A. W. FRANZMANN

The

BIGHORN SHEEP IN IDAHO

Its Status

Life History

and Management

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By

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STATE OF IDAHO
Department of Fish and Game
Boise, Idaho

STATE OF IDAHO

Department of Fish and Game

PART I

The Bighorn Sheep in Idaho
Its Status, Life History and Management

PART II

A Survey of Winter Ranges along the Middle Fork of the Salmon River and on Adjacent Areas

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Foreword

It was only through the unfailing cooperation from many outside agencies and individuals that the collection and evaluation of a large part of the information presented in this bulletin were possible. The study was initiated and, for the first year and a half, directed by the Idaho Cooperative Wildlife Research Unit. Subsequently, the work was carried on by the Idaho Fish and Game Department as a Federal Aid project.

Acknowledgments are due the Federal Aid Division office in Portland, Oregon, for approving necessary funds and providing helpful advice concerning the conduct of the investigation. Other major contributions were made by the U.S. Forest Service; the Public Health Service Laboratory in Hamilton, Montana; and the Fish and Wildlife Service Laboratory at Denver, Colorado. Several departments at the University of Idaho, Montana State College and Idaho State College furnished important services.

This bulletin is divided into two parts. Part I deals chiefly with the history, habits and ecology of the bighorn sheep. Part II is concerned with evaluating the condition, trend and productiveness of the winter range, not only as related to mountain sheep but to other big game animals as well. The ultimate purpose of the study was to learn more about the bighorn's status, life history and relationship to the range in order to formulate a management program which would not only give maximum assurance of the species' perpetuation, but maintain a population capable of providing a surplus for sportsmen to harvest.

The assets provided by the estimated 2,500 bighorn existing in Idaho today cannot be measured in dollars and cents. The aesthetic and recreational benefits to hunters, photographers and others who appreciate nature, far outweigh any material worth.

This bulletin is presented for the information and enjoyment of those who hope, along with us, that the opportunity to view a bounding lamb with its mother, or a majestic ram atop a rocky crag, will not be denied future generations.

ROSS LEONARD, *Director*
Idaho Department of Fish and Game

FIGURE 1. Twenty-four bighorn sheep string out along the base of a cliff in the Big Creek drainage, a tributary of the Middle Fork of the Salmon River. Note how body color and white rump patches blend with rocks and snow.

January 22, 1953

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A LOOK INTO THE FUTURE

To interpret events of the past is as important as to evaluate conditions of the present if a wise course is to be charted for the future. Therefore, we shall begin at the beginning . . . as recorded in early Idaho history.

Early explorers and settlers reported seeing bighorn sheep by the thousands in the valleys and mountains of Idaho. Disease and the restrictions of native habitat by an advancing civilization were cardinal factors in reducing the statewide population to an estimated 1,000 animals by the early 1920's. At about this point the downward trend was halted. More rigid hunting restrictions and a decrease, during that period, in the number of people and livestock in wilderness areas were key factors coming to the bighorn's aid.

When this study of bighorn sheep in Idaho was initiated in 1949, it was generally accepted that some recovery had been made. Forest Service estimates indicated a statewide population of more than 2,000 animals. Nevertheless, game administrators and sportsmen agreed that increases had been unsatisfactory, particularly in view of the many years that mountain sheep had received protection from the sportsman's rifle. Evidence supporting these opinions was obscure, however, and management procedures were not based on adequate information. Interested persons were asking, "What losses are suffered by bighorn sheep? How important is each source of loss? What is the current status of bighorn in Idaho and how should they be managed in the future? Can sportsmen expect the opportunity to harvest surplus animals?"

In searching for answers to these and other important questions, broad aspects of life history and ecology were investigated. Extensive studies of mountain sheep habitat provided data for describing ranges occupied during different seasons of the year. Key winter ranges along the Middle Fork of the Salmon River were selected for intensive studies, and permanent plots were established to analyze range condition and trend. Utilization of browse was determined by linear twig measurement. About 56,000 acres of important winter range land was mapped to show major vegetation cover types. Productivity studies were made and most of the major herd units were censused. Food habits were investigated by several methods while searching for any deficiencies that might exist in quality or quantity of forage. The bighorn's relationships to other species of wildlife were observed and analyzed. In relating these life history and ecological data to management,

emphasis must be placed on the practical question: "What factors are currently depressing bighorn productivity to a point where satisfactory population gains are not being made?"

Disease and parasites, though important in early declines, are believed to have caused few deaths in recent years. However, diseased conditions may have escaped notice or contributed to death in cases where the casual agent was not determined.

Predation is popularly accepted as an important mortality factor. In reality the loss from this source appears to be small. The cougar is limited in number but, as an individual, is probably the most effective of all predators on sheep. Coyotes are the most numerous of the predators on Salmon River ranges; yet evidence of this study indicates that they kill few bighorn. Eagles are widely credited with killing the young of wild sheep and there are verified records to support this contention. Close examination of their predatory activities, however, indicates that losses to eagles are not large. Bobcats and black bears are present in small numbers on the ranges studied, but their toll of mountain sheep is thought to be negligible.

Accidents are high on the list of established causes of bighorn deaths as determined by this investigation. Some animals died in rock or snow slides, others by falling on precipitous terrain. It is conceivable, too, that flight from predators or weakness related to disease contributed to some of these accidents. Several injured rams were seen during and after each breeding season. Fatal injuries may be sustained by rams and ewes alike during this hectic period.

Illegal killing is a factor of unknown importance. Many local persons having knowledge of the situation believe that poaching is largely responsible for lack of increase in some herds.

A low birth rate is characteristic of mountain sheep. Ewe-lamb ratios based on counts held shortly after lambing were found to average about 1 : 0.75. By the second winter after birth the ratio dropped to an average of about 1 : 0.30. This represents a loss of 60 percent of the juveniles in the first 1½ years of life.

Other limiting factors, though less obvious than disease, predation, accidents or poaching, may be highly significant and should be considered. One possibility is a nutritive deficiency in the food supply at one or more seasons of the year. Or perhaps the scarcity of one or more key plant species is more detrimental than has been recognized—bitterbrush and mountain mahogany appear to be likely candidates for this classification. Other limitations to production are related to the basic habitat requirements of bighorn.

Mountain sheep require areas with highly specific topographical and vegetational characteristics. And because of this limitation, expanded human populations have drastically confined bighorn distribution.

Several factors now have been discussed. Standing alone, none are fully responsible for the lack of satisfactory increase among mountain sheep herds. Combined, however, they exert considerable pressure—particularly now, when the bighorn population is low.

Now that the current status of bighorn sheep in Idaho has been described, it is time to "look into the future." To improve the view it is necessary to define the principal objectives toward which management should aim.

There is little question that the bighorn management program in Idaho still must be concerned with "restoration." Recent gains, while encouraging, do not constitute an adequate safeguard against dangerous population declines. Therefore, a primary goal is to increase the numerical margin of safety by building up existing herds and establishing new ones. Another objective is to furnish sportsmen with the maximum amount of hunting, provided harvest is on a sound basis and does not conflict with the goal of increasing the population. A third objective—and a very important one—is to integrate bighorn sheep management with multiple use objectives of the habitat in a manner assuring the public the fullest aesthetic values from both the bighorn and his environment. It is highly improbable that the economic and recreational values enjoyed by sheep hunters will ever constitute more than a small fraction of the total values rewarding those who have the opportunity to see and photograph the impressive bighorn in his natural surroundings.

What are the tools that can be used to attain the objectives outlined? Census is the first logical step. This is not necessarily true of all game species, but bighorn are present in small numbers and the need for accurate population data increases inversely to abundance. While the population of many of the larger herds is known with sufficient accuracy to require only annual trend counts on key areas, little is known about many small, isolated herds.

Predator control is another management tool. But it should be applied only after thoughtful determination of local needs. While mountain sheep in Idaho are scarce enough to merit every reasonable protection, management should carefully consider all predator-prey relationships before attempting to manipulate their balance.

Salting may be of some value in bighorn management but little is known concerning physiological need—and effectiveness in con-

trolling migration has yet to be demonstrated. Bighorn preference for various mineral compounds has been tested and iodized salt has been distributed experimentally. A need exists for additional study along these lines. Sodium chloride as a factor controlling big game migration is now under statewide scrutiny.

Hunting seasons and bag limits are among the most easily manipulated and commonly used tools of game managers. With sheep populations at present levels, only mature rams should be harvested and these on a permit basis so that the number of animals from any area can be controlled. The opportunity to collect management data from these hunts should not be overlooked.

Harvest regulations for elk and deer are at least as important to bighorn management as harvesting of the sheep. Once the desired priority of game animals has been determined, time and length of hunting seasons can be employed, not only to bring game populations into balance with range capacities, but to eliminate adverse competition with preferred game species. It is the writer's opinion that, on a few key wilderness ranges, the preferred species should be bighorn sheep.

Trapping from well established herds and releasing in new areas is a potential means of extending the range and thereby increasing production. However, this type of operation is expensive and frequently only moderately successful. It is important, therefore, that such a program be approached with caution. The technique of managing limited areas for the maximum benefit of sheep may often be the most practical and inexpensive means of increasing total production.

Bighorn sheep, as indeed all living things, ultimately depend upon the fertility of the soil for their well-being. Care of the range, then, is of utmost importance in a bighorn management program. The term "wilderness" is filled with wonderful connotations. It brings to mind a picture of natural splendor, of lush stands of flowers and grass and nourishing shrubs, of sparkling clear water and abundant game and fish living in this setting of primeval beauty. This pleasant state of affairs, unfortunately, is seldom found. Game populations—uncontrolled by man or the predators which remain after being poisoned, trapped or shot—have multiplied and left stark reminders of our failure to grasp the significance of nature's checks and balances. Short-lived grasses, unhealthy shrubs, unpalatable weeds and eroded hillsides are found where once, old settlers tell us, bunchgrass bound the soil beneath fine stands of bitterbrush or mountain mahogany.

Long-term range studies should be carried out along with

other phases of management. It is important that the intensive studies already begun on winter ranges along the Middle Fork of the Salmon River be continued. Other key bighorn ranges should be analyzed and long-term studies initiated.

Several known principles of game management have been proposed in this discussion. They are all important. However, it is essential that management objectives for a species as scarce as mountain sheep provide for the continuing collection and interpretation of basic data against a possible time when all our knowledge and ingenuity may be required to maintain the species.

The present degree of understanding of the bighorn and his habitat has been materially increased by this study. A management plan, based upon the findings of research, is beginning to operate. Nevertheless, it would be far from the truth to assume that there is nothing further to be learned. Management, which must be conducted on a practical level, is still attempting to function without full understanding of many of the fundamentals involved.

All too apparent is the lack of understanding concerning mortality among young sheep. The importance of key forage plants to the welfare of the animal is not fully comprehended. More information is needed concerning seasonal migrations and interchange among herds if harvest regulations are to be applied wisely and trend counts interpreted realistically. Social behavior patterns are only partially understood. The importance of artificially supplied minerals, to both animals and range, needs further study. The significance of such mortality factors as disease, predation and illegal killing should be weighed more precisely. And these are but a part of the problems still unsolved.

At the risk of over-simplifying these complex questions, the author believes when fundamental ecological relationships are more thoroughly understood, the clue to good bighorn management may be found in good, basic conservation practices rather than spectacular and artificial techniques available to modern game managers. Present information strongly suggests that the greatest challenge today is the task of maintaining adequate suitable habitat in the face of growing commercialization and industrial demands. A wilderness animal, the bighorn will surely be the loser if there are additional exploitations of the wild lands in central Idaho. An important battle will be won if the Rocky Mountain Bighorn Sheep, in addition to reasonable protection, can be assured adequate food and cover and an undiminishing habitat in which to live.

PART I

The Bighorn Sheep In Idaho
Its Status, Life History and Management[1]

INTRODUCTION

Approximately 125 Rocky Mountain Bighorn Sheep[2] have been killed legally in Idaho during the past 25 years. Despite this small hunting removal sheep populations have failed to show any marked increase. Realizing that good conservation practices require more than restriction of legal hunting, the Idaho Fish and Game Department encouraged a bighorn sheep investigation which was initiated in May 1949, under the supervision of Dr. Paul D. Dalke of the Idaho Cooperative Wildlife Research Unit. This study continued through October 1950, culminating in a master's thesis entitled "Life history and ecology of the bighorn sheep in Idaho." Then, on December 1, 1950, the Fish and Game Department, in cooperation with the Federal Aid Division of the U.S. Fish and Wildlife Service, initiated a project to continue the study. Field work on the Federal Aid project was concluded in November 1952, although yearly population trend counts, range studies and other phases of the investigation are being continued by conservation officers and biologists of the Idaho Fish and Game Department.

Major objectives of the investigation were to accumulate information concerning the life habits and requirements of mountain sheep, to study and analyze factors affecting productivity and to make accurate censuses as a basis for bighorn management. The tangible result most urgently desired was to formulate, from this collection of facts, a management program designed to increase the present number of bighorn within the limits of range capacities, at the same time permitting maximum harvest consistent with that goal.

As is common with an investigation of this sort, the key problem was found to be too complex, too inter-woven with the biology of other wildlife and too dependent upon the nature and condition of the habitat to be isolated from the many facets of wild lands and wild game management. For this reason, while emphasis was placed on phases most directly related to practical management, other relationships were explored as well. These

[1]This study was conducted in cooperation with the Idaho Cooperative Wildlife Research Unit, and with Federal Aid in Wildlife Restoration funds under Idaho Project W-99-R.

[2]For convenient reference, scientific names of plants and animals mentioned in this bulletin are listed in the *Appendix* and do not appear in the text.

associated findings are presented whenever they contribute to the major purpose of this bulletin—to relate past and present status and life history data of the bighorn sheep to an action program that will be: (1) practical enough to provide contemporary, wise management; (2) fundamental enough to recognize the complexity of the ecological relationships that exist; and (3) flexible enough to permit ready adjustments of the program as new facts are brought to light.

In addition to the agencies and institutions mentioned in the "Foreword," many individuals cooperated in various phases of the investigation. Special thanks are due Melvin Hyatt, John G. Kooch and Glenn A. Thompson of the U. S. Forest Service for their cooperation with the field work. Dr. William L. Jellison of the U. S. Public Health Service contributed significantly to the study. Food habits analyses of coyote scats were made by Charles C. Sperry of the U.S. Fish and Wildlife Service. Fellow employees of the Idaho Fish and Game Department whose assistance will be especially remembered are Stewart M. Brandborg, Melvin R. Francis and Wesley M. Shaw. Many other members of the department have assisted with phases of the field work and preparation of the manuscript.

Men who were hired for specialized and hazardous work were A. P. Smothers, veteran riverman, and Smith Stoddard, back-country pilot, who was later killed when his plane crashed in the Salmon River mountains. The willingness with which Wally Hutchison, Clay McCulloch, Mike Mitchell and Ed Tewalt, all temporary state employees, shared the hardships of extended pack trips, long hikes and wet boat trips is gratefully acknowledged. I will not attempt to mention all of the ranchers and other old-timers who helped, but they are not forgotten. To the A. A. Bennett, Jess Taylor and Willard Rood families, I am especially indebted for their western hospitality and fine cooperation.

I am grateful to the following men for their critical review of the manuscript and their many constructive suggestions: Drs. John C. Craighead, Paul D. Dalke, George H. Kelker, Jessop B. Low, D. I. Rasmussen and Lee E. Yeager; and Robert E. Latimore, Kenneth W. Parker and William P. Dasmann. And to Bob Gilliam—my appreciation for his fine editorial assistance.

Expressions of appreciation would not be complete without mentioning the contribution of my wife, Carol. She and our two youngsters, in a succession of isolated cabins and through long weeks alone, never failed to accept the unfamiliar role of pioneer with cheerful resourcefulness.

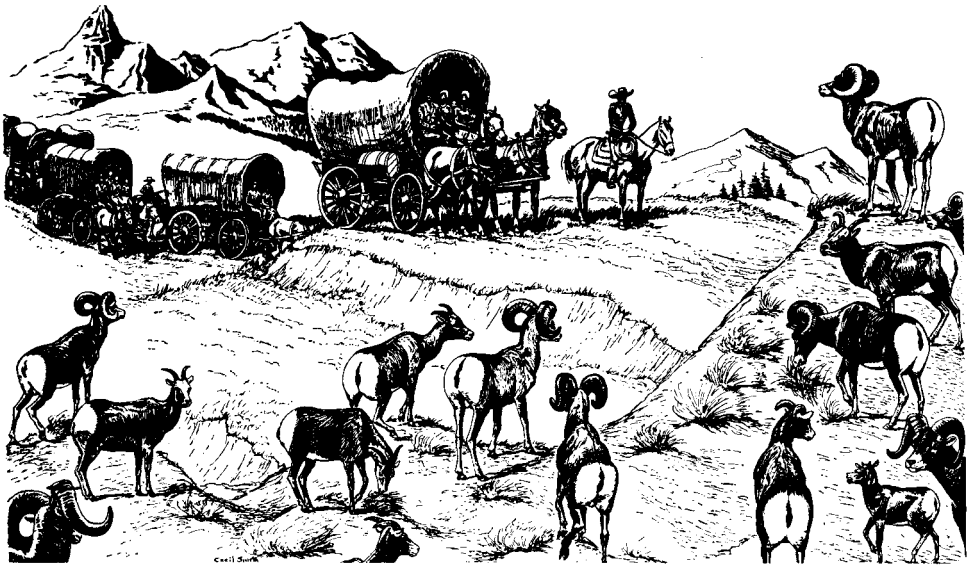
THE PROBLEM

There have been alarming declines in the number of wild sheep in North America since the latter part of the nineteenth century. And game administrators, wildlife specialists and conservation-minded sportsmen have combined their efforts in serious analyses of possible counteractive measures to rescue the bighorn from his apparent plight.

Ernest Thompson Seton (1929) estimated the number of mountain sheep in North America to be between 1,500,000 and 2,000,000 in primitive times. He estimated the population in the United States to be about 28,000 in the 1920's. Big game inventory figures released by the Fish and Wildlife Service for the year of 1952 place the population of native sheep in the United States at 17,500.

Early losses were rapid and widespread. Entire herds were wiped out while others were reduced to a fraction of their primitive number. Regulations restricting or eliminating the legal harvest of mountain sheep were put into effect. Still many herds remaining in remote and rugged wilderness outposts continued to decline, becoming separated into small and isolated groups.

Fortunately, this unhappy status of mountain sheep has been recognized and heeded—we shall hope in time. Several research projects have been initiated, principally during the past 15 years, to gather data from which a management program could be formulated. Some of these surveys pursued only those phases where potential findings could be applied directly to management. Other projects employed pure research to obtain information concerning life history and ecology, regardless of the immediate utility of the facts discovered. Together, these two approaches have borne fruit in the form of much valuable information. But despite the combined efforts of pure and applied research, many problems of productivity remain unanswered, and many basic ecological relationships are still a mystery.



HISTORY OF BIGHORN IN IDAHO

A problem soon becomes apparent when you begin reviewing literature and interviewing old-time residents concerning populations of a wilderness species such as mountain sheep. In the first place, these animals are difficult to count or study. Seemingly insurmountable problems are encountered in piecing together a historical sketch when this fact is combined with the faultiness of normal memory and the frequent relating of impressions as facts. Many other factors tend to dim and confuse unrecorded and sometimes initially inaccurate observations. Nevertheless, the written and verbal accounts relied upon for this historical review were selected carefully and a reasonably accurate chronology of population fluctuation is believed to have been assembled.

Early Numbers

Records from nineteenth century traders, explorers and naturalists indicate that sheep were quite abundant throughout the Rocky Mountain chain and the central portion of Idaho.

During the winter of 1832 Captain Bonneville, his men and a large party of Indians, camped along the Salmon River a few miles north of the present site of Salmon City. The Indians had reported plenteous hunting in this region and Bonneville's party was not

disappointed, as the following report attests (Irving, 1843, p. 169): "Besides numerous gangs of elk, large flocks of the ahsahta or bighorn, the mountain sheep, were to be seen bounding among the precipices. These simple animals were easily circumvented and destroyed. A few hunters may surround a flock and kill as many as they please. Numbers were daily brought into camp, and the flesh of those which were young and fat, was extolled as superior to the finest mutton." Now bighorn are reported only occasionally in this same area.

The first white settlers appeared in the Salmon River drainage in the 1850's. At this time bighorn were considered to be very abundant, especially in Lemhi Valley, according to Mr. George E. Shoup, a long-time resident of the Salmon River Valley. Much of Mr. Shoup's historical information comes from conversations with early white settlers and old Indians whose memories reached back to dates preceding the Civil War. Mountain sheep have not been reported in the Lemhi Valley in recent years.

Seton (1929) remarks that his guide, Abe Leeds, had seen thousands of sheep in the Lost River area of Idaho in the late 1800's. All but perhaps a few dozen animals have disappeared from these ranges. In a letter from M. W. Miner, Mr. Seton was informed of an estimated 2,000 to 2,500 sheep ranging in the mountains near the upper end of the Middle Fork of the Salmon River in 1897. Though the exact geographical limits involved in this estimate are uncertain, there are certainly no more than a few hundred sheep on the same ranges today.

The Initial Decline

It is generally agreed that a major decline in this area occurred between 1870 and 1880, when scores of mountain sheep died from what now appears to have been scabies. Epidemics of scabies and a severe winter around 1890 are reputedly the cause of a second decline in numbers. Another reduction occurred about 1910. Since the first die-off in the 1870's, the bighorn population has never returned to primitive levels.

Other conditions frequently mentioned by old-timers as causing heavy losses are hunting pressure, competition of domestic livestock for forage and space, and the presence and activity of man on the bighorn's native domain. A combination of all these factors undoubtedly contributed to the rapid elimination of this species from many of its original ranges.

Origin of Present-Day Herds

The principal question regarding the origin of recent populations of bighorn sheep in Idaho is whether they were originally confined to the valleys and foothills, as recorded by early explorers, or also populated the cliffs and steep canyons which are inhabited today. There is much supporting evidence that the bighorn sheep of the Rocky Mountain region once roamed far from the rugged terrain that is now considered an essential part of their habitat. Reliable early-day accounts, such as those by Baillie-Grohman (1882) and Roosevelt (1888), tell us of bighorn sheep being observed on prairies and valleys, many miles from the nearest mountains.

Old-timers interviewed during this study expressed the opinion that white man's intrusion onto arable and grazing lands of central Idaho precipitated a gradual migration to the remote and relatively inaccessible ranges along the east, south and middle forks of the Salmon River and the rocky, precipitous canyons of the main Salmon below Shoup.

On the other hand, early written records about the Middle Fork and Salmon River drainages reported an abundance of bighorn sheep on ranges that are occupied today. Mr. George E. Shoup, mentioned previously, has become skilled in deciphering the many Indian paintings found in this area. From these drawings he reached the conclusion that mountain sheep were abundant on their present ranges as far back as 300 years ago. The evidence provided in the literature and from interviews with men having intimate knowledge of early-day conditions, indicates that there may have been limited migration of sheep from the areas of settlement, but that most of the ancestral stock of modern herds were indigenous to present ranges. It appears that unrestricted hunting, disease of epidemic proportions and competition from domestic livestock may have destroyed valley and foothill herds until few remained to escape westward into the mountains now inhabited.

Recent Status

Probably the bighorn sheep population reached its lowest ebb in the 1920's and early 1930's. The history of individual herds, however, varies considerably. Some groups have remained relatively stable throughout the past 30 years, while others have declined and risen again during that period. Perhaps a few herds are still diminishing in numbers.

A. P. Smothers, who has observed mountain sheep along the Salmon River during most of the last 25 years, states that he has noted little change in their status from Little Squaw Creek to Big Squaw Creek, a distance of about 10 miles. There has always been, he reports, about 30 or 40 sheep ranging in that area. Upriver from this herd, Mr. Smothers believes that the sheep declined in the late 1930's and early 1940's but have slowly increased in recent years.

Frank Lantz, a long-time employee of the U. S. Forest Service, has lived along the Salmon River since 1916. He reports that a herd near the mouth of the Middle Fork apparently disappeared just prior to 1920 and sheep were not seen in that location for the next eight or 10 years. Detailed counts made during the current study show that about 60 animals now inhabit the same area.

Gutzman and Buckingham (1935) estimated that there were 400 bighorn in 1934 on the 60 miles of Middle Fork winter range from Marble Creek downstream to the mouth. The 1952 estimate for the same area was 920 head.

During the period of 1929 to 1933, inclusive, the Forest Service, in cooperation with the Biological Survey and State Game Department, kept two men on winter game studies on the Middle Fork of the Salmon River. On the basis of this 5 year study and other observations, Godden and Gutzman (1938) concluded that sheep numbers had remained fairly constant since 1917 except for a possible decline during the last few years before 1938.

Several pioneer residents were interviewed during the investigation. Some of their impressions are pertinent to this discussion. "Les" Gutzman, a forest ranger, first studied game on the Middle Fork in 1928. He reports that bighorn numbers were small at that time and further decreased until 1936 or 1937, when slight increases were noted in certain bands. A. A. Bennett, long acquainted with the Middle Fork country, stated that the Short Creek and Rattlesnake Creek herds have decreased materially since about 1930. Lantz, mentioned earlier, reported observing 212 mountain sheep in the Stoddard Creek drainage in 1916 or 1917. The writer counted an even 100 sheep in the same general area in 1951.

Gaufin and Ellis (1941) report the mountain sheep population was either static or decreasing slightly at the time of their study. They listed a total of 125 sheep between Papoose Creek and Reese Creek. The 1951 count for this same area was 133. It would appear that the Gaufin and Ellis 1941 count should be the most complete as it resulted from many repeated counts, while the 1951 count was based on a 3 day census. These figures indicate some increase in these herds over the past 10 years.

Various game reports and records, which have been reviewed, indicate that past bighorn population trends on the Salmon National Forest were quite typical of conditions on other ranges. Consequently, the trends indicated in Table 1 are roughly comparable with those in other parts of the state. It is recognized that the populations shown in Table 1 are derived from general estimates made by forest rangers and men assigned to game studies and are not based on detailed counts. Still these estimates were made by men who spent much time in the field and usually consulted local residents and other informed persons before submitting their reports. Therefore, the statistics should indicate general trends.

The period from 1917 through 1927 shows relative stability. In 1928, despite the fact that some additional territory had been added to the Salmon Forest, a downward trend is noted. Small populations are reported until 1934, when the figures rise to about the same level reported during the 1917-1927 period. A decided increase appears in 1940. However, in February 1940, over 66,000 acres along the west side of the lower Middle Fork were added to the Indianola Ranger District. This district reported 215 more sheep in 1940 than in 1939, which nearly accounts for the increase from 250 to 510 shown for the entire forest. Considering this enlargement in area, it appears that the population remained nearly static between 1934 and 1945. A fairly constant increase is reflected by the estimates from 1945 to the present.

The statewide population of mountain sheep ranging on national forests in 1922 was estimated at 869. Today there are about 2,500 bighorn in the national forests of Idaho.

Table 1
Bighorn sheep population estimates for the Salmon National Forest

Year	No. of Sheep
1917	205
1918	
1919	250
1920	250
1921	250
1922	255
1923	250
1924	250
1925	331
1926	320
1927	236
1928	156
1929	94
1930	112
1931	198
1932	196
1933	205
1934	271
1935	245
1936	230
1937	225
1938	250
1939	250
1940	510
1941	550
1942	480
1943	505
1944	510
1945	560
1946	630
1947	700
1948	790
1949	810
1950	850
1951	880
1952	880

APPROACH TO THE PROBLEM

Early Studies in Idaho

This investigation is not the first study of bighorn sheep to be conducted in Idaho. Foster Robertson, an employee of the U.S. Forest Service, investigated mountain sheep for a two month period during the summer of 1938. His headquarters were at Reese Creek, a tributary nine miles up the Middle Fork of the Salmon River. Mr. Robertson also spent a month studying the sheep on their summer range in the Bighorn Crags.

On January 2, 1940, David M. Gaufin, leader, and F. Gordon Ellis, assistant leader, initiated the Idaho Mountain Sheep Survey under the Federal Aid Project No. 7-R-C. The project was scheduled for five years duration but was discontinued in June 1941, when the project leader entered the armed forces. At this time there had been 17 months of nearly constant study by one or both men. The headquarters for this investigation was on Stoddard Creek, about three miles south of Robertson's camp on Reese Creek.

Wesley M. Shaw carried out, under the auspices of the Idaho Fish and Game Department, a survey of the bighorn sheep along the East Fork of the Salmon River and near Challis during the winter and spring of 1942.

In addition to the reports resulting from these full-time studies, considerable historical data have been assembled from letters, newspaper articles and miscellaneous reports. Most of the material was found in the files of the Salmon and Challis National Forest headquarters and the Idaho Fish and Game Department office. Many pioneer residents with intimate knowledge of early-day game conditions have been interviewed. Their statements were recorded and filed for future reference. These opportunities to build a background of historical information were helpful in many ways. Not only was duplication of investigative efforts reduced but a basis was provided for comparison of findings over a substantial period of time.

Study Methods

Transportation—first, last and always—is the matter of greatest concern in a wilderness study. The problem, not only of getting where you want to be, but keeping supplied with food, camping paraphernalia and study equipment becomes almost monumental at times.

Where roads lead into mountain sheep country, a pickup or jeep can be used. When trails are followed you walk or ride a horse; and, if the trip is long, a packstring is led behind. Horseshoes and hobbles are basic necessities; but, even so, horses may become lame, or master the art of traveling while hobbled and you spend hours—or days—catching them again. Where the trail ends you walk, or maneuver a rubber boat down the river.

Food spoils in summer, freezes in winter and gets soaked in the boat or when fording a river; but you soon learn to overcome most of these difficulties. Porcupines, mules, packrats and bears may raid the grub boxes or otherwise raise havoc with the outfit. Anyone who has shared these experiences knows that he will spend one-third of his working hours just "living" and "getting ready to do something." But all of this is a part of the job and, when recalling it, one never feels that it has been a hardship.

In July and August 1949, two pack trips, covering 450 miles and requiring six weeks time, were made on summer and winter ranges to count game and become familiar with sheep country. A camp was established in the Bighorn Crags in 1950. One month was spent here observing the summer activity of bighorn and surveying their ranges.

Two boat trips were made through the lower 50 miles of the Middle Fork of the Salmon River during the summer of 1951. One

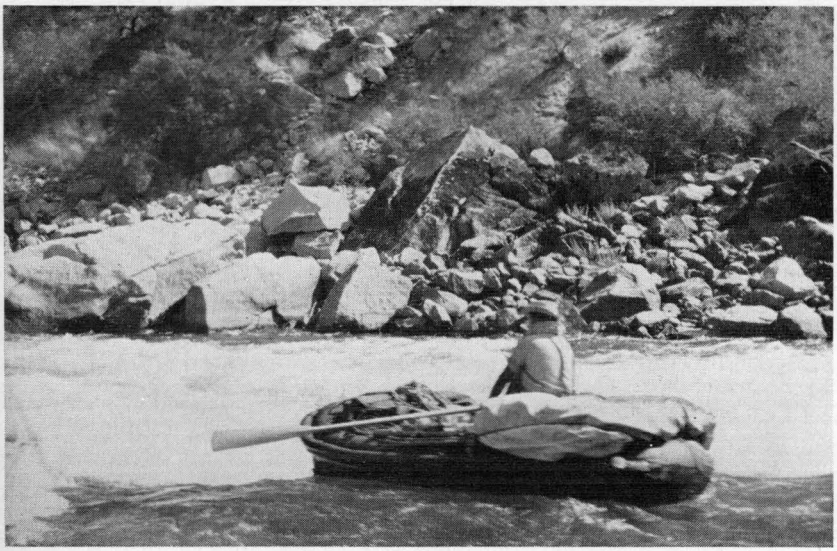


FIGURE 2. Camp supplies and study equipment are moved downriver in a rubber boat while conducting range survey. No pack trails or roads traverse winter ranges along the lower 25 miles of the Middle Fork of the Salmon River.

September 19, 1951

trip, principally to census mountain sheep and other big game, required 18 days to complete. Most of the count was made during side trips on foot. Nearly six weeks were spent on the second boat trip, when a survey of winter range was conducted.

From mid-December 1951, until early April 1952, study headquarters were at the Flying B Ranch, 40 miles up the Middle Fork of the Salmon River and over 20 miles by trail from the nearest road. This area is accessible only by airplane in the winter, and includes some of the finest bighorn range in the state. Close surveillance was maintained over 20 miles of sheep range along the Middle Fork throughout the winter.

Three pack trips, requiring a total of 33 days, were made on summer ranges during the summer of 1952. An additional 18 days were spent on two trips into the Middle Fork winter range area to investigate game use of browse. A 13 day boat trip through 65 miles of the main Salmon River canyon was made late in April to count big game and inspect winter range. These are the major trips. Many trips of shorter duration were made on foot or horseback.

To summarize—more than 500 days were spent in the field observing the animals, investigating range conditions or studying

other factors related to mountain sheep. Over 3,200 bighorn were tabulated during the study. This figure includes repetitions and possibly represents an observed population of no more than half that number. An additional 400 sheep were counted in aerial censuses conducted in March 1951, and the same month in 1952.

In addition to the detailed notes taken regarding bighorn sheep and their habitat, notice also was taken of predatory birds and mammals and their relationship to sheep. To add to the ecological picture the occurrence of all big game, fur-bearers, predators, rodents, upland game birds and song birds was recorded.

From May 1949, until April 1950, Stewart Brandborg, who was conducting a study of mountain goats, operated from the same base camp and cooperated on the many phases that were common to both studies. After the first year a temporary employee was hired from time to time for a specific task or an extended trip into the back country. Otherwise, the study was a one-man project.

BIGHORN HABITAT

Location

Mountain sheep in Idaho have been geographically restricted by the encroachment of civilization upon much of their ancestral range. At one time the domain of Idaho sheep herds abutted the state boundary at many points. Now, with the exception of the few small and scattered herds shown in Figure 9, mountain sheep populations have been reduced until they are confined almost entirely to the Salmon River watershed in the central part of the state.

Present sheep herds of importance can be further circumscribed to three major tributaries of the Salmon River: The East Fork, Middle Fork and South Fork rivers; and ranges along the main Salmon River from Shoup to Riggins. This area spreads over four counties: Custer, Idaho, Lemhi and Valley. Six national forests, the Bitterroot, Boise, Challis, Nez Perce, Payette and Salmon, are represented in the same locality.

Topographical Features

On their historic expedition to the Pacific, Lewis and Clark turned back only once—when they heard the roar of the "white water-rapids" and saw the forbidding walls closing in on the banks of the Salmon River. It was here, a few miles below the mouth of the North Fork of the Salmon, that Indians convinced the two captains that the Salmon River canyon was impassable (DeVoto, 1953). Today the canyon has been traversed but is recognized as one of the most rugged in North America. From rim to river its depth in several places exceeds 6,000 feet.

From its source amid the rugged peaks of the Sawtooth Range, through 390 miles of valleys and canyons to its confluence with the Snake River, the Salmon falls more than a mile. Within the area where basic studies were conducted, the river flows at an elevation of about 3,000 feet and has an average gradient of 14 feet per mile. Large areas along the canyon are bordered by cliffs and the talus originating from them. The high country is characterized by subalpine valleys surrounded by ridges which are studded with spires of jagged rock. Glaciated basins are rimmed with talus and outcroppings of barren granite.

There is considerable difference in the elevations of summer and winter ranges adjoining the lower Salmon River, as compared with the heights at which sheep summer and winter near the

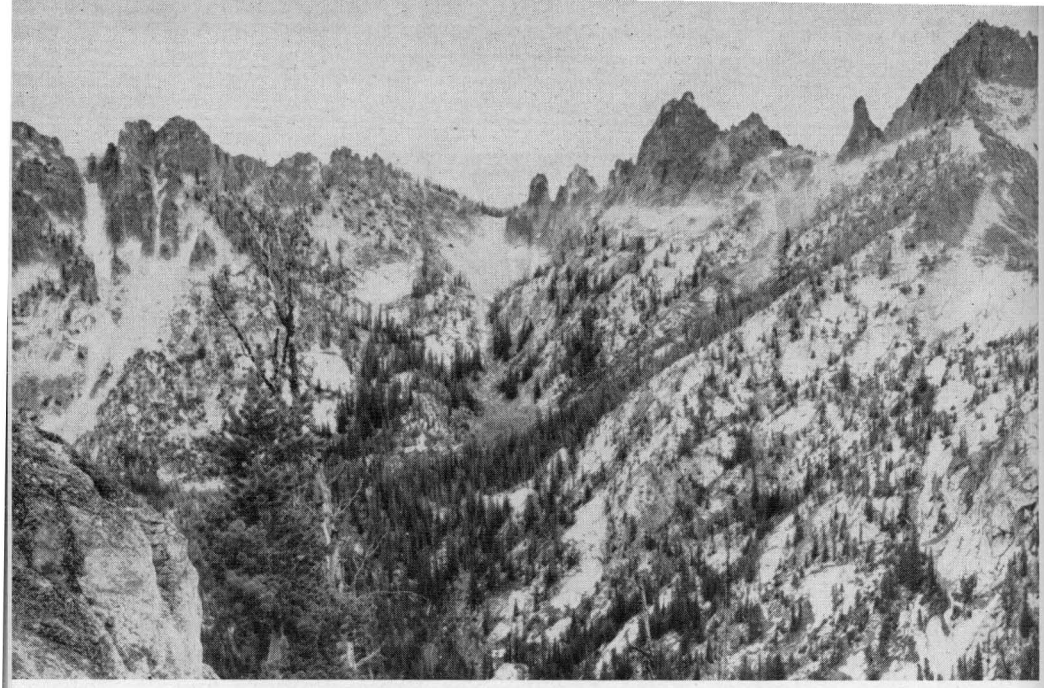


FIGURE 3. Mountain sheep habitat in the Bighorn Crags. This area is typical of the granitic high altitude ranges common to the Salmon River watershed.

Photo by M. Edson, August 30, 1953

upper end of the drainage. The elevation at the mouth of the South Fork is 2,000 feet above sea level. Few of the peaks in that region rise above 8,000 feet. By way of contrast the East Fork flows at about 6,000 feet through the sheep range, and there are peaks exceeding 11,000 feet in the White Cloud Mountains where East Fork bighorn herds range in summer.

While there are definite variations between micro-habitats found in the two extremes described, there is marked homogeneity in their over-all physiographic character. Therefore, unless exceptions are noted, it may be assumed that subsequent discussions of physiography are applicable to all major ranges in the state which are now occupied by bighorn sheep.

Geology

The Salmon River canyon and the Middle Fork and South Fork tributaries cut deep into the huge Idaho batholith, a vast granitic mass measuring some 70 by 240 miles. This body of granite is one of the largest of its kind in the world (Shenon and Reed, 1936).

It is interesting to note that, while much of the historic population occupied areas underlain by sedimentary rocks, modern

herds are almost entirely confined to granitic regions. The Lemhi and Lost River ranges and the Miocene lake beds around Salmon are described by Rhodenbaugh (1953) as being largely sedimentary in nature. These areas were inhabited by thousands of bighorn a hundred years ago. Though it was the early settlers with their agriculture and industry and guns who first eliminated wild sheep from these fertile river valleys, there may be a direct relationship between the healthy condition of those early herds and the low productivity of our present-day herds. Since soils derived from sedimentary rock are generally more fertile than granitic soils, the historic herds were occupying inherently better ranges than are mountain sheep today. This difference could be significant in determining the productive potential of a herd.

Climate

The Salmon River drainage has a rather dry, hot climate. In the city of Salmon, the mean annual precipitation has averaged 8.79 inches over a 42 year period. Weather records available from areas in the mountains west of Salmon indicate average precipitation to be about 12 inches annually. Most of this precipitation is received from late autumn to early spring. Six to 18 inches of snow can be expected on most of the winter ranges from late December through February, and sometimes well into March. High winds are infrequent in most areas and drifted snow seldom interferes with the winter movement of big game. Snow slides, however, are common and the presence of big game carcasses in slide debris attests to the hazard presented.

Temperatures of more than 100°F. are often recorded during July and August. However, low humidity combined with the gentle air currents that are usually present, greatly reduce effects of the heat. Sub-zero temperature can be expected for short periods in December, January and February. The lowest reading for the study period was in February 1951, when the mercury dropped to -30°F. at Salmon. Temperatures this low are seldom recorded in this region, however. The highest reading was in August 1949, when the temperature soared to 111°F. near the mouth of Colson Creek. But most of the sheep are in high subalpine country during the summer, and temperatures are much cooler there. At study headquarters, elevation 8,100 feet, the hottest day between July 20 and August 17, 1950, was 80°F. During the same period at the mouth of Camas Creek, elevation 3,800 feet, the mercury rose to a maximum of 99°F.

FIGURE 4. This summer range, near Twin Peaks and west of Challis, is largely sedimentary in nature. Limestone and chalk formations are found to a limited extent on both summer and winter ranges in the upper Salmon River watershed. Seven bighorn sheep and one mountain goat were grazing on the open slope in the left foreground when this photo was taken. Close inspection reveals a network of trails gouged out of the hillside by game.

August 13, 1952

It is important to record snow depths, maximum and minimum temperatures, total precipitation, barometric pressures and wind velocities. However, unless there are marked extremes in any of these factors, a most exhaustive review of such data tells little about the direct effect of climate upon the welfare of game animals.

The most satisfactory means for judging the consequence of weather on game populations is by direct observation of conditions in the field. The amount of snow present is not as important as the condition of the snow. A heavy crust may render large areas of range unavailable. The degree and duration of this crust, as well as the temperature and depth of snow, determine the severity of a winter. It is on winter ranges during winter and early spring that weather becomes a particularly significant factor in the bighorn's odds for survival.

There is, of course, a very important relationship between precipitation and temperature and the development of forage. The part that climate assumes in the production and availability of food, and the effects of varying snow conditions, are discussed later in connection with range studies.

Summer Range

Most bighorn sheep summer ranges in Idaho are quite similar in topography, geology and vegetative characteristics. The Bighorn Crags, a high altitude range lying immediately east of the Middle

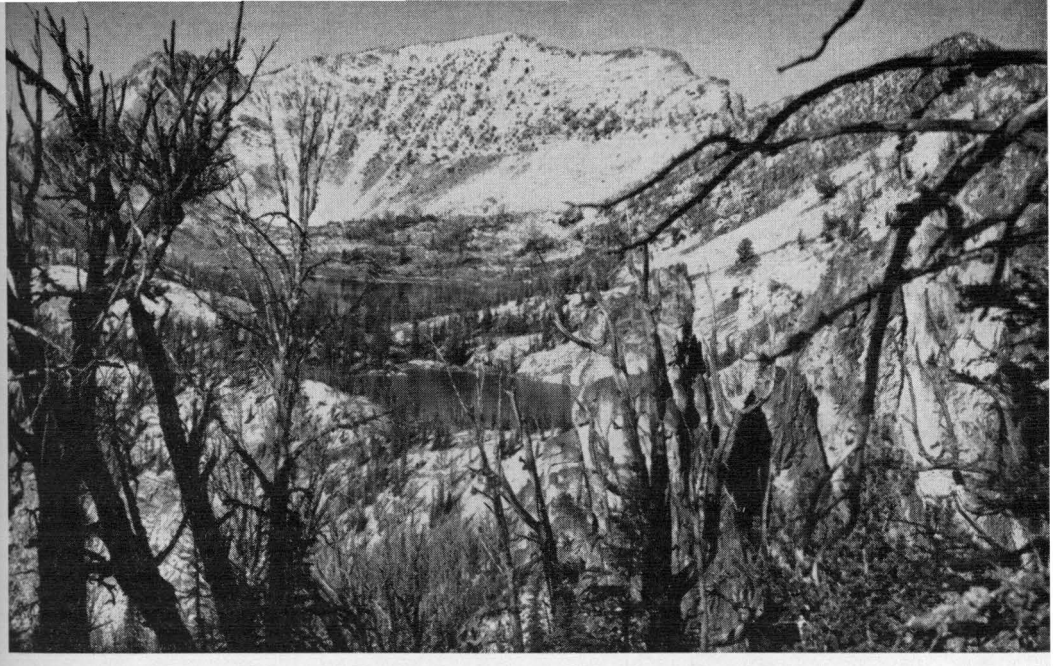
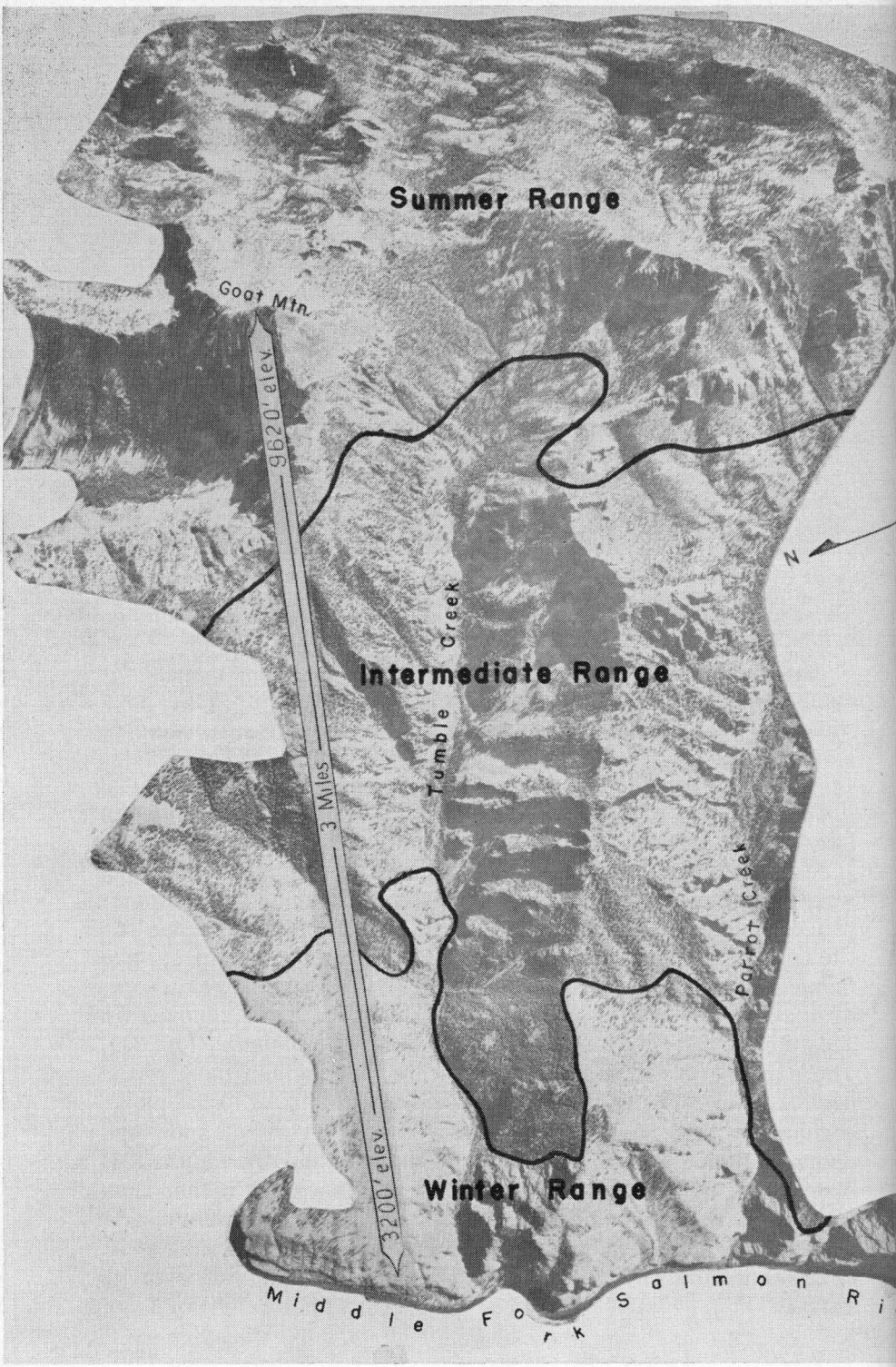


FIGURE 5. Harbor Lakes Basin. These two lakes lie at an elevation of 8,800 feet and are fed by melting snow and icy freshets from subterranean springs emerging from the surrounding slopes. Visits to this basin during the summer of 1950 were often rewarded by the sight of several ewes and lambs feeding, sunning or frolicking around the basin walls. Bighorn were not observed near the lake shores which are surrounded by lush stands of sedge, grass and rushes. Rather, the sheep preferred the upper slopes with their sparse vegetation and abundance of talus slides and barren rock.
Photo by M. Edson, August 30, 1953

Fork of the Salmon River, was studied most intensively and the following is based largely upon the finding of that survey.

All of the mountain sheep observed in the Bighorn Crags were found at elevations over 8,000 feet. Most of this summer range occupies a subalpine position between the forest proper and the treeless alpine tundra, assuming characteristics of the spruce-fir zone at its lower border and abutting the alpine zone on some of the highest peaks. (Classification of vegetation zones is in accordance with the standards established by Daubenmire [1952]). There are perpetual snowbanks scattered throughout most of the high country range. These may be remnants of wind-blown cornices, drifted snow in deep crevices or the residual snow and debris that inevitably collects at the base of narrow chutes and steep basin walls. Bighorn frequently eat this snow rather than descend to the creeks or lakes for water. It is not uncommon to see entire bands of sheep sunning themselves on a large snowbank, or kicking up sprays of icy snow as they run and slide over its surface.


Summer Range
Goat Mtn.
9620' elev.
3 Miles
3200' elev.
Tumble Creek
Intermediate Range
N
Parrot Creek
Winter Range
Middle Fork Salmon Ri

The floor of each basin contains from one to a half-dozen lakes surrounded by scattered stands of alpine fir, Engelmann spruce and occasionally white-bark and lodgepole pine. Labrador tea, mountain heath and beargrass often flourish under spruce, fir and lodgepole, especially near the lakes and streams. Frequently small mountain meadows dot the lake shores and border the creeks which flow through glaciated valleys before pitching downward in tumultuous descent to the river below. Spruce and lodgepole disappear as the slopes are ascended; white-bark pine and alpine fir become stunted and deformed. Small-leaved huckleberry is an especially characteristic member of the impoverished ground cover. A species of rush, little ricegrass and sedges are abundant in some areas.

Dwarf juniper and wind-distorted white-bark pine can be found in crevices nearly to the summits of the peaks, but the density of all vegetation is noticeably decreased above 9,500 feet. It appears, however, that this dearth of vegetation is related more to a lack of soil than to altitude. On one peak, at an elevation exceeding 9,900 feet, small patches of soil were producing vigorous stands of herbage.

In considering Figure 7, it must be borne in mind that there are many micro-habitats within subalpine ranges; it would thus be unsound to conclude that all sites at the same elevation and exposure would necessarily conform to the plant composition shown. The major difference between the slopes examined is that the drier, southwest exposure is essentially a grass type while moist conditions prevailing on the northeastern exposure have encouraged the production of shrubs.

On a few of the major summer ranges visited, considerable variation was noted in physiographic characteristics. A brief discussion of these variations follows.

Twenty miles south of the Bighorn Crags an important bighorn summer range is situated between Camas Creek and Loon Creek. This range, while retaining the familiar deeply dissected

FIGURE 6. An aerial view of ranges occupied by the Tumble Creek-Parrot Creek bighorn sheep herd. The topography is more precipitous than usually found, but there are several bighorn herds in Idaho that range in country equally rugged. Boundaries shown must be considered with certain reservations. In reality, they can be defined only generally because use varies from year to year in response to weather conditions. The habitat shown cannot be considered as the entire range for this herd because it is known that they roam beyond the pictured area, particularly on the summer range.

Photo by Geological Survey, September 24, 1947

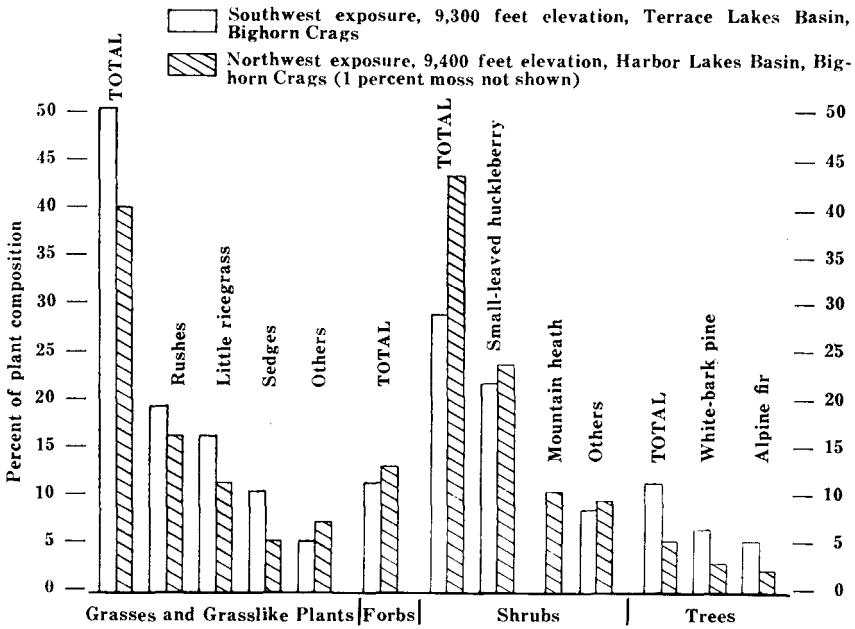


FIGURE 7. Comparison of the vegetation on two slopes within a subalpine range as indicated by measurements of forty 10-meter line intercepts on each slope.

relief and glaciated cirques, exhibits wider contrasts in soil and vegetation than is found in the Crags. Huge extrusions of granite alternate with areas of red and purple-hued shale and occasional limestone ledges. Evidence of the complexity of micro-climate and soil is illustrated by the islands of sagebrush-grass type that appear on some of the southerly slopes overlooking subalpine basins. Big sagebrush, arrowleaved balsamroot, bluebunch wheatgrass and Idaho fescue are the more important plants inhabiting these ecological oddities. Another departure from the associations observed in the Bighorn Crags was the occurrence of curlleaf mountain mahogany at high elevations. North of Bear Creek, stands of vigorous mountain mahogany are first associated with the upper limits of Douglas fir, then extend up through scattered lodgepole

FIGURE 8. Stoddard Creek winter range. This is one of the better mountain sheep habitats in central Idaho. Open grass is the dominant type; bluebunch wheatgrass and Idaho fescue are the principal forage species. Mountain mahogany and other desirable shrubs are relatively abundant among the flanking cliffs. Approximately 125 bighorn winter largely within the area pictured at right.
Photo by Geological Survey, September 24, 1947


Cradle Creek
Stoddard Creek
Reese Creek
Middle Fork Salmon Riv
1 Mile
N

pine and open cliffs until they intermingle with white-bark pine at elevations over 9,000 feet.

The White Cloud range, which furnishes the East Fork herd with summer pasture, differs from the Bighorn Crags principally in elevation. Several peaks are in the neighborhood of 11,000 feet, with Castle Peak towering 11,820 feet above sea level. Bighorn summering in these mountains are reported to spend most of their time at the upper limits of the spruce-fir zone or above timberline. This survey was too cursory to establish limits of summer use in that area with accuracy.

During the summer more than 500 bighorn sheep range in the mountains immediately west of the Middle Fork of the Salmon. There are few peaks above timberline and the sheep pasture at elevations between 6,500 and 8,500 feet, usually in the spruce-fir or Douglas fir zones, but sometimes within the upper extensions of the ponderosa pine zone.

Winter Range

Just as winter and early spring is the critical period in the life of the bighorn, so is the abundance and condition of available winter range a determining factor in his survival. In recognition of this fact, intensive range studies were conducted on limited key areas occupied by mountain sheep in winter. The findings and conclusions based on these studies are presented in Part II of this bulletin, where winter ranges are described in detail. Therefore, only sufficient description is given here to familiarize the reader with general winter range characteristics. The following discussion is based largely upon the intensively studied lower 50 miles of the Middle Fork and adjacent Salmon River ranges, which are representative of most bighorn habitat in the state.

Vegetation zones are vaguely defined in terms of elevation on all ranges in the Salmon River drainage. Sharp definition of these zones is especially lacking on the lower ranges. Ponderosa pine constitutes the principal zone and reaches its best development within certain fairly definite limits of altitude. However, it characteristically sends extensions down to considerably lower elevations bordering the river on the north-facing slopes and may be scattered intermittently on the south-facing slopes. Ponderosa pine also occurs along the summits of dry ridges and on southern exposures at altitudes well above those where well-defined Douglas fir stands are found on northern exposures. Open grassland parks typical of the wheatgrass-bluegrass zone are

associated with timber stands in many situations on the lower ranges.

With the exception of lodgepole pine found at the uppermost limits of winter ranges, the only noteworthy trees are Douglas fir and ponderosa pine. The major shrubs are mountain mahogany, spiny greasebush, rubber rabbitbrush, big sagebrush and bitterbrush within its range. Bluebunch wheatgrass, Idaho fescue and Sandberg's bluegrass, in that order of importance, are the usual grasses present. Numerous forbs, of which balsamroot is the most common and most important in the bighorn's diet, are found on all ranges.

Intermediate Range

On most sheep ranges there is an area between the upper limits of winter range and the lower limits of summer range that does not belong to either. This region is important in that it provides food and cover during spring and fall migrations and, on some ranges. is used during the lambing and breeding periods. It is difficult to define because its location and extent varies greatly with each locality.

Some ranges have long migration routes that cross 15 or 20 miles of intermediate range. In other areas there may be practically no intervening territory between summer and winter ranges. Upper extensions of ponderosa pine, the Douglas fir zone and, sometimes, lower reaches of the spruce-fir forest compose the usual intermediate range.

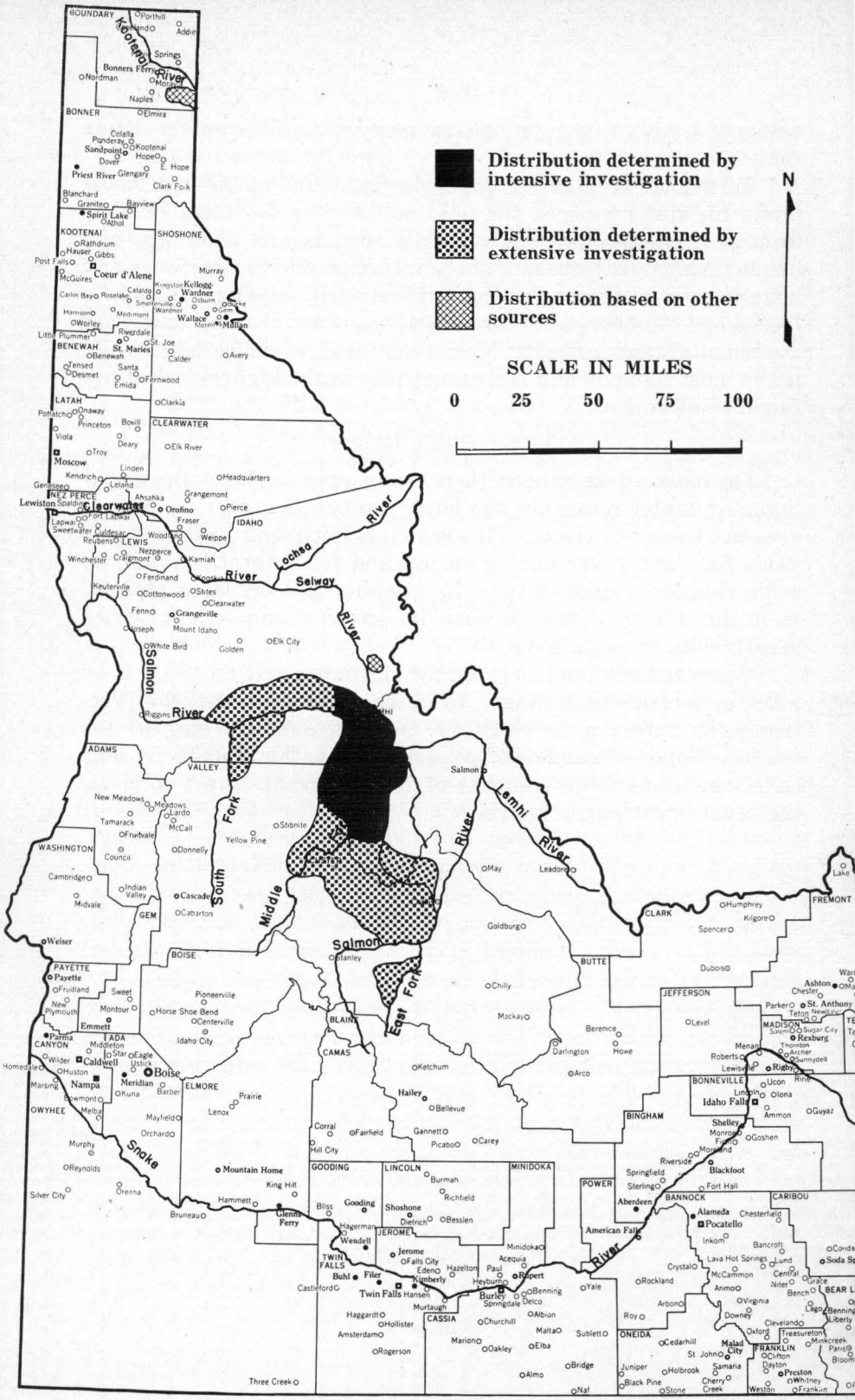


FIGURE 9. Distribution of bighorn sheep in Idaho in 1952.

DISTRIBUTION

It was decided at the outset of this study to confine major efforts to certain key areas of bighorn abundance rather than to engage in a state-wide survey. In those areas inhabited by mountain sheep but not visited by this writer, it was necessary to rely upon the observations and knowledge of others to arrive at population estimates.

Foremost contributors of information relating to the size and distributions of sheep herds were U. S. Forest Service personnel. Game counts, reports from employees, packers and guides and personal observations were some of the means relied upon by forest rangers in making yearly estimates. Game department officials furnished much reliable data, often secured in the same manner as by the forest rangers.

Sources of information were considered carefully before population data were accepted in this study. Figure 9 indicates the basis for the population estimates for each bighorn area in the state. Figure 10 shows estimated herd numbers within the area selected for basic studies. Herd boundaries shown in Figure 10 roughly approximate the limits of winter range.

Highly specific habitat requirements and the delimiting effect of civilization have greatly restricted the distribution of mountain sheep in Idaho. This is apparent in Figure 9, which shows that about 95 percent of the bighorn population lives within the Salmon River drainage. Approximately one-half of these animals find suitable year-around habitat inside a rectangular area about 20 by 60 miles in size, which is bisected by the Middle Fork of the Salmon River. The expansion or restriction of future distributions will depend largely upon industrial and other developments by man. Even the most intensive type of management will ultimately have little value if present ranges are opened up by roads or exploited by industrial developments.

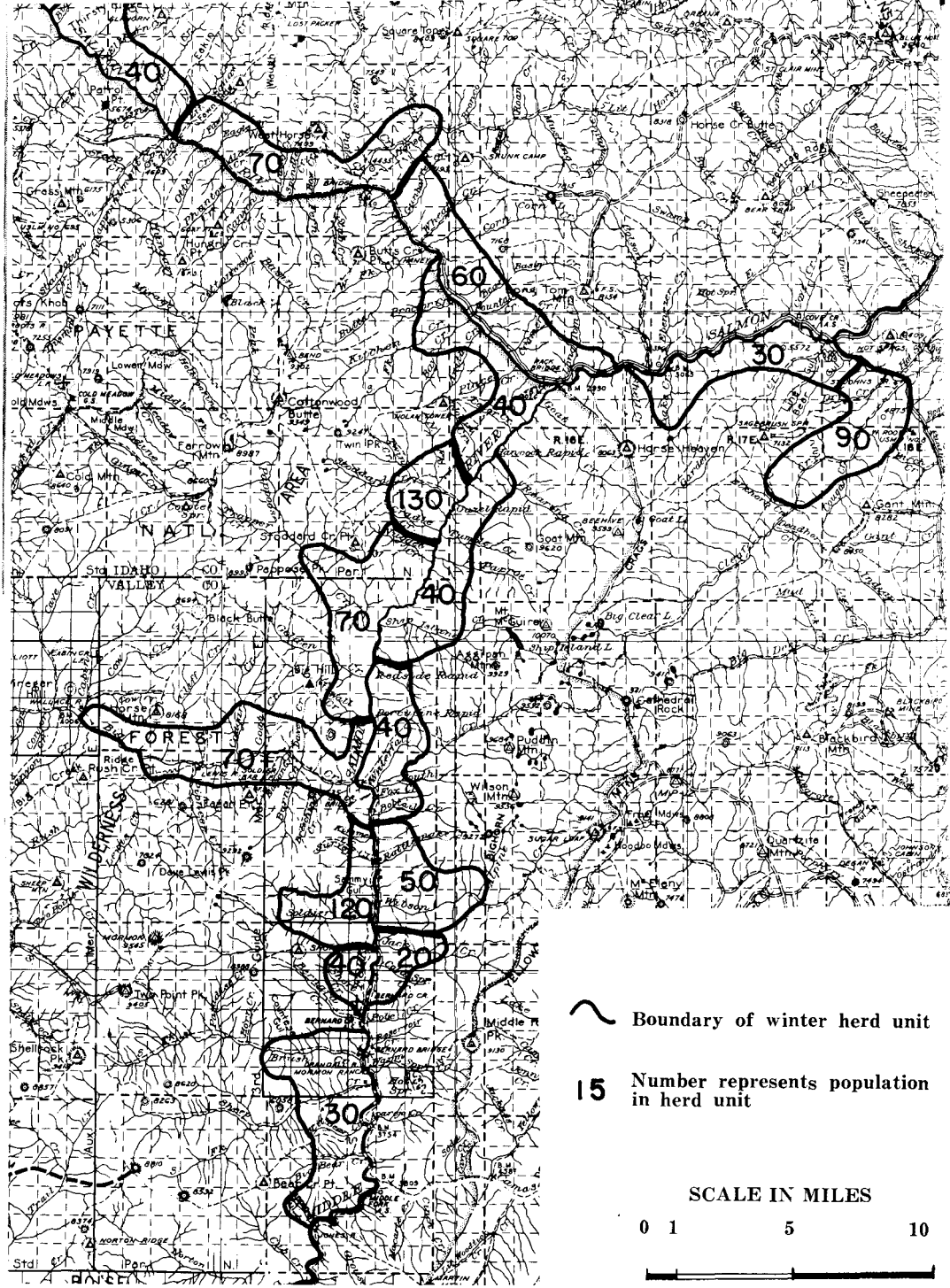
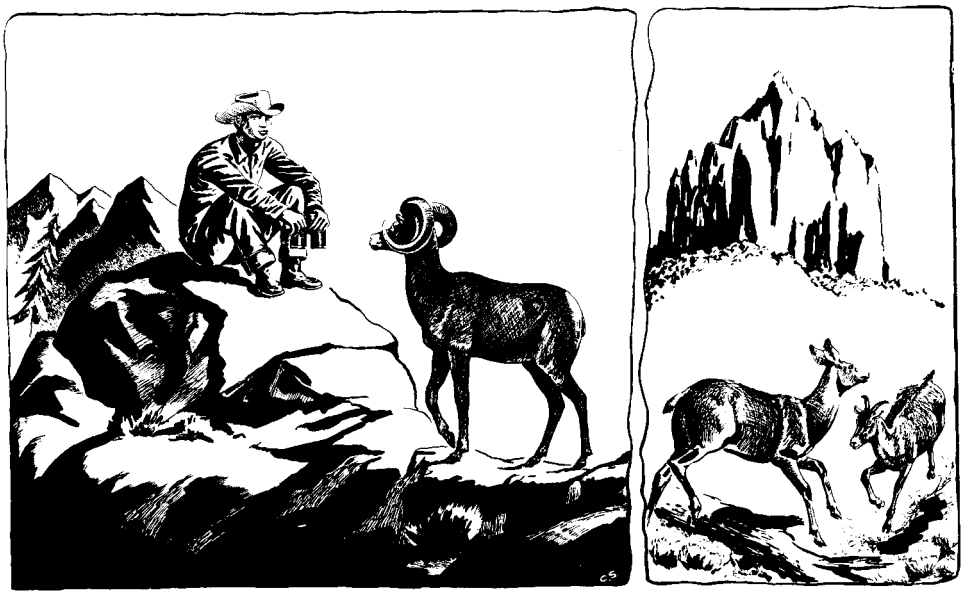


FIGURE 10. Estimated bighorn sheep population within the Intensive Study Area as determined by repeated counts during the winter of 1951-1952. Boundary lines shown approximate the upper limits of bighorn winter range.



BIGHORN BEHAVIOR

Seasonal Migration

Topographical characteristics, featuring steep slopes and cliffs that rise abruptly from winter to summer ranges, reduce the necessity of long seasonal migrations. This feature of the terrain provides summer and winter pastures often separated by only a few precipitous miles. Measurement showed some of the canyon walls to average over 90 percent slope. In a few places the distance between a grassy slope 3,000 feet above sea level and a subalpine basin at 9,000 feet is not more than two miles. The actual migration route taken by the sheep may not exceed five miles. It is more common, however, for the animals to travel 10 to 20 miles.

Sheep that winter near Challis and on the East Fork of the Salmon River are reported to travel as much as 40 miles between their wintering and summering areas. These are believed to be the longest bighorn migrations in Idaho. The Clear Creek herd migrates about 25 miles and the Rush Creek herd travels at least that far on fall and spring treks.

Fall migration of the herds observed seemed to be entirely a response to weather conditions. In most cases bighorn do not

have to cross a series of high passes enroute to winter range. They already are "on top of the world," near the rim of the drainage in which they will winter. Their preference for high country habitat apparently induces them to remain on subalpine pastures until the first snowstorm. Since their diet on these ranges consists almost exclusively of low-growing herbage, only a few inches of snow buries this food supply, causing them to descend to lower snow-free elevations. If the season's first snowstorm occurs in September, as frequently is the case, the downward movement may be checked by "Indian summer" weather and they may return to higher ridges and basins throughout another month of mild conditions.

Ewes, yearlings and lambs are usually the first to arrive on the winter range. The date of arrival varies with the weather but generally is between October 15 and November 15. Perhaps the reason for the rams appearing shortly afterward can be attributed to the courtship and breeding activities which are near at hand.

Fall snowstorms in the high country were observed to precipitate more rapid migrational activity among sheep than elk or mule deer. Presumably this difference is related to food habits. Elk and deer are able to forage successfully on the taller browse species after the sedges, rushes, grasses and low forbs, so highly favored by sheep, are covered with snow. However, it should be explained that all big game moves out of the high regions quite rapidly; the principal difference being that bighorn sheep, once started downward, continue at a fast rate until they are well beneath the upper limits of the winter range. Frequently they continue virtually to the banks of the drainage where they will spend the winter. Elk and deer, in contrast, may descend only part way, then tarry for several weeks in timbered and brushy areas described previously as "intermediate" range.

It is interesting to note that Spencer (1943), in describing the Tarryall herd of Colorado, states, "It was found that regardless of weather conditions, these migrations . . . take place about the same time each year . . ." Contradictory to this, Honess and Frost (1942) found in Wyoming that, "In short, the seasonal movement of the bighorns are conditioned by the weather." Observations in Idaho decidedly agree with the situation reported in Wyoming.

The urgency, so apparent as the animals leave the snow-covered mountains in the fall, is not to be found in their leisurely departure from the lower altitudes in spring. When the snow has

melted from south-facing slopes and extensions of bare ground begin creeping upward, the sheep often stay near the snow line where they feed on freshly uncovered mosses and lichens as well as cured grasses and forbs. This initial tendency to move to higher slopes lasts only until forage along the stream banks begins to "green-up." Then the bighorn will be found near the streams, feeding on fresh blades of cheatgrass, young balsamroot leaves and other vernal vegetation.

Plant growth on the lowest ranges can be expected to start about the middle of March, and low-growing plants often remain succulent well into June. Nevertheless, this does not keep the rams from starting their drift back to summer pastures. Usually they have disappeared entirely from the winter range by the middle of May. Bands of young animals frequently begin moving toward the high country at about the same time.

Considerable variation in behavior was detected among the ewes. Where suitable terrain was available near the rivers, ewes delayed spring migration until after lambing in late May or early June. On those ranges where long, grassy slopes bordered the river, the ewes would work their way up side drainages, seeking seclusion among the cliffs to bear their young. This habitat was located about midway between summer and winter range in some of the areas studied. Some ewes remained in the lambing territory for a few weeks after parturition. Other ewes resumed, or began, their upward drift almost immediately; either in small groups or as family pairs.

In localities where mountain sheep summer at moderate elevations, the rams usually precede other groups by a few weeks. Where slowly melting snow delays their arrival until early July, groups of rams, juvenile bands and ewe-lamb groups appear in the high country almost simultaneously. Both sexes and all ages were seen at elevations over 9,000 feet in the Bighorn Crags on July 3, 1950. At this time many north-facing slopes still lay buried under deep snowdrifts, and protected sites on southerly exposures were snow-covered also.

There were numerous instances when bighorn were seen crossing the Salmon River and its tributaries in search of salt or more desirable pastures. Picking their way across on the ice in winter seemed to be as common as swimming across in summer. In either case their cross-over appeared to be only temporary and they would soon be back on their "home" side. It was generally assumed that rivers were not crossed in the course of seasonal migration. An occurrence on April 15, 1952, however, indicated

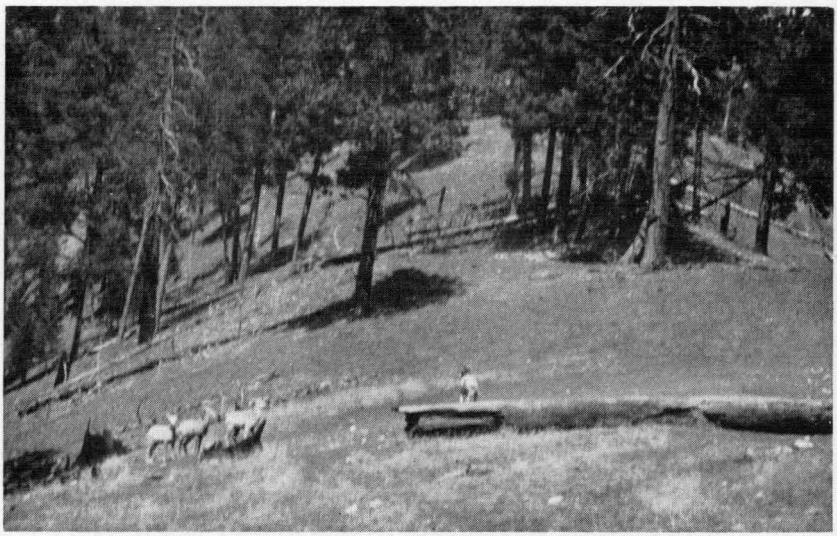


FIGURE 11. These ewes are near the upper limits of the winter range in Dwyer Creek. They will continue moving upward to their lambing grounds located on the intermediate range. In some areas the ewes lamb within a few hundred yards of the river.

April 17, 1952

that the full extent of seasonal migrations may not be fully appreciated. On this date three large rams were observed swimming across the Middle Fork of the Salmon River from east to west.

The significance of this incident lies in the fact that mature rams seem to be scarce on some ranges east of the Middle Fork in summer, while a high percentage of rams are found in the summer herds ranging west of the river. Winter counts show that ram abundance is comparable between opposite sides of the river, so the inference of this lone observation is that rams may migrate to the west side of the river in the spring and not return to the east bank until fall.

The import of such a situation on the establishment of hunting unit boundaries for the harvest of mature rams in September is obvious. One isolated observation is far from conclusive, of course, but it does merit thought and points to the need for a trapping and marking program to help piece together the puzzle of migration.

Non-Migration

While definite shifts of population were apparent, many exceptions to regular migration were observed. Probably more than three-fourths of all sheep adhere to the normal pattern, but

the remainder engage in short, erratic movements apparently not extending above the intermediate range.

Mountain sheep were observed on low winter ranges throughout each summer of the study. A barren ewe, or ewe with lamb, were occasionally seen alone at low elevations in mid-summer, but they were more often in small to medium-sized bands which usually included a few yearlings. Rams were rarely seen on winter ranges during summer months. Two year old males are apt to accompany the rams to high-altitude ranges although some remained with those ewes, lambs and yearlings occupying low ranges throughout the summer.

Mineral licks are usually located on winter ranges where sheep are seen in summer. Frequently these sheep were utilizing the licks when observed, which suggests that a desire for minerals may contribute to non-migration.

Local Drifts

There is an entirely different type of movement, apart from migration, which characterizes the habits of mountain sheep. In the summertime a group of sheep may enter a subalpine basin and remain there for a few days, feeding haphazardly around the basin walls, but seldom traveling more than a mile in any direction. Then one day, in response to what appears to be a synchronous compulsion, the flock moves out. They travel slowly but steadily along the divides, grabbing a mouthful of forage here and there as they move. They may travel a mile, or several miles, before settling down to a few more days of feeding and resting in another basin.

In the winter a herd of sheep may occupy one section of the range for several days, circulating within a radius of only a few hundred yards each day. Then, as described for the summer range, they will move as much as several miles to a new location suitable to their tastes. A pattern of grazing rotation was observed on the lower slopes of Clear Creek during the winter of 1949-50, and on Short Creek, Soldier Creek and Waterfall Creek in the winter of 1951-52. One area would be occupied for several days, vacated for about two weeks, then re-occupied. This procedure would be repeated several times during the winter. In addition to the rotation of use described, there is a temporary shifting of preferences for exposure and cover type associated with changes in weather.

Sheep eventually move to the protection of cliffs or scattered stands of timber during extended periods of inclement weather. There is a very noticeable movement of bighorn onto open, grassy

slopes once the snow has melted in the spring. A decided shift in preference for exposures at different seasons was noted on all winter ranges studied. Over three-fourths of the sheep observed during the early spring period were occupying southerly exposures. The fact that south-facing slopes are the first to be open and furnish new vegetation is probably the attracting feature. Conversely, an equal preponderance of use was found on northerly exposures in late summer and autumn. Shady north slopes are cooler and the vegetation more succulent than on southerly exposures at this time of year.

Besides weather and the unknown causes discussed, disturbance by predators, the activity of man and the presence of domestic livestock all are potential causes of local drifts.

Herding Characteristics

The number of bighorn sheep comprising each of the 496 observations made during this study varied from solitary animals up to herds with as many as 46 sheep. Herd sizes are indicated in the following tabulation:

Group size:	Singles	2-9	10-19	20-29	30-39	45	46
No. of obs.:	73	331	68	15	7	1	1

Thirty-eight of the 73 lone individuals were rams, 23 were ewes and the remaining 12 were either immature or unidentified animals. Excluding those found singly, the herd size averaged 7.3 sheep per herd. Baillie-Grohman (1882) reported that the average flock in the Rocky Mountains, over 70 years ago, numbered about eight. This comparison is interesting as it indicates that, despite the greatly reduced populations of today, the degree of gregariousness among mountain sheep has remained about the same.

There are, in a sense, no definite herds in areas of relative bighorn abundance. True, certain individuals winter on given ranges and summer within certain general limits; but, even during the rut when gregariousness is most prominently displayed, there are frequent fluctuations in herd composition as rams roam between groups of ewes, and immature animals periodically join their elders, then drift away. At other seasons there is an erratic display of individualism as numerous combinations of sexes and ages are formed, broken up and formed again.

Gaufin and Ellis (1941) point out that yearlings and lambs along the Middle Fork of the Salmon River band together after the late fall breeding season and remain separated from the ewes until late spring. The findings of the current study revealed that,

although there were exceptions, this type of segregation in the winter and spring seasons was a common occurrence. This herding characteristic, added to the fact that young animals were inclined to inhabit the least "observable" sites, frequently resulted in unrealistically low lamb and yearling spring count. For example, in April 1951, the census in the vicinity of Stoddard Creek was showing a decided paucity of lambs. On the last of a 3 day census in that area, a herd of 10 ewes and 20 lambs was discovered. This evidence that family groups were broken up indicated the ease with which erroneous sex and age ratios can result if groups of animals are missed during spring counts.

The herding instinct of mountain sheep seems to be an ally when facing the danger of predators. On several occasions coyotes were watched as they stalked a scattered herd of sheep. Once appraised of the danger the stragglers would hasten to join the main band, from where they would all maintain an alert attitude until the danger had passed, or would flee as a group to the nearest cliffs.

Daily Routine

Significant in the daily life of bighorn sheep is the seeming lack of "routine" connected with their daily habits. With high disregard for the stereotyped activity patterns sometimes attributed to them, the bighorn often acts in an unpredictable manner. Roosevelt (1888, p. 247) reported that he observed badland sheep that were moving across open valleys, far from their natural habitat, at mid-day in the summer. He points out that, ". . . mountain sheep act more erratically and less according to rule than do most other kinds of game."

When large flocks of sheep were observed feeding, there usually would be one to several individuals bedded in their midst. Conversely, at times when most of the herd was resting, a few sheep would be up feeding. It was noticed, however, that considerable bedding occurred after both morning and midday feeding periods. After arising from their mid-afternoon siestas, most animals feed until late evening when they begin seeking a bedground for the night. Beds used for daytime siestas are hastily selected and may be in any location where the animal happens to be feeding. On the other hand, night beds are carefully chosen, usually on a steep, rocky site near the crest of a ridge. Frequently they are situated in such a manner that the recumbent sheep will be protected from the rear by a cliff or large rock.

After all field data had been compiled, several methods of analysis were attempted to determine if weather or seasons directly affected the daily activity of sheep. Nothing of real significance was discovered. It appears that the typical alternation of feeding and bedding periods occurs throughout the day, with only slight regard for weather or time of year. The primary modification of habits related to the season was that more time was spent foraging in winter when deep snows forced the sheep to paw for food. Consequently, less time was devoted to bedding during the winter months.

Couey (1950) found evidence of sheep escaping storms by utilizing caves and protected places at the base of cliffs. Similar behavior in the face of severe weather was occasionally observed on the study area, but for the most part, the sheep seemed to be indifferent to moderately severe conditions. Sunny weather following showers was found to be an ideal time for observing, as the animals were most active at that time.

A character of sheep, differing markedly from elk and deer, is the infrequency with which they "shade-up" during the heat of the day. Rather than seeking shade they usually can be found sunning themselves on exposed areas. The principal exception to this habit is found among the non-migrating individuals that remain on winter ranges during the hot summer months. These bighorn often congregate in groups under stands of timber.

Reaction to Man

Mountain sheep are one of the most easily approached of big game species in Idaho. The author has frequently walked to within less than 50 feet of sheep herds on the winter range. Animals on the summer range were somewhat more wary but would often permit an observer to come within 100 feet or less.

Findings from this study agree with the following description by Couey (1950, p. 33) concerning his experiences with the Sun River herd in Montana.

> A peculiarity of bighorns is their tendency to become alarmed when one is a great distance away but their apparent disregard of a person when he is quite near . . . it was found that the best way to approach a band was to appear in plain sight below them and, keeping in sight of them, approach slowly in a quartering direction, never directly at them. In this way, one can work up to within 20 to 50 feet of them without alarm. If one approached from above, they would quickly stampede.

Contrary to some popular opinion the old rams and ewes do not appear to be "sentinels of the flock" or the ones to sound the

FIGURE 12. Five ewes and two lambs, watching man approach, display curiosity but not fear.

Photo by M. Francis, April 5, 1952

danger alarm. In mixed herds, mature rams were the least concernced about the presence of an observer. If present, lambs most frequently stampeded the herds. Yearlings, too, were more wary than their elders. An example of younger animals becoming frightened without inciting fear in an adult was provided by the following incident. A ewe, three yearlings and one lamb were bedded when the writer's sudden appearance startled the young animals, who promptly fled pell-mell down the slope. The ewe, lying across the only escape route, remained bedded and nonchalantly continued chewing her cud. Her only acquiescence to their behavior was to duck sharply as each sheep hurtled overhead. Later the ewe arose to begin feeding in a normal manner, indicating that her quietude was not the result of injury or abnormality.

Curiosity or indifference are more frequent reactions to humans than fear. The following account of an adult ram's curiosity is taken from the author's daily notes for November 18, 1949.

> He (the ram) was about 50 yards away. As I . . . remained completely still, he began approaching . . . rapidly up the slope . . . When he had approached to within 10 feet, I jumped to my feet; whereupon he stopped, then leaped in a stiff-legged fashion for about 35 yards down the slope where he stopped to look back. I spoke in a low tone and he ran quickly for another 100 yards down the slope before stopping to look back again.

From the writer's daily notes of May 29, 1951, is the following account of curiosity displayed by two rams.

(They) . . . were within 25 yards before seeing us. My dog and I were in a conspicuous spot . . . to the windward of the rams. After detecting us, they came straight in our direction until only 10 yards away, then abruptly turned and walked over the ridge.

The persistent efforts of bighorn to attain higher ground often results in an entire herd angling upward, following an adopted course which may nearly converge with the observer's line of travel.

In one instance the writer surprised a group of 37 ewes, yearlings, lambs and young rams. A promontory of rock overlooking the river was directly below them and they sped directly to this temporary refuge. Their agitation increased as they were approached until finally, despite the fact that there were two easy avenues of escape downhill, they suddenly fled upslope, passing within 50 feet of the writer.

The following observation concerning two rams, two ewes and a yearling is recorded in the field notes for March 16, 1952.

. . . when I was about 200 yards directly above them, all five, led by a ewe, started up the slope toward me. They were indecisive, seeming not to know whether to go behind or in front of me. Finally they broke into a run and passed within 30 feet . . .

Inter-Relationships With Other Species

That mountain sheep prefer to travel in bands the year around long has been a recognized characteristic, according to the records of early explorers. Their sociability extends to several other big game species as well, the principal one being mule deer. On 16 occasions deer and sheep were observed grazing or utilizing mineral licks together. Small groups—two sheep with three deer; large groups—31 sheep with five deer and nine sheep with 14 deer; and such associations as one ewe with seven deer and nine sheep with two deer were among the combinations observed.

All 16 instances of fraternization between sheep and deer were observed in the spring at times when they were grazing on young vegetation. In most cases there was an attitude of complete indifference between the two species. However, the following excerpt from the author's field notes describes a more sociable relationship.

Three sheep were grazing in company with two deer. At one time the sheep began shaking their heads, then ran playfully toward the deer; whereupon the deer jumped and frolicked about the sheep, sometimes acting as though they were going to butt them.

Oftentimes the presence of deer was a liability when the sheep were being studied. The bighorn, usually undisturbed by human intruders, were frequently stampeded by nearby deer which began running while the observer was still at a considerable distance.

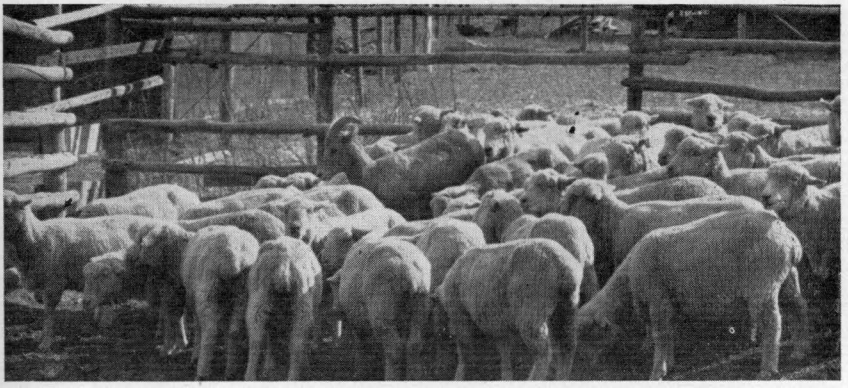


FIGURE 13. A young bighorn ram with a herd of domestic sheep. On the open range, and in the corral, he was most content when near the center of the band.

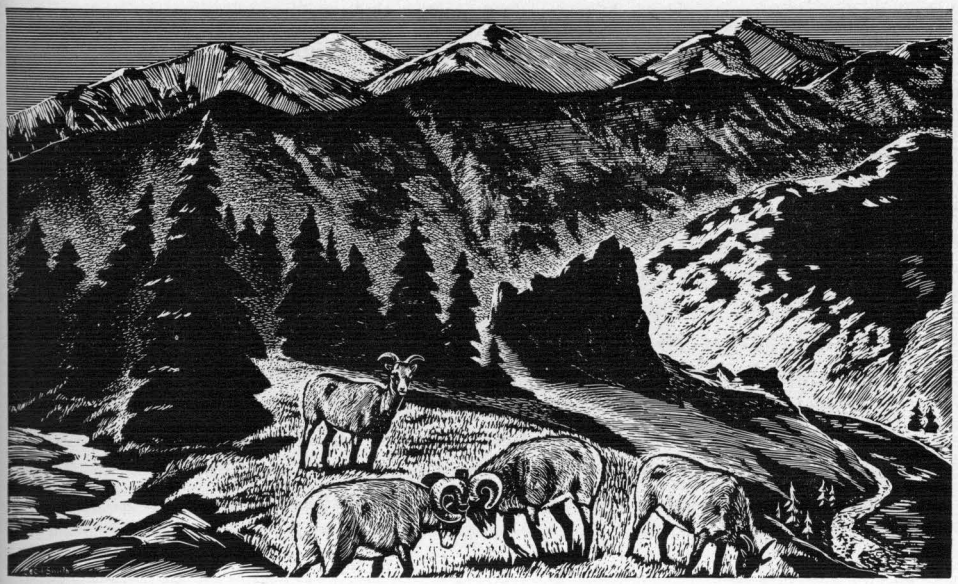
Photo by S. Brandborg, October 20, 1952

Elk were observed feeding with bighorn only twice. In each instance there were deer in the same group. Eleven sheep were observed feeding for more than an hour in the company of six mountain goats. On another occasion four sheep and two mountain goats fed and bedded together for nearly an hour. Neither species gave evidence of being disturbed by the presence of the other. A discussion of competition for food among big game species is given in Part II of this bulletin.

The literature is replete with references to fraternization of bighorn sheep with horses, cattle and domestic sheep. The following incident which occurred near Shoup, Idaho, in October 1952, deserves mention. The young bighorn ram shown in Figure 13 entered a rancher's corral one night with a band of 60 domestic sheep. He remained with them for about 10 days, leaving the corral in the morning to graze on the foothills and returning in the evening when the rancher's dog fetched the band. It was reported that on his last morning with the domestic herd, the wild ram appeared very restless. When released from the corral he headed for the mountains and was not seen again.

On a number of occasions during late winter and early spring, magpies were found perched on the backs of bighorn sheep where they busily pecked along the spinal region. At other times they would peck at the heels. Usually several birds visited a band simultaneously, and it was not uncommon to see two birds on one sheep at the same time. One magpie was in constant attendance to a flock of four ewes for 75 minutes. Each ewe was visited several times. They usually appeared unconcerned about the presence of

the bird, but occasionally seemed to resent the pecking. It is known that ticks and mites infest the pelage of the mountain sheep, so perhaps a symbiotic relationship exists between magpie and bighorn whereby the bird receives its dinner in return for a de-parasitization service. Murie (1940) suggests the possibility of magpies thus performing valuable service. He cites an example of the stomach of a magpie, collected near some deer, containing engorged ticks. On the other hand, magpies have caused running sores by irritating the wounds of domestic livestock; hence the relationship may not always be beneficial.



REPRODUCTION

Sexual Development

Biologically it is probable that both male and female bighorn reach puberty by the second breeding season after birth. A wild ram, which was approximately 1½ years old, remained with a herd of domestic sheep near Shoup, Idaho, for about 10 days. During that time this ram was reported to have copulated several times with the tame ewes. This was in mid-October. It is not known whether or not his efforts met with success because the ewes were sold later that fall and no record of their progeny has been found.

It is known that deer and antelope, both males and females, are sexually mature when 1½ years of age. Domestic sheep frequently breed when they are long-yearlings. From information that he had collected, Seton (1929) concluded that bighorn ewes conceive when 1½ years old. Honess and Frost (1942) concluded that bighorn ewes do not breed until they are 2½ years of age. This opinion is supported by Spencer (1943) and Allen (1939). It is the opinion of the writer that a few ewes breed at 1½ years of age, and that all normal ewes are receptive to breeding in the autumn when they are 2½ years old.

Presumably the opinion that rams may not breed until they are four years old, as suggested by Couey (1950), is founded upon the supposition that service by younger rams is prevented by combat. However, the indifference exhibited by older rams after having copulated is an indication that physical superiority may not be a cardinal factor in eliminating younger males from their quest for a mate. Young rams are physically outclassed by the old rams, it is true, but the ewe is sometimes secured by a 3 year old ram after the victor has lost interest in her, or by stealth while the old rams are engaged in battle. Interested as they were, 2 year old rams were not observed taking advantage of opportunities presented during the confusion of rutting activities. In this regard it should be mentioned that, while the field observation method employed in this study furnishes some information about the sexual conduct of juveniles, it does not provide conclusive data concerning the minimum age when insemination or conception occurs.

Breeding activities are limited to a period of less than two months but interest exists the year around, especially among young males. Behavior, consisting chiefly of mild jostling, butting and occasional mounting of females, was observed in January, February, April, May and July. This activity was indulged in mostly by 2 and 3 year old rams, although yearling males joined in at times. The ewes were never observed to be receptive and actual copulation was not witnessed except during the breeding season.

Since nature is harsh in her treatment of the aged and infirm, it is believed that the number of senile rams or anile ewes on a range would be few. However, there is little positive information about the maximum age attainable by mountain sheep. Cowan (1940) reports that two rams shot in British Columbia were determined to be between 15 and 17 years old. Seton (1929) mentions the death of a captive bighorn ram in Washington Zoo at the age of 20 years. Dr. Cowan, basing his conclusions on a study of 761 specimens gathered throughout North America, reported that he found no evidence to indicate that bighorn in the wild normally reach the advanced age mentioned by Seton.

Courtship and Breeding

An interesting characteristic of bighorn sheep is the extreme fervor with which they engage in the perpetuation of their kind. By late October or early November the rams have moved to the lower ranges and are beginning to lose the fraternal attitude with

which they regarded their fellows during the summer months. Their necks become noticeably swollen and their coats are rich and glossy. The playful bouts seen in the high country take on a more serious aspect and frequently their conduct becomes decidedly unsportsmanlike. Rams were observed using their horns to deliver fierce blows to the rear or side of an adversary as well as to engage in the more common direct charges. Striking upward at the sides or belly of an opponent with a stiffened foreleg may precede an all-out battle. Spencer (1943) mentions "battles royal" involving as many as 14 rams, and chases with up to 11 rams following one ewe. Mills (1937), in Yellowstone National Park, witnessed nine rams in pursuit of one ewe. The number of rams observed jousting, or chasing ewes, in the Salmon River country varied from two to five.

The question of physical superiority may be decided at the conclusion of a battle, but the victor does not attempt to evict the vanquished from the herd. No instances were observed where one warrior was battered until exhausted or unable to continue. On the contrary, after several terrific head-on collisions or a few well-placed blows from some other quarter, the weaker male would walk away or merely ignore the stronger ram.

On several occasions rams were seen methodically visiting each ewe in a flock, apparently in search of one in oestrus. Often they were unsuccessful and would either continue grazing or lie down after having inspected the herd. Several times when groups were quietly feeding or were bedded down, a ram would leap suddenly to his feet and start toward a ewe. He might pass several other ewes in order to reach the one of his choice. If the ewe was lying down when he reached her, he would strike her with a front hoof until she arose. It is evident that rams are quickly aware of a ewe in oestrus. Usually only one ewe in a herd is in a receptive mood at any one time.

The ram has a characteristic manner when approaching the ewe. The head is cocked slightly to one side, nose outstretched and upper lip curled back. He often stops several feet short of the ewe, waiting for her to make the first move. At this point one or more rams may join the first. Sometimes the ewe voluntarily begins the chase. Other times she is encouraged to do so by a vicious butt from the ram. Once the chase has begun it may lead back and forth across a slope for a quarter of a mile or more in each direction. The rams frequently interrupt their pursuit with battles between themselves. The ewe stops running until the fight

is over, then the chase is resumed. Sometimes the ewe stops suddenly, whereupon the rams pose, motionless, with heads back and noses tilted upward. At other times the ewe will be covered almost instantly when she stops. One ewe was observed to be covered by two rams within the space of a few seconds.

When a ewe has been singled out for pursuit the remainder of the herd usually displays no particular interest. At times the younger animals will climb upon a vantage point from where they appear to view the antics of their elders with interest.

The breeding season lasts for more than a month. The average ram-ewe ratio calculated was approximately 1 to 1.3. Mature rams were seen moving freely between bands of ewes and juveniles during the rut. Therefore, it seems nearly impossible for a ewe to remain unbred at the close of the mating season. In fact, it has been suggested by Pulling (1945) that temporary sterility of the ewes may have resulted in Nevada because of over-breeding by the rams. Rush (1942) also proposed the theory that excessive service by the rams may cause sterility.

The earliest actual breeding which was observed during this study was on November 17. The intensity and frequency of rutting activities reached the most fevered pitch around the first of December. Breeding activities tapered off during the latter part of December, and copulation was not observed in January.

Physical Effects of the Rut

Mountain sheep are in excellent condition when they return from summer pastures. But much of this physical well-being is lost during the rut. The outburst of courtship and breeding activity, carried out over the most rugged terrain, is physically exhausting. Less time is devoted to eating and numerous injuries are sustained.

Rams, moving from one herd to another and constantly alert for receptive females, undoubtedly expend more energy than the ewes. Yet the exhaustion and abuse suffered by the females during an unrelenting chase by several males, may result in as much physical depletion as experienced by the rams. Excluding serious injury, however, neither sex is truly in poor condition at the end of the rut.

It is possible, however, that the frequent injuries and occasional deaths directly related to rutting activities are of less importance to productivity of the herd than the psychological disturbances that may be incurred. Considering the relationship of

a healthy psychological atmosphere to fertility among humans, it would seem that the excessive fatigue and excitement visited upon the ewes by their suitors might induce a temporary condition of sterility. This is mere conjecture, but it "reasons well" and deserves future attention.

Lambing Ranges

Lambing ranges all embody similar characteristics. One common requisite is that all areas be precipitous and liberally covered with cliffs and rock outcroppings. The protection afforded the lambs from predators would seem to be the motive behind selection of these topographical features. The warmer and drier southerly exposures were the only ones where very young lambs were observed. The physiography of each particular range determined the location and elevation of lambing areas. Where cliffy terrain is available at low elevations, lambs may be born within a few hundred feet of the river. On other ranges suitable lambing habitat might be situated halfway between winter and summer range. Lambing grounds were close to a good supply of forage in all cases, but the distance from water did not appear to be significant.

Figure 14 was photographed from the head of a "chute" which drops 1,500 feet to the Salmon River below. Average slope from top to bottom is 70 percent. The area in the left foreground is well covered with bluebunch wheatgrass and Idaho fescue. Small ledges and crevices among the rocks support scattered mountain mahogany and fairly dense stands of wheatgrass. The grassy area in the left foreground was observed to be a favorite playground for lambs.

Ewes with lambs were observed among these cliffs during four consecutive seasons. The following counts show the maximum number of lambs counted each spring:

May 20, 1949—6 ewes and 7 lambs
June 6, 1950—8 ewes and 8 lambs
May 29, 1951—7 ewes and 7 lambs
May 27, 1952—9 ewes and 8 lambs

Birth and Early Activities

A few workers believe the gestation period of mountain sheep to be 150 days in length, but the majority agree that 180 days is more nearly correct. In this study the earliest observation of actual breeding was on November 17, 1949. The earliest date that lambs were recorded was on May 15, 1950, when two lambs estimated to be two days old, were seen. Each season of the study the breeding

FIGURE 14. Lambing range on a southern exposure overlooking the Salmon River.

June 1950

intensity was greatest around December 1 and the peak of lambing occurred between May 15 and June 1. These observations would indicate that the gestation period is 180 days or slightly less.

Twin births are exceedingly rare among bighorn ewes in Idaho. Several times it seemed that twins had been located when suddenly another ewe would appear to claim the extra lamb. There were only two instances out of 215 observations of ewe-lamb groups in which there was one more lamb than ewes. In both cases the observation had been prolonged for more than two hours. Twinning may, and probably does occur, but not in sufficient instances to materially affect productivity.

Lambs scamper after their mothers with astonishing speed and stamina when only a few days old. Throughout the early part of the summer their coats are noticeably lighter in color than those of the adults. The rump patch is less distinct and there is a dark stripe down the back. By the middle of September the rump patch becomes clearly visible, the dark stripe all but disappears and the coat color becomes very similar to that of adults.

Lambs were seen nibbling at vegetation a few days after they were born. The exact diet was difficult to ascertain, but their nibblings included all classes of forage. Mother's milk probably remains the staple dietary item until the lamb is well past two months of age. A lamb nurses ravenously, sometimes butting the ewe's

udder vigorously. The discomfort thus inflicted must at times overcome mother instinct, as the ewe frequently kicks at her offspring —an effective means of terminating the feeding period. The lambs were never found to stop suckling voluntarily. Very young lambs were observed to suckle at intervals of approximately 30 minutes. Gradually the feedings became more and more infrequent. Lambs observed late in July went more than four hours without nursing.

The age at which lambs are weaned seems to vary widely. Gaufin and Ellis (1941) observed nursing on the Stoddard Creek range as late as September 23. Couey (1950) gives the latest nursing date observed in Montana as October 21. Honess and Frost (1942) state that in Wyoming, ewes did not start weaning the lambs until January or February. The latest suckling observed during this study was on September 13. Many hours were spent each year observing ewe-lamb groups during the November-December rutting period. Not a single case of nursing was observed at that time. It may be concluded from this that lambs in the Salmon River country are weaned before they are six months old.

Gregariousness of lambs becomes evident after they are one or two weeks old. Whenever two or more lambs were present in a group, they appeared to exhibit more affinity for one another than for their mothers, usually bedding and playing together. Play routines of these youngsters are zestful and amusing to watch. Much of their gamboling takes the form of butting and pushing, and group games are frequently engaged in wherever lambs congregate. At one time eight lambs were observed playing "follow-the-leader" for several minutes. They bounded recklessly over rocks and down precipitous slopes at breath-taking speed. Once, four of them broke away to chase each other around a large tree for several revolutions. One ewe remained near the lambs all the while they were playing. She grazed a little but spent more time watching her charges. Seven other ewes grazing nearby did not show the slightest interest in the lambs.

FOOD HABITS

Methods of Study

The food items and forage classes utilized by bighorn sheep were determined by six methods: 1) direct observation of feeding animals, 2) band trailing, particularly in winter, 3) careful inspection of restricted areas immediately after observed feeding, 4) forage utilization transect studies (summer range), 5) linear measurements of twigs before and after use (winter range) and 6) analysis of stomach samples taken from all bighorn found dead.

A total of 488 feeding observations were made during the study. Each feeding observation indicates only that sheep were feeding upon a particular class of forage when observed. An observation might either consist of one animal or a group of several animals. Species of plants being fed upon were recorded whenever they could be recognized. Of 341 observations of feeding on grass or forbs only 122, or 36 percent, could be identified as to species being used. One hundred and twenty-two, or 92 percent of the 132 browsing observations, could be classified as to species taken.

Band trailing was an effective means of determining forage preferences, particularly when there was snow to facilitate tracking. At times it was feasible to inspect a restricted area immediately after it had been vacated by a herd of feeding sheep. Composition of the vegetation was estimated and recorded. Plants eaten were noted and the degree of utilization of each species was estimated. Twenty 2 x 50 foot transects were studied in the same manner. The twig measurement method, used to study browse utilization on the winter range, is described in Part II.

General Account of Food Preferences

That the bighorn's appetite is versatile has been shown in several studies. Their diet is generally conceded to favor the more succulent and tender forms of foliage, but in times of adversity an amazing assortment of items may be eaten. Couey (1950) reports that the stomach of a very old ewe that died in February contained 30 percent grass and 70 percent material which appeared to be dry duff, composed of twigs, soil, dry fir needles, bearberry leaves, sage and miscellaneous roots. Eight stomach samples collected by Honess and Frost (1942) contained a wide assortment of grasses, forbs and shrubs; and even traces of fir, pine, spruce and juniper needles.

On Idaho ranges bighorn diet is composed of considerably more grasses and forbs than browse. In only about one-third of the feeding observations was it possible to identify herbaceous species being taken, but usually grasses could be distinguished from forbs. Evidence of the study pointed out that substantially more grasses and grasslike plants than forbs were being consumed the year around.

Various methods for studying mountain sheep food habits have been employed by other investigators with comparable results. Over a dozen studies have been reviewed in which grass in the diet varied from 60 to over 90 percent. Murie (1944), examined 75 Dall Sheep stomachs in Mount McKinley National Park, Alaska, and found the contents to average 81.5 percent grass; these stomachs were collected in fall, winter and early spring. Cowan (1947), basing his information on 4,060 animal minutes of feeding, reports the December diet of bighorn in Jasper National Park, Alberta, as 83 percent grasslike plants, 10 percent forbs and 7 percent shrubs. In Montana, Couey (1950) found that the stomachs of 6 sheep dying in late fall and winter contained an average of 63 percent grass, 14 percent weeds, 17 percent browse and 6 percent miscellaneous.

During the course of this study, stomach samples were collected from five bighorn sheep which were found dead. Contents of these stomachs are shown in Table 2. Identification and quantitative analysis of food items was made under the supervision of Dr. Edson Fichter, Idaho State College at Pocatello, Idaho (Fichter, 1953).

Table 2. Contents of five bighorn sheep stomachs collected on Salmon River ranges in Idaho.

Month of death	Description of sheep	Principal food items (in percent)				Remarks
		Grass	Mountain mahogany	Coniferous trees	Unidentified	
February	ram	40	60	Trace		Died a lingering death after falling in rockslide.
April	ram	95	5	Trace		Also trace of barberry. Died in fall from cliff.
August	lamb	85		8	5	Also 2 percent willow. Believed killed by falling rocks.
September	lamb	100				Died from unknown cause.
Unknown	undetermined	80	Trace	7	13	No skull for determination of sex. Identified by hair.

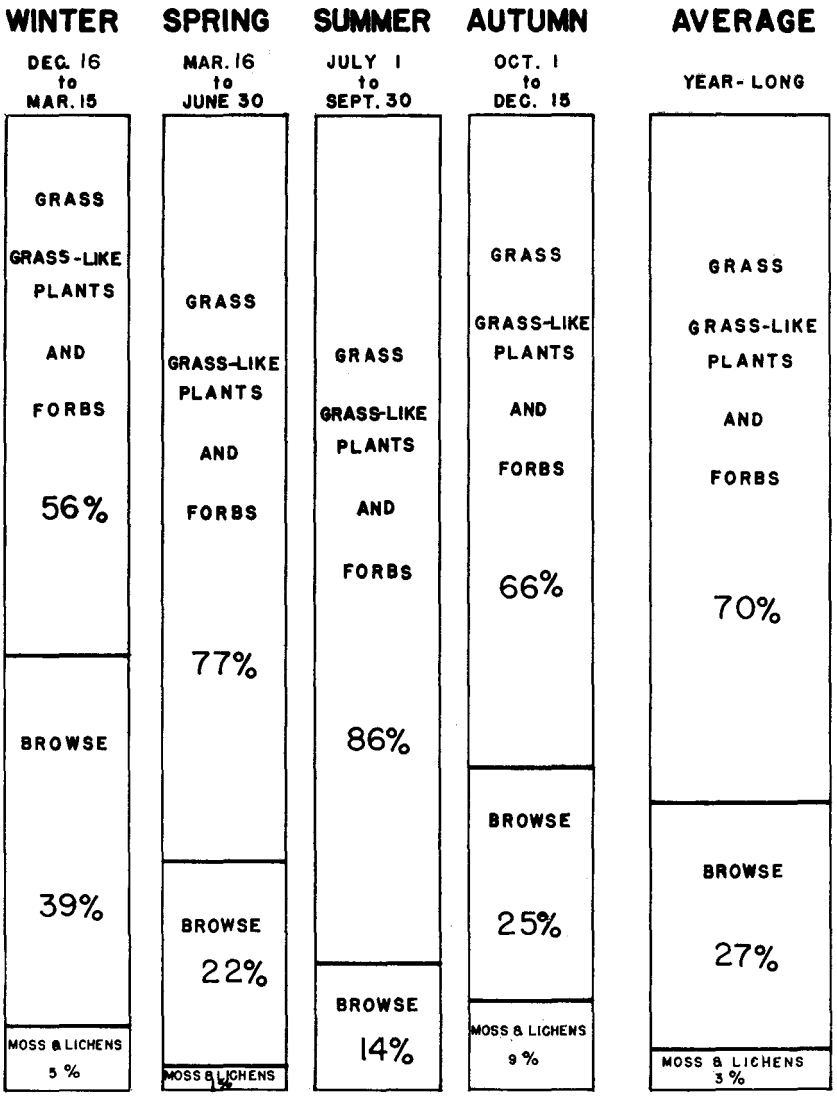


FIGURE 15. Forage classes utilized by bighorn sheep on Salmon River ranges, May 1949 - September 1952, as determined by 488 feeding observations. A group feeding on one class of forage was recorded as (1) observation.

Figure 15, showing a winter diet of 56 percent grass and forbs, reflects the increased dependence of bighorn upon shrubs at a time when smaller plants are buried under the snow. Nevertheless, the fact that more than one-half of the winter diet is herbaceous

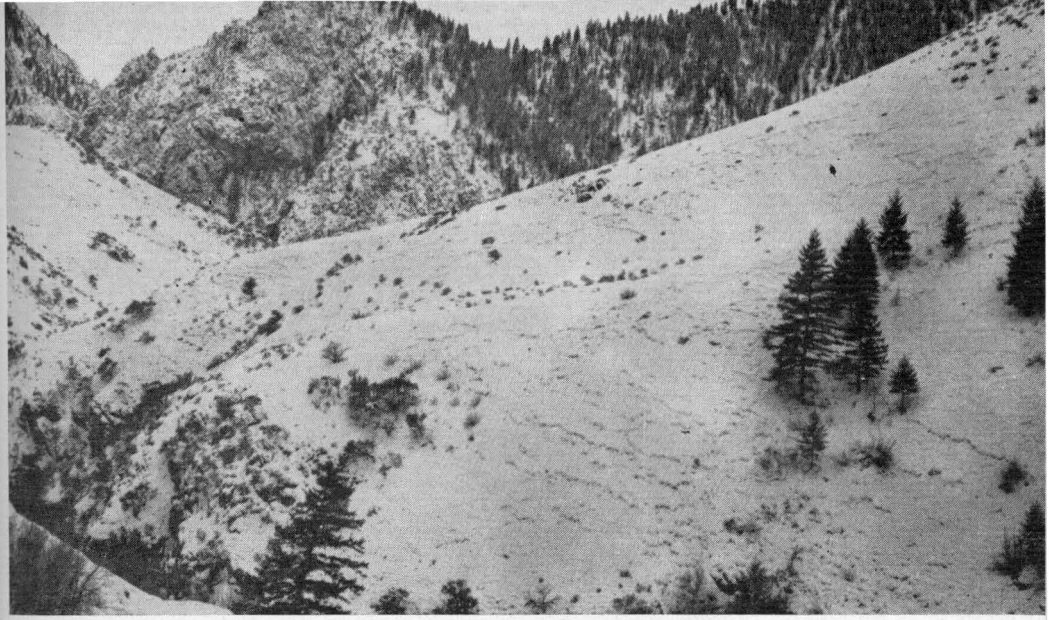


FIGURE 16. Snow trenches where bighorn sheep have been pawing through about 18 inches of snow to feed on grasses and forbs. The trails above show the bighorn's characteristic of contouring across the slope when feeding.

January 23, 1952

testifies to the desirability of such plants. Because the importance of winter feeding habits requires more than brief treatment, Part II of this bulletin contains a detailed discussion of the effects of snow, weather, exposure, vegetation types and other factors.

Food habits undergo rapid changes early in the spring. The consumption of grasses and forbs increases markedly, averaging 77 percent for the spring season as indicated by observation of feeding animals. Cheatgrass is relished for three or four weeks, then completely disregarded when it becomes mature. Idaho fescue appears to receive more early use than bluebunch wheatgrass. Balsamroot is one of the most favored species while in its early stages of growth. On April 27 the writer observed four rams feeding for two hours on a hillside. The slope was visited immediately after their departure and it was discovered that they were feeding exclusively upon shoots of balsamroot. Fifty-two of these plants were counted in a circle having a 20 foot radius. All had been grazed nearly flush with the ground.

The summer diet of 86 percent herbs is made up largely of grasslike plants and forbs. Transects studied on Bighorn Crags summer ranges, where sheep had been observed feeding, revealed the following plants to have been utilized: bluegrasses, rushes, little ricegrass, sedges, woodrush, spike trisetum, tufted hairgrass, western ryegrass, and Penstemon. These forage plants

are listed in order of decreasing numbers taken. Band trailing and direct observations of feeding substantiated the importance of some of the plants listed above. As determined by these methods, sedges, rushes and little ricegrass seemed to receive the most summer grazing pressure. It is of interest to note that rushes are not generally mentioned as food items for bighorn in other parts of North America where investigations have been conducted. However, Godden and Gutzman (1938) also found that rushes received considerable use on the same high country ranges that were investigated in this study.

Table 3. Bighorn feeding habits as determined by direct observation. As considered here, an observation may represent either an individual or a group.

Food Item	Number of Observations				
	Winter	Spring	Summer	Fall	Total
Grass—Grasslike Plants—Forbs					
Bluebunch wheatgrass	20	28	6	15	69
Idaho fescue	7	5		2	14
Arrowleaved balsamroot	1	8	1		10
Sedges			7		7
Rushes			4		4
Goat's beard	1	1	1		3
Horsetail	2				2
Hawkweed	2				2
Eriogonum	2				2
Cheatgrass		2			2
Little ricegrass			2		2
Woodrush			1		1
Penstemon		1			1
Junegrass		1			1
Vetch				1	1
Thistle		1			1
Browse					
Curlleaf mountain mahogany	35	31	2	10	78
Big sagebrush	11			1	12
Rubber rabbitbrush	6			1	7
Spiny greasebush	3	2			5
Syringa		3	1		4
Golden currant	4				4
Bitterbrush	1	2			3*
Western chokecherry	1	1			2
Rose	1				1
Willow		1			1
Labrador tea			1		1
Haplopappus			1		1
Small-leaved huckleberry			1		1
Snowbrush				1	1
Alder			1		1
Moss and Lichens					
Moss and Lichens	8	5		2	15

* Bitterbrush was present on less than half of the winter ranges studied; consequently, this number does not reflect the true importance of bitterbrush wherever it was present.

FIGURE 17. Utilization of balsamroot by bighorn sheep. A herd of 14 sheep was observed feeding at the site of this picture. More than 100 plants, within an area of about one acre, had been dug out and eaten in their entirety. A ewe was frightened away from the large roots shown above. The root on the left has been shredded as the ewe attempted to jerk it from the ground with her teeth. The amount of soil removed by pawing can be appreciated by looking at the root on the right.

March 15, 1952

Consumption of grasses and forbs decreases again in the fall when they become dry and apparently less palatable. A factor which accounts, at least in part, for the increased use of browse is that over three-fourths of the animals observed during the fall period were occupying northerly exposures. North-facing slopes characteristically produce more shrubs than are found on southerly aspects, and this undoubtedly has some effect upon bighorn feeding habits.

Mineral Requirements

Mineral licks are scattered over summer and winter ranges throughout the Salmon River watershed. As far as has been determined, natural licks are substantially outnumbered by those that have been artificially salted. Often, licks thought to be natural were discovered to have resulted from earlier salt placement by stockmen, packers and Forest Service or Fish and Game Department personnel.

Five natural licks on the Middle Fork river were analyzed (Gaufin and Ellis, 1941) and found to contain an average of 900

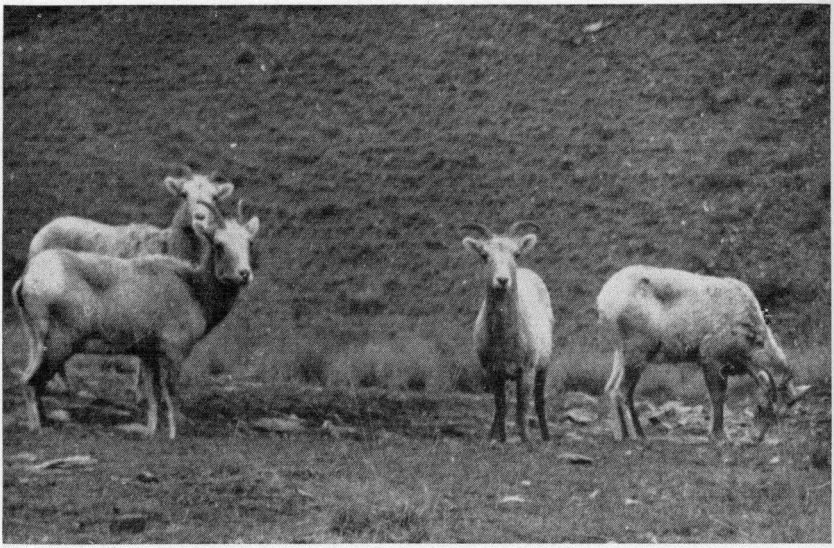


FIGURE 18. Four ewes visit Sammy Gulch Salt Lick. They are part of a herd of 31 bighorn. The entire herd came to the lick while the author was sitting on a rock only 25 feet away. This lick was artificially salted a few years ago. A soil sample collected in 1951 tested 574 p.p.m. total salts.

March 28, 1951

parts per million of water soluble salts. Soil from each of four artificial licks was analyzed during this study. Soluble salts in these samples ranged from 575 to 800 p.p.m. Although still actively used, none of these licks had been replenished with salt for several years. In 1949 a lick was started on Stoddard Peak by a herd of bighorn. No salt had been placed on the site. Mineral content of the soil, as determined from several samples, averaged 250 p.p.m. On the Middle Fork winter range, samples of normal soil taken from an open, southerly exposure contained only 70 p.p.m. of water soluble salt. None of these soil analyses indicate high concentrations of minerals. Many good garden soils, as a matter of fact, contain more than 1,000 p.p.m. of soluble salts. Lack of minerals in the soils of these granitic ranges warrants the speculation that plants growing in them may be low in mineral content.

The avidity with which the bighorn seeks minerals appears to exceed that of other big game animals on these ranges. Early spring is the period when eagerness for minerals is most pronounced, but a desire for saline materials is evident throughout the year.

Animals often were observed urinating in salt licks. The presence of urea is presumably a factor encouraging use of licks, years after artificially supplied salt has been consumed. An interesting sidelight in this regard was encountered during the summer of 1950 when the study headquartered in a high mountain meadow for a month. The men in camp urinated each morning from the top of a low cliff. In a short time a buck deer began coming in to eat the urine saturated soil. By the end of a month a sizable hole had been dug at the base of the cliff and the deer would be waiting each morning as the supply of urine was replenished. Two years later the writer returned to find this "lick" was no longer being used.

An aerial salting program is employed in Idaho to place 50 pound blocks of sodium chloride on summer and intermediate ranges. Mountain sheep locate and begin utilizing this salt with surprising promptness. Some of the local drift in summer seems to be influenced by the presence of salt. The actions of non-migrating bighorn suggest that their habit of frequently visiting licks at low elevations during the summer may be a factor influencing them not to migrate.

Limited experimentation was conducted to determine the preference, if any, of bighorn sheep for various compounds. Two "mineral cafeterias" were established on the Middle Fork of the Salmon River ranges in 1952. This technique for studying mineral

Table 4. Bighorn sheep and deer use of different minerals at Short Creek and Sammy Gulch cafeterias. All samples weighed 96 ounces when cafeterias were established.

Compound	SHORT CREEK CAFETERIA (Established Feb. 11, 1952)		SAMMY GULCH CAFETERIA (Established April 1, 1952)	
	Actual Weight May 23, 1952	Est. Weight Sept. 20, 1952	Actual Weight May 23, 1952	Est. Weight Sept. 20, 1952
NaI	6*(†)	3*	37*	10*
NaH_2PO_4	35*	15*	74	60*
NaCl	59*	40*	59*	50*
H_2SO_4	79	destroyed	78	no use
$Fe\ SO_4 \cdot 7H_2O$	79	no use	76	"
KCL	78	"	73	"
$MgCl_2 \cdot 6H_2O$	79	"	73	"
$CaCl_2 \cdot 6H_2O$	80	"	75	"
$CuSO_4$	78	"	75	"
$CoCl_2 \cdot 6H_2O$	55*	40*	75	"
Untreated soil	81	no use	80	"

* Use evident as determined by examination of samples.

† A second 96 ounce sample of NaI was placed in the Short Creek cafeteria on May 23, 1952.

FIGURE 19. This "mineral cafeteria" is constructed of poles. These support the waxed cardboard containers into which the mineral samples were placed. Each compound was dissolved in one pint of water. Five pounds of soil were then saturated with this mineral solution. Untreated soil served as the control.

April 5, 1952

preference was adopted after consultation with E. L. Cheatum and D. S. Stockstad of the Montana Cooperative Wildlife Research Unit.

The first cafeteria was established in the Short Creek drainage on February 11, 1952. The second one was set up near Sammy Gulch on April 5 of the same year. At each cafeteria five grams of sodium chloride and the equivalent ionic weights of nine other chemically pure compounds were placed in a pint of water and mixed with five pounds of soil taken from the cafeteria site. Each sample of mineral-saturated soil weighed 96 ounces when it was placed in the containers. The experiment tested preference for the following elements:

Calcium	Copper	Iron	Phosphorus	Sodium
Cobalt	Iodine	Magnesium	Potassium	Sulfur

The samples were re-weighed on May 23, 1952. At this time sodium iodide had been so heavily used in the Short Creek cafeteria that a new sample was supplied. The weights recorded in Table 3 cannot be considered on a strictly quantitative basis since the amount of moisture added by rain and snow, and the moisture lost through evaporation, were not the same for each container. This was because differing amounts were consumed from the various samples and some containers became tipped in such a manner that they caught more precipitation than others. It is not significant that all of the samples fall below the original 96 ounces since they were much drier when re-weighed than when

the cafeterias were established. Samples were checked a second time on September 20, 1952. At this time scales were not available, so estimated weights of the mineral-saturated soil remaining in the containers had to be relied upon.

Populations of bighorn sheep and mule deer were about equal at both cafeteria sites. Elk and mountain goats did not occupy these ranges during the experimental period, and deer were absent after the middle of May. Therefore, it is believed that the major use was by sheep.

Table 4 shows that each compound containing the sodium ion was taken to some extent and the sodium iodide sample received the greatest amount of use. This preference for sodium appears to support the findings of Stockstad and his colleagues on Montana ranges (Stockstad, *et. al.*, 1953). Only one non-sodium compound, cobaltous-chloride, was utilized, and this in limited quantities at one cafeteria. This compound also received light use in the Montana study. Whether or not these preferences indicate a physiological need is an unanswered question, however.

DISEASE AND PARASITES

Many theories have been advanced in an attempt to explain the causative agents responsible for bighorn mortality. Foremost among these is the belief that parasites and disease are major factors. Strong evidence of what now appears to have been Scabies epidemics in the late 1800's and early 1900's, indicate that the infecting *Psoroptes* mite may have been largely responsible for the initial decline of mountain sheep herds. It should be stressed, however, that so-called "epidemics" often have many contributory factors, including prolonged adverse weather, malnutrition and over-crowded range conditions. Normally healthy sheep are commonly infected with both internal and external parasites without noticeable harm. The infestation may become debilitating, however, if there is simultaneous and prolonged exposure to one or more of the conditions described above.

For the past several years, there has been little incidence of disease reported. Few unthrifty bighorn sheep were observed during the study, but disease and parasites may have contributed to death in some cases where the cause or causes were not definitely established. Vigorous scratching or rubbing of nearly all parts of the body was commonly witnessed, particularly in late winter and early spring. This, along with the frequent occurrence of magpies pecking on sheep, suggests the presence of irritating external parasites.

An old ewe from a subalpine range in the Bighorn Crags was collected on August 15, 1950, for the purpose of autopsy. Dr. Charles L. Davis of the Bureau of Animal Industry Pathological Laboratory in Denver examined lung and liver sections and reports as follows (Davis, 1950) :

> On section the areas of consolidation in the lung were found to be due to extensive parasitic infestation in the bronchi and in the lung parenchyma of a nematode, probably **Muellarius capillaris.** The liver section shows chronic inflammation and proliferation of the bile ducts resulting from the cestodes found in the liver.

The cestodes were tentatively identified by Mr. McIntosh of the Agricultural Research Center in Beltsville, Maryland, as the tapeworm *Wyominia tetoni.*

Between July 1949 and August 1951, 229 fresh droppings samples were collected from several bighorn sheep herds in Idaho. Analysis of fecal specimens for endoparasites was made by Dr. Stewart C. Schell of the University of Idaho (Schell, 1954).

A sedimentation method was used to examine the droppings, which had been preserved in a 5 percent potassium dichromate

solution. In this method the feces are soaked in water, then mashed and strained through cheesecloth into a 500 c.c. sedimentation cone. Solid matter settles and the supernatant fluid is poured off. After this decanting process has been repeated a second time, the sediment plus some water is poured into a 10 c.c. cone. One hour later two to three drops of sediment are drawn from the cone with a pipette and this sample is placed on a slide for examination under the 32 m.m. objective of a microscope.

Most of the infected specimens contained a few parasites, usually less than a half dozen eggs, oocysts or larvae in the 2 or 3 drop samples inspected. Only 15 specimens, or seven percent, were regarded as being heavily parasitized. Eleven of these were infected with lungworm larvae, *Protostrongylus* sp., and four contained the oocysts of a coccidial parasite, *Eimeria arloingi*. A specimen was considered heavily infected if one to four larvae or oocysts could be seen in each field of the microscope as the slide was moved across the stage.

Packard (1946), reporting the results from bighorn pellets analyzed by a sugar-flotation method, scaled parasite presence in one drop of sugar solution as follows: 1 to 5, light; 5 to 25, moderate; over 25, heavy. Many of the specimens which he collected in Rocky Mountain National Park, Colorado, were judged as moderately or heavily infested by these standards. Couey (1950) commonly found several dozen lungworm larvae in each field of the microscope when he examined bighorn droppings gathered on the Sun River range in Montana. By comparison, then, it would seem that the most heavily parasitized bighorn feces collected during the current study actually represent only light infestation. However, it is a difficult matter to translate abundance of parasites in fecal material into terms of harmfulness to the host animal. At best, the results from limited samples, such as the one reported here, can furnish only enough information to warrant generalization.

In 74 instances, samples were gathered from mountain sheep that were observed defecating. The sex, age and apparent condition of these individuals was recorded for future correlation with results from examination of their feces. These data were analyzed in a number of ways to compare the relationship of sex and age to degree of infestation. No significant differences were detected among rams, ewes and yearlings. But lambs were freer of endoparasites than older animals. This would be expected, however. Only three out of 13, or 23 percent, of the lamb feces collected in July and August harbored parasites. All three infected samples

contained *Eimeria arloingi.* Species of *Eimeria* are the causal agent of hemorrhagic coccidiosis in cattle, swine and domestic sheep. Udall (1943) reports that coccidiosis is typically a disease of the young in domestic livestock, with most cases in cattle occurring between the ages of four months and two years. The disease may reach epidemic proportions where animals become concentrated. Although moderate numbers of coccidian oocysts may be harbored without apparent ill-effects, heavy infestations have been known to kill large numbers of juvenile domestic animals in a short time.

Lungworms in addition to coccidia, were found in only one lamb fecal specimen. This was collected on August 2 when the animal was probably about two months old.

Table 5 summarizes, by herd areas, the percent of samples infested by each kind of endoparasite found in bighorn fecal samples. The comparatively low incidence of parasites, and the light infestation of those feces containing eggs, larvae or oocysts, indicates that debility caused by parasite-induced pathologies is unlikely. Only 50 percent of the 229 specimens collected held lungworm larvae. Couey found from 75 to 100 percent infestation among Montana bighorn herds. Average occurrence of lungworm in 360 droppings samples which he collected on the Sun River range was 85 percent. It is interesting to note that Gaufin and Ellis (1941) found lungworms in only 52 percent of 68 fecal specimens collected from the Stoddard Creek herd along the Middle Fork of the Salmon River.

Lungworm infestations ranged from 35 percent in January to 93 percent in February, but these percentages are based on small samples, 11 and 15 respectively, and are not reliable indicators of true conditions. Samples taken during the remaining months of the year varied only slightly from the mean of 50 percent. To truly measure any seasonal fluctuations that may exist, it would be necessary to collect greater numbers of samples from the same herd during each month of the year.

Flies were frequently observed annoying the sheep on summer ranges. Twelve species of gnats and flies were collected in the Bighorn Crags during the summer of 1950. Nine of these species were identified by Dr. C. B. Philip of the Rocky Mountain Laboratory in Hamilton, Montana (Jellison, 1950). The other three were classified by Dr. Alan Stone of the National Museum, Washington, D.C. (Stone, 1950). Eight of the flies were members of the sub-family *Tabaninae,* commonly known as horseflies. One deerfly, *Chrysops pertinax,* was identified. Two species of *Simu-*

Table 5. Parasites found in 229 bighorn sheep fecal specimens collected on Salmon River ranges between July 1949 and August 1951.

		PERCENT OF SAMPLES CONTAINING PARASITE						
	Number of samples	Lungworms[1]	Tapeworm (*Moniezia benedeni*)	Whipworm (*Trichuris ovis*)	Coccidia[2]	Stomach Worms (*Ostertagia marshallia*)	Pinworm (*Skrjabinema ovis*)	All parasites
SUMMER RANGE:								
Bighorn Crags	87	60	6	3	18	1	2	63
WINTER RANGES:								
Cramer Creek	64	34	25	17	6	3	..	58
Clear Creek	37	60	3	16	..	11	..	62
Middle Fork, above Big Creek	18	44	..	6	..	..	..	44
Corn Creek to Dwyer Creek, Salmon River	12	42	33	8	..	..	..	58
East Fork	11	36	..	18	27	..	..	64
Average percent infestation in all samples	..	50	11	10	10	3	1	60

[1] Three types of lungworm were identified, and were found in the following number of droppings: *Protostrongylus sp.* (possibly *P. rushi*)—109; *P. rufescens*—2; *Muellerius minutissimus*—2.

[2] Two coccidia were identified, and found in the following number of droppings: *Eimeria arloingi*—18; and *E. granulosa*—5.

liidae, snipe flies, and a buffalo gnat *Symphoromyia atripes,* complete the collection. *Simulium arcticum,* one of the Simuliids collected, is reported by Twinn (1947) as having caused the death of 94 cattle and 39 other farm animals, and the brief but serious illness of many more. A textbook on medical entomology states that another species of *Simulium* was responsible for the death of over 16,000 horses, mules and cattle in Rumania several years ago. Scores of deer and other big game were killed at that time. Actual loss of blood was reported as the probable cause of the deaths.

In this study the oldest and the youngest animals were found to be least able to resist adverse environmental influences. Old rams and ewes, and yearlings and lambs were often thin, even emaciated, by early spring. Several times animals in this condition were followed by the author. The difficulty with which they breathed after only slight exertion attested to their weakened condition.

In attaching significance to physical condition in the spring, it is well to point out that wild game, as opposed to domestic stock, are seldom sustained by wholly adequate winter diets under even the most favorable range conditions. Moderate numbers of parasites may infest perfectly normal animals. Consequently, observers should be cautious about diagnosing thin or heavily parasitized big game as "abnormal" when the condition is detected in late winter or early spring. Healthy individuals will generally recover with the improvement of forage supplies and weather conditions.

PREDATORS

Cougar

Considered as an individual, the cougar is an important predator on bighorn sheep in Idaho. His agility and size, combined with his habit of seeking prey in rough terrain, are characteristics that cause him to be potentially dangerous to bighorn populations. Mr. Willard Rood, Jr., a rancher and former state trapper, reports an incident which occurred several years ago when he trailed a cougar to the freshly uncovered carcasses of six bighorn sheep that were previously cached. A few cougar-killed bighorn were reported in Banff National Park by Green (1949). Mr. Green reporting an 11 year study of the bighorn, cites three instances of observations of a cougar stalking or pursuing a group of ewes and lambs. The sheep successfully eluded the big cat on each occasion.

Cougar have been hunted quite consistently for many years in the Salmon River watershed and their numbers have not reached alarming proportions. However, in recent years high wages have enticed many part-time bounty hunters to more lucrative means of earning a living. This may account, at least in part, for recent reports of increased numbers of these huge cats. Bounties formerly were paid in only part of the state. They were made statewide in 1953, which may revive wider interest in cougar hunting.

From the standpoint of abundance of large prey—particularly deer—and the general difficulty in keeping total game numbers within range capacities, a moderate cougar population appears desirable. It must be considered too, that a number of people hunt this animal primarily for sport. However, there should be no hesitation to destroy individual cougars whenever there are reliable reports of specific predation upon bighorn herds.

Coyotes

Coyotes are by far the most numerous of the predators occupying bighorn ranges, and there are reliable reports of their predation upon mountain sheep. Therefore, considerable effort was made to collect data concerning the importance of the coyote as a sheep killer. The collection and analysis of coyote droppings was one of the techniques employed.

Inspection of Table 6 indicates that bighorn sheep are relatively unimportant in the diet of the coyote, being found in 2.8

Table 6. Classification of 937 occurrences of food items in 687 coyote droppings collected on Salmon River ranges—May 1949 to September 1952.

Food Items	Droppings in which food item occurred		Food Items	Droppings in which food item occurred	
	No.	Percent		No.	Percent
Large Mammals			**Birds**		
Deer	412	60.0	Grouse	46	6.7
Bighorn	14	2.1	Non-game bird	10	1.5
Bighorn lamb	5	0.7	Eggshell	6	0.9
Horse	1	0.1	Owl	1	0.1
			Magpie	1	0.1
Small Mammals			**Others**		
Meadow mouse	116	16.9	Grasshopper	31	4.5
Rabbit and Hare	106	15.4	Snake	16	2.3
Pocket gopher	37	5.4	Lizard	4	0.6
Ground squirrel	32	4.7	Grass	2	0.3
Marmot	27	3.9	Sedge	2	0.3
Pine squirrel	24	3.5	Ribes	2	0.3
Packrat	17	2.5	Beetle	2	0.3
Chipmunk	9	1.3	Ponderosa pine	1	0.1
Porcupine	8	1.2	Ant	1	0.1
Beaver	1	0.1	Corn	1	0.1
Mole	1	0.1	Leather strap	1	0.1

percent of the droppings. Deer, providing the largest single food supply, was recorded in 60 percent of the scats. The remains of small mammals were found in 55 percent of all droppings collected.

By studying the dates and locations of the 19 sheep-containing scats collected (Table 7), it can be seen that probably not more than eight carcasses are represented. In three areas where scats containing sheep remains were collected, a bighorn was known to

Table 7. Summary of 19 bighorn occurrences in 687 coyote droppings.

Date	No. of droppings	Location	Remarks
7-31-49	3	Salt lick near Stoddard Lookout	Lamb. Snake in one scat
3-23-50	1	Wilson Creek Ford, Middle Fork River	
4-18-50	6	Between mouth of Middle Fork and Color Creek	One occurrence each of marmot, meadow mouse and rabbit
5 -3-50	1	Cramer Creek, Salmon River	
5 -5-50	3	Between mouth of Middle Fork and Color Creek	
6-13-50	1	Dry Gulch on Panther Creek, Salmon River	Also rabbit
4 -6-51	2	Stoddard Creek, Middle Fork River	Lamb
5-20-51	1	Horse Creek, Salmon River	Also rabbit
4 -6-52	1	Wilson Creek, Middle Fork River	

have died from causes other than predation. How much of the remaining ingested material was carrion and how much was from kills is, of course, mere conjecture.

Significance may be attached to 230 droppings that were gathered in May and June. Most of the lambs were born between May 15 and June 15. These months, then, would seem to be the time when the young would be most vulnerable to predator attack. Yet lamb remains were absent entirely from droppings collected during this period.

Coyotes were observed hunting in the vicinity of mountain sheep on several occasions, and a few times were seen actually stalking them. Ordinarily, groups of a half dozen or more sheep would watch nearby coyotes with interest but without outward manifestation of fear. If approached directly the sheep would band together before fleeing to the nearest cliffs where they remained alert until the danger had passed. On a few occasions one or two coyotes were seen stalking young animals or ewes and lambs detached from larger groups. In these cases the sheep sped to their companions. Then, emboldened by safety in numbers, the entire herd would present a common defiance that discouraged further pursuit.

Many trappers and long-time residents of the Salmon River back country were interviewed regarding their observations and opinions relative to the extent of coyote predation upon bighorn. Although there was not complete agreement, the general opinion was that coyote predation is a relatively unimportant drain on bighorn populations.

The over-abundance of deer inhabiting many bighorn ranges constitutes a valuable buffer for the sheep. However, it is conceivable that sharp reductions in deer numbers would increase coyote pressure on the bighorn. Then, because of their limited population, bighorn sheep might need protection in the form of local coyote control. But, aside from this, the status of coyote predation on the ranges studied is aptly described in the following statement by Craighead (1951, p. 22), "On wildlife lands where economic returns are slight, the natural regulatory control exercised by predators on their prey constitutes a harmonious relationship that cannot be improved on by man."

Eagles

The golden eagle is common throughout the central part of Idaho. Bald eagles also are present but were observed only

occasionally on mountain sheep ranges. Because of the controversial nature of their relationship to the young mountain sheep, these raptors were closely observed.

Eagles frequently were seen soaring high above sheep ranges in all seasons. In 123 instances they were observed flying near the ground in search of food. Eight were frightened away from the carcasses of deer. It did not appear that the eagle had made the kill in any of these cases. On six occasions eagles were observed swooping over or diving at groups of bighorn. Their presence did not elicit more than casual watchfulness on the part of the sheep, unless they approached suddenly and without warning.

It is not desired to make light of the possibility of eagle predation. There are verified cases where golden eagles attacked and killed big game animals. Kennedy (1948), in New Mexico, discovered a golden eagle feeding upon the carcass of a bighorn lamb. The body was still warm and tracks nearby indicated an attempt by the ewe to protect her young. Casebeer, *et al.* (1950) reported observing a bald eagle in Montana out-feint a mountain goat nanny in order to grasp her kid and soar away, with the kid dangling helplessly in its talons. Other instances can be cited of actual observations of eagle predation on big game.

Early investigations of the relationships of various big game species to eagles often gave much credence to tales of extensive killing of large mammals by these birds. Then, as a background of creditable observations was accumulated, researchers became more critical of "hearsay" evidence. Nests were located in many states and Alaska. The birds were observed as they fed their young and the contents of their nests were examined. Thousands of man-hours were spent observing eagle activity. Little by little, it became evident that the eagle's diet was composed largely of rodents and small game, and that most of the large prey consumed was in the form of carrion. The same holds true in Idaho where the bulk of the evidence indicates that a program of eliminating eagles would not be a panacea for our problems.

Other Predators

The importance of bobcats as predators on sheep was not established during the course of this study. There is little question, however, that bobcats are capable of capturing bighorn sheep. But these cats are not numerous on the ranges studied and their scarcity would seem to exclude them as serious predators. Nevertheless, it is of interest to note the importance of large prey in

their diet as shown by Latham (1950), who reports two Vermont studies of bobcat food habits. One study lists deer as comprising the largest single food source. The other, based on analysis of 244 stomachs, placed deer as second to hares and rabbits, with deer making up 17.1 percent of the diet.

Black bears are common on central Idaho mountain sheep ranges. Their diet is composed chiefly of small rodents, insects and vegetable matter in season. They do eat the flesh of large mammals, but mostly in the form of carrion. Bears are comparatively slow and clumsy and, except for the occasional "killer," it is doubtful that they catch healthy big game animals under normal circumstances. Their habit of hibernating throughout the winter lessens the probability of predation on big game species which are most vulnerable during those months. The precocity of bighorn lambs and their tendency to inhabit rough terrain should give them more safety than is accorded the young of elk or deer which are killed occasionally by bears.

Ravens are quite numerous on both summer and winter ranges. Einarsen (1948) postulates that, since ravens are known to indirectly kill domestic lambs by picking out their eyes, they might also be predatory upon antelope kids in the same manner. Jones (1950) states that F. R. Oberhansley, reporting on Yellowstone bighorn, found that ravens were apt to attack newborn lambs. No indication of such activity was observed during this study, but it is a possibility that merits consideration.

FIGURE 20. A bighorn ram killed "by hanging" after falling from a 15 foot cliff. He may have been chased by a predator, become blind or dizzy because of pathological conditions or perhaps was simply careless. When found, he had been dead too long for the post-mortem autopsy to be diagnostic.

Photo by S. Brandborg, April 24, 1951

ACCIDENTAL DEATHS

Accidental deaths are a common source of loss among mountain sheep, but most of these losses must be considered as a normal drain on the population. It is possible that some accidents, such as falls from high places, may involve pathological conditions. Heavy parasitization by lungworms, for example, may result in a pneumonic condition which could bring about weakness or dizziness resulting in the so-called accidental death of an afflicted animal.

Travel over precipitous terrain is often the circumstance responsible for accidental fatalities. A dead ram was found April 24, 1951, at the base of a 15 foot cliff (Figure 20). His horns were caught in the crotch of a large alder. Tracks indicated that he walked directly off the face of the cliff.

FIGURE 21. This lamb had been trapped on the ledge pictured above for at least a day before it was so badly frightened by the author and a companion that it made, and survived, a desperation leap to the rocks more than 25 feet below.

Photo by M. Francis, November 28, 1951

On November 28, 1951, a lamb was observed bedded on a small ledge in cliffy terrain. A day later the lamb was still there. When approached to within 10 feet it leaped to the rocks more than 25 feet below (Figure 21). The lamb appeared weak and was limping as it traveled to more level country. The presence of hair on the rocks above the ledge indicated that the lamb had lost its

footing, but was stopped by this protrusion from the face of the cliff. Considering the length of time the lamb was known to have been stranded, it appeared that it was unable to climb and afraid to leap from its entrapment until frightened by the approach of the writer and a companion. It is believed that this animal would have weakened and eventually perished had it remained undisturbed.

A ram was observed on February 9, 1952, with severe head injuries and a front leg that would not support him. It appeared to have been in a serious accident. Nine days later he was found dead.

Injured rams were seen during the rutting season each year of the study. Other studies have reported serious injuries being sustained during battles. Murie (1944) knew of at least one ram suffering a broken neck after falling in the course of a strenuous battle.

Several times during the study remains of sheep were found where rock or snow slides were known to have occurred. In February and March 1952, 74 slides varying from 10 to more than 600 feet across were encountered along 12 miles of trail bordering the Middle Fork of the Salmon River. This evidence of high slide hazard conditions indicates the potential danger to animals living in the area.

ILLEGAL KILL

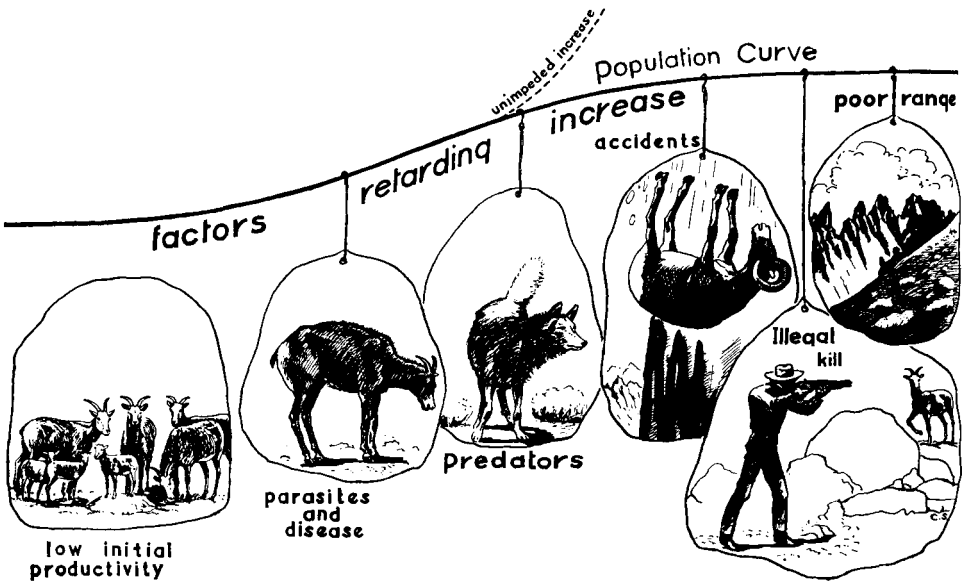
The greatest loss to illegal hunters was sustained in the early 1900's. This period witnessed the peak human population in back country areas inhabited by bighorn sheep. Men, swarming into the Salmon River mountains to search for gold, were closely followed by those who served their needs. Families settled in the rugged canyons and began raising cattle, sheep and horses. Laws protecting the bighorn had just been enacted, but the deeply imbedded philosophy of "living off the land" had not been overcome.

The end of the mining "boom," followed by World War I and better times, emptied the mountains of most of their human occupants before 1920. After more than a decade, the depression years of the '30's brought men and families back into the hills to eke a living from their mining claims and gardens—and the wild game. Again the curious sheep were easy targets for their guns.

The 1940's saw another war and more good times remove all except a few rugged individualists and guest ranch operators who yet remain in wilderness places. Undoubtedly some bighorn sheep still are being killed illegally each year, although the extent of this loss is difficult to measure. In the early stages of the study it was believed that local inhabitants were accounting for few losses. Several had, in fact, aided in the protection of sheep herds and the apprehension of poachers. However, as information was collected it became apparent that some of these folks were yielding to the temptation provided by the fine flavored meat of wild sheep and the ease with which they can be killed in winter-time. Unfortunately, it is generally the most important animals, the females and juveniles, that are hardest hit by illegal hunters.

Bighorn are sometimes killed for camp meat during other big game hunts. A few may be lost to the over-anxious hunter who mistakes them for a deer or elk. There are a few instances where it has been reported that rifles have actually been "zeroed in" on mountain sheep by men who have no compunction about killing all wild creatures which they encounter.

Several violators have been apprehended in recent years and a maximum fine of $300 and costs has generally been assessed. The evidence points out that a few accessible herds may have decreased in recent years solely because of illegal killing. It is to be hoped that continued vigilance by all conservation-minded persons and unceasing efforts to inform the public of the seriousness of illegal and indiscriminate killing will reduce this loss.



THE PRODUCTION PROBLEM

Knowledge of productivity is vital in the formulation of an intensive game management program. The method selected for determining the rate of production in this study involves analysis of sex ratios and age classes which are based on incidence of occurrence. Taken from field observations during specific seasons, cumulative sex and age classifications are believed to represent productivity with fair accuracy.

Sex Ratios and Age Classes

As the study progressed it became apparent that cumulative sex and age ratios, taken over the entire study period, were not always valid. First, in order for year-around counts to constitute reliable sex and age ratio information, one must assume that the observer's opportunity to see a true cross section of the herd will be equal throughout the year and, therefore, any errors will tend to compensate. This assumption was made in the initial report of the study (Smith, 1951). However, further investigation and analysis of data revealed that certain errors in sex and age classification were cumulative rather than compensatory.

One such error stemmed from the nature of ram behavoir during much of the year. With the exception of the fall rutting season and early winter period, when rams are closely associated

with bands of ewes and young animals, it was found that mature rams were consistently less "observable" than females and juveniles. Among factors responsible for low ram counts was their inclination to utilize inaccessible areas, early dispersal from winter ranges and habit of breaking into small bands when not in the company of ewes and lambs. For these reasons the only ram-ewe ratios considered to be acceptable were those calculated from the winter counts. Table 8 indicates wide variability in ram-ewe ratios except during this early winter period.

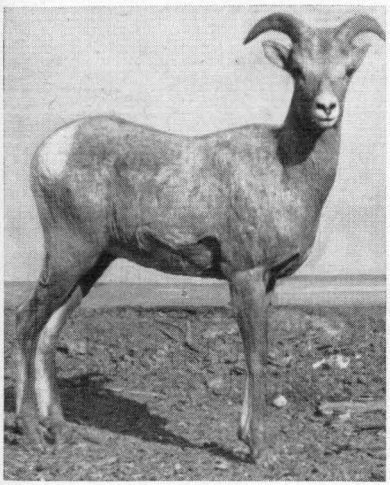


FIGURE 22. A young ram—about 1½ years old. At a distance even an experienced observer might mistakenly classify him as a ewe.
Photo by S. Brandborg, October 20, 1952

At long distances the most easily recognized animals are lambs and rams, two years and older. Older ewes often can be identified as can ewes accompanied by lambs. Yearlings, particularly males, frequently cannot be distinguished from young adult ewes unless they are near at hand. The inclusion of identified animals in partially classified groups, then, would tend to erroneously lower the yearling component of calculated age ratios. This source of error was overcome by the complete exclusion of partially classified groups of animals in the computation of sex and age ratios given hereafter.

Yearlings were often inaccurately represented in pre-lambing counts conducted in March and April and post-lambing counts made in June, July and August. During these periods yearlings are frequently separated from the ewes and lambs. When year-to-year and season-to-season comparisons of the figures in Table 8 are made, it becomes apparent that some of the ewe-yearling ratios do not represent a true cross section of the herd. Yearlings mingle most freely in heterogeneous groups during early winter. As for mature rams, this is the optimum season to determine their true status.

Figure 23 begins with each year's lamb crop and follows it until accurate aging becomes impossible. The curves, showing progressive decline in ewe-juvenile ratios, are located by inspection.

The unreliability of yearling numbers in all except winter counts prohibits serious consideration of ratios involving the yearling age class. Vertical lines denoting time of counts are not equidistant because the period of time between counts was not equal.

Table 8. Bighorn sheep sex and age ratios as determined by classifications of animals observed.

	Total number of animals in completely classified groups				Ratios*			
	1949	1950	1951	1952	1949	1950	1951	1952
Post-lambing Counts (June 15-Aug. 18)								
Ram-ewe	101	114	18	35	2.26	15.29	2.00	3.37
Ewe-lamb	108	191	21	47	**0.54**	**0.78**	**0.75**	**0.74**
Ewe-yearling	88	121	13	35	0.26	0.13	0.08	0.30
Winter Counts (Nov. 14-Jan. 18)								
Ram-ewe	113	81	119		**1.35**	**1.61**	**1.13**	
Ewe-lamb	93	85	96		**0.41**	**0.70**	**0.52**	
Ewe-yearling	76	69	82		**0.24**	**0.38**	**0.30**	
Pre-lambing Counts (Mar. 15-Apr. 29)								
Ram-ewe		96	218	235		1.34	2.46	3.12
Ewe-lamb		75	230	241		**0.36**	**0.48**	**0.35**
Ewe-yearling		65	202	202		0.18	0.30	0.13

* Heavy figures denote those ratios most representative of true herd status.

The post-lambing ewe-lamb ratios of 0.78, 0.75 and 0.74 for 1950, '51 and '52 respectively, do not indicate significant differences in lambing success. Preceding the low 0.54 ratio calculated for 1949 was a winter of unusually low temperatures and deep snow. The more successful lambing seasons following 1949 were preceded by relatively mild winter weather. This suggests a correlation between severity of winters and the successful bearing of young.

Only winter counts were used for calculating the average ram-ewe ratio for the full study period. The weighted average for the three winter counts conducted is 1 ram to 1.33 ewes. No optimum ram-ewe ratio has been ascertained but, considering the polygamous nature of bighorn sheep, this proportion of males should be more than adequate to insure breeding of all receptive females on the range. Because of the isolation and smallness of many of the herds, it appears that a ratio wider than one ram to three ewes would be undesirable.

Basic Requirements of Habitat

The ability of a game animal to survive, in the face of ever-expanding agricultural and industrial development of its natural habitat, depends largely upon its tolerance of wide variations in

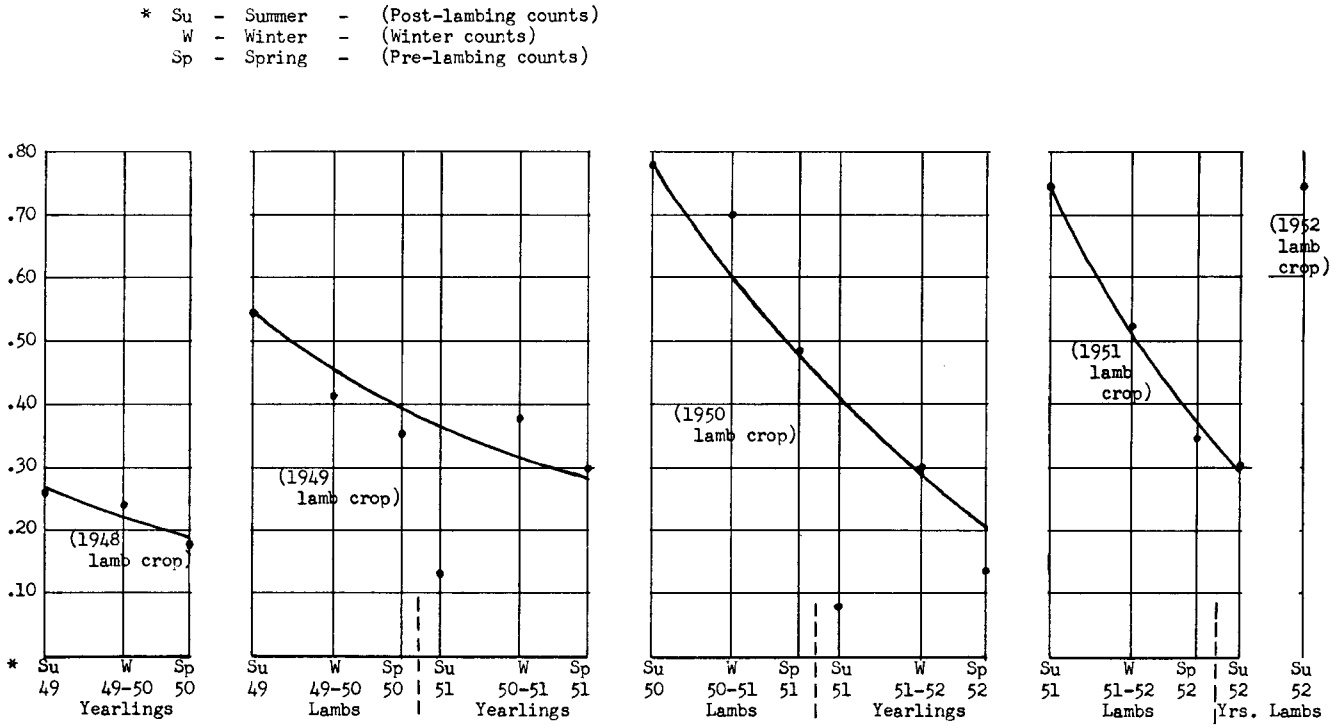


FIGURE 23. Ewe-lamb and ewe-yearling ratios as indicators of productivity of bighorn sheep.

the composition of its range. As the primitive state is altered to suit the requirements of advancing civilization, native species often must readjust to an entirely new pattern of living. Fortunately, the history of wildlife has witnessed an amazing resiliency to disruption of their life habits.

At the outset of a discussion on basic requirements of bighorn habitat, it should be understood that the standards are only contemporary. It should also be made clear that the requirements described for Idaho ranges may not be applicable for herds of the same sub-species elsewhere.

First, perhaps the relationship of the bighorn, a wilderness animal, to its environment should be discussed. Leopold (1933, p. 134 describes wilderness game as, ". . . species harmful to or harmed by economic land uses, and therefore suitable for preservation only in special public game reservations, or in public wilderness areas." He then classifies mountain sheep, along with grizzly bear, moose and caribou, as animals that usually fail to thrive in contact with settlement. Bighorn in Idaho have undeniably been "harmed by economic land uses." Unlike elk and deer, which often migrate from their summer ranges in the mountains to agricultural lowlands for winter, mountain sheep seldom trespass in an agrarian community. Their range in the Salmon River watershed is confined largely to areas receiving a minimum of disturbance by man, and where settlement is in the form of an occasional isolated ranch or cabin.

The first requirement of bighorn habitat, then, is that it be located in a wilderness or other undeveloped area. A second requirement involves competition for range. Although gregarious, bighorn in Idaho have not exhibited an ability to thrive where elk or deer are overly abundant. Where common game use has not deteriorated the range, there is evidence that mountain sheep can live harmoniously with the other inhabitants. It is from abused areas that bighorn "disappear," leaving the elk and deer to multiply and further deplete the vegetation. The requirement for a thrifty range is not peculiar, of course, to bighorn sheep; but they do appear to be more immediately and adversely affected by mismanagement than either elk or deer.

Precise physiographical standards for ideal sheep range would be difficult to define because of the variability among equally successful ranges. Nevertheless, certain characteristics were found to be common to all of the more productive sites. It was discovered, for example, that the presence of open bunchgrass associations increased the desirability of an area as winter habitat. Another

FIGURE 24. Good bighorn sheep range along the Middle Fork of the Salmon River. Browse covered cliffs intersperse numerous open grassy slopes. Only a moderate population of deer compete for the forage. On April 8, 1952, 78 sheep were grazing on the slope in the foreground.

April 8, 1952

common denominator of all sheep ranges is ruggedness of topography. Even those open, grassy slopes utilized by sheep in winter are bordered by steep rocky terrain. It is not clear whether this requirement of proximity to cliffs is primarily in response to a need for protection from predators or because there is less competition for the mountain mahogany and bitterbrush that grow on these cliffy sites. It is known that cliffs play an important role as lambing grounds.

Paucity of suitable habitat is an important factor limiting the total production of bighorn sheep. Restriction of their habitat proceeded rapidly in the early stages of settlement of the Lemhi, Lost River and Salmon drainages, but has slackened or halted entirely in recent years. In fact, some lands have been withdrawn from agricultural uses because of economic impracticability or the restrictions imposed by controlling agencies. However, the curtailment of livestock use may be offset by the enactment of numerous proposals designed to open up many of the remaining tracts of wilderness lands. These proposals include timber and mining operations, hydroelectric and water storage projects, and guest ranching—and the access roads and settlement that go along with such economic uses.

If past bighorn behavior is a guidepost to the future, we can

be assured that the enactment of even part of these proposals will result in significant losses of acceptable habitat. We must, however, remember that restriction of range is only partially responsible for the present sparse population of sheep. On some ranges it appears that mountain sheep numbers can be increased materially without exceeding the carrying capacity. This is particularly so if a priority is established favoring sheep production on inaccessible lands where it is difficult to encourage adequate harvest of deer or, in some cases, elk. There are historic ranges where bighorn can be reintroduced by transplanting or, perhaps, through natural extension of their present range.

Can we expect to restore Idaho's sheep herds to their historic status? The answer is, of course, "No." The reduction in available range has been so great that it cannot be compensated by improved husbandry. However, it appears that our present estimated 2,500 head of mountain sheep can be increased materially, using only the range resources now available. There is always the possibility, too, that a wider tolerance for range composition may be slowly acquired. This would open up areas not presently considered as sheep habitat. It is true that the latitude of environmental tolerance exhibited by bighorn is much narrower than for deer and elk, but we know that the past 100 years has witnessed significant modifications in their requirements. Perhaps the next century will bring about equally important adaptions.

Significance of Life Habits

The life habits of a species relate both directly and indirectly to its productive potential. A problem deserving attention is the interpretation of each behaviorism in terms of its plus or minus value to the species concerned. Field observations indicate that a particular behavior pattern may be detrimental under one circumstance while highly beneficial under another. For example, the high degree of polygamy among mountain sheep is advantageous when populations are low and there are few rams among scattered flocks. This same characteristic, when populations are large and rams congregate in numbers, may bring about injury, physical exhaustion, and other undesirable results through excessive servicing and harassment of the ewes.

The precocity of lambs can be extolled as a great asset in evading predators. But can we truthfully say that flight is a superior technique? The elk calf or deer fawn, lying passively and well concealed, may actually be safer in some instances than the energetic lamb for all his strength and agility.

The strong herd instinct of the bighorn has been cited as a protective measure against danger. But which is it, asset or liability, when it contributes to decimation of herds through disease and other evils of localized over-concentration? Misfortune, which might have spared a less gregarious species, has recently struck the bighorn in Colorado. Excellent progress was being made in building up mountain sheep herds. Then, even before it was felt that a shootable population had been attained, verminous pneumonia began killing numbers of sheep (Moser, 1953). Hair lungworm (*Protostrongylus stilesi*) was determined to be directly responsible for the pneumonia. Mr. Moser describes the relationship of heavy parasite infestation to over-concentration of game and states (p. 19), "the Game and Fish Commission has decided that . . . harvest . . . can eliminate this over-concentration by scattering herds into new areas." Could it be that the herd habit works helpfully when populations are low but becomes a hindrance at an abundance which man does not always recognize as the point of saturation?

It has been suggested that the use of precipitous terrain by mountain sheep is advantageous in escaping from predators. This appears to be valid reasoning. Yet, is this protection from predators nullified by the high rate of accidental deaths occurring because of the rugged nature of that very same habitat?

It is not intended to attribute undue complexity to the cause and effect of behavior. Many of the apparent contradictions in the purpose of various life habits may, after all, be entirely in harmony with nature. But it is important to recognize our limitations by maintaining adequate flexibility in any management program — and in our thinking — to permit adjustment to future findings.

Eagerness to promote recovery of the bighorn is laudable. But it may be that a very necessary process of natural selection will be thwarted by over-protection or over-management. It frequently develops that we cannot interfere too much with the processes of nature without unfortunate results. Perhaps it will prove wisest to heed the current trend in medical science and return to a natural, "breast-feeding" approach.

WHAT DOES THE FUTURE HOLD

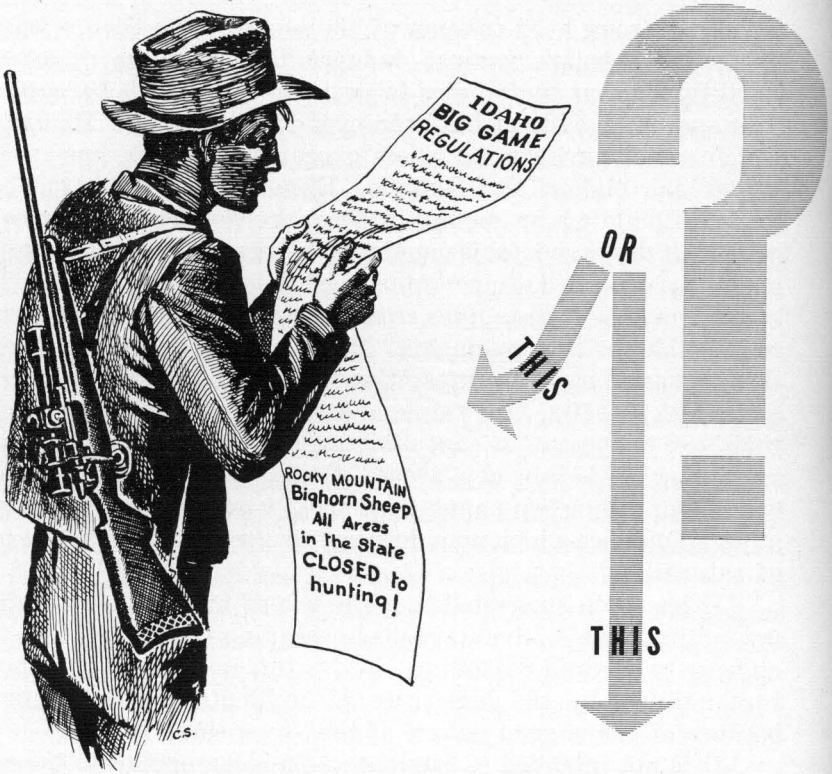
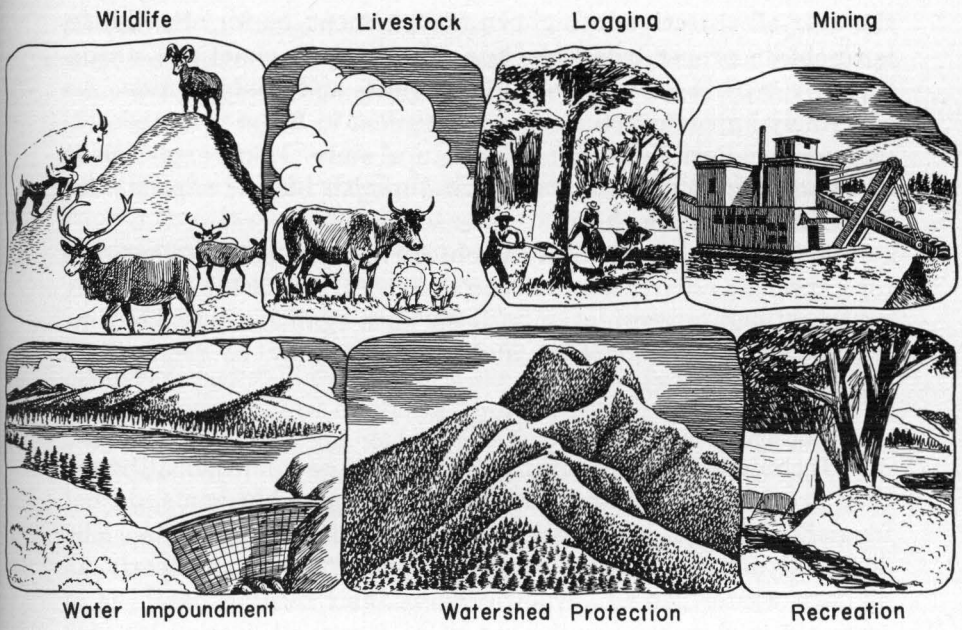


Photo of H. S. Dyer



BIGHORN MANAGEMENT IN IDAHO

Objectives

An important objective in managing a minority species, such as bighorn sheep, must surely be to provide a numerical margin of safety that minimizes the possibility of extinction or even reduction of the species. While this means that the usual objective of producing a huntable population may at times be subordinated to other considerations, the present status of Idaho herds indicates that a few hunters also may be able to share the recreational values provided by the bighorn. However, no matter how much success rewards our efforts to increase the population, it does not appear probable that economic and aesthetic values accruing to hunting will ever contribute more than a fraction of the human values that will reward those who cherish the spectacle of a magnificent animal surrounded by natural primitive beauty, whether they are hunters, fishermen, photographers or casual visitors.

There are many interacting factors to consider in developing any big game management plan. These include soil, vegetation, weather and the inter-relationships among the species making up the ecological community. So aside from perpetuating the species,

the over-all objective in bighorn management, as for all wildlife, is to obtain proper balance of use; always, and sometimes unfortunately, with a view to the current wants and needs of man. An extremely important phase of management in Idaho is the preservation of wilderness habitat in its natural state. Man's exploitation of remaining wilderness tracts will diminish Idaho's capacity for producing mountain sheep.

It is essential, too, that the objectives of a management plan for a species as scarce as mountain sheep provide for the continuing collection and interpretation of basic data against a possible time when all of our knowledge and ingenuity may be required to maintain the species.

Census

Techniques for measuring trends in range condition, although they are important indicators of the status of big game, do not furnish adequate information about bighorn populations. Elk, deer and mountain goats occur in some numbers on nearly all bighorn winter ranges. Knowledge of their feeding habits is of some aid in determining the extent of forage utilization by each species, but does not clearly define the position of the bighorn in the common use picture. It then becomes necessary to find a more precise method for determining current bighorn abundance and direction of numerical trend.

Pellet group counts have been used successfully to estimate game populations in other states. After sufficient testing, this approach may prove valuable in estimating mountain sheep populations in Idaho. However, it appears that the nature of the terrain would be an obstacle to accurate sampling; and the fact that pellets of deer, mountain goats and bighorn are often difficult to distinguish would further complicate the technique.

Based on present knowledge, it appears that actual census is required if bighorn populations are to be accurately evaluated. But the sprinkling of small herds over a vast and extremely rugged country makes total census an impractical, if not impossible, task. Therefore, ground and aerial trend counts of key areas of bighorn production appear to be the most practical methods for obtaining the population data needed for management purposes.

Aerial census, while not always economically or operationally feasible, can be of decided value in many situations. Aerial counting over inaccessible areas is often the only means possible for accomplishing the work at an optimum time. These counts should

be limited to areas where a maximum of open grassy slopes constitutes the winter range, and at a time when the sheep are concentrated on these slopes. This is usually about April 1. Data obtained can be of considerable value in determining trend, provided the census areas are carefully selected and year-to-year census techniques are well standardized. Accordingly, annual trend counts have been established and described in detail (Smith, 1952). Aerial reconnaissance can also be extremely useful in determining the proper time for ground counts.

The efficiency of two types of aircraft were compared on one trend count. From a model 170, 145 hp. Cessna used in 1951, two observers counted 155 bighorn sheep at the average rate of 0.57 animals per minute of flying time. A PA-11, 85 hp. Piper Cub was used in 1952 when 236 bighorn were counted by one observer at the rate of 1.1 animals per minute. Weather and range conditions were similar each year and the same routes were followed. Ground checks failed to reveal any significant change in population between the two years. The difference in flight characteristics of the planes is the most apparent explanation for the greater success of the Cub.

There are a number of light planes that perform satisfactorily for game census over rough terrain. The following comparisons are given to illustrate some of the problems found important in aerial mountain sheep census rather than to recommend a certain make or type of aircraft. The experience and ability of the pilot undoubtedly transcends many other considerations.

The slower air speed of the Cub (60-70 mph) enabled the observer to scan the slopes more thoroughly than when traveling at an air speed of 90 to 100 mph in the Cessna 170. Furthermore, it was easier to identify locations with respect to streams and other landmarks from the slower plane. The Cub was more maneuverable, making it possible to negotiate the twisting, turning canyons at a lower altitude while counting. Observations can be made downward at a steeper angle from the Cub. This is important when flying steep, narrow drainages where one must stay midway between the cliffs, and tilting the plane to permit a view of the terrain directly below is unsafe. The Cub's more rapid rate of climb eliminated costly circling to regain altitude after flying down a steep canyon.

On some ranges ground counts can add materially to the understanding of population trends. Four ground trend count areas have been established along Salmon River winter ranges. These counts are scheduled during the spring months when it is

advisable to check range use, winter kills, predator losses and general condition of big game. Therefore, the work can be carried out by field personnel in conjunction with other phases of management. Routes for counting are established along roads or trails as a means of facilitating the work and obtaining uniformity of coverage. Schedules and methods of coverage are described in detail for each trend count established (Smith, 1953a).

Another source of census information is the observations made by U.S. Forest Service employees on lookout stations located within bighorn sheep summer range. The collection of these data has been successful in past years and should be continued.

Control of Predators

The most apparent solution, when developing a program to protect a scarce species such as bighorn sheep, is to recommend the elimination of all possible sources of loss. Closed seasons and predator control are usually the first two measures that come to mind. In our concern to protect a single species, however, we should not lose sight of the importance of other members of the biotic community nor overlook their significance to the whole environment. To properly evaluate the relationship of predators to bighorn sheep, we must consider not only predators and bighorn but the status of the entire wildlife population as well.

Predation is popularly accepted as an important mortality factor among mountain sheep in Idaho. In reality the loss from this source appears to be rather small, though it does exist and most certainly must receive consideration in management planning.

Field observations and food habits analyses of all predatory species, save perhaps the coyote, were insufficient in this study to permit adequate appraisal of predator-prey relationships. It can be said, however, that no evidence was uncovered to indicate that it would be advisable to inaugurate a wholesale control program for any predator on mountain sheep ranges. This is not to say that local control of specific predators may not become necessary to protect the mountain sheep. Such necessity is always a possibility and we must be alert to prevent serious predator losses from occuring without detection. On the other hand, many of the common use ranges occupied by bighorn are relatively inaccessible to hunters. Frequently conditions on these ranges attest to total over-population by big game. Under these circumstances it would be short sighted, indeed, to initiate a predator control program

based on the outmoded premise that, "It might do some good and surely couldn't do any harm."

Salting

Whether or not to include a salting program as a part of bighorn sheep management is a difficult question to answer. It is true that sheep eagerly lick blocks of stock salt and eat huge quantities of soil found in natural and artificial licks. But, insofar as this writer is aware, it has not been demonstrated that the absence of supplementary sodium chloride has ill effects upon bighorn any more than it has been proven that its presence is beneficial. Certainly the data collected in this study are inadequate for reaching definite conclusions regarding mineral requirements.

The entire salting program in Idaho is being reviewed critically and a concerted effort is being made to determine the value of salt in controlling big game movement. At this writing there are more conjectures than facts regarding the effectiveness of the program. Jones and Moser (1953) report that, in Colorado, they were able to lure the Pikes Peak bighorn herd a distance of four miles with the aid of salt. The most promising employment of salt, then, seems not to be the fulfilment of physiological needs but as a technique for securing proper distribution of range use. Even in this respect the ultimate advantage gained by such a procedure is open to question. Literature available indicates that significant redistribution of big game through the use of salt has been attained only in isolated situations, and then only by very carefully executed programs. Leopold, *et al.* (1951) discusses salting under the heading *Impractical Management Suggestions* where it is pointed out (p. 132), that "No evidence was obtained that salt induced any general redistribution of the animals (deer)." In a letter to the writer, Arthur S. Einarsen (1954) advises that after three years of experimental work in Oregon, salt has not been proven to be necessary or particularly encouraging as a tool in mule deer management. He further states that salt has been ineffective as a means of influencing deer movements.

The introduction of salt, in the case of bighorn, may actually concentrate range use rather than distribute it. Considering the lack of knowledge concerning big game need for salt and the general absence of evidence supporting its effectiveness in controlling animal movement, it is well to approach the subject with caution. It seems advisable that salt be supplied to mountain sheep in Idaho only experimentally until proof, one way or the other, can be furnished.

Hunting

To kill a trophy ram is the cherished ambition of many big game hunters. And an important objective of the Idaho Fish and Game Department is to furnish the maximum hunting sport consistent with good management practices. However, there are many things to consider before deciding whether or not to conduct a harvest of bighorn sheep.

FIGURE 25. Bighorn Ahead! A sight to thrill the heart of any sportsman.
Photo by M. Francis, February 10, 1952

Assuming that multiple use objectives have been taken into consideration, the next step is to determine whether total game numbers should be increased or decreased. Following this, it is necessary to establish a desired management priority among the species present. Thus, establishment of hunting regulations for all species of big game is an integral part of the bighorn management program. The order of preference among species depends, not only upon the interrelations between habitat and animals, but the relative attractiveness of each species to the hunter as well.

A brief review of the status of all resident big game species is needed before discussing bighorn sheep hunting. In recent years elk have been increasing rapidly over much of the Salmon River country. Bighorn are making slow gains, while deer have decreased in number. Mountain goats are competitive only in a few localized spots. But the important consideration is that *total* game use appears to have increased substantially on many Salmon River wilderness ranges.

These ranges can support only so much use, and the most desirable means for controlling this use is by hunting. But past public apathy about the seriousness of range deterioration, coupled with indignation concerning supposed "annihilation" hunts, has lessened the effectiveness with which this important management tool has been employed.

Hunting also has been impeded by the character of the Salmon River back country. Much of the region is accessible only by trail

or air travel. Long pack trips are arduous, flying over rugged terrain and landing on short, mountain airstrips is hazardous—and both methods are expensive. Indeed, few people consider a deer worthy of the inconvenience and expense involved to hunt in these remote regions. More hunters will enter the same territory for either elk or bighorn. Both animals are highly desired for meat or trophy.

The question then arises: "What priority should be established where harmful competition exists, or may develop, on key areas of bighorn production?" Before discussing this question it should be stressed that such areas in Idaho are confined principally to the Salmon River drainage between the Middle Fork and South Fork, and along the lower half of the Middle Fork.

Based on hunter preference alone, it seems reasonable that deer should be considered less desirable than elk or bighorn sheep. It is of added importance that deer have the highest requirement for the least abundant class of forage, which is browse. Also, having a relatively wide tolerance for habitat, deer have prospered in many sections of the state where there is easy access for hunters and where elk or bighorn can never be established. Reductions of deer in a few locations would be, therefore, of little consequence to the sum total of deer hunting in Idaho.

The hunting trends witnessed in recent years make it quite apparent that elk can be properly harvested in remote regions if hunting regulations provide ample opportunity for the sportsmen to do so. Unfortunately, elk require more food, furnish less hunting per unit area and usually are more destructive to the range than deer. But, while elk might not be desirable on some easily accessible ranges, they are of major importance as a game animal on the wilderness lands under discussion here. In fact they are, or may become, the foremost competitors of mountain sheep on a large part of these ranges.

Top priority should be given bighorn in their key areas of production. This thinking is based on consideration of their present scarcity, the limited habitat in which they thrive and their desirability, from both material and recreational standpoints. Such priority does not suggest elimination of all other big game. It does mean reducing deer numbers as low as possible through encouraged and directed hunting pressure. It also requires that elk populations should be kept low enough to bring about measurable relief to depleted winter ranges. The resulting combination of reduced competition and revitalized range should tilt the scales sufficiently in favor of the bighorn to encourage healthy increases.

Bighorn have been protected more seasons than hunted since 1910. Following eight years of closed seasons, special hunts for mature rams were held in 1946 and 1947. Twenty-nine sheep were known to be killed on the two hunts. After five more years of closure, another special hunt was held in 1952. This followed nearly three years of study which determined that sheep populations were gradually increasing and there were approximately three rams to every four ewes. Considering the upward population trend and polygamous nature of the animals, it appeared that a carefully controlled hunt of mature rams would not reduce productivity of the herds.

Dates of the 1952 hunt were September 15-25, inclusive. A total of 45 permits were issued for three hunt units, each of which permitted 15 hunters. Location and size of units, and number of permits, were determined on the basis of repeated censuses and the completion of a spring trend count preceding the hunt. Thirteen rams were reported killed by 44 participating hunters. This represents a hunter success of approximately 29 percent.

Another special hunt was held in 1953. Census of additional areas, and data collected from the 1952 hunt, indicated that additional territory could be opened for hunting. The original three hunt units were enlarged and two more units were added. Ten permits were issued for each unit, making a total of 50 permits. Dates for the hunt were September 1-10. Forty-seven participants reported killing 18 rams for a hunter success of 38 percent. Several fine trophy rams were killed. Four had horns measuring 39 inches or more around outside of curl and had basal diameters up to 16 inches. Checking station records show that six additional rams had curls larger than 34 inches.

Lower jaws were collected at special checking stations to aid in determining age classes harvested. Although most of the rams were mature, a few 3 and 4 year olds were killed each year. The minimum limit of "three-quarter or more curl" allows 4 year old rams to be taken, while 3 year olds are in a "borderline" category.

A program of conservative hunts held each year is more desirable than larger harvests held periodically and followed by long closures. It is believed that in this way the game manager can best meet his obligation to permit the hunter, not starvation, disease or other causes to harvest the game resource. Naturally, any positive evidence of detriment to the productive potential of bighorn herds would be grounds for terminating the hunts.

With sheep populations at present levels, only mature rams can be harvested safely. The hunt should be continued on a permit basis in order to control the number of animals removed from any one area. It is important that the season be set early in the fall when the rams are segregated from the ewes and juvenile animals. Both sexes and all age groups begin banding together late in October. Hunting at this time would increase the likelihood of ewes and young being killed, interfere with courtship and breeding activities and be potentially dangerous to herd productivity—and, furthermore, it cannot be overlooked that recreational value is an important part of bighorn management. Such value would be materially lessened by hunting when the animals are concentrated on winter ranges where they can be shot from trails or roads along the river. It should be emphasized that it is not the aim of game management to assure meat or trophies to every hunter but, rather, to offer very fine sport along with reasonable opportunity for success to as many sportsmen as possible.

Trapping and Transplanting

Reintroduction of animals on historic ranges or introducing them into new areas has been accomplished successfully with most big game species. Couey (1953) reports that 16 bighorn were obtained from Colorado's tarryall herd in 1947 and planted on Montana's Fort Peck Game Range. By 1952 the herd had multiplied to an estimated 75 head. Mr. Couey suggests that transplants should not be too small and that it may be advisable to construct release pastures for holding the animals together as a unit until they become acclimated to their new surroundings.

Although transplanting programs have been successful, as pointed out in the Montana studies, this technique for increasing total production should not be applied without careful preliminary investigation. Trapping and transplanting of big game excites the imagination and often gains widespread approval before its worth has been given serious consideration. No record has been found of a bighorn transplant in Idaho. No careful investigation of potential transplant sites have been made. Wholly superficial observations indicate, however, that favorable results might be obtained from transplants on a few historic ranges. Most prominent of these are the Lost River, Seven Devils and Sawtooth mountain ranges.

There are, however, many aspects that should be considered before a transplant site can be adjudged "suitable." It is not enough that the proposed range appears similar to ones currently occupied,

or even that it once harbored healthy bands of sheep. After it has once been determined that general physiographical features are satisfactory, the winter range should receive first consideration. Is the range in good condition and what is its present trend? Is it large enough to support an expanding population? Does it provide the necessary interspersion of grass, cliffs and desirable shrubs? What of the present competition by big game and domestic stock?

If important winter ranges meet these requirements, a similar analysis should be made of summer ranges. And, if they are satisfactory, the survey can go on to more general questions. Are predators abundant and likely to be detrimental in the area? Is the territory relatively undisturbed by man and what are the plans for future industrial or agricultural development? What will be the logical priority among big game animals if undesirable competition develops on the range proposed for transplants—and on adjacent areas to which the sheep may migrate?

A survey should not be concluded without first determining the reactions of local residents to the proposal for introducing bighorn. Will they cooperate in protecting the sheep or is it quite evident that they will contribute to their decline?

Trapping and transplanting should not be discouraged entirely. Well-planned operations may be advisable, but they should be instituted only after adequate studies have been completed. Bighorn trapping in other states has entailed much vain effort and discouragement before success has been attained. In nearly all cases the operation has been costly.

Recent unexpected appearance of mountain sheep in locations far from known herd concentrations indicate that key areas, if developed into habitats capable of producing greater numbers of sheep, might well result in sufficiently large herds to encourage a natural extension of their range. The technique of managing limited areas for the maximum benefit of sheep may be a more practical and inexpensive, if less spectacular, means of increasing total production than by trapping and transplanting.

Preservation of Wilderness Habitat

It is difficult to choose one phase of management as being more important than another. But we may be certain that, if civilization continues its attrition of the remaining tracts of primitive country, all of our scientific knowledge and its specialized techniques may come to nothing. Not only the bighorn's existence, but much of his intrinsic value to man as well, depends upon the pres-

ervation of his habitat. It is more than likely that a hunter's memory of his stately ram is at least equalled by remembrances of mountain peaks, glittering lakes and green, untrampled meadows.

One of our greatest opportunities to aid the bighorn is to work to prevent despoilment of his range. If we can be assured that the primitive areas in central Idaho will remain inviolate by the advance of civilization, we can then turn to research and the application of known principles of game and range management with a feeling of lasting accomplishment.

An important battle will be won if we can assure the bighorn of adequate food and cover and an undiminishing habitat in which to live.

PART II

A Survey of Winter Ranges along the Middle Fork of the Salmon River and on Adjacent Areas

INTRODUCTION

Big game ranges in the Salmon River watershed of central Idaho conform to the usual situation found in northern mountainous regions where quantity, quality and availability of winter forage regulate the number of animals that a range will produce. The condition of soil and vegetation, and trends exhibited by the range as a whole, are measures for determining the total game population which the range can properly support. Knowledge of interspecific competition for food and space is essential to realistic evaluation of the aggregate carrying capacity of the range.

With these thoughts in mind an intensive winter range survey was conducted in key areas of bighorn production along and adjacent to the Middle Fork of the Salmon River. The stated objective, "To determine composition, availability, utilization and abundance of forage on winter range, and to determine trends in range condition," encompassed the habitat of deer, elk and mountain goats as well as bighorn, but was intended to focus special attention on the particular niche occupied by mountain sheep in the common use picture.

Part of the range survey work, such as cover type mapping, will not require further attention to satisfy the immediate purposes of management. On the other hand, investigations initiated to measure range condition, trend and use should be continued for many years. Some of these studies will require yearly attention; others may need only periodic checking through the years, but none should be neglected if we are to know what the range is doing and what we should do for the range.

RANGE CONDITION AND TREND STUDIES

Wise management of the range resources requires more than a precise method for appraising current status. A valid source for drawing conclusions from past history is essential if we are to predict future trends with accuracy. Consequently, the selection of a range study method for use on bighorn winter ranges was influenced by the desire, not only to furnish a basis for present management, but to establish a point of beginning upon which a cumulative history of accurate data can be built.

Trend in Range Conditions as Determined by the 3 Step Method

The principal method employed in the bighorn sheep winter range study was the 3 Step Method for Measuring Trend in Range Condition. This method was developed by Kenneth W. Parker, Division of Range Research, U. S. Forest Service. It has been accepted as the standard method for measuring condition and trend on most national forest ranges in Idaho.

The 3 step method, as the name implies, consists of three major steps. Briefly, they are:

1. Establishment of permanently marked transects and collection of basic field data from these transects and the site within which they are located.
2. Field analysis of these data, classification of condition at time of record and estimation of current range trend.
3. Permanent photographic record of range conditions on the site that is sampled.

Certain additions and omissions, with respect to the 3 step method, were made to comply with the objectives and circumstances of this study. Furthermore, criteria for evaluating both soil and vegetation condition and trend were developed for the specific ranges upon which the method was applied.

Provision was made for the collection of browse form and age class information as suggested by Dasmann (1951). The crown cover afforded by overstory species was measured and all big game pellet groups were recorded along each transect line.

Between July 20 and September 24, 1951, 18 clusters of three 100 foot transects each, and one cluster of two transects were permanently established on key range areas along the lower 50 miles of the Middle Fork of the Salmon River. During the summer of 1952, another cluster of three transects was established on the Middle Fork. A similar cluster was measured on Marco Creek, a tributary of the East Fork of the Salmon River.

FIGURE 26. Employing the 3 step method for measuring trend in range condition.

August 2, 1952

A rock monument, witnessing the point of beginning for the Marco Creek Cluster, can be seen at right in Figure 26. Leaned against the monument is a ½ x ¾ inch angle iron stake used for marking transect ends, and a ½ inch diameter steel rod which will be driven at the 50.5 foot mark on the tape to further mark location of the line. Both types of markers are 36 inches in length. Their tops were dipped in orange paint to increase visibility. The stakes were driven until only nine inches remained above the ground surface. A ⅜ inch section of ¾ inch waterpipe welded to one end was used to take observations along the 100 foot steel tape shown at the center of Figure 26.

Vegetation, litter, bare soil and rocks were recorded whenever they fell within the ¾ inch loop which is plumbed from each foot mark along the transect. Plants were recorded by species and classified as *desirable, intermediate* and *undesirable.* These classifications were based largely on soil holding capabilities, successional status and value as big game forage. Criteria were established and, along with each procedure, were outlined carefully in a completion report submitted at the end of the range survey (Smith, 1953).

All browse plants occurring along the transect lines were classified according to the form and age classes shown below:

Form Classes		Age Classes
1. All available	Little or no hedging	S—Seedling
2. " "	Moderately hedged	Y—Young plant
3. " "	Severely hedged	M—Mature plant
4. Largely available	Little or no hedging	D—Decadent Plant
5. " "	Moderately hedged	
6. " "	Severely hedge	
7. Mostly unavailable		
8. Unavailable		

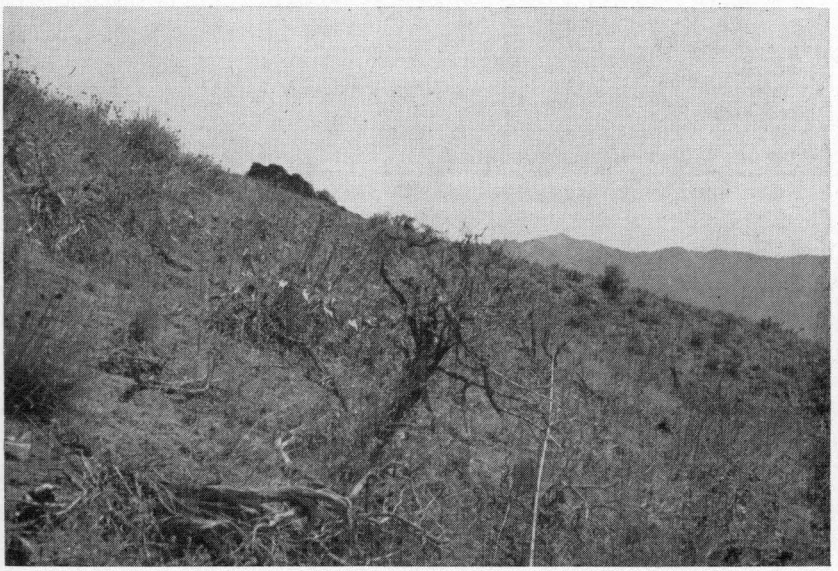
Parker (1951) employed keys to evaluate trends in forage condition and soil stability. When the bighorn winter range survey was initiated, however, insufficient data pertaining to soil characteristics and plant status had been collected from the ranges investigated to warrant construction of keys. Therefore, range trend was determined from general observations recorded at the site of each study plot when the transects were measured. After the field work was completed, information gathered was used to set up tentative standards for determining soil and vegetation condition classes.

A photographic record of each study plot was made at the time the transects were measured. Two photographs were taken from each end of the cluster. The set of four photos taken at each of the 21 cluster sites were filed as a permanent record of

Table 9. Summary of composition of primary forage species as determined by measurement of 21 clusters (sixty-two 100 foot transects) by the 3 step method.

Species	No. of clusters in which species occur	Average composition in clusters where species occur	Variation in composition
		(percent)	(percent)
DESIRABLE SPECIES			
Bluebunch wheatgrass	20	30.7	5.2 to 57.8
Idaho fescue	15	18.4	0.7 to 49.5
Balsamroot	12	13.4	0.6 to 32.2
Bitterbrush	4	8.1	4.5 to 11.9
INTERMEDIATE SPECIES			
Western yarrow	7	3.5	1.6 to 7.3
Lupine	3	2.5	1.3 to 3.9
UNDESIRABLE SPECIES			
Cheatgrass	15	24.5	2.9 to 72.4
Rabbitbrush	8	6.8	1.2 to 25.9
Big sagebrush	7	16.7	5.2 to 63.1

Oblique Close-up



General-type

FIGURE 27. Photographic records for Transect 1, Cluster 9. Bighorn sheep and mule deer fall, winter and spring use has been excessive on this range. The vegetation condition rating for this site, as determined by the 3 step method, is VERY POOR. Soil stability is POOR and the general range trend is "down."

August 11, 1951

the study and will be used for comparison when the work is repeated.

Only limited conclusions can be based upon present data. The principal value of the study will be gained by its continuance over a long period of years. Pertinent information which was collected during the preliminary work is tabulated in Tables 9, 10 and 11 and presented graphically in Figure 28.

The areas represented in the 3 step method studies are not homogeneous with respect to composition, condition or trend. But they are all located in areas that serve a common purpose as winter range for mountain sheep and deer and—to a limited extent—for elk and mountain goats. Cover composition varies widely among clusters as can be seen in Table 9. Nevertheless, the relative importance of important plants is apparent.

Table 10. Summary of form and age classes of primary browse species encountered on sixty-two 100 foot transects.

Species	Total Shrubs	Form Classes[1]						Age Classes[1]				Dead
		(1)	(2)	(3)	(4)	(6)	(7)	(S)	(Y)	(M)	(D)	
Big sagebrush	107	62	24	3	..	..	..	2	19	33	35	18
Rabbitbrush	47	31	7	5	..	..	1	1	13	23	7	3
Forsellesia	32	31	..	..	..	..	1	..	3	23	6	..
Bitterbrush	20	8	..	3	..	..	..	1	..	3	1	1
Bitterbrush	20	8	..	3	..	..	..	1	..	3	1	1
Bitterbrush	20	8	..	3	..	..	..	..	4	2	5	9
Mountain mahogany	6	..	..	2	1	1	1	1	..	3	1	1

[1] See page 110 for explanation of symbols.

A review of form classes in Table 10 reveals that most sagebrush, rabbitbrush and spiny greasebush are not severely hedged, but a glance at the age classes of the same species shows that they are not reproducing well. Large numbers of sagebrush and bitterbrush plants are dead. General observations indicated that overall use of bitterbrush and mountain mahogany was more severe than it appeared from this small sample.

The two species shown in Table 11 were selected to point out the plant succession that appears to be in progress on the ranges studied. Bitterbrush was the most prevalent desirable browse species. Rabbitbrush, a well-known *invader* species, was common.

All 21 clusters studied are analyzed in Figure 28. The fact that cheatgrass was recorded as a "hit" caused some of the averages to be somewhat unrealistic, particularly within the *poor* vegetation class. Cheatgrass was most abundant on the *poor* ranges and exerted maximum influence upon results in that class.

Table 11. A desirable browse species and a common invader plant compared as to favorability of age classes.

	Age Classes							
	FAVORABLE				UNFAVORABLE			
	Seedling	Young	Mature	Subtotal	Decadent	Dead	Subtotal	Total
	(Percent)							
DESIRABLE								
Bitterbrush.....	0	20	10	(30)	25	45	(70)	(**100**)
UNDESIRABLE								
Rabbitbrush....	2.1	27.6	49	(78.7)	14.9	6.4	(21.3)	(**100**)

Inclusion of this annual grass decreased the number of bare soil readings and increased plant density. The average percent *undesirable* species also was increased by measurements of cheatgrass. On ranges classified as *very poor,* even cheatgrass was much reduced. Although recording this undesirable annual as a hit had little effect upon the final classification of condition, it does tend to distort the picture and, when the work is repeated, should be tallied but not considered as contributing to plant density.

"Classification of Plant Species" in Figure 28 lends graphic emphasis to the relationships of desirable and undesirable forage species on ranges of varying conditions.

Figure 28 shows that use, as determined by pellet group counts, was lightest on good ranges and most intense on poor ones. There was, however, a sharp curtailment of use noted on ranges classed as *very poor.* This suggests that, once a range becomes sufficiently depleted, herbivorous animals having free choice will shun it in preference for areas of more abundant forage. This natural reduction of animals on impoverished ranges is vividly portrayed in Figure 28. When it is considered that eight out of 21, or nearly 40 percent, of the areas sampled were rated as very poor, there is cause for concern. It is no more reassuring to note that 10 cluster sites exhibited a downward trend, an equal number were classed as static, and only one was judged to be improving.

Experience gained in the first year of the study, points to a need for certain revisions and additions when the work is repeated. Vigor measurements based on average growth of key perennial grass species should be used as a factor for determining vegetative condition. Damage by trampling should receive additional attention. Disturbance of litter, and soil displacement caused by game movements on loose granitic soils, deserve more consideration than was given in the basic investigation. It would enhance the value

of the work to separate soil and vegetation for trend classification. Range trend was considered as an entity and judged solely on the basis of general observations in the initial survey.

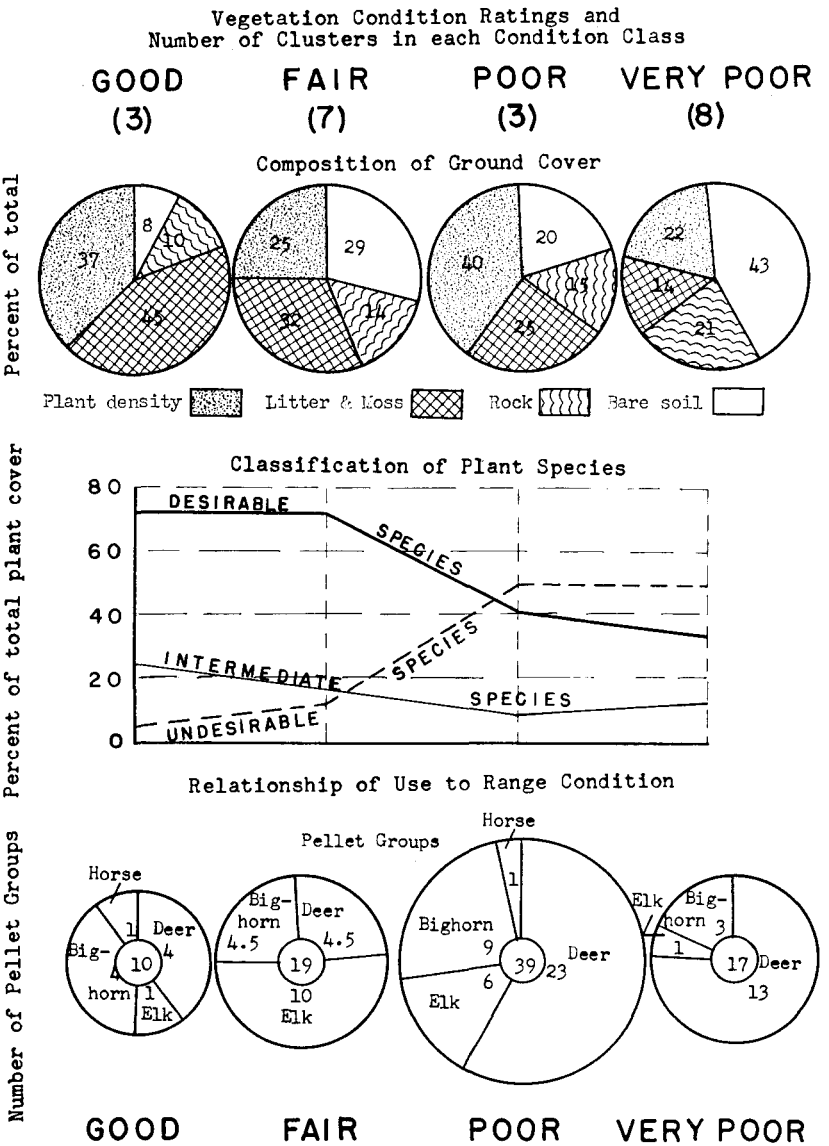


FIGURE 28. Correlation of vegetation condition rating with cover composition, desirability of plants, and use; and presented as averages of the clusters within each condition rating.

It should be stressed that continuance of this study is essential if its maximum value is to be realized. Only the initial phase has been accomplished. Future repetitions of the work will provide the basis for analysis of trends in range condition—trends which may not become apparent for many years. However, there is always the danger that if the study lies dormant for long periods it may die from lack of interest and continuity of effort. Therefore, it is suggested that re-examination of the study plots be made at intervals of not more than five years.

An Analysis of Condition and Trend Through Study of Exclosures

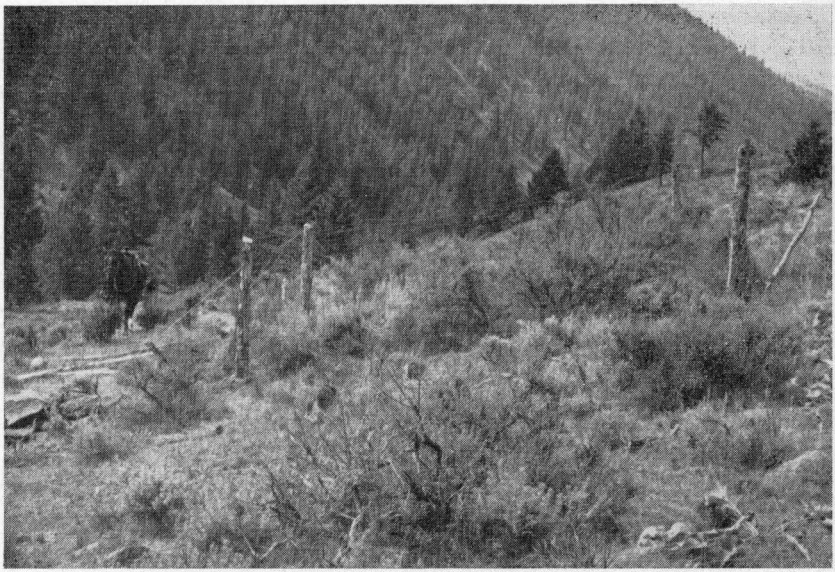
The U.S. Forest Service constructed a 16 foot x 16 foot exclosure on Cow Creek in 1929 and one on Cabin Creek in 1930. See Figure 43 for locations. Woven-wire fences, about seven feet in height, excluded both big game and livestock. An unfenced check plot had been marked by rock monuments on similar sites in the vicinity of each fenced plot.

In the spring of 1931, using a plane table, the crown cover of each browse species was delineated in the exclosures and check plots. Browse seedlings and balsamroot plants also were plotted. General notes were taken regarding vigor and density of grasses, forbs and shrubs.

The original data for these study plots were obtained with the aid of Challis National Forest personnel. Techniques of the initial work were duplicated as nearly as possible in 1952. Crown cover of browse species was charted carefully, as shown in Figures 30 and 31. Browse seedlings and balsamroot plants were plotted and general notes pertaining to the vigor and density of all plants were recorded and compared with the original data.

The most recognizable changes in range condition and trend are shown by Figures 30 and 31. Figure 32 summarizes trends of the four principal species found in the study plots.

Before discussing trends it is necessary to describe two assumptions made when analyzing the data. First, it was assumed that related exclosures and check plots were established on sites which were comparable in vegetative composition and condition. Yet a glance at Figure 32 reveals that the average ground cover afforded by browse when it was first measured in 1931 was about 22 percent on the check plots as compared with 29 percent inside the fenced plots. At this same time, balsamroot was most abundant on the check plots. Check plots in each area have the same site



Cabin Creek Exclosure—established October 27, 1930

Cow Creek Exclosure—established March 23, 1929

FIGURE 29. U. S. Forest Service 16 foot x 16 foot exclosures located within browse types on Middle Fork of the Salmon River winter ranges. The current study is indebted to Arthur Buckingham and Lester T. Gutzman who were the forest rangers in charge of the construction and study of these plots over 20 years ago.

July 26, 1952

characteristics and are separated by only a few hundred feet from their exclosure counterparts. Therefore, it is believed that part of the difference shown between check plots and exclosures in 1931 was because one exclosure had received only one year's protection, while the other had been fenced for two years prior to the 1931 measurements.

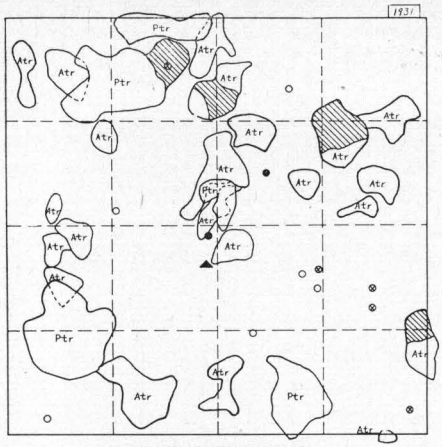
The second assumption involves the ecological classification of big sagebrush. It should be stressed that this shrub is not always an invader species. The history and present ecology of the ranges under consideration suggest that big sagebrush existed in pristine associations and will persist in secondary climax plant communities.

The two major changes related to the shrubs, both in and out of the exclosures are: 1) increase or decrease in number and 2) growth or deterioration of those shrubs present in 1931 which survived until 1952. Numbers of plants present on check plots and exclosures are diagramed in Figure 32. Crown cover of living shrubs was measured from the scale drawings, and percentage of total ground cover was calculated for each shrub as it existed in 1931 and as it appeared in 1952. These percentages then were plotted to indicate trend.

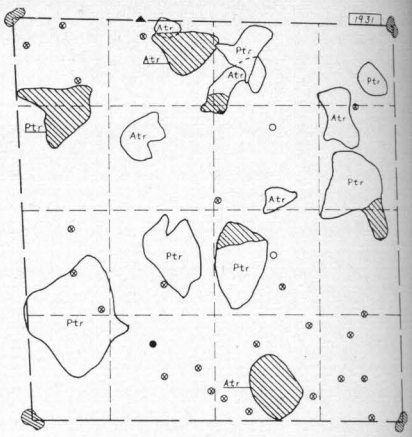
It should be pointed out that the classification *partially dead,* as used in the exclosure study, does not imply that the shrub was necessarily decadent. As a matter of fact, young and vigorous plants frequently have dead portions caused by such factors as browsing injury, rodent girdling and insect damage.

The history of use on the two study sites should be discussed before analyzing vegetation changes. Field notes written in 1929 and 1930 by Forest Rangers Buckingham and Gutzman refer to both areas as having been overgrazed badly by domestic stock prior to that time. Deer use was reported as being very heavy and, since then, has ranged from moderate to heavy. Elk were mentioned as occasional summer visitors but did not winter on Middle Fork ranges until the late 1930s. They are now abundant on both Cabin Creek and Cow Creek. There was light use then, as now, by mountain sheep.

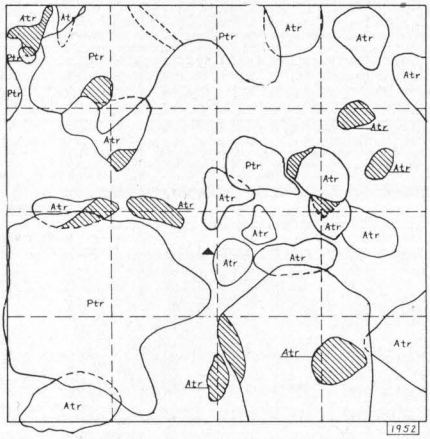
Records of livestock allotments involving both study sites were supplied by the Challis National Forest. The allotment which included the Cow Creek area was cancelled after 1942. At that time grazing was allowed for 23 horses from April 16 to November 15, and seven head of cattle from July 1 to September 30. Cattle and horse use had been quite heavy until 1936. The Cabin Creek allotment was continuing in 1952, with 17 horses being permitted

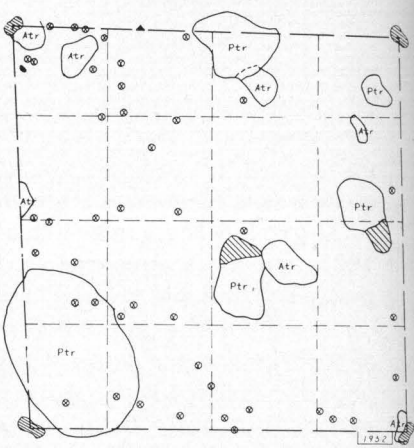


EXCLOSURES



CHECK PLOTS





Exclosure fence

Check plot boundary

Rock monument —corner marker for check plots

Plane table hub

Crown pattern of shrubs

Perimeter of shrubs overstoried by larger plants

Atr Big sagebrush *(Artemisia tridentata)*

Cna Rubber rabbitbrush *(Chrysothamnus nauseosus)*

Ptr Bitterbrush *(Purshia tridentata)*

*— Partially dead shrub (Cow Creek plots only)

Dead portion of shrub (Cabin Creek plots only)

Sagebrush seedling

Rabbitbrush seedling

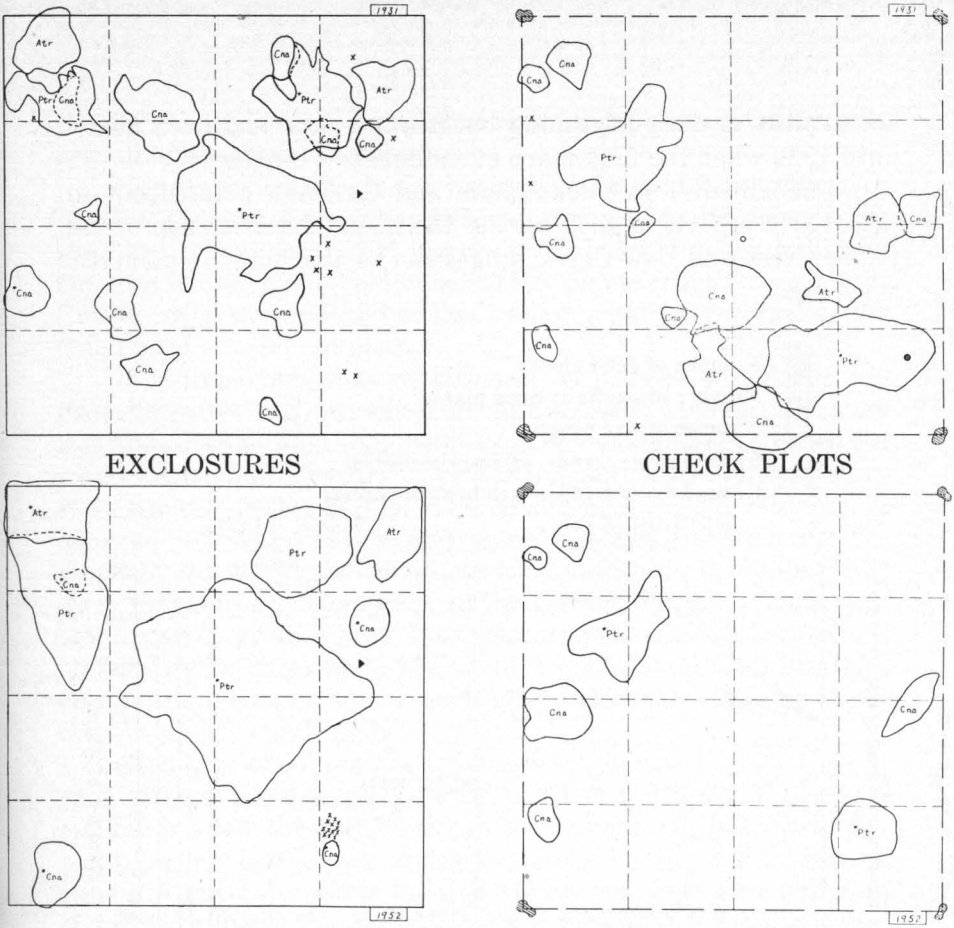
Bitterbrush seedling

Balsamroot plant *(Balsamorhiza sagitatta)*

Scale for all plots (in feet)

0 1 4 8 12 16

FIGURE 30. Cabin Creek study plots. The scale drawings above show crown area of shrubs and location of balsamroot plants and browse seedlings.



Exclosure fence

Check plot boundary

Rock monument —corner marker for check plots

Plane table hub

Crown pattern of shrubs

Perimeter of shrubs overstoried by larger plants

Atr Big sagebrush *(Artemisia tridentata)*

Cna Rubber rabbitbrush *(Chrysothamnus nauseosus)*

Ptr Bitterbrush *(Purshia tridentata)*

*— Partially dead shrub (Cow Creek plots only)

Dead portion of shrub (Cabin Creek plots only)

Sagebrush seedling

Rabbitbrush seedling

Bitterbrush seedling

Balsamroot plant *(Balsamorhiza sagitatta)*

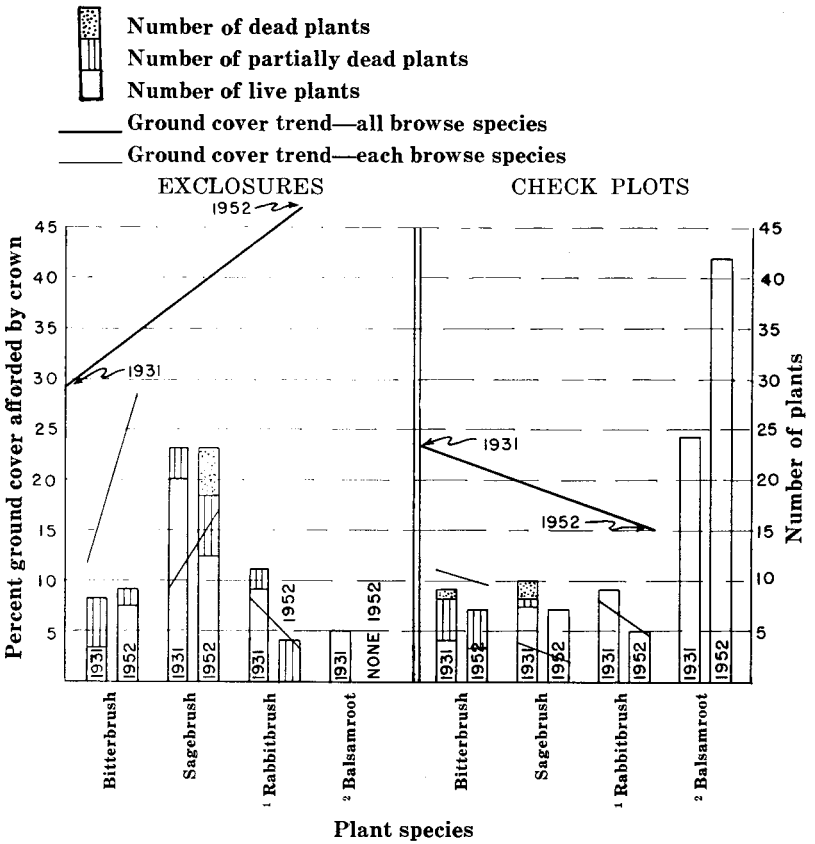
Scale for all plots (in feet)

0 1 4 8 12 16

FIGURE 31. Scale drawings of Cow Creek study plots.

six months grazing beginning on May 16. Use had been heavy until 1926 when the first sharp curtailments were made.

Undoubtedly, as Buckingham and Gutzman pointed out in their early reports, a good part of the initial deterioration of the Cabin Creek and Cow Creek ranges can be attributed to domestic stock use.



[1] Rabbitbrush occurred on Cow Creek study plots only
[2] Balsamroot occurred on Cabin Creek study plots only

FIGURE 32. Vegetation changes that have taken place on the Cabin Creek and Cow Creek exclosures and check plots during the past 21 years.

Inspection of Figure 32 shows that total crown area of living bitterbrush in the exclosures more than doubled from 1931 to 1952, while the number of plants only increased from eight to nine. By way of comparison, bitterbrush in the plots where use was

unrestricted decreased from eight to seven plants and total crown area diminished considerably.

Big sagebrush inside the exclosures declined in numbers of plants. The drop from 23 to 18 shrubs, however, did not prevent the total crown area from increasing by almost a hundred-fold. On unprotected plots the number of live plants remained constant. Crown cover was reduced to less than one-half, a reversal of the trend inside the fenced plots.

It is important that rabbitbrush on both protected and unprotected sites has decreased in numbers and volume; although it is not unusual that this subclimax invader should be crowded out where more than 20 years of protection has fostered a secondary succession of better plants. The condition to which attention is directed is: Where stock and game use was unrestricted, the normally invading rabbitbrush is also diminishing in numbers and size. Balsamroot, found only on the Cow Creek study plots, was eliminated completely from the exclosure while its numbers nearly doubled on the check plot. The trend for all browse cover indicates significant increases in the exclosure and equally important decreases on the check plots.

Seedlings of all browse species present were reported in the exclosures and check plots in 1931. When the plots were re-examined in 1952, the only seedlings were a clump of 13 rabbitbrush plants in the Cow Creek exclosure. However, there were several young bitterbrush plants in both exclosures. Seed production of bitterbrush inside the fenced plots was noticeably superior to that on the less vigorous shrubs occupying adjacent unprotected areas.

Comparison of initial estimates with those made in 1952 points out that there have been marked increases of grasses and forbs within the exclosures but little change on the unprotected sites. Number and volume of shrubs on the ranges studied have decreased gradually during the past 20 years. Volume of browse cover within the exclosures has increased; and this would be encouraging except that numbers of plants have not increased and no desirable seedlings are being established.

The evidence points to a plant succession from browse to grass type under present conditions of use. However, it appears questionable that complete protection will result in a primary restoration of browse cover. The implication of this limited study is that the first manifestation of range recovery will be a vigorous stand of bluebunch wheatgrass, other grasses and forbs.

With most of the winter ranges along the Middle Fork either static or exhibiting a downward trend, there is little opportunity

to observe the characters of an improving range. It would be a valuable contribution to the management of these ranges to go further into the investigation of plant succession and other characteristics on areas receiving total protection from big game. If future management programs enable expansion of such range studies, the exclosures should be at least one acre in size. The "edge effect" and other inadequacies of small exclosures were obvious in the current study.

Results from the observation of additional exclosures might not become apparent for 10 or 20 years, but it is from long-range studies that sound management practices are formulated. Otherwise, management continues to flounder amid the confusion and contradictions that inevitably accompany short-lived, inadequate surveys.

The results of the current study are presented with the realization that the sample was too limited to permit many factual conclusions. If, however, the study succeeds in pointing out the importance of adequate sampling and continuity of effort in long-term investigations it will have served a good purpose.

BROWSE UTILIZATION STUDY

Twig Measurement Method

The principal method employed to determine browse utilization by bighorn sheep and other big game species was the linear measurement of twigs before and after game use. A total of 400 browse plants was tagged and measured on eight sites along the Middle Fork of the Salmon River. See Figure 43 for locations. Measurements were taken in November 1951, before fall use had begun. Re-measurement of the shrubs in the spring of 1952 provided an accurate estimate of the degree of use during the winter. Twenty-two shrubs were lost to the study during the winter through various causes.

Locations for measuring utilization were selected primarily on the basis of the presence of bighorn sheep on the winter range. Each cluster of 50 tagged shrubs was situated where it appeared that past use had been normal for that particular area. An attempt was made to base selection of individual shrubs upon average conditions of availability.

Both current and older growth was measured from attached identification tag to terminal end of branch and recorded to the nearest one-half inch. Growth in addition to the current year's increment was measured because cropping of twigs frequently removes more than annual growth under conditions of heavy use. Failure to recognize this condition would be to predicate faulty conclusions regarding the actual extent of use on the plant in question.

It would have been desirable to confine measurement to the *young* and *mature* classes, and the *all available* and *largely available* form classes. However, this was frequently impossible because of the prevalence of undesirable form and age class shrubs on the study areas. To check accuracy of twig measurements, 104 shrubs showing no use were re-measured in the spring. Plus and minus deviations from the fall measurements indicated that the errors from this source were small and largely compensatory. The cumulative error, about one percent, indicated a slight tendency to get larger measurements in the spring.

Ninety-six percent of all measured bitterbrush plants were browsed. Average use of annual growth was well over 60 percent. Over one-fourth of the measured old growth also was consumed on those plants receiving use.

Mountain mahogany is generally abundant in the vicinity of rock outcroppings and cliffs, and is highly palatable to big game. However, past over-use has resulted in such a large number of hedged, high-lined and decadent plants that the selection of a representative number of suitable shrubs was impossible in most clusters. The extent of use shown in Table 12 implies that mountain mahogany stands, as compared with other important shrubs, have received some respite from severe over-use. This, unfortunately, is not true. Because of the undesirable form and age classes present, many shrubs of doubtful availability were measured in order to obtain a representation of this species. Observations in the spring indicated that mahogany was browsed as heavily as physically possible in most cases. Average utilization of annual growth on browsed plants would undoubtedly have been much higher than 59 percent if the foliage had been available. Even so, over one-half of these plants received more than 60 percent removal of the annual growth and over one-third of the measured old growth was utilized.

Rabbitbrush received the highest average use on browsed plants—72 percent on annual growth and 36 percent on old growth. Over three-fourths of all plants receiving use had more than 60 percent of the current year's growth removed.

Removal of the current growth of sagebrush averaged 66 percent on browsed plants, but only about half of the measured branches were browsed. The tendency to feed upon older growth was not as pronounced as on rabbitbrush.

Spiny greasebush is quite localized, being found largely on the more steep and rocky portions of the range. The fact that six of the nine plants measured received an average use of 71 percent suggests that, where present, this small shrub furnishes significant amounts of food.

Ninebark and syringa received scattered light use. Their general confinement to browse and timber types on the more northerly slopes further reduces their usefulness to mountain sheep, who make only limited use of these slopes in winter. An average of 50 percent of the annual growth was utilized on four of the six chokecherry branches that were measured. This shrub occurs sparsely on most ranges. Otherwise it would be an important source of forage.

Breaking of branches by feeding animals is an important consideration. The more over-populated the range and less available the forage, the more serious becomes this destruction of browse

Table 12: Utilization of browse on Middle Fork of the Salmon River winter ranges during the winter of 1951-52, as shown by linear measurement of twigs.

Species	No. of shrubs	No. of browsed plants		Total length measured		Average utilization, all plants		Average utilization, browsed plants		Browsed plants with over 60 percent use
	**	A	O	A	O	A	O	A	O	A
				(inches)		(percent)		(percent)		(percent)
Bitterbrush	176	168	94	11,652	4,320	62	15	64	27	64
Mountain mahogany	84	66	38	2,898	3,878	46	19	59	34	54
Rabbitbrush	33	26	..	3,687	698	57	14	72	36	77
Big sagebrush	21	11	4	1,481	521	35	4	66	22	73
Golden currant	19	4	2	823	791	5	1	23	13	..
Syringa	16	4	..	828	667	7	..	28	..	..
Western chokecherry	6	4	..	324	206	33	..	50	..	17
Ninebark	6	1	..	296	319	3	..	19	..	..
Spiny greasebush	9	6		617		47		71		83

**In this table A=Annual growth; O=Old growth—that portion between annual growth and identifying tag.

and its capacity to produce. Continued severe cropping increases the brittleness of shrubs and their susceptibility to breakage.

One-half of the 400 browse plants measured for utilization were located in Short Creek drainage, an area of heavy deer and moderate mountain sheep use. The remaining 200 shrubs studied were on ranges in Soldier Creek, Survey Creek and Rattlesnake Creek. Deer and bighorn use is moderate to light on the last three sites named.

Table 13. Comparison of annual growth utilization of principal browse species between a heavily and moderately used range.

Species	Short Creek (a heavily used area)	Soldier-Survey-Rattlesnake (moderately used areas)
	(Av. percent use)	(Av. percent use)
Bitterbrush	62	62
Mountain mahogany	46	46
Rabbitbrush	77	37
Big sagebrush	33	35

Table 13 considers all plants measured, whether receiving use or not, in the calculation of percentages. Bitterbrush and mountain mahogany received the same average use, and sagebrush use was essentially the same on both areas. However, on heavily populated Short Creek the animals readily shifted their browsing to rabbitbrush which received more than double the use on moderately browsed ranges. Results of the utilization study and field observations suggest that rabbitbrush, as a member of browse associations found on Middle Fork ranges, deserves more credit as big game forage than has generally been recognized. It is unfortunate that it is often an indicator of unfavorable range trends.

It should be emphasized at this point that the suppressed condition of browse, particularly bitterbrush and mountain mahogany, often makes it impossible for an animal to browse all of the current growth. A figure of 70 percent utilization, for example, may mean that practically 100 percent of the available browse has been taken. Because of this condition it appears that, while the measured utilization of a stand of desirable shrubs may not appear excessive, the physical difficulty of browsing severely hedged plants may cause the animals to turn to inferior species where current growth is readily available.

If we accept the criteria suggested by many range specialists —that utilization of most browse species should not exceed 60 percent of annual growth if plants are to remain healthy—it is

manifest that winter ranges studied on the Middle Fork of the Salmon River are receiving excessive use. Form and age classes of important browse species are over-balanced in favor of decadent and unavailable individuals. Reproduction of the more valuable plants is almost nil and large segments of valuable bitterbrush stands are dying out. A high percentage of desirable browse plants are receiving use in excess of 60 percent of annual growth. Observations of this investigation and range study records kept by Challis and Salmon National Forest offices add concurrence that continued utilization at this level is decidedly detrimental to bitterbrush and mountain mahogany stands.

Visual evidence from exclosures, reports by range technicians and good common sense tell us that protection from use is an important aid to browse recovery.

But, we ask, how much is it necessary to curtail use? Murie (1951, pp. 301-302) says, "When a class of forage has been reduced virtually to the point of extermination, even any elk at all, so to speak, will tend to keep it at that point and prevent recovery." This maxim applies to use by any browsing animal and merits thoughtful consideration by those responsible for the management of over-used ranges.

Present information does not provide us with a yardstick for measuring the degree of utilization that will permit browse regeneration. Again the words of Dr. Murie accurately describe the situation here when he states (p. 301), "So far there is no answer. It must be sought on a trial basis."

It is to be hoped that informed public opinion and thoughtful administrative decisions will permit the setting aside of appropriate game management units where use can be gradually restricted until: 1) the browse recovers or 2) it is proven that a plant succession is underway which cannot be halted by simply manipulating game populations. Perhaps the answer to deteriorated browse stands will be found in the area of artificial plant propagation. In any event, it will be deplorable if a policy of producing "the most game for the most hunters" is followed without careful consideration of how long a high yield can be maintained.

The degree and effect of big game utilization of key forage species should continue to be analyzed through the use of the twig measurement method. It is suggested that a growth index be employed to evaluate relationships between volume produced and amount consumed. The average twig length for each species should be computed yearly as an index of the quantity of forage produced. Differences in precipitation and other climatic conditions influence

the annual production of forage and this must be taken into consideration if utilization measurements are to be applied realistically as a factor for determining carrying capacity.

Availability—and Its Importance to Utilization

Although snow is commonly thought of as the principal deterrent to utilization, there are several other reasons why palatable plants may escape use. The more important factors influencing availability are portrayed in Figures 33 to 37.

FIGURE 33. This western chokecherry has been severely cropped or "hedged" by deer. All of the current growth has been removed as well as many of the older stems up to one-half inch in diameter. Another type of hedging, perhaps most common to mountain mahogany, usually does not represent total consumption of annual growth as above. Nevertheless, the mechanical obstruction presented by the stubby, cropped twigs effectively shields remaining annual growth from further use.

March 25, 1951

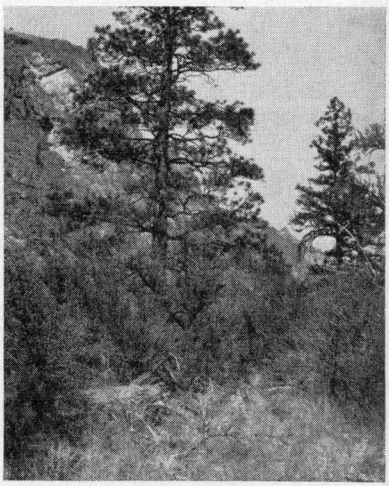


FIGURE 34. It is difficult to visualize this healthy, vigorous mountain mahogany stand as being "unavailable"; yet it is essentially that. Only 200 yards away, this species is receiving moderate use by deer and bighorn sheep. None of the shrubs above received use during the last winter and their appearance indicates that they may never have been browsed by big game. This aversion to accessible areas which, to man appear wholly desirable, is an often unaccountable characteristic of animals in the wild.

September 17, 1951

FIGURE 35. This picture was taken from the same position as Figure 27, only now the ground is covered with 15 inches of snow and much of the shrubbery, along with grasses and forbs, is relatively unavailable. Snow was 12 to 18 inches deep on this range for more than two months during the winter of 1951-52.

February 27, 1952

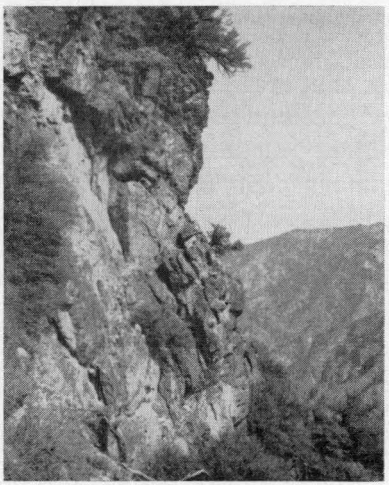


FIGURE 36. This ledge and cliff, 1,000 feet above the river, is sprinkled with healthy mountain mahogany; yet no use is being made of these shrubs. Thousands of acres of good forage are denied big game because of this type of unavailability. September 19, 1951

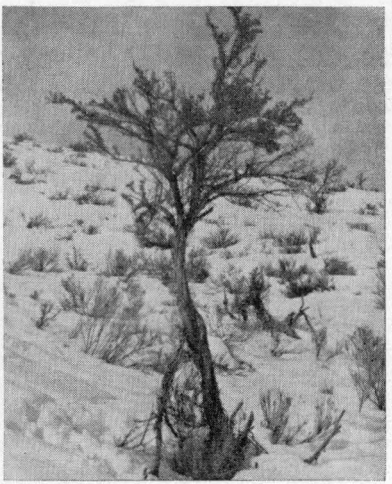


FIGURE 37. This bitterbrush is an example of "highlining." Vigorous twigs in the crown are totally unavailable to the deer and bighorn sheep that occupy the range. February 3, 1952

Use of Browse by Species Other Than Big Game

There are numerous ranges within the Salmon River drainage that have been seriously depleted because of past over-use by cattle, horses and domestic sheep. Ranges included within the boundaries of the cover type map, Figure 43, have been subjected to a lesser amount of abuse; although early records are so fragmentary that accurate analysis of cause and effect is impossible.

In 1952, only three habitations were located within the 56,510 acres of cover mapped during this survey. Two horses were owned by these three families. Five ranches are located adjacent to this intensively studied area and, in 1952, they were not running more than 75 head of horses. The greatest stock use is by transient riding and pack stock associated with fishing and hunting parties. This use is limited primarily to the vicinity of camp sites and headquarters for pack outfits. For the most part, little can be done to alleviate unsatisfactory range conditions occasioned by such use. It must be recognized that lack of access roads necessitates the extensive use of pack and riding stock if the wildlife is to be properly harvested.

The importance of rodent damage is based only upon field observations during this study and not upon detailed investigative procedures. From the standpoint of ill effects to the revegetation of primary browse species, it appears that small rodents are most harmful. White-footed mice, meadow mice and pocket gophers are among the small rodents present. They consume aerial portions of herbaceous plants, but their primary destructiveness is the girdling of roots. In addition, quantities of viable seeds falling to the ground are either eaten or cached by mice.

Ground squirrels are scattered throughout the range and occasionally reach sufficient proportions to seriously disturb the ground cover by their burrowing activities. Marmots are common on rocky sites. Snowshoe rabbits are scarce, while cottontail rabbits may be locally abundant. Wood rats inhabit cliffs and rock outcroppings. The importance of the rodents mentioned above is confined principally to their consumption of the aerial portions of shrubs, forbs and grasses. Browse utilization studies along the Middle Fork indicate that rodent use of key forage shrubs is slight.

The relationship of insects to health and vigor of vegetation is important and complex; and would require detailed investigation to thoroughly interpret. Therefore, only apparent evidence of insect damage is included here. The following discussion refers

specifically to the summer of 1951 when insect damage was particularly severe on Middle Fork ranges.

Scattered communities of tent caterpillars were noted on bitterbrush stands, but the most spectacular evidence was on chokecherry. Entire slopes were dotted with shrubs that were virtually covered with caterpillars. Leaves would be stripped, leaving the fruits to wither and fall to the ground.

Grasshopper damage was severe in 1951. Especially damaging attacks were noted on elderberry and balsamroot. Cicada exoskeletons were found in a few places and their utilization of the foliage of Haplopappus and bitterbrush was recorded. The insect damages reported here refer only to seasonal loss of foliage and not to some permanent damages which appear to have taken place.

COVER TYPE MAPPING

It is basic to intensive management to know the area and type of habitat that supports the game population. In order to give perspective to otherwise disassembled phases of the range survey, a cover type map was prepared for ranges along the lower 30 miles of the Middle Fork of the Salmon River and on areas adjacent to its mouth. Most of the field work was accomplished during the summer of 1951.

Vegetation cover types were divided into five major classes. They are: *Open timber, browse, cliff, open grass* and *waste.* In some cases, as with *open grass,* these arbitrarily chosen type classifications appear to correspond with Daubenmire's (1952) definition of a "plant association." But this does not apply in all instances. For example, many areas typed as *cliffs* may consist of sev-

FIGURE 38. An example of the complex interspersion of cover types found on Middle Fork winter ranges. The foreground is occupied by an open grass type with a scattering of sagebrush and rabbitbrush. The upper and center background typifies the browse class. An alluvial fan, lower left, supports a stand of open timber, while the area at the extreme upper left assumes characteristics of the cliff type. To avoid a refinement more detailed than warranted by the objectives and methods of this investigation, 20 acres was established as the minimum unit to be considered for mapping purposes. No one cover type represented above exceeds 20 acres so, despite the obvious lack of homogeneity, the dominant association of browse was the class recognized.

August 19, 1951

eral associations. Such inconsistencies with Daubenmire's widely accepted system of classification are justified on the basis of the initial purpose of this mapping project; namely, to evaluate big game use in different types of habitat.

In most instances the cover types mapped were *seral,* or temporary, rather than climax in condition. Some *open timber* stands are occupied primarily by mature and over-age timber species, with younger age classes absent or scarce. The history of plant succession, as reconstructed by plant ecologists, indicates that such areas may, in time, assume the characteristics of *browse* or *open grass* types. Many *browse* stands not only are failing to reproduce but are further deteriorating from the combined effects of overuse, insect and rodent damage and other factors. It is quite possible that these types will eventually appear as *open grass.* On the other hand, there are grassy areas where abuse of the range is fostering encroachment by such browse plants as sagebrush and rabbitbrush.

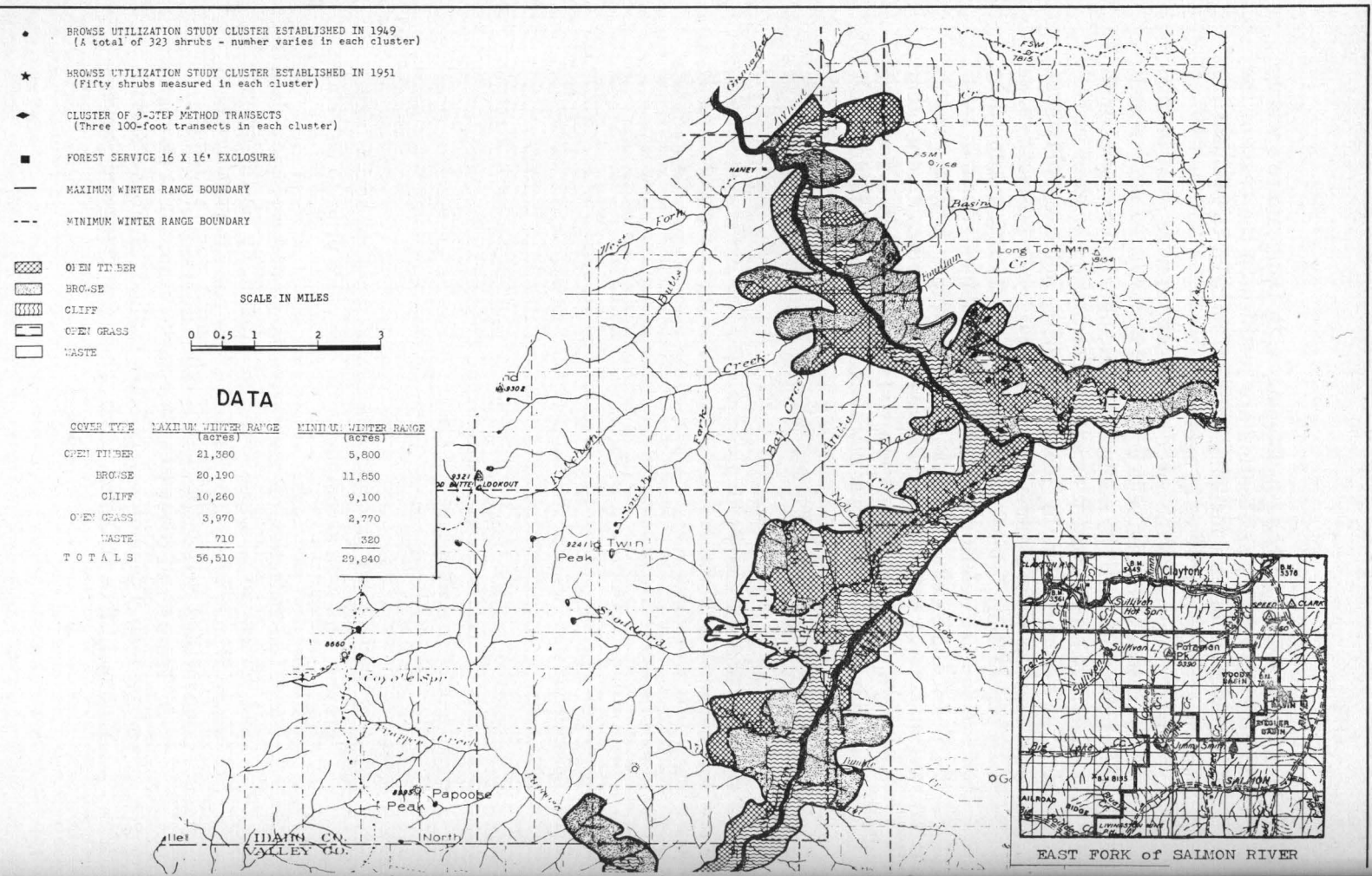
Methods

The bulk of the ranges involved in this study are in isolated territory far from roads, or in some cases, trails. Transportation was often difficult. This resulted in equipment and supplies being limited to bare essentials, a requirement that fostered some techniques more crude than normally used in range survey work.

A rubber boat proved to the most satisfactory mode of transportation through the study area. Supplies, equipment and 200 pound boat were transported by pack string from Meyer's Cove to the mouth of Camas Creek, a distance of 16 miles. Here the boat was launched for the trip to the mouth of the Middle Fork. Most of the range inspection was made on foot, though it was possible to make limited use of horses.

The principal steps required to develop the cover type maps were as follows:

1. Delineation of vegetation cover types on aerial photographs. This was accomplished in the office prior to entering the field.
2. Field collection of qualitative range and ecological data and correction of those type lines found, by on-the-ground observations, to be inaccurate. Areas not sampled by the 3 step method were meandered through on foot or horseback.
3. Transfer of cover type boundaries from aerial photos to a base map. The photos were taken to the U. S. Forest Service Regional Office at Ogden, Utah, where the Maps and Surveys


BROWSE UTILIZATION STUDY CLUSTER ESTABLISHED IN 1949
(A total of 323 shrubs - number varies in each cluster)
BROWSE UTILIZATION STUDY CLUSTER ESTABLISHED IN 1951
(Fifty shrubs measured in each cluster)
CLUSTER OF 3-STEP METHOD TRANSECTS
(Three 100-foot transects in each cluster)
FOREST SERVICE 16 X 16' EXCLOSURE
MAXIMUM WINTER RANGE BOUNDARY
MINIMUM WINTER RANGE BOUNDARY
OPEN TIMBER
BROWSE
CLIFF
OPEN GRASS
WASTE
SCALE IN MILES
0 0.5 1 2 3
DATA
COVER TYPE | MAXIMUM WINTER RANGE (acres) | MINIMUM WINTER RANGE (acres)
OPEN TIMBER | 21,380 | 5,800
BROWSE | 20,190 | 11,650
CLIFF | 10,260 | 9,100
OPEN GRASS | 3,970 | 2,770
WASTE | 710 | 320
TOTALS | 56,510 | 29,840
Long Tom Mtn
Twin Peak
Papoose Peak
Coyote Spr.
Trapper Creek
Clayton
Sullivan Hot Spr.
Sullivan L.
Potzman Pk.
Jimmy Smith
SALMON
EAST FORK of SALMON RIVER

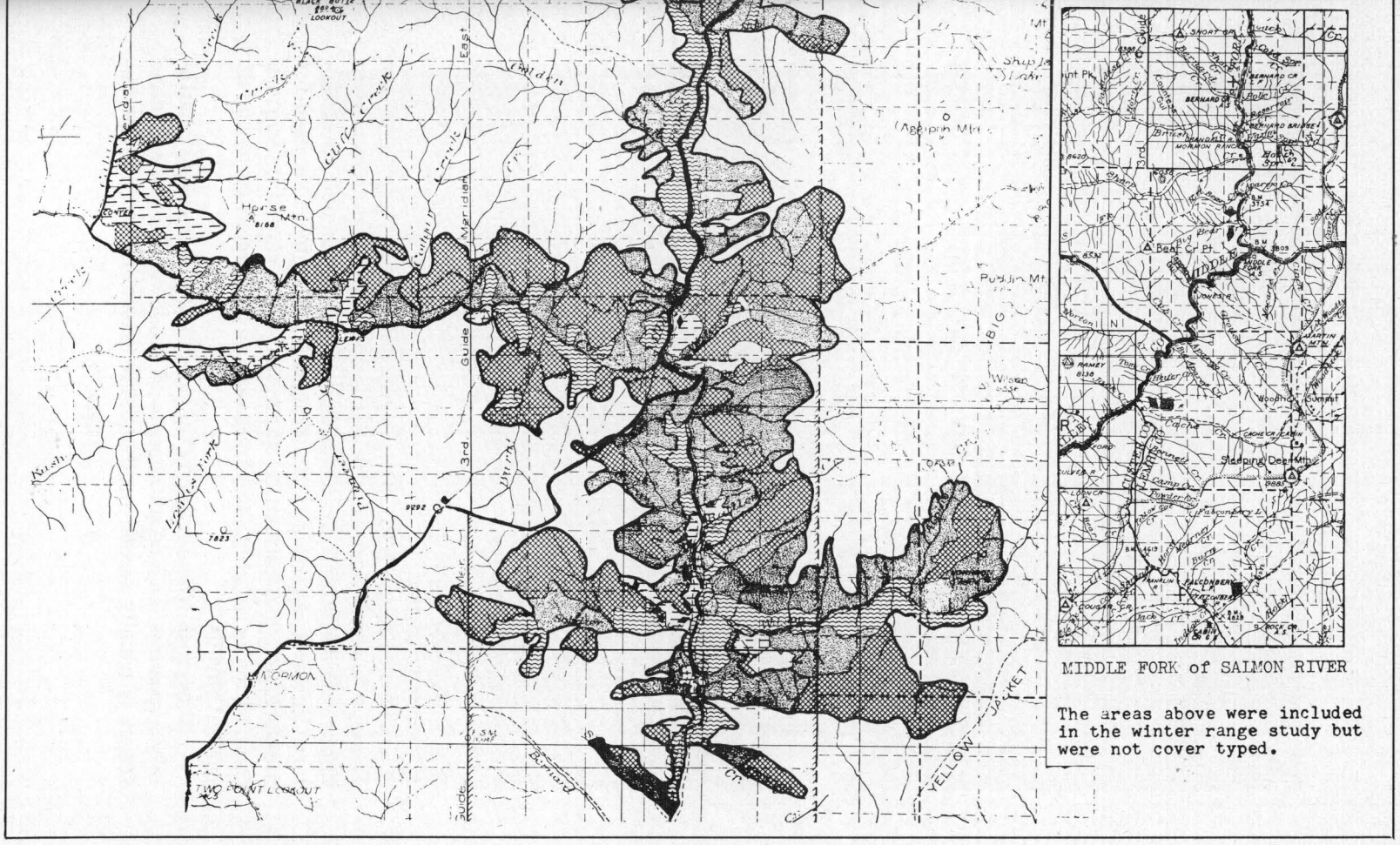


FIGURE 39. Cover type map of bighorn winter range along the lower Middle Fork of the Salmon River and on areas adjacent to its mouth.

Section of the Engineering Division furnished specialized equipment and technical assistance.

4. Determination of minimum and maximum winter range. After considering known elevations, measured snow depths and observations of winter feeding by bighorn; and after analyzing browse utilization studies and such factors as slope, exposure and cover type, a boundary was drawn along what was considered available habitat during severe winters (minimum range). Since the intensive survey was conducted during a relatively severe winter, some of the above criteria were lacking for establishing amount of usable habitat on a mild winter (maximum range). However, distribution of pellets and indications of past browse use gave a fairly accurate idea of the areas used.

5. Calculations of total area for each cover type. After the map was completed, a grid-type "acreage calculator" was employed to measure each cover type unit to the nearest 10 acres.

The descriptions that follow are based upon data collected from 3 step method transects, line interception measurements and ocular reconnaissance observations. The forage plants discussed are species that have been recorded on the ranges visited during the current study. Although a complete inventory of the flora is not given, the major forage species have been included.

Open Timber Type

Bighorn sheep use during the period when the ground is snow-covered is lighter in open timber than any other cover type. However, sheep that occupy low ranges during the summer tend to forage under open stands of timber. A short period in early autumn also finds them using the timber type freely, particularly on shady north-facing slopes.

The only noteworthy trees found in the open timber type are Douglas fir and ponderosa pine. Composition of understory species alters with variations in elevation, exposure, slope and other factors. However, analysis of the results from all methods used for measurement and estimation show that the average understory composition is roughly: 45 percent grass, 25 percent forbs and 30 percent shrubs.

Bluebunch wheatgrass is the dominant grass on most southerly exposures, and on all aspects at the lower elevations. Idaho fescue is usually second in abundance, assuming its greatest im-

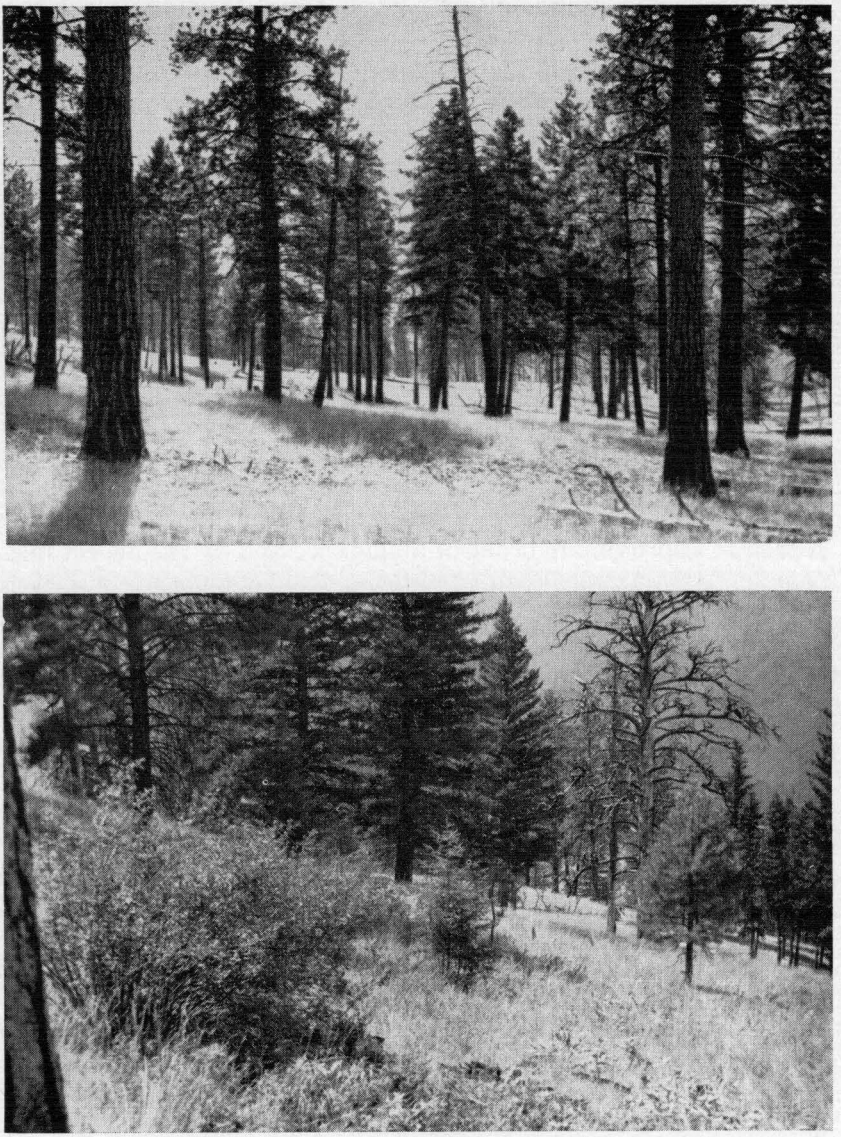


FIGURE 40. OPEN TIMBER cover type. Habitats shown are about equally favorable to the requirements of mountain sheep. (UPPER) An even-aged stand of ponderosa pine. Undercover species are principally grasses, a few forbs and occasional shrubs.

September 18, 1951

(LOWER) An uneven-age stand dominated by Douglas fir. Undercover species present under ponderosa pine may be included here, but shrubs are usually of more importance. Dominance of all vegetation favors species adaptable to moister sites.

August 18, 1951

portance within the shade pattern of trees, on northerly slopes and at higher elevations. At times it may predominate over wheatgrass. Pinegrass is a common, sometimes dominant, grass near the upper limits of the winter range. It may also be found at elevations of 4,000 feet or less on northerly slopes which are abundantly covered with timber. Sandberg's bluegrass is scattered throughout the winter range, usually occuring where wheatgrass is dominant. Junegrass and elk sedge are extremely spotty in occurrence and are most abundant on north-facing sites. Cheatgrass is present on sites which have been mistreated. It occurs in bedgrounds, along trails, and on areas of general over-use as a remnant of abuse so historical that other indicators are scarcely recognizable.

A list of all forbs identified in the open timber type would be lengthy, but important plants are not overly numerous. Balsamroot is the most valuable and abundant. It is distributed widely but is most common on south-facing slopes. The following forbs are presented in approximate order of abundance and by the aspect most commonly supporting them.

Southerly exposures: Western yarrow, lupine, Eriogonum, hawkweed and goat's beard.

Northerly exposures: Pea vine, Erigeron, gromwell, long-plumed avens and western wood strawberry.

Though total density may be less, a greater variety of shrubs flourish under stands of open timber than in any other cover type. Most shrubs exhibit some preference for certain soil and microclimatic conditions. On southerly exposures sagebrush, rabbitbrush, bitterbrush* and mountain mahogany are present, usually in that order. Shrubs are more abundant on north-facing slopes where the stand is closer and Douglas fir is the dominant tree. Composition varies greatly but the following shrubs are typical of northerly aspects: Ninebark, snowberry, serviceberry, white spirea and barberry.

Spiny greasebush, syringa, golden currant, western chokecherry, Gooding's gooseberry, elderberry and snowbrush are ubiquitous with respect to exposure. The following species are frequently scattered on moist sites and along streambeds: Willow, alder, Red Osier dogwood and quaking aspen.

Browse Type

Mountain sheep use per acre was found to be lighter in browse

*Bitterbrush occurs along the Middle Fork of the Salmon River above Big Creek. Below Big Creek it is virtually absent from the native flora.

FIGURE 41. BROWSE cover type. Quantitative data are lacking for a valid comparison of the habitats shown. However, qualitative analyses indicate that ranges similar to the one in the lower photo furnish the most forage to bighorn. (UPPER) This stand of browse receives light use by bighorn but is heavily browsed by deer. Low density of grass and forbs and depleted condition of browse are factors reducing its value for sheep.

July 27, 1952

(LOWER) Excellent interspersion of grass, shrubs and rocks creates a favorable habitat for mountain sheep. Use on browse is heavy but generally not severe.

September 21, 1951

associations than on other types. This is due largely to the bighorn's preference for grasses and forbs, and the limited period that they occupy this cover type. Unless browse habitat is adjacent to open grass or cliffs, or is liberally dotted with rock outcroppings, its value is restricted. Nevertheless, the browse type is important. It constitutes 40 percent of the minimum winter range and furnished 30 percent of the foraging observed during the study. Some use has been noted during late fall rutting and on south slopes in early spring when the bighorn are eager to abandon snow-covered areas for any spot of bare ground. Peak importance accrues to this type, however, during the critical winter months when snow covers grasses and forbs, forcing the sheep to increase their consumption of browse. Based on percentages, the three major forage classes can be divided approximately as follows: Grass, 30; forbs, 30; and shrubs, 40.

Species requiring conditions provided by an overstory of trees are confined largely to northern exposures or are absent entirely. Pinegrass and elk sedge, for example, either occur rarely or not at all in those areas typed as browse.

Shrubs favoring semi-desert conditions achieve general dominance, with spiny greasebush, sagebrush and rabbitbrush being the most abundant. Mountain mahogany, and bitterbrush within its habitat, follow closely. Those plants described as ubiquitous on open timber ranges have equally wide distribution in browse associations. Shrubs listed under open timber as being especially adapted to northerly exposures or moist sites are often lacking in the browse type.

Cliff Type

Perhaps the greatest importance of cliffs to bighorn sheep is the provision of suitable habitat for lambing. Shortly after the snow has melted, the sheep begin moving into cliffy terrain. The rams remain only a few weeks, then move to higher summer pastures. But the ewes stay on and begin lambing about mid-May. It is frequently past July 1 before they leave the protection of the cliffs. Again in the fall, cliffs come in for a share of use as the animals move restlessly about after returning from summer pasture. Use of the more precipitous escarpments is negligible during mid-winter; although the writer has witnessed the rather alarming spectacle of sheep making their precarious way along narrow, snow-covered ledges to nibble at vegetation clinging there.

About one-half of the plant cover is composed of shrubs while the approximate percentages of grass and forbs are 30 and 20,

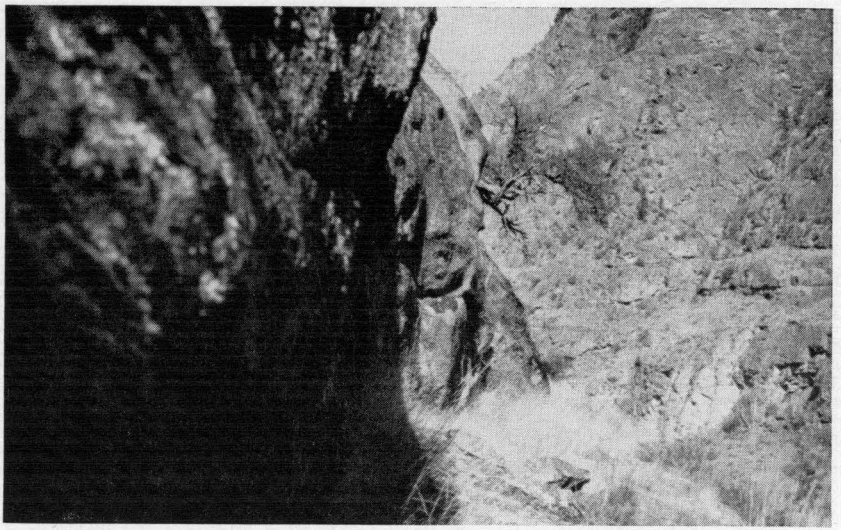


FIGURE 42. CLIFF cover type. Fortunately, low-value ranges like the one pictured at the top of this page form a minority of this type. (UPPER) These rocky escarpments rise sharply on either side of the river. Small crevices and narrow ledges furnish a small amount of forage but a large part of the shrubs, grasses and forbs clinging to these steep walls are inaccessible even to sheep.

September 19, 1951

(LOWER) This range slopes obliquely from the river. Small benches and soil-covered extrusions and gulleys are contiguous to cliffs and barren rock and are inhabited by a variety of plants. This type of country is favored as a lambing ground.

July 27, 1951

respectively. Sparse vegetation and inaccessibility are important deterrents to big game use. Plant densities of less than 10 percent are not uncommon.

Some differences are noticeable in plant occurrence and distribution, as compared with browse or open timber. Cheatgrass and balsamroot usually are less abundant, perhaps because of less trampling and reduced seed dissemination between widely separated ledges. Bitterbrush, sagebrush and rabbitbrush also find conditions unfavorable for development, though they often are present in limited numbers. Mountain mahogany, spiny greasebush and Gooding's gooseberry, in that order, are important shrubs. The steepness of some northerly aspects simulates the effect of a shading overstory and results in the frequent occurrence of those shrubs listed as being associated with moist sites and north-facing slopes under open timber. Mosses and lichens reach their best development in the cliff type.

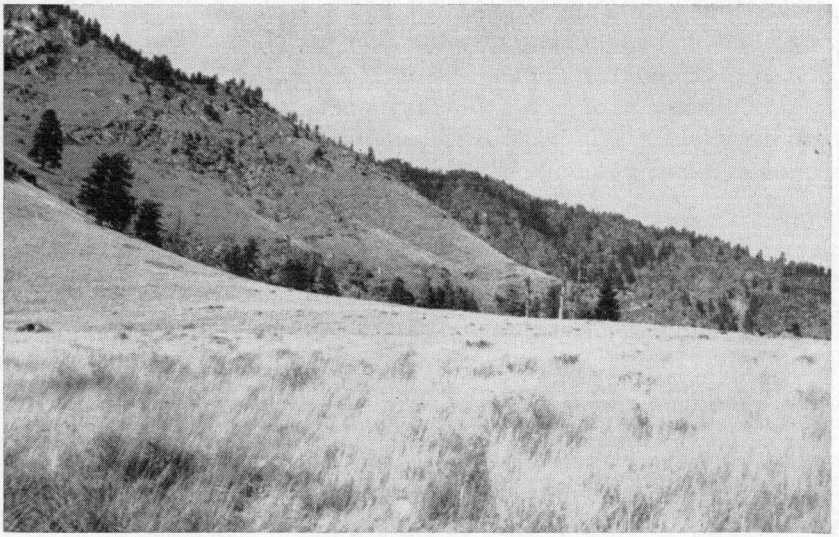
Open Grass Type

The smallest yet most important cover type is open grass. It occupies only seven percent of the total area mapped but furnished 24 percent of observed feeding by bighorn.

Most grass ranges are situated on southerly exposures where slopes tend to be relatively gentle. The estimated composition of major forage classes is: Grass—60 percent; forbs—30 percent; and shrubs—10 percent.

Many factors combine to accentuate the importance of this type. Being largely southerly in exposure and lying at such an angle of repose as to receive maximum benefit of the sun, many of these slopes are the first to "bare-up" in the spring. Late March and early April of an average season finds mountain sheep congregated almost exclusively upon open south-facing slopes. After lambing among the cliffs, ewes often lead their offspring onto grassy slopes for brief feeding periods. Considerable feeding has been observed at times when up to 18 inches of snow covered the ground. During the infrequent instances when snow accumulates to that depth, open grass may be less important than adjacent browse areas.

After the cover type map was completed, and compared with known herd locations, it became apparent that open grass ranges were focal points in the winter habitat of major bighorn herds. Two of the largest wintering populations are at Soldier Creek and Stoddard Creek. Lesser herds winter near the mouth of Rattle-



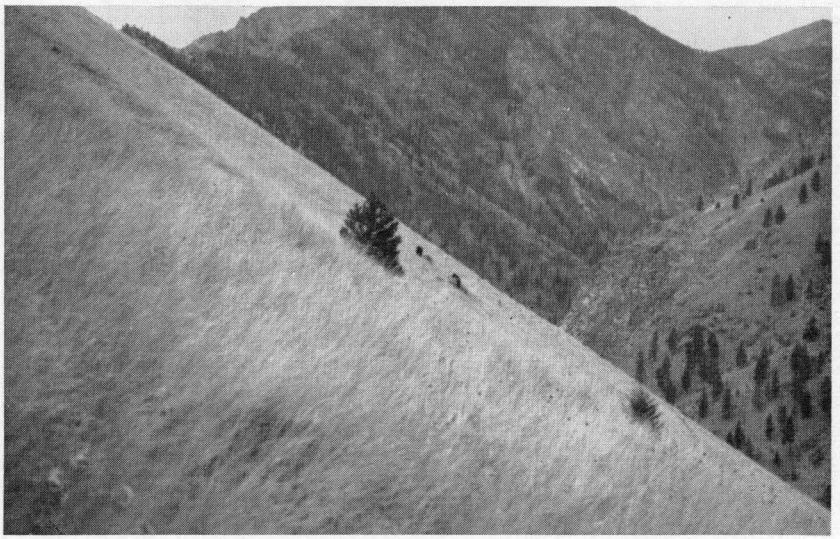


FIGURE 43. OPEN GRASS cover type. The specific habitat requirements exhibited by bighorn favors the range pictured at top of page.

(UPPER) This wide bench is flecked with sagebrush and rabbitbrush but grasses and forbs dominate. The exposure is southerly.

September 24, 1951

(LOWER) Except for balsamroot and a few minor forbs, this is a nearly pure stand of grass. Volume of forage produced is high but use is unexpectedly moderate. Absence of browse limits deer use, and the northerly aspect may be a deterrent to sheep who prefer south-facing slopes during the winter.

September 10, 1951

snake, Waterfall and Cliff Creeks, and in Cramer Basin. A glance at the cover type map shows the correlation between open grass and winter concentrations.

Composition of grass and forb species conform quite well to the description presented under open timber. Shrubs are sometimes present, but only in limited numbers.

Waste

The two principal conditions resulting in a classification of waste are: 1) complete inaccessibility under winter conditions and 2) heavy stands of timber at all elevations.

Only 710 acres were classified as waste within the maximum and minimum winter range boundaries. Waste regions outside these boundaries were not mapped.

Summary—Cover Type Mapping

In the course of mapping Middle Fork winter ranges, total acreage of each cover type was calculated and the boundaries of minimum and maximum winter range determined as accurately as the techniques of this survey permitted. See Figure 44 for total area of each cover type. Descriptions of each type included a listing of the major plants and a general account of use by bighorn sheep. But interpretation of this information in terms of importance to big game requires a more specific evaluation of cover types.

The carrying capacity of a range is limited ultimately to those wintering grounds providing forage during severe winters. Therefore, only minimum winter range is analyzed in the following discussion. First, let us consider only mountain sheep. The bighorn population wintering on the ranges mapped in Figure 43 was carefully estimated to be 680 head in 1952. The number of acres available for each mountain sheep can be determined by dividing acreage of each type by 680. It is quite apparent, however, that an acre in the browse type does not furnish the same amount of desired and available forage as an acre of open grass.

In order to calculate the importance of each cover type, a compilation was made of the vegetation type being used each time sheep were observed feeding. A total of 304 observations were recorded of bighorn feeding within the confines of the minimum winter ranges. For this purpose one observation might consist of one animal or a group. Numbers of observations and their conversion to percentage use, by cover types, are shown in Table 14.

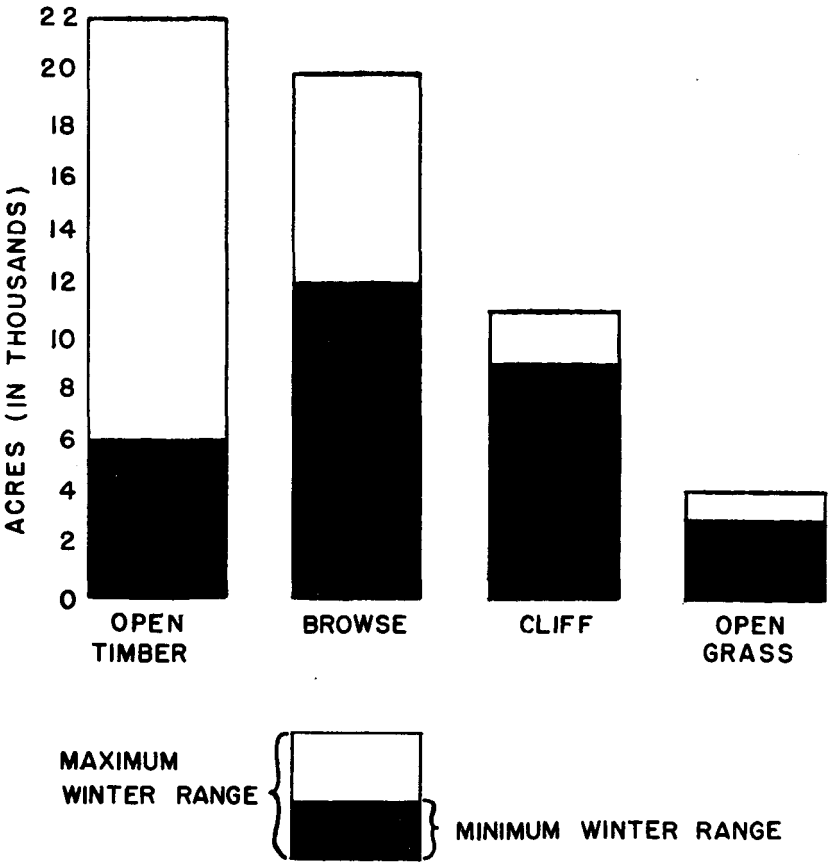


FIGURE 44. Classification of 55,800 acres of usable bighorn winter range.

Based on data presented in Table 14, there are 43.4 acres of minimum winter range available for each sheep. During open winters an additional 26,280 acres, or 38.7 acres per bighorn, is estimated to be available.

A means of comparing importance, on minimum winter range, of the arbitrarily selected cover types recognized in this study is to calculate the number of days bighorn use per acre for each cover type. The approximate period that bighorn spend on minimum winter range is from November 15 to May 15. This is a total of 180 days.

Calculated on the basis of percent of observed use and number of acres of each cover type, bighorn days per acre are: Open timber, 3.8; browse, 3.1; cliff, 3.8 and open grass 10.6.

Table 14. Relationship of cover types to area and use as determined by the number of times bighorn sheep were observed feeding on each type. (Minimum winter range only)

Cover Type	No. of acres	Percent of Total area	No. of observations	Percent of observed use	Actual acres available per bighorn (Col. 1 ÷ 680)
Open Timber	5,800	20	55	18	8.5
Browse	11,850	40	92	30	17.4
Cliff	9,100	31	85	28	13.4
Open Grass	2,770	9	72	24	4.1
TOTALS	29,520	100	304	100	43.4

This indicates that an acre of open grass receives roughly three times more use than an acre in any of the other cover classifications. It is important, however, to note that even during severe winters the concentration of bighorn on these ranges would be considered light by almost any standards.

It is apparent also that this method for analyzing use is subject to errors. However, the fact that the cover types considered are quite large, never less than 20 acres and usually more than 100 acres, eliminates some of the variability that would be caused by such factors as time of day, weather, season and disturbance by an observer.

Although preference of mountain sheep for grass and forbs reduces competition with other big game, there is common use on many species of forage. This must be considered when analyzing carrying capacity of the range for sheep. It is estimated that approximately 1,000 elk, 3,000 deer and 200 mountain goats spend at least part of the winter within the boundaries of the 55,800 acres mapped as maximum winter range.

Elk, for the most part, winter in basins and along open, timbered ridges above the habitat classed as minimum range. In early spring some elk, along with deer, join the sheep in grazing young herbaceous plants on the lower slopes. The bulk of elk winter diet, however, is composed of browse. Locally, elk may be highly destructive to shrubs that also are utilized by bighorn. Deer are more widely distributed and are present in greater numbers than all other big game combined. But the fact that browse is the staple item in the winter diet of deer, and that they prefer browse and open timber types, lessens the extent of their direct competition with sheep. Mountain goat populations are low and they compete little with bighorn sheep on these ranges.

AN ANALYSIS OF CARRYING CAPACITY

This study has developed no special formula, no magic number to be termed an *absolute maximum* of bighorn sheep that can be carried safely on the ranges being discussed.

Conservation of soil and vegetation, as well as consideration for the fauna present, demands that minimum winter range be given priority in management planning. This means that stocking of the entire range should not exceed the carrying capacity of the area usable on a moderately severe winter. Management that ignores this fact invites disaster to key wintering areas and virtually assures periodic big game losses through starvation, disease and other mortality factors operating on overpopulated ranges. Moderately severe winters can be expected about every four years. Is it prudent or humane to impose periodic death sentences upon game animals? Certainly we cannot afford to deplete our ranges seriously every four or five years by gearing management to mild winter conditions.

A few of the difficulties encountered in fixing a desired stocking figure should be pointed out. In many areas it appears that deterioration of browse stands cannot be stopped short of drastic herd reductions. Must this decline in shrub abundance be halted at any cost to game numbers? Can we afford to sacrifice some browse for the sake of maintaining huntable populations if the condition of the soil and its cover of litter, grasses and forbs is not impaired? Should the range be managed for the benefit of elk, mountain sheep, deer, mountain goats? What other land uses must be considered? Unless we can answer these and other questions, any figure purported to represent *proper* stocking is apt to be more hypothetical than realistic.

General appreciation is accorded the importance of perpetuation of soil and watershed values. Yet management that insures full recovery of deteriorated Middle Fork ranges might well necessitate reductions in game numbers far more severe than anything now contemplated by game administrators. In the words of Murie (1951, p. 301), ". . . the normal carrying capacity of an overpopulated range is less than that of one that has not been injured, and to promote a recovery an abnormally low population must be maintained." What could, in the light of future experience, emerge as *proper* stocking may be considered entirely unacceptable for many years to come. No one would expect wholehearted support for gross reductions of game, at least until after a long period of presenting factual information to the public.

It is obvious that there must be some stated program—some objective. The writer is convinced that this objective should not be a number of animals to work toward but a certain range condition, or at least a favorable trend leading to that condition. Both range condition and trend and game population trends must be considered in units of several years to avoid the chaotic fluctuations of hunting regulations that would result from year-to-year comparisons of trend figures.

Creating goals in terms of numbers of animals has an air of finality. Once the goal is believed to have been reached—present census techniques seldom tell us precisely when—we frequently find that conditions have changed and a new number is needed. And once more the sportsman, game administrator and public must be convinced of the reasons they should favor revision of the original objective.

Acceptance of the relationship of range condition and trend to game population trend provides a dynamic policy for developing management regulations. But this policy will be appropriate only in proportion to the ability of land and wildlife managers to recognize and interpret the trends exhibited by both game and range.

APPENDIX

Common and Scientific Names of Species Mentioned

TREES

Fir, alpine	*Abies lasiocarpa* (Hook.) Nutt.
Fir, Douglas	*Psuedotsuga taxifolia* (Poir.) Britt.
Juniper, dwarf	*Juniperus communis* L. var. *montana* Ait.
Pine, lodgepole	*Pinus contorta* Dougl. var. *murrayana* Engel.
Pine, ponderosa	*Pinus ponderosa* Dougl.
Pine, white-bark	*Pinus albicaulis* Engelm.
Spruce, Englemann's	*Picea englemannii* (Parry) Engelm.

SHRUBS

Alder, mountain	*Alnus sinuate* (Regel) Rydb.
Aspen, quaking	*Populus tremuloides* Michx.
Barberry	*Berberis aquifolium* Pursh.
Bitterbrush	*Purshia tridentata* (Pursh.) D. C.
Chokecherry, western	*Prunus virginiana* L. var. *demissa* (Nutt.) Torr.
Currant, golden	*Ribes aureum* Pursh.
Elderberry	*Sambucus coerulea* Raf.
Gooseberry, Gooding's	*Ribes gooddingii* Peck
Greasebush, spiny	*Forsellesia spinescens* (Gray) Greene.
Happlopappus	*Happlopappus* sp.
Heath, mountain	*Phyllodoce empetriformis* (Sm.) D. Don.
Huckleberry, small-leaved	*Vaccinium scoparium* Leiberg.
Mahogany, curlleaf mountain	*Cercocarpus ledifolius* (Pall.) Britt.
Ninebark	*Physocarpus malvaceus* (Greene) Kuntze.
Rabbitbrush, rubber	*Chrysothamnus nauseosus* Nutt.
Red Osier dogwood	*Cornus sericea* f. *stolonifera* (Michx.) Fosberg.
Roses	*Rosa* spp.
Sagebrush, big	*Artemisia tridentata* Nutt.
Serviceberry	*Amelanchier alnifolia* Nutt.
Snowberrys	*Symphoricarpos* spp.
Snowbrush	*Ceanothus velutinus* Dougl.
Spirea, white	*Spirea betulifolia* Pall.
Syringa	*Philadelphus lewisii* Pursh.
Tea, labrador	*Ledum glandulosum* Nutt.
Willows	*Salix* spp.

FORBS

Avens, long-plumed	*Geum triflorum* Pursh.
Balsamroot, arrow-leaved	*Balsamorhiza sagittata* (Pursh.) Nutt.
Erigerons	*Erigeron* spp.
Eriogonums	*Eriogonum* spp.
Goat's beard	*Tragopogon pratensis* L.
Gromwell	*Lithospermum ruderale* Lehm.
Hawkweeds	*Hieracium* spp.
Lupines	*Lupinus* spp.
Pea vines	*Lathyrus* spp.
Penstemons	*Penstemon* spp.
Strawberry, western wood	*Fragaria vesca* L. var. *bracteata* (Heller) Davis.
Thistles	*Cirsium* spp.
Vetches	*Vicia* spp.
Yarrow, western	*Achillea lanulosa Nutt.*

GRASS AND GRASSLIKE PLANTS

Beargrass	*Xerophyllum tenax* (Pursh.) Nutt.
Bluegrasses	*Poa* spp.
Bluegrass, Sandberg's	*Poa secunda* Presl.
Cheatgrass	*Bromus tectorum* L.

Fescue, Idaho	*Festuca idahoensis* Elmer.
Hairgrass, tufted	*Deschampsia caespitosa* (L.) Beauv.
Horsetails	*Equisetum* spp.
Junegrass	*Koeleria cristata* (L.) Pers.
Pinegrass	*Calamagrostis rubescens* Buckl.
Ricegrass, little	*Oryzopsis exigua* Thurb.
Rushes	*Juncus* spp.
Ryegrass, western	*Elymus glaucus* Buckl.
Sedges	*Carex* spp.
Sedge, elk	*Carex geyeri* Boott.
Trisetum, spike	*Trisetum spicatum* (L.) Richt.
Wheatgrass, bluebunch	*Agropyron spicatum* (Pursh.) Scribn. and Smith.
Woodrush	*Luzula parviflora* (Ehrh.) Desv.

LARGE MAMMALS

Antelope, pronghorn	*Antilocapra americana americana* (Ord)
Bear, Rocky Mountain black	*Ursus americanus cinnamonum* Audubon Bachman
Beaver, Snake River	*Castor canadensis taylori* (New subspecies)
Bobcat, pallid	*Lynx rufus pallescens* Merriam
Cougar, Rocky Mountain	*Felis concolor hippolestes* Merriam
Coyote, Great Basin	*Canis latrans lestes* Merriam
Deer, mule	*Odocoileus hemionus hemionus* (Rafinesque)
Elk, Rocky Mountain	*Cervus canadensis nelsoni* Bailey
Goat, Rocky Mountain	*Oreamnos americanus missoulae* Allen
Sheep, Rocky Mountain bighorn	*Ovis canadensis canadensis* Shaw

SMALL MAMMALS

Chipmunk	*Eutamius* sp.
Gopher, pocket	*Thomomys* sp.
Marmot, chestnut-bellied	*Marmota flaviventer nosophora* Howell
Mouse, meadow	*Microtus* sp.
Mouse, white-footed	*Peromyscus sp.*
Porcupine, yellow-haired	*Erethizon epixanthum* Brandt.
Rabbit, Black Hills cottontail	*Sylvilagus nutalli grangeri* Allen
Rabbit, Rocky Mountain snowshoe	*Lepus bairdii bairdii* Hayden
Rat, wood	*Neotoma* sp.
Squirrel, ground	*Citellus* sp.
Squirrel, pine	*Tamiasciurus* sp.
Vole, mountain	*Phenacomys* sp.

BIRDS

Eagle, bald	*Haliaeetus leucocephalus*
Eagle, golden	*Aquila chrysaetos canadensis*
Magpie, American	*Pica pica hudsonia*
Raven	*Corvus corax*

PARASITES

Coccidia	*Eimeria arloingi* Marotel
Coccidia	*Eimeria granulosa* Christenson
Lungworm	*Muelleria capillaris* Mueller
Lungworm	*Muelleria minutissimus* Megnin
Lungworm	*Protostrongylus rufescens* Leuckart
Lungworm	*Protostrongylus rushi* Dikmans
Lungworm, hair	*Protostrongylus stilesi* Kamenski
Mite	*Psoroptes* sp.
Pinworm	*Skrjabinema ovis* Skrjabin
Stomach worm	*Ostertagia marshalli* Ransom
Tapeworm	*Moniezia benedini* Moniez
Tapeworm	*Wyominia tetoni* Scott
Ticks	*Dermacentor* spp.
Whipworm	*Trichuris ovis* Abildgaard

INSECTS

Deerflies	*Tabanus* spp.
Gnat, buffalo	*Symphoromyia atripes* Bigot
Horseflies	*Chrysops* spp.
Horsefly	*Chrysops pertinax* Williston
Snipefly	*Simulium arcticum* Malloch

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