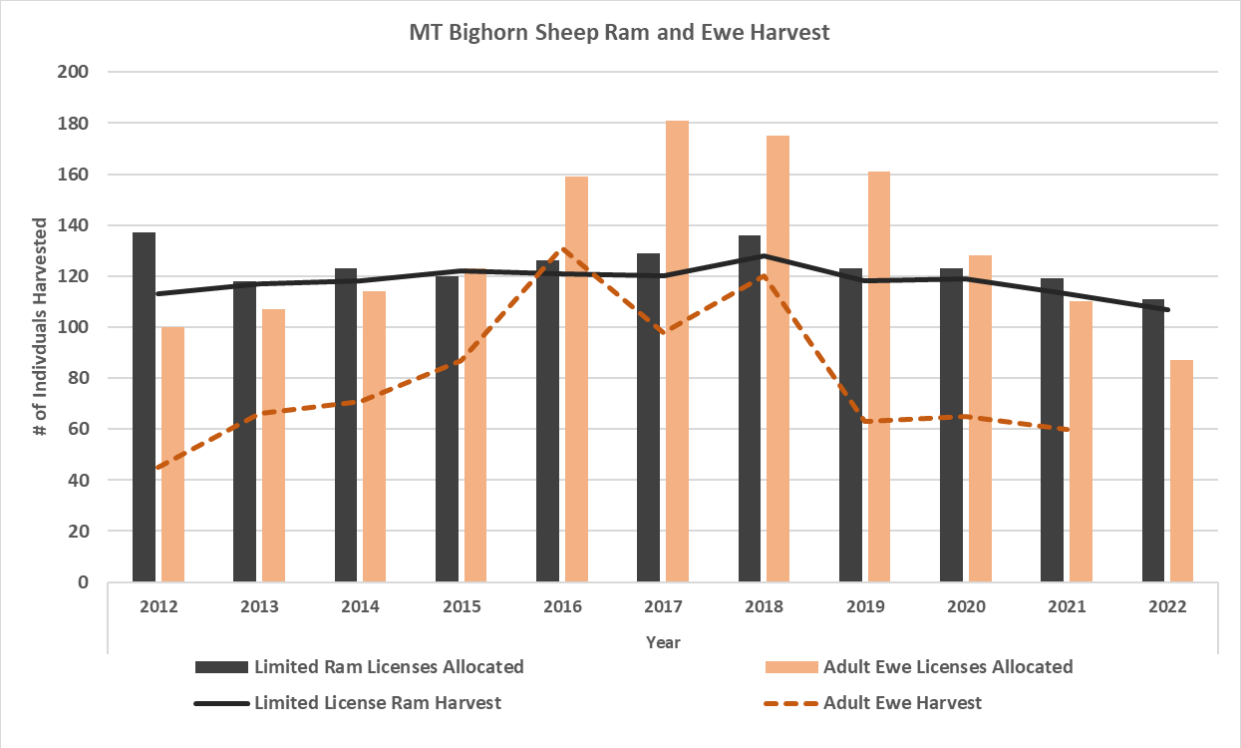
Licenses and Harvest

Montana has 34 RMBHS hunting districts (HDs) providing opportunity for limited either-sex/legal ram, unlimited areas (quota areas), and adult ewe license permit types. For 2022, a total of 111 limited either-sex or legal ram licenses were allocated statewide. Recent average statewide limited either-sex/legal ram license drawing success rates is 0.47%. In recent years, there continues to be increased interest for this hunting opportunity yet cumulatively (all HDs) maintained or decreased license allocation for a variety of reasons, meaning, the odds of drawing these licenses over time is getting more difficult. For example,

in 2022, over 33,000 applications were submitted for 111 limited licenses. Similarly, applications for adult ewe hunting opportunity continues to increase while in general (statewide), license allocation has become more limited. 2022 adult ewe hunter license draw success was approximately 11% for the state, while 5-10 years ago these odds were consistently above 20%.

Annual statewide either-sex limited license harvest success rates average just over 95% (Figure 2). Five HDs in Montana provide unlimited legal ram hunting opportunity that is monitored via individual quota systems. 2022 harvest data portray a 2% harvest success (all five HDs combined) for these license holders (n=371 license holders). Annual statewide average age of harvested rams is consistently a little over 7 years old. Limited adult ewe hunting opportunity also is currently available in four HDs with a total of 87 licenses that were available for the 2022 season. Recent annual average statewide harvest success rates for adult ewe licenses are just under 60% (Figure 2). Ewe hunting opportunity is an ongoing balance correlated with other population/distribution control measures where necessary (i.e., translocation work).

Figure 2. Montana bighorn sheep ram and ewe harvest, 2012 – 2022.



Disease and Herd Health

Other than one area, there are currently no known significant disease outbreaks occurring in RMBHS within Montana state jurisdiction. The recent Little Belt Mountain translocation work continues to show some level of disease impacting wild sheep involved with this area, in combination with predation. High mortality rates have occurred to date of RMBHS associated with this work. Monitoring these sheep is ongoing. There are several herds that continue to recover from more recent disease and die-off episodes over the last decade or more, with some herds (not all) showing improved progress towards population stability and/or recovery. As such, several RMBHS herds in Montana are below population objective. For many of these areas, monitoring and/or recently completed or ongoing research is occurring to better understand and inform future management direction.

Finally, Montana is in the final stages of prepping for a large-scale multi-year research project looking at a host of management level interests across the state within RMBHS and Mountain Goat populations, to include better understanding, in an experimental design approach, management practices to reduce commingling rates between wild and domestic sheep/goats. Partners involved with this cooperative project (among others) includes the Montana Woolgrowers Association, the Montana Wild Sheep Foundation and the Wild Sheep Foundation, Montana State University Animal & Range Science Department and MT Fish, Wildlife & Parks.

Test and Remove

Formal disease test and removal work in Montana has not occurred until most recently. The Tendoy Mountains RMBHS de-/repopulation project is currently in primarily a monitoring phase after initial translocation of RMBHS into that area in 2021. Pending performance of these sheep and availability of supplementary source sheep, there are potential plans for additional augmentations into this area in the future. Currently, the Highland Mountains RMBHS population is undergoing a 5-year research effort to better understand ongoing impacts of disease and general herd health since their initial die-off nearly 30 years ago. The project is in year two with effort to understand vital rates, disease sampling and cause-specific mortality being a large component of the work to date. Year three (2023) will begin the process of treatment work, including test and removal and mineral supplementation options, and monitoring to better understand correlations to lamb survival and overall population performance.

Brent Lonner, Montana Department of Fish, Wildlife and Parks

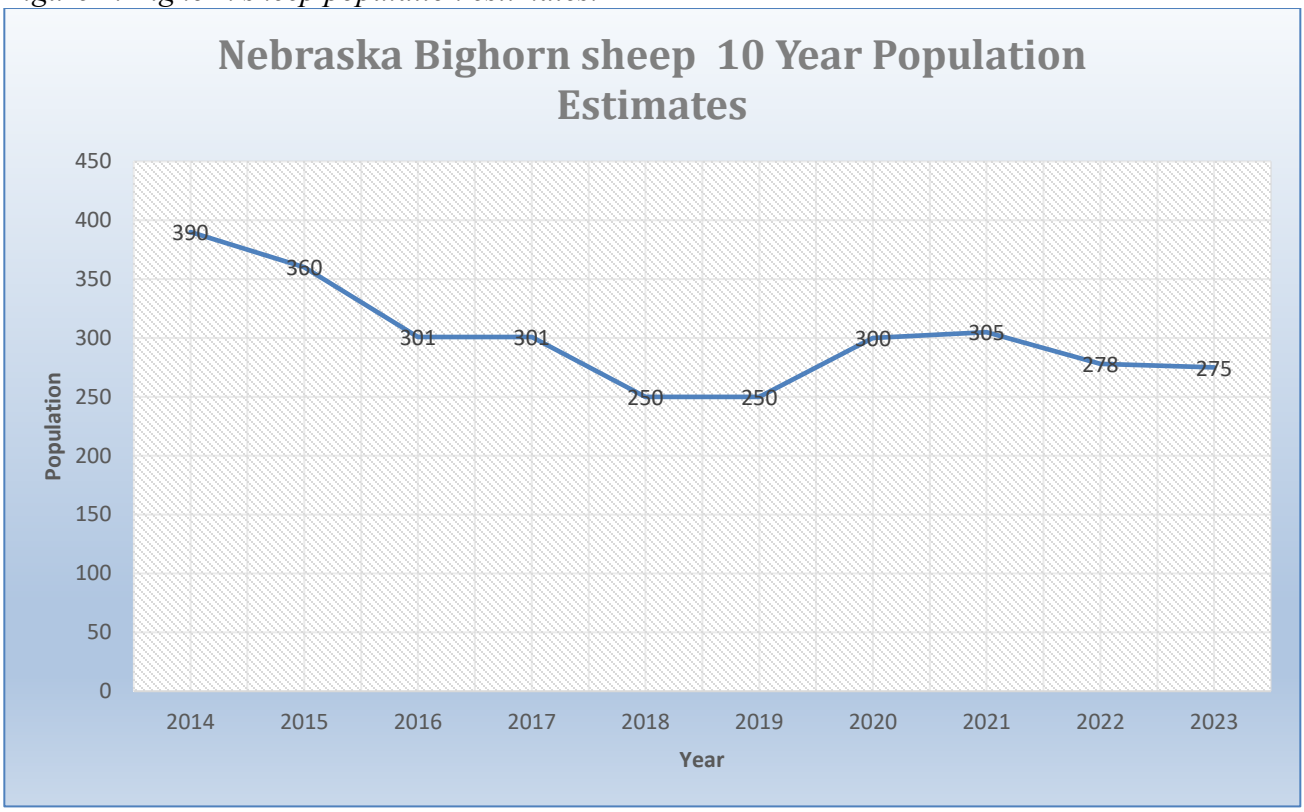
Nebraska

Rocky Mountain Bighorn Sheep

Populations

The Rocky Mountain Bighorn Sheep (RMBS) population consists of 5 herds totaling approximately 275 sheep scattered throughout western NE. After a nearly 100-year absence to the state, 1981 marked the first of 5 reintroductions to establish bighorn sheep back into their historic habitats. Over the past 10 years, RMBS numbers have declined by about 30% (Figure 1).

Figure 1. Bighorn sheep population estimates.



From 1981 to present, Nebraska has conducted 5 translocations of approximately 175 RMBS. One internal translocation was conducted in 2014. Other translocations are being considered in unoccupied habitats as RMBS become available for transplant.

Licenses and Harvest

Since 1998, 32 rams have been harvested in Nebraska with a success rate of 100%. Permits typically consist of 1 auction permit and 1 Nebraska resident lottery permit. Any sheep (ram or ewe) is allowed for harvest but only rams have been taken thus far.

Test & Remove

Over the past few years, the Test and Remove method has been implemented in 3 of the 5 herds showing some initial positive results with greater lamb recruitment in some regions. More recently, a bighorn sheep capture took place in February of this year experimenting and evaluating 3 different *Mycoplasma Ovipneumoniae* (Movi) detection methods. These included the standard lab tests through the Washington Animal Disease Diagnostic Laboratory (WADDL) as well as the Biomeme field testing unit (Table 1) and Working Dogs for Conservation. While there was not a 100% percent match between

methods, having in-field results with possible Movi detections did allow for more immediate management decisions to be made. Initial plans to transplant some of these captured sheep from this previously clean herd were put on hold until further evaluations can be made. Below are comparisons amongst WADDL and the Biomeme unit from the Hubbard's Gap and Cedar Canyon herds in Nebraska's southern panhandle. Kate Huyvaert, Washington State University, conducted the Biomeme testing and results analysis. Evaluation from the Working Dogs for Conservation is ongoing.

Disease testing will continue with each herd through future helicopter captures, darting and any mortalities, along with future plans to fill unoccupied habitats with RMBS sheep from clean herds.

Table 1. Movi infection and serologic status (proportion of total tested) by testing method. Animals were captured by helicopter and sampled during February 2023, Wildcat Hills, NE, USA.

	Hubbard's Gap (n=25)			**Cedar Canyon (n=11)**		
Test	Positive	Indeterminate	Negative	Positive	Indeterminate	Negative
WADDL PCR	0	0.04	0.96	0.18	0	0.81
Biomeme PCR	0.12	0.04	0.84	0.18	0.18	0.54
WADDL cELISA	0.36	0.12	0.36	0.36	0.18	0.45

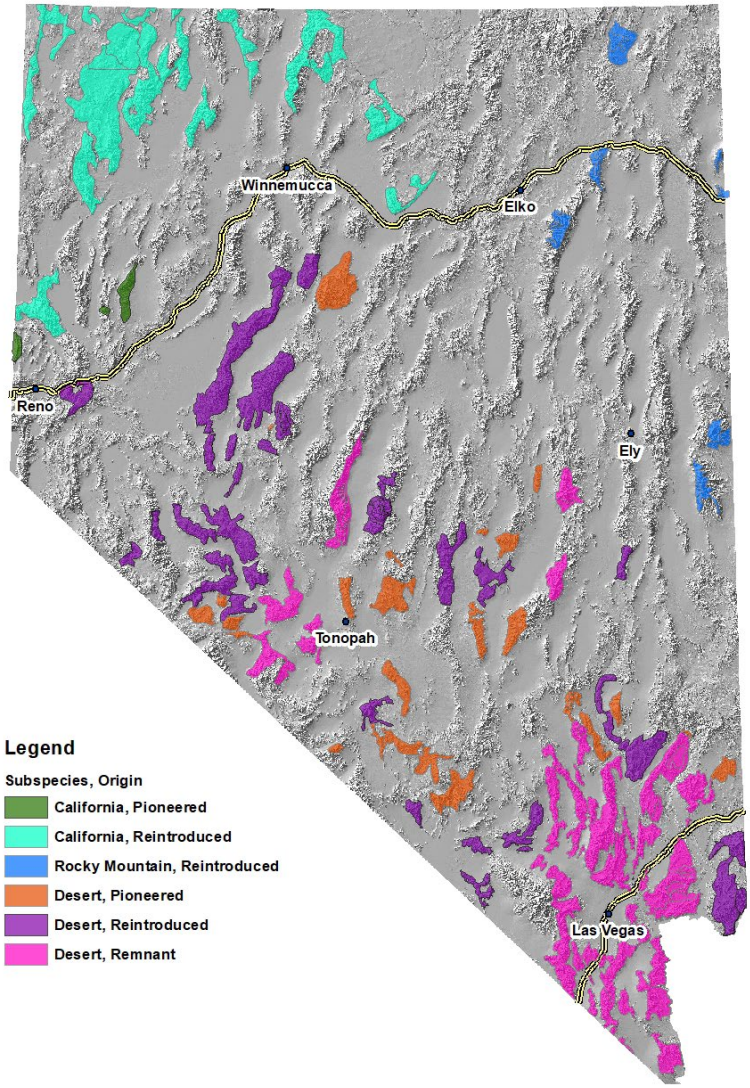
-Todd Nordeen, Nebraska Game & Parks Commission

Nevada

Bighorn Sheep

It is estimated based on historic explorer and naturalist records, well-documented anecdotes in early newspapers, broad paleontological data, and a geospatial analyses of bighorn terrain, that Nevada's bighorn sheep numbers prior to European settlement were 30,000 – 50,000. In the early 1900s bighorn sheep subspecies in Nevada was incorrectly surmised by a handful of skulls, no concept of landscape ecology, and no understanding of wild sheep propensity to disperse large distances (Cowan 1940 and Hall 1946). Recent genetic and morphometric analysis (Ramey 1993, 2000; Wehausen 2000) with full appreciation of no landscape barriers in the Mojave and Great Basin Deserts, correctly identified the entire state as a single desert bighorn subspecies adapted to a tremendous amount of climatic and elevation gradient.

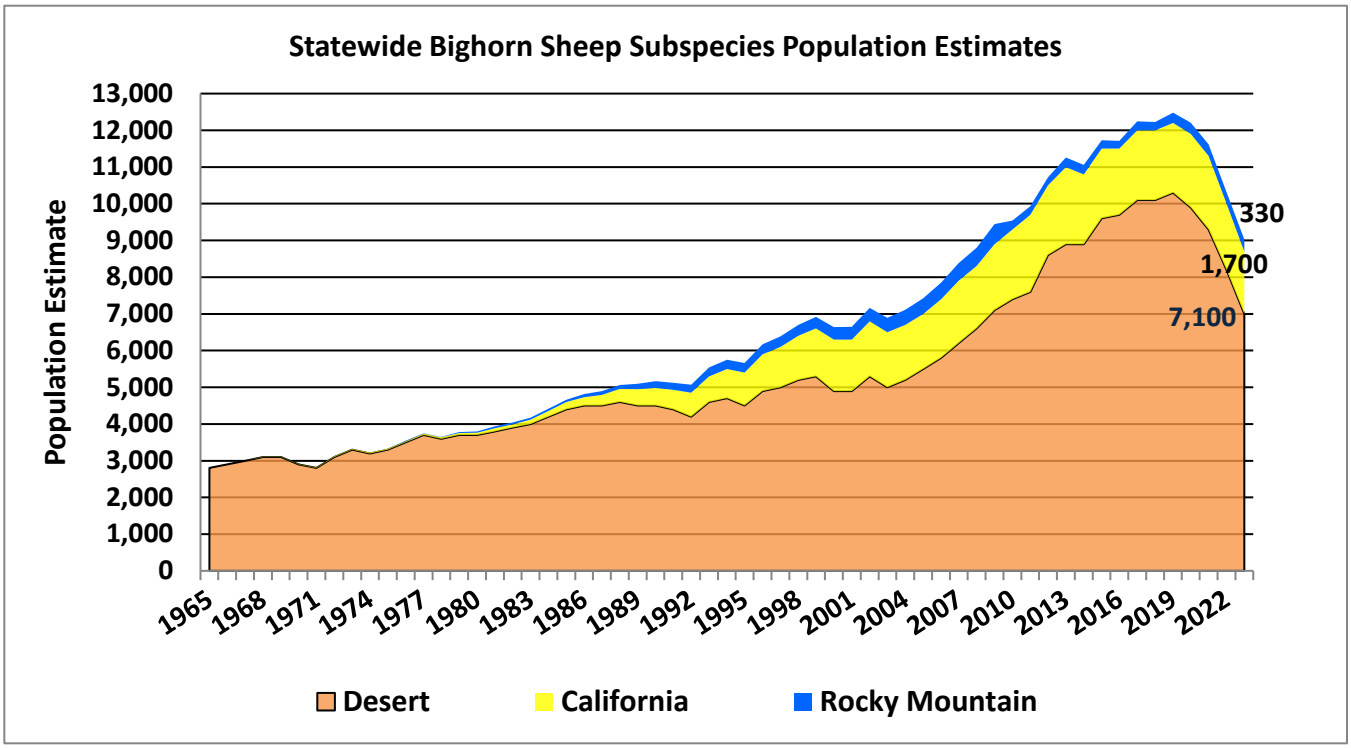
Figure 1. Occupied bighorn sheep habitat distribution of bighorn sheep in Nevada categorized by remnant, introduced, and pioneered in Nevada.



Nevada's bighorn sheep population was at its lowest in the late 1950s at approximately 2,500 primarily occupying the lower one-third of the state with the entire northern half of the state completely extirpated of bighorn primarily from pneumonia dieoffs contracted by comingling with domestic sheep that

numbered as high as 3 million in Nevada in the early 1900s. The first experimental bighorn transplants occurred in 1968 but it wasn't until the late 1970s that they were successful. To date, 2,111 desert bighorn were reintroduced, and 987 California and 326 Rocky Mountain bighorn were introduced into Nevada. Most of the transplants were highly successful with the peak bighorn population estimate in 2019 at 12,500. Due to disease, drought, and competition with free-roaming horses and burros, the 2023 statewide estimate dropped to 9,100 bighorn adults (Figure 2).

Figure 2. Statewide bighorn sheep population estimates by subspecies 1965 – 2022.



Recruitment and Population Performance,

Desert Bighorn

The 2022 statewide lamb ratio of 23 lambs:100 ewes from aerial and ground surveys was only slightly above the record low lamb ratios from 2021 and 2020, but well below rates necessary to maintain a stable population. Combined with above-normal adult mortality in some herds in 2022, Nevada's desert bighorn population experienced a large decline of 31% from its peak in 2019 at 10,300 to the 2023 statewide estimate of 7,100 adults (Figure 2). This decline is attributable to: 1) the multi-year drought, 2) continued high lamb mortality and elevated adult mortality from recent pnuemonia events, and 3) competition at and destruction of critical riparian/water sources from excessive feral horses and burros.

California Bighorn

Late summer 2022 aerial surveys classified 858 California bighorn sheep with an improved lamb ratio of 43 lambs:100 ewes compared to the low lamb ratio of 29 in 2021. Unfortunately, the multi-year drought, overgrazing and degraded riparian areas from excessive use by free-roaming horses and burros and cattle, and mountain lion predation continues to suppress population growth. The 2023 statewide California bighorn population estimate is 1,700 adults a slight decline from 1,800 in 2022.

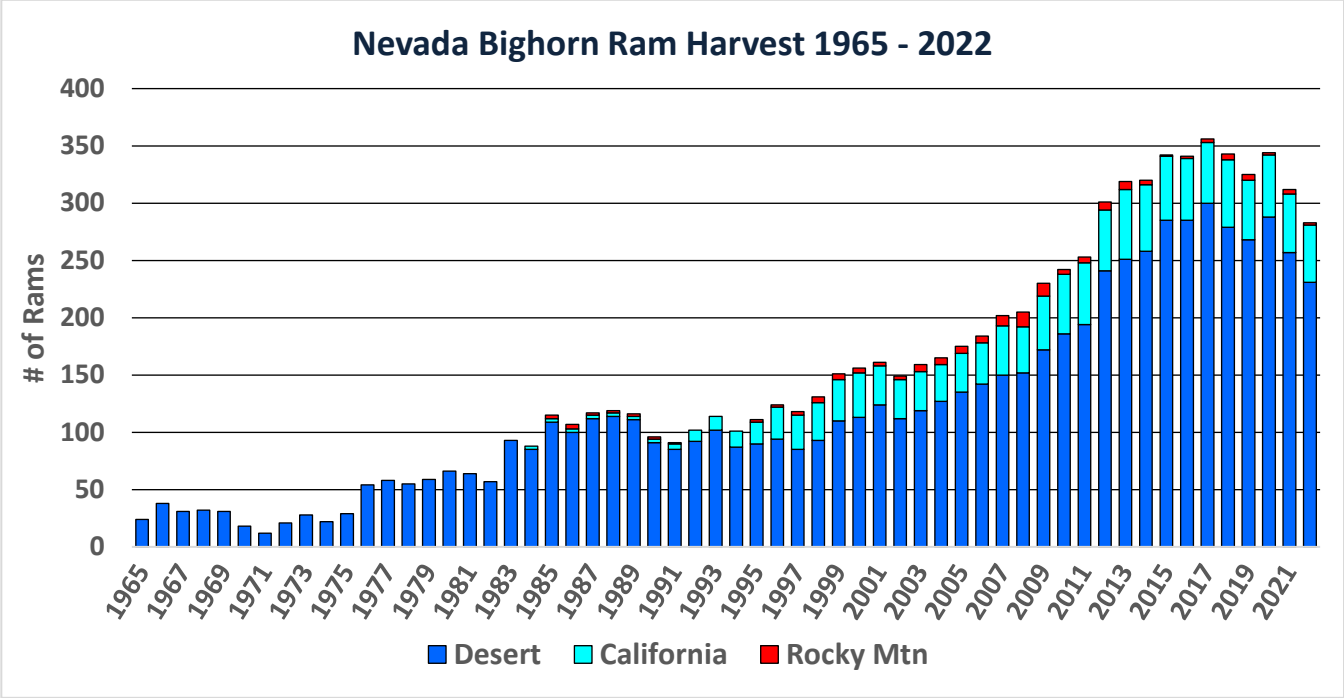
Rocky Mountain Bighorn

The statewide population estimate of the 6 Rocky Mountain bighorn herds is 330 adults.

Hunt Metrics for all Subspecies

Figure 3 depicts annual ram harvest for all subspecies since 1965. Peak ram harvest was 356 in 2017 with 300 rams being deserts. The most recent 2022 season saw only 283 rams harvested. The average age of desert bighorn rams was 6.8, slightly higher than the long-term average of 6.6 and California ram age was one of the lowest on record at 6.3. Currently, there are only 2 herds that have ewe hunts to manage their populations within their estimated habitat carrying capacity (water and forage availability). There have been up to 5 herds with ewe hunts since the first one initiated in Nevada in 2014. A total of 749 ewes have been harvested since 2014 with high hunter demand.

Figure 3. Ram Harvest in Nevada by subspecies 1965 - 2022



Disease and Herd Health

Pneumonia dieoffs have significantly impacted Nevada bighorn herds in the last 20 years. Approximately 40 of the state's 90 bighorn herds have experienced upper respiratory disease events. The impacts to the herds involved >20% adult loss the first year after the pathogen spillover and variable/cyclical lamb mortality lasting 1 to 18 years. It is estimated that over 4,000 adults died of pneumonia and innumerable lambs perished that would have normally been recruited into the population. Extensive disease surveillance and post event testing has confirmed *Mycoplasma ovipneumoniae* (*Movi*) as the "trigger" pathogen involving approximately 15 different strains. Most of the pathogen spillovers over the last decade have been bighorn to bighorn transmission.

Test and Remove

The first Test and Remove (T&R) project was initiated in 2015 in the Snowstorm Mountain California bighorn herd and key signs (test results and lamb ratios) indicate the herd has been cleared of *Movi.* The Santa Rosa California bighorn herd T&R began in 2021 involving 77 adults sampled through early 2023

and 7 actively shedding *Movi* that either died or were euthanized. This project is in collaboration with Oregon Department of Fish and Wildlife involving an interstate herd. A third T&R began in 2021 with the Nevada Test and Training Range desert bighorn herd that had its pathogen spillover in 2014. This involves a large metapopulation with 3 additional herds on adjacent BLM lands that all have connectivity. A total of 63 animals have been sampled with 3 actively shedding *Movi.*

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Mike Cox, Nevada Department of Wildlife

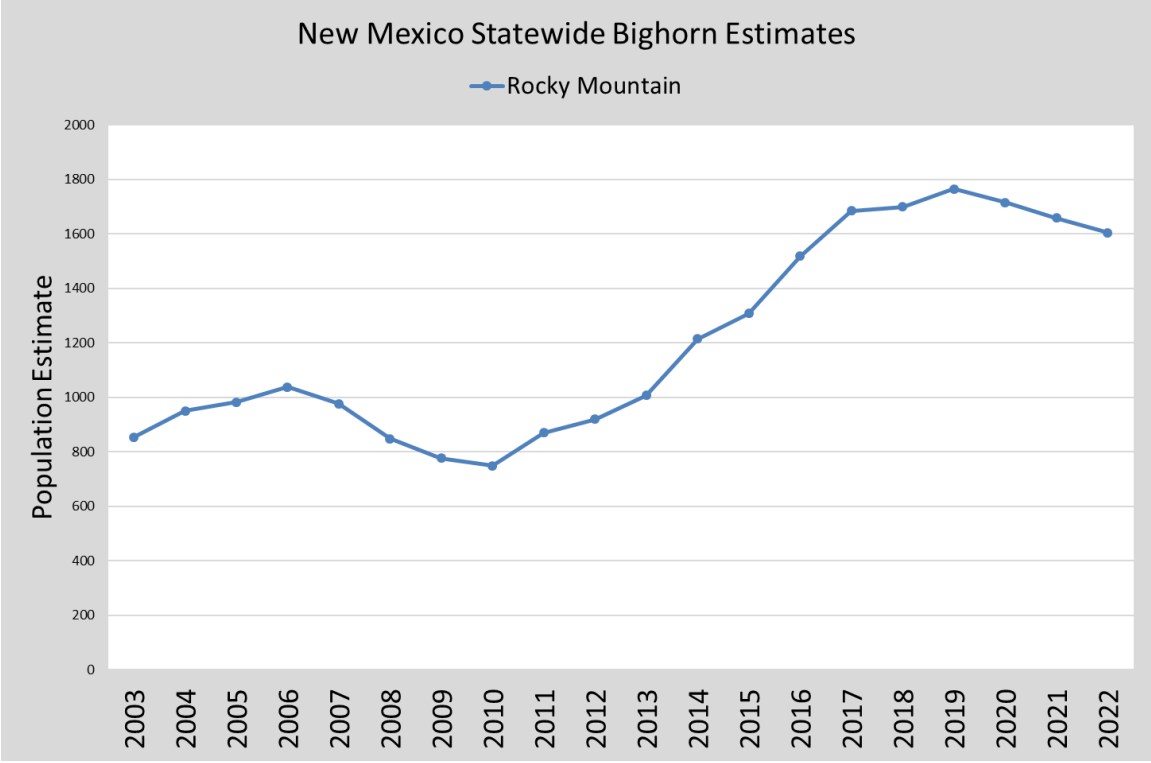
New Mexico

Rocky Mountain Bighorn Sheep

Population

New Mexico has observed slight declines in the statewide estimates for both Rocky Mountain and desert bighorn subspecies over the last five years. Decreasing numbers of Rocky Mountain bighorn are in part driven by the ewe harvest program implemented in the Rio Grande Gorge. The management objective was to decrease this burgeoning low elevation population that resides in close proximity to private domestic flocks of sheep and goats. Rocky mountain bighorn have been restored to all known historic habitat since their extirpation in the early 20th century and are now estimated near 1,600 (Figure 1) across 11 populations statewide. No obvious restoration sites remain, and only a few potential areas would be considered at this time. With the last translocation occurring in 2017, recent management has focused on optimizing hunter opportunity and tracking the spillover of *Mycoplasma ovipneumoniae* (M. ovi) into several naïve populations.

Figure 1. The estimated number of Rocky Mountain bighorn sheep throughout New Mexico (N).



Licenses and Harvest

Rocky Mountain bighorn sheep hunts occur in the Game Management Units (GMUs) shown in blue in Figure 2. These areas represent 9 of the 11 Rocky Mountain bighorn populations, while the remaining two are not hunted. Thirty ram licenses were issued in 2022 (Figure 3). A suite of metrics is used to inform ram harvest decision making throughout the state. In areas where bighorn populations use both tribal and public land, tribal harvest levels are also considered. The metrics that guide license determination for rams are 2.5% of local population size, 10% of total rams, and 25% of CIII and CIV rams. Success on ram hunts has been near perfect and averaged 96% from 2020-2022. Horn restrictions do not apply and the

bag limit is defined as any ram. The average age of Rocky Mountain bighorn rams harvested in 2022-2023 was 8.7.

Management ewe hunts for Rocky Mountain bighorn sheep were initiated in 2011 in the Latir Mountain herd, but ewe hunting has been limited to the Pecos and Rio Grande Gorge populations in recent years with 58 licenses issued in 2022 (Figure 4). Success rates on ewe hunts declined from ~ 75% since 2018 to ~ 60% in 2022. The number of ewe hunting licenses issued varies with population size and herd objective but has averaged around 21% of the estimated ewe segment resulting in a harvest rate averaging 11%.

Figure 2. New Mexico bighorn sheep hunts occur in the outlined GMUs, with orange boundaries indicating desert bighorn hunt units and blue boundaries indicating Rocky Mountain bighorn hunt units. Some GMUs are divided by major roadways indicated by green lines (e.g. GMU 20 North & South).

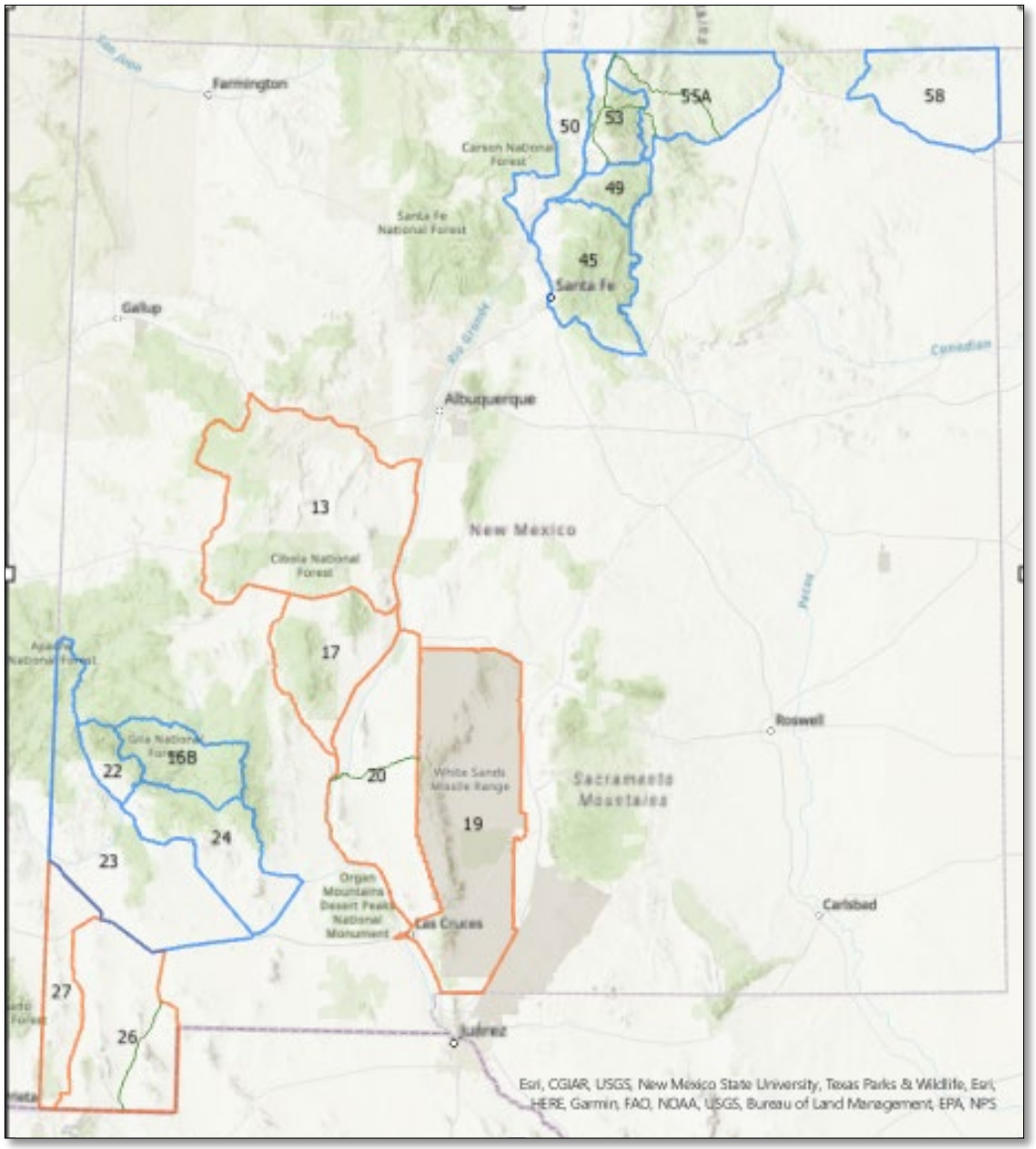


Figure 3. The total number of ram licenses issued annually for Rocky Mountain bighorn sheep and harvest rate as a percentage of the statewide estimate (N).

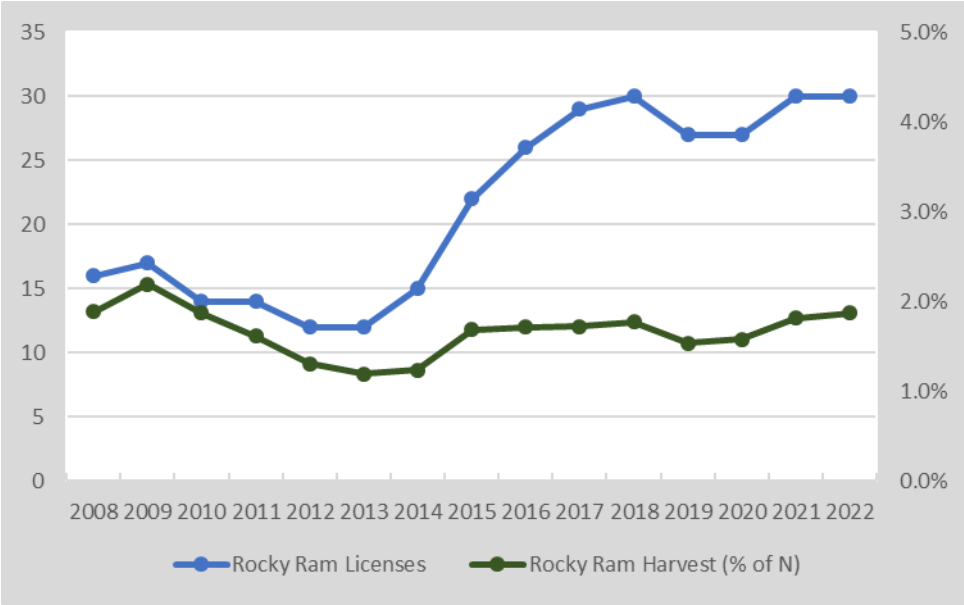
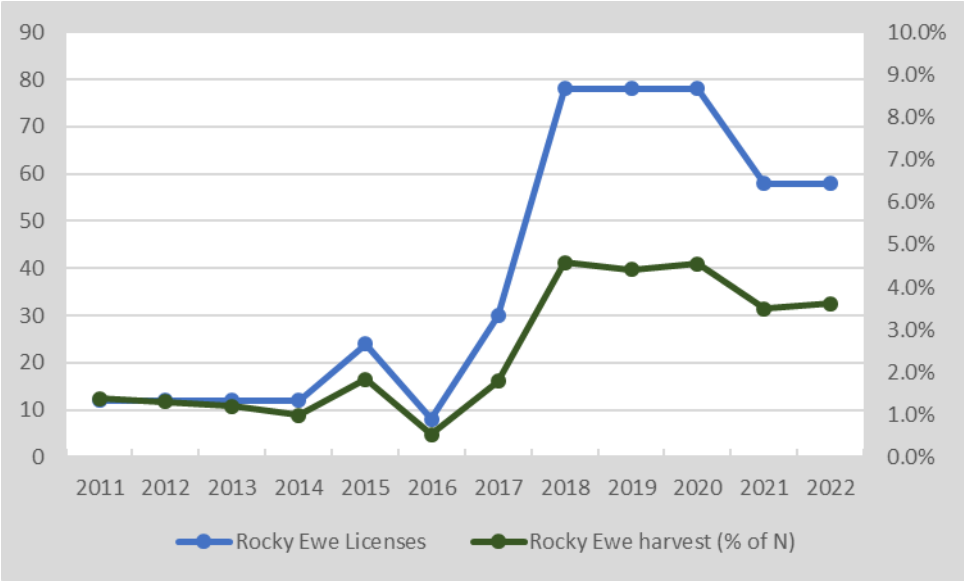


Figure 4. The total number ewe licenses issued annually for Rocky Mountain bighorn sheep and harvest rate as a percentage of the statewide estimate (N).



Disease and herd health

A ram mortality in the Red River population uncovered the spillover of M. ovi into this herd since previous testing done in 2017 and 2020 was negative for exposure. A collaring effort ensued here in March 2022 to facilitate monitoring a potential outbreak. M. ovi was also discovered for the first time in the Wheeler Peak herd, coinciding with the observation of 10-15 overwinter carcasses and

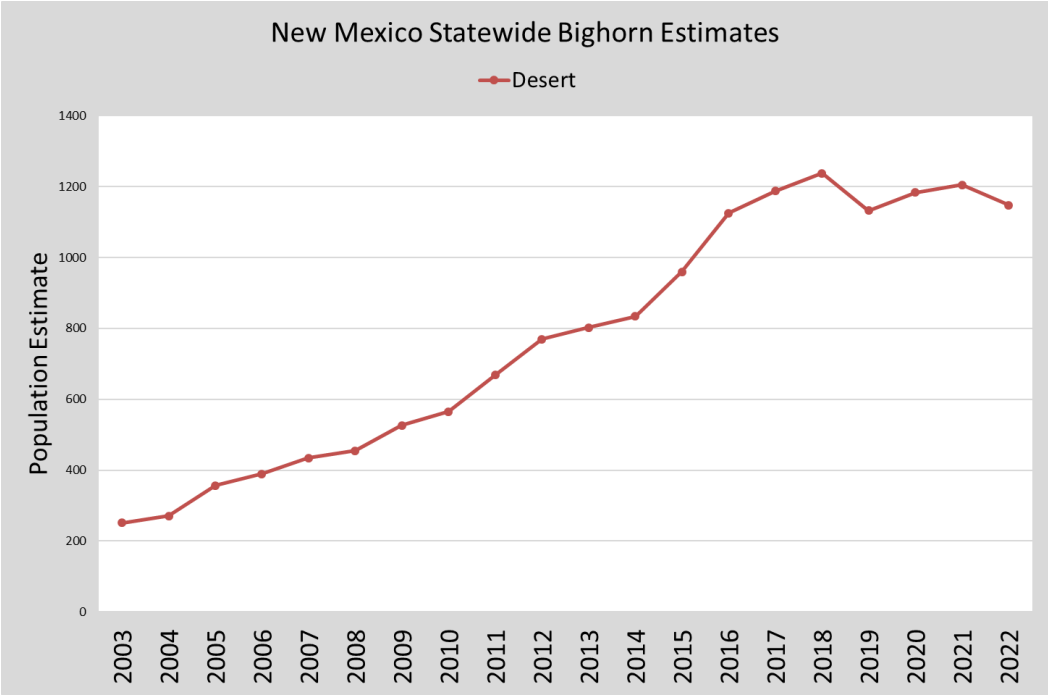
symptomatic sheep observed in July 2022, yet the July aerial survey resulted in one of the highest counts in recent years with a minimum of 200 bighorn observed. Notable changes in lamb:ewe ratios were observed in the Rio Grande Gorge (11:100) and Wheeler Peak herds (14:100).

Desert Bighorn Sheep

Population

The status of desert bighorn has improved since their state endangered delisting in 2011, but the statewide population has declined slightly in recent years to an estimate near 1,150 (Figure 5). Prior to 2017, M. ovi had only been documented in the San Andres desert bighorn population. As of 2022, M. ovi is present in four additional herds, including those adjacent to the San Andres in the central geographic region of New Mexico. Lion predation continues to be a leading cause of mortality in desert bighorn despite ongoing removal efforts within most desert bighorn ranges. Translocations to augment existing herds or restore populations continue. Most recently, desert bighorn were restored to the Alamo Hueco mountains in the "Bootheel" region southwestern New Mexico in 2021. A second release will likely occur in the Alamo Huecos within 1-2 years. Other vacant desert bighorn habitat remains on the landscape. With a few potential restoration sites remaining, harvest of desert bighorn ewes is not currently being considered.

Figure 5. The estimated number of desert bighorn sheep throughout New Mexico (N).

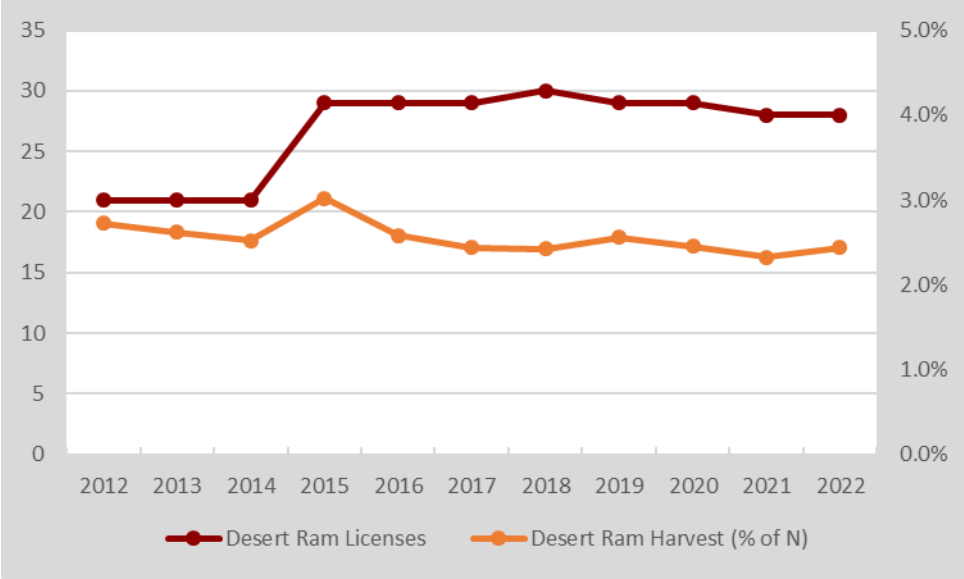


Licenses and Harvest

Desert bighorn sheep hunts occur in the GMUs shown in orange in Figure 6. These areas represent 6 of the 7 desert bighorn populations, with one not hunted. Twenty-eight ram licenses were issued in 2022. As with the Rocky Mountain subspecies, the metrics that guide license determination for desert rams are 2.5% of population size, 10% of total rams, and 25% of CIII and CIV rams. Success on ram hunts has

averaged 100% from 2020-2022. Horn restrictions do not apply and the bag limit is defined as any ram. The average age of desert bighorn rams harvested in 2022-2023 was 7.8.

Figure 6. The total number of ram licenses issued annually for desert bighorn sheep and harvest rate as a percentage of the statewide estimate (N).



Disease and herd health

No new disease events or pathogen detections occurred for desert bighorn in 2022. Spring lamb:ewe ratios were lower in the central herds (17:100) and higher in the Bootheel herds (59:100) compared to recent averages.

Caitlin Ruhl, New Mexico Department of Game & Fish

North Dakota

Rocky Mountain Bighorn Sheep

Populations

The North Dakota Game and Fish Department's 2022 bighorn sheep survey, completed by recounting lambs in March, revealed a record 347 bighorn sheep in the Little Missouri National Grassland of western North Dakota, up 4% from 2021 and 15% above the five-year average. The 2022 survey was the third consecutive record total and surpassed the previous record of 335 bighorns in 2021.

The 2022 survey saw an increase for the fifth consecutive year. Altogether, biologists counted 96 rams, 206 ewes and 45 lamb (Figure 1). Not included are approximately 40 bighorn sheep in the North Unit of Theodore Roosevelt National Park and 80 bighorn sheep in the Fort Berthold Indian Reservation.

The northern badlands population increased 4% from 2021 and was the highest count on record. The southern badlands population was unchanged at the lowest level since bighorns were reintroduced there in 1966.

Adult rams were down just slightly from 2021, and adult ewes were at record numbers. Unfortunately, following a record summer count of lambs, winter survival was only 54%, the lowest level on record and well below the long-term average. The lamb recruitment rate was also near a record low. Nearly six months of harsh winter conditions was the likely cause of poor winter survival of lambs.

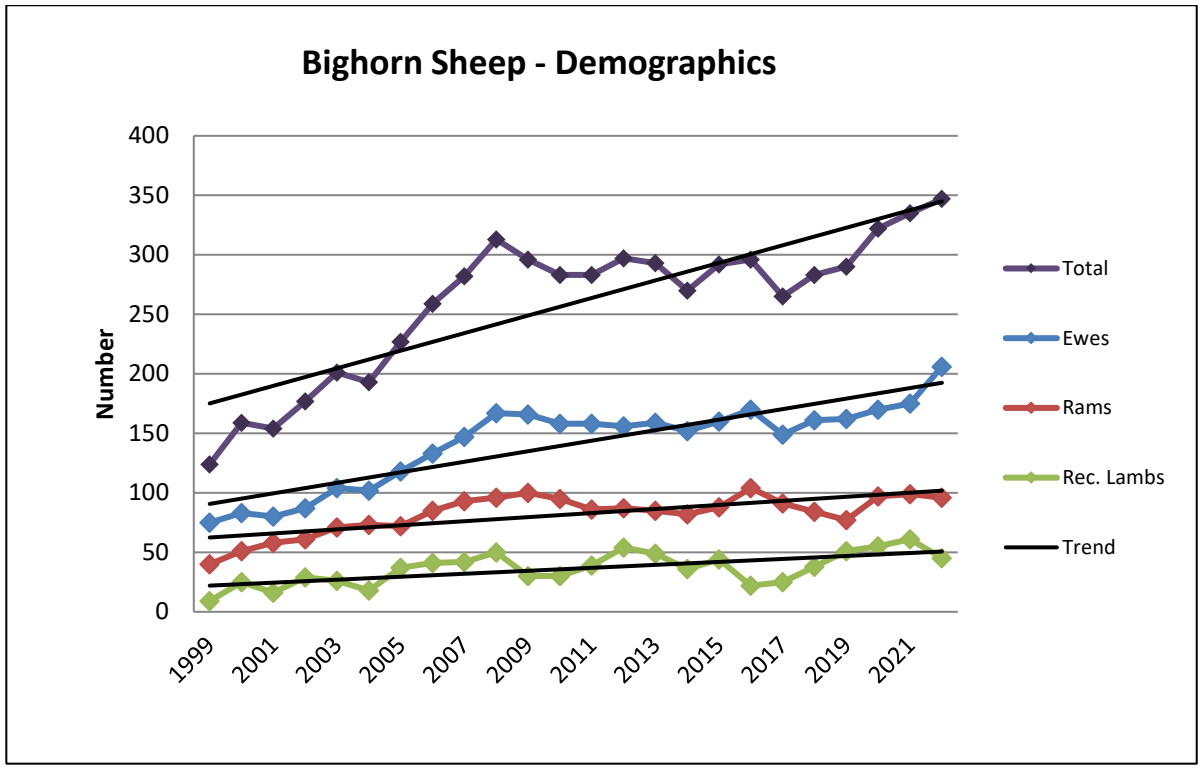
Department biologists count and classify all bighorn sheep in late summer, and then recount lambs the following March, as they approach 1 year of age, to determine recruitment.

Department staff, in conjunction with biologists from the Three Affiliated Tribes Fish and Wildlife Division, also reported the bighorn sheep translocated in January 2020 from Rocky Boy's Reservation in Montana to the Fort Berthold Reservation performed exceptionally well their third year in the state, as the population has nearly tripled.

There are currently about 470 bighorn sheep in the populations managed by the North Dakota Game and Fish Department, National Park Service and the Three Affiliated Tribes Fish and Wildlife Division.

Department staff were encouraged by the results of the 2022 survey considering the severity of the winter.

Figure 1. Population change not including populations at Theodore Roosevelt National Park and Fort Berthold Reservation.



Licenses and Harvest

A bighorn sheep hunting season is tentatively scheduled to open in 2023.The status of the season will be determined September 1, following the summer population survey. Game and Fish issued five licenses in 2022 and all hunters were successful in harvesting a ram. A total of 264 bighorn rams have been harvested in North Dakota since 1975, with a success rate of 98%. A record 19,423 applicants applied for a lottery license in 2022, including 314 non-residents.

Test & Remove

North Dakota experienced a significant epizootic in 2014. *Movi* was detected in 100% of mortalities. Despite the population currently at record numbers, animals that test positive via PCR during annual winter capture and collaring operations are euthanized. No detections occurred during 2021 and 2022.

Brett Wiedmann, North Dakota Game and Fish Department

Northwest Territories

Not Available

Oregon

Rocky Mountain Bighorn Sheep

Population

Oregon currently has nine Rocky Mountain bighorn sheep herds, six of which are viable. All extant Oregon herds are the result of re-introductions. Since the first successful release of 20 animals from Alberta, Canada in the Lostine River in 1971, 31 additional releases of 410 animals from 7 state or provinces including Alberta, British Columbia, Colorado, Idaho, Montana, and Oregon have occurred. Release size has averaged 13 but has ranged from a low of 2 or 3 animals to as high as 29 animals.

The combined annual population estimate for Rocky Mountain bighorns in Oregon has averaged 680 animals over the last 22 years (Figure 1) with a 2022 estimate of 800 – 900 animals. Fluctuations are primarily the result of pneumonia induced, all age die-offs followed by variable degrees of population recovery.

Harvest

Since Oregon began hunting Rocky Mountain bighorns in 1978, a total of 397 animals have been taken. Harvest has been primarily rams. Since 2001, an average of 9 controlled tags, 1 special auction tag, and 1 special raffle tag are allocated annually (Figure 2). Annual average harvest is 11 rams annually.

Figure 1. Recent population trend of Rocky Mountain and California bighorn sheep in Oregon, 2001 – 2021.

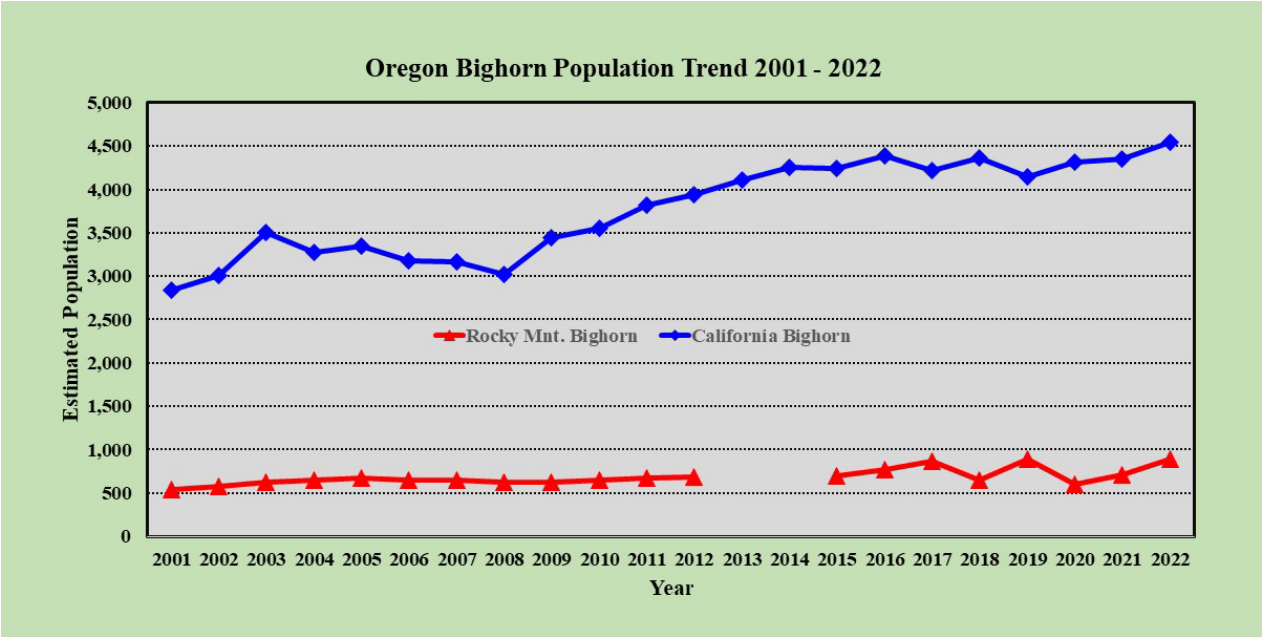
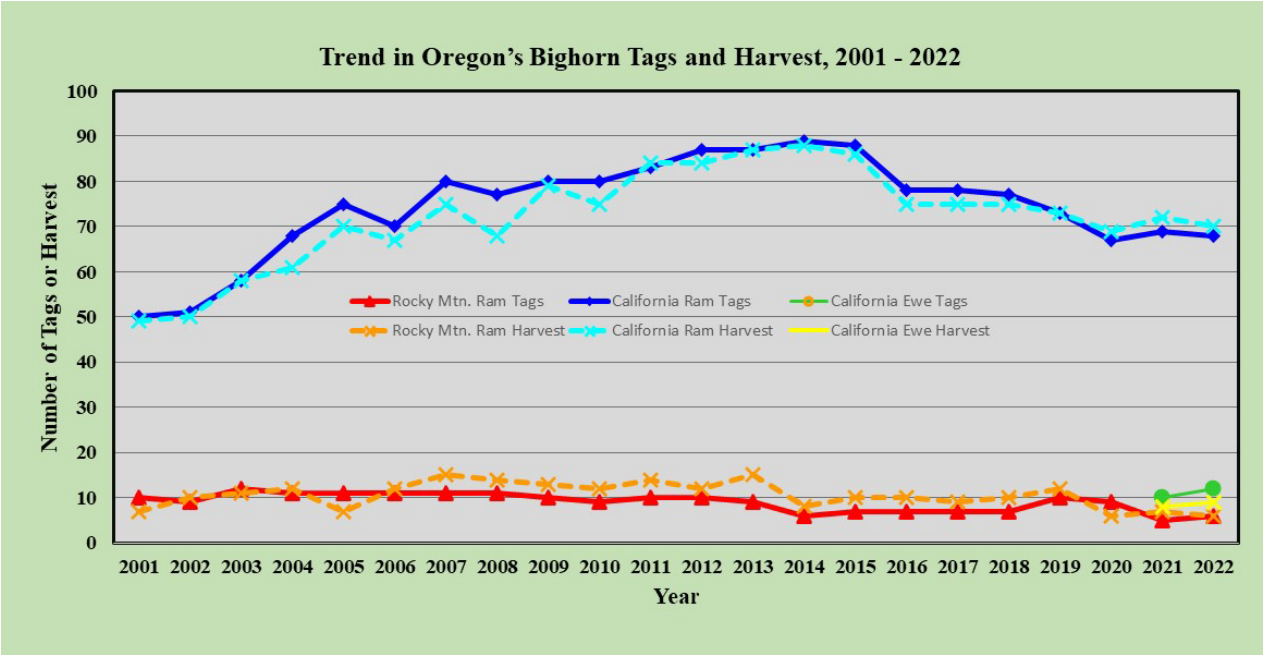


Figure 2. Recent trend of Rocky Mountain and California bighorn sheep harvest in Oregon, 2001 – 2021.



California Bighorn Sheep

Oregon currently has 30 extant herds of California bighorn sheep, all of which are the result of reintroductions. Since the first successful release of 20 animals from British Columbia, Canada on Hart Mountain National Antelope Refuge, 98 additional relocations of 1,343 California bighorns from Oregon have occurred. Seventy one of these releases (1,009 animals) were conducted within Oregon. Twenty seven relocations (334 animals) were Oregon animals released in 4 other jurisdictions (Idaho, Nevada, Washington, Wyoming).

The combined annual population estimate for California bighorns in Oregon has averaged about 3,800 animals in recent years (Figure 1) with a 2022 estimate of 4,000 – 5,000 animals. Fluctuations are primarily the result of pneumonia-induced, all age die-offs followed by variable degrees of population recovery.

Harvest

Since Oregon began hunting California bighorns in 1965, a total of 2,620 animals have been taken. Harvest has been primarily rams, but ewe harvest began in two herds beginning in 2021. Since 2001, an average of 74 controlled ram tags are allocated annually (Figure 2). Ten and 12 ewe tags were allocated in 2021 and 2022, respectively. Annual average harvest is 72 rams annually.

Disease Management

Oregon is currently conducting test and remove operations in 3 bighorn populations. Pneumonia induced by *Mycoplasma ovipneumoniae* (*M. ovi.*) was first detected in the Rattlesnake-Tenmile California bighorn herd in southeastern Oregon in 2012, with detection of mortalities beginning in 2015. During late winter 2019-2020, *M. ovi.* induced pneumonia was detected in the Lookout Mountain herd of Rocky Mountain bighorns along the Snake River in northeastern Oregon. By fall of 2020 the disease had crossed Interstate 84 to the west and *M. ovi.* was detected in the Burnt River California bighorn herd.

Test and remove operations began for all three populations during winter 2021-2022. In the Rattlesnake-Tenmile California bighorn herd, any animal testing positive is removed from a single positive is removed. In Lookout Mountain and Burnt River, 2 or more positive tests is required for removal.

Don Whitaker, Oregon Department of Fish & Wildlife

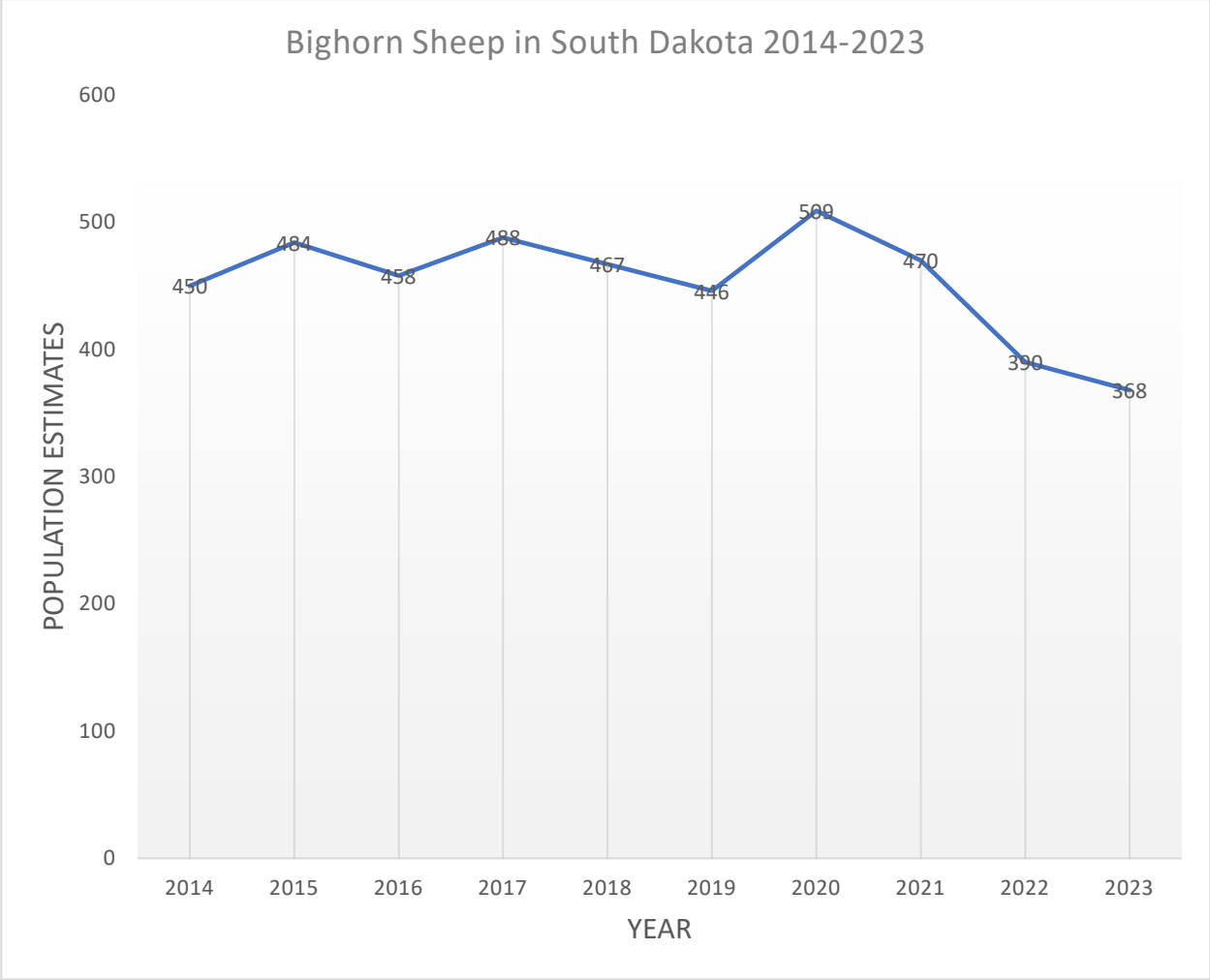
South Dakota

Rocky Mountain Bighorn Sheep

Populations

The Rocky Mountain Bighorn Sheep (RMBS) population consists of 6 herds totaling approximately 390 sheep scattered throughout western SD. Bighorn sheep were numerous on the prairies of western SD and the Black Hills before their extirpation in the late 1890s. United States Senator Peter Norbeck orchestrated their reintroduction in the early 1920s and this began a conservation success story where bighorns once again occupied their native habitats in SD. Unfortunately bighorn populations have fluctuated greatly since their reintroduction in the 1920s most likely due to pneumonia related mortality. In 2023, there an estimated 370 RMBS in SD (Figure 1).

Figure 1. Population trend, 2014 – 2023.



Licenses and Harvest

Going back to 1978 licenses offered have varied from 2 to 11. Harvest since 1978 has been at a success rate of 100%. Permits typically consist of 1 auction permit and several South Dakota resident random draw permits. Rams are only allowed for harvest. Ewes hunts can be implemented when deemed necessary.

Test & Remove

Unfortunately researchers in SD have documented bighorn disease die-offs in 4 populations related to pneumonia from *Mycoplasma Ovipneumoniae* (*Movi*) since 2004. To recover these populations SD has implemented the Test and Remove method in all 4 populations. In 3 of the populations (Custer State Park, Rapid City, and Deadwood herds) this method has successfully removed the *Movi* pathogen and allowed lamb survival to recover to normal levels. In the most recent population (Badlands) Test and Remove was just initiated in 2023. The Test and Remove method was important in reducing pneumonia related mortality in both adults and lambs and allowed recovery in 3 populations (Garwood et al. 2020, Ensrud 2022, SDGFP unpublished data).

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Ensrud, A. N. 2022. A post-pneumonia epizootic evaluation of the Rapid City, South Dakota bighorn sheep herd. M.S. Thesis, South Dakota State University, Brookings, SD, USA.

-Chad Lehman, South Dakota Department of Game, Fish, and Parks

Texas

Desert Bighorn Sheep

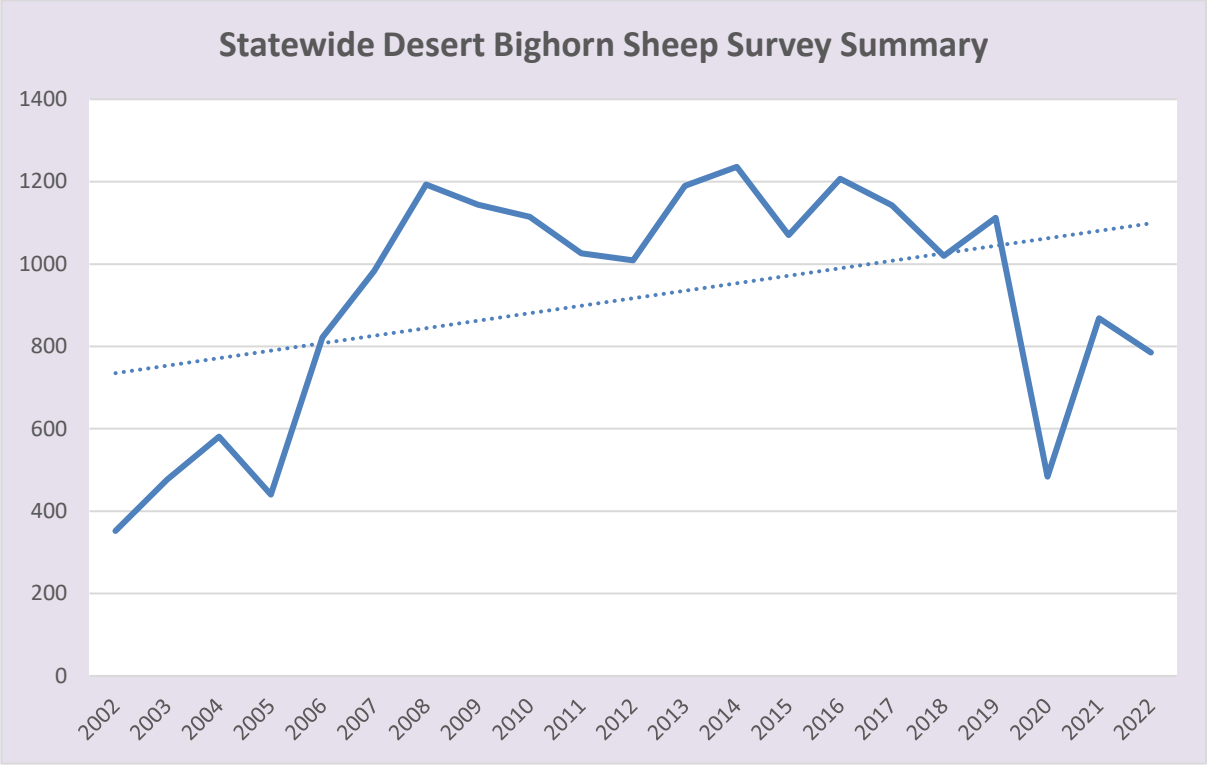
Population

Historically, desert bighorn sheep occupied 15-16 mountain ranges in the Trans-Pecos Region of Texas. It is estimated that as many as 1,500 desert bighorn sheep inhabited these mountain ranges in the 1880s, and possibly 2,500+ prior to 1880; however, by the early 1960s, native Texas bighorns had been extirpated. Early restoration efforts focused primarily on captive propagation and subsequent releases. Desert bighorns from various states, including Nevada, Arizona, Utah and Baja California (Mexico), were brought into Texas to help with captive propagation.

The population steadily increased to levels thought to be present in the 1800's. As a result, in December 2010, Texas began actively capturing free-ranging desert bighorns, on a 2- to 3-year cycle, and translocating them to restore unoccupied habitat, as well as to supplement existing populations. These efforts resulted in population growth to approximately 1,500 animals in 11 of their historic mountain ranges, where the population estimate remained for several years.

In the last 3 years, the population has declined to less than 1,000 animals, possibly due to disease. In November 2022, at the conclusion of annual aerial surveys, a total of 785 animals were counted (Figure 1).

Figure 1. 2002-2022 Statewide desert bighorn sheep survey summary.



Disease and Herd Health

The first known disease event was detected in the Fall 2019 in one population (Van Horn Mountains), followed by another in the Spring 2020 in a distinct population (Black Gap Wildlife Management Area). *Mycoplasma ovipneumoniae* was found in both disease events.

The Black Gap population appears to have since stabilized with a 2022 survey count of 117 animals and a ratio of 33 lambs per 100 ewes. The Van Horn Mountains' population is still struggling and only 6 animals were observed during the 2022 surveys. However, 2 weeks after surveys concluded, 16 animals were observed in the survey area. Close monitoring continues in both populations.

Licenses and Harvest

In 2018, the permit issuance and allocation system was changed from the system that had been in place since the late 1980s when desert bighorn hunting was reinstated in Texas. This change, which issues no more than 20% of the standing Class IV rams observed at time of survey, promoted the increase of permits and maximized hunting opportunities.

Since 2018, a total of 82 permits have been issued. Of those, 67 permits were issued to private landowners, and 15 to the State (auction and public draw system) with a 93% success rate. Due to the recent disease events and population decline, only 7 permits were issued in the 2022-2023 hunting season, which ends on the last day of July.

-Froylán Hernández, Texas Parks and Wildlife Department

Utah

Not Available

Washington

Not Available

Wyoming

Population

Rocky Mountain Bighorn sheep populations throughout Wyoming have declined since the early 1990s from an estimated 7,000 sheep in 1990 to a low of 5,800 sheep in 2019. Since 2010 bighorn sheep numbers have generally declined, but showed some recovery in 2019 (Figure 1). At least some of this estimated increase is due to prospering reintroduced herds such as the Ferris/Seminoe and Devil's Canyon populations. After the 2021 hunting season it was estimated there were about 6,400 bighorn sheep. License issuance and harvest (Figure 1) has similarly declined over the past twenty years. In part, the decline in licenses issued and harvest is linked to several things other than population trend including harvest success, average age of harvested rams, and hunter effort. Because bighorn sheep hunting is so coveted (and now a once-in-a-lifetime opportunity), managers are very conservative with hunting opportunity, but harvest over the past decade has been consistent with change in population size (Figure 2).

Figure 1. Estimated population size and number of rams harvested.

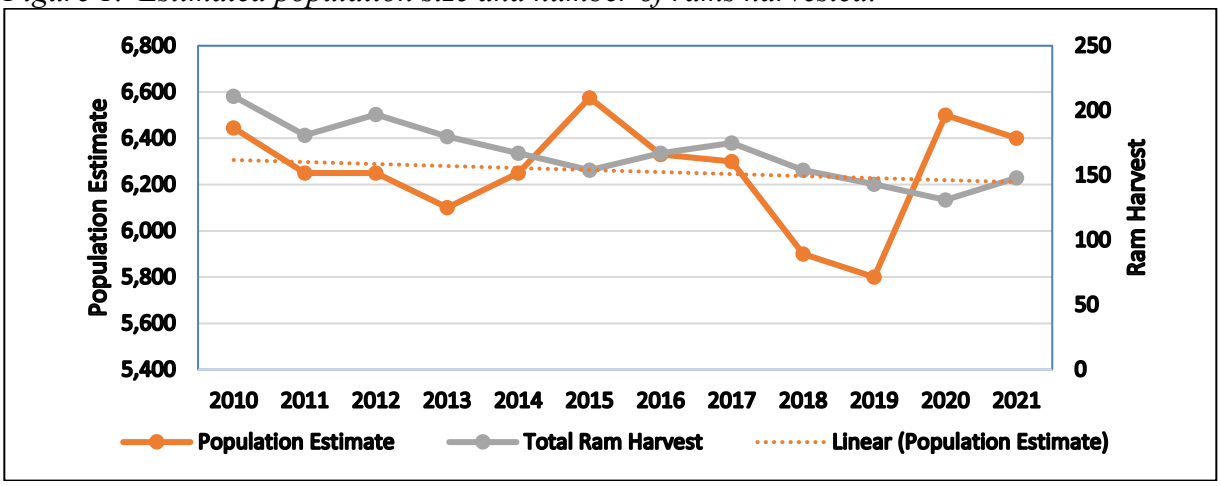
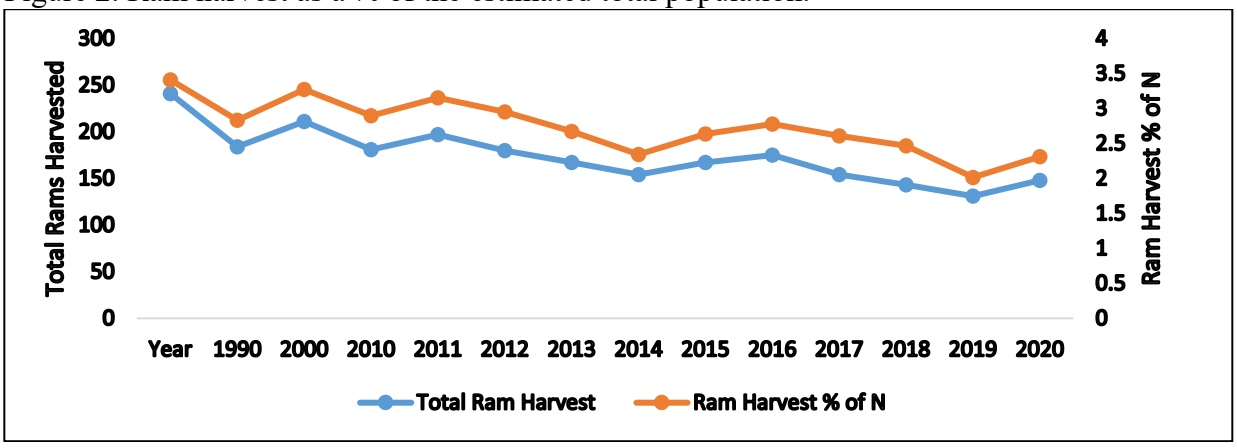


Figure 2. Ram harvest as a % of the estimated total population.



Disease and Herd Health

The Devil's Canyon herd in northcentral Wyoming experienced an all-age die off. Immediately following the end of the 2022 hunting season a significant mortality event impacted the Devils Canyon Herd. The death of a GPS collared ewe in Late October revealed another 36 sheep carcasses over the course of three days. Fresh carcasses were necropsied and samples sent to the Wyoming Game and Fish Department's Wildlife Health Laboratory. Four living sheep were removed by department personnel after exhibiting

clinical signs of pneumonia such as nasal discharge and extreme lethargy (unwillingness to move). Wildlife Health Laboratory staff concluded that this outbreak was triggered by a novel strain of the pathogen *Mannheimia haemolytica*. Disease related mortality continued through the fall and into the winter. By December 31, 2022: approximately 44% of the collared sheep (n=6 ewes: 6 rams) were lost to the pneumonia outbreak. Although the impact to the entire herd is not yet known, surveillance flights were conducted in November, December, January, and February where 30-83 sheep were counted. Spring recruitment surveys and summer trend counts will likely reveal the extent of this pathogenic episode.

Test and Remove

Given the significant and continual decline in bighorn sheep in the Whiskey Mountain Herd and following over a year's worth of in-depth discussion with other sheep experts, local managers and researchers took a novel approach for Wyoming and implemented "Test and Remove". The goal is to lower the prevalence of the pneumonia-causing pathogen, *Mycoplasma ovipneumoniae* (M. ovi), by removing "chronic carriers" and ultimately increase overall herd health and lamb survival. We decided to first test this approach with the smaller Red Rocks portion of the Whiskey herd. Testing for M.ovi has been conducted during captures each December and March since 2015. Based on these testing results, 11 ewes within the Red Rocks sub-herd have been removed (7 in 2022 and 4 in 2023). Of the 7 ewes removed between December 2021 and May 2022 during the initiation of this approach, detailed lab necropsies found 6 of 7 (86%) had chronic pneumonia and 4 of 7 (57%) had sinus masses. Of the 4 removed in 2023, 1 (25%) had chronic pneumonia and 2 (50%) had sinus masses. Though we have likely lessened the opportunity for mother-to-lamb and then lamb-to-lamb pneumonia transmission to occur, there are other untested ewes within this sub-herd from which transmissions could continue to occur. Lambing season in 2022 was the first glimpse at reproduction/survival after removing 7 of the chronic carriers. During 2022-2023 winter classifications, personnel counted 15 ewes, 7 lambs, 7 mature rams, and 1 yearling ram. This number of lambs (ratio of 47:100) has not been observed in this sub-herd in the past 6 years. In fact, this is more observed lambs than has been seen in the last 6 years combined. We are still in the beginning stages of the project, and are not making inferences about this increased number of lambs, but this is an encouraging step forward.

Daryl Lutz, Wyoming Game and Fish Department

Yukon

Not Available

Acknowledgements

Information in this report was provided by Wild Sheep Initiative members from the 20 Western Association of Fish and Wildlife Agencies (WAFWA) with wild sheep and compiled by Daryl Lutz. Contributors are listed after their respective state, province, or territorial report. We would also like to thank WAFWA Director Sponsor Brian Nesvik.