CHAPTER 1

BACKGROUND INFORMATION FOR BIGHORN SHEEP CONSERVATION STRATEGY

WILD SHEEP IN NORTH AMERICA

Origin

Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) are believed to be descendants of wild sheep from Asia, which migrated to the North American continent over the Bering Sea land bridge during the late Pleistocene (Clark 1964). Isolation of the ancestors of bighorn sheep in the western United States during the following Wisconsin glaciation period resulted in the differentiation of Rocky Mountain bighorn sheep and desert bighorns (*Ovis canadensis nelsoni*) (Korobitsyna et al. 1974 in Demarchi 2000). Today two species, Dall's sheep (*Ovis dalli*) and Rocky Mountain bighorn sheep (*Ovis canadensis*), are recognized by taxonomists in North America.

Early Distribution and Classification

James Clark, in his 1964 book titled *The Great Arc of the Wild Sheep*, described the distribution of wild sheep of the world as an arc extending across three continents from the islands of Corsica and Sardinia off the coast of Italy, and the middle east, through Central Asia and Siberia, across the Bering Sea to Alaska and south along the Rocky Mountains into Mexico and the lower peninsula of California. Within this arc all the species of wild sheep are distributed–the mouflons, urials, argalis, Asiatic, Dall's, and the bighorn of North America. Of the nine geographic races or subspecies of North American wild sheep listed by Cowan (1940), six are recognized today: Dall's (*O. d. dalli*), stone (*O. d. stonei*), Rocky Mountain (*O. c. canadensis*), Audubon (*O. c. auduboni*), California (*O. c. californiana*), and

desert (*O. c. nelsoni*). Taxonomists continue to debate the true existence of the California and the Audubon sheep races. Ramey (1999) recommends that the Rocky Mountain and California subspecies be treated as one subspecies (*O. c. canadensis*). His research was based on not only skull and horn measurements, but also protein and mtDNA analysis. Ramey and Wehausen (1996) also dispute the true existence of the Audubon subspecies, which was thought to exist in much of what is now eastern Montana.

The Audubon Sheep

With few actual specimens available of the Aububon sheep (*Ovis canadensis auduboni*), it was very difficult for early taxonomists to demonstrate the true existence of the subspecies. Lewis and Clark, in the early 1800s, and Audubon, in the 1830s, encountered bighorn sheep along the breaks of the Missouri River and the Badlands of North and South Dakota. Many years later, in 1901, C. Hart Merriam named this eastern population (*O. c. auduboni*). The type specimen was a young adult male from South Dakota taken in 1855. Audubon sheep were considered to be "heavier jawed" with "lighter pelage" and "darker eyes" than those of the Rocky Mountains (Couey 1950, Thompson 1950).

Cowan (1940) reviewed the classification of all North American wild sheep and based his conclusions primarily on skull measurements. He described the range of this eastern population as "the badlands adjoining the Missouri River in North and South Dakota, extreme western Nebraska, and probably into eastern Wyoming." He measured only two male (both four years old) and two female (one immature and one six years old) skulls from the eastern population area, none from Montana. He reported that *auduboni* ewes have wider nasal and maxillary widths and possibly mastoid breadth, while rams have wider basioccipital and longer upper tooth row length. He regarded the specimens as a "weak race" because of the slight cranial differences and small number of specimens. Ramey (1996) examined seven male (two from North Dakota, ages three and six; two from South Dakota, ages four and four; and three from Montana, ages seven, seven, and eight) and four female (three from Montana, ages four, four, and five) specimens. He found the upper row tooth length measurement in ewes to be longer for *auduboni* specimens than Rocky Mountain. For rams he found palates to be shorter and the cranial length measurement to be larger for *auduboni*. These few differences were not sufficient to persuade Ramey that *auduboni* deserved recognition, because similar variation was noted in other areas west of the Rockies and thus recognizing the Audubon subspecies would have necessitated designating many other subspecies. Also, based on the lack of geographic barriers between Rocky Mountain and Audubon, he concluded it is difficult to imagine that the two remained separate "especially given that during periods of Pleistocene glacial advance, most of the foothills of the Rocky Mountains and plains to the east were open steppe habitat and therefore, open to bighorn dispersal."

If one accepts the *auduboni* as a separate race or subspecies, then it follows that the race probably developed as a result of long periods of separation from those sheep occupying the Rocky Mountains to the west. Ken Thompson (1950) speculated that the breaks of the Missouri River were first occupied by badland sheep that then expanded their range down the Musselshell River to the Bull Mountains, eastward along the badlands of the Missouri River to its junction with the Yellowstone River, and into the Dakotas by way of the Missouri. Along the Yellowstone, the route of migration reversed and left well-established bands in the Glendive breaks, the Sheep Mountains around Terry, and then westward to about Forsyth. Thompson found no data documenting mountain sheep west of Forsyth. He continues that another branch of the Yellowstone movement moved down to the Powder River breaks and sent offshoots as far as the Chalk Buttes and the Finger Buttes of Carter County. Although this description is highly speculative, it does provide a good picture of the early distribution of the Audubon sheep in Montana. Picton and Lonner (2008) provide a series of maps depicting historical distribution of bighorn sheep in Montana (Figure 1). The earliest distribution of bighorn in Figure 1 is for 1890. By 1890, the impact of European man through excessive hunting and disease (scabies) had already caused major declines numerically and in overall distribution of bighorn sheep (Buechner 1960). It is quite likely that the historical distribution of bighorns in Montana was significantly greater than depicted in Figure 1 and included most of the western part of the state.

Most reports of the numbers of Audubon sheep observed in the late 1800s in eastern Montana were of "bands of five or six to fifteen or twenty" (Thompson 1950). Prior to this time, numbers were probably higher in the best habitats as witnessed by Lewis and Clark and Maxmillian in the early 1800s. Following a die-off of the Two-Calf herd in the Missouri

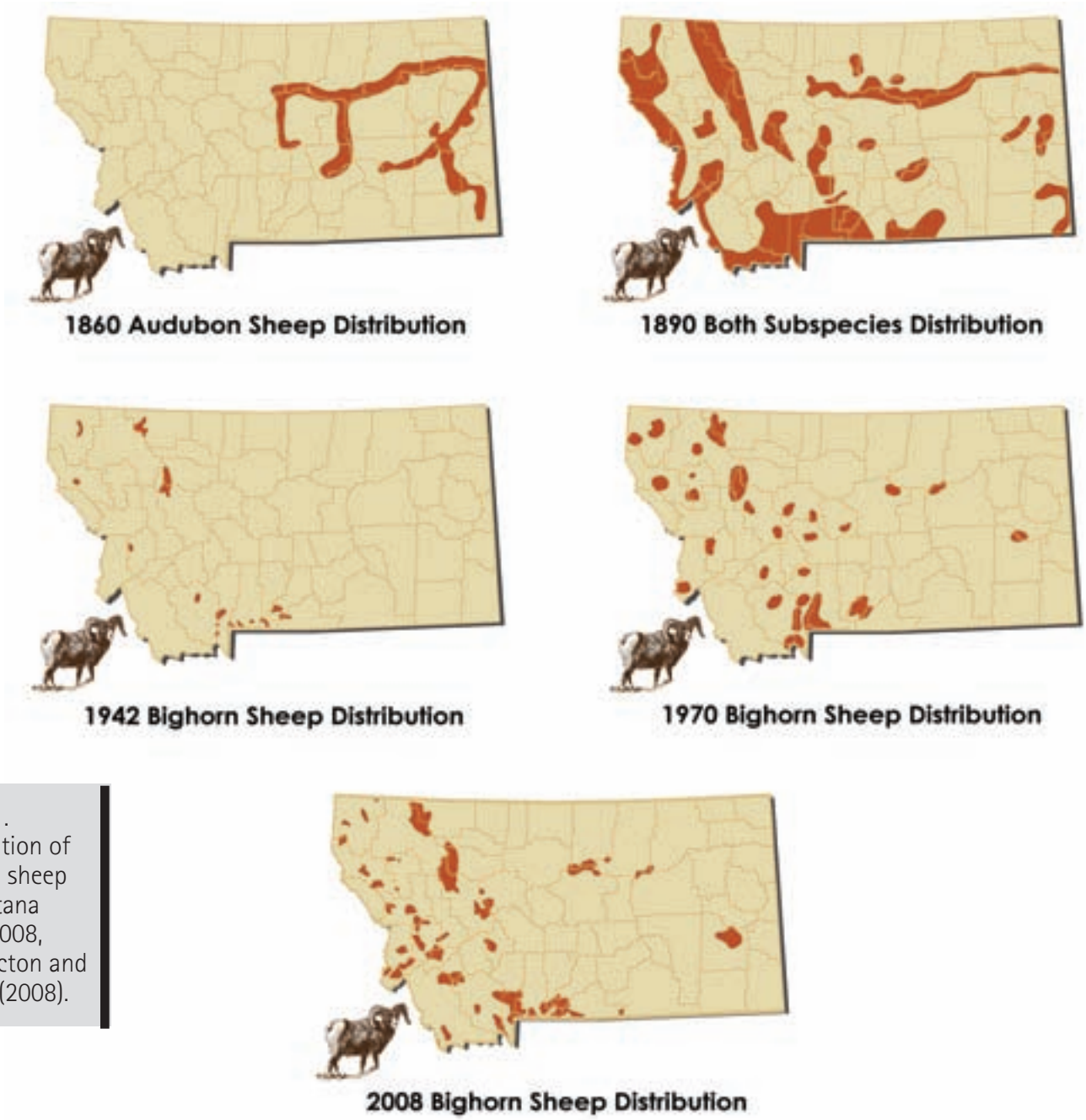


Figure 1. Distribution of bighorn sheep in Montana 1860–2008, from Picton and Lonner (2008).

Breaks, C. R. Watts, former FWP wildlife biologist, and Larry Eichhorn, former Bureau of Land Management natural resource specialist, speculated that Rocky Mountain bighorns (*O. c. canadensis*) might not be able to adapt to the breaks-type habitat (Eichhorn 1972). Today, as a result of transplants, the large number of Rocky Mountain bighorn along the Missouri River testifies to the fact that the habitat in that region can support large numbers of sheep and probably did prior to the westward movement and settlement of Montana.

The Lewis and Clark Expedition crossed into what is now Montana on April 27, 1805, and sighted their first bighorn near the current town of Culbertson on April 29, 1805. Ironically, this was the same day Lewis and another man killed their first grizzly bear (Moulton 1987). Lewis wrote in his journal that Joseph Fields of the expedition had first reported seeing bighorn earlier in North Dakota, near the junction of the Yellowstone and Missouri rivers. Clark first wrote about these animals when they "procured two horns of the animale the French Call the rock mountain sheep…" He continued that the Mandans called this sheep "Ar-Sar-ta" which Moulton (1987) determined was probably the Mandan term "ánse xte," or "big horn." On

May 25, the corps killed their first bighorn (river mile 133), about one mile below the old ferry and power plant, which was built in the 1800s to provide energy for mining in the Little Rocky Mountains to the north (Graetz 2001).

Ken Walcheck, in his 1980 *Montana Outdoors* magazine article titled "The Riddle of Existence: Audubon Bighorn Sheep," wrote that the journals of Lewis and Clark show 18 references of bighorn made east of the Marias River (possibly the Audubon subspecies). In his article, he also includes 48 separate sightings of bighorn within the area occupied by Audubon sheep. A list of sightings of Audubon sheep can also be found in Thompson (1950). He states that the last known Audubon sheep in Montana were reported as seen in the following areas: Powder River Breaks (1893), Chalk Buttes (1898), Larb Hills (1914), Glendive Breaks (1915), and Billy Creek in the Missouri River Breaks (1916).

The assumed last known Audubon bighorn at that time was killed at Billy Creek in 1916, within the Snow Creek Game Preserve, which was established in 1911 to protect the vanishing species (Thompson 1950).

Early Explorers and Early Recorded Distribution

The first sighting of an American wild sheep was recorded in California by the Spanish explorer Coronado in 1540. It was not until 1697 that a fuller description came from a Spanish missionary to California, Father Picolo (Nisbet 2005). Seton (1927) estimated that prior to 1800 there were between 1.5 and 2 million bighorn sheep across North America and into Mexico. Demarchi (1977) disputed this figure as being 10 times too high because bighorn sheep currently occupy a fairly narrow niche of habitat and Seton's area encompassed a wide expansive area, that included habitats not known to be occupied by bighorns.

On November 13, 1800, Duncan McGillivray and David Thompson, while exploring the waters of the Bow River near Banff, Alberta, came upon a band of sheep. Recognizing them as something new, they saved a complete specimen. This new animal was described by Dr. George Shaw in 1804 and named *Ovis canadensis canadensis*. In an 1803 issue of the scientific journal *Medical Repository*, edited by Dr. Samuel Mitchill, Duncan McGillivray described the expedition as follows: "While Mr. Thompson was taking a meridian altitude, I went forward with the Indian to have a shot" at a small herd of animals. McGillivray recorded the latitude and longitude of the place where the sheep was killed and noted the Cree name for the sheep translated as "ugly rein deer," that Canadian explorers called the animals "mountain rams," and that their flesh was "the sweetest feast in the forest" (Nisbet 2005). Nisbet speculates that, since Thomas Jefferson was well acquainted with the *Medical Repository*, and a friend of Dr. Mitchill, the president probably read about the existence of this animal and learned about the explorations of the Northwest Fur Company, perhaps encouraging him to launch the Lewis and Clark Expedition in 1804.

The History of Bighorn in Montana

Lewis and Clark recorded sightings of bighorn sheep 27 times while traveling through Montana in 1805 and 1806 (Walcheck 1980). The majority of the sightings of bighorns recorded on the expedition were along the Missouri and Yellowstone rivers. Lewis and Clark do not mention bighorns when they crossed the Rocky Mountains, but other references to their existence there can be found. Bradbury described Indian bows made from the male horns of an animal the French called "gros corne" (Thwaites, *Early Western Travels*, Vol 5, 1809-11), and Gabriel Franchers, in his voyage to the northwest coast of America described an animal with great curved horns like domestic sheep (Thwaites, Vol 6, 1811-14). Thompson "saw about 50 or 60 sheep in a herd" on the Clark Fork River near Saleesh House, March 24, 1810 (Nisbet 2005). Alexander Ross, in March 1824, subsisted chiefly on mountain sheep for about a month in Ross Hole in the Bitterroot Valley (Koch 1941). He stated that mountain sheep were plentiful in the mountains and reported one of the ram's horns measured 49 inches in length and had a circumference of 28 inches, weighing 11 pounds (Koch 1941). Bighorn sheep were also noted by Captain Mullan, a road engineer, in the peaks around the Deerlodge Valley (Koch 1941). Bighorn sheep were also well known in and adjacent to what is now Yellowstone National Park. Osbourne Russell, an early trapper in the West, noted bighorn in the area from 1834 to 1839 (Haines 1955). He issued this statement to hunters about the perils of sheep hunting: "Hunting sheep is often attended with great danger especially in winter season when rocks and precipices are covered with snow and ice but the excitement created by hunting them often enables the hunter to surmount obstacles which at other times would seem impossible."

Conquest of the American West – The Bighorn Sheep Decline

Although bighorn sheep were numerous in Montana and were used for food and other implements by Native Americans and the early explorers, the settlement of the West led to significant declines of bighorns and other big game species (Mussehl 1971). The causes most often cited were contact with domestic sheep, range competition from livestock, contraction of diseases, and subsistence hunting. Contact between domestic sheep and wild sheep has been implicated in several large die-offs of the latter. Often poor range conditions, severe weather events, and high numbers of wild sheep were cited as concurrent factors present during reported outbreaks of scabies, anthrax, lungworm, and pneumonia-related diseases.

Montana's largest bighorn sheep herd occurs in the Sun River drainage within the Rocky Mountains. Die-offs of this population were recorded in 1925, 1927, 1932, and most recently in 1984.

An estimated 1,500 bighorns were present in Glacier National Park in 1916, but had declined to 180 by 1965 (Biennial Report 1941-42 in Couey and Schallenberger 1970).

Attempts to save sheep included the artificial feeding of them along the Gardiner River in 1919, before the area was included in Yellowstone National Park (Picton 2002).

Other major die-offs in earlier years were noted in the Stillwater River and Rock Creek areas.

By 1930, bighorn sheep were reduced to small remnant bands and were considered by some to be an endangered or rare species (Couey and Schallenberger 1971). Poor range conditions and severe winter weather led to significant losses of sheep in the Sun River area in 1932 (Picton and Picton 1975). Couey and Schallenberger (1971) stated the department records of 1941 indicated bighorn were "at a low ebb both in density and distribution."

Reestablishment of Bighorn Sheep in Montana

The present distribution and status of bighorn sheep in Montana is due to improved range conditions, reduced competition for forage from livestock and other wildlife, reductions in domestic sheep and goats, regulated hunting, and transplanting. Prior to the turn of the century, public sentiment turned toward wildlife protection and predator control due to uncontrolled hunting, the fate of the buffalo, and low numbers of other game species. The following account of the early game laws comes from Couey and Schallengerger (1971):

The first conservation law, passed in 1869 by Montana's Territorial Legislature, closed the hunting season on introduced game birds. In 1872 the hunting season on buffalo, moose, elk, deer, bighorn sheep, mountain goats, antelope and hares was closed February 1 to August 15 each year. The first state laws of 1889 set the open season on bighorn sheep from September 15 – December 31. In 1895, the legislature established a board of Game Commissioners and specified a bag limit of 8 sheep.

The Montana Fish and Game Department was formed on April 1, 1901, and a charter created eight fish and game districts and authorized the appointment of deputies to enforce the game laws. The game laws became increasingly restrictive, and the limit on sheep was reduced to one each season in 1907. Ultimately the sheep-hunting season was closed statewide in 1915. In 1921, the Fish and Game Commission was given the power to open and close seasons. By 1935, a total of 46 game preserves had been established across the state (Musshel 1971) in an attempt to protect the remaining wildlife populations from hunting and human harassment.

At the turn of the century, Montana sportsmen, landowners, and agency personnel worked together to begin to restore Montana's wildlife populations. In 1910, elk from Yellowstone National Park were relocated to Fleecer Mountain, thus beginning the effort to restore wildlife populations through a trapping and transplanting effort. Butte and Anaconda sportsmen paid the cost of $5 per elk to cover the transportation. Soon after that, the first transplant of bighorn sheep into Montana occurred on the National Bison Range near Moiese in 1922, with 12 bighorn from Banff, Alberta.

Passage of the Pittman-Robertson Act in 1937 by the U. S. Congress initiated the Federal Aid in Wildlife Restoration Program, which provides federal funds from excise taxes on firearms, archery equipment, and ammunition to states for wildlife restoration projects. This funding allowed the Montana Fish and Game Department to begin a bighorn sheep research and management program in 1941, with the objective of increasing populations (Couey and Schallenberger 1971). Bighorn sheep slowly began to increase in the Sun River and a few other areas of the state. Acquisition of the Sun River Game Range provided winter range for elk, improving bighorn sheep winter range conditions in areas where range competition with elk was noted previously. Domestic sheep numbers decreased significantly beginning in the mid-1940s throughout Montana, reducing the potential for disease transmission and

competition for forage. The first effort to trap sheep in the Sun River area and move them to other areas, although unsuccessful, was attempted in 1938 (Picton and Picton 1975).

The 1941 research program culminated in the publication of a 1950 Montana Fish and Game Commission Bulletin titled "Rocky Mountain Bighorn Sheep of Montana" by Fay M. Couey. In the bulletin, Couey estimated that about 1,200 bighorns occupied 16 different areas within the state in 1950. The bulletin also provided an excellent description of the habitat utilized by bighorns, their food habits and behavior, susceptibility to disease and parasites, the influence of predators, and poaching. Couey's following observation provides a good summary of bighorn sheep status in 1950:

Most of the bighorn herds in the state are not increasing. Some remain in a static condition. Others may build to fair numbers and then suddenly die off from diseases. This fluctuation has been reported as occurring for the last fifty years, probably since white men came in and reduced their numbers by hunting; then they were crowded into small areas where they had to compete with other game, man and his livestock. Their low resistance to disease, coupled with a drain from predators and poachers, has been enough to keep their numbers in check.

Couey (1950) also recommended: 1) establishing a "ranch" to hold captured bighorns for disease studies and future transplant stock; 2) using salt blocks containing Phenothiazine to treat bighorns for intestinal nematodes; 3) offering limited permit hunting of rams; 4) trapping and transplanting bighorns to new areas to expand distribution; 5) controlling predators; and 6) posting signs to educate hunters on the characteristics of bighorns to prevent accidental shootings.

Although the "ranch" was never established and the salt-block treatments proved to be unsuccessful, the limited permit hunting season was reopened in 1953 when 30 licenses were issued and 20 sheep were taken. The number taken that year was less than 2% of the estimated statewide sheep population at that time. Conservative harvests, primarily focused at the larger male (¾-curl or larger) segment, were the norm until 1974 when adult ewe licenses were first implemented. Since that time, harvest levels have increased to control herd size in several locations.

Although the first transplant of bighorns into Montana occurred on the National Bison Range near Moiese in 1922, the availability of Pittman-Robertson (federal) funding provided the impetus for transplants of all game species including bighorns. From 1941 to 1950, new populations of bighorn sheep were established through transplants to Wildhorse Island in Flathead Lake, the Gates of the Mountains, the West Fork of the Gallatin River, and Billy Creek in the Missouri Breaks. From 1939 to 2009, 2,067 bighorns have been trapped within Montana for transplants within the state. An additional 465 bighorns were trapped in Montana and made available to other states for transplants, including Oregon, Idaho, Washington, Nebraska, Utah, Wyoming, Colorado, and North Dakota.

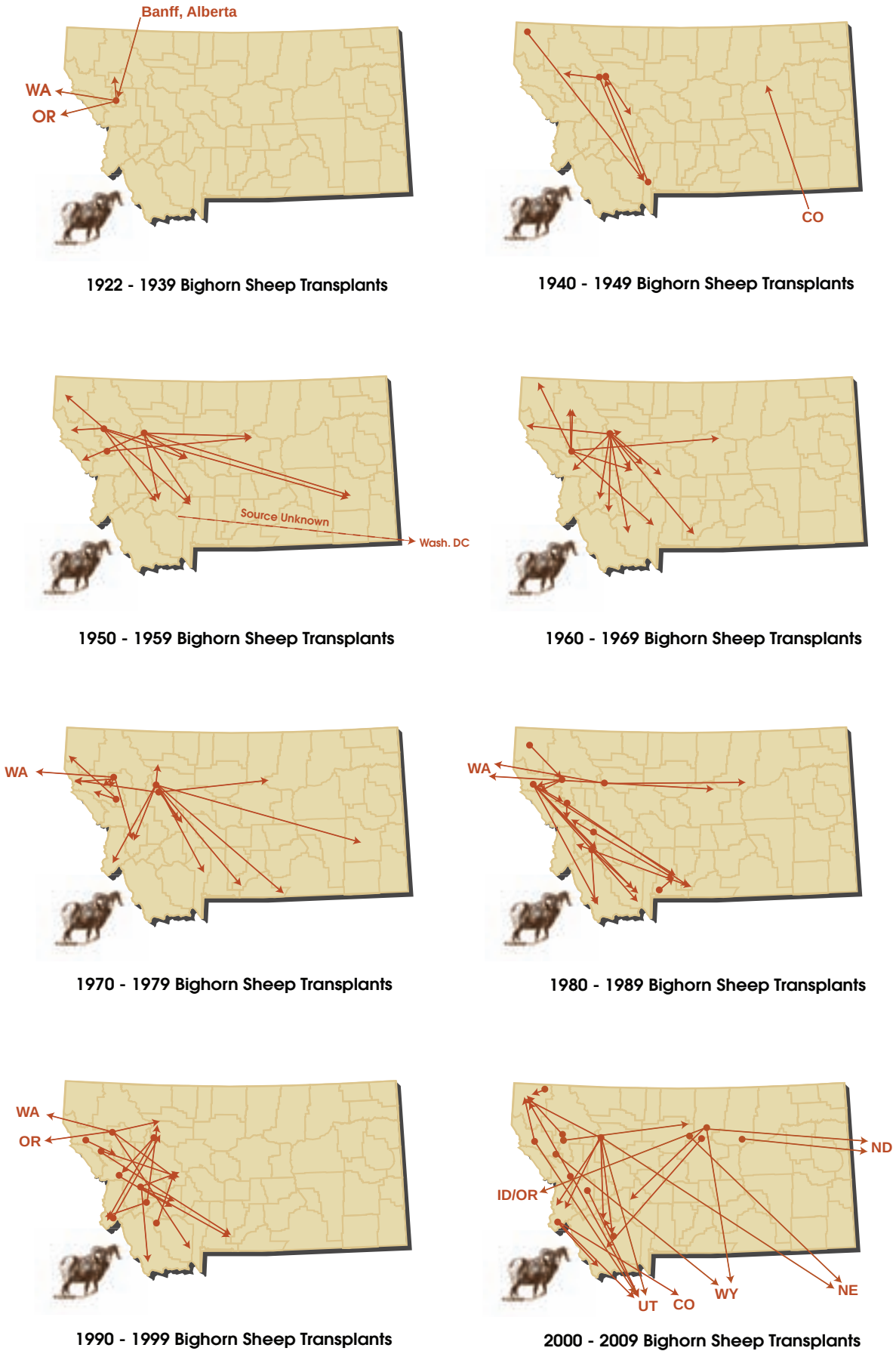
Since 1922, Montana has received 28 bighorns for transplants from other states or provinces. Sixty-six bighorns have been trapped for research efforts and zoos. Most transplants in Montana occurred after 1960. A majority of transplant source animals have either come directly from Sun River populations or from transplants established from Sun River stock (Appendix C). A graphical depiction of transplant history is shown in Figure 2.

Unpublished FWP Wildlife Division records show statewide bighorn population estimates by Merle Rognrud, then Wildlife Division bureau chief, of 2,000 in 1957 and 1,500 in 1968 based on the estimated percent of the population harvested. By the early 1970s, 11 major herds were known to exist in the state and 13 other areas had been stocked by transplanting. Of those areas with transplanted stock, at least four were considered not successful at that time.

Current Status

Today (as of 2008), there are 45 different populations in the state, with an estimated 5,694 total bighorn sheep (Figure 3). Figure 3 begins in the year 1950 as that is the first estimate of bighorn sheep numbers in Montana (Couey 1950). Seton (1929) estimated there were one and one-half to two million bighorn sheep in the west prior to European man arrival. Based on that estimate and with an abundance of suitable bighorn habitat in Montana it is reasonable to think historic numbers of bighorns in Montana could have been well above one hundred thousand. There are an additional 650 to 700 bighorns in Glacier National Park and Waterton Lakes National Park in Alberta, Canada (Kim Keating personal communication). The habitat occupied is diverse, from the badlands and breaks habitat of eastern Montana to the high alpine mountains of south-central Montana, and from the lower mountain foothills of southwestern Montana, including portions of Yellowstone National Park, to the intermountain valleys and higher elevations of northwestern Montana, Glacier

Figure 2. Bighorn sheep transplant history in Montana, 1922-2008, from Picton and Lonner (2008).



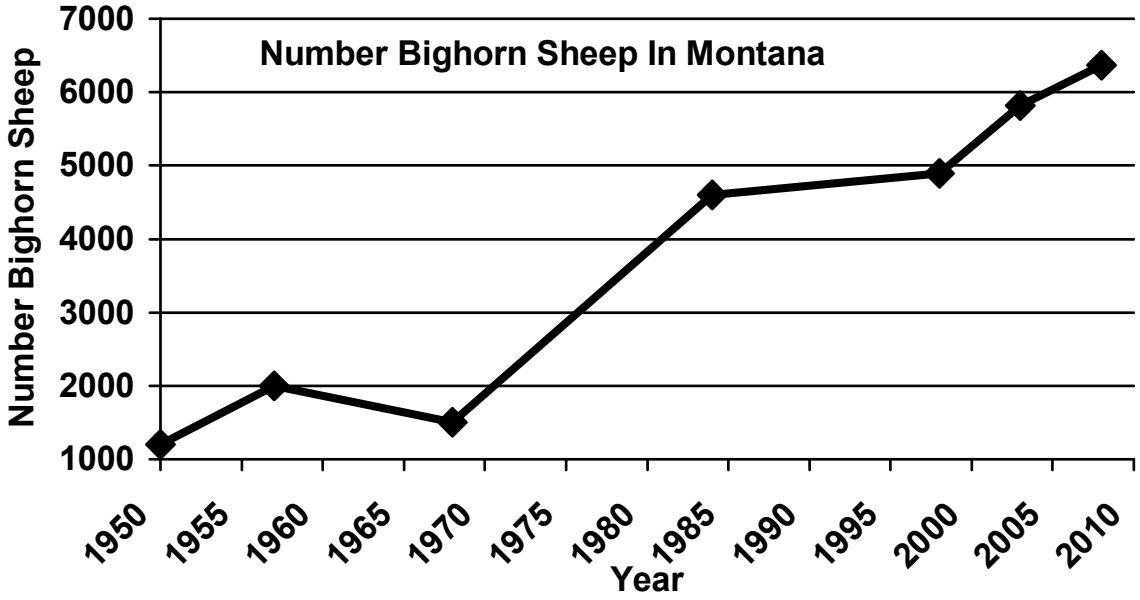


Figure 3. Trend in the number of bighorn sheep in Montana, including Glacier National Park and Waterton Lakes National Park, 1950-2008.

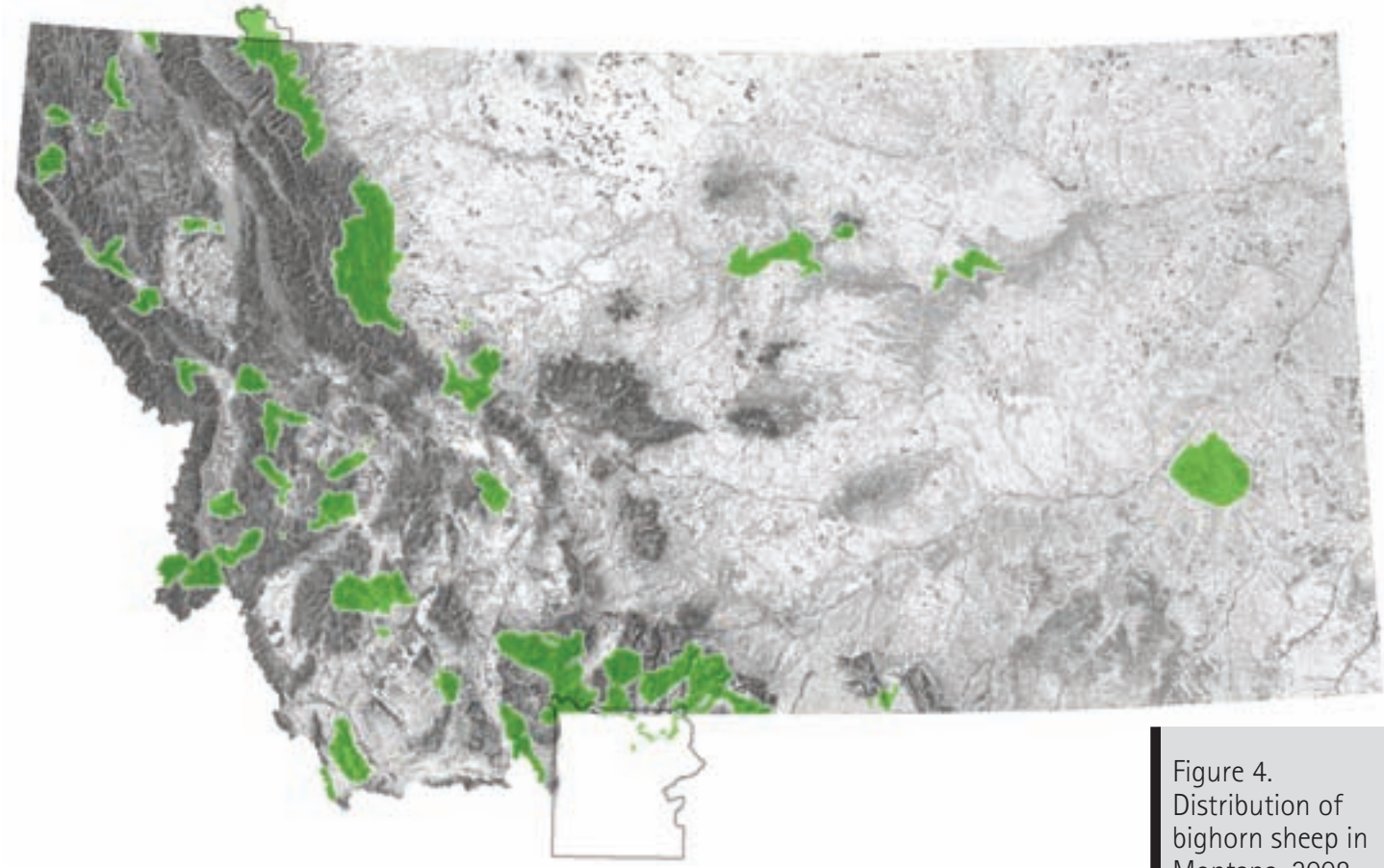


Figure 4. Distribution of bighorn sheep in Montana, 2008.

Park National Park, and Waterton Park in Canada (Figure 4).

Although bighorn numbers have partially recovered through transplant efforts, populations continue to, as Couey observed in 1950, "build to fair numbers and then suddenly die off." Bighorn sheep die-offs have been recorded in Montana since the early 1920s. Not only did the native Sun River herd experience die-offs, but those in Glacier National Park, the Stillwater herd in south-central Montana, and the Rock Creek herd in western Montana all experienced die-offs and were reduced to small remnant bands by 1930. Couey (1950)

described the cause this way: "The bighorns were primarily infested with lungworms (*Protostrongylus stilesi*) with secondary invasion of *Corynebacterium pyogens*, although *Pasteurella* was always present."

Nothing has changed during recent times, except the cause of die-offs has been further researched. Bighorn populations still build in numbers and suddenly die off. Since 1984 there have been significant die-offs in 14 bighorn populations as well as smaller declines in other herds (Table 1). Most native populations tend to experience periodic gradual declines or less severe drops in population due to weather events. Although many transplanted herds seem to prosper for a decade or two, they tend to be more vulnerable to the catastrophic all-age die-offs often associated with *Pasteurella* outbreaks. Although many transplanted herds tend to recover, often following augmentation, some do not, and those that do tend to be less in number and have reduced lamb survival for many years.

Most of the herds experiencing die-offs recovered, some due to augmentation, but the specter of another die-off still exists. Although many different attempts were made over the years to prevent die-offs from occurring, none were proven effective enough to be applied broadly. Thus, prevention turned into minimizing the effects of the die-offs by maintaining lower populations (herd segments generally less than 200), issuing adult ewe licenses and transplanting to control herd size, maintaining separation between populations to minimize interchange, maintaining separation from domestic sheep and goats to minimize disease transmission, and inoculating transplant stock to reduce likelihood of disease or parasite transfer to new areas.

Role of Hunting in Bighorn Sheep Management

Early Hunting Seasons

The passage of state legislation to protect wildlife and to create the first hunting seasons were predicated on the fact that once numerous and widely distributed wildlife populations in the West were declining or had completely disappeared by the early 1900s. Early efforts were made to control hunting through first establishing a license to hunt and then restricting seasons by time of year and the number of animals that could be taken. This was followed

Table 1. History of recent die-offs in Montana bighorn sheep populations, 1984-2008.

Population	Hunting District	Pre die-off number	Post die-off number	Native or Transplanted	Year(s) Transplanted	Year(s) of Die-off
Sun River	441, 421,423, 424	900	500	Native		1984
Ural Tweed	101	200	<100	Native	Augmented 1963	1999
Mickey Brandon Buttes	622	150	50	Transplanted	Transplanted 1980	1997,01
Kootenai Falls	100	100	30	Transplanted	1954, 55	1995
Spanish Peaks	301	200	<100	Native	Augmented 1944, 47	1999
Pryor Mtns	503	250	145	Transplanted	1971, 74	1995
Highlands	340	400	12	Transplanted	1967-69	1994
Tendoys	315	150	20	Transplanted	1984-86, 96	1994
Lost Creek	213	400	100	Transplanted	1967	1991
Beartooth WMA	455	300	50	Transplanted	1971, 73, 75	1984
Taylor/Hilgards	302	>100	20-30	Native	Augmented 1988, 89, 93	1997
Lower Boulder River	504	100	2	Transplanted	1985, 87, 89, 95, 97	1999, 2000
Sleeping Giant	381	115	39	Transplanted	1992, 93	2001, 06
Elkhorn Mtns	380	230	20	Transplanted	1996, 97, 00	2008

by further restrictions on the sex and size of the animal to be taken.

In 1872, the hunting season for bighorn sheep was closed February 1 to August 15 each year. Prior to that, there was no hunting season. Bighorn sheep could be taken at any time of the year, and there were no limits on the number that could be taken. In 1889, the open season was shortened again to September 15 to December 31. Then, in 1895, a bag limit of eight sheep was imposed, and the open season was set from September 1 to January 1. Based on FWP records compiled by Wildlife Division staff, the season in 1903 was set from September 1 to December 1, and the bag limit was one sheep. The first Montana resident hunting and fishing license was created in 1905, cost one dollar, and was valid for the whole family. In 1909, the sheep season was shortened to October 1 to December 1. In 1913, only rams were legal, and in 1915, the sheep season was closed in Montana.

Couey (1950) recommended opening a hunting season on bighorn in the Sun River area:

It would be desirable to take about 10 rams annually from the Sun River area by hunting. A regular open season would not be advisible as there is danger of taking too many. If these rams could be taken by a special license system under the supervision of Department representatives or guides, some benefit would be realized from the herd, no harm would be done, and the resultant activity might make the remaining sheep more alert and conscious of danger from humans.

Following Couey's recommendation, the bighorn sheep season was again opened in 1953 after 38 years of closure. A limited number of licenses for rams with at least a ¾-curl were made available in three areas: Sun River (Hunting District 42), Gallatin-Madison (Hunting District 201), and Stillwater (Hunting District 202). A sheep license that year cost $15 for both residents and nonresidents, and a drawing was used to award licenses.

Evolution of Regulation Types in Montana

As populations continued to expand in distribution and number, hunting seasons became more liberal. Although transplant efforts initially met with highly variable results, newly established herds provided another opportunity for expanded hunting. In 1954, hunting began in the Ural and Rock Creek areas of western Montana. A sheep season was also held for two years (1955-56) on the Fort Peck Game Range in eastern Montana. In the 1960s, hunting seasons were established in the West Fork of the Bitterroot (Hunting District 25), Clark Fork (Hunting District 12) near Thompson Falls, and in the Blue Mountains (Hunting District 760) of eastern Montana. A season was also held for two years in the Buck Creek/Dudley Creek (Hunting District 301) area of the Gallatin from 1966-67 and in the Armells Creek (Hunting District 482) area of the Missouri Breaks for four years.

During the 1970s, seven new areas were added. In 1975, the Sun River area (Hunting District 42), following the recommendations of a four-year research project (Erickson 1972; Frisina 1974), was divided into four new areas (Hunting Districts 421, 422, 423, and 424) to better distribute harvest (Erickson et al. 1976).

In the 1980s, an additional 12 hunting areas were established; some were portions of previously hunted areas, but several new areas were also included. In 1989, hunting in the Blue Mountains (Hunting District 760) was closed due to the lack of hunter access to private land.

During the 1990s southwest Montana was hit particularly hard with bighorn die-offs, and previously hunted locations were closed periodically. Closures occurred in the Tendoys (Hunting District 315), Highlands (Hunting District 340), Spanish Peaks (Hunting District 301), and Elkhorns (Hunting District 380). Hunting has since resumed in the Tendoys, and the population in the Spanish Peaks has recovered sufficiently for reopening that area.

Trophy Hunting

There have been numerous reports and articles in magazines discussing the pros and cons of harvesting older "trophy" rams. Morgan (1974) sparked considerable controversy when he questioned trophy ram hunting and what he called "the pro-hunting bias" of the state managing agencies. As a result, the Boone and Crockett Club co-sponsored a workshop in 1974 along with the Wildlife Management Institute and National Audubon Society to bring together all the evidence available at the time. This effort refuted "trophy" ram hunting as the cause of population declines, but also identified needed research. Coltman (2002) questioned harvesting older large-horned rams because of the potential to deplete genetic variation for large horns by removing genetically superior rams from the gene pool before they have a chance to pass on their genes. However, the study was conducted at the same time as a significant increase in the population; thus, the observed decline in horn growth could have been a result of density and nutrition factors. Singer and Nichols (1992) reported on the results of their 15-year study of heavily hunted Dall's sheep populations in Alaska. Their study

found no evidence that removal of all or nearly all rams with greater than ¾-curl for the first 11 years and greater than 7/8-curl for the last four years influenced productivity, recruitment, or survival.

Three-Quarter Curl Ram Seasons

Early seasons in Montana restricted harvest to greater than ¾-curl rams. With a few exceptions, this season type remains primarily associated with unlimited license areas today, where the number of sheep harvested is regulated by a harvest quota and the backcountry nature of the hunting districts.

No records were found that indicated why a greater than ¾-curl ram regulation was first recommended in Montana, but it was apparently first used in Wyoming in 1930 (Trefethen 1975). Merle Rognrud, an FWP game manager in Missoula at the time, indicated they typically looked at what was being done in other areas before recommending hunting seasons.

From its beginning in the 1940s, game management in Montana had three major objectives: 1) to develop and sustain the maximum game populations consistent with available habitats and other uses of the land; 2) to ensure maximum production and utilization of game surpluses; and 3) to provide the maximum possible amount of recreational opportunities for sportsmen (Mussehl 1971). As wildlife populations began to return to viable numbers, managers sought ways to sustain them within the habitat and other land use capacity while striving for maximum recreation by sportsmen. Allowing the harvest of a limited number of "surplus" older (¾-curl) rams fit well with these goals and was implemented widely throughout bighorn sheep ranges by the state management agencies of the time.

As populations continued to expand during the second half of the 20th century, regulations were liberalized, and hunter demand also began to influence greatly what seasons and bag limits were imposed. Since ram horns grow continually throughout life, the resulting natural curl of the horn lends itself to limiting harvest by horn curl size. The ¾-curl regulation was essentially a permutation of the old "buck laws" of the same time period. Since the ¾-curl regulation typically protected rams two to three years of age and younger, and knowing that rams typically can breed by 18 months of age (Nichols 1978), the ¾-curl regulation essentially provided some protection to maintain breeding potential, but allowed for nearly maximum sustained harvest of rams by hunters. There was an underlying premise, however, to begin harvest of the female segment early on to control population size within habitat carrying capacity, but this would take a few more years to develop.

Initially, the ¾-curl regulation in Montana was loosely defined. It was depicted in Montana hunting regulations as rams with horns crossing into the third quarter of a circle when viewed from the side (Figure 5). Although this early depiction was further clarified with wording changes in the regulations in the early 1970s, it wasn't until 1977 that the ¾-curl definition was essentially eliminated in favor of the current "legal ram" definition:

Judging A "Legal Ram" 3/4-Curl

When a straight line extending from the front base of the horn through any portion of the eye opening intercepts any portion of the horn, the ram is legal. If the horn is not long enough to be intercepted by the line, the ram is not legal.

Base of the horn shall be considered as the point where the horn meets the hairline of the head.

Determination of a legal ram should be made from a broadside view of the head.

Figure 5. Graphic depicting a legal ram according to Montana's definition.

During the preceding year, 1976, nine of the 14 sheep harvested in the Spanish Peaks (Hunting District 301) did not meet the previous ¾-curl regulation. Prosecution was attempted in four cases, two of which were successful. The county attorney felt the ¾-curl regulations were too obscure. As a result, the legal ram definition was recommended based on ram horn growth characteristics (i.e., although a few two-year-old rams would be legal under the definition, most three-year-old and older rams would have horn growth well beyond the requirement, thus making it easier for hunters to identify a legal ram in the field). At the time, a questionnaire was sent to all 1976 license holders (N=550) in

the unlimited areas (301, 500, 501, and 502). Out of 348 returned questionnaires, it was determined that 63% supported the proposed change in definition and 9% did not express an opinion one way or another; 28% opposed the change or offered another recommendation. It was stated by the department at the time that the proposal was favored by the public because:

1) It is simple much easier to apply.
2) It is well defined, with specific and interpretable reference points.
3) It is less subjective than the current one.

Influence of Age, Habitat, and Environmental Conditions on Horn Growth

Because ram horns grow throughout life and approximate a full circle at maturity, the legal age of rams for harvest has been defined by the degree of horn growth (the portion of a full circle) attained. Male mountain sheep possess three basic horn forms: convergent (tight curl); parallel (medium or average curl); and divergent (open or flaring curl) (Clark 1964). Although the subspecies tend to possess different forms of horn growth, there is considerable variability within each subspecies. Geist (1971) categorized rams using age and horn growth characteristics into four classes. Class IV rams were those eight years of age (rarely seven) or older with horns protruding well beyond eye level. If broomed (broken tips), the tips must reach at least the eye level if the ram is to be included in this class. He described these rams as the leaders of bands, doing most of the breeding, and as the most dominant sheep. Rams from different areas tend to reach the same curl category at nearly the same age, but the size (mass and horn length) of their horns can vary greatly. This variability is thought to be a result of genetics, habitat, and environmental conditions.

In Montana, many of the largest rams taken have come from transplanted herds. Examples include the Missouri Breaks (Hunting Districts 482 and 680), Flint Range (Hunting District 213), Rock Creek (Hunting District 216), and the Highland Mountains (Hunting District 340). Yet the breeding stock from these areas has come from the Sun River herd, which is not noted for producing the largest rams. Hook (1998) compared the horn growth by age class of 703 bighorn rams harvested from four areas of Montana from 1978 to 1997. Data from the original Sun River herd was compared to the three transplant populations in Lost Creek, Upper Rock Creek, and the Missouri River Breaks. The analysis showed greater horn growth in the transplanted herds than in the parent population, particularly in the younger age classes.

Picton (1994) reviewed the horn growth characteristics of 59 rams representing 18 Montana hunting districts. The study compared ram horn measurements based on herd location, horn mineral content, and precipitation. Rams from high-altitude areas surrounding Yellowstone National Park have long been known for their smaller, tightly curled horns. Although previous work (Stewart and Butts 1982) had proposed that the difference in horn size among different populations could be related to genetic bottlenecking and consequent inbreeding, asymmetry measurements by Picton did not support this hypothesis. Picton stated, "It appears that the sheep of the high-altitude ranges surrounding Yellowstone National Park may represent an adaptive suite that includes smaller tightly curled horns." The iron, aluminum, magnesium, phosphorus, calcium, lead and zinc mineral levels reported previously for this area also did not show significant correlations with annual growth increments (Picton and Eustace 1986). The study did find that areas notable for large horn sizes had particularly high rates of growth in the early years of life (ages two to four).

Either-sex and Any-Ram Seasons

Either-sex licenses were first utilized in 1961 in the Rock Creek area (Hunting District 220) in an attempt to initiate some ewe and younger ram harvest. Although the regulation was also implemented in the Bitterroot area at about the same time, it was not until the early 1970s that it became more widely applied.

The first season established in the Highlands (Hunting District 340) was either-sex, and the season type was soon applied to the Sun River and several other areas.

The reasons for implementing either-sex seasons were: 1) to initiate some limited ewe harvest; 2) to remove some pressure on the older rams; 3) to allow a hunter to choose freely what animal to harvest and remove the fear of an animal being confiscated; and, finally, 4) to reduce or eliminate abandonment of harvested sub-legal rams in the field.

Either-sex seasons are currently applied in 28 of 31 limited-entry hunting districts in the state. Under the limited-entry season structure, the number of licenses issued controls the number of hunters, and thus the ram harvest. Currently, the number of either-sex licenses issued has been generally based on taking a percentage of the number of more than

¾-curl rams observed the previous winter or spring. McCarthy (1986) listed the following advantages to this type of season:

1) Because permits are based on a percentage of rams that will be in the ¾-curl or better category during the hunting season, rams taken that are just ¾-curl or less essentially leave an older, larger ram in the population.
2) This type of season does away with the inconsistency with which rams enter curl categories. It also allows for the taking of animals that will never reach a prescribed category no matter how long they live. The combined factors of genetics, habitat, and age determine whether or not an animal will become ¾-curl or better and at what stage in life this will happen. Herds in Montana seldom have rams over 10 years of age. There are, however, males entering the ¾-curl category anywhere from 3.5 to 5.5 years of age, and reaching the 7/8-curl category by the age of 5.5. Others, because of brooming, genetics or natural mortality, never reach this 7/8-curl category.

In Montana, any-ram seasons were first established in northwestern Montana (Hunting Districts 100, 121, and 123) in 1979. The basis for this season type was similar to an either-sex season but limited harvest to the ram segment. The end result of this season type has proven to be essentially the same as the either-sex season due to hunter preference for and selection of larger rams.

Half-Curl Ram Seasons

Half-curl or less ram seasons were first initiated in two areas of northwestern Montana (Hunting District 216 in 1984 and Hunting District 121 in 1985) as a population control measure. This regulation was only used for a few years. McCarthy (1986) states the theory behind this season as:

Younger rams may be removed from a population without affecting the future number of larger animals as long as removal rates are compensatory for, and not additive to, natural mortality. As long as this requirement is met these smaller rams may be taken from a population without reducing either the reproductive base, or the numbers of larger rams available to the hunter.

Ewe Seasons

The first hunting season on ewes in Montana was established in the Blue Mountains area (Hunting District 760) of eastern Montana in 1968. This season type became more widely utilized in the early 1970s following a report of the results of implementing ewe seasons in Alberta, Canada (Wishart 1976). The following summarizes the findings of research conducted on the Ram Mountain bighorn sheep herd in Alberta.

Alberta implemented its first "ewe season" in 1966. In 1968, the ewe season was changed from any bighorn with horns less than 12 inches in length to the shooting of ewes and lambs only, because of problems with hunters shooting yearling rams. The year prior, yearling rams comprised over 20% of the harvest. Between 1968 and 1975, ewe seasons in Alberta resulted in 40% of the harvest being less than three years old. The percentage of lambs, yearlings, and two-year old ewes was in reverse to their normal occurrence in nature. Wishart (1976) stated that there appeared to be hunter selection against lambs, less selection against yearlings, and a heavy selection for two-year-old ewes compared to three year olds. He surmised this resulted from a selection by hunters against ewes with lambs, since the majority of ewes do not have lambs until they are three-years old.

The first ewe seasons also created concern that unknown numbers of lambs would be orphaned and increased mortality would occur. To test the impact of orphaning on lamb development and survival, a sheep study on Ram Mountain was initiated in 1971. The study found that survival of orphan and non-orphan lambs was similar. There was, however, evidence of some of the surviving orphans becoming stunted by the age of one year (Wishart 1971). Further analysis determined that in the Ram Mountain population, a 10% harvest could potentially result in 4% of the yearlings being stunted. Stunting was evident primarily in rams. Although not in all cases, orphaned rams tended to have shorter horn lengths, smaller horn bases, and smaller live weights than non-orphans. This resulted in a recommendation to account for this additive factor in calculating ewe quota levels, since the benefits of population control far outweighed the negative effects of orphaned lambs.

Jorgenson (1993) tested whether ewe hunting would cause a decline in population size or in trophy ram production and whether a reduction in ewe density would increase the size of ram horns. The experiment was conducted from 1971 to 1991 again on Ram Mountain in Alberta. The number of ewes remained stable during nine years despite the removal of 12-24% of the total ewe population. The removals did not affect ewe mortality from other causes, lamb production by adult ewes, or lamb survival. The number of trophy rams in

the population and the number shot by hunters were independent of ewe numbers. A threefold increase in ewe numbers over the 10-year post-removal period did not affect the number of trophy rams, but rams born during the removal years had larger horns at four and five years of age than rams born in the post-removal years. Researchers summarized that ewe seasons have the potential to limit population increase and can increase trophy ram size. In absence of predation, about 12% of the ewes could be harvested annually. Jorgenson (1993) also cautioned against ewe removals in populations with a history of pneumonia, because in these herds, population growth following die-offs appears slow and density independent, and hunting mortality would likely be additive.

Currently, adult ewe permits are issued in 15 hunting districts in Montana to control population size. The number of licenses issued is influenced by the success of trapping sheep in the area and transplanting them to other locations. Fitzsimmons and Buskirk (1992) recommended maintaining sheep populations at over 150 animals to avoid short-term loss of genetic variability. Overpopulation clues can be displayed in poor lamb crops, poor growth rates in young ewes, and poor early incremental growth in ram horns (Wishart and Jorgenson 1998). One aspect of high population numbers can be high densities. However, it is possible to have a large population with a relatively low density and conversely, a small population with a relatively high density. Density of bighorn sheep is largely a function of the amount and quality of habitat available. It's often stated that density of bighorns plays a role in disease transmission. Cassirer (2002) tested the hypothesis that population density was a causal factor in precipitating disease outbreaks in bighorn sheep. They monitored four herds in the Hells Canyon area of Oregon, Washington, and Idaho over a six-year period. Their preliminary analysis did not support the hypothesis that high population density triggered a disease outbreak.

The term "adult ewe" versus ewe was first utilized in 1974 in the Sun River area. The current definition describes an adult ewe as "a female bighorn sheep one year old or older. Lambs (young of year) are not included."

Since 1974, ewe seasons have been used to manage bighorn populations and to provide additional bighorn sheep hunting opportunity. The number of licenses issued has varied over time depending on the objectives for certain populations and the status of those populations (Figure 6). In 2006, there were a total of 15 hunting districts providing some level of ewe harvest, and there were a total of 169 ewe licenses issued through special drawing.

In some years, some of the more productive bighorn populations, such as in the Sun River and Missouri River Breaks areas, require a combination of translocation and ewe harvest to manage population numbers. Success on ewe licenses varies depending on the area, increasing with ease of access, and ranges from 75% to 90%.

Unlimited Areas

When bighorn sheep hunting in Montana reopened in 1953, a total of 30 (¾-curl) ram

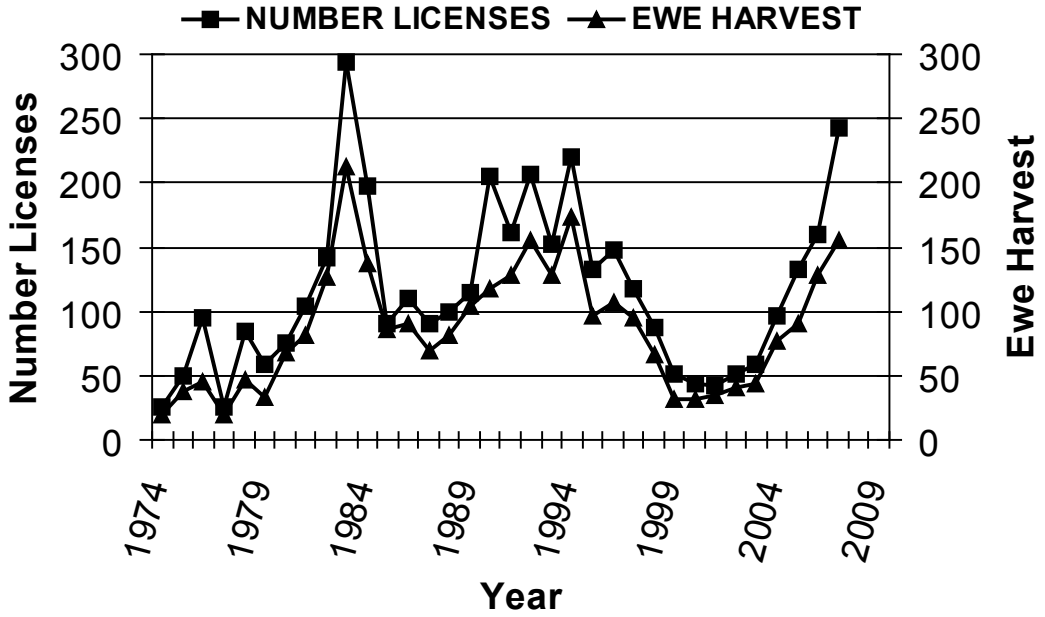


Figure 6. Number of ewe licenses and ewe harvest in Montana, 1974–2007.

permits were issued in three areas. In 1956, two areas, the Spanish Peaks and the Absaroka-Stillwater, were combined and established as "unlimited" hunting districts. This area has remained in an unlimited status for the most part, although some districts have closed due to declines, and the area has also been portioned into smaller districts over time. Initial hunting regulations consisted of a ¾-curl regulation and a long season (McCarthy 1986). Beginning in 1967, some districts went to an either-sex regulation, and the hunting of ewes in certain populations was implemented in 1974 as a method of managing numbers. To control harvest, a quota was implemented in the unlimited districts in 1975. In 1977, a simplified legal ram definition was implemented primarily in the unlimited districts to make it easier for the hunter to determine what a legal ram is in the field.

The unlimited districts, which allow anyone to purchase a license and go hunting, have over time provided significant hunting opportunity and harvest. In 1974, when hunter numbers and harvest peaked, the six unlimited districts accounted for 89% of the hunters and 47% of the ram harvest. Following that hunting season, population declines in some unlimited districts resulted in their closure and a subsequent decline in hunting opportunity and harvest (Figure 7). In 2005, the remaining four unlimited districts accounted for 43% of the state's bighorn sheep hunters but just 6% of the ram harvest.

Thirty hunting districts were limited-entry, and there were a total of 168 either-sex, 245 adult ewe, 1 legal ram, and 5 any-ram licenses issued. In the five unlimited hunting districts, there was a total quota of 11 legal rams. In the unlimited districts, licenses were purchased at license providers or through the regular drawing. Nonresidents were eligible for up to 10% of the licenses. License costs in 2008 for resident and nonresident hunters were $130 and $755, respectively, and ram and ewe license costs were the same.

Waiting Periods and License Requirements

In 1956, a 10-year waiting period was imposed on all bighorn sheep license holders in Montana, whether they were successful in harvesting an animal or not. This regulation was also made retroactive to 1953. The 10-year waiting period remained in place until 1963 when it was replaced with a seven-year waiting period for those who were successful at harvesting a sheep in the limited permit areas. Those unsuccessful at harvesting a sheep were required to return their unused license to be eligible the next year. Unlimited permit area license holders remained exempt from this requirement until 1972, when those successful at harvesting a sheep in the unlimited areas were also required to wait seven years before becoming eligible for another license. In 1975, hunters in the unlimited areas were also required to purchase their licenses by August 31 of each year, and unlimited seasons

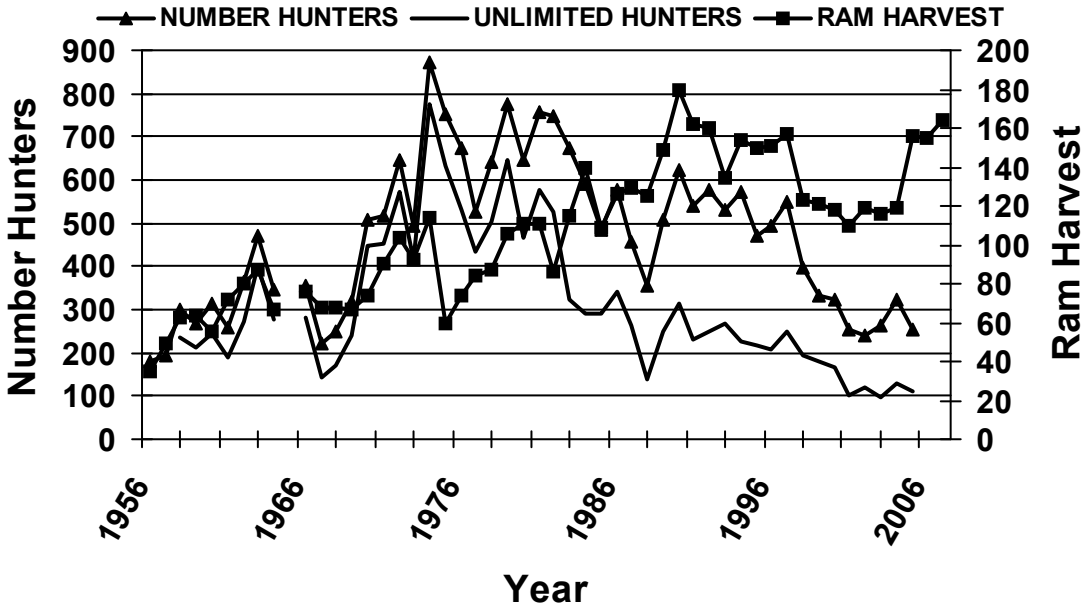


Figure 7. Total number of hunters, number of hunters in unlimited districts, and ram harvest in Montana, 1956-2007.

Current Season Structure

In 2008, there were a total of 35 hunting districts open for bighorn sheep hunting. with quotas could close on 48 hours notice. That same year, transportation permits and plugging of all ram horns was required for all harvested rams taken in Montana. Hunters

taking a bighorn sheep were also required to show, on demand for inspection, the kill site and complete head.

Comparison of Other State and Canadian Province Regulations and Seasons

A summary of Rocky Mountain bighorn sheep hunting regulations is shown in Table 2. With the exception of four to six unlimited license areas (depending on the year) surrounding Yellowstone National Park in southern Montana, all states utilize limited numbers of licenses to control the number of hunters allowed to hunt. The Canadian provinces of Alberta and British Columbia have unlimited seasons. With the exception of the very small harvest of ewes and lambs experienced under either-sex seasons, all jurisdictions allowing the harvest of ewes utilize limited licenses. Limiting the number of licenses significantly reduces hunting opportunity but provides control over the harvest and reduces or eliminates hunter overcrowding.

Although unlimited hunting areas place no limit on the number of hunters that may hunt, wildlife management agencies do partially control hunter numbers by other means. The Canadian provinces of Alberta and British Columbia require nonresident hunters to utilize a licensed guide. The guides, in turn, are allocated an area to hunt and are further restricted by harvest quotas for that area. In Montana, hunters may purchase an unlimited license by May 1, or apply in the drawing by May 1 and choose between a limited or unlimited area as their first choice. Since the demand for limited licenses is high, many hunters choose not to apply for the unlimited areas, thus reducing the number of hunters in those areas each year.

Horn Curl Restrictions

Bighorn sheep have been managed under a variety of horn definitions throughout North America. Curl-size regulations were first used as a means to control overharvest of the ram segment and to prevent assumed breeding problems, since it was known that the older rams typically did most of the breeding. Hunter demand for larger "trophy" sheep also contributed to implementing the first ¾-curl laws, which came about at the same time as the old "buck laws" for deer. Both Montana and Idaho implemented a ¾-curl regulation in 1953 (Demarchi 1978). Alberta followed in 1956, and British Columbia first used a ¾-curl restriction in 1966. As hunter numbers increased and sheep populations became more accessible to the hunter, horn curl restrictions became more stringent. Objectives also changed from only preventing overharvest of the ram segment and protecting breeding potential, to one of producing trophy rams for the hunter. Alberta instituted a 4/5-curl regulation in 1968, and British Columbia implemented a 7/8-curl regulation in 1972. Montana revised its ¾-curl regulation in the early 1970s and adopted the current "legal ram" definition in 1977 in the unlimited areas. Both Alberta and British Columbia retained their unlimited hunting areas and currently utilize horn curl regulations (Alberta: 4/5-curl; BC: full-curl).

Horn Curl Regulations in Limited License Areas

Nearly all jurisdictions surveyed utilize ram only or either-sex regulations to regulate the harvest of rams in limited license areas. The number of licenses issued controls the number of rams taken. In Colorado, limited license holders have been restricted to taking ½-curl or larger rams in nearly all areas since 1983. Since hunters tend to select the larger and older rams, the result of the ½-curl regulation is nearly the same in most cases.

Horn Curl Regulations in Unlimited License Areas

Alberta and British Columbia in Canada both utilize unlimited hunting seasons together with a horn curl regulation to manage the ram segment of sheep populations. Of all the states, Montana is the only one to currently utilize the unlimited season with a horn curl regulation, and it is restricted to only four to six areas in the south-central part of the state. In Montana, the horn curl restriction is defined as a "legal ram." This restricts harvest to only rams four years old or older (rarely three) and is similar to the previous ¾-curl regulation but is easier for hunters to determine a legal ram in the field. With the exception of four areas managed under a full-curl regulation, Alberta utilizes a 4/5-curl definition. British Columbia began using a full-curl regulation to limit harvest to older Class IV rams in 1976. In addition, an eight-year or older regulation has been implemented in some areas where heavy brooming of horns by rams has been noted. The full curl regulation is intended to maintain a more diverse ram age structure and still provide for hunting opportunity.

Dall's sheep hunting in Alaska and British Columbia, Canada, is also restricted to full curl, but there are dramatic differences in horn growth between the two species. One significant

Table 2. Summary of 2007 Rocky Mountain bighorn sheep hunting regulations in western states and provinces.

Jurisdiction	License Restriction	Horn Curl Restriction	Ewe Season	License Limit	Earliest and Latest Season Dates	Mandatory Inspection	License Cost		Other
							Ram / Trophy	Ewe/Non Trophy	
Alberta, CA	Mostly Limited-some unlimited Entry	28 areas 4/5- curl 4 areas Full-Curl	Non-trophy limited entry	1 kill/yr	Sept. 5 - Nov. 30	30 days inspection/ plug horns	Res: $50.09 Nonres: $316.35	Res: $26.58 Nonres: NA	Guide Required for Nonres.
Arizona	Limited	Any ram	None	1 license/ life	Nov. 1 - Dec. 31	Within 3 days close of season inspection/ seal	Res: $272.50 Nonres: $1407.50	NA	
British Columbia, CA	Mostly Limited Entry some Unlimited	¾-curl, Full-Curl, Mature Ram (> 8 yr)	None	1 kill/yr	Aug. 15 - Oct. 20	30 days inspection/ plug horns	Res: $60 Nonres: $620	NA	Guide Required for Nonres.
Colorado	Limited	½-curl, ¾-curl	Ewe > 5”	1 kill/5-yr Preference System	Aug. 6 - Oct. 11 + Special Archery	5 day inspection/ plug horns	Res: $251 Nonres: $1716	Res: $251 Nonres: $1716	Mandatory hunter harvest report
Nebraska	Limited	Any ram	None	1 permit/ life	Dec. 1 - 22		Res: $25	NA	
New Mexico	Limited	Any ram	None	1 license/ life	Aug. 22 - Jan.17	10 days inspection/ seal	Res: $162 Nonres: $3,172	NA	
North Dakota	Limited	One male bighorn	None	1 license/ life	Oct. 5 - Oct. 28	Inspection / plug horns	Res: $20 Nonres: $500 +$100 app. fee	NA	
Idaho	Limited Unsuccessful must return license	Rams Only	None	1 kill/life	Aug. 30 - Oct. 31	10 day inspection/ plug horns	Res: $174.50 Nonres: $1759.50	NA	Mandatory Course/ Exam
Montana	Limited	Either-Sex/ Legal Ram	Adult Ewe 1yr and older	1 license/ 7 year (rams) Preference System	Sept. 15 - Nov. 25	48 hr inspection / 10 day plug horn	Res: $130 Nonres: $755	Res: $130 Nonres: $755	
	Unlimited	Legal Ram	None	1 kill/7 yr	Sept. 1 - Nov. 25	48 hr inspection / 10 day plug horn	Same	Same	Harvest quota/ 48 hr closure
Nevada	Limited	Any ram	None	1 license/ 10 years	Sept. 1 - Oct. 30	5 days inspection/ seal	Res: $120 Nonres: $1,200	NA	
Oregon	Limited	One bighorn ram	None	1 license/ life	Aug. 30 - Oct. 31	72 hr inspection/ plug horns	Res: $101.50 Nonres: $1083.50	NA	
South Dakota	Limited	Any bighorn sheep	None	1 license/ life	Oct. 3 - Nov. 30	24 hour inspection/ marking horn	Res: $255	NA	
Utah	Limited	One bighorn ram	None	1 license/ life Preference System	Sept. 22 - Nov. 30	72 hr inspection/ plug horns	Res: $508 Nonres: $1513	NA	Mandatory harvest report within 30 days of end of season
Washington	Limited	One bighorn ram	None	1 kill/life	Sept. 15 - Nov. 30	10 day inspection/ plug horns	Res: $109.50 Nonres: $1095.50	NA	
Wyoming	Limited	Any ram	Any bighorn sheep in one area	1 license/ 5yr	Aug. 15 - Oct. 31	15 day inspection/ plug horns	Res: $96 Nonres: $1901	NA	

difference is the frequency and extent of ram horn brooming. Nearly all bighorn rams broom their horns and many broom back their horns to nearly ¾-curl. Severe brooming of horns is typical of slow-growing or stable native bighorn sheep populations. Only those bighorns with the fastest growing horns (typically in expanding transplanted herds) seem to escape this tendency. Heimer (1998) noted the following about the use of a ¾-curl regulation for Dall's sheep management in Alaska:

Although brooming is common in Dall's rams, they seldom break both horns and broom as severely as bighorn. Since Dall's sheep grow horns faster than bighorn, the ¾-curl regulation resulted in the harvest of significant numbers of young juvenile rams in some areas of Alaska. As hunting pressure increased in Alaska, and virtually all-legal rams were removed from some populations, negative impacts were noted; lamb production declined and mortality of younger rams greatly increased. Some lambs were still produced by adult ewes, but 95% of these adult ewes reproduced only in alternate years. Frequency of reproductive activity among 18-month-old ewes rose from about 5% to 25%. These young ewes typically conceived late and delivered stunted lambs well after the normal peak of lambing by adult ewes. Survival of rams was also impacted because immature rams became more active breeders and mortality increased. This then lowered the sustainable ram harvest. Instituting the full-curl regulation allowed for increased harvest of mature rams through doubled lamb production and increased young ram survival.

U.S. states and Canadian provinces have at one time or another revised their definitions to enable hunters to better determine a legal ram in the field and to enable enforcement of these regulations. Although similar, each jurisdiction has a slightly different definition for legal sheep. The following lists each jurisdiction's current definition:

"Full-Curl" Ram Definition

Alberta – A male bighorn sheep with horns, one of which is of sufficient size that when viewed in profile, its tip extends upward beyond a straight line drawn from the rear-most point of the base of the horn to the centre of the nostril.

British Columbia – Any male bighorn mountain sheep, the head of which, when viewed squarely from the side, has at least one horn tip extending upwards beyond a straight line drawn through the centre of the nostril and the lowest hindmost portion of the horn base. If the skull and horns are presented for examination, when viewed squarely from the side with both horns in alignment, at least one horn tip extends upward beyond a straight line drawn through the lowest hindmost portion of the horn base and lowermost edge of the eye socket.

"Mature" Bighorn Ram

British Columbia – Any bighorn ram mountain sheep that has attained the age of eight years as evidenced by true horn annuli as determined by the regional manager or designate, or whose horn tip, when viewed squarely from the side, extends upwards beyond the forehead-nose bridge.

"4/5-Curl" Ram Definition

Alberta (trophy sheep) – A male bighorn sheep with horns, one of which is of sufficient size that a straight line drawn from the most anterior point of the base of the horn to the tip of the horn extends beyond the anterior edge of the eye when viewed in profile.

"3/4-Curl" Ram Definition

British Columbia – Any male bighorn mountain sheep, the head of which, when viewed squarely from the side, has at least one horn tip extending beyond a straight line drawn through the back of the eye opening and at right angles to a line drawn between the centre of the nostril and the lowest hindmost portion of the horn base. If the skull and horns are presented for examination, when viewed squarely from the side with both horns in alignment, at least one horn tip extends beyond a straight line through the back edge of the eye socket and at right angles to a line drawn through the lowest hindmost portion of the horn base and the lowermost edge of the eye socket.

Colorado – A male sheep with a horn or horns that have one or both tips grown at least through three-quarters (3/4), or 270 degrees, of a circle to be measured by first establishing a reference line that bisects the eye and the base of the ear; then by establishing a line that intersects the reference line at the base of the ear and is perpendicular thereto; and which has horn tips that have grown at least as far as the downward projection of the perpendicular line.

Montana (legal ram) – When a straight line extending from the front base of the horn through any portion of the eye opening intercepts any portion of the horn, the ram

is legal. If the horn is not long enough to be intercepted by the line, the ram is not legal. Base of the horn shall be considered as the point where the horn meets the hairline of the head. Determination of a legal ram should be made from a broadside view of the head.

"1/2-Curl" Ram Definition

Colorado – A male sheep with a horn or horns that have one or both tips grown at least through one-half, or 180 degrees, of a circle to be measured by first establishing a reference line that bisects the eye and the base of the ear; and which has horn tips that have grown at least as far as the projection of this reference line.

Montana – No definition provided in regulations.

Ewe Seasons

Currently, ewe seasons are held in Alberta, British Columbia, Colorado, and Montana. The definition used by the four jurisdictions to describe a legal sheep in an ewe season varies. Alberta and British Columbia allow the harvest of lambs of both sexes, while Colorado and Montana do not. Montana and Colorado's definitions are similar in that they both limit harvest to adult ewes. However, Colorado uses a horn length to determine a legal female sheep, while Montana uses the age class of one year old or older. Essentially both definitions protect female and male lambs, but the five-inch requirement in Colorado takes that one step further and has the potential to protect some yearling females as well, depending on how successful hunters are at determining the length of horns in the field.

"Ewe" Definition

Alberta (non-trophy sheep) – A female bighorn sheep or a male bighorn sheep under one year of age.

British Columbia – A lamb or ewe.

Colorado – Any female sheep having a horn or horns of at least five inches in length as measured on the outside curve of the horn from the skull to the tip.

Montana (adult ewe) – A female bighorn sheep one year old or older. Lambs (young of year) are not included.

License Limits

All 10 of the states and provinces surveyed restrict the number of licenses a hunter can have in a lifetime. Four of the 10 restrict a hunter to one bighorn harvested in a lifetime. Three restrict the hunter who draws a license to one in a lifetime whether the hunter is successful or not during the season. Other restrictions used are one harvested bighorn for every five or seven years, or one license obtained for every five or seven years.

Competition between resident hunters and nonresident hunters is a frequent topic of discussion by the regulatory agencies in the states and provinces and in the hunting community. British Columbia and Alberta have implemented increases in license costs and guide requirements to control nonresident sheep harvest and alleviate overcrowding and competition. In British Columbia, nonresident hunters are required to have a guide, and the guides are restricted to an area and an annual quota. These regulations controlled the minority of guides that had overexploited the mature ram segment in their hunt area in the past, promoted the outfitting industry, and reduced nonresident competition with residents, especially in the more accessible and less rugged areas of the province (Demarchi 1978). At the same time, license costs for nonresidents were raised to account for the loss in revenue from these nonresident restrictions.

The western states control nonresident sheep hunters through the price of the license, drawing procedures, and a limit on the percentage of nonresidents that can draw a license in any one year. Montana, Oregon, and Utah limit nonresidents to hunt only in certain hunting districts. Wyoming has separate drawings for resident and nonresident licenses.

Season Dates

General hunting season dates are similar between all jurisdictions surveyed. With few exceptions, hunting is limited to a period between September and the end of October or November. Shortened seasons are utilized in some areas to restrict harvest of older rams. Late seasons were implemented to harvest rams that were unavailable to hunters in the earlier hunting period due to migration from a protected area or inaccessible, rugged, and difficult to traverse terrain. Wyoming, Oregon, Idaho, and North Dakota close the season at or near the end of October, before the major rutting period begins. This restricts harvest of mature rams because they are less available prior to the rut, and prevents disruption of the rutting period. Montana's limited seasons occur primarily from September 15 through the Thanksgiving weekend in late November. A few areas close at the end of October, and later seasons were implemented in the past in

areas where the sheep were unavailable during the regular hunting season. The unlimited areas primarily open in early September and close within a few days, or when the harvest quota is reached.

License Costs

Resident bighorn sheep license cost ranges from $20 in North Dakota to $508 in Utah (Table 2). Nonresident bighorn sheep license cost ranges from $316 in Alberta to $3,172 in New Mexico. The cost of Montana's resident license ($130) and nonresident license ($755) are in the middle of the other jurisdictions. Alberta reduces the cost of their non-trophy or "ewe" license from that charged for ram hunts, but Colorado and Montana do not.

Nonresident and Resident Permit Allocations

Most states and Canadian provinces provide opportunities for nonresidents to hunt. Wyoming sets aside 10% of the sheep licenses for nonresidents in a separate drawing. The states of Idaho, Oregon, Utah, Colorado, Washington, and North Dakota all limit nonresident sheep licenses. British Columbia and Alberta limit nonresident hunters through requirements to hire a guide and to hunt areas with sheep quotas for each guide or outfitter.

In Montana, nonresidents are restricted to certain districts. Nonresidents are also limited to, but not guaranteed, 10% of a region's quota. Districts where nonresidents may apply are listed on the moose, bighorn sheep, and mountain goat nonresident application but may change when final quotas are set in June. This procedure has been implemented as a result of state legislation (Mont. Code Ann. 87-2-506 (2)) limiting nonresidents to 10% of big game licenses when applications exceed the number to be issued. In practice, the number of licenses available in an administrative region (seven regions in Montana) is first totaled. Nonresidents are eligible for up to 10% of the licenses, so they could actually be issued less than 10% of the licenses if they aren't successful in the random drawing. All districts with 10 licenses available get one of the regional total nonresident licenses allocated (10%), and those with 20 get two (10%) and so on. Then, each district in the region with less than 10 licenses gets one of the regional nonresident licenses allocated until they are all allocated. This same procedure occurs in each region where sheep licenses are available. Since there are usually more districts than licenses available in a given year, a rotation is used beginning with the remaining districts in sequence the next year. This results in a nonresident having a chance of drawing a license in each district approximately every third year. Since the actual number of nonresident licenses issued in a year is set after the applications are due and is based on the luck of the draw, fewer than 10% of the licenses available typically go to nonresidents.

A court case in Arizona in 2002 made national headlines when the federal court based its ruling on the premise that states' disparate treatment of nonresidents violated restrictions imposed on activities involving state commerce (Conservation Force v. Manning 301 F.3d 985 (9th Cir. 2002)). This was significant, because some 30 years earlier, a U.S. Supreme Court case had determined that recreational hunting was not a privilege protected by the Privileges and Immunities clause of the Constitution, that state residents bore more of the burden of wildlife conservation, and that the states had the right to treat nonresident hunters differently from resident hunters.

The issue also divided the hunting community. At the request of the state wildlife agencies, Senator Harry Reid (D-NV) introduced a bill called the "Reaffirmation of State Regulation of Resident and Nonresident Hunting and Fishing Act of 2005." On May 10, 2005, the president signed into law House Bill 1268. Section 6063 of Senator Reid's bill has essentially made subsequent court challenges involving the constitutional issues of limits placed on nonresident licenses moot by providing:

It is the policy of Congress that it is in the public interest for each State to continue to regulate the taking for any purpose of fish and wildlife within its boundaries, including by means of laws or regulations that differentiate between residents and nonresidents of such State with respect to the availability of licenses or permits for taking of particular species of fish and wildlife, the kind and numbers of fish and wildlife that may be taken, or fees charged in connection with issuance of licenses or permits for hunting or fishing.

Boone and Crockett Records

Horn size is a good reflection of animal health and the quality of habitat it occupies as well as genetics, and therefore should be a good source to review when determining overall population vitality.

Prior to 1974, no rams legally harvested in Montana were recorded breaking a 200-point score in the Boone and Crockett records. Of the 10 rams recorded with a score over 200,

seven were taken in Alberta and two in British Columbia; one with a recorded score of 200 was taken in the Wind River Range of Wyoming in 1883. The world record, at the time, scored 208 1/8, and was taken in Blind Canyon, Alberta, in 1911.

The current Montana state record scored 204 7/8 Boone and Crockett points and was taken in Granite County in 1993. According to the 2005 Boone and Crockett Record Book, six rams exceeding 200 points have been harvested from Montana since 2000. Forty-five percent of the Boone and Crockett record book rams scoring between 190 and 200 were harvested in Montana. Forty-eight percent of the entries meeting the minimum score of 180 were harvested in Montana.

The Winter 2007 issue of Boone and Crockett's *Fair Chase Magazine* contained an article entitled "Destination – The Biggest Bighorns," by Wayne Van Zwoll. In the article Van Zwoll compared the records for bighorn sheep and found that over the last 10 years, Montana had more entries than any other state or province with 261. Alberta was the next closest with 54. The top seven Montana counties were Granite (56), Sanders (44), Blaine (33), Fergus (28), Missoula (23), Ravalli (23), and Lewis & Clark (20).

Trapping and Transplant Program

Early Transplants and Policies

Between 1947 and 1950, five corral-type traps were constructed in Montana for the capture of bighorn sheep (Couey 1950). One was constructed on the Kootenai in the Ural-Tweed area, one on the West Fork of the Gallatin River, two on the Sun River, and one on Deep Creek in Teton County. The latter was primarily for catching mountain goats.

As Couey (1950) described them, the traps were constructed of poles set in the ground and covered on the inside by woven wire to the height of eight feet, making an enclosure of about 12 feet by 24 feet. A trap door was left open at each end until the sheep felt comfortable entering the trap, which was baited with salt. The trap door at one end was then closed, and when sheep entered the trap a person could pull a trip wire closing the door. Eventually, the woven wire was covered with boards or canvas/burlap to prevent injury caused by sheep jumping into the wire. The sheep were captured by rope or hand and loaded in a crate that was carried on a horse. The sheep were unloaded to a stock truck and taken to a holding pen where they were kept for several weeks. They were fed hay and rolled oats. Then the sheep were captured again and taken to the release site.

The traps used today are very similar with rough-cut boards or nets used as the sidewalls and, in some cases, the addition of side chutes for working individual animals.

Even in those early years, agency personnel took great care in selecting transplant sites. Couey described the sites chosen as places with rehabilitated range, free from parasites and disease and with few predators. The early efforts also used holding pens at the transplant location to allow the sheep to stay together and get used to the area before release. Transplants to Wildhorse Island in 1941 and 1947, and a transplant in 1947 into the Billy Creek area of the Missouri River Breaks were two of the first areas selected.

The early transplants were often unsuccessful and, according to Alan Schallenberger, then Choteau Wildlife Biologist, this led the wildlife division to consider suspending further transplants of bighorn in 1966. Prior attempts at capture were primarily conducted in the spring using salt followed by releases on spring or summer range. Animals typically dispersed widely and then died out. Schallenberger suggested: 1) trapping 25 -30 sheep during the winter and releasing them on winter range; 2) supplementing the transplant the following year or as soon as possible; 3) choosing an area with suitable winter range and escape cover for the transplant; 4) trapping in very cold weather and baiting with hay rather than salt; and 5) releasing the sheep as soon after capture as possible, without holding pens. These changes to policy resulted in much better success in the following years, and subsequently formed the basis for more formally adopted protocols.

The use of snowmobiles and crates with sleds to haul captured bighorn in Sun River from remote locations along Gibson Lake also prompted Schallenberger, in 1967, to work with Murray Duffy of Central Air Services in Lewistown and Bert Goodman, then Sun River Game Range Manager, to design an angle iron, strap iron, rebar, and wire crate with a plywood bottom which could be slung below a helicopter. This device was first used on January 7, 1968, to transport sheep from Reclamation Flat in the Sun River to Blacktail and subsequently proved very successful at significantly reducing the labor involved with moving sheep from remote locations to vehicles for further transport to the release site.

Current Transplant Program and Policies

One way to judge the success of the trapping and transplant program is through review of the

number of herds in the state and the estimated total population at various times in Montana's history. Following major die-offs along the Rockies in 1925, 1927, and 1932, bighorn sheep in Montana were considered rare or even endangered. Couey (1950) described 16 herds in the state with an estimated population of 1,200 bighorns. Unpublished Wildlife Division records show estimates by Merle Rognrud, then division bureau chief, of 2,000 in 1957 and 1,500 in 1968; these estimates were based on the estimated percentage of the population harvested. By the early 1970s, 11 major herds were known to exist in the state, and 13 other areas had been stocked by transplanting. Of those areas with transplanted stock, at least four were considered not successful at the time, resulting in a total of about 20 established herds within the state. In 1998, there were 42 herds with an estimated population of 4,890 (Toweill and Geist 1999). In 2001, there were 43 herds in the state with an estimated population of 4,230 (Erickson July/Aug 2001 *Montana Outdoors*). In 2008, there were 45 different herds in the state with an estimated 5,694 total bighorn sheep, not including Glacier National Park.

Transplants have always been a cooperative venture, involving sportsmen and sportswomen, landowners, public and state land management agencies, and FWP. An example of the importance placed on the cooperative approach was the 1969 directive from the FWP director of the time, which stated the following requirements before a transplant could proceed:

1) An investigative report on suitability of the transplant site.
2) A signed agreement by the landowner where the transplant was to occur
3) A cooperative agreement signed by the U.S. Forest Service or Bureau of Land Management if the transplant involved public land.

FWP Policies

Today, FWP and public land management agencies have policies that guide trapping and transplanting efforts. FWP policies and guidelines are directed by state law (MCA 87-5-701-721), which provides for the importation, introduction, and transplantation of wildlife. This statute provides that transplantation or introduction of any wildlife is prohibited unless the FWP Commission "determines, based upon scientific investigation and after a public hearing, that a species of wildlife poses no threat of harm to native wildlife and plants or to agricultural production and that the transplantation or introduction of a species has significant public benefits."

In the statute, transplantation is defined as the "release of or attempt to release, intentional or otherwise, wildlife from one place within the state into 'natural habitats' in another part of the state." Natural habitat means "any area in which the introduction of wildlife species may result in an uncontrolled, naturally reproducing population of that species becoming established."

The requirements of this statute have been interpreted by FWP legal counsel to apply to transplants to new areas where bighorn do not currently exist but not to the augmentation of existing herds.

FWP's Wildlife Division first adopted "Bighorn Sheep Transplant Guidelines" on October 9, 1986. These guidelines provided the internal procedures for personnel to follow when planning for a bighorn sheep transplant. Additionally, in 1995 the FWP Commission adopted the "Bighorn Sheep Transplant Policy," which provided the criteria about how sites were to be selected for transplant. This policy was adopted following an extensive review of disease issues and evidence at the time that new transplants to locations in close proximity to domestic sheep and goats should not be undertaken due to the increased risk of a significant bighorn sheep die-off. Among other provisions, the policy gives preference to sites that are not in close proximity to domestic sheep or are separated by physical barriers and that have sufficient habitat and landowner agreement to provide future access to hunters, so that the population can be managed within objectives through hunter harvest.

The 1986 Transplant Guidelines and the 1995 Transplant Policy are the basis for the translocation program presented in this document (see Translocation Program section).

Forest Service Direction

The USFS has recognized the importance of finding solutions to the incompatibility between domestic and bighorn sheep (Schommer and Woolever 2001). Since most wildlife biologists and veterinarians have now concluded that bighorn and domestic sheep should not occupy the same ranges and should not be managed in close proximity to each other, the current recommendation for minimizing pneumonia outbreaks in bighorn sheep is to maintain spatial or temporal separation between bighorn and domestic sheep on native ranges at all times. To implement this, Schommer and Woolever (2001) recommended a collaborative approach between lessees, the USFS, and other interested parties,

with options including finding replacement grazing allotments for domestic sheep when transplants of bighorns are contemplated, provisions to keep bighorn and domestic sheep separated by herding, and alternate time periods for grazing by domestic sheep in areas of seasonal use by bighorn sheep.

BLM Policies

In 1992, the BLM issued Instruction Memorandum 92-264, "Guidelines for Domestic Sheep Management in Bighorn Habitats," as part of an effort to restore bighorn into historically occupied habitats on public lands. These guidelines were reviewed in 1997 and updated following a meeting of bighorn and domestic sheep specialists in April 1998. The BLM continues to utilize the revised guidelines whenever reintroductions, transplants, or augmentations of wild sheep populations, or proposed changes in a livestock grazing permit on BLM administered lands, are being considered (Reference BLM Instruction Memorandum No. 98-140). The significant provisions of these guidelines are:

1) When agency and industry agreement has been reached to maintain and/or expand native wild sheep numbers, the agencies and the domestic sheep industry will be held harmless in the event of disease impacting either native wild sheep or domestic sheep and goats.
2) Domestic sheep or goat grazing and trailing should be discouraged in the vicinity of native wild sheep ranges.
3) Native wild sheep and domestic sheep or goats should be spatially separated to reduce the potential of interspecies contact.
4) Except where topographic or other barriers exist, buffer strips of up to 13.5 km (9 mi) surrounding native wild sheep habitat should be established when reviewing new domestic sheep or goat grazing applications or when conversions of cattle permits to sheep or goat permits are proposed in areas with established wild sheep populations.
5) Domestic sheep and goats should be closely managed and carefully herded where necessary to prevent them from straying into native sheep areas.
6) Trailing of domestic sheep or goats through native wild sheep ranges is permitted when safeguards can be implemented to adequately prevent physical contact between native wild sheep and domestic sheep or goats.
7) Cooperative efforts should be undertaken to quickly notify permittees and appropriate agencies to remove any stray domestic sheep or goats or wild sheep in areas where contact could occur.
8) Unless cooperative agreement has been reached to the contrary, native wild sheep should only be introduced into areas where domestic sheep or goat grazing is not permitted.

Montana State Lands (DNRC) Policies

The Montana State Land Board adopted a domestic sheep grazing policy and Administrative Rule (36.25.127) in 1998. This policy was a direct result of a ruling by the Supreme Court of Montana in 1995. Sportsmen had filed suit against the Department of State Lands, which had granted a change in a livestock-grazing lease from cattle to domestic sheep on state trust lands in the Sula area of Ravalli County. The sportsmen were concerned about the potential adverse affects on bighorn sheep in the area. The court ruled that the Department of State Lands had not adequately determined the significance of the impacts associated with grazing domestic sheep on lands adjacent to bighorn sheep, and had acted arbitrarily, capriciously, and unlawfully when it concluded that changes to the lessee's grazing plan reduced the probable significant impact to bighorns. The policy adopted in 1998 requires DNRC to identify state tracts that lie within or immediately adjacent to occupied bighorn sheep ranges. The lessee/licensee is to notify DNRC if he/she has not grazed sheep on the allotment within the previous 10 years and intends to graze domestic sheep. Authorization to make a change to accommodate grazing of domestic sheep would then require preparation of an environmental analysis under the Montana Environmental Policy Act (MEPA) by DNRC. In preparation of the MEPA document, DNRC is to consult with FWP and seek comment from surrounding landowners and the interested public.

Trapping and Transplant Techniques and Methods

The techniques used to trap and transplant bighorn sheep began with the use of corral traps constructed of logs, poles, and woven wire and baited with salt blocks and alfalfa hay. Drives, using sportsmen on foot, were first used on Wildhorse Island (Picton 2002). Permanent corral traps were replaced with net traps constructed similarly, and blasting caps instead of a trip wire were frequently

used to trigger closure of the gate. Transport included the use of crates on packhorses, rafts, snowmobiles with sleds, boats, and finally helicopter slings. Captured sheep were loaded into small ¾-ton stock trucks and horse trailers for transport to the release location. Use of a helicopter in driving sheep into nets supported by poles was tried successfully on sheep capture in the 1980s. Today, sheep are captured almost exclusively using a hand-held net-gun fired from a helicopter.

Schmidt (1976) described the drop-net technique of capturing bighorn sheep and use of apple pulp as bait. They used a 70-square-foot drop-net that weighed 280 pounds including the supporting poles. The net was dropped using a radio-controlled detonator.

Devos et al. (1999) evaluated post-capture survival of 711 bighorn following captures by drop-nets, darting with chemical compounds, and aerial net-gunning. Survival rates ranged from 0.942 for aerial net-gunning to 0.983 for aerial darting with chemical compounds. They concluded that all methods tested yielded high survival rates in bighorns and that selection of a particular technique should be based on project objectives, terrain, and personnel training. Aerial capture methods allow selection of specific age and sex ratios, whereas drop-netting captures large numbers of bighorns at one time with sex and age ratios determined by the bighorns that come under the net. Aerial captures may also optimize genetic diversity because bighorns can be captured from several areas.

Hunter (1999) reviewed immobilization techniques used in the capture of free-ranging bighorn sheep. Hunter stated that the most effective and safest agents for field immobilizations are the narcotic agents (Schedule II drugs). These drugs are extremely potent, and human exposure must be avoided. Special handling and safety precautions are mandatory.

The net-gunning technique of capturing wild ungulates and sheep is described by Innes (1999). After capture, he recommended getting the animal to its feet as quickly as possible and back into the field. Slinging animals upside down without the use of drugs is an effective way for animals to be quickly moved from the capture location to the processing area. Although regurgitation problems have been encountered in some instances during transport upside down, this has been rare, and the review of capture records in several states did not show a difference in survival between the use of sling bags and slinging the animal upside down. Recently, it has been shown that sheep and goats and other animals of similar size can be taken inside the helicopter for transport, if properly restrained.

Capture and Handling Recommendations

The 2nd North American Wild Sheep Conference held in Reno, Nevada, in 1999 provided extensive recommendations for sheep capture, handling, and transplants. The pertinent recommendations are summarized as follows:

1) Wild sheep should be reestablished in all vacant historical ranges that still provide suitable habitat.
2) Transplants may be used to establish new herds or to augment existing herds. Maintenance of metapopulations should be considered when selecting transplant sites, and transplant sites should have the potential to support at least 100 animals.
3) Potential transplant sites should be fully evaluated, including habitat, predator abundance, and the potential for livestock or other wild ungulate competition.
4) Transplant stock should be native subspecies, utilize similar habitat, and have food habits and habitat-use patterns compatible with the transplant site.
5) Initial transplants should include at least 30 sheep; higher numbers and multiple transplants enhance success. Smaller numbers used to supplement small herds is a viable technique. Transplanted sheep may be released at multiple locations.
6) Do not remove large numbers of sheep from small source populations.
7) Test source herds for diseases and do not transplant sheep from herds with recent histories of pneumonia.
8) Obtain adequate samples for genetics analysis from each group of transplanted sheep.
9) Monitor transplanted sheep for at least a year, use mortality sensing collars, and collar as many animals as possible.
10) Maintain a database of transplant histories, including genetics and disease information.
11) If propagation pens are used to maintain a source herd and provide transplant stock, maintain numbers of sheep with supplemental feed ad libitum, if food quantity or quality is limiting, and remove primarily

young rams to maintain a 1:5 ram: ewe ratio.

12) Develop written protocols for capturing, handling, and transplanting sheep. Capture teams should include veterinarians. Soft release, using a temporary enclosure, is not recommended.

The conference's effort to standardize practices was incorporated in "Wild Sheep Capture Guidelines," prepared by Craig Foster, Oregon Department of Fish and Wildlife, and adopted by the Northern Wild Sheep and Goat Council in 2005. This document provides a detailed guide for wildlife managers listing 1) the requirements for transport of bighorn sheep from Canada to the United States, 2) animal health and testing procedures, 3) capture and handling procedures, and 4) transport and release protocol.