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BIGHORN SHEEP IN NORTH-CENTRAL COLORADO, PAST, PRESENT AND FUTURE

Abstract: Before the advent of white man Rocky Mountain bighorn sheep *(Ovis canadensis canadensis)* were abundant in north-central Colorado and utilized suitable habitats from above treeline to the edge of the plains. Many sheep migrated from winter ranges in the foothills to alpine summer ranges. Hunting, grazing of domestic stock, construction of roads, fences and settlements, and disease contributed to the loss of all bighorn ranges below 2440 m and half of all high elevation ranges before 1945. Transplants have been used since 1946 to restore sheep to historical ranges. Present populations, both native and reintroduced, can be characterized as small, isolated and non-migratory. Innovative use of transplants is suggested as a means of increasing distribution of bighorn and reestablishing historical range-use patterns and altitudinal migrations.

Trapping and transplanting bighorn sheep has been used extensively as a management tool to reestablish populations on historic ranges. Usually a single transplant is made at one release site within a unit of historic range. In some cases sheep fail to fill available habitat due to barriers of unsuitable habitat between suitable areas and/or lack of exploratory behavior (Geist 1974, Hanna and Rath 1976, Bear 1979). Plants of bighorn into areas used originally as seasonal ranges often result in year-round use since traditional migration patterns are not reestablished (Geist 1974). As a result, areas of reintroduction support fewer sheep than they could potentially support.

In north-central Colorado both remaining native herds and introduced populations of bighorn sheep are generally small, isolated and non-migratory. In this paper I attempt to reconstruct the distribution and seasonal habitat use of bighorn that existed when white man arrived in the area to provide a pattern of optimum range use. Causes for declines in bighorn distribution and numbers over the last 120 years are reviewed, and the success of transplants to reestablish herds on historic ranges is evaluated. Finally, I suggest ways that transplanting of bighorn could be used innovatively to increase distribution of bighorn and reestablish historical patterns of seasonal range use and altitudinal migration.

My premise is that restriction of distribution and loss of altitudinal migrations are causes of the static or declining conditions of many bighorn herds in Colorado. Restoration of natural distributions and range-use patterns would provide herds capable of maintaining themselves without intensive management. Based on this premise some outbreaks of diseases endemic to bighorn, especially pneumonia involving lungworms (*Protostrongylus* spp.), are symptoms of the altered and much reduced pattern of habitat use. Management programs that emphasize treatment of bighorn diseases could divert attention and resources from solving the real problem of reestablishing patterns of habitat use that were common during evolution of Colorado's bighorn sheep.

I acknowledge the National Park Service, Rocky Mountain National Park, and the U.S. Forest Service, Arapaho and Roosevelt National Forests, for support while conducting the literature searches on which this paper is based. I thank David Stevens, Research Biologist, Rocky

Mountain National Park for directing me to Park files containing historical information. Bob Allison, Forester, Boulder District, Arapaho and Roosevelt National Forests, helped investigate the history of bighorn in the North St. Vrain Canyon. Dr. James A. Bailey reviewed the manuscript and provided helpful editorial comments.

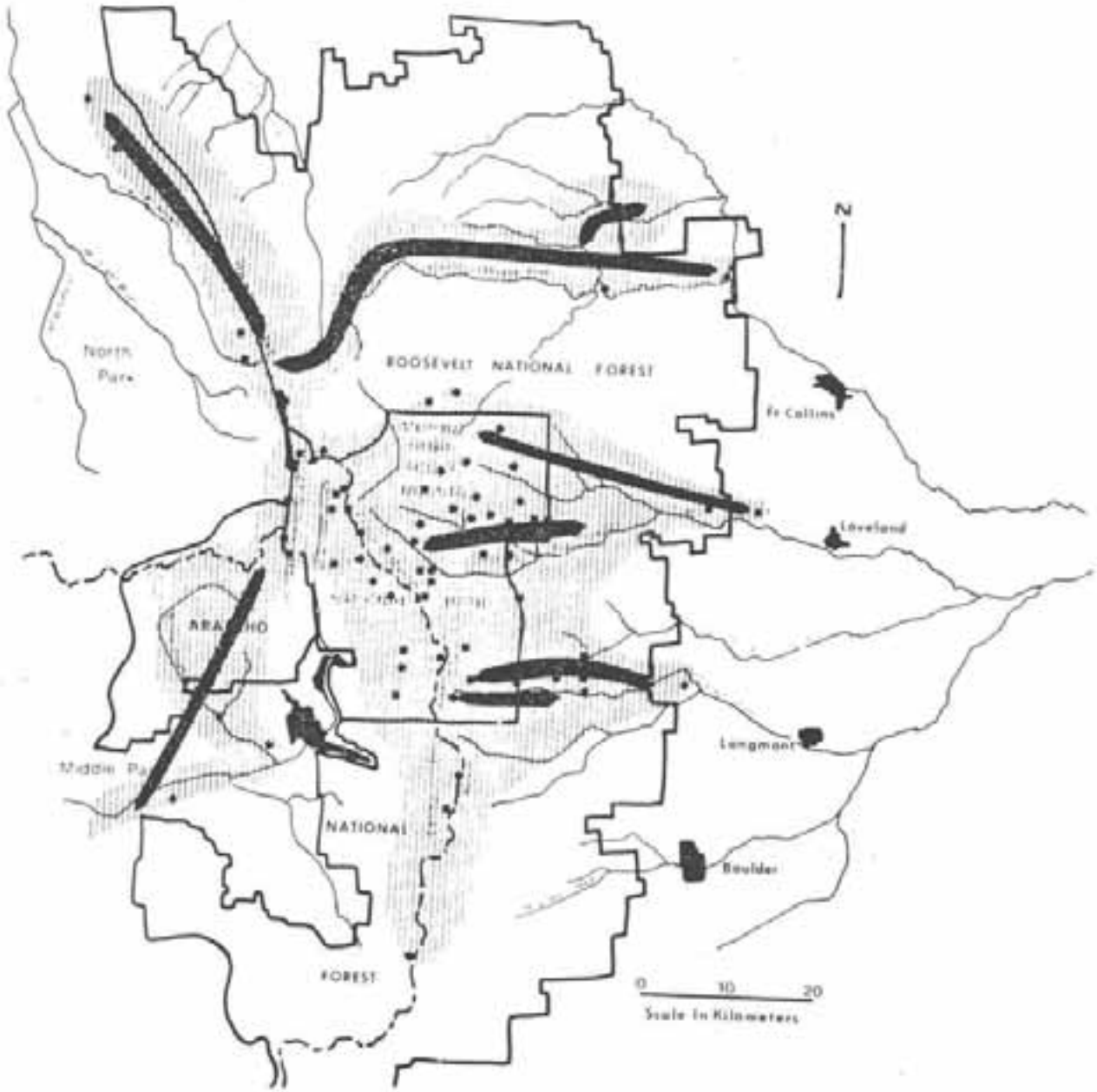
STUDY AREA

The study area is located in north-central Colorado. It straddles the Front Range from the plains on the east to North Park and Middle Park on the west, and extends from the Wyoming border south to Boulder, Colorado (Fig. 1). It includes 8140 sq km and elevations ranging from 1830 m at the edge of the eastern plains to 2440 m in North and Middle Parks, and rises to 4346 m on Long's Peak.

Lower elevations are characterized by mountain shrub communities. Between 2100 m and 2400 m these types are interspersed with stands of ponderosa pine *(Pinus ponderosa)* on the east slope and aspen *(Populus tremuloides)* and lodgepole pine *(Pinus contorta)* on the west slope. Above 2400 m forests of lodgepole pine, Engelmann spruce *(Picea engelmannii)* and subalpine fir *(Abies lasiocarpa)* rise to treeline at 3400 m. Terrain is mountainous and rugged. Steep cliffs, rock faces and talus are common in the higher mountains and in canyons in the foothills.

Nine bighorn sheep ranges are considered. The Poudre Canyon, Big Thompson Canyon, St. Vrain Canyon, Lone Pine Canyon, and Cow Creek are low elevation ranges lying between 2134 m and 2896 m. The Rawah Peaks, Mummy Range, Never Summer Range, and Indian Peaks are high elevation ranges lying largely above treeline.

Fig. 1. Hatched area represents historic distribution of bighorn sheep in north-central Colorado. Solid circles indicate documented records of bighorn. Dates vary from the late 1800's to 1940, but all are considered by the recorders to represent historic range. (See text for references). Arrows indicate possible migration routes.


North
Park
ROOSEVELT NATIONAL FOREST
Ft Collins
Loveland
Longmont
Boulder
NATIONAL
FOREST
N
0
10
20
Scale In Kilometers

METHODS

This paper is based on a literature review of published and unpublished information on historical distribution and management of bighorn sheep in north-central Colorado.

RESULTS AND DISCUSSION

When white man settled in north-central Colorado in the early-mid 1800's, they found bighorn abundant. Ratcliff (1941) estimated 4000 bighorn inhabitated the area defined approximately by extension of the northern and southern boundaries of Rocky Mountain National Park to the plains on the east and mountain parks on the west. Bighorn ranged over a much greater area than they do today (Fig. 1). References from the 1920's or earlier include populations in the Never Summer Range, Rawah Peaks, Mummy Range, Front Range and the Indian Peaks. Estes Park and the canyons associated with the major rivers, the Cache La Poudre, Big Thompson, St. Vrain and Colorado were also identified as sheep ranges (Quaintance 1934; Packard 1939, 1940, 1941, 1946; Anon. 1939a, 1939b, 1939c; Estes 1939; Shepherd 1976; Goodson 1978a, 1978b, in prep.) Bighorn wintered as far east as hogbacks at the mouths of the Big Thompson and St. Vrain Rivers and to Greyrock on the Poudre. On the west side they ranged in the foothills to Willow Creek and the Colorado River in Middle Park (Packard 1939, 1941; Shepherd 1976).

What was the original pattern of use? Workers on the Grand Ditch in the Never Summer Range (1912-1925) reported bighorn bands above treeline at all seasons and movement of bands across Cameron Pass between the Never Summer Range and the Rawah Peaks (Quaintance 1934). Ranchers

living at the eastern edge of the foothills reported sheep were seen year-round in the foothills but were much more numerous in winter (Packard 1939). Apparently, many sheep migrated from low elevation winter ranges to summer ranges above treeline.

Early settlers and researchers agreed that unrestrained hunting for food and sport was the first major impact. In 1867 hunting pressure increased to supply a game meat market in Denver. Although elk were the primary targets, deer and sheep were also shot in great numbers (Anon. 1939a). Bighorn ranging into the foothills and mountain parks suffered greater losses than did bands remaining at higher elevations (Packard 1941).

Sheep were especially vulnerable to hunting due to the predictability of their habits and their use of rocky outcrops as escape cover. Hunters would set a trained dog on bands observed within a mile or two of Mary's Lake near Estes Park and the sheep would invariably head for a rock outcrop near the lake where hunters could easily kill the entire group (Estes 1939). Magnitude of the hunting pressure can be judged by the impact on elk. White men arrived in Estes Park in 1859, by 1880 elk were rare, by 1900 they were eliminated from the region (Guse 1966).

An additional blow to the sheep herds was an epidemic of scabies which raged during the late 1890's. Hundreds of sheep died before the epidemic subsided in 1903 (Packard 1939). Crowding of sheep and poor nutrition caused by loss of low elevation winter ranges may have contributed to the epidemic.

Hunting, grazing of domestic stock and construction of roads, fences and settlements in the foothills and canyons east of Estes Park caused

bighorn to abandon most foothill ranges by 1920 (Packard 1939). However, populations ranging largely above 2440 m were considered healthy in 1910. Herds had recovered from the scabies epidemic. Enactment of game laws reduced pressure from hunting (Anon. 1939a). In addition, extirpation of elk from the area resulted in lessened competition for forage. When Rocky Mountain National Park was established in 1915, its bighorn sheep population was estimated at 1000 head (Packard 1939).

However, by the early 1920's, remaining sheep populations were entering another decline. Records indicate grazing of domestic sheep and cattle was an important factor. After World War I (1918), increased demand for wool and mutton led to grazing of domestic sheep throughout bighorn ranges in the Rawah Peaks and Never Summer Range, then outside Park boundaries. Packard (1939) estimated 10-20 thousand domestic sheep were pastured in the Never Summer and adjacent ranges in the 1920's. A 1916 allotment map in Rocky Mountain National Park files indicates the north Mummy Range was grazed by domestic stock until after Park establishment. Low elevation parks on the east side of Rocky Mountain National Park were in private ownership and grazed by domestic livestock as were areas adjacent to the Park (Dixon 1940). Many of these areas were winter ranges of bighorn.

Bighorn herds declined or disappeared in many of these areas. An all-age die off occurred in the Never Summer Range and the Mummy Range in the mid 1920's (Anon. 1939a, Shepherd 1976). Signs now associated with the lungworm-pneumonia complex were noted in bighorn during the die off (Shepherd 1976).

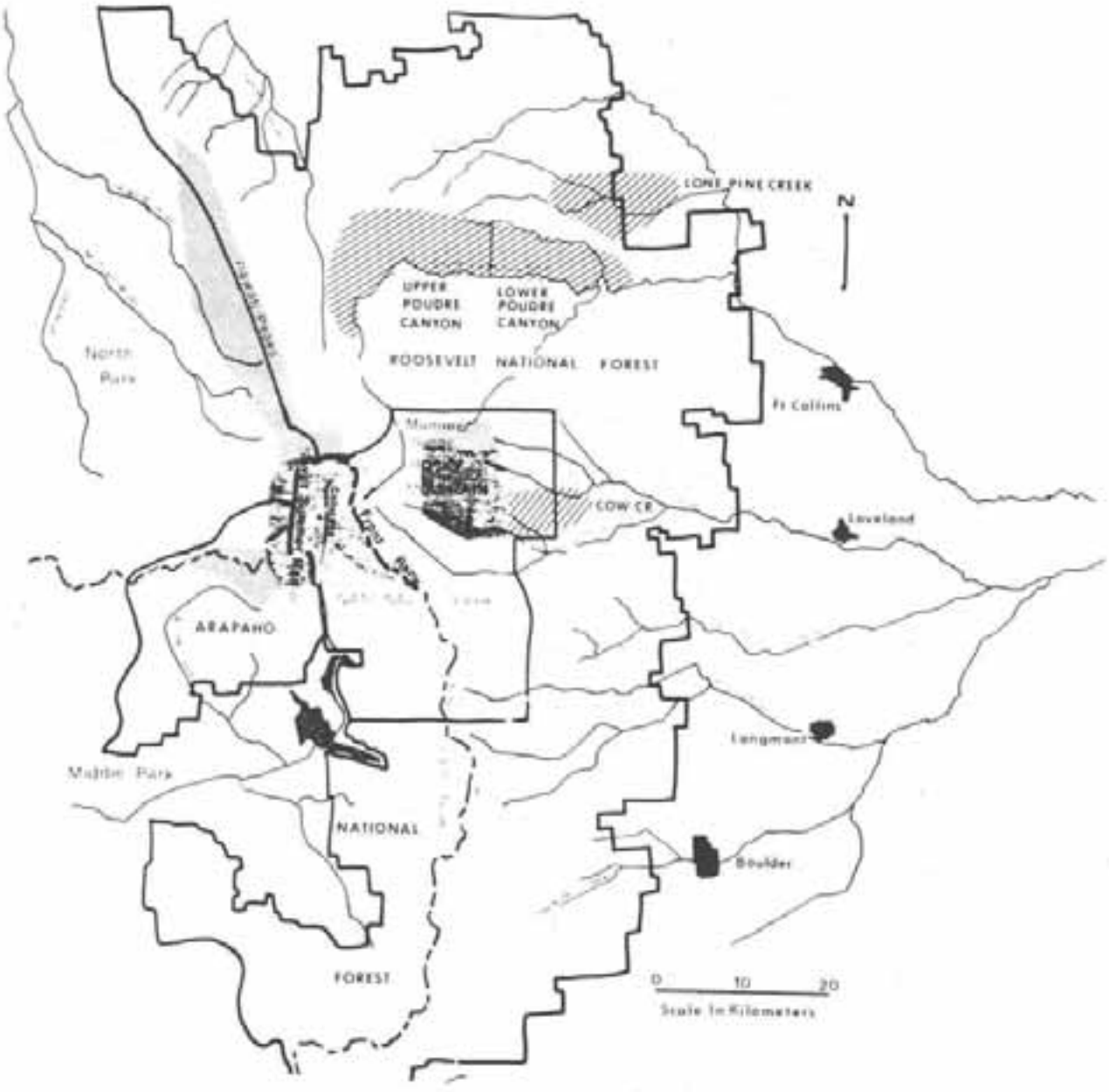
Elk were reintroduced to the region in 1912 and 1913 (Guse 1966). They increased rapidly and may have contributed to competition on ranges shared with bighorn (Ratcliff and Sumner 1945). Elk displaced bighorn from ranges above treeline used in summer (Packard 1939) and winter (Contor 1958, Goodson 1978a).

Certain ranges, however, were lost to bighorn although they were never grazed by domestic stock and use by elk and deer has always been low. These areas, the southern Front Range in Rocky Mountain National Park and the Indian Peaks (Fig. 1), may have been lost because they never functioned as year-round ranges. They may have been used as summer ranges by bighorn wintering in lower canyons. Loss of winter ranges in the St. Vrain canyon due to overgrazing and bisection of traditional migration routes coincided with loss of populations on the Front Range (Goodson 1978b).

Bighorn populations and distribution had dropped to low levels by the 1940's (Fig. 2), and concerned state and Park Service biologists began management to increase the herds. In Rocky Mountain National Park an effort was begun to purchase low elevation winter ranges and remove domestic grazing (Guse 1966). Artificial regulation of elk and deer populations through shooting and trapping and transplanting began in the winter of 1943-44 and continued until 1968 (Guse 1966, Stevens 1968).

In 1947 the Colorado Division of Wildlife began a transplant program for bighorn in this area with reintroduction of sheep from the Tarryall Mountains into the Poudre Canyon (Fig. 2). The herd built to an estimated 75 head by 1970 (Rutherford 1972). However, bighorn occupied only a

Fig. 2. Present distribution of bighorn sheep in north-central Colorado. Shaded areas are primary ranges of native herds. Dotted areas are areas used infrequently or only by rams of native herds. Hatched areas are ranges used by transplanted herds.


LONE PINE CREEK
N
UPPER POUDRE CANYON
LOWER POUDRE CANYON
ROOSEVELT NATIONAL FOREST
North Park
Ft Collins
COW CR
Loveland
ARAPAHO
Longmont
Middle Park
NATIONAL
Boulder
FOREST
0 10 20
Scale In Kilometers

portion of the suitable habitat on the Canyon and showed no tendency to increase their range.

In the late 1960's and early 1970's grazing by domestic livestock was significantly reduced on the Roosevelt and adjacent National Forests (Allotment Folders, Arapaho and Roosevelt National Forests). Reduction in allotted numbers of sheep, lower prices for mutton and wool, increased costs of transporting sheep and increasing conflict with recreation, caused all sheep and goat allotments to become vacant. A number of cattle allotments at lower elevation became vacant due to changes of land use on base ranch property to residential development or to dude ranching. Concern about resource damage caused by grazing in steep, rocky areas contributed to removals. As a result of reductions in grazing, some historic bighorn ranges became suitable for reintroduction.

In 1976, the Division of Wildlife transplanted bighorn from the upper to the lower Poudre Canyon, a distance of 25 km, in an attempt to extend the range of the herd (Fig. 2). Although some of the transplanted sheep returned to the capture area within 37 days, 16 remained in the lower canyon and use in that area has become established (Bear 1979).

Transplants continued in 1977 when bighorn were reintroduced to low elevation range (at Cow Creek) on the eastern boundary of Rocky Mountain National Park in a cooperative project between the Division of Wildlife and the National Park Service (Fig. 2). Transplanted sheep came from high elevation range in the Tarryall Mountains. In their new habitat the sheep drifted upward during the summer and joined native bighorn on alpine range in the Mummy Range. Observations indicate transplanted sheep return to the release site in winter. Apparently, the transplant

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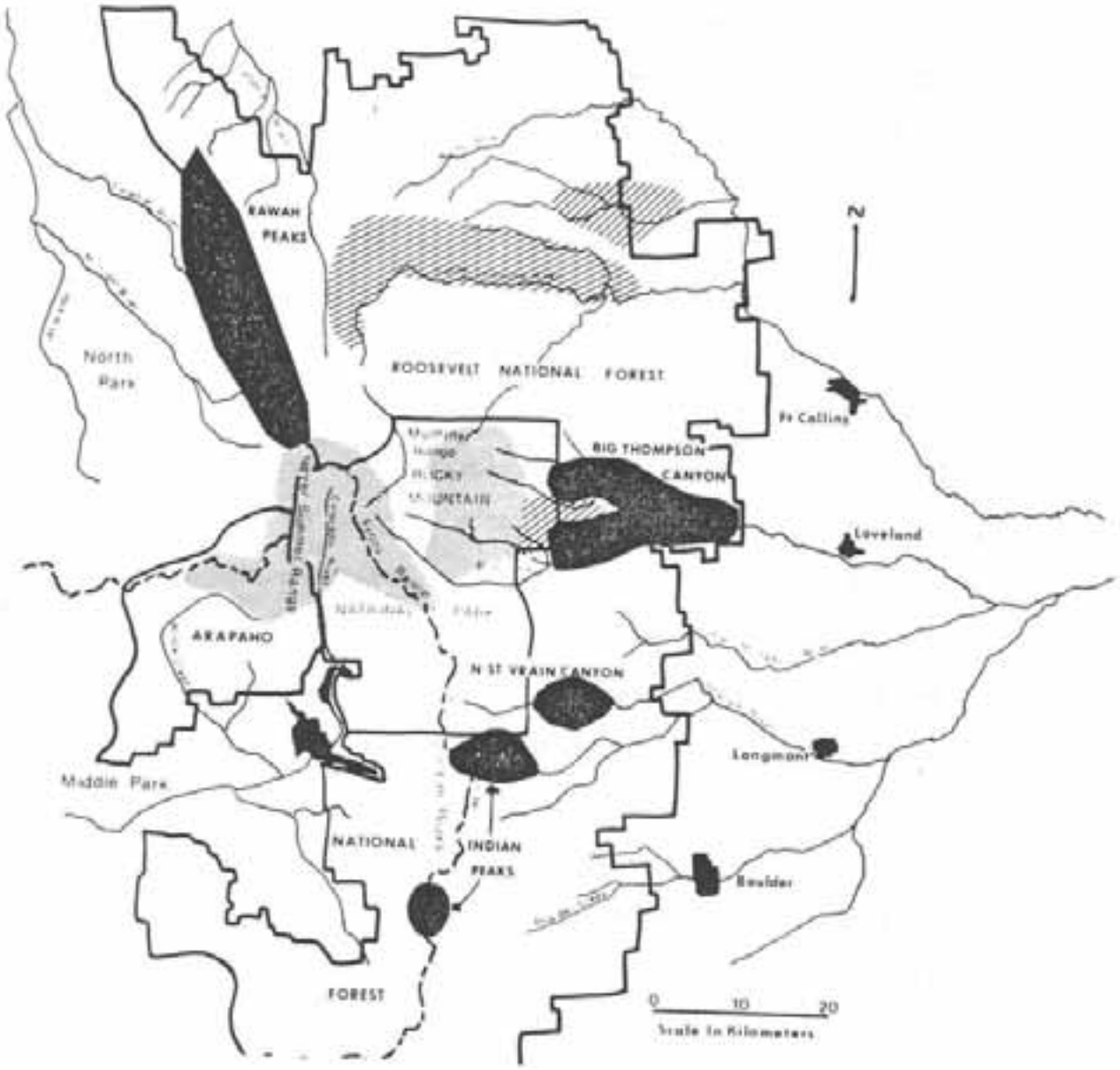
has succeeded in establishing an altitudinal migration (pers. comm. David Stevens, Park Research Biologist).

In 1977 sheep were introduced into Lone Pine Creek Canyon north of the Poudre Canyon on Division of Wildlife land adjacent to the Roosevelt National Forest. This herd has grown to about 50 head which can be found near the release site at all seasons (pers. comm. Ron Desilet, Colorado Division of Wildlife) (Fig. 2).

In 1977 biologists from the Division of Wildlife and the Arapaho and Roosevelt Forests met and discussed five potential reintroduction sites proposed by the Division (Fig. 3). The North St. Vrain Canyon and the Big Thompson Canyon were given highest priority for evaluation. Evaluation of the North St. Vrain Canyon was completed in spring, 1978. Twenty bighorn were released in the area in March of 1980.

The present distribution of bighorn reflects transplants made during the last 35 years as well as the distribution of native herds (Fig. 2). The pattern is one of mostly isolated non-migratory herds. Seasonal migration is limited to some altitudinal drift in the Poudre Canyon and movements of the Cow Creek transplants. Native herds are small and isolated due to a history of range restriction and loss of migration routes which has confined them to relatively small areas which escaped major disturbance. Transplanted herds have generally also been sedentary due to the lack of exploratory behavior in bighorn. Advancing forest succession in lower elevations promoted by aggressive fire control by the Park Service and Forest Service has contributed to shrinking and partitioning of bighorn habitat.

Fig. 3. Future distribution of bighorn sheep in north-central Colorado? Dotted areas are ranges of native herds. Hatched areas are ranges of bighorn reintroduced prior to 1980. Dark shaded areas include proposed future transplant sites and the North St. Vrain Canyon where bighorn were released in March 1980.


RAWAH
PEAKS
North
Park
ROOSEVELT NATIONAL FOREST
Ft Collins
BIG THOMPSON
CANYON
Loveland
ARAPAHO
N ST VRAIN CANYON
Longmont
Middle Park
NATIONAL
INDIAN
PEAKS
Boulder
FOREST
0 10 20
Scale in Kilometers

What is the future of bighorn in north-central Colorado? All remaining transplant sites have problems. The Big Thompson Canyon has a high degree of human disturbance especially during summer. The Rawah Peaks may have a remnant native herd and have much recreation use in summer. Bighorn using the Never Summer Range and the Continental Divide in Rocky Mountain National Park may extend their range into the Rawah Peaks in summer, accounting for sheep sightings there. The Indian Peaks and southern Front Range in the Park are high elevation alpine ranges with an uncertain capacity for winter use and high recreation use during summer. We are left with bits and pieces of sheep habitat. Transplants into these pieces may give us isolated small herds or possibly no herds at all. Can we reestablish a distribution and habitat-use pattern similar to the historic pattern through transplantings?

In the Cebolla Creek area of Colorado, rams migrated to low elevation winter range while ewes remained on the alpine tundra all year. Transplanting of ewes to the lower ranges resulted in reestablishment of migration in the female-juvenile segment of the population (Bear 1979). In the Cow Creek transplant, reintroduction of sheep into an area adjacent to occupied range resulted in linking herds and establishment of altitudinal migration and appropriate seasonal ranges. In the Poudre Canyon transplanting sheep into adjacent suitable range succeeded in extending their range. These examples show that bighorn have ability to home over fairly long distances but remember their way to return to transplant sites and will follow other sheep to learn new range-use patterns. In other areas, transplanted herds derived from populations habituated to humans have retained this characteristic (pers. comm. Bruce K. Johnson). These

traits can be used to plan a reintroduction program to establish altitudinal migration and seasonal range use through transplants designed for such purposes.

What are the possibilities? Transplant sheep to adjacent ranges from nearby but separate herds to create linked populations, migration routes and seasonal range use. Transplant bighorns from high elevation ranges into low elevation ranges where the opportunity to migrate to higher ranges exists. Transplant ewe-juvenile groups into ranges used only by rams. Transplant into ranges capable of providing year-round range that are used only seasonally. Use multiple transplants spaced at intervals where interaction between groups is likely to occur and would encourage filling suitable intermediate habitat. Use sheep habituated to humans for transplants into highly disturbed areas.

In the study area, multiple transplants could be used to reintroduce bighorn into the Big Thompson Canyon and the Indian Peaks. Ram movements from Rocky Mountain National Park should link Park and Indian Peaks populations. Using transplant sheep from a high elevation range for reintroduction into the Big Thompson Canyon may induce migration. Assuming sheep use in the Rawah Peaks is limited to summer drift from the Never Summer Range, reintroduction of bighorn into the Rawah Peaks could establish a year-round herd linked with Park sheep. Through further transplants sheep range could be extended down the Poudre Canyon to its mouth. Exchange of sheep between adjacent herds is a viable possibility between the Poudre Canyon and Lone Pine Canyon, the Poudre Canyon and the Rawah Peaks, the Big Thompson Canyon and the Mummy Range,

the Indian Peaks and the eastern foothills, and the North St. Vrain Canyon and high elevation ranges in Rocky Mountain National Park. The successful application of these techniques in north-central Colorado would link patches of alpine and low elevation range (which alone may be incapable of supporting viable herds) into a productive seasonal range pattern. In addition, linking nearby populations by migration patterns would encourage utilization of all patches of suitable habitat lying between them.

Reestablishment of historic movement patterns including altitudinal migration would result in healthier herds due to improved nutrition (Hebert 1973) and lower lungworm burdens due to less concentration of bighorn (Stelfox 1974). Transplants should be coordinated with prescribed burning and timber harvest to create "pathways" of suitable, attractive habitat over an elevational gradient between low-elevation winter range and high-elevation summer range.

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QUESTION - RESPONSES

Jim Bailey: Nike, in your review of the literature did you find anything that would suggest this fidelity to a lamb area that was mentioned earlier?

Nike Goodson: Fidelity to a lambing area?

Jim Bailey: For instance, is a transplant that involves putting in pregnant ewes more apt to establish a population at the site of the transplant, assuming they lamb there, as opposed to a transplant that is put in later in the year?

Nike Goodson: I didn't run into that, but that's real interesting.

Jim Bailey: It was brought out by the study in Montana that made me recall a paper I heard at the Desert Bighorn Council recently in the Hatchet Mountains. It was a release inside of a fenced paddock, the animals lambed there and then they were released, the fence was taken down, they moved around the mountain, they encountered native sheep on the other end of the mountain range, but the following lambing year they returned to that paddock and lambed there again. There may be some really important things here that are useful to us.