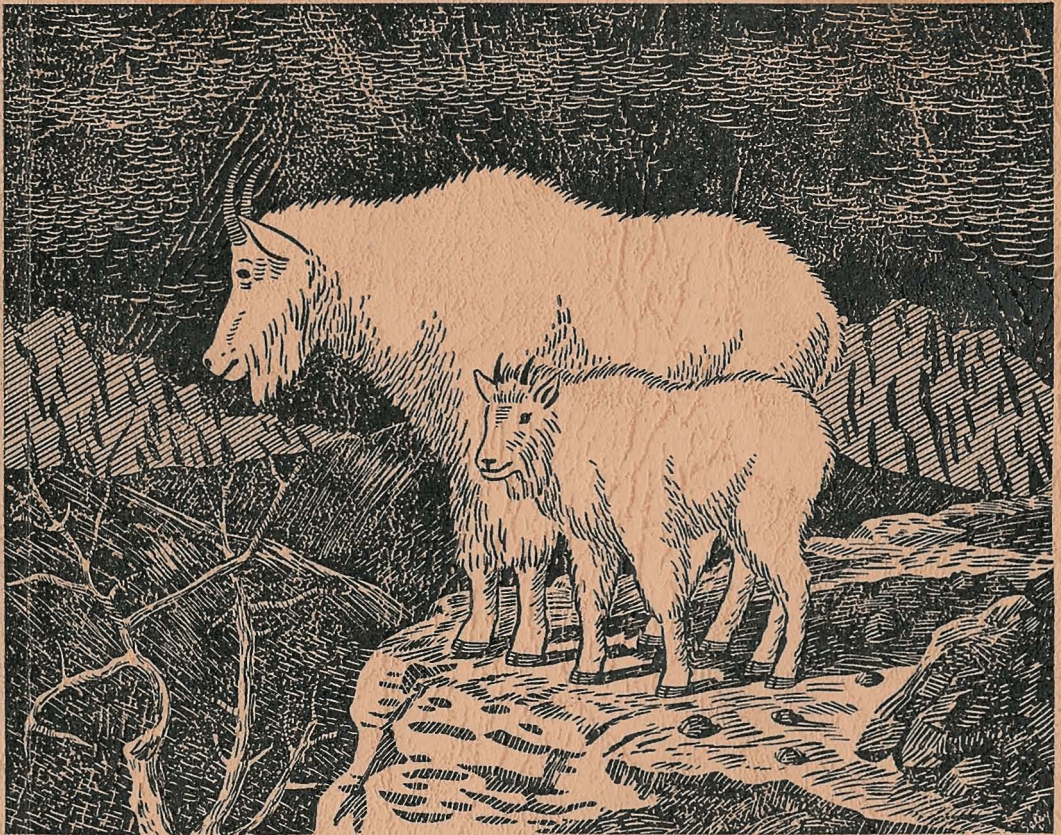


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*Life History and Management*

— of the —

# MOUNTAIN GOAT IN IDAHO



*Stewart M. Brandborg*

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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

**LIFE HISTORY AND MANAGEMENT  
OF THE  
MOUNTAIN GOAT IN IDAHO**

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Stewart M. Brandborg

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**Wildlife Bulletin No. 2**

A report of a study sponsored from the fall of 1950 through 1953 by the Idaho Fish and Game Department under Federal Aid to Wildlife Restoration Project 98-R, from the spring of 1949 to the fall of 1950 by the Idaho Cooperative Wildlife Research Unit (the University of Idaho Forest, Wildlife and Range Experiment Station, the Idaho Fish and Game Department, the U. S. Fish and Wildlife Service, and the Wildlife Management Institute), and during 1947 and 1948 by the Wildlife Restoration Division of the Montana Fish and Game Department under Pittman-Robertson Project 1-R.

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1955



## Foreword

In the belief that most people are interested in wildlife, and that many are interested in detailed and specific information regarding particular species, we present this bulletin dealing with a study of the mountain goat in Idaho.

Wildlife management is often complex and difficult, but it certainly must be based upon sound, factual information. Research, study, and many hours afield must all be combined into the written word, providing us with an accurate record to be used for future management, and to further our knowledge of specific wildlife species.

This report is published in the belief that it will be of valuable assistance to the trained wildlife worker—the student—the sportsman—and the amateur naturalist.

Our mountain goats have many important values. Not only do they furnish sport for the hunter, but also pleasure for all those wildlife enthusiasts who enjoy observing these animals under natural conditions on their rugged mountain ranges.

This bulletin is provided for the information and enjoyment of everyone interested in our wildlife with the hope that it will contribute to the proper management and perpetuation of the mountain goat in Idaho.

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

September, 1955

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The study could not have been completed without the wholehearted cooperation received from the U. S. Forest Service personnel who provided many observations and aided in the over-all planning. Use of Forest Service facilities greatly expedited field work in the remote areas of the Lewis and Clark National Forest in Montana, the Bitterroot National Forest, the Kaniksu National Forest and the Salmon National Forest in Idaho.

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S.M.B.

# LIFE HISTORY AND MANAGEMENT OF THE MOUNTAIN GOAT IN IDAHO

## INTRODUCTION

This is a report on the life history of the mountain goat. It will serve as an introduction to the habits and environment of this animal and to some of the factors to be considered in planning its perpetuation and management. It is hoped that it will also aid in designing future studies of this important member of the North American big game fauna.

Early explorers, visiting the coasts of British Columbia and Alaska in the late eighteenth century, brought back the first reports of mountain goats which they variously referred to as white bears, white buffalo and white sheep. Diaries of the Lewis and Clark Expedition (1804-1806) contain descriptions of goats that had been taken by Indians at points along the route through the Columbia River basin. The first complete written reports and eye-witness accounts of the species are attributed to Alexander Henry (Seton, 1927) who described the animals at Kootenay Park on the Continental Divide in 1811. In the years that followed, goats were encountered fairly frequently by explorers, trappers and settlers who traversed the rocky-canyon wildernesses of the Northwest, but even as late as the 1880's some questioned the existence of this animal (Whitney, et al., 1904).

Today, although we accept the mountain goat as a symbol of the wild and high country, we still find little information on its habits and way of life. In the absence of management programs to insure its perpetuation, we recognize that the goat's remarkable adaptation to a rugged and largely inaccessible environment is responsible for its survival over most of the original ranges in the northern Rockies and Coastal Mountains of the United States and Canada. It has remained over the years as one big game species which, for the most part, has not been displaced by the encroachments of civilization.

Within recent years a definite need has developed for more complete knowledge of the mountain goat in order that its place be maintained among those big game animals which have made the wild and undeveloped areas of the Northwest outstanding for



the quality of outdoor living they provide. In this study an attempt has been made to determine the general status of goat populations within the areas covered, their productivity in terms of harvestable surpluses, and those factors most important in limiting their natural increases. To realize even part of these objectives, it has been necessary to start from the beginning in the collection of basic information on the animal's life history, its food and habitat requirements, and those physical characteristics which can be relied upon for recognizing differences in age and sex. Although many of the findings of this study are inconclusive, a substantial body of information is represented by the descriptions of ranges which were visited, comparative age composition and population trend figures, descriptions of seasonal migration, mating habits, variations in grouping, intraspecific relationships of animals and other behavior characteristics which may be significant from the management standpoint.

Field work was begun during the summer of 1947 in the Red Butte area on the West Fork of the Sun River in Montana for the Wildlife Restoration Division of the Montana Fish and Game Department as Pittman-Robertson Project 1-R. This work was continued in the same locality during the spring of 1948, as well as in the Deep Creek-South Fork of the Teton River area and the Bitterroot Range. In May, 1949, a year's intensive field work was begun in Idaho on three small herds in the vicinity of the mouth of the Middle Fork of the Salmon River under the auspices of the Idaho Cooperative Wildlife Research Unit. This was continued in September, 1950, when the investigator was employed by the Idaho Department of Fish and Game as leader of Pittman-Robertson Project 98-R to conduct census and distribution studies and collect harvest data on the Salmon River drainage and in the Selkirk Mountains of northern Idaho. An extensive coverage of the latter range was completed in August, 1951. Limited coverages on the Salmon River during October, 1950, and April, 1951, permitted continuation of age composition counts on the herds in and adjacent to the areas that were studied intensively during 1949 and 1950.

Studies were continued on these ranges, as well as on those along the main Salmon River above the mouth of the South Fork, from September, 1951, until January, 1953. Preliminary census and distribution coverages were also accomplished during the latter period in portions of the Bitterroot and Lemhi Ranges. An extensive coverage of ranges on the upper Selway River was con-

ducted during August and September, 1951, and during July, August and September, 1952.

## METHODS

The detailed notes maintained during this study included descriptions of mountain goat ranges and considerable life history information, although the determination of distribution (Figure 1) and population size was the primary purpose of coverages in the Bitterroot Mountains of Idaho and Montana and along the Salmon River from Little Squaw Creek to the South Fork of the Salmon River in Idaho. Binoculars and a twenty power spotting scope were used in field observations and airplanes proved of value in conducting preliminary censuses on some ranges.

Part of the vegetation descriptions of Idaho ranges was obtained with the line interception method described by R. H. Canfield (1941), but where time was limited, species abundance listings were used in describing cover. Current growth of shrubs on the Salmon River was measured before and following the winters of 1949-50 and 1951-52 to determine the extent of winter utilization by mountain goats and big game competitors. The percentage cropping of total length of available twig growth was determined by a method similar to that described by Aldous (1945).

Grouping observations were made whenever possible, with animals being aged into kid, yearling, and two-year-old and over classes. However, the sex of most goats was not determined because of the difficulty in distinguishing males from females at a distance. Body measurements from 26 animals and a limited collection of skulls provided information on body sizes and dental succession. In addition, four jaws and nine reproductive tracts were collected by hunters during fall harvests. Ovarian sectioning, as described by Cheatum (1949), was used in examining ovaries to determine reproductive performance in females collected during fall hunts. Mountain goat droppings were analyzed by a sedimentation process for evidence of endoparasites. Coyote scats were examined to determine the frequency and importance of mountain goat remains in the diet of this predator.

Harvest records were maintained during Idaho's 1952 and 1953 mountain goat hunts to determine hunter success and to obtain horn measurements, female reproductive tracts, and jaws. Autopsies were performed on animals found dead in the field. During live-trapping operations on Deep Creek in Montana, body

measurements were obtained by trapping crews and these data constitute the majority of measurements reported in this paper.

All photographs except those illustrating stages of tooth succession and horn development and the aerial picture of Figure 4 were taken by the author. The mountain goat photographs are copyrighted by the author.



## NUMBERS AND DISTRIBUTION

The mountain goat, *Oreamnos americanus* Blainville, is a member of the family *Bovidae*, and is the only member of the genus *Oreamnos*. The animals observed during this study in Idaho and Montana are described by J. A. Allen (1904) as belonging to the subspecies *missoulae*, which he reported as the smallest representative of the species *montanus*. This species designation was later changed to *americanus* (Hollister, 1912), and the name has remained *Oreamnos americanus missoulae* Allen.

## HISTORICAL RANGE AND NUMBERS

Elers Koch (1941), writing on the early history of big game in Montana, quoted the following record: "The fur-trapping expedition of Alexander Ross in 1823 and 1824, through western Montana and Idaho, presents a graphic picture of game conditions at that early date . . . Passing on up the Bitterroot Valley (in March), elk, deer, and mountain goats were very numerous. . ."

The records of early explorers did not always refer to the game encountered by their parties and frequent errors in identi-

fication have been made. It is well known that the ewe bighorn (*Ovis canadensis canadensis*) was often called a goat, and therefore, unless goats and sheep shared a common range, it is not advisable to accept the records *per se*. The absence of references to mountain goats in early journals is not proof that they did not exist in an area. The route of the travelers along valley bottoms and through open terrain during mid-summer, when the goats were at high elevations, precluded observation of them.

Mountain goats, in contrast to most of our big game animals, occupy essentially the same ranges where they were found when white men first explored the West. Generally they have not been forced to leave their chosen homes as a result of man's activities, and it is only on a few of the more accessible ranges that they have been reduced by over-shooting.

From available information it appears that there has been neither the demand nor a concerted effort by hunters, even since hunting regulations have been enacted, to harvest mountain goats within Idaho and Montana. Harvest estimates reported for Idaho during 18 hunting seasons between 1927 and 1953 show light harvests in which the total estimated kill for any year rarely exceeded 100 animals. A conservative take of 10 per cent of the estimated populations would have provided a kill of at least 200 to 300 animals during this period.

Annual estimates of game numbers by the U.S. Forest Service provide the only available records of mountain goat numbers over the years since about 1917. These estimates are subject to wide variation due to frequent changes in personnel and the limited opportunities to observe the herds. Although they are the best information available, they cannot be considered reliable for comparison because of the large errors involved in their derivation. Casebeer, Rognrud and Brandborg (1950) report totals of these estimates ranging from 2,480 to 5,207 for 12 national forests in Montana over the 24-year period from 1919 through 1942. These often showed wide and unexplained differences in successive years, as in 1923 and 1924 when the total population figures jumped from 2,480 to 3,254. In the period from 1944 through 1948 there was a decline from 5,207 to 4,143 in the numbers reported.

Similar variations in year to year estimates were apparent in most of the records for the ten national forests in Idaho where mountain goats were reported. On the Salmon National Forest, for the period from 1917 through 1950, estimates increased stead-

ily from an estimated 240 to 650 animals. It is not known whether these increases represent growth in the population or a greater number of observations by an expanded force of field personnel traveling on an improved road and trail system. It was generally found that population estimates based on a limited number of casual observations were higher than those resulting from more intensive surveys. There is often a tendency to estimate goats on the basis of the amount of typical range that is seen rather than on actual counts of animals.

A limited number of observations by old-time residents were used to define population trends over the past years in the areas covered most intensively during this investigation. These observations, based on infrequent visits to the mountain goat ranges, were subject to the errors of human memory since no written records are available. It is, therefore, impossible to compare population figures obtained from these sources to the numbers which are currently reported from census coverages. Few individuals have had the opportunity to observe herds closely over extended periods, and as a rule, local residents were cautious in defining population trends on the basis of their limited observations. Co-operators were more inclined to report on depleted herds than those which were stabilized or increasing. The observations presented here apply to ranges covered in the drainages of the Salmon and Selway Rivers and in the Selkirk Mountains.

The major decline in the mountain goat populations on the Salmon River during the present century can apparently be attributed to two factors: (1) the influx of prospectors and placer miners into the area during the depression years, and (2) construction of the Salmon River road in the 1930's which made herds more accessible than at any previous time. Mr. Frank Lantz, resident of this area since World War I, provided information on the comparative numbers of mountain goats along a 19 mile stretch of the Salmon River from Big Squaw Creek to the end of the road at Corn Creek. It was his observation that mountain goats were more abundant at the time of his first trips into this country than at present, but that there has been a gradual growth of herds during the past 10 years. This observation coincides with that of E. F. Van Arsdall who has occupied Sheep Hill Lookout on a lower section of the canyon for the past 17 years while employed by the U. S. Forest Service. He also reported a gradual increase in the numbers of mountain goats over the period of his observation on that portion of the canyon which is inaccessible except by trail and river boat.

Mr. Willard Rood, Jr., who has spent more than 40 years on his Panther Creek ranch, has observed gradual reduction in goat numbers on ranges in the area which were made accessible by construction of the Salmon River road in the 1930's. Some of these herds have been severely depleted. A few years later, when the road was extended down the Salmon River to Corn Creek, the herds farther down the river were forced to carry the brunt of the hunting pressure. The low cost of tags and generous hunting seasons combined with the increased accessibility contributed to the depletion of herds on Boulder Creek, Panther Creek, Cove Creek, Owl Creek, Long Tom Mountain, the lower Middle Fork of the Salmon River, and along the river breaks between Pine Creek and Panther Creek.

During the 1930's most of the habitable bars along the Salmon River were occupied by placer miners who were able to derive a living from mining and the abundance of game which was available for the taking. These people were dependent upon wild meat and undoubtedly utilized mountain goats whenever they could be obtained conveniently. Availability of mountain goats, as compared to elk (*Cervus canadensis nelsoni*), mule deer (*Odocoileus hemionus hemionus*), bighorn sheep and black bear (*Ursus americanus*) probably influenced the number that were killed illegally more than any other factor, with the heaviest removals being made from those species which were most accessible.

Foster Robertson, who conducted a bighorn sheep study on the Middle Fork of the Salmon River in 1938 for the Forest Service, reported an interesting observation of Mr. Parrot, a miner on the lower Middle Fork. Mr. Parrot believed that indiscriminate killing was the chief factor limiting the numbers of both mountain goats and bighorn sheep and told of wholesale slaughter of these animals by local and outside hunters in the years previous to 1938. Walter Wadesick, who has resided along the upper Salmon River south of Salmon for many years, reported that there was once a fairly large herd of mountain goats on the northern portion of the Lemhi Range between the headwaters of McKim Creek and Warmspring Creek. Animals have rarely been seen in this area since the decline in numbers which occurred as a result of heavy hunting pressure during the late 1930's and until closure of the mountain goat season in 1948.

As was the case for Salmon River herds, information on the original number and distribution of mountain goats in the Selkirk Range and on the upper Selway River is fragmentary. Dis-

tribution appears to be much the same as it was originally throughout most of these ranges although a few severely depleted herds were observed. In the northeastern portion of the Selkirk Range, herds on Parker Creek and lower Canyon Creek are much smaller than originally and goats are no longer reported on Farnham Creek and Fisher Creek where they were once found. Mr. Sam Skeels, an employee of the U. S. Forest Service on the Bonners Ferry District for 23 seasons, noted a definite drop in the goat population during the period from 1928 through 1950. Mountain goats were observed frequently by him during his first years on Burton Peak where he was employed as lookout, but in recent years they were rarely seen there.

Population estimates for the Coeur d'Alene National Forest from 1920 to 1925 contain reports of five mountain goats on Pond Peak. Animals are no longer known to occur on this range and it is believed that the herd was eliminated. On the upper Selway River the major decline in mountain goat numbers followed the completion of the road in the 1930's which made a few small herds accessible to hunters. Each of these was reported to have shown noticeable declines during the period that followed and no recovery has been apparent to date. The most severely depleted herds were those that ranged on the lower Little Clearwater River, Horsejaw Mountain and Indian Creek. Lower on the Selway there were two small herds that originally ranged on the river breaks in the vicinity of Puzzle Point and Goat Mountain. The last of these are believed to have been taken by hunters during the early 1930's.

Evident depletion of mountain goat populations on accessible ranges in northern Idaho emphasizes the need for controlled harvesting methods by which hunting pressure can be distributed in accordance with each herd's capacity to support removals. General open seasons are a thing of the past, except possibly in the case of a few remote areas where harvests are very light.

#### Present Numbers and Distribution

Idaho's mountain goat population is presently estimated at 2,785 animals. The herds are scattered widely over the Rocky Mountain Range from the Canadian line south throughout the Sawtooths almost to the Snake River Plain (Table 1 and Figure 1). This represents the southernmost extremity of the animals' natural range in Continental North America. Idaho's population is less than that of 4,451 animals reported in Montana by Casebeer, Rognrud and Brandborg (1950), while Washington,

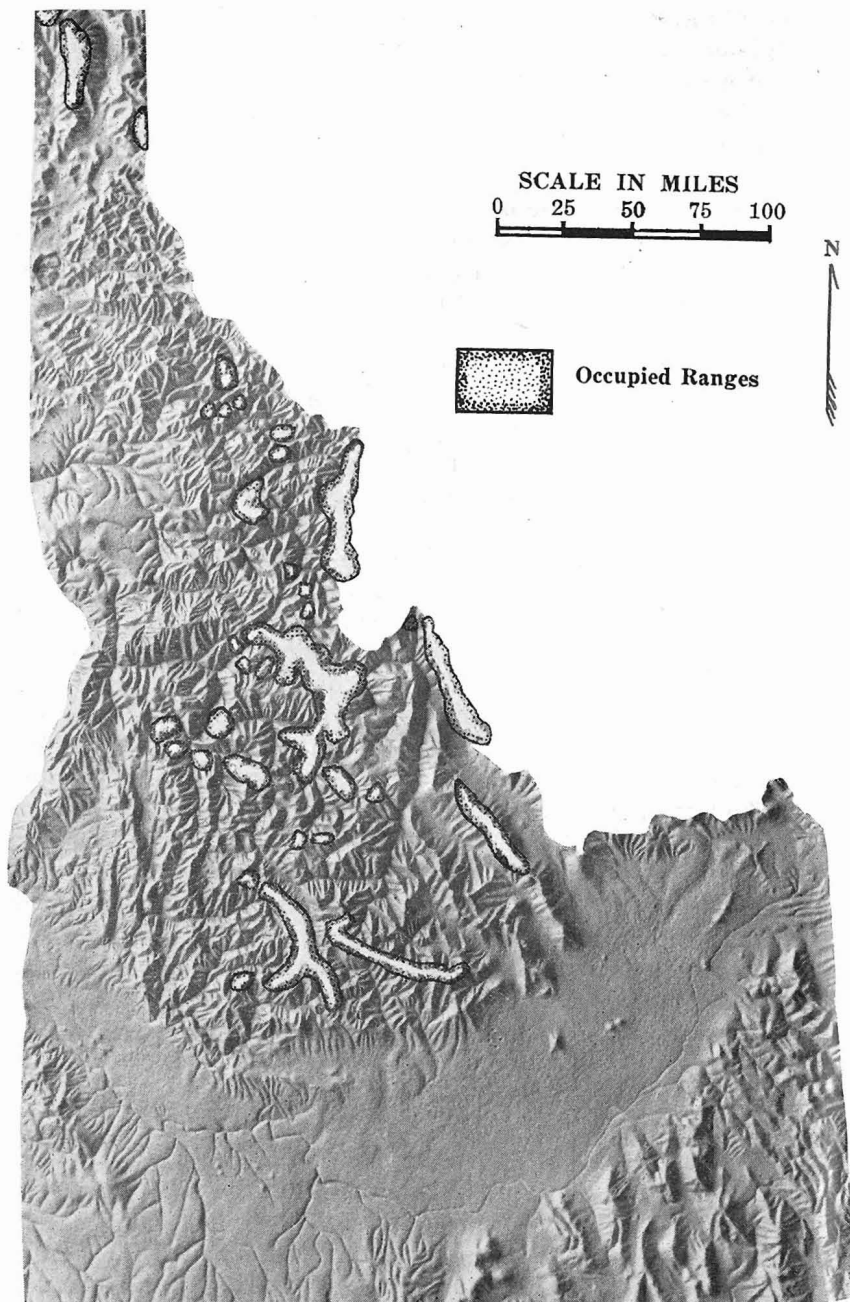


FIGURE 1. Distribution of mountain goats in Idaho, showing approximate ranges of present day herds.

TABLE 1. Estimated populations of Idaho mountain goat herds. Roman type figures are estimates based on field coverages completed during this study, while those of the U.S. Forest Service and other sources are shown in parentheses.

Area	HERD	Estimated Population	Herd Total	
Selkirk Range.....	Lion Creek.....	35	195	
	Indian Creek-Two Mouth Creek....	50		
	Pack River-Myrtle Creek.....	20		
	Parker Creek-Canyon Creek.....	25		
	Smith Creek-Abandon Creek.....	40		
	Trapper Peak-Mollies-Bugle Ridge..	15		
	Snowytop Mountain.....	(10)		
Cabinet Mountains.	Lightning Creek.....	(25)	25	
North Fork of the Clearwater River...	Snow Peak.....	(30)	280	
	Goat Ridge-Mallard Peak-Black Mountain.....	(150)		
	Eagle Point.....	(25)		
	Elizabeth Creek-Cold Springs-Pot Mountain.....	(25)		
	Moose Mountain-Twin Peaks.....	(50)		
Lochsa River.....	Old Man Creek-Fern Mountain-Rhoda Creek.....	(50)	220	
	Boulder Creek.....	(30)		
	Stanley Creek-Long Lake Point-Eagle Mountain.....	(50)		
	Squaw Creek.....	(35)		
	Rhodes Peak.....	(30)		
	Goat Roost.....	(5?) <sup>1</sup>		
	Blodgett Mountain-Big Flat Creek-Ranger Peak-South Fork Lolo Creek.....	(20?)		
Selway River.....	Diablo Mountain.....	(20)	315	
	Goat Heaven Peaks.....	(25)		
	Saddle Mountain-East Fork of Moose Creek.....	20		
	Granite Creek.....	(15)		
	Bear Creek-Paradise Creek.....	35		
	Cub Creek.....	(30)		
	Paloma Creek-Cliff Creek-Brushy Fork.....	50		
	White Cap Creek above Cliff Creek.	35		
	Indian Creek.....	(15)		
	Little Clearwater River.....	15		
	Horsejaw Mountain.....	5		
	Salmon Mountain-Three Lakes Creek	40		
	Wilkerson Creek.....	10		
Salmon River.....	Big Trout Creek-Lemhi Creek.....	10		
	Big Mallard Creek.....	30		
	Bargamin Creek.....	25		
	Dillinger Creek-Maggie Creek.....	10		
	Bruin Creek-Barth Hot Springs.....	(10)		

<sup>1</sup> A question mark is shown where animals have not been reported in recent years. Estimates of five were given where a herd had been severely depleted or only occasional animals were reported.

TABLE 1. (Continuation)

Area	HERD	Estimated Population	Herd Total		
Salmon River..... (Continuation)	Sabe Creek-Black Creek.....	30	600		
	Big Squaw Creek.....	20			
	Chamberlain Creek.....	20			
	Fawn Creek-Little Squaw Creek.....	25			
	Fern Creek-Cottonwood Creek-Otter Creek.....	70			
	Horse Creek.....	40			
	Corn Creek-Bear Creek-Proctor Creek.....	35			
	Long Tom Mountain.....	( 5)			
	Cove Creek-Owl Creek.....	15			
	Lower Panther Creek-Trail Creek-Fritzer Creek.....	5			
	Boulder Creek.....	10			
	North Fork of the Salmon River-Allan Mountain.....	20			
	Bitterroot Range-Sheep Creek-Pyramid Peak-Carmen Creek-Ajax Peak-Freeman Creek-Kirtley Creek-Geertsen Creek-Bohanon Creek-Goldstone Mountain.....	60			
	Lemhi Range-Poison Creek-Morgan Creek-Morse Creek-Falls Creek-Patterson Creek-Timber Creek.....	(100)			
	White Mountain-Valley Mountain-White Goat.....	(20)			
	Whitecloud Peaks-Blackman Peak-Patterson Peak-Slate Creek.....	(35)			
	Bowery Creek.....	( 5)			
	South Fork of the Salmon River.....	Porphry Creek-Wolf Fang Creek....		( 5)	90
		Lick Creek-Fitsum Creek.....		(65)	
		Squaretop Peak.....		(10)	
Goat Creek-Halfway Creek.....		(10)			
Middle Fork of the Salmon River.....	Color Creek-Goat Creek-Roaring Creek-Nolan Creek.....	25			
	Lower Big Creek-Eagan Point-Goat Creek.....	(25)			
	Shellrock Peak-Paint Creek.....	(25)			
	Cougar Basin-Center Mountain.....	(50)			
	Jacobs Ladder Creek.....	( 5)			
	Logan Mountain.....	( 5)			
	Ship Island Creek-Puddin' Mountain-Wilson Mountain-Wilson Creek-Middle Fork Peak-Jackass Creek.....	(70)			
	Soldier Creek.....	(30)			
	Sleeping Deer-Martens Mountain-Horse Creek-Bennett Creek.....	(50)			
	Ruffneck Peak.....	( 5?)			
	Vanity Lake-Shady Creek.....	( 5?)			
	Capehorn Mountain.....	( 5?)			
	Copper Mountain.....	( 5)			
	Cabin Creek Peak-Tango-Mount Jordan.....	(15?)			
	Mayfield Peak.....	( 5)			
	Sherman Peak.....	(10)			

TABLE 1. (Continuation)

Area	HERD	Estimated Population	Herd Total		
Middle Fork of the Salmon River..... (Continuation)	Muskeg Creek-Chicken Creek-Fall Creek.....	(15)	350		
	Warm Springs Creek.....	(35)			
South Fork of the Payette and Boise Rivers.....	Ten Mile Creek.....	(10)	460		
	Steel Mountain.....	(25)			
	Elk Creek-Stanley Lake Creek-Goat Creek-Observation Peak-Thompson Peak-Heyburn Mountain-Baron Creek-Redfish Creek-Cony Peak-Mount Cramer-Edaho Mountain-Queens River-Glens Peak-Snowyside-Mattingly Creek-Alturas Lake Creek-Rossview-Leggit Creek.....	(300)			
	Big Peak.....	(40)			
	Marshall Peak-Emma Creek.....	(30)			
	Ross Peak.....	(20)			
	Big Lost River.....	Ryan Peak-North Fork Big Lost River.....		(25)	90
		Pioneer Mountains-Kane Creek-The Devil's Bedstead-Hyndman Peak-Standhope Peak-Bear Canyon-Iron Bog Lake.....		(65)	
	Big Wood River....	Smoky Mountains-Placer Creek-Brodie Creek-Prairie Creek-Royal Gorge-West Fork Creek.....		(100)	160
		Galena Peak-Silver Peak-Ibex Creek-West Pass Creek-Ryan Creek.....		(60)	
TOTAL ESTIMATED POPULATION.....		2,785			

the only other State supporting native herds, has an estimated population of approximately 5,000 animals (U. S. Fish and Wildlife Service, 1953).

Mountain goats occur typically in small and scattered herds within their distributional limits in Idaho and Montana. A listing of herd estimates for use in planning future investigations within major areas of Idaho is shown in Table 1. The reliability of these estimates varies in accordance with the amount of time which has been spent in obtaining them, and their accuracy is much greater on those ranges where field inventories have been completed. Herds were censused within only four of the eleven areas shown—the Selkirk Range, Selway River, Salmon River and Middle Fork of the Salmon River. Since the size and distribution of herds cannot be accurately defined in the absence of field coverages, many of the herd names listed are used in designating

areas in which animals occur and may not represent actual herds. On ranges where no field work has been done, several herds are undoubtedly reported as one. This is the case for the larger herds listed for that part of the state south of the main Salmon River as well as for those areas in the northern part of the state which have not been covered. It is significant that 89 per cent of the herds listed represent 50 animals or less, and that nearly two-thirds of Idaho's total mountain goat population is found in herds of this small size. If herd ranges were known in areas reporting larger concentrations, it is probable that the percentage of the population occurring in these smaller herds would be greater. It is doubtful that herds will survive in the several areas where five or less animals were reported, unless the actual numbers present exceed these small estimates.

Over a thousand animals, more than a third of Idaho's mountain goat population, are found within the Salmon River watershed. The Clearwater River watershed rates a close second with herds totaling 815 animals, or 29 per cent of the state's total population, on three main tributaries—the Lochsa, the Selway, and the North Fork. Smaller numbers are recorded for the South Fork of the Payette, the Boise, the Big Lost, and the Big Wood drainages which include the southern limits of goat ranges within the state.

In general, goat populations in Idaho appear to be fairly stable and in many areas slight increases have been reported since 1948 when most of the ranges were closed to hunting except under controlled hunts. Unfortunately, time has not permitted the revisiting of all of the trend count areas which have been established in the course of the present investigation and, therefore, it has not been possible to define population trends which may have occurred during this period. Three Salmon River herds which were censused annually showed an upward trend in numbers from 1950 through 1952.



## ENVIRONMENTS

### Salmon River Range

Probably no other feature of mountain goat habitat is more apparent to the observer than the rugged and broken terrain with the cliffs, ledges, projecting pinnacles and talus slopes that are characteristic of the goat country. The Salmon River canyon is one of the deepest and most rugged in North America. From mountain crest to river level its depth in several places exceeds 6,000 feet, and the steepness of the slopes that drop from the high peaks lying on the edge of the gorge causes many of the streams to follow narrow canyons in cataracts and steep drops to the river (Figure 2). It was here that members of the Lewis and Clark expedition encountered the unnavigable river and impassable canyon slopes that turned back the expedition. It is popularly known today as "The River of No Return."

Most of the area covered during this work lies within the

Idaho batholith, a granitic intrusion traversed by the Salmon River which cut deeply into this mass as a gradual uplift occurred, giving rise to the gorge as it is today (Shenon and Reed, 1936). Cliffs and talus cover large areas of the canyon's slopes, which make the range largely inaccessible to big game species other than mountain goats and bighorn sheep. The highest summer ranges of the Big Horn Crags, the headwaters of West Horse Creek, and other tributaries of the Salmon River are characterized by narrow glaciated valleys and cirque basins.

Coarse, shallow, gravelly soils with poor water-retaining capacities, steep slopes, semiarid conditions, and short growing seasons limit the vegetative productivity of most of the lower Salmon River mountain goat ranges. At the Salmon weather station (elevation 3,949 feet), the mean annual precipitation over a 42-year period was less than nine inches (U. S. Department of Commerce, 1952). Although rainfall is heavier than this in the adjacent mountains and on the upper slopes of the river gorge to the west, much of the mountain goat winter range along the river lies within a semiarid belt.

Snowfalls, usually beginning during October on the river breaks (below 6,000 feet), are light and seldom exceed two feet in depth on the valley floor at any time during the winter. With an increase in elevation the snow gradually accumulates until, on the alpine ranges, it often exceeds 10 feet. As a rule, mild weather occurring in late February and March removes the snow from the lower canyon slopes, and grasses on the warmer south-facing aspects begin to show growth which continues during the rainy period of May and June. Hot, dry weather on the breaks of the lower river results in a cessation of plant growth during the summer, when most of the mountain goats are occupying higher ranges. Temperatures of more than 100° F. are often recorded along the river during July and August.

Many of the steep slopes of the Salmon River canyon below 4,500 feet elevation are within what Daubenmire (1952b) describes as the wheatgrass-bluegrass zone. Bluebunch wheatgrass (*Agropyron spicatum*)<sup>1</sup> and mountain mahogany (*Cercocarpus ledifolius*) are principals of the community within which a large part of the mountain goats winter. These two plants, which constitute an important part of the mountain goat's winter diet, are present on practically all of the precipitous and rocky breaks of the Salmon River and the lower Middle Fork where observations

<sup>1</sup>R. J. Davis' Flora of Idaho (1952) was the principal taxonomic key used in describing the vegetation of the study areas.

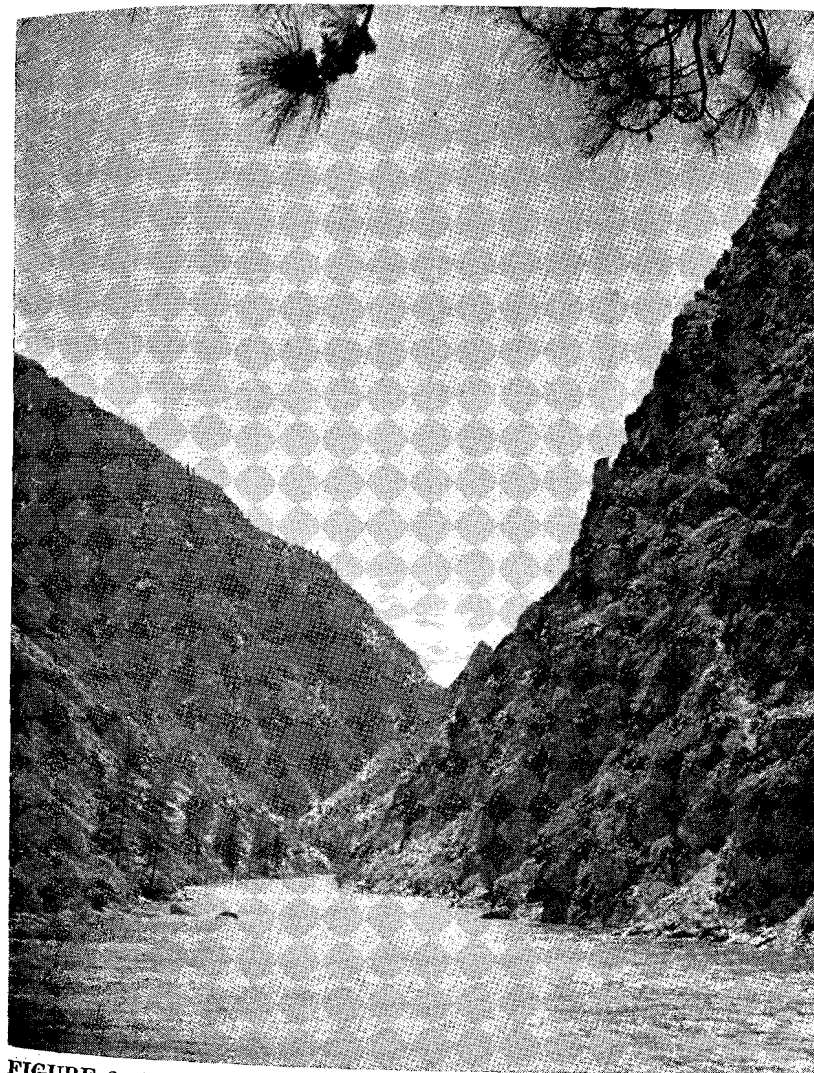


FIGURE 2. A view of the Middle Fork as seen from its confluence with the main Salmon River. The precipitous slopes along this section of the canyon are occupied by mountain goats during the late fall, winter and spring.

were made. Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa secunda*), cheatgrass (*Bromus tectorum*), spiny greasebrush (*Forsellesia spinescens*), big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus nauseosus*), syringa (*Philadelphus lewisii*), willow (*Salix* spp.), currant (*Ribes* spp.),



balsamroot (*Balsamorhiza sagittata*) and yarrow (*Achillea lanulosa*) are among the other important plants found on these ranges. The Douglas fir (*Pseudotsuga taxifolia*) zone extends down the canyon slopes to the river on some of the shaded north-facing aspects. Pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), Junegrass (*Koeleria cristata*), Idaho fescue, snowberry (*Symphoricarpos* sp.), mountain maple (*Acer glabrum*), chokecherry (*Prunus virginiana* var. *demissa*), serviceberry (*Amelanchier alnifolia*), spirea (*Spirea* sp.), syringa, currant, ninebark (*Physocarpus malvaceus*) and thimbleberry (*Rubus parviflorus*) are among the more important species found here under mixed stands of ponderosa pine (*Pinus ponderosa*) and Douglas fir. Lodgepole pine (*Pinus contorta*) occurs as a seral member of this association at higher elevations.

Where the ponderosa pine zone is adjacent to the wheatgrass-bluegrass zone on dry south-facing aspects, the cover is represented by the ponderosa pine/bluebunch wheatgrass association. Typically the vegetation is dominated by bluebunch wheatgrass and Idaho fescue which grow under open stands of pine. On some sites, this association extends to the river bottom, although in many places it is found largely above the wheatgrass bluegrass zone at elevations above 4,000 feet. At its upper edge and along its discontinuous extensions onto north-facing aspects and more moist sites, the ponderosa pine/bluebunch wheatgrass association overlaps the Douglas fir zone.

On the upper breaks of the river this zone is most commonly represented by a Douglas fir-ninebark shrub association in which ponderosa pine and lodgepole pine are seral members (Daubenmire, 1952a). Higher ranges (6,000-7,000 feet), characterized by this association, are used extensively by mountain goats during the summer and fall. Midwinter snows start the animals moving to lower ranges along the river breaks within the ponderosa pine and wheatgrass-bluegrass zones. However, on some ranges of the upper tributaries of the North Fork of the Salmon River and the Lemhi River, the comparatively favorable conditions provided by isolated lower areas are not available to the goats and they remain within the Douglas fir zone at elevations of more than 6,000 feet, where there are several feet of snow throughout the winter.

Summer ranges of mountain goats in Idaho and Montana lie largely within the Engelmann spruce-alpine fir zone. In the Big Horn Crags, within the Salmon River watershed, alpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*),

are dominant trees along the snow-fed streams and lakes in the narrow canyons and cirque basins above 8,000 feet. As one ascends the slopes to the ridges it is seen that spruce is confined largely to the lower areas, and whitebark pine (*Pinus albicaulis*) and alpine fir are the dominant trees. It is only on the highest ridges and pinnacles, at elevations of nearly 10,000 feet, that dwarfed tree growth is not seen.

Grasses, herbs and shrubs are sparsely distributed between areas of talus and cliffs where shallow soils have developed. Millet woodrush (*Luzula parviflora*), sedges (*Carex* spp.), rushes (*Juncus* spp.), and little mountain rice (*Oryzopsis exigua*) are the most important of the grass-like forms. Beargrass (*Xerophyllum tenax*) is the most plentiful of several forbs which were observed. Grouseberry (*Vaccinium scoparium*) is often the dominant shrub, although mountain heath (*Phyllodoce empetri-formis*) and Labrador tea (*Ledum glandulosum*) are locally abundant on some of the lower slopes of the basins in the more moist sites.

#### Bitterroot Range

The portion of the Bitterroot Range covered during this study lies within the drainage of the upper Selway River in Idaho and extends eastward to include tributaries of the Bitterroot River in Montana. The crest of this range serves as the divide between the two states and the watersheds of the Bitterroot and Selway Rivers. Most of the rock of the upper Selway area is the granite of the Idaho batholith. Elevation of the Bitterroots exceeds 9,000 feet in many places, with its highest mountain, Trapper Peak, reaching 10,131 feet. As with the other high mountain areas where mountain goats have been observed, this range shows well-defined evidence of glacial action in the U-shaped canyons that head along its crest.

Most of the summer ranges covered during this investigation lie on the upper portions of these canyons, while the winter ranges are situated on their lower reaches. The trench of the Selway River attains a depth of 4,000 feet. Its valley floor ranges from 2,192 feet in elevation at the mouth of Moose Creek, on the northwestern edge of the area, to 4,057 feet at the mouth of Deep Creek, approximately 30 airline miles up the canyon.

The Selway drainage is characterized by climatic variations in localities that are not widely separated either altitudinally or latitudinally, and well-defined snow belts are recognized along the length of its upper canyon. Parsell (1950) reported the annual precipitation for the Moose Creek ranger district as aver-

aging only 26 inches, while in excess of 60 inches has been recorded along the Bitterroot divide. Most of this falls in the form of winter snow which often exceeds depths of four feet between Moose Creek and Deep Creek. Snow depths on the mountain crests are considerably greater, and huge drifts often remain until the middle of July. Summers along the river are typically hot and dry, but at high elevations the temperatures are usually cool, with frosts occurring during every month of the season.

The summer ranges of mountain goats within the Engelmann spruce-alpine fir zone on the upper Selway River are similar in many respects to those in the Big Horn Crags and the Selkirk Mountains. Alpine fir, whitebark pine, and alpine larch (*Larix lyallii*) are principal dominants on the slopes and ridges (Figure 3). Engelmann spruce ascends the canyons to the upper basins and lower edges of the goat range, but is not found commonly on the drier sites of the canyon slopes. The spruce-fir/beargrass association, the spruce-fir/menziesia association, and the spruce-fir/grouseberry association as described by Daubenmire (1952a) are all represented in this zone.

Species abundance lists indicate the dominance of alpine fir, larch, menziesia and beargrass on the upper north-facing slopes. A variety of grasses, sedges and rushes are found in the moist sites where soil has developed on ledges and talus slopes. South-facing aspects are characterized by mixed stands in which alpine fir is the dominant species. Grouseberry and mountain heath are among the most commonly observed shrubs. Beargrass is the dominant forb on southern aspects and is also common on north-facing slopes.

Winter ranges along the breaks of the Selway River were observed to lie largely within the Douglas fir and ponderosa pine zones and compare closely to those described within these zones on the Salmon River. Douglas fir and ponderosa pine are dominant trees on a south slope winter range in the upper White Cap Creek drainage at approximately 5,500 feet elevation. Lodgepole pine was also found here with scattered white fir (*Abies grandis*) and Engelmann spruce occurring along the lower slope and creek bottom. Mountain maple, snowbrush (*Ceanothus velutinus*), serviceberry, chokecherry, huckleberry (*Vaccinium membranaceum*), spirea, and oceanspray (*Holodiscus discolor*) are abundant. Bluebunch wheatgrass, elk sedge, Idaho fescue and pinegrass are the most important grass species. These plants and a variety of forbs are found between talus and rock faces that cover a large part of the slopes.

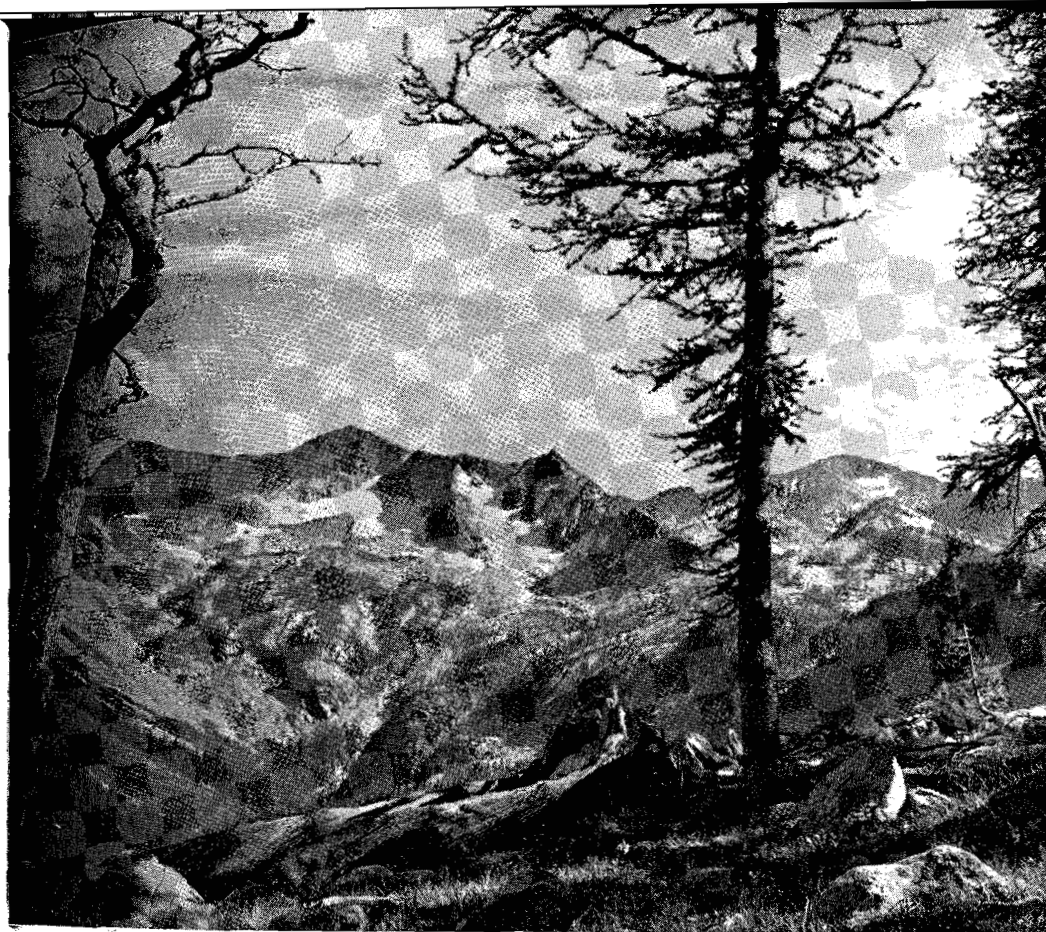


FIGURE 3. Summer range of mountain goats along the Idaho-Montana line at the headwaters of Tin Cup Creek, a tributary of the Bitterroot River.

Cliffs of the Selway River canyon, which are covered by the ponderosa pine/bluebunch wheatgrass association, are similar to winter ranges on the breaks of the Salmon River and on the lower south-facing slopes of the canyons draining into the Bitterroot River from the Idaho-Montana divide. Pinegrass and elk sedge are important in this association, which is contiguous with the Douglas fir zone at its upper edge and on north-facing slopes. Snowberry, ninebark, mountain mahogany, willow, serviceberry, mountain maple, snowbrush, chokecherry and elderberry (*Sambucus* spp.) are common on the southern aspects where winter use by mountain goats is most apparent.

#### Selkirk Range

That part of the Selkirk Range encompassed in this study is bounded on the west by Priest River and its tributaries, and

on the east by the glacially modified Purcell Trench and the valley of the Kootenai River. The crest of this range extends from north to south with drainages running to the west into the Priest River watershed, and to the east into the Kootenai River and the Pack River, a tributary of Lake Pend Oreille. The highest peaks lie at elevations of nearly 7,700 feet, while the valley floors at each side range in elevation from 1,800 to 2,400 feet.

In appearance, the summer mountain goat range in the Selkirks is similar to that seen in the Bitterroot Mountains. On their upper reaches, the canyons are deep, narrow and glaciated and are separated from each other by sharp ridges. Nearer the valleys, as the distance increases from the crest of the range, the mountains show evidence of greater age, and the slopes are rolling and less steep. The heavy timber cover here is in strong contrast to the extensive areas of precipitous range on the upper canyons where the granitic cliff-faces and talus are the outstanding physiographic features.

Snows are heavy throughout this range during winter, with the first heavy falls commonly occurring in the latter part of November. In the valleys an average of 29 inches of annual precipitation is recorded. Two-thirds of this precipitation occurs as snow, and the depths often exceed three or four feet. Higher slopes are covered by several times this amount, and it is usually late June before they are bare.

The abundant precipitation within the Selkirk Range has enriched the vegetation. Here we find a comparatively complex flora within the ponderosa pine, Douglas fir, cedar-hemlock (*Thuja plicata-Tsuga heterophylla*) and Engelmann spruce-alpine fir zones, as described by Daubenmire (1952a). Summer ranges lie largely within the Engelmann spruce-alpine fir zone in which the plant cover is essentially similar to that described for this zone in the Bitterroot Range and the Salmon River.

Many of the winter ranges in the lower canyons of the Selkirk Range lie within the cedar-hemlock zone. Here ponderosa pine, Douglas fir, larch (*Larix occidentalis*), lodgepole pine and white pine (*Pinus monticola*) are the principal seral conifers. As on other ranges, the topo-edaphic climax on cliff and talus slopes is composed of a variety of browse species. The heaviest use on some of these wintering areas is found where snowslides from rock faces have denuded the slopes of conifers, allowing the shrubs to become established. Among the more important species on these ranges are snowberry, chokecherry, mountain maple, spirea, Oregon grape (*Berberis aquifolium*), redstem ceanothus

(*Ceanothus sanguineus*), snowbrush, rose (*Rosa* spp.), serviceberry, syringa, thimbleberry, oceanspray, bearberry (*Arctostaphylos uva-ursi*), ninebark, currant, willow, mountain ash (*Sorbus scopulina*) and mountain lover (*Pachistima myrsinites*). Most of these shrubs also occupy precipitous ranges lying within the Douglas fir zone, while some of the most dense growths are found where fires had burned the forest canopy and the shrubs have become established. Stands of conifers are seen in various stages of growth as they gradually reestablish themselves as the dominants on these ranges. This brings about a displacement of the shrubs and a resulting decrease in forage production. It is evident that fire plays an important part here in increasing productivity of some mountain goat winter ranges by favoring the establishment of browse. Although shrub growth is present on and around rock outcroppings, adjacent stands of closed timber are poor producers of those browse species which are of great importance during critical winter periods when deep snows cover the low-growing vegetation.

#### Red Butte Range

The Red Butte area, lying near the headwaters of the Sun River about 40 miles west of Augusta, Montana, is bounded on the east by the West Fork of the Sun River, and on the west by the Continental Divide. The goats occupy ranges lying at elevations from 6,000 to 8,000 feet.

The area is underlain by an argillite and quartzite rock formation striking north and south and dipping steeply to the west. As a result, the west-facing slopes are steep and nearly uniform inclines, whereas east exposures are broken into steep cliffs and ledges. Glaciated cirques on this east exposure give rise to the main streams which drain into the West Fork of the Sun River.

Most of the Red Butte range is covered by several feet of snow throughout the winter, and this restricts the animals to lower southern aspects and small areas on ridges which are bared by action of the wind. The snow persists from late September or October through April, and generally it is not until May that bare ground can be seen on some of the higher ridges and in the ravines.

The upper part of the range lies within the Engelmann spruce-alpine fir zone, which is adjacent to the Douglas fir zone on the lower slopes. Timber cover was destroyed by a fire in 1916 and the vegetation is now composed of communities of shrubs, grasses and forbs, with a scattering of dwarf alpine larches, firs

and whitebark pine. Casebeer (1948), in describing the vegetation analyses that he and the author completed in 1947, found that shrubs (largely grouseberry) compose more than half of the total forage weight on this range. Beargrass, mountain heath and elk sedge make up most of the remaining cover along with several other forbs, grasses, sedges and rushes. Vegetation on the winter range is composed largely of shrubs which make up 68 per cent of the total estimated forage weight, as compared to 30 per cent for grasses and grass-like plants, and two per cent for forbs. Willow is the major shrub species, making up 52 per cent of the cover, while bluebunch wheatgrass is the important grass. Serviceberry, mountain maple, twinberry (*Lonicera involucrata*), chokecherry, spirea, snowberry and huckleberry are among the other shrubs that are also found on the lower southern aspect winter ranges.



## FOOD, WATER AND MINERALS

### Summer Food Habits

Cowan (1944) found in the examination of five goat stomachs from Jasper and Banff National Parks that 63 per cent of the summer food by volume consisted of grasses and sedges, 23 per cent browse, and 14 per cent forbs. From his observations he lists willow, strawberry (*Fragaria glauca*), green lily (*Zygadenus elegans*), purple milk vetch (*Astragalus alpinus*), yellow hedsarum (*Hedysarum sulphurescens*), alpine sorrel (*Oxyria digyna*), alpine equisetum (*Equisetum variegatum*), spike trisetum (*Trisetum spicatum*), bluegrasses (*Poa* spp.) and thick-spike wheatgrass (*Agropyron dasystachyum*) as preferred forage species on the summer ranges.

Snowbush (*Ceanothus velutinus*) was described by Anderson (1940) as the most important item in the spring and summer food of the goat in Washington. Grasses, huckleberry, aspen (*Populus tremuloides*) and several forbs were also listed. Case-

beer (1948), in reporting a summer food-habits study of the mountain goat which he conducted in the Red Butte area, considered grasses and forbs of secondary importance in the summer diet of the goat. Shrubs were of primary importance and 96 per cent of the summer use within five principal vegetative types was recorded on this class of forage. Grouseberry, which made up 49 per cent of the available vegetation, composed 96 per cent of the summer diet.

A stomach sample from a goat collected on Sweeney Creek in the Bitterroot Range during the early fall indicated that elk sedge and grasses were items of major importance in the fall diet. An average of 35 per cent of the stomach contents of four mountain goats collected during October from the Douglas fir zone on the Middle Fork of the Salmon River was composed of sedges, horsetails (*Equisetum* sp.) and grasses (Gutzman et al., 1935). Rock moss (possibly lichens) averaged 18 per cent of the contents, ninebark averaged 15 per cent and juniper (probably *Juniperus communis*) averaged six per cent of the total stomach samples. Generally utilization of the summer range is light and animals are highly selective, making accurate utilization estimates impossible. Feeding observations made during this study indicate, however, that grasses, grass-like plants and forbs are of primary importance in the summer diet.

### Winter Food Habits

Since it is on winter ranges that forage shortages become critical, greater effort has been expended in defining vegetative cover, animal preferences, and the effects of utilization on preferred species. Casebeer (1948) found that grass composed 63 per cent and 68 per cent of the winter forage of mountain goats in the Red Butte area (Figure 4) and the Rattlesnake range<sup>2</sup>, respectively; Junegrass and bluebunch wheatgrass were the two principal species despite their relatively low availability. This was in accord with observations of Anderson (1940) who stated that bluebunch wheatgrass, when available on Washington ranges, composed as much as 90 per cent of the winter forage. He found that shrubs and forbs were less important, making up only ten per cent of the winter diet, except when deep snows made grasses unavailable and browse was the principal food. Casebeer found that shrub species, mostly willow and serviceberry, were of secondary importance and constituted 35 per cent and 29 per cent of the diet on the two Montana winter ranges. Forbs

<sup>2</sup>Rattlesnake Creek lies immediately north of Missoula, Montana.

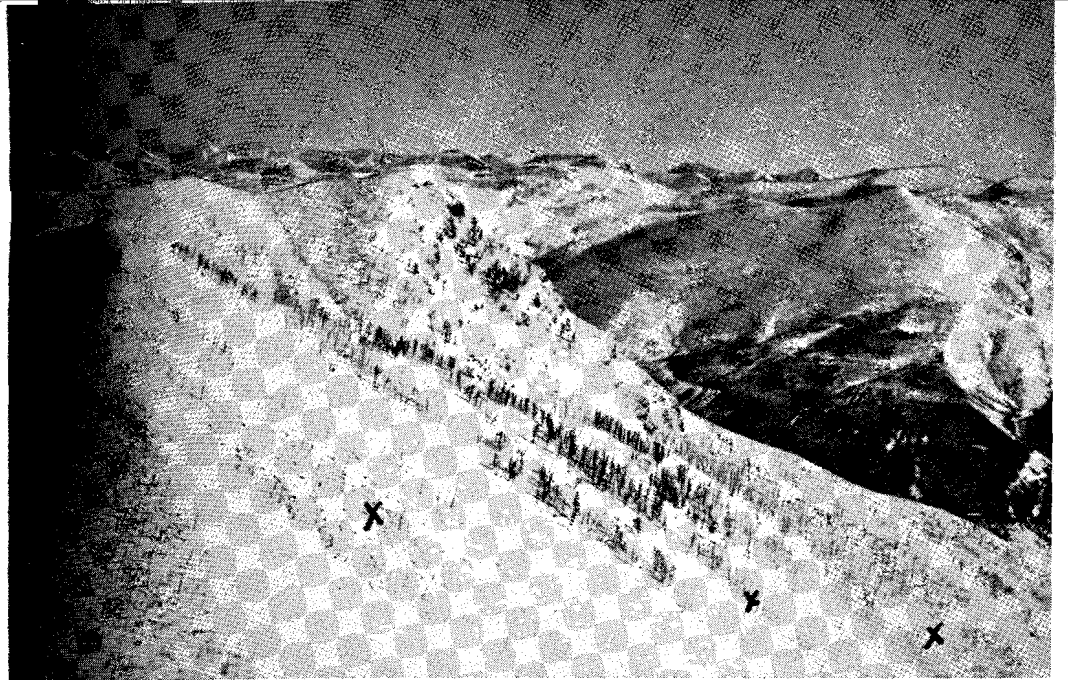


FIGURE 4. Windswept slopes (marked) on a southern aspect ridge which was utilized as winter range by mountain goats in the Red Butte area. The slopes shown here lie at elevations of between 7,500 and 8,000 feet.

made up two per cent of the feed on the Red Butte range as compared to three per cent on the Rattlesnake area; beargrass was the only forb showing heavy winter use in the Red Butte area with 85 per cent of its available weight being removed. This contrasted to the negligible use recorded during the summer. Casebeer also found that many of the browse species which had been used heavily during the summer were avoided in winter.

Trees and shrubs which included balsam fir<sup>3</sup> (*Abies lasiocarpa*), aspen<sup>4</sup> (*Populus Trichocarpa*), dwarf birch (*Betula glandulosa*), red osier dogwood (*Cornus stolonifera*), raspberry (*Rubus* sp.), rose (*Rosa macounii*) and several species of willow were given high winter palatability ratings by Cowan (1944) from his observations in Banff and Jasper National Parks. Forbs were not recorded as winter foods, but several species of grasses, including alpine equisetum, spike trisetum, bluegrasses and black-spiked wheatgrass, were shown as being highly preferred the year round.

Hanson (1950), in reporting on food habits of mountain goats in the Black Hills, listed winter foods in their probable order of importance as follows: bearberry (*Arctostaphylos uva-*

<sup>3</sup>Listed by Cowan as balsam fir, probably alpine fir.  
<sup>4</sup>Listed by Cowan as aspen, probably cottonwood.

ursi), tree lichen (*Unsea barbata*), black chokecherry (*Prunus melanocarpa*), paper birch (*Betula papyrifera*), currant (*Ribes inebrians*) and serviceberry (*Amelanchier* spp.). Ponderosa pine, white spruce (*Picea glauca*), juniper (*Juniperus communis*) and willow were listed as being of unknown or little importance in the goats' diet. He also reported that the importance of the tree lichen was striking both from the standpoint of preference and the quantity eaten. Bearberry was described as a staple food item which the goats pawed through the snow to uncover. Harmon (1944) indicated that winter and spring food on this range is quite varied with the diet consisting of about 60 per cent twigs and needles of ponderosa pine, and 10 per cent miscellaneous items including ferns, grasses, currant, juniper, willow and erigeron (*Erigeron* sp.).

During this investigation, winter foods and food preferences of mountain goats were determined by four methods: (1) timed observations of feeding animals; (2) examination of stomach contents; (3) estimations of the percentage by weight of current growth of shrubs removed in course of winter use; and (4) measurement of current growth of preferred browse species on key winter ranges before and following the winter period of use.

The most intensive work was done on the winter ranges along the breaks of the Salmon River canyon at elevations of approximately 4,500 feet where the principal forage species were bluebunch wheatgrass and mountain mahogany. Little time had been spent on these ranges before it was recognized that these two species were succumbing to the concentrated use of mountain goats on limited portions of the preferred wintering areas. It was evident in many cases that the strong attachment of animals to home ranges often prevented movement to adjacent slopes where the same forage species were only lightly used. Often goats remained on these restricted ranges for months, to the detriment of both the range and their own physical condition. The effects of these concentrations on preferred ranges were seemingly proportional to the number of animals involved, and in frequent cases where two or three animals "yarded" in this manner the resultant damage was confined to small areas. Snow depths of two to three feet further restricted the animals' movements during severe winters, thereby increasing the competition for the available browse.

As the winters progressed the less choice, coarser middle and basal stems were taken. It is possible that the findings of Aldous (1945), which indicated that protein was concentrated in the

terminal buds of bitterbrush (*Purshia tridentata*) and that decreasing amounts occurred in proximal portions of the twig, are applicable to mountain mahogany. Thus, with a general drop in protein content, which is believed to occur in shrubs during the winter, and the gradual reduction in availability of the choice terminal twigs as they are consumed, there is probably a progressive decrease in the quality of winter forage.

Analysis of six stomach samples from similar mountain mahogany and bluebunch wheatgrass ranges on the Salmon, Bitterroot and Selway drainages indicated that grasses and mountain mahogany provided 96 per cent by volume of the winter food of mountain goats, while Oregon grape (*Berberis aquifolium*), forbs, ponderosa pine needles, lichens and mosses were found in minor quantities (Table 2). These findings correspond fairly closely with feeding observations except for the comparatively heavy use which was seen for foliose lichens (*Umbilicaria vellea* and *Dermatocaroon minutum*) that were found only as traces in the stomach samples (Figure 5). Heavy use of the lichens was observed in February and March when melting snow on rock surfaces provided moisture favorable to their growth.

Bluebunch wheatgrass is the most important of the grasses utilized along the Salmon River by mountain goats. In winter, green basal leaves of fall growth are found in clumps which ripen after the spring and early summer growing period. Early spring growth is highly preferred and plants are often damaged by

TABLE 2. Stomach contents, as expressed in percentages of volume, of six mountain goats from comparable mountain mahogany-bluebunch wheatgrass winter ranges in Idaho and Montana.

Area	Grasses	Mountain Mahogany	Oregon Grape	Forbs	Lichens and Mosses	Ponderosa Pine Needles	Unidentifiable
Indian Creek, Selway River.....	70	20	..	..	..	..	10
Chaffin Creek, Bitterroot River, No. 1...	50	50	T <sup>1</sup>	T	..	..	..
Bitterroot River, No. 2...	10	80	10	..	..	..	..
Sheep Creek, Middle Fork of the Salmon River.....	T	100	..	T	..	T	..
Corn Creek, Salmon River...	95	5	..	T	..	T	..
Bargamin Creek, Salmon River.....	100	..	..	..	T	..	..
AVERAGE.....	54	42	2	T	T	T	2

<sup>1</sup>T — Trace.

FEEDING TIME	STOMACH CONTENTS
GRASSES 23 %	GRASSES 54 %
MOUNTAIN MAHOGANY 36 %	
OTHER SHRUBS 16 %	MOUNTAIN MAHOGANY 42 %
FOLIOSE LICHENS 24 %	
FORBS—1 %	
	OTHERS — 4 %

FIGURE 5. Winter food habits of mountain goats as indicated by (a) 669 minutes of feeding observations on the Salmon River, and (b) analyses of the contents of six stomach samples from comparable winter ranges on the Salmon and Selway Rivers, Idaho, and the Bitterroot Range, Montana.

heavy use before the goats disperse from concentration areas. On many ranges the wheatgrass has been depleted severely and the annual cheatgrass has replaced it as the dominant (Figure 6).

In the falls of 1949 and 1951, and in the springs of 1950 and 1952, current growth of shrubs was measured to determine the extent of utilization of tagged stems. The per cent cropped of total length of available twig growth was determined from these measurements. During the first winter 311 plants were tagged on five different areas to determine general preferences for browse species by mountain goats, bighorn sheep, mule deer and elk. On



FIGURE 6. Winter mountain goat range on Corn Creek, a tributary of the Salmon River, at an elevation of approximately 4,200 feet. Bluebunch wheatgrass, mountain mahogany and lichens are the principal winter forage on this range. Concentrated use of the wheatgrass is resulting in its replacement by cheatgrass. Two nannies are shown with their eleven-month-old kids.

one of these areas use was primarily by mountain goats and bighorn sheep, but the other four were utilized by elk, mule deer and bighorns. Mountain mahogany was found to be the most abundant and preferred browse of the 13 species measured. Average utilization ranged from less than 10 per cent to more than 50 per cent of the current growth.

In the second winter 396 twigs of mountain mahogany were measured on a key Salmon River winter goat range. Fifty-four per cent of the total current growth of 9,057 inches had been consumed by spring and 65 per cent of the measured twigs showed use in excess of 50 per cent of the new growth. This utilization was compared with the degree of hedging resulting from use during previous years by placing each plant in one of three hedging classes at the time of the fall measurement. Half of the plants were classed as severely hedged, while 34 per cent were placed in the moderately hedged category. Only 16 per cent were considered to have been lightly hedged. It is significant that animals

were less concentrated on this range during the winter of 1951-1952 than they were in the mild winter of 1949-1950 when the first measurements were made, and it is probable that the damage to the mountain mahogany during the first year's observation exceeded that of the later period.

Elk and mule deer compete with mountain goats for the preferred bluebunch wheatgrass and mountain mahogany on the more accessible portions of the Salmon River winter ranges. Bighorn sheep also utilize these species heavily (Smith, 1951) and, were it not for their preference for open grass slopes, they would undoubtedly compete more directly for the forage within the winter goat ranges.

During severe winters all of these big game species are concentrated on lower slopes of the Salmon River canyon and it is then that mule deer and elk often utilize broken terrain that is normally occupied largely by sheep and goats. The preference of all of these big game animals for the new growth of bluebunch wheatgrass which is available in the low warm sites during late March and April causes a concentration of use that frequently results in depletion of this grass and invasion by cheatgrass and forbs (Figure 6).

Heavy winter use of conifers was indicated from stomach samples taken in the Red Butte area and on Rattlesnake Creek in which ponderosa pine, whitebark pine, alpine fir, Douglas fir and Engelmann spruce occurred. Stomach samples from three animals found dead on the Red Butte winter range indicated that alpine fir and whitebark pine are apparently used as emergency forage. These conifers are probably the principal winter food of mountain goats during critical periods on many of the higher wintering areas when deep snows cover all of the herbaceous growth and all but the upper stems of shrubs. It is probable that they are also an important source of food on many of the high wintering areas such as those observed at elevations of approximately 6,000 feet on the North Fork of Salmon River, Old Man Creek on Lochsa River, and Two Mouth Creek within the Selkirk Range. Casebeer (1948) commented on the use of needles of fallen Douglas fir and ponderosa pine which were taken in preference to foliage that was available on standing trees. That grasses were important is indicated by their occurrence in two of the three Red Butte stomach samples and it is probable that they are utilized heavily whenever available.

Shrubs appeared to be the most important item in the food of Selkirk goats on winter ranges lying at elevations of approxi-

mately 4,000 to 5,000 feet. All but one of the five wintering areas visited were on south-facing slopes where from two to five feet of snow covered grasses and forbs, making them unavailable throughout most of the winter. Competition with mule deer was evident on two of the winter ranges, although for the most part goats in the Selkirk range winter above the main concentrations of deer.

Fires which occurred approximately 20 years ago were responsible for the increased production of shrubs on three of the ranges visited. However, on many areas of the steep canyon slopes, seral shrub communities are evidently the result of conifers being removed by snowslides. Plant composition studies using the line-interception method showed that shrubs made up 32 to 66 per cent of the cover on ranges examined, but that they are now losing their dominance as the competition from conifers increases and the forest canopy closes. This will make it necessary for the animals to adjust their feeding habits to the available forage which will be dominated by conifers, or undergo a natural reduction in numbers to bring about an adjustment between available food and the number of animals utilizing these winter ranges.

Winter utilization of shrubs on the Selkirk ranges was determined by estimating the per cent of the season's current growth removed during the winter. Mountain maple was found to be a key browse species. Rose, serviceberry, chokecherry, syringa and redstem ceanothus showed moderate to heavy use. In the areas of greatest animal concentration these species were severely depleted and the large number of dead and dying mountain maples was indicative of past heavy use. Grasses had been taken in the spring, and in many of the warmer sites had suffered depletion. Heavy browsing of the terminal branches of Douglas fir was noted on some of the wintering areas.

It is evident that on many of the mountain goat winter ranges food shortages are frequently critical and animals are dependent on what appears to be low quality forage. Where deep snows occur, intraspecific competition is intensified due to the strong tendency of animals to concentrate on limited portions of the wintering areas. Although many winter goat ranges lie at elevations well above those utilized by mule deer, elk and bighorn sheep, there is evidence of competition for preferred grass and browse on lower areas which are occupied commonly by two or more of these species.



Where use by mountain goats has been concentrated over the years, forage productivity has usually dropped as a result of the depletion of the plant base. On some ranges this process is hastened by vegetative succession where browse associations, which have become established as a result of disturbances, are being replaced by either seral or climax conifer associations. Winter food shortages are recognized as a principal factor limiting herd increases on many ranges. In the absence of control of populations through proper harvest, a balance between animal numbers and food supplies is accomplished by nature, following a severe depletion of the winter ranges. These natural reductions have apparently occurred on many of the mountain goat ranges throughout Idaho and Montana, and they will undoubtedly continue until such time as it is possible to observe the small and widely scattered herds at sufficiently frequent intervals to define the relationship between animal numbers and the forage production.

#### Water Requirements

Anderson (1940) stated that watering places were a necessary requirement of goat ranges and that they limited the summer distribution of animals on some areas in Washington. However, water does not appear to be a limiting factor on any of the goat habitats observed during this study. Springs and melting snowbanks on the high summer ranges provide water in abundance, while on the lower ranges of the Salmon River it becomes less plentiful as summer progresses and intermittent streams dry up. By this time most of the goats have migrated to higher ranges where run-off from melting snows is available.

When a group of animals comes to water, some, but not all, will usually drink, and goats frequently wade or jump over a stream without stopping. There is no evidence that animals make daily trips to sources of water, although the abundance of watering places on most ranges made it impossible to determine the length of periods that they went without drinking. Goats sometimes take several mouthfuls of snow when they first walk onto a snowbank during warm weather and are occasionally seen eating snow during the winter.

#### Use of Natural and Artificial Licks

Mountain goats will travel several miles to utilize natural and artificial licks during spring and summer months. On the South Fork of the Flathead River in Montana, goats are believed

to be drawn from as far as 15 miles to natural licks. Cowan and Brink (1949) mentioned goats having traveled through miles of forest in reaching natural licks within Jasper Park in Canada. Similar long distance movements were reported to the large mineral lick near Walton on the southern edge of Glacier National Park. Many of the natural licks in this area and on the Sun River are associated with brightly colored red and green out-croppings of argillite and quartzite rocks. Dry soil from the Walton lick showed the presence of 600 parts per million of soluble salts, high availability of phosphorous, and a pH of 8.2. A similar test of colored soil from the Little Salmon lick on the South Fork of the Flathead River showed a pH of 8 with 235 parts per million of water soluble salts, light to medium amounts of magnesium, sodium, chlorides, and traces of sulfates and calcium. The presence of available phosphorous on the Walton lick may be responsible for its heavy use by goats since this is an essential element for animal nutrition, and available sources of it are described as being scarce in this area. The 235 parts per million of soluble salts present in the dry soil of the Little Salmon lick is not high. However, the predominant salt was found to be sodium chloride, which would make the lick attractive to animals in the absence of better or more concentrated sources.

Surface soil from two natural licks on Lion Creek within the Selkirk Range showed approximately 20 parts of salt per million. Both of these samples showed from 0.01 to 0.03 mil equivalents of sodium, potassium, and chloride per liter. This salt content is very low and would be expected to occur in most soils of the area. It was suggested by the analyst that use of these natural licks may reflect a mineral deficiency in the diet which is partially satisfied by these soils. Stockstad, *et al.* (1953), in reporting on mineral preference tests in the form of mineral cafeterias and soil impregnation tests on ranges of mountain goats, elk, mule deer, and white-tailed deer in western Montana, found sodium to be the mineral preferred by these ruminants. A very limited and inconclusive cafeteria experiment conducted during this investigation on the Salmon River indicated that sodium iodide was utilized in spring by mountain goats in preference to nine other salts.

Goats have been observed licking soil and drinking water from mud holes in high subalpine basins. In one observation each animal of a large group drank from a stagnant pool that was 25 feet from a small snow-fed stream.

Judging from sign, and from frequent observations, it appeared that mountain goats made regular use of artificial salt

licks during spring and summer. In places where salt was no longer present, animals licked and chewed the soil where it had leached into the ground.

There is no evidence that artificial sources of salt satisfy any physiological requirement of mountain goats despite the fact that they show a strong appetite for it. Murie's (1951) statement concerning salt use by elk may be applicable to mountain goats: "The normal food supply . . . undoubtedly contains the various mineral salts in quantity sufficient for the animals' physiological needs. Well-meaning efforts to improve . . . condition by feeding salt may be simply introducing a new habit that further study may show is useless, if not harmful, in the long run." There is some indication that salting of goats for the purpose of attaining desirable distribution and spring movement from winter ranges may be practicable. However, its placement on permanently located salting grounds would be expensive on the widely scattered mountain goat ranges, even if this were accomplished with airplanes.

Observations during this study indicate that consumption of salt by goats, as well as by elk, mule deer and bighorn sheep, reached a high point during spring and early summer when the new growths of succulent forage were taken. As summer progressed, less time was spent on salting grounds and by winter little, if any, use was made of them. Hanson (1950) found that the greatest use, as defined by the average number of goats seen on a Black Hills salting lick per man-hour of observation, occurred during June and July. Except for the period from December through March, they took some salt during every month of the year.

Artificial licks are often used communally by mountain goats, elk, deer and bighorn sheep. Goats in the Red Butte area were frequently driven from licks by elk only to return to be chased again. In one case, a large goat passed brazenly between two bulls that licked salt blocks 50 feet from each other. Goats were aggressive in the presence of mule deer on licks, and frequently chased them from the salt. Bighorn sheep and goats have not been seen at licks together, but they have been observed to intermingle many times while feeding without any displays of intolerance. Intraspecific competition for salt occurs among mountain goats and usually one animal licks a block while the less aggressive wait their turn.

Salt has been used successfully as bait for goats which were transplanted in Montana. Traps constructed around established salting grounds, which had been used by the animals for several years, were found to be the most successful.

## PHYSICAL CHARACTERISTICS

To collect the needed management information on the mountain goat it is necessary to have sufficient knowledge of those physical characteristics which enable determination of age and sex. Weights from 55 animals and measurements from 26 animals collected during this study provide more complete information on the body dimensions of *Oreamnos americanus missoulae* than has been available heretofore. On the basis of a small number of measurements this subspecies has been previously described as the smallest representative of the species *americanus*.

### Age and Size

#### KIDS

A kid born on June 17, 1949, in a holding pen of the Montana Fish and Game Department at Helena, Montana, weighed 6.5 pounds, measured 22 inches in total length, and was 13.5 inches high at the shoulder (Table 3). Figure 7 shows a kid that was approximately a week old. Anderson (1940), in a Washington study, recorded weights of six pounds and eight pounds for two kids (*O. a. americanus*) which were less than two weeks old. A fetus weighing 3.2 pounds was collected from a nanny killed on the Salmon River on April 5, 1950, six to 10 weeks before parturition would have occurred. A four-month-old animal killed in the Bitterroot Range weighed 25 pounds hog-dressed, with the head, skin and legs remaining on the carcass. A total weight of 25 pounds was recorded for an emaciated seven-month-old kid (animal No. 30, Table 3) which apparently had starved to death.

#### YEARLINGS

Weights of three eleven- and twelve-month-old goats show little differences in male and female sizes. Two males (Nos. 3 and 4) weighed 45 and 43 pounds, while the female (No. 2) weighed 42 pounds. These three animals measured from 37.5 to 39 inches in total length and from 24 to 25 inches high at the shoulder. The latter measurements compare closely to the seven-month-old animal (No. 30) that measured 24.5 inches at the shoulder. The rapid rate of growth during the second summer is indicated from measurements on a female of approximately 16 months of age (No. 5) which was killed on October 10, 1947. This animal measured 27 inches high at the shoulders and 41 inches in total length.

It was difficult to age the yearling animals during their second fall and winter unless they were observed at fairly close



FIGURE 7. A female with a kid less than one week old in the Selkirk Range.

range. When observations were made at distances of several hundred yards, as they often were during this investigation, the long yearlings may have been recorded as adults because of the difficulty in distinguishing them from the older animals.

#### TWO-YEAR-OLDS

The weights of two males (Nos. 9 and 10) and a female (No. 8), thought to be two years old on the basis of dentition and horn development, ranged from 57 to 67 pounds. Lengths of the three animals ranged from 42.0 to 46.0 inches, and hind foot measurements varied from 10.5 inches to 11.5 inches. The 24.5 inch shoulder height of one of the males was considerably smaller than those of either of the other two goats which measured 30 and 32.5 inches, respectively. The shoulder measurement of the smaller animal compares closely with those for yearlings, but because of differences in the horn size, dentition, weight and total length, it is classed as a two-year-old. It was found that although the two-year-old is smaller than older animals it is not readily distinguishable in the field.

The weights of six yearlings and two-year-olds were averaged with those of 19 animals which were estimated to be one-and two-year-olds by trappers. Mean weights for nine males and sixteen females were calculated separately; both were 57 pounds, with a range from 37 to 90 pounds. Most of the measurements were taken in the spring when the animals were down in weight, and it is possible that some of the goats included in the trappers' estimates were aged incorrectly.

#### THREE-YEAR-OLDS

The four healthy three-year-old mountain goats ranged from 101 to 118 pounds. They averaged approximately 45 pounds heavier than the two-year-olds and were seven to nearly 10 inches longer. Although the average total length measurements for the males and females varied slightly (females, 53.5 inches; males, 51.8 inches), the males averaged 1.7 inches higher at the shoulder than the females in this age class. Hind foot measurements of the three-year-olds ranged from 11.8 to 13.0 inches.

Live-trapped animals showing two pairs of permanent incisors in the spring were placed in this age group. For purposes of field aging, mountain goats at this age are indistinguishable from older animals since it is usually impossible to approach sufficiently close to count the horn rings.

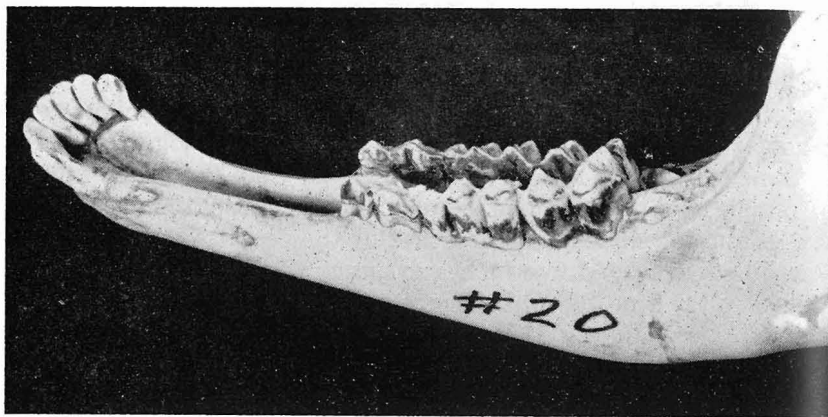


FIGURE 8a. A kid approximately eight months of age having a complete set of milk incisors and premolars. The first molar is fully developed and the second is beginning to emerge. Note the three-rooted and three-cusped characteristics of the lower fourth milk premolars.

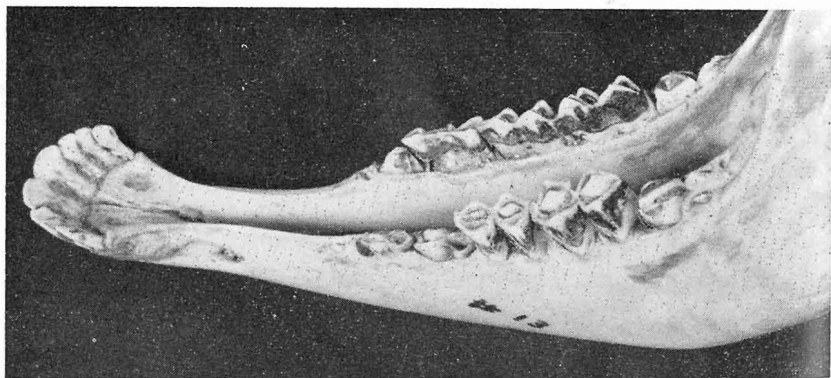


FIGURE 8b. An animal 23 months of age in which the first pair of permanent incisors are present. The third and fourth permanent premolars are emerging beneath the milk teeth which are being shed, while the second premolars have not yet emerged. The three-rooted and three-cusped fourth milk premolars are being replaced by two-rooted bicuspid permanent teeth. The first and second molars are fully developed, but the third molar is still erupting.

## FIGURE 8. Tooth succession in the mountain goat.

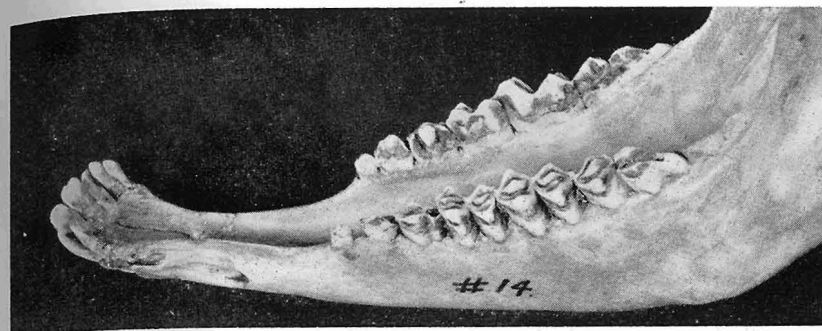


FIGURE 8c. A 35-month-old animal having two pairs of permanent incisors, and a complete set of premolars and molars. The two outer pairs of milk incisors were present in this jaw originally, but one on the left side had been lost at the time this photograph was taken.

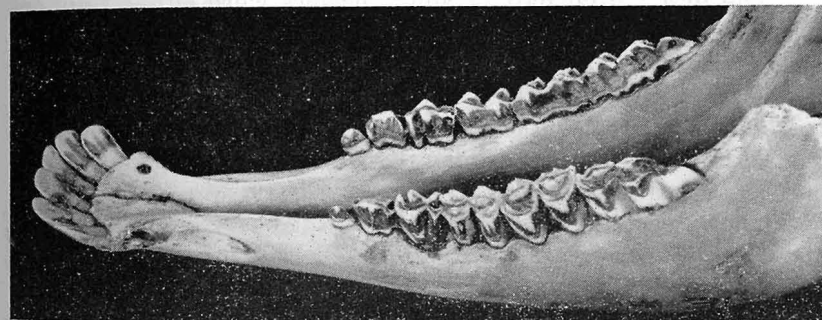


FIGURE 8d. A 39-month-old animal having three pairs of permanent incisors and complete sets of premolars and molars. The outer pairs of milk incisors are sometimes lost a few months before their permanent replacements emerge.

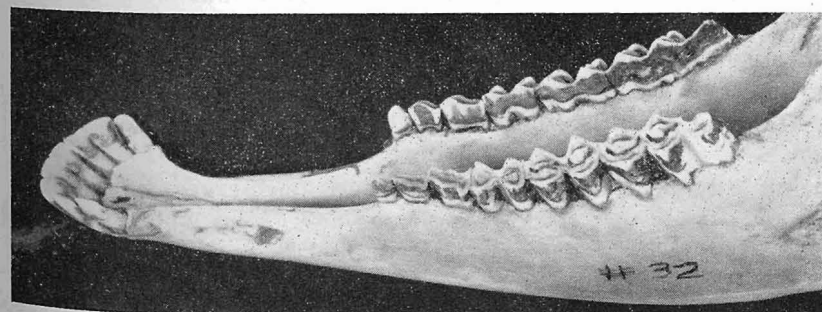


FIGURE 8e. A complete set of permanent teeth is present by the time the animal is approximately four years of age. Wear indicates that this goat was older than four years.

in a few, only the root "stubs" remained. Uneven wear on the opposing surfaces of upper and lower premolars and molars leaves the tooth rows with alternating hollows and protruding points that hinder mastication. The narrower teeth of the mandible show this more quickly than the upper premolars and molars, which are wider and therefore wear more slowly.

Two adult skulls were collected which show an extra tooth in the upper jaw. Both of these were situated against the inner surfaces of the second and third premolars in animals which had complete sets of otherwise normal permanent teeth. They were imperfectly shaped and approximately the same size as the anterior premolars. Their occluding surfaces showed only slight wear resulting from lateral movement against the teeth of the mandible.

### Characteristics of Horn Growth

The horns of the mountain goat, though small when compared to those of some of the other big game animals in North America, are sought by many hunters. As true horns, they are never shed, and it has become apparent that their growth rings

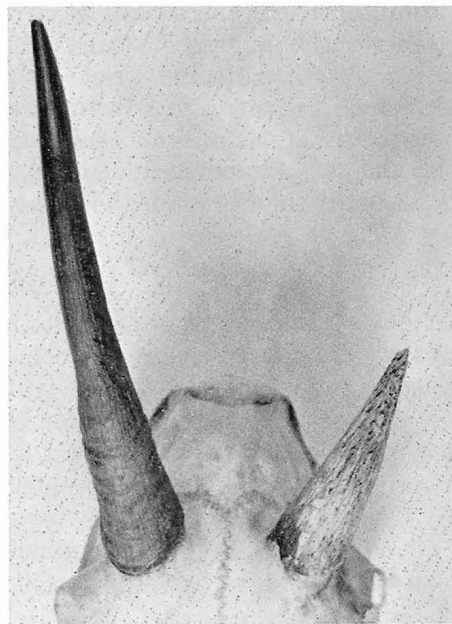


FIGURE 9. The sheath and bony core of the mountain goat horn. The sheath is epidermal in origin and, as a result, its growth occurs from the base. The two parts of the horn often separate after an animal has been dead a few days, making it possible to detach the sheath

serve as a permanent record of the conditions under which an animal has lived. The function of the horns appears to be that of defense, and their sharp points, when powered by the quick upward thrust of the animal's head, present formidable weapons.

There are two parts to the mountain goat's horn—the core, which is an outgrowth of the frontal bone of the skull, and its black, horny, sheath-like covering (Figure 9). The sheath is

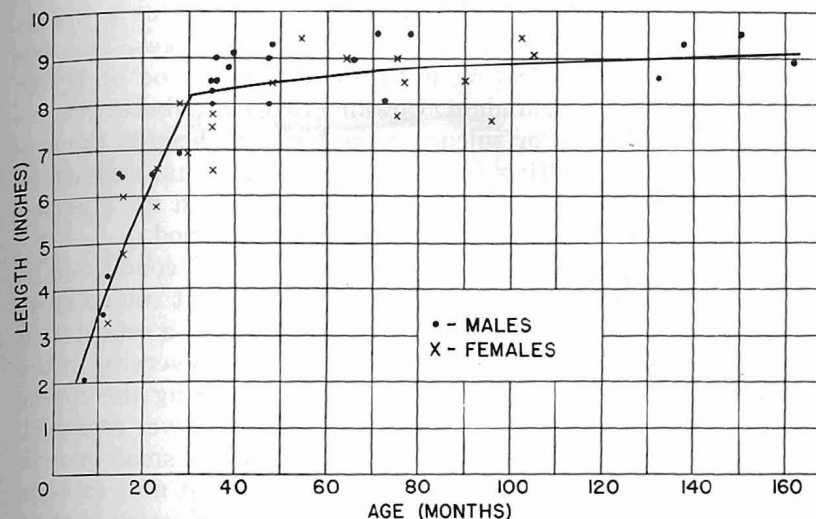


FIGURE 10. The relation of horn length to age in mountain goats (as determined by the logarithmic method of least squares) showing the change in growth rate at approximately thirty months of age. Both the teeth and horns were used to age animals less than four years old, while horn rings provided approximate ages of older animals. The data were divided into two groups for thirty months as the dividing point.

from the core. The bony axis extends approximately four inches into the sheath of a nine inch horn, but unlike the outer covering, shows no backward curvature of the tip.

Probably most of the bone growth takes place by the time the goat is four or five years of age, and there is a comparatively small increase in the basal circumference of the horn as an animal grows older. The horny sheath attains the greater part of its length during the first three summers of an animal's life (Figure 10), but additional basal segments representing the amount of growth for each growing period are usually well-defined. Narrow rings resulting from a recession of growth during the late fall, winter and early spring seasons separate these "growth bands" following the second growth period. As a rule, no mark is left on the horn as a result of retarded growth during the first winter, and it is not until the second winter that the first ring is formed. Usually this is not as well defined as subsequent rings, and occasionally the only evidence of the second winter period is the wrinkling of the surface of the horn.

Couturier (1938), in describing the chamois (*Rupicapra rupicapra* L.) of Europe, recognized that the horn of the animal

underwent an arrestment in the winter development due to the effects of adverse weather and resulting food shortages. This period was described as lasting until March when food of better quality became more abundant. Cowan (1940) attributes the development of the ring, or sulcus, in the bighorn sheep to the cessation of growth resulting from the increased sexual activity of the rut. Growth was believed by him to be retarded for a period of several months before and after the mating period.

It appears probable that less favorable food conditions of winter and the increased sexual activity of the rut interplay to reduce horn growth in winter, and it is evident that a retardation of horn growth represents the yearly period of adversity in the mountain goat's life. Any growth that is lost during the course of the spring-summer-early fall growing period is never regained, with poor seasons being readily recognized by their small growth segments. The periods of retarded growth are most noticeable in the smaller horns of animals which suffered privation during their first three growing periods.

#### KIDS

The inconspicuous small protrusions of the frontal bones, which can be felt on the kid's skull at birth, grow rapidly during the first summer. A kid taken in September had one inch horns. By winter these reach lengths of between 1.5 and 3.0 inches (Figures 10 and 11a, and Table 4). The horns of two animals, seven and eight months old, measured 2.1 inches and 1.6 inches in length, while the basal circumference measurements were 2.1 and 1.9 inches respectively. Development of the young animal's horns probably commences in the spring at an age of about 10 months so that they reach a length of approximately three to four and a half inches by the time the animal is one year old.

#### YEARLINGS

With the continuation of growth through the second summer and fall, the 16- to 18-month-old yearling possesses horns which normally range from 5 to 6.5 inches in length. It is at this age that the greater basal width of the males' horns becomes apparent (Figures 12 and 13) and the first annual ring begins to form as a result of the recession in growth during the animals' second winter-early spring period. Increase in horn length during the combined kid and yearling growing periods is more rapid than at any other time during the animals' life, and ranged from 4.0 to 7.1 inches while averaging 5.9 inches (males—6.3 inches; females—5.7 inches) in 39 pairs of horns.

TABLE 4. Horn measurements (in inches) of mountain goats from Idaho and Montana.

Animal Number	Sex	Approximate Age	Length on Front Curve <sup>1</sup>	Circumference at Base	Greatest Spread
30	M	7 mo.	2.1	2.1	2.6
1	?	8 mo.	1.6	1.9	...
3	M	11 mo.	3.5	2.8	3.3
2	F	1 yr.	3.3	2.5	2.8
4	M	1 yr.	4.3	3.0	3.4
58	?	1 yr. 1 mo.	5.0	3.4	...
60	M	1 yr. 3 mo.	6.5	4.5	...
6	M	1 yr. 4 mo.	6.4	4.3	4.8
56	F	1 yr. 4 mo.	4.8	3.1	4.1
5	F	1 yr. 4 mo.	6.0	3.0	3.8
8	F	1 yr. 11 mo.	5.8	3.2	4.0
53	F	1 yr. 11 mo.	6.6	3.6	4.6
9	M	2 yr.	5.5	3.3	3.5
10	M	2 yr.	6.5	4.1	3.9
52	F	2 yr. 4 mo.	8.0	4.0	4.1
50	M	2 yr. 4 mo.	6.9	4.5	...
11	F	2 yr. 6 mo.	6.9	3.4	...
12	F	2 yr. 11 mo.	6.6	3.6	...
13	F	2 yr. 11 mo.	7.6	4.0	6.0
14	F	2 yr. 11 mo.	7.8	3.8	4.3
15	M	2 yr. 11 mo.	8.0	4.5	5.5
68	M	2 yr. 11 mo.	8.3	4.6	...
16	M	2 yr. 11 mo.	8.5	4.5	4.4
67	M	3 yr.	8.5	4.5	...
31	M	3 yr.	9.0	5.1	5.4
61	M	3 yr. 3 mo.	8.8	5.0	...
44	M	3 yr. 4 mo.	9.1	5.1	5.0
45	M	3 yr. 4 mo.	9.0	4.9	6.0
17	M	3 yr. 11 mo.	8.0	5.0	5.5
25	M	3 yr. 11 mo.	9.0	5.3	6.3
26	M	4 yr.	9.3	4.8	6.6
20	F	4 yr.	8.5	4.5	6.3
18	F	4 yr. +	9.0	3.9	6.3
71	F	4 yr. 6 mo.	9.4	4.0	...
19	F	4 yr. +	9.5	4.0	5.3
55	F	4 yr. +	9.9	4.3	6.5
57	F	4 yr. +	10.1	4.2	6.8
32	M	4 yr. +	8.8	4.8	5.6
33	M	4 yr. +	9.5	5.8	5.9
23	M	4 yr. +	9.5	5.3	6.0
39	F	5 yr.	9.0	4.3	4.8
36	M	5 yr.	8.9	5.4	6.5
24	M	5 yr.	9.5	5.8	5.8
54	M	6 yr.	8.1	5.3	...
27	F	6 yr.	7.8	3.9	...
51	F	6 yr.	9.0	4.1	6.0
21	F	6 yr.	8.5	4.0	4.8
37	M	6 yr.	9.5	5.6	...
22	F	7 yr.	8.5	3.8	...
69	F	8 yr.	7.7	3.4	...
42	F	8 yr.	9.4	4.3	...
29	F	8 yr.	9.1	3.8	5.6
70	M	11 yr.	8.6	4.6	...
43	M	11 yr.	9.3	5.4	7.4
38	M	12 yr.	9.5	5.5	...
49	M	13 yr.	8.9	4.8	...

<sup>1</sup> The larger of two horn measurements is shown.

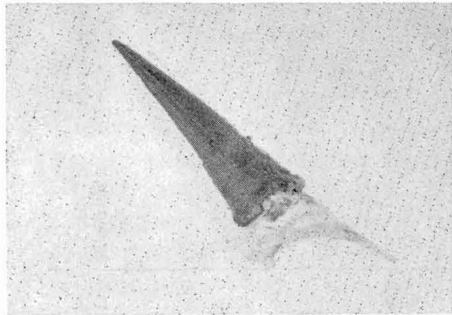


FIGURE 11a. A horn (1.6 inches in length) of an eight-month-old kid.



FIGURE 11b. A 22-month-old female that died before spring growth had commenced to demark the first annual ring. The horns measured 6.6 inches in length.

FIGURE 11c. A 28-month-old female with horns eight inches in length. The 1.6 inches of growth for the current period is that between the first rings and the horn bases. Additional development probably would have occurred before the end of this last growing period.



FIGURE 11d. A three-year-old male which was killed in June after the fourth period's growth had commenced and the horns had reached the length of nine inches. The rings of the second and third winter periods (as marked) are well defined at 2.1 inches and 0.3 inches from the bases, respectively.

FIGURE 11. Stages of Horn Development in the Mountain Goat

distributed along their entire length, while the horns of the nannies often show their greatest curvature within a few inches of the tips. Horn curvature also varies between individuals of the same sex, making this method impracticable for sexing in the field. Sex determinations were made during this study when the animals were seen at sufficiently close range to observe the genitalia, by the basal width of the horns, or when nannies were accompanied by young.

There is rather wide variation in horn spread of both females and males, with some of the nannies showing larger measurements between the outside edges of the horns at the point of greatest spread than those of the billies. As seen in Table 4, however, this difference is not consistent, and in some cases males of comparable horn length showed greater spreads than the females. One female with a horn length of 10.1 inches showed a 6.8 inch spread, while a billy with horns which were 9.3 in length had a horn spread of 7.4 inches.

Occasionally the horns show anomalies which are of interest. Jellison (1930) described a pair of deformed secondary mountain goat horns which developed behind the normal horns of an old

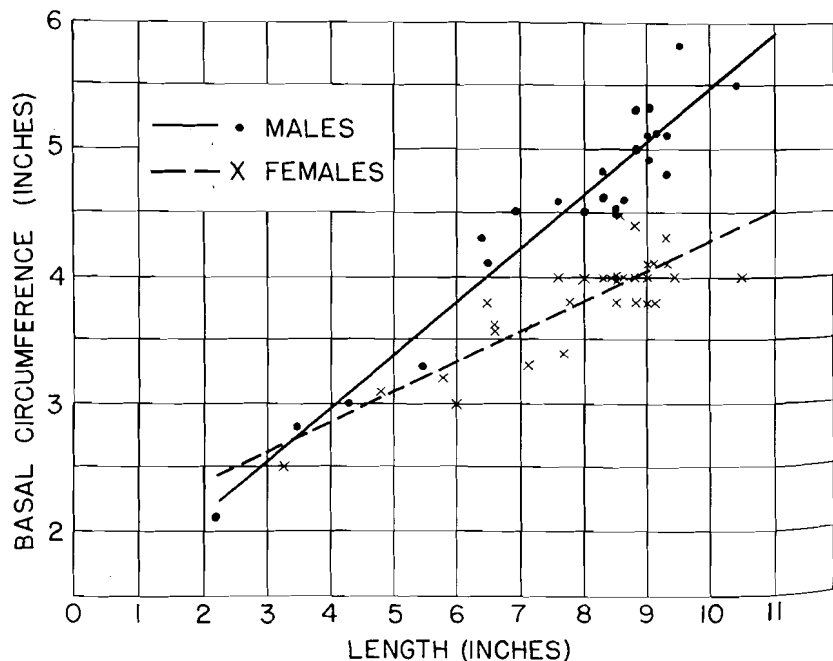


FIGURE 13. A comparison of the basal circumference of male and female mountain goat horns.

male. These were irregular in shape and were supported by a firm cartilaginous base on the smooth anterior surface of the parietal bone. The larger of the two extra horns measured 1.6 inches in length and had a basal circumference of 4.3 inches. Only the base of the right secondary horn was in contact with the back of the normal horn, but the entire length of the shorter left secondary horn was attached to the normal horn.

Deformation of the tips of the horns of a few animals was observed during this study. The distal inch and a half of the horn tips of one 16-month-old yearling were twisted posteriorly at an angle of nearly 45 degrees to the basal portion of the horn. Occasionally the horns are broken and deformed. On the Salmon River two animals were seen with horns broken off within an inch of the base. A few instances of horns that were broken near the tips of the sheaths were also recorded.

#### Determining Age by Teeth and Horns

Preceding descriptions of horn development and tooth succession in mountain goats from Idaho and Montana ranges provide a useful technique for age determination. Aging information from animals harvested during hunts is of value in defining herd productivity and survival rates. The following sections summarize those horn and dentition characteristics of use in determining age.

#### KIDS

The kid goat in its first fall is readily recognized by its small body size and small horns (1.5 to 3.0 inches). It has a full set of milk teeth (eight incisors, twelve premolars), four permanent first molars, and the emerging second molars may be present.

#### YEARLINGS

The second molars emerge in animals as they approach the yearling age. Sixteen-month-old goats have horns of approximately 5.0 to 6.5 inches in length, with most of their second year's growth occurring during the late spring, summer and early fall. No ring, or sulcus, is formed during the animal's first winter as a kid. The horns of a yearling taken during the late fall, winter, or early spring will not show these rings until after growth begins later in the spring, when the animal reaches an age of approximately 22 months (Figure 11b). Occasionally this first ring is indistinct and is represented by a slight wrinkling of the horn surface. Animals which are 18 to 22 months old



also have horns of approximately 5.0 to 6.5 inches in length, although occasionally where growth has been retarded they may be considerably shorter.

It is during the second year of life that the second molars reach their full development and the third molars and first pair of permanent incisors emerge. The first pair of permanent incisors are emerging, or are nearly completely developed, by the animal's second fall. These teeth can be recognized by their large size in comparison to the milk teeth. The milk premolars are present in the yearling, but they are frequently lost to be replaced by the permanent premolars during the animal's second fall and winter.

#### TWO-YEAR-OLDS

The basal segment of the horn representing growth that has occurred between 22 and 24 months is very small in the two-year-old, and the horns are only slightly larger than during the previous fall and winter. After growth commences in the spring, the first annual ring on the horn of the two-year-old is usually recognizable. Since most horn growth of the third year probably occurs in the spring, summer, and fall, when an animal is from 22 to 30 months of age, there is little difference between the horn size (an approximate length of 7.0 to 8.0 inches) of a goat that is killed in the fall at an age of approximately 29 months (Figure 11c) and one that is taken during the following spring when the animal is approximately 34 months old. The stage of tooth development is also very similar to that of the long yearlings during their second winter. The second pair of incisors erupt during the third year and are usually found to be emerging in the 28-month-old animal along with the permanent premolars, which sometimes are completing the replacement of their milk predecessors. The third molars are emerging at this time, with the lower teeth developing slightly earlier than those of the upper jaw.

#### THREE-YEAR-OLDS

A complete set of fully emerged permanent premolars and molars are found in three-year-olds. It is during the early part of the mountain goat's fourth summer and fall that the third pair of permanent incisors emerge. The last pair of incisiform teeth may be slower in developing than the first, second and third pairs, and may not be fully emerged until the animal's fifth summer. The horns of the three-year-old may range from 7.6 to 9.0 inches in length, but by the following winter they usually exceed 8.0 inches. The animal that is nearly three years old will show



FIGURE 14. Well-defined annual rings on the horns of a male goat that died after the thirteenth growing period when it was approximately 12½ years of age. No ring is formed during the animal's first winter.

only one ring until after growth has commenced in the spring and the second sulcus becomes apparent, while the goat that is over three years of age will show two annuli representing the two winters since it was a yearling.

#### FOUR-YEAR-OLDS AND OVER

The horns of the animal that is 46 months old show two distinct annual rings; the first of these represents the animal's second winter as a yearling, while the second is formed in the animal's third winter. The 48-month-old goat will show three rings, the last of which is formed during the fourth winter and demarks the upper edge of the basal current growth segment.

After the fifth year the annual rings are often difficult to distinguish, and it is necessary to check both horns carefully while paying special attention to their posterior surfaces where the rings are more distinct. In some cases with animals over 10 years old it is nearly impossible to determine age without the possibility of error by one or two years. By counting the number of summers' growth, starting with the two summers represented by that portion of the horn between the tip and first ring, the approximate age of an animal having distinct annuli can be determined fairly accurately (Figure 14).

All goats over four years old probably have their full set of permanent teeth. Further collections will be necessary to break down the five-year-plus age classes on the basis of wear. As with deer and elk, differential wear is apparent and broad age groupings of the older classes can be made.

### Hooves

The mountain goat's hoof is an adaptive feature which allows the animal to display greater dexterity on rough terrain than any other big game species in North America. In place of the concave surface within the horny shell of the hoof, as in deer, the mountain goat has pliable pads which are slightly convexed so that they protrude beyond the outer hard covering (Figure 15). These provide the traction which enables the goat to travel over the smooth surfaces of rock inclines in its characteristic slow, deliberate manner.

Approximately half of the hoof measurements obtained showed greater lengths than widths with the two bluntly pointed and nearly parallel digits reaching their greatest width posteriorly. Front hooves of several of the larger animals had equal length and width dimensions, making their tracks more square in shape than those of deer. Both the front and hind hooves of a newborn kid measured 1.3 by 1.0 inches. Average hoof size for three yearlings was 1.7 by 1.9 inches for the front hooves and 2.0 by 1.5 inches for the hind hooves. A pair of two-year-old males measured 1.9 by 2.3 inches on the front hooves and 1.7 by 1.9 inches for the hind hooves. Six females over two years of age showed average front hoof dimensions of 2.5 by 2.4 inches and hind hoof measurements of 2.3 by 2.1 inches. These were slightly smaller than the males, which averaged 2.7 by 2.4 inches for the front hooves and 2.4 by 2.1 inches for the rear hoof measurements. The largest hoof measurements of 2.9 by 2.5



FIGURE 15. The protruding pads of the mountain goat hoof which provide traction on smooth rock surfaces (actual size).

inches and 2.9 by 2.1 inches for the front and hind hooves, respectively, were taken from a large male (No. 24, Table 3). Tracks of the mountain goat within these size limits can be confused in the field with those of bighorn sheep and mule deer, two species commonly found on the same range with the goat. However, the characteristic square shape of the goat track usually enables one to recognize it.

### Horn Glands

The crescent-shaped glands occurring at the posterior base of the horns are unique in the anatomy of the mountain goat. These are black and from one to two inches in diameter (Figure 16), extending nearly half way around the horn of the adult. They were not evident externally in a fetus and a day old kid which were examined.

Seton (1927) described goats which were seen slashing at shrubs with their horns, an activity which he thought stimulated secretion of these glands during the mating period. Anderson (1940) also associated the secretion of the horn glands with the mating period, and stated that they are "particularly active" at this time.

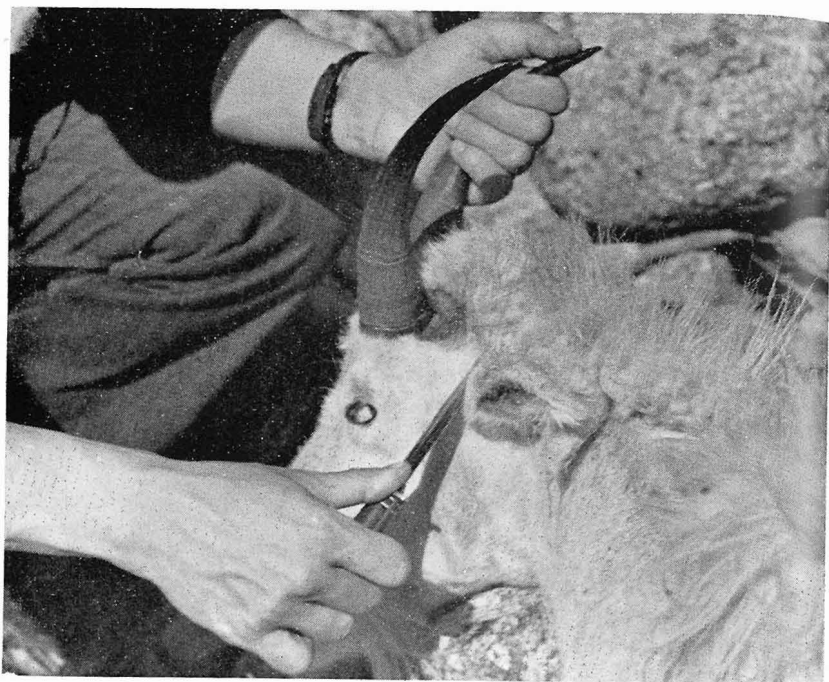


FIGURE 16. Gland at the posterior base of the horn of a three-year-old male mountain goat killed in June.

Couturier (1938) has linked the activity of the post-cornual gland of the chamois to the period of sexual activity. These glands, which are present in both sexes as in the mountain goat, are active during the rut, with those of the males secreting a strong odoriferous substance. The smaller glands of the female apparently are not secretory, although they show enlargement during the rutting period. After this peak of activity, in which the male chamois spreads the exudate by rubbing his head on rocks and tree trunks, the glands diminish in size and gradually atrophy in the summer months. Couturier suggested that the secretion of the male's glands aids the animals in locating each other and in exciting the female in preparation for mating.

Male mountain goats were not observed rubbing their horns against shrubs during the rut in the manner described by Seton, nor on more than a few occasions at other times. Unfortunately, no collections of males were made during the mating period to allow examination of these glands.

The mountain goat does not have the characteristic odor associated with the domestic goat. This would be expected, considering that the two species are unrelated and the term "goat," as applied to *Oreamnos americanus*, is a misnomer.

#### Pelage and Coloration

The mountain goat is the only big game species in the United States having a white coat. This stands out conspicuously against the rock-covered slopes of its summer environment, but merges almost imperceptibly into the snow backgrounds of winter. During the late summer, when the new coat shows little discoloration, its whiteness is in sharp contrast to the animal's black horns, nose and hooves.

Seton (1927) reported that one-third of the mountain goat pelts at the American Museum of Natural History contained a scattering of coarse brown hairs along the back, rump and tail section. He described a male kid from the Cascade Mountains of Washington that had a dorsal mane of brown hair an inch in width. This was not well-marked anteriorly, but on the tail it was brown and bristly and ended in a tuft of long dark hairs. Definite scatterings of dark brown hairs of similar distribution were noted in the coats of a day-old kid and a yearling during this study. These were confined largely to a narrow dorsal strip and were not present in sufficient numbers to detract from the predominant white color except upon close examination. Hanson (1950) described a dark, ashy-brown, dorsal band running from the neck to the tail of most of the young goats in the Black Hills of South Dakota. He thought that this dark coloration disappeared from the front portions of the body at the beginning of the first winter, but persisted posteriorly until the following spring.

Coarse guard hairs that grow to lengths of more than seven inches on the back and legs give the mountain goat its characteristic high-shouldered profile. The prominent growth of hair on the chin is probably responsible more than anything else for the acquisition of the misnomer "goat," due to the similarity of these "chin whiskers" to those of the domestic goat. Longer guard hairs are conspicuously absent on the lower leg for approximately eight inches above the hoof. The dense underfur is very fine and is believed to be of a quality which compares with the finest cashmere. Although we do not commonly utilize this today, it is known to have been highly prized for weaving by some of the Indians that originally lived near the goat ranges.

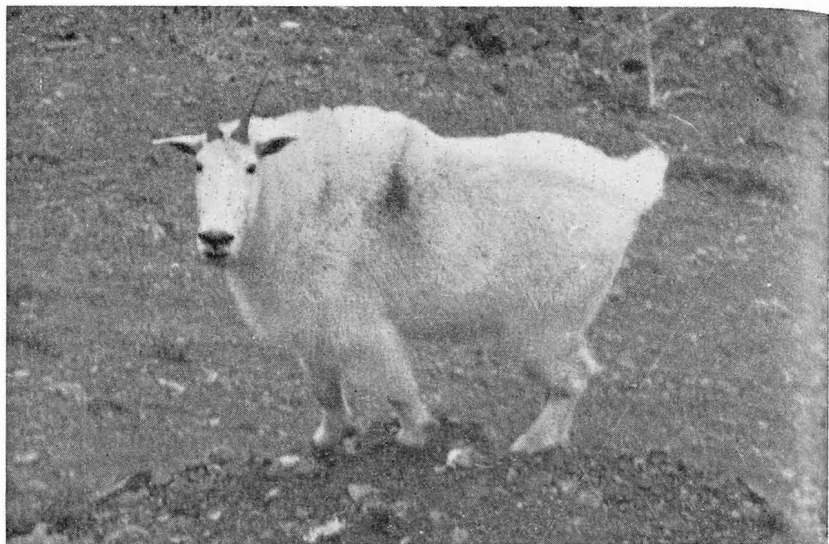


FIGURE 17. The coat condition of an adult female mountain goat a few weeks after shedding.

Gradual discoloration occurs in the goat's pelage, resulting in a change of its hue from that of a creamy shade of white to a dull gray which makes the animal visible against a snow background. Black spots, similar to the one shown on the animal in Figure 17, are sometimes seen for a few days following spring and summer rains. These apparently do not result from bedding on moist ground, since goats usually lie on their legs and sides where the least discoloration is observed, but they may be caused by animals rubbing against moist overhanging rocks of the ledges that they often use during rainy periods. The frequently observed soiling of the carpal joints is believed to result from animals kneeling as they bed in moist soil.

Mountain goats observed during early May frequently showed dark red spots in the coat which extended from the throat and neck regions to the brisket. Nicholas Kramis, of the U. S. Public Health Service in Hamilton, Montana, has observed a number of similar cases in early spring. One such animal collected by him was found to be heavily infested with wood ticks (*Dermacenter andersoni*). It was Mr. Kramis' opinion that the red coloration resulted from the parasites' excrement becoming wet and forming a stain that spread over the hair. Wood ticks were abundant in the spring on all of the ranges studied and the animals were usually heavily infested.

Loose strands of hair hanging from mountain goats during the latter part of April are the first evidence of shedding. This old hair, usually densely matted and dirty, seems to annoy the animals and on several occasions they were seen biting and pulling out the loose strands, scratching with their horns and rubbing against rocks and trees. There is considerable variation in the time that the change of coat is completed, and it was found that adult males and females without young were usually finished a few weeks sooner than nannies with kids.

By the middle of May, some animals lose patches of the old hair from the neck and shoulders, which are usually the first parts of the body to shed. Of 10 animals observed at close range on July 14 near Red Butte, only one adult male had shed the old hair completely. A lone adult female had shed more on the back and sides than had any of three nannies with kids which had lost the old hair from only their necks and shoulders. Some of the yearlings retained remnants of the old coat until August. However, on most of the animals the white new growth of hair had replaced the old coat by this time. The soft and comparatively short pelage of the kids continues its growth throughout the first summer and fall.

### Voice

One can spend many hours in close association with mountain goats on their ranges without hearing their voices. The most frequently heard utterance of the goat is the high pitched and rather plaintive bleat of the kids when they become separated from their mothers. A nursing kid will sometimes emit a high squeak as it punches the female's udder with its nose. Yearlings occasionally bleat in a manner similar to the kids.

Only one instance of an adult making a vocal sound was recorded; this was a female which bleated upon losing her kid which had momentarily strayed from her. Hanson (1950) described a male that bleated softly when surprised by the observer. The deep coarse grunt described by Seton (1927) as the common call was never heard, but many of the author's observations were made at distances from which vocal sounds would have been inaudible.

### Senses

Although Anderson (1940) and Hanson (1950) stated that the sense of smell is highly developed in the mountain goat, observations during this study indicate that it may not be as acute

as in some of the other big game species. The human scent at bedding grounds, salt licks and traps usually caused no noticeable reaction in the goats. A large male jerked its head vigorously when it touched its nose to a rope snare on a salt lick, six feet from observers concealed in a blind, but continued licking for an hour with little display of fear.

During the rut males frequently smelled the genitalia of nannies, and there was evidence to indicate that attraction to females during oestrus was largely olfactory. Goats were occasionally observed smelling the urine and droppings of other animals. It also appeared that they used their noses to select the place from which soil was taken on a salting ground. Mother goats would usually sniff their kids thoroughly after they had been lost.

The response of mountain goats to loud noises varies considerably. The alertness shown by goats upon hearing sounds indicated that they are fairly dependent upon their sense of hearing for detection of other animals. The sound of rolling rocks, however, did not usually incite concern, and animals would sometimes pause for only a few seconds to look quizzically toward the source of the noise before resuming their normal activities. One goat ran for several hundred yards after being startled by the loud rumbling of a small snowslide a few hundred feet away. On another occasion an animal stood for several minutes listening to horse bells which were heard from a quarter mile distance. The reaction of goats toward most noises in comparison to the lack of response to rolling rocks demonstrates awareness of unrecognized noises and relative unconcern over familiar sounds.

The vision of the mountain goat is extremely sharp in detection of movement and it is rare that the person traveling below an animal situated on a vantage point goes unobserved, even though the distance may exceed a half mile. Animals were frequently seen watching a person at a distance of several hundred yards. The inability of goats to see stationary objects was demonstrated several times when the observer was approached within 20 feet by animals which apparently neither saw him nor were frightened by his scent.

#### Reaction to Humans

Mountain goats are very curious and will usually pause several minutes to watch a person moving toward them before becoming frightened. This characteristic makes them easy prey for the hunter. On several occasions the curiosity of animals was used to draw them close for observation in much the same

manner as used in luring antelope to close range. The best results were obtained by partially concealing one's self while waving a cloth or some other object that could be seen by the approaching animal. The female and kid in Figure 7 were observed at a distance of 25 feet for 2 hours and 40 minutes by using this method. In this case the observer approached slowly while in plain sight of the animals, occasionally calling or whistling softly while waving a white handkerchief. Both the female and kid bedded several times as pictures were being taken during this observation.

Animals which had seen the observer were sometimes approached with greatest success by following a route that quartered by them. They would often stand to watch as long as the path of the observer did not intercept their position. Some of the best close range observations were made by taking a position and sitting quietly along the route of animals which were feeding across a slope. One group, that came within 20 feet, watched the manipulation of the camera for a few minutes before commencing to feed again.

Because of the mountain goat's preference for a bedding place on a vantage point offering a good view, it is often difficult to stalk animals from below. Sometimes they could be approached from above where the terrain was broken and provided concealment. Most of the animals observed during this study had not been molested for several years and were probably less wary than herds which had been hunted.

Three characteristic behavior patterns were displayed by goats when they were approached closely: tail erection, stamping the ground with the front feet, and squatting. Most common was the tail erection shown by animals when they appeared to be frightened by an observer at close range. Ground stamping with the front feet was a characteristic response of the animals to situations which seemingly aroused their curiosity, while goats that were surprised at close range often squatted in a position similar to that observed when they were being harassed by eagles. Responses of different animals to a given situation often varied considerably. The presence of observers in a blind a short distance from an artificial salt lick apparently caused two animals to leave the lick a few moments after arriving, but a billy that arrived minutes later stood and ate salt at this same spot for nearly an hour. He showed little fear but would stand for minutes at a time studying the blind in which the two observers were concealed.

Handling of mountain goats in transplanting has provided excellent opportunities for observing their behavior. Due to their apparent lack of fear of entering a man-made enclosure they are easily taken in traps built around salting grounds. Even after the trapdoor closes there is little outward display of anxiety, and after once striking a wire enclosure, goats usually become quiet and will often continue to eat the salt. With the approach of humans, trapped animals become apprehensive and usually bunch closely in a corner of the trap. It is under such conditions that they occasionally injure each other with their sharp horns. In one instance a billy killed a nanny by piercing her abdomen.

A trapped goat is to be approached with caution, as the quick upward thrust of its sharp horns can easily cause injury. When approached in a trap a goat will usually stand watching a person closely, frequently stamping its front feet in the same manner as described for animals encountered in the field. Two men are required to safely throw a big goat, but once downed, an animal will usually stop struggling and is submissive to handling without further resistance. Trappers tell of instances in which struggling animals that were being carried to releasing points have suddenly become completely relaxed as though dead. After being laid upon the ground and left by themselves they would raise their heads, look around, and then quickly spring up and run away. Blindfolding has been found helpful in handling animals by reducing the shock which may result from fright. Besides submitting itself to all types of handling without resistance, a blindfolded goat will usually accept food or snow from the hand of a person. Water and food placed in the pen is usually taken quite readily.

### Sign

Bedding grounds, well-marked trails across precipitous slopes, and strands of hair hanging from shrubs are the most conspicuous evidence of the mountain goat's occupation of an area. The bedding grounds are most frequently located on high slopes and vantage points from which the animals may obtain an unobstructed view of their surroundings. Occasionally these are situated under overhanging ledges which provide both shade from the sun and protection from inclement weather. Although goats commonly bed on rocks or on slopes covered by vegetation, they often seem to prefer the old beds that provide loose, exposed soil. Continual use of some of these throughout the years has caused the disappearance of the plant cover (Figure 18), leaving



FIGURE 18. A bedding ground of mountain goats in the Red Butte area, Montana.

denuded spots of considerable size that are readily recognized. Accumulations of droppings measured nearly an inch in depth on some of the favored bedding sites within the Red Butte area.

It is in the beds providing exposed soil that the goat dusts itself. By lying in an upright position and throwing loose soil over its body with a foreleg, the animal becomes well covered before rising and shaking the soil from its coat. This activity occurs frequently during warm afternoons and it apparently provides some relief from flies. Shady bedding places are occupied during these warm summer days, as are the snowbanks where the animals often wallow.

Woolly strands of white hair hanging from shrubs are also conspicuous markers of the ranges used by goats. During summer, a patch of recently shed hair will sometimes be seen from a distance of several hundred yards.

Some well-marked and regularly used trails were seen on Idaho and Montana goat ranges. The trails observed near Red

Butte followed steep slopes, and in many places were too precipitous to be followed by a person. A Deep Creek goat trail contoured across talus slopes, and showed evidence of having been used for several decades, if not centuries. Few well-defined trails were seen on the Salmon River, although animals were frequently concentrated in small areas where tracks and other signs were abundant.

The fecal pellet of the mountain goat is similar in size to that of deer, but it differs in shape by being somewhat squared with a slightly concaved surface on one end and a small projecting point at the other. At times the pellets, which normally are found in groups, show these characteristics plainly, but frequently they are difficult to distinguish from those of deer and bighorn sheep.



## GROUPING

Mountain goats are observed in small groups during most periods of the year. Females leave the bands to seek isolation before the kids are born, only to rejoin them a few days later with the new offspring. The males are usually seen singly or in small groups during the spring and summer. During the rut they join the females, yearlings and kids, and it is in this period and the following winter months that the groups reach their largest size. Aggregations grow smaller during March and April as the males gradually move away and the gravid females begin to split from the groups. Changes in groupings are illustrated in Figure 19 in which the average number and per cent of the animals seen in groups of two or more are shown by monthly periods.

The tendency for the female to seek isolation previous to parturition was observed on both the Red Butte and Salmon River ranges. From May 15 to 31, 1950, 82 percent of 66 animals seen on the Salmon River were either solitary adults or females with young kids. In May, 1952, 75 per cent of the 114 animals observed on the same ranges were represented by these group classes. The predominance of single animals previous to kidding

is made less apparent by the rapid rate at which females with newborn young join the others. This results in a rapid increase in the average group sizes as the kidding period progresses (Table 5 and Figure 19). Although the Salmon River data indicate a drop in the average group size during mid-June, it appears that these mixed groups of females, kids and yearlings are found throughout the summer on most of the ranges.

The few animals which remained on the lower Salmon River ranges during summer were largely solitary adults and thus the average group sizes derived from observations of them are misleading. The average of 3.4 and 3.6 animals for groups in the Selkirk Range, during June and July respectively, are probably more typical of the summer aggregations. Similar averages for the number of animals observed in groups were obtained on the Selway River during July and August, and it is apparent that the majority of goats spend the summer in groups ranging in size from two to a dozen or more.

TABLE 5. A monthly comparison of average group sizes and the percentage of mountain goats observed as singles and in groups of two or more on Idaho and Montana ranges.

Month	Range	Singles (Percent)	Two or More (Percent)	Total Number Animals	Average Group-Size
Jan.	Salmon River	10	90	62	3.5
Feb.	Salmon River	12	88	95	3.5
Mar.	Salmon River	23	77	70	3.9
April	Salmon River	41	59	502	3.3
May	Salmon River	55	45	225	2.7
	Red Butte	21	79	89	3.5
	Bitterroot River	39	61	218	2.6
June	Salmon River	15	85	123	3.6
	Red Butte	10	90	289	3.3
	Selkirk	9	91	67	3.4
July	Selkirk	22	78	23	3.6
	Red Butte	5	95	237	7.5
	Selway River	9	91	58	3.8
	Deep Creek-South Fork of the Teton River	4	96	51	6.1
Aug.	Salmon River	30	70	60	3.0
	Red Butte	3	97	195	6.1
	Selway River	15	85	26	2.8
Sept.	Salmon River	41	59	49	2.2
	Selway River	19	81	102	3.8
Oct.	Salmon River	26	74	191	2.8
Nov.	Salmon River	18	82	229	3.0
Dec.	Salmon River	21	79	99	3.3

One of the best evidences of the mountain goat's gregarious nature is its preference for company at the bed grounds. Often single animals and small groups that become scattered while

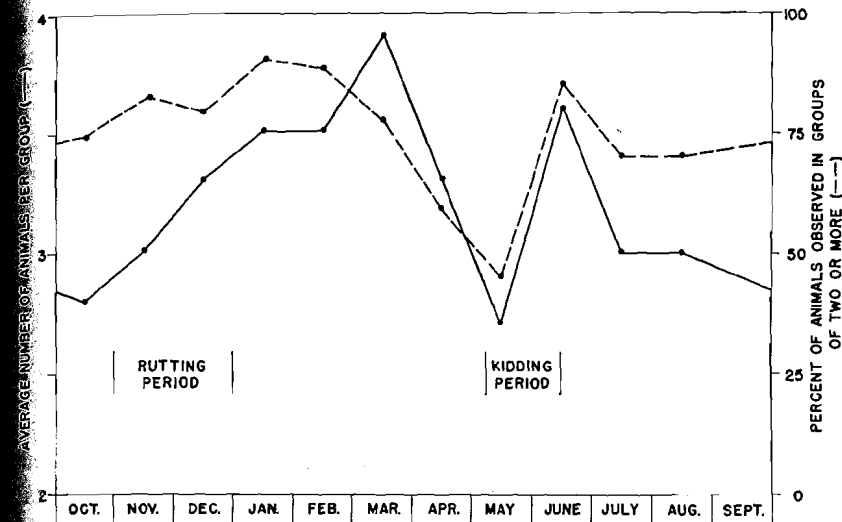


FIGURE 19. Seasonal changes in grouping of mountain goats on Salmon River ranges.

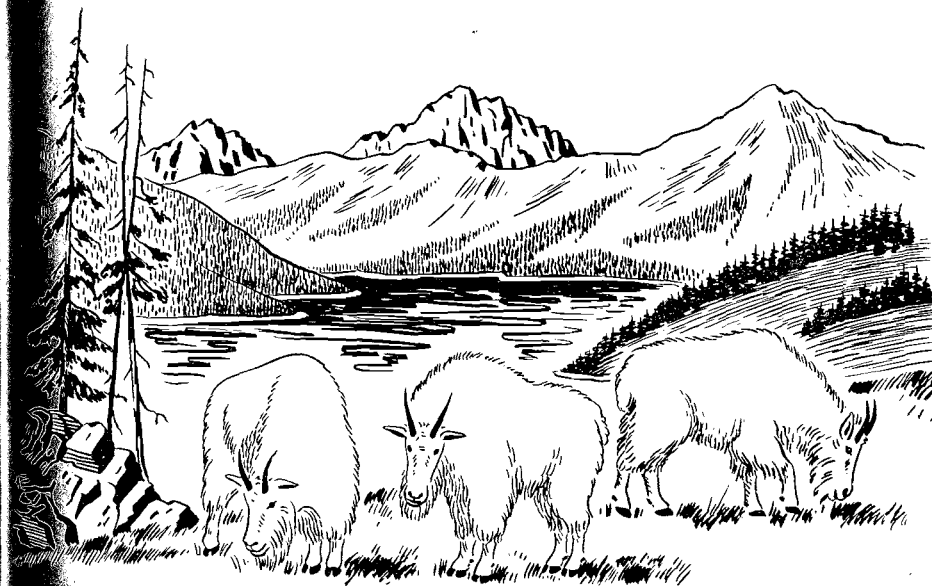
feeding will return to a common bedding spot. This is especially noticeable during the rut. Dispersal occurs as single animals rise and begin to feed, and frequently groups of as many as 30 animals become widely scattered within an hour after leaving the bedding area. Occasionally animals that range widely over many acres return repeatedly to the same bedding grounds, and thus remain as a group for several days at a time. During November and December approximately 80 per cent of the mountain goats observed in the Salmon River area were seen in groups of two or more animals. They showed no apparent tendency to disperse following the peak in the rut and the large groups continued to be seen on the lower winter ranges throughout January and February.

No tendency was observed for the nannies with kids to join billies in the formation of close family groups after the kidding period, as suggested by Seton (1927) and Anderson (1940). Nannies and kids are usually seen in small bands with yearlings and females that are not accompanied by young. The occasional occurrence of males in mixed groups during the spring and summer indicates that they do not lead an entirely solitary existence at this season; they are frequently seen by themselves and in groups of two or three. Yearlings are rarely seen alone except during the early part of the kidding period when the females desert them.



It will be noted in Table 5 that while the average number of mountain goats per group within the Red Butte area was comparable to that of other ranges during June, group sizes were much larger during July and August (7.5 and 6.1 animals per group, respectively). This was attributed to the greater population density on the Red Butte range and the movement of goats in a circular route over a limited area of nearly two square miles. This resulted in regrouping of the approximately 35 animals which occupied the area by bringing them together frequently in the course of the normal movements. During the 1946 census, 40 animals were seen in one band near Red Butte (Rognrud, 1946), while 31 goats were the greatest number seen the following summer in the same area. Eighteen animals observed on Mallard Creek in late April, 1952, was the largest group seen in the course of work on the Salmon River. The second largest group of mixed nannies, kids and yearlings, totaling 16 animals, was seen on Fawn Creek during late June.

Fall, winter, and early spring groups of from eight to twelve animals are not uncommon, but smaller groups are more frequently seen on most of the Salmon River ranges. One group of 17 animals was observed in September near Salmon Mountain on the upper Selway River. Average group size in the Selway area during July, August and September was much less than this, ranging from 2.8 to 3.8 animals, with more than 80 per cent of the goats occurring in groups of two or more. A similar high percentage of animals were grouped on the Selkirk Range during the summer.



### DAILY ACTIVITY AND MOVEMENT

It takes only a few observations to reveal that the greater part of the mountain goat's day is divided between two activities—bedding and feeding. Usually one of the longest feeding periods of the day is from dawn until mid-morning, when many animals bed down. From mid-day until early afternoon some animals are seen feeding, but in warm weather the majority are inactive during these hours. The late afternoon and evening are the best periods for censusing, since most animals are moving about while feeding and are therefore more likely to be seen. As it grows dark the goats usually bed down again. There is apparently some nocturnal activity, however, as they have been heard moving about in the darkness when only the noise of rolling rocks revealed their presence.

During periods of inclement weather in spring and summer goats show greater irregularity in their activities than on clear and warm days. This may be attributable to absence of the high afternoon temperatures which cause many animals to retreat to shaded spots or snowbanks. On cool days mountain goats are more active in the mid-day and afternoon hours. During rain storms they sometimes bed and remain inactive for extended periods, although they are often seen feeding in the rain, pausing fre-

quently to shake the moisture from their coats. Sunny periods that follow afternoon showers are ideal for observation, as the animals are active at that time. The greatest irregularity in the mountain goats' living habits occurs during the rutting period when mating and the males' constant competition for receptive females dominates the activity.

The ease with which the mountain goat moves over broken, rocky mountainsides provides ample demonstration of its fine sense of balance. Animals have been observed walking the lengths of small windfalls, sometimes traveling considerable distances through areas of down timber without touching ground or breaking a steady gait. Even with these capabilities, however, goats encounter cliffs which they are reluctant to cross, and several times they were observed to retrace their steps and take a different route in order to avoid seemingly impassible places. They can jump several feet to cross a crevice, but if unhurried they will usually seek a safer route. None has been observed to be injured in a fall, but there is little doubt that this occasionally happens, especially during the winter months when the rocks are covered with ice and snow. One female that missed a ledge in a jump landed on her feet and returned to the same place to succeed on her second attempt. Her kid, unable to follow, was forced to find another route.

The extent of the mountain goat's daily movement is of concern to both the hunter and the game manager. At times animals remained in small areas for days, while on other occasions they traveled several miles in a few hours. During the rut groups of as many as ten animals often remained in limited areas of a few acres for several days at a time. Generally, with the exception of transient males which traveled extensively in search of receptive females, movements were confined to small distances.

Typical summer trips in the course of a day's feeding range from a few hundred yards to a third of a mile, although many times goats will travel farther than this. A band of 12 animals moved a mile and a quarter during an eight hour period in the Red Butte area. Another group on the same range covered less than three-quarters of a mile in over nine and one-half hours. Two males observed for a period of ten and a half hours near Red Butte traveled two miles up a ridge to gain a thousand feet in elevation.

Animals frequently moved between Red Butte and the Chinese Wall, a cliff several hundred feet in height forming the eastern face of the Continental Divide, and some may have

traveled the entire 12 mile length of this formation several times in the course of the summer. The trip between Red Butte and the Chinese Wall involved a half mile passage through a burned-over area which was largely covered by windfalls and snags.

Fairly frequent observations were made of animals moving through burns, dense stands of timber, and even lowland valleys where there was no broken terrain of the type normally associated with their ranges. Goats are where you find them, and wandering animals may be found as many as 25 miles from their known home ranges.

Impressive speed is demonstrated by mountain goats in fleeing over rough precipitous terrain. One group of frightened animals went more than three-quarters of a mile in 25 minutes, while gaining 1,000 feet in elevation. A single goat covered nearly a half mile in similar broken terrain in 15 minutes. Animals which ran long distances appeared tired and showed signs of exhaustion. They are seldom required to exert themselves for any length of time due to their reliance on rough terrain for escaping from their enemies.

No particular sex or age group assumes the leadership of a band in its movement over the range. Instead, the route appears to be a matter of chance, as one animal after another moves ahead while feeding.

Movements of mountain goats on winter ranges are usually very limited and animals may remain in small areas for weeks at a time. A Salmon River band of approximately 10 animals lived for three months (February to May) on a winter range of less than 200 acres. A one-horned female, which was readily recognized, remained within an even smaller area. On some of the highest winter ranges deep snows may restrict travel, but along the lower slopes of the Salmon River canyon the snowfall is comparatively light and depths are not usually sufficient to impede animal movement. Forage depletion is often evident where animals concentrate during these periods of limited winter movement and nearby ranges may be utilized very lightly.

Two artificial salting grounds near Red Butte, which had been salted with white crystal block salt for several years previous to the time of observation, were visited frequently by the goats during the spring and summer. Cattle salting grounds in the high meadows between the South Fork of the Teton River and Deep Creek showed evidence of use by a band of goats that ranged along the barren, rock-covered ledges less than a third of a mile away.

## MIGRATION

Migrations of mountain goats occur between summer and winter ranges on all of the areas in Idaho and Montana which were visited during this study. Anderson (1940) describes migrations of approximately 10 miles on Washington ranges, and it appears that even greater distances may be covered in Idaho and Montana. Generally it has been found that mountain goats will occupy the lowest available winter ranges that provide preferred combinations of broken terrain and vegetative cover. These are usually situated on south-facing aspects where snow depths are least extreme, but occasionally animals are seen during winter on the highest ridges where the snow is several feet deep except for small areas which are bared by the wind's action.

Downward migrations in the fall seem to be a response to snowfalls on high ranges, and usually occur after early storms bring the first heavy snows to the high country. Upward spring migrations are gradual, with females accompanied by kids and yearlings remaining on lower areas after most of the other animals have left.

Ranges along the breaks of the Salmon River canyon have provided some of the best observations on seasonal migrations. The winter ranges, at elevations of between 3,000 and 5,500 feet, were unoccupied during the summer except for a few scattered animals seen even during the hottest periods when temperatures reached 110° F. During late May and June most of the animals move to ranges above 6,500 feet in elevation, the males usually preceding the females with young in their upward migration. The herds that winter on Fawn Creek and West Horse Creek move north to the higher canyons adjacent to Waugh Mountain, lying at an elevation of 8,882 feet. On the lower Middle Fork of the Salmon River the animals move into upper tributary canyons which head against the Big Horn Crags. The ascent from winter ranges to summering areas involves movement over a horizontal distance of less than six miles.

The downward migration from Salmon River summer range usually occurs during the latter part of October or in November with the onset of the first heavy snowfall on this high country; goats usually appear on the lower ranges within two or three days after snow begins to accumulate at the higher elevations. The small counts made on the Salmon River wintering areas during coverages in October, 1950, and early November, 1952, were attributed to absence of heavy snowfalls on the high ranges.

Normally, the animals are on the lower slopes by November 15, but occasionally with early storms they are present on the upper slopes of wintering areas in late September.

The average elevation at which 130 animals were observed during November, 1949, was 4,300 feet — 600 feet below the October average for 104 animals. Even more animals utilized ranges below 4,500 feet in February, 1950, when the snow had reached its greatest winter depth of nearly three feet at 5,000 feet elevation. The inaccessibility of the snow-covered slopes prevented coverage from some of the higher points used during other seasons, and since there were no observations made on the high ranges it was not possible to conclude that all of the animals spent the late winter months below 5,000 feet. It was apparent, however, that most of the goats moved down to ranges below this elevation.

In April and early May the animals move lower than at any time throughout the winter and they are frequently seen within a few hundred feet of the Salmon River. It appears that they descend the slopes for the new growth of forbs and grasses available on the warmer sites. Some of the shaded areas on northern aspects which are not used during the winter because of heavy snow accumulations are reoccupied in early May as the animals begin to scatter to ranges above 5,000 feet. At this time they make greater use of the forage within open stands of Douglas fir and ponderosa pine on upper wintering areas. By June, 1950, about half of the animals in three herds under intensive observation had moved to ranges above 6,000 feet. Inability to make daily trips above this elevation and the tendency of the goats to utilize the shade of coniferous trees during warm days precluded the collection of more complete information on the upward migration. Usually most of the goats move to ranges above 6,000 feet by mid-June. However, in June, 1952, after a late spring, a larger number of animals remained on these winter ranges than were seen in either 1949 or 1950.

Although wintering areas of goats in the Salmon River canyon differ in several respects from most of the goat winter ranges in Idaho and Montana, many of the migrational characteristics are similar to those of herds in other areas. Late summer and early spring observations in the U-shaped glaciated canyons of the Bitterroot Range, draining into the Bitterroot Valley of western Montana, provided information on migration in the area lying adjacent to the upper Selway River. Goats which were scattered widely during September, at elevations as high as 9,000

feet, were confined to the lower south-facing slopes of each canyon by the following spring, and there was evidence that there had been a complete movement of animals from higher areas and northern aspects to the lower snow-free southern exposures that lay at elevations between 4,000 and 6,000 feet. One hundred and three goats were seen in 138 minutes of aerial coverage over the snow-free southern aspect ranges of the major canyon tributaries of the Bitterroot River on May 12 and 14, 1948. The following spring, on May 13, 85 goats were observed in the same canyons during 95 air minutes of observation. No animals were seen either on the snow-covered ranges of upper canyons or on northern aspects.

Migration to these wintering areas involved movements as far as 15 miles from the high summer ranges, and it is probable that some of the animals which summer in Idaho on the Selway River slopes of the Idaho-Montana divide migrate to these lower canyons for the winter. Similar migrations were seen on the southern extension of the Bitterroot Mountains along the Continental Divide within the watershed of the Lemhi and Salmon Rivers; animals which summer on high ranges up to 9,000 feet move to the lowermost portions of the canyons in the fall. Winter observations were made of goats on these south-facing ranges at elevations between 4,300 and 7,500 feet, from December, 1951, through February, 1952. No animals were seen in a March 7 flight over high snow-covered ranges in this area, as apparently all had migrated to lower slopes.

Where ranges providing the necessary broken terrain and forage are not found at lower elevations, goats remain higher for the winter. With greater snow and the decrease in forage availability, these higher areas provide less favorable wintering conditions than are found along the Salmon River or in the lower canyons of the Bitterroot Range. A small herd on the headwaters of the North Fork of the Salmon River winters at an elevation of nearly 6,000 feet, where snow depths exceed five feet. Similar observations of animals using high winter ranges were made on Old Man Creek, a tributary of the Lochsa River, during February of 1951. Five animals were observed on Two Mouth Creek in the Selkirk Range at elevations of over 6,000 feet during March, when several feet of snow covered the ground.

The highest early spring observation was made on April 11, 1952, of two animals at nearly 10,000 feet on the headwaters of Patterson Creek within the Lemhi Range. These goats were living along a ridge that had been cleared of snow by the wind over

an area of approximately 25 acres. Marten trappers provided a few observations of mountain goats on the high altitude ranges of the Selkirk and Bitterroot Mountains. In six winters of trapping the Salmon River-Selway River divide, Mr. Frank Lantz reported only one winter observation of an animal on the high summer ranges near Waugh Mountain. No goats were seen by the author in an April 12 aerial coverage when deep snows blanketed this area.

In most cases the mountain goat winter ranges lie at higher elevations than those of mule deer and elk, although an occasional range is occupied commonly by all three species. In the Selkirk Mountains and on the Selway River most of the goats move to the lower canyon slopes to winter. Some of the goats on the upper Selway River utilize winter ranges along the canyon breaks, a few hundred yards from the river. As on Salmon River ranges, a few scattered animals remain on these low areas during summer after most of the goats have migrated to the higher ranges at elevations of 6,000 to 9,000 feet.

Fall migrations in the Red Butte area involve movements from the Chinese Wall and high ranges along the Continental Divide to south-facing slopes, open areas on wind-swept ridges, and the east-facing cliffs near Red Butte. On May 17, 1948, the ledges of the Chinese Wall, which are occupied during summer, were still covered by several feet of snow and no animals were seen. Twelve animals were counted on the south-facing slopes and east-facing cliffs of the Red Butte area where they had also been seen in the latter part of December and March. Their movements had apparently been limited to elevations of between 6,000 and 8,000 feet throughout the winter, although strands of goat hair were found on lower Indian Creek more than half a mile from the lowest slopes upon which animals were seen. The occurrence of this hair on branches of lodgepole pine, six to seven feet above the ground, indicated that the goats had been in this area during the winter. Whether they remained in this dense stand of timber for part of the winter, or were passing through en route to other ranges, is not known.

In the Deep Creek-South Fork of the Teton River area, Montana, there appear to be regular migrations between extensive summer ranges and the lower portions of canyons. The occurrence of a dead female goat on the rolling foothills, a mile and one-half east of what is normally considered to be winter range on Deep Creek, is in accord with other observations which indicate that migrating goats often move through areas that are

atypical of their preferred habitat. This animal died in early May at an elevation of 3,800 feet, within a half mile of the open grass prairie of the Great Plains.

There appears to be a well-defined tendency of mountain goats to return to the same winter ranges year after year. This has been demonstrated by animals which were recognized on the same ranges during successive winters; the female which had a broken horn was seen on the same Salmon River range during the winters of 1950, 1951 and 1952.

It appeared that the same routes were used in the seasonal migrations and in some areas trails were readily recognized. On the Deep Creek-South Fork of the Teton River a goat trail across a talus slope was noticeable at a distance of half a mile, and had apparently been used for years. Another trail was found across the floor of Lion Creek canyon within the Selkirk Range. This was probably used by animals in seasonal migrations between northern and southern aspect ranges.



## REPRODUCTION

### Mating

The height of mountain goat mating activity in Idaho and Montana occurred during November and early December. The earliest activity was observed during the last week of October, whereas the latest mating was seen on December 8. Most of the kids were born between May 15 and June 15. This corresponds with observations of the rut, assuming that the gestation period of the species is approximately 178 days, as reported by Seton (1927) from a Bronx Zoo breeding record.

Several activities characterize the behavior of mountain goats during the mating period. The male follows the female, rubs his head and neck against her rump and noses her. He will often force a bedded female to rise and then follow her closely

while prodding her with his horns and pushing against her with his body. The mountain goat is polygamous and billies constantly search for females that are receptive to their attentions. In one instance, a male climbed back and forth over a distance of nearly one hundred yards between two nannies that divided his interest. A single billy usually accompanies a receptive female, and other males attempting to steal her are driven away. Females are allowed to join a male's harem but are not rounded up with the same frenzied activity that is characteristic of the bull elk's rutting habits.

No actual combats between males were observed. Most of these encounters amounted to little more than one animal rushing at another when it ventured too close to a chosen female. In one instance the animal being rushed headed for the aggressor instead of taking flight as was commonly the case, and caused the retreat of the attacking animal. This was the only observed instance in which one billy succeeded in taking a female from another. Seton (1927) cited a fight between two billies in which fatal injuries were inflicted, and it appeared that casualties must occasionally result from skirmishes between rival males during the breeding season. Most encounters, however, appear to be settled by a few fast rushes, followed by the prudent retreat of one participant.

A tendency of the goats to form large groups during the mating period was evident, and several times as many as 10 animals were seen together, while the proportion of single and paired animals dropped sharply. For the months of November and December in 1949, 1951 and 1952, 78 per cent of 336 goats observed on the Salmon River were in groups of three or more animals. Single goats, which were believed to have been billies that either had been driven from groups by other males or were traveling in search of receptive nannies, were common during the rut. Often the male goat was not successful in maintaining a harem and was seen with only a single female. The relationship of a male to members of his harem usually lacked permanency, and a group often drifted apart as some of the females were claimed by other billies. Heated competition in a group of 10 animals was seen when a male tried to appropriate two receptive females of other billies. These two females had been guarded jealously throughout the day.

It appears that isolation of animals on rugged ranges may affect breeding success and solitary females may occasionally pass through an entire rut without being bred. Where animals

were scattered widely during the rut, mated pairs and small groups were most common.

Bedding and feeding habits during the mating period are irregular and goats are often more active than normal during midday. Grouped animals are restless and there is almost constant activity and movement among them. The distances traveled in the course of a day are usually limited, with goats occasionally remaining in a small area for more than a week at a time.

Hansen (1950) reported that mating occurred throughout the month of November, and that 18-month-old yearlings participated in the rut. He cited an observation of an adult female which was being followed by a yearling male and an older billy. He also noted that all the yearling females were accompanied by males, but no evidence of the yearlings' participation in mating was obtained. That young animals do show certain behavior characteristics which are associated with mating is indicated by the author's observation of a 10-month-old kid which mounted another animal of the same age. This, of course, is no indication that the breeding age had been reached.

### Young

Young goats are born during May and June in Idaho and Montana, with the peak of kidding occurring from mid-May through the first half of June. May 15 was the earliest date that a new kid was observed, whereas the latest record was a June 27 observation in the Selkirk Range of a kid (Figure 7) that was less than a week old. Seton (1927) described the kidding period as occurring during late April or early May. Hanson (1950), in the Black Hills of South Dakota, concluded that the parturition period extended through May, and that a small percentage of the young are born during the last week in April and early June. In Washington, Anderson (1940) stated that a majority of the young were born between June 1 and 15 and that the earliest date of birth was approximately May 10. The earliest record for goat kids in Glacier National Park was made by Ranger Ben C. Miller, who observed them in upper Park Creek valley on February 27, 1935 (Casebeer, Rognrud and Brandborg, 1950).

Most of the kids are born on the roughest terrain within the goat ranges, providing them with ample opportunity to traverse steep slopes while only a few hours old. Seton (1927) described a newborn kid in the New York Zoological park on May 20, 1908, that walked within ten minutes after birth.

Usually one kid is born to a female, although twinning is

not uncommon. During the period from 1947 through the spring of 1951 the author did not encounter a pair of twins in more than a hundred kids observed on Idaho and Montana ranges. Neither were twins observed among the 46 kids counted by the Montana Fish and Game Department during the 1946 mountain goat census on the South Fork of the Flathead River and the Sun River. In the fall of 1951 on the Salmon River two females were accompanied by pairs of kids which were probably twins. During the following spring four pairs of twins were counted among approximately 35 kids within the same area. An early summer count by Anderson (1940) in the Island Mountain-Many Trails Peaks area of Washington included three sets of twins in a total of 23 kids counted. Hanson (1950) saw no twins in the Black Hills, while Seton (1927) recorded one field observation of twins in Glacier Park, as well as a report of a pair of twins that were born in Washington Zoo on May 20, 1921. Some reports of twins are obtained when more than one kid follows a single female after a group is frightened, and when kids at play become separated from their mothers and are seen with another kid and nanny.

The females are usually very attentive to the young during their first days; they often nose the kids thoroughly and sometimes are seen to lick them. The new kid takes milk regularly at what are usually less than hourly intervals, and the nursing periods range in length from a few seconds to more than ten minutes, depending on the mother's cooperation. The mother usually ends these feeding periods when she walks away, frequently knocking the kid over if it attempts to continue. A week-old kid nursed five times during a three-and-one-half hour period. Another animal of the same age nursed at least 10 times during a two-hour-and-forty-minute period. The feedings during the latter observation, however, were shorter and more frequent than normally as a probable result of the mother goat's apparent concern over the nearby observer.

Kids are seen taking forage and ruminating during their first days of life, and at an age of six weeks feed regularly at their mothers' sides. As the summer progresses the nursing periods gradually grow shorter and less frequent, and by late summer the kids often are ignored by the females when they attempt to nurse. On June 22, a kid nursed for one minute, while on the same day three other females were seen to avoid their young when they attempted to suckle. Each of three kids observed on July 12 nursed for less than a minute. Kids were seen nursing

for periods of less than 30 seconds a few times during August when it appeared that they took milk no more than two or three times daily. Some of the females killed during the 1950, 1952 and 1953 September hunting seasons in Idaho were still producing milk, but it appeared that they were nearing the end of the lactating period.

Mother goats on Salmon River ranges frequently utilized the shade of mountain mahogany shrubs, ledges and scattered trees while the young were small. One female, observed with her newborn kid on May 15, spent most of the warm day under a mountain mahogany, returning to it after each feeding period.

Newly arrived kids stay close to the females, and it is not until they are several days old that they venture more than a few yards from the mothers. The female is intolerant of strange kids, and she usually frightens them away if they approach closely. Similar intolerance is shown by the female toward other goats—billies, nannies without kids, and yearlings—and seldom are these animals permitted between the mother and her offspring. Most spurned by the mothers are the yearlings, which apparently have independence forced upon them by the arrival of the young, and are slow to learn that the females have new and more important cares. Throughout the summer these animals are chased by the mothers whenever they wander close to a kid, and this often results in their tagging behind the nanny and young goat. Yearlings are also chased by other adults which they occasionally follow after being driven away by their mothers.

The kids remain with the females until April or early May, when they are nearly a year old. Although they sometimes become separated from the mothers while feeding, they usually bed at their sides. The 11-month-old yearlings taken in Montana traps during April followed the mothers and few were seen alone.

After their first weeks the new kids show less inclination to stay close to the nannies, and this occasionally results in their becoming separated from them. One such instance was observed in June when a nanny continued feeding up a hillside after her kid had bedded and gone to sleep. Nearly 15 minutes later the kid rose and walked down the hill in search of its mother, which was by then out of sight. After the young animal had run back and forth on the slope for several minutes, the nanny stopped feeding and walked to where her offspring had been bedded. From there she sighted the kid and proceeded to it quickly, allowing it to nurse for a few seconds before leading it back up the slope. Another kid lost its mother when she walked away from a group

of 30 goats that had been bedded together. It ran back and forth among the remaining animals, approaching one after another in its attempt to locate the mother. An attitude of indifference was displayed by most of the females toward the young animal, and it was quickly driven off when it approached a female with a kid. It bleated continuously as it ran up and down the ridge, but it had not found its mother when it finally went out of sight after 20 minutes. In another instance a kid was observed for half an hour as it ran from one group of goats to another while searching unsuccessfully for its mother among 29 animals that had scattered upon being frightened by the observers. The bleating of this kid was heard distinctly at a distance of a third of a mile.

No description of the separation of a mother goat from its young would be complete without mentioning a Salmon River observation of a newborn kid that was unable to leave the ledge where it apparently had been born. When first observed, the kid was attempting to climb a 10 foot face of rock above the narrow ledge (approximately 20 feet in length and 5 feet wide) upon which it was confined. The mother stood above her offspring on the top of this barrier, waiting expectantly as the kid tried unsuccessfully time after time to scale it. Finally, after several minutes of these efforts, the kid bedded and the mother began to feed on the slope above the ledge. She returned an hour later to allow the kid to nurse and again the kid attempted to scale the rock face. The mother goat descended and, after nosing the kid for a few seconds, would climb the rock again as though to demonstrate the ease with which this could be done. In the succeeding five days it was necessary for the mother to leave the kid by itself for periods of more than an hour while she fed on slopes above the ledge. The kid sometimes grew restless during these confinements and would walk back and forth on the narrow rock shelf or repeat its attempts to scale the wall. The mother, upon her return, was always received enthusiastically by the young animal which was quick to seek the food she provided. On the fifth day the nanny happened onto the one place on the ledge where the cliff was broken, making descent to a lower slope possible. She followed this and was able to lead the kid onto the adjacent hillside. This was the only observed instance of a kid being separated from the female because of its inability to traverse the goat range. Occasionally, a young animal was forced to find another route in order to keep up, but this never resulted in the separation of the mother and the offspring.

Separation of the kid from its parent undoubtedly accounts

for some losses among the young. On July 17, three Red Butte kids were seen playing at the side of a nanny nearly 75 feet from the nearest other adults, but after a few minutes both of the extra kids were seen to follow two nannies that joined the group from below. As many as three kids have been observed to follow a female after being frightened while grouped in this manner, and it is readily seen how easily they become separated from their mothers. Normally the stray kid is not tolerated by other adults and is quickly driven off if it approaches too closely. The apparent bewilderment and aimless wanderings of kids that became separated from their mothers indicated that the animal which is orphaned when less than a year old stands little chance of survival. One case in evidence was that of an emaciated seven-month-old kid found by itself on the Salmon River before dying from what appeared to have been starvation.

Kid goats display their greatest agility and speed of movement over the steep slopes of their range during the play periods when, with stiff-legged jumps, they enter into mock battles with each other. These chasing and bunting games resemble those of domestic lambs. Another pastime was the jumping and sliding which the kids seemed to enjoy during the summer whenever they walked onto a snowbank. The young goats would climb over the resting females and occasionally would smell and lick the mothers' noses.



## PRODUCTIVITY

### Status of Populations

Mountain goats have shown low rates of increase on most of the ranges where they have been studied. Seton's 1925 estimate of 15,000 animals within the United States compares fairly closely to the U. S. Fish and Wildlife Service estimate of 13,499 for 1952. Cowan (1944), in his coverage of bands in Jasper National Park, stated that ". . . field work . . . made it evident that there had been no spectacular increase or decrease in the goat population in the last few years." He considered the population "more or less" stabilized. The study conducted by Anderson (1940) had as a primary objective the determination of factors responsible for the small increases of mountain goats in Washington during fifteen years of protection. Hanson (1950), in reviewing census data maintained by the Forest Service on the Black Hills mountain goat herd since 1921, reported relatively stable populations in all areas. Goat introductions in South Dakota and Washington were described as having been followed by 10 to 15 year periods of steady growth in numbers, after which the populations stabilized. Montana and Idaho populations have shown similar stability over the past few decades, with no noteworthy increases during hunting closures. In Glacier National Park numbers are reported to be static (Casebeer, Rognerud and Brandborg, 1950). Intensive observations on Salmon River herds over the past four years (1949-1952) show a constancy of numbers, with slight increases, indicating a high degree of population stability.

Mountain goat populations in Idaho and Montana are typically represented by small herds (Table 1). In Idaho it is estimated that nearly 89 percent of the herds number less than 50 animals, while in western Montana 95 per cent of the 170 herds for which data are available represented 50 animals or less.

### Age Composition Counts

Cumulative totals of age composition counts over seasonal periods were used in analyses of productivity during this investigation. It appeared that all of the counts from a herd over a seasonal period provided a better index to age composition than did the largest counts used individually, although it was found that the ratios derived by the latter method compared rather closely to those obtained from cumulative counts. Often, over a sea-

sonal period, the largest count for a herd represented much less than half of the estimated population, and because of the herd's small size the resulting data were not as representative of the herd composition as were the cumulative totals from all counts. This was especially significant during the periods when it was difficult to obtain daily counts of more than a few animals from the smaller bands. At other seasons, when a day's count represented as much as two-thirds of a given herd's estimated size, it appeared that these figures were fairly representative of all age classes. Considerable duplication occurred in successive counts of the herds which were covered repeatedly, but it was possible to eliminate this almost completely from those which were covered only once in the course of one or two annual censuses. Most of the duplication occurred in the Red Butte area and in the three areas covered intensively on the Salmon River from 1949 to 1953.

Age composition analyses presuppose sex ratio counts from which the number of adult males and females in a population can be derived. With mountain goats, sexing in the field has proven to be difficult since sexual characteristics are not recognized except at fairly close range. Sex was determined for 118 animals on the Salmon River, providing a ratio of 87 males to 100 females, as compared to a ratio of 73 males to 100 females derived from the limited count of 26 animals on the Selway River. Even sex ratios were assumed for other populations from which age composition counts were obtained. Cowan (1950) found 74 males for each 100 females in a total classified count of 272 adult goats. He remarked that the life expectancy for males (referring to elk, mule deer, bighorn sheep and mountain goats) is considerably less than that of females, even where man is not selectively removing males. He also indicated that the disparity in the sex ratios of goats and bighorns is small when compared to the Cervidae. Anderson (1940) reported ratios of 87 and 83 males per 100 females from counts in Okanogan and Chelan Counties, Washington (Table 6). Hanson (1950) found nearly equal numbers of males and females in his observations in the Black Hills of South Dakota.

The Salmon River and Selway River sex ratio tabulations presented here do not include counts from groups of animals which were composed only of nannies with kids, or those in which only females accompanied by young could be sexed, unless they were observed at sufficiently close range for sex to be determined by horn and body characteristics. In cases where

nannies of a group were accompanied by young, other adults which were unaccompanied by kids were sexed before the group count was included in the total from which the final ratio was obtained. If these precautions had not been taken, the sex ratio would have been biased as a result of the frequent tabulations of females for which the sex could be determined because of the presence of young. Generally, sex ratios of mountain goats in Idaho and Montana appear to favor females slightly.

Seasonal variations in grouping also influence sex ratio observations. Males, which are frequently found by themselves during the summer, are observed less often than the grouped nannies because of the greater probability of sighting groups. A somewhat similar circumstance may result in bias favoring the count of females during late May and June on some of the ranges, such as those on the Salmon River where billies and possibly some females precede the nannies with newborn young in the upward migration to summer ranges. Although the nannies seek isolation during the kidding period, many of them group soon afterward with other females, kids and yearlings, and for this reason are more frequently observed than the solitary males.

With the coming of fall, the billies are seen commonly in company of females, and by the rut in November and December they are largely grouped on lower, more accessible ranges with other animals. For this reason the rutting period and following winter months appear best suited for collection of sex ratio data. Cowan (1950) commented, "Goats . . . for one reason or another cannot be counted on to yield accurate sex ratios on any reasonably accessible and circumscribed area of range . . . (and) while usually wintering in bands in which the sexes are represented in their true proportions, are almost always inaccessible, . . . (whereas) in the summer the majority of the billies are apart from the rest of the herd." His observation on the inaccessibility of winter ranges applies equally for most of the areas covered during this study, and it appears that sex ratio counts must be made largely during the late fall and early winter periods.

During the kidding period three age groups are readily recognized: the newly arrived kids, the 12-month-old yearlings, and the animals that are two years of age and older. The kids are easily aged throughout their first year. Yearlings can be recognized during the second summer, but by the time they are 16 months old become increasingly difficult to distinguish at a distance from those animals over two years of age. And despite

their smaller size, it is not always possible to recognize these animals during their second fall and winter. This resulted in some of the yearlings being recorded as adults or being listed as unclassified animals when there was some doubt as to their age. Thus, during the fall, winter and early spring periods, the number of yearlings shown by the counts is probably slightly smaller than that actually present, while the error resulting from classing these animals as adults is reflected in increases of the number over two years of age.

On the Salmon River ranges, where the late fall and winter periods have been preceded by summer observations in which yearlings were readily recognized, the proportion of yearlings has been assumed to be the same as during the summer, with this number being subtracted from the counts of animals over two years of age. This was done only for the periods of October through December, 1949, and September, 1952, through January 17, 1953 (Table 7). Some error in the kid-female ratios may also have resulted from inclusion of two-year-olds as breeding animals, when actually the first young may not be born until females are three years of age. Since two-year-olds cannot be distinguished in the field at the distance from which they are observed, there appears to be no way of compensating for this. The change from kid to yearling and from yearling to adult classifications was made in the spring as soon as the first new kids were observed, usually about May 15. Kid counts, made during the early part of the parturition period before most of the new kids were born, are not included in the data presented.

Age classification counts by Anderson (1940) and Hanson (1950) show the highest rates of productivity found by any workers (Table 6). A kid-female ratio of 86:100 was obtained from the cumulative count by Hanson, while Anderson found that 73 per cent of the females in Okanogan County were accompanied by kids. Petrides (1948), in a summer count of 132 animals in Glacier National Park, found a juvenile-adult ratio of 42:100. Cowan (1944) reported only 45 kids per 100 females in Jasper National Park.

Totals of cumulative counts within the Red Butte area on the Sun River during the summer of 1947 and the spring of 1948 indicated kid-female ratios of 79:100 and 76:100, respectively. The latter count was made during the kidding period when dispersal and wider movement of males and the females without young may have biased results by causing the kid production to appear larger than it actually was. An unduplicated summer

TABLE 6. Age ratios of mountain goats from Idaho, Montana, Washington, South Dakota, and Jasper National Park ranges.

Area	Period	Number Classified	Males	Females	Young	Yearlings	
WASHINGTON (Anderson, 1940)	Okanogan County.....	1939-1940 Summer, Fall and Winter...	293	87	100	73	11
	Chelan County.....	1939-1940 Summer, Fall and Winter...	161	83	100	58	11
SOUTH DAKOTA (Hanson, 1950).....	1949 Summer, Fall and Winter.....	233	100	100	86	52	
JASPER NATIONAL PARK, CANADA (Cowan, 1944).....	1943 Summer.....	139	74	100	45	..	
	1944 Summer.....	*	74	100	..	28	
MONTANA	Flathead River-Sun River (Rognrud, 1946).....	1946 Summer.....	317	**	100	39	31
	Red Butte area, Sun River (Brandborg, 1950).....	1947 Summer.....	468***	**	100	79	17
	Red Butte area, Sun River (Brandborg, 1950).....	1948 June 1-8.....	141***	**	100	76	55
	Deep Creek-South Fork of the Teton River (Brandborg, 1950).....	1948 June-July	99	**	100	58	..
IDAHO	Selkirk Range (Brandborg, 1952).....	1950 Fall.....	36	**	100	33	7
	Selkirk Range (Brandborg, 1952).....	1951 Winter.....	18	**	100	40	..
	Selkirk Range (Brandborg, 1952).....	1951 Summer.....	90	**	100	72	24
	Selway River (Brandborg, 1952).....	1951 Summer.....	59	72	100	53	16
	Selway River (Brandborg, 1952).....	1952 Summer.....	97	72	100	56	29

\* The number of animals classified is not indicated other than mention of bands of goats which included 36 females and 10 yearlings.

\*\* An even sex ratio is assumed. It should be noted that whenever an even sex ratio is assumed, the numbers of young and yearlings, as indicated by kid-female and yearling-female ratios, are shown to be larger than would be the case if the actual sex ratios of the populations were comparable to those in Washington, Jasper National Park, the Selway River and Salmon River areas.

\*\*\* The number of animals classified includes duplication in counts of a herd of 30-39 animals in the summer of 1947, and 27 animals in June, 1948.

TABLE 7. Age classification counts of mountain goats on the Salmon River, May, 1949-January, 1953. Kids and yearlings are expressed as the number for each 100 females over two years of age using the sex ratio of 87 males to 100 females.

Herds	Period <sup>1</sup>	Number <sup>2</sup> Classified	Young	Yearlings
Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek	1949			
	May 24-June 9	18( 5)	40( 48)	13( 0)
Lower Middle Fork of the Salmon River, West Horse Creek, Swet Creek and Three Lakes Creek (upper Selway River).....	July-Sept.	71(24)	44( 50)	10( 0)
	Oct.-Dec.	321(38)	20( 23)	.....
Cove Creek-Owl Creek, Corn Creek-Bear Creek-Proctor Creek, Lower Middle Fork of the Salmon River, Panther Creek.....	1950			
	Jan.-May 14	221(49)	23( 33)	7( 9)
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River.....	1950			
	May 30-June 7	36(14)	112( 93)	37(47)
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek, Fern Creek-Cottonwood Creek-Otter Creek, Fawn Creek-Little Squaw Creek.....	1951			
	Oct. 11-21	49(35)	27( 33)	..(13)
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek, Fern Creek-Cottonwood Creek-Otter Creek, Fawn Creek-Little Squaw Creek, Chamberlain Creek, Big Squaw Creek-Harrington Creek, Horse Creek.....	1951			
	April 4-24	159(97)	39( 35)	..( 5)
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek, Fern Creek-Cottonwood Creek-Otter Creek, Fawn Creek-Little Squaw Creek.....	1951			
	Sept.-Dec.	137(87)	48( 39)	17(14)
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek, Fern Creek-Cottonwood Creek-Otter Creek, Fawn Creek-Little Squaw Creek.....	1952			
	Jan.-May 15	141(62)	40( 50)	15(21)
Chamberlain Creek, Big Squaw Creek-Harrington Creek, Sabe Creek-Black Creek-Arctic Creek, Dillinger Creek-Magpie Creek, Bargamin Creek, Big Mallard Creek, Big Trout Creek-Lemhi Creek.....	1952			
	April	69(69)	26( 26)	.....
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek, Fern Creek-Cottonwood Creek-Otter Creek, Fawn Creek-Little Squaw Creek.....	1952			
	June-Aug.	88(72)	117(123)	39(44)
Cove Creek-Owl Creek, Lower Middle Fork of the Salmon River, Corn Creek-Bear Creek-Proctor Creek.....	1953			
	Sept.-Jan. 17	50(34)	18( 18)	.....

<sup>1</sup> All dates are inclusive.

<sup>2</sup> The numbers of observations include duplications and recounts of the same animals from coverages that were sometimes repeated several times during the period. Totals of the largest single counts and resulting age composition figures are shown in parentheses.

count of 99 animals in the Deep Creek-South Fork of the Teton River area, Montana, showed 58 young for every 100 females. Counts of 90 animals involving very limited duplication within the Selkirk Range during the summer of 1951 provided a kid-female ratio of 72:100. On the Selway River the ratios of 53:100 and 56:100 for the summers of 1951 and 1952 were closely comparable.

It should be noted that whenever an even sex ratio was assumed, as was the case in the Red Butte area, other Montana ranges and the Selkirk Range, the numbers of young and yearlings are shown by the young-female ratios to be larger than would have been the case if the actual sex ratios of the population were similar to those for herds in Washington, Jasper National Park, the Selway River and Salmon River areas.

Cumulative classified counts on Salmon River herds at intervals over a four-year period furnish a basis for comparing year to year productivity on one area (Tables 7 and 8). Previous to October of 1950, the majority of these counts were made on the Cove Creek-Owl Creek herd, the lower Middle Fork of the Salmon River herd and the Corn Creek-Bear Creek-Proctor Creek herd. They were subsequently continued on these ranges, as well as on additional herds farther down the Salmon River canyon.

Spring and summer counts taken during and following the kidding period of 1950 and 1952 were subject to question because of their high kid-female ratios and the apparent absence of males and possibly some of the barren females on the accessible fall, winter and early spring ranges. Observation of the four pairs of twins among the 88 animals classified on lower ranges in June, 1952, was partially responsible for the high ratio of 117 kids to 100 females. Although this shows a disproportionately large number of young, it indicates a considerably larger production of kids than had been observed in the limited spring and summer counts of the previous years.

Late fall, winter and early spring age classification counts on the Salmon River are more indicative of herd composition than those obtained at other seasons because of the greater tendency for all age classes and sexes of animals to be grouped on ranges that were accessible for observation. The kid-female ratios of 20 and 23 per cent obtained from the comparatively large fall, winter and early spring counts of 1949-50 represent a smaller kid crop for those seasons than was seen during the next four years, excepting the 18 per cent ratio obtained from the very limited and possibly misleading count of 1952-53.

TABLE 8. Age ratios of mountain goats from Salmon River ranges, 1949-1953. Kids and yearlings are expressed as the number for each 100 females using the sex ratio of 87 males to 100 females.

Period	1949-1950		1950-1951		1951-1952		1952-1953	
	Number Classified*	Yearlings Young	Number Classified*	Yearlings Young	Number Classified*	Yearlings Young	Number Classified*	Yearlings Young
Spring (during kidding period)**	22	40	36	112	37	88	117	39
Summer.....	71	44	49	27	137	48	18	***
Fall.....	324	20	159	39	141	40	15	.....
Winter and early spring.....	221	23	.....	.....	.....	.....	.....	.....

\* The number of animals classified includes some duplications in counts of herds which were observed more than once during a period.

\*\* After the first young were born in May, the kids of the previous spring were classified as yearlings.

\*\*\* Yearlings over 16 months were sometimes difficult to distinguish from smaller animals over two years of age during the fall, winter, and early spring. The ratios obtained for this age class during these periods indicate a smaller number of animals than were present due to placement of some of the animals in the two years and over age class.

Yearling-female ratios for the first year's observations show a small crop of surviving young from the 1948 kidding period. The winter of 1948-1949 was characterized by heavy snows, low temperatures and other conditions unfavorable to game, and was probably responsible for the small number of kids and yearlings observed in the spring of 1949. It is known that impoverished females may resorb or abort their young. Murie (1944) cited an instance in which a bighorn lamb, born to a ewe rescued from starvation, died because its emaciated mother was not lactating. Cheatum and Severinghaus (1950) found in white-tailed deer that fertility is a direct reflection of nutritional condition, and that poor quality forage, lack of availability due to snow depths, and long periods of restriction and competition for available food may contribute to lower reproductive success in the spring. These same factors are undoubtedly operative within mountain goat populations. Heavy rains and low temperatures during the 1949 kidding period may also have caused some losses in the kid crop.

The 1950-1951 Salmon River pre-kidding period ratio of 39 young per 100 females (Table 8) was significantly greater than that of the previous year, possibly because the preceding winter had been favorable and was without extended periods of extreme cold, excessive snow depths, or crusted snows. Counts made during the fall and the winter and early spring periods of 1951-1952 showed even greater increases in production and/or survival of young with ratios of 48 and 40 per cent, respectively. These surpassed all previous figures from the Salmon River except those collected during the spring period of 1950 and the summer of 1952 when ratios may have been misleading because of the migration of some of the animals to higher ranges. The previous winter of 1950-1951 was comparatively moderate, although snow depths slightly exceeded those of the winter of 1949-1950.

Twenty-six kids for each 100 females were observed in an unduplicated count of 75 animals on ranges between Chamberlain Creek and Lemhi Creek during April, 1952. These counts were made at considerable distances and as a result no animals were classified as yearlings. The inclusion of yearlings with those animals over two years of age causes the young-female ratio to reflect a smaller number of kids per 100 females than actually existed. As stated previously, the presence of four pairs of twins in the summer of 1952 resulted in a young-nanny ratio of 117:100. The limited counts during the following fall of only 18 kids for each 100 females would seemingly indicate a heavy loss of

young during their first summer. However, the fall data were believed to have been misleading as a result of the scattered distribution of goats on lower ranges during an unusually mild period of October weather in which there was little snow to concentrate animals on the lower, more accessible slopes.

The consistently wide difference between the number of yearlings and kids observed on the various ranges is indicative of heavy losses in these age groups (Table 7). On areas observed in consecutive summers on the Selway River, these losses during a year's period amounted to nearly half of the original kid crop as represented by a drop from a young-female ratio of 53 per cent to a yearling-female ratio of 29 per cent. A similar condition was noted on Salmon River ranges for the fall, winter and early spring periods of 1950-1951 and 1951-1952 when approximately half of the kids of the first year survived to the long yearling age (Table 8). The kids observed during the latter year showed comparatively high survival to the yearling stage in counts which were made during the summer of 1952. However, these were also completed on low ranges where nannies, kids and yearlings predominated after males and possibly the females without young had migrated to higher summering areas. Perhaps the drop in the young-female ratio from 79:100 to the yearling-female ratio of 55:100, as seen in the Red Butte area over the winter of 1947-1948, was more representative of normal losses since a larger part of the animals on this range was accessible for observation during the seasons when coverages were conducted.

Some discrepancies in successive age classification counts of animals on the Salmon River warrant explanation. Such a case is the difference between the kid ratio of 23 per cent for the winter and early spring period of 1949-1950 and the 37 per cent yearling ratio during the following spring of 1950-1951 (Table 8). In the latter period the small count of only 36 animals probably yielded a less accurate ratio than the previous winter and early spring classified count of 221 and, hence, is of questionable reliability. The larger count of 159 classified animals during the 1950-1951 winter and early spring period yielded a young-female ratio of 39 per cent which was reduced by the following fall (1951-1952) to 17 per cent. This represents a substantial loss between the kid and yearling ages, even though part of this difference may have resulted from the difficulty in distinguishing yearlings and the inadvertent placement of them in the two-year and over age group during the fall of 1951. The

yearling count of 15 per cent for the following winter and early spring period of 1951-1952 was very close to this. It was made on winter ranges under conditions that allowed recognition of the yearlings. Both of these ratios, based on relatively large counts (137 and 141), indicate, by comparison to the young-female ratios of 1950-1951, heavy losses in animals during their first two years of life.

The similarity between young counts of the winter and early spring of 1951-1952 and yearling counts of the summer of 1952-1953 indicates greater reliability and less error than previously shown due to the possible upward spring migration of some age classes from the ranges under observation. The cumulative counts during both periods were sufficiently large to be fairly reliable, and it is probable that losses of kids counted during the fall, the winter and early spring of 1951-1952 were light. In general, however, most of the herds visited during this study showed a wide and consistent disparity between yearling and kid numbers, and there can be little doubt that losses were extremely heavy in young animals.

TABLE 9. Results of macroscopic analyses of ovaries from eight mountain goats collected in Montana and Idaho during September and October. Ages were estimated from the horn length-age curve of Figure 10.

Estimated Age (Years)	Follicle-like Bodies	
	Right Ovary	Left Ovary
1½	Nothing	2-less than 1 mm.
2½	2-5 mm., 1-2 mm., 2-less than 2 mm.	1-3 mm.
2¾	1-5 mm., 1-less than 2 mm.	1-6 mm., 2-less than 2 mm.
3 plus	2-5 mm., 3-less than 2 mm.	1-5 mm., 3-less than 2 mm.
3 plus	1-4 mm. (2 possible rupture sites)	1-4 mm. (2 possible rupture sites)
3 plus	1-8 mm., 3-less than 2 mm.	2-3 mm. (1 possible pigment spot)
3 plus	2-2 mm. (possible pigment spot)	3-less than 2 mm. (possible pigment spot)
3 plus	1-(no measurement)	2-6 mm. (2 possible pigment spots)

#### Analysis of Ovaries

Ovaries of five mountain goats over three years of age, examined macroscopically using the method described by Cheatum (1949), contained what may have been developing follicles. These ovaries, collected from September 15 to October 15, contained follicle-like bodies which ranged in size from eight millimeters to less than one millimeter (Table 9). One ovary of a yearling showed what may have been developing egg follicles of less than

one millimeter in diameter, while nothing was found in the other ovary. The ovaries of two 28-month-old females contained what appeared to be developing follicles. These scanty findings indicate that there is follicular development in September and October previous to the mating period and that two-year-old animals may breed during their third fall. It was not determined if the pigment spots observed in animals over three years of age represented degenerate corpora lutea. Ovaries of two females over three years of age showed what appeared to be current follicular development. Courtier (1938) found that the chamois first mates at an age of 18 to 19 months, and drops its first young after a gestation period of 160 to 170 days, at an age of two years.

#### Synopsis of Productivity

In general, the data collected during this study seem to establish that production of young varies with conditions under which females winter previous to parturition, and that there is usually a heavy loss in the young during their first two years of life. Adverse wintering conditions, resulting in lowered availability of foods and use of those of poor nutritional quality, were reflected, as in other big game species, in lower survival and production of young.

Kidding period young-female ratios ranged from 39:100 to 117:100 in Montana and Idaho herds from which classified counts of over 50 animals were obtained. The summer ratios from the Selkirk Mountains and Red Butte area, which ranged from 72:100 to 79:100, probably were slightly lower than the data indicated since an even sex ratio was assumed and subsequent productivity studies on other ranges have shown unbalanced sex ratios favoring the females. Young-female ratios of between 50:100 and 70:100 are probably fairly typical of production during average years on most ranges. The observation of four pairs of twins in 35 kids seen in the spring of 1952 on the Salmon River would indicate that the reproductive potential of the mountain goat is high, and that during occasional favorable periods the ratio may attain a level of nearly one young per female over two years of age. There is no evidence to indicate that goats mate as yearlings to produce their first young as two-year-olds.

## PARASITES AND DISEASE

Generally it has been found that nutrition is a primary factor in determining the susceptibility of an animal to parasites and disease-causing organisms. Animals which appear to be healthy may support reservoir populations of internal and external parasites without succumbing to their effects, unless infestations become unusually heavy during periods of adversity.

The overcrowded conditions which prevail on many mountain goat winter ranges would seemingly contribute to malnutrition, making the animals susceptible to disease. It was usually difficult to determine the organisms responsible for symptoms discovered in field observations and autopsies, but an attempt was made to collect samples for identification whenever possible.

Abnormal loss of hair during the late winter and early spring was noted several times on animals in Idaho. A female goat taken on April 5 on the Salmon River showed a large denuded area of black and scaly skin on the neck and shoulders. There was no evidence of mite infestation, intense irritation or exudation that might have been responsible for the almost complete loss of the hair. Microscopic examination of skin tissue by Dr. J. K. Frenkel of the U. S. Public Health Service revealed a thicker hyperkeratotic epithelium with an increased amount of pigment in the basal cells. There was also more collagenous connective tissue in the dermis and a thicker portion of the denuded skin showed epidermoid carcinoma. It was thought that this hair loss may have been induced by the animal's emaciated condition or by a heavy infestation of more than 200 wood ticks (*Dermacentor andersoni*), a large part of which occurred along the margins of the denuded area. The condition may have resulted from the animal rubbing its shoulders against shrubs or other objects to relieve the irritation caused by the ticks, as reported in the case of moose that were heavily infested by the winter tick (*Dermacentor albipictus*) in the studies of Fenstermacher and Jellison (1933) and Cowan (1951). The infestation of winter ticks on this goat was light, and less than a dozen were found.

Woodticks became abundant with the first warm weather of spring on all of the ranges visited, and it appeared that most of the animals were heavily infested. On a few occasions magpies were observed picking at the backs of goats in an apparent effort to eat the engorged ticks. When disturbed by this, the animals would shake themselves vigorously, causing the birds to fly from their backs, while on other occasions they would allow them to

pick the ticks without any outward display of annoyance. Cowan (1951) reported both wood ticks and winter ticks on goats examined in western Canada.

Three nymphs of the spinose ear tick (*Otobius megnini*) were found in the outer ear of the female collected April 5 on the Salmon River. A collection in Banff Park had previously provided the first record of this parasite in the mountain goat (Cowan, 1951). Autopsy of the Salmon River animal revealed a heavy infestation of fringed tapeworm (*Thysanosoma actinoides*). This parasite contributes heavily to winter mortality in domestic sheep and it undoubtedly has harmful effects on mountain goat hosts when present in large numbers during critical winter periods. Several cysts of the tapeworm (*Taenia hydatigena*) were present on the mesenteries, and a nematode from the intestine was identified as the pinworm (*Skirjabinema* sp., probably *S. crami*). The absence of mesenteric fat on this 128-pound animal was indicative of its emaciated condition.

An autopsy of an aged nanny found on Rattlesnake Creek, Montana, showed several cysticerci (*Taenia* spp.) within the pleural cavity and considerable congestion in the lungs. All other internal organs appeared normal, except for the intestines which were empty due to an impaction that had stopped the passage of food from the stomach. An infection was present between two molars which were worn nearly to the gums. This animal weighed only 68 pounds and was extremely emaciated.

A kid found a few days following death was covered by an extremely heavy infestation of the domestic sheep foot louse (*Linnognathus pedalis*). This was believed to have been the first record of this parasite on the mountain goat, although Cowan (1951) reported occurrence of the biting louse (*Damalinia parallelus*) on goats in Banff Park. Fragments of tapeworms from the intestines were identified as *Thysanosoma actinoides*, possibly *T. wyominia*, which was previously reported for sheep in the Big Horn Crags (Smith, 1951). One hundred and three adult winter ticks and three nymphs were picked from the hide of this kid along with three adult woodticks. Six nymphs of the spinose ear tick were also taken from the ear. Blood serum was found to be negative for Q fever and spotted fever in the complement fixation test completed by the Rocky Mountain Laboratory of the U. S. Public Health Service. This animal, which weighed 25 pounds, was in an extremely emaciated condition and had apparently become separated from its mother previous to its death during the first week in January. Most of the necropsy findings

were consistent with changes observed in states of inanition and starvation.

Examinations of 75 samples of mountain goat fecal material from the Salmon River, the Selkirk Range, the Selway River and Red Butte area have shown the presence of several internal parasites in these herds (Table 10). Larvae of lungworms (*Muellerius minutissimus* and *Protostrongylus* spp.) were found in droppings of animals from each area, while eggs of the stomach worm (*Marshallagia marshalli*<sup>1</sup>) were found in droppings from the Salmon River, Selkirk Range and the Selway River, and *Trichostrongylus* spp. was found in one Salmon River sample. Cowan (1951) describes serious effects of infestation of the hair lungworm (*Protostrongylus stilesi*) in the lungs of mountain goats and bighorn sheep where they caused blockage of air passages and blood vessels. In the worst cases reported by him as much as one-third of the lung tissue was rendered useless by the infestation of this parasite and resultant bacterial infections.

Other ova found in droppings resembled those of the whipworm (*Trichuris ovis*), the threadworm (*Strongyloides* spp.), tapeworms (*Monezia expansa*, *Thysanosoma* spp., and *Thysaniezia giardi*), the lancet fluke (*Dicrocoelium dendriticum*), and the liver fluke (*Fasciola hepatica*). Eggs or larvae occurred in from 30 to 70 per cent of the samples from the four areas with the highest incidence of parasitism being found in animals on the Selway River, where unfortunately the number of collections was very limited. Cowan (1951) reported occurrence of the broad tapeworm (*Monezia benedini*), fringed tapeworm, thin-necked bladderworm (*Cysticercus tenuicollis*), hair lungworm, stomach worms (*Ostertagia circumcincta*, *O. occidentalis*, *O. marshalli* and *O. trifurcata*), thread-necked strongyle (*Nematodirus fillicollis*), whipworm, and the pinworm (*Skrjabinema oreamni*) in parasite examinations of mountain goats in western Canada. He also reported three cases of the fungus infection of actinomycosis (*Actinomyces israeli*), two of which involved tooth abscesses while the other was a case of actinomycotic foot rot in a kid. No cases of actinomycosis or evidence of this have been found or reported in animals or skulls collected in Idaho and Montana.

With the exception of pasteurellosis and coccidiosis infections in the lungs and caecum of an autopsied male and an abscess on a hind leg of a female, there was little apparent evidence of disease in mountain goats that were transplanted in Montana. The heavy woodtick infestations on most of these animals were

<sup>1</sup>Genus *Marshallagia* is synonymous with *Ostertagia*.

TABLE 10. Number of occurrences of mountain goat parasites in Idaho and Montana as determined from identification of larvae and eggs in droppings.

Area	No. of Samples	Lungworm ( <i>Muellerius minutissimus</i> )	Lungworm ( <i>Protostrongylus</i> spp.)	Stomachworm ( <i>Marshallagia marshalli</i> )	Stomachworm ( <i>Trichostrongylus</i> spp.)	Whipworm ( <i>Trichuris ovis</i> )	Tapeworm ( <i>Monezia expansa</i> )	Tapeworm ( <i>Thysanosoma</i> spp.)	Tapeworm ( <i>Thysaniezia giardi</i> )	Threadworm ( <i>Strongyloides</i> spp.)	Lancet Fluke ( <i>Dicrocoelium dendriticum</i> )	Liver Fluke ( <i>Fasciola hepatica</i> )	Negative
Salmon River (late winter collections)	20	.....	.....	4 E <sup>1</sup> (P) <sup>1</sup>	1 L <sup>1</sup> (P)	.....	.....	1 E (P)	1 E (P)	1 E (P)	2 E (P)	1 E (P)	9
Selkirk Range (spring collections)	31	3 L	.....	2 E	.....	.....	2 E (P)	.....	.....	.....	.....	.....	24
Selway River (summer collections)	10	2 L	3 L	5 E	.....	3 E	.....	.....	.....	.....	.....	.....	3
Red Butte (summer collections)	14	.....	7 L (P)	.....	.....	4 E	.....	.....	.....	.....	.....	.....	5

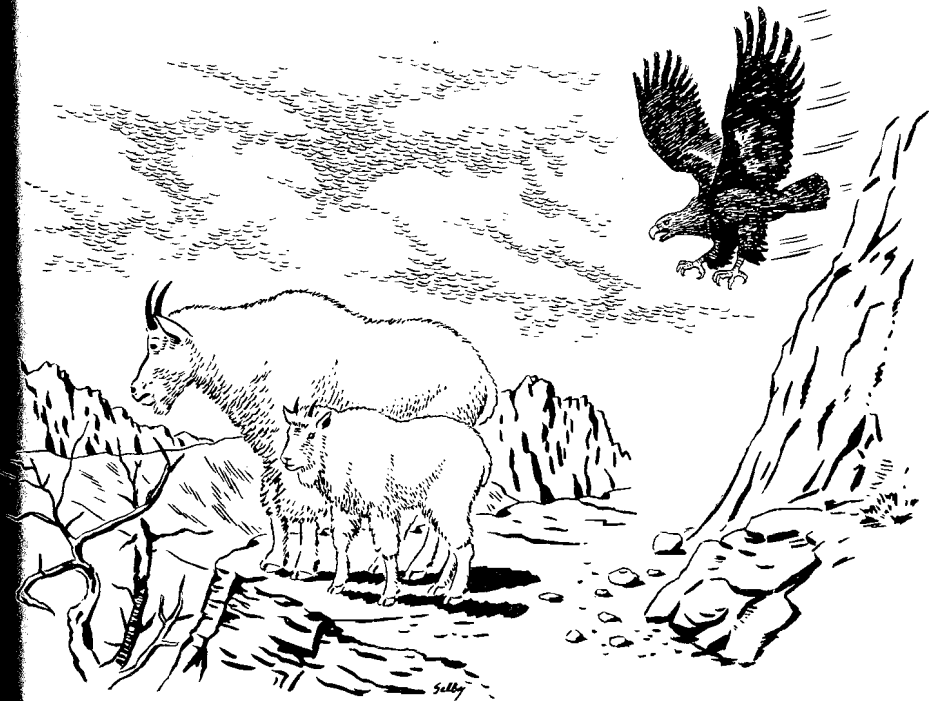
<sup>1</sup>E—Eggs, L—Larvae, P—Probable identification.



thought to have been partially responsible for their emaciated condition.

Flies bothered goats considerably during warm weather, and animals were frequently observed shaking and dusting themselves as these insects hovered about them. Seton (1927) described the death of one of a pair of newborn twins in the Washington Zoo which resulted from flies blowing the umbilicus and anus.

Importance of parasites and disease as decimating factors of the mountain goat could not be determined from the small amount of data collected during this investigation. The high incidence of parasitism as shown by autopsy and fecal analyses indicates that parasites may possibly contribute to mortality during critical winter periods when animals suffer from malnutrition.



## PREDATORS

### Coyotes

Although coyotes are common on all of the ranges covered during this study, no conclusive evidence of their predation on goats has been found. Occasional kills would most likely occur on open ranges where several working together could bring a goat down. Kids wandering in search of their mothers would seemingly be the most frequent victims of these predators.

One coyote approached within 150 feet of a band of goats before they sensed its presence and ran to nearby cliffs. A winter observation of two coyotes stalking a pair of mountain goats was made on the Salmon River. After approaching within 50 feet of where the animals lay, the coyotes detoured around them and proceeded up a broken slope. It was not until they had disappeared that one of the goats rose and looked down the mountain side in the direction from which the two animals had approached. The coyotes may have been conditioned from their previous encounters with goats, which according to reports are to be feared by

the unwary canine assailant. One case of a dog having been killed by the lightning-fast horn thrusts of a cornered goat was reported by Mr. Frank Rood, a Salmon River resident.

Analyses of 960 coyote droppings collected during this investigation on the Red Butte area, Selkirk Range, Selway River and Salmon River provide a check on the occurrence of goat flesh or hair in the coyote's diet. Thirteen of the 68 coyote scats (19 per cent) collected on the Red Butte area contained hair or other goat remains, while less than one per cent of 721 scats collected on the Salmon River showed presence of this food in the coyotes' diet. Many of the specimens taken on the Salmon River were on deer and bighorn sheep ranges where goat populations were small or absent. No evidence of goats having been used as food was found in 129 collections on the Selkirk Range, or 42 that were taken on the Selway.

Since many of the animals that coyotes feed upon die from other causes, the occurrence of goat remains in the droppings cannot be taken as an indication of coyote predation. Although most of the carcasses found during this study had been visited by coyotes, there was no evidence that they had made the kills.

#### Cougars and Bobcats

Cougars and bobcats are common but seldom seen occupants of goat ranges. On the Salmon River bobcats were abundant on the winter ranges, and cougars were frequent transients. Over the past 10 years there has been an increase in cougar populations on the Selway and Salmon Rivers and throughout the Bitterroot Range.

Little information is available as to the importance of these two cats as predators of the goat, but it is believed that they may be major decimators within some of the more remote ranges because of their ability to traverse the rugged terrain upon which the goats depend for escape from most of their enemies. Cougars move with their food supply, and once having located an isolated band of goats, would likely stay with it through the winter. Such depredations would seemingly make serious inroads on small herds.

Young and Goldman (1946) cite an eye witness account of a cougar killing and consuming a goat near Banff, Alberta. Cowan (1944) mentions an observation of a game warden who found a goat killed by a cougar in the Athabaska Valley, Jasper National Park, Canada. A mountain lion that was killed in October, 1951,

by Lowell Hayes on Como Lake in the Bitterroot Range of Montana had recently fed on a mountain goat.

#### Bears

Neither grizzly nor black bears were considered of importance as predators on the Red Butte range. Grizzlies were more common than the blacks on the high ranges of the Sun River and South Fork of the Flathead River, but only black bears inhabited the other goat ranges visited during the investigation. Predation by bears could probably occur when goats are caught at a distance from cliffs, but it is doubtful that a bear could catch a healthy goat under normal circumstances in rough terrain. Cowan and Brink (1949) mention occasional ambush by bear and cougar of goats which traveled through timbered areas on their way to licks. Ranger Horace Godfrey's observation of a group of animals feeding within 75 feet of a grizzly on Kid Mountain on the South Fork of the Flathead River shows that goats can be approached closely by bears. In this case neither the bear nor any of the goats seemed aware of the other's presence.

#### Eagles

Golden eagles were seen almost daily on Idaho and Montana mountain goat ranges, while bald eagles were observed infrequently in both the Red Butte area and along the Salmon River. Golden eagles displayed considerable interest in goats, and were seen harassing them on several occasions. The goats frequently watched these birds closely as they flew nearby, although many times they paid little attention. Sometimes they assumed a squatting position when being harassed by birds which dove and circled above them.

A Forest Service employee, who was stalking a nanny and kid on the South Fork of the Flathead River, photographed an eagle (presumably golden) at close range as it carried away the kid. Anderson (1940) reported a case in which an eagle (species not recorded) knocked a yearling goat from a cliff. The animal landed on a lower ledge and showed no ill effects from the fall. Another instance, in which an eagle struck an adult, was also reported by him. In both of these cases it appeared that the birds had attempted to knock the goats from the cliffs. An interesting eye witness account of an eagle attacking a young goat in the Cabinet Mountains near Clark Fork, Idaho, was described by Mr. Don Samuelson (1951) of Sandpoint. He and Mr. Lester Gissel saw the eagle as it dove in pursuit of a kid running along a nar-

row rocky ridge. They shot at the bird when it was within three feet of the kid, causing it to veer off as the kid jumped into a rock crevice. The observers, upon investigating, found the kid unharmed and, after taking photographs, watched as it bounded down the mountainside.

On the afternoon of June 3, 1948, a bald eagle was seen to carry a kid away from its mother in the Red Butte area. The following excerpt from the author's field notes describes this incident:

At 4:15 a bald eagle flew by the cliffs on which two nannies, two kids, and a yearling had been feeding. One of the nannies crowded close to her kid as the bird circled about 25 feet above them. The eagle then dove within a few feet to land on a pinnacle of rock ten feet above on the cliff face. The nanny left the kid and started up the cliff toward the eagle and was within five feet of the bird when it jumped from its perch and flew over her, picked up the kid, and sailed out over the cliff. The bird glided to a point a third of a mile away, where it began to lose altitude and apparently landed, out of sight of the observers. The kid hung helplessly and the eagle did not move its wings during the entire flight. The mother goat spent several minutes searching the slope before a yearling came running from where it had been feeding, 150 feet above on the cliffs. She drove it off and continued searching, but fifteen minutes later was feeding quietly with the yearling following 100 feet behind. The kid, which was only a few days old, probably weighed less than seven pounds.

Two golden eagle nests were found on the Salmon River in April, 1952. No remains of goats or any other big game animal were discovered in the nest which was accessible, or at the base of cliffs beneath either of the nests. Mr. Glen Smith of Missoula reported finding goat hair around a nest in the Pintler Range in Montana. Murie (1944), in discussing golden eagle predation on Dall sheep (*Ovis dalli dalli*), found a very low incidence of lamb remains in 632 pellets collected from perches and nests in the lambing area. In examining 20 nests (thirteen occupied and seven unoccupied) only two were found to contain remains of young sheep. He states, "The considerable information available supports the conclusion that only occasionally does an eagle feed upon a lamb. Such lambs may have been carrion or may have been killed by the eagles. If killed, they may have been healthy, weak, or deserted. In any event, whatever eagle predation exists, it is apparent that it would have no appreciable effect on the mountain sheep populations." Neither Honess and Frost (1942), in their original sheep study, nor Spencer (1943), studying the Tarryall Mountain herds, found any evidence of golden eagle predation on bighorns. Dwight R. Smith has not reported any evidence of eagle predation during his work on Salmon River bighorn ranges from 1949 to 1953, although eagles are common there.

It is apparent from observations and reports that both golden and bald eagles occasionally prey on mountain goats. Verified reports of predation, however, are comparatively few. Golden eagles frequently harassed goats by diving and circling over them, but only one attack by a bald eagle was witnessed during the investigation. Probably most depredations by eagles occur during the kidding period and a few weeks following it when the young are still very small. Occasionally an unwary older animal may be struck, resulting in a fatal fall from a ledge. In general, though, there is no information to establish that the eagle is an important enemy of the goat.



### NATURAL HAZARDS

Snowslides occurring throughout the late winter and early spring probably are responsible for more accidental deaths than any other natural cause. Severity of slides varies from year to year depending on the weather, snow conditions and other factors, but there appears little doubt that they frequently take the lives of many goats. In late March and early April, 1952, slides had occurred within nearly every canyon and major ravine on the northern aspect winter range occupied by 70 goats on the Salmon River breaks in the vicinity of Cottowood Creek. A week of unusually warm weather caused loosely packed snow to slide and created a serious hazard.

One goat was found partially buried by snow and debris in a ravine that had been filled by a spring slide in the Red Butte area. Darrel Slavin of Salmon reported a kid which had been carried down by a snowslide into Camas Lake on the Middle Fork of the Salmon River. The goats' habit of walking on the overhang of snow cornices must also account for occasional fatalities. This is

indicated in an observation (field notes, July 12, 1947) of a goat in the Red Butte area as follows: "The cornice overhanging the cliff could easily have given way under the animal's weight, causing it to plunge several hundred feet to the talus slope below."

Landslides occur frequently on the goat ranges, especially during periods of heavy precipitation when the erosive action of water causes movement of soil. Goats sometimes start slides as they feed or move across steep slopes, and although they usually paid little attention to the noise of rolling rocks, they were seen to take flight on the occasions when nearby slides gained sufficient momentum to be heard plainly. There is little doubt that these occasionally result in injury to animals, but only a few cases were noted.

Although goats have been observed to fall on only a few occasions, they undoubtedly make fatal missteps, especially during the winter when rocks are covered by snow and ice. Nearly half of 25 carcasses found during this investigation were at the bases of cliffs.

Accidental separation of the kid from the mother during the first year of life is seemingly responsible for some loss in the young. Several observations were made of young kids which wandered aimlessly after becoming separated from the females, and it appeared that they are vulnerable to enemies and starvation under these circumstances. Judging from frequent observation, this loss from separation may be appreciable, especially when females are harvested. The kid, which occasionally stands at a distance watching the hunter as he dresses and skins the nanny, is left to its own devices and survival is doubtful.

Fighting is also believed to be responsible for the occasional injury and death of mountain goats. Although the animals frequently chased one another, they were observed fighting only once and it appeared that either of the goats involved could have fatally wounded the other. This encounter began near Red Butte (June, 1948) when a large goat, which was within 50 feet of five adults and a yearling, stood pawing the ground before making a quick lunge with lowered head toward a smaller adult in the group. The two moved quickly in a close circle, striking at each other with their lowered heads as a cloud of dust rose around them. After nearly a minute of this, the smaller animal turned and ran out of sight with the aggressor following close behind. Seton (1927) cited a fight between two billies in which fatal injuries were inflicted, and there is little doubt that serious wounds

must occasionally result from such encounters, especially those which occur between rival males during the rutting season.

Cold rainy weather may adversely affect survival of kids during the first weeks of their lives. Severe climatic conditions are often responsible for heavy losses in domestic lambs and it would seem that the continuous cold rains that frequently occur during the kidding period would be harmful to the young goats.

The effects of rain squalls on the actions of goats of all age classes seemed to vary; a few observations were made of animals that ran from open slopes to the protective cover of cliffs with the onset of rain, while in other instances animals continued to feed with no apparent concern. The following Salmon River observation (March 17, 1950) was fairly typical of those that seemingly indicated a definite response of animals to a sudden change in the weather: "When a wind and rain squall settled suddenly, two of the three animals being observed walked quickly around the hillside to the leeward slope. The remaining animal followed after nearly five minutes."

One of the most serious consequences of inclement weather is food shortages which result from heavy snowfalls. As previously mentioned, forage conditions on many of the winter ranges are critical because of excessive snow depths which make much of the forage unavailable. These food shortages probably have their most serious effect on the young.



## MANAGEMENT

### The Management Problem

The mountain goat occurs naturally in only three states — Idaho, Montana and Washington. There are few other areas of the country where comparable herds of big game animals can be seen and hunted within wilderness and undeveloped areas. And with the rapidly growing appreciation of the outdoors it is becoming increasingly important that this big game resource be managed in such a way as to render the greatest possible sporting and esthetic returns. The presence of the goat in huntable numbers within Idaho contributes to the distinction the state enjoys from its unexcelled variety of big game species.

One of the biggest obstacles to proper management of the mountain goat has been the lack of information on its numbers, distribution and life history. Because of this, little has been ac-

complished in establishing management practices that allow adequate harvests while insuring sustained production of the herds. The occurrence of nearly two-thirds of the population in groups of 50 animals or less necessitates refinement of harvest methods if these small herds are not to be depleted. This need is intensified by the attachment of mountain goats to their historic winter ranges to which they return year after year, with little apparent movement between adjacent herds or from an area of concentration to a range where populations have been depleted. Often one herd is isolated geographically from others, as well as from suitable unoccupied ranges in adjacent areas.

The strong tendency of animals to concentrate on preferred portions of wintering areas results in severe forage depletion, and it is probable that in the case of goats, as with deer, adequate cropping of a population will induce greater vitality and productivity through maintenance of a healthy balance between the winter food supply and animals' requirements. On many goat ranges natural losses may have absorbed surpluses which would better have been taken by the hunter. Increases in productivity should occur with proper harvesting and the attainment of a closer balance between the winter forage needs of a population and the plant resource.

With the small populations involved it is necessary that removals be set at levels commensurate with productivity rates, and that downward population trends be recognized quickly if severe reduction in numbers is to be avoided. The apparent need for information on populations can be only partially satisfied through the use of methods which are practicable within the present limitations on funds for management and research. These limitations will become less restrictive as hunting pressures increase and the necessity for basic information, as a requisite for sound management planning, becomes more apparent to the public.

In the face of urgent needs for information on elk and deer herds, which provide the bulk of Idaho's big game harvest, it is not currently possible to place the mountain goat program high on the list of work priorities. Yet, it must be recognized that without up-to-date population inventories and other essential information, this species cannot be managed efficiently and without risk to the herds. Intensive research designed to provide complete descriptions of daily, seasonal and yearly movements of mountain goats is one of the greatest needs at this time. Biotic conditions are ever-changing and without a continuous effort in collection of information on the animals and ranges on which

they live, little can be expected from management programs. The successful application of the following recommendations is contingent upon an increase in big game management personnel and a program which provides for training of the present force in conducting and interpreting field investigations.

### Harvests

Considering the size of the mountain goat populations, harvests in Idaho and Montana have been small. Estimates of kill over 27 years in Idaho reveal no significant trends (Table 11), and except for 1933 and 1946, no removals of over 100 animals were reported for any year. Previous to 1950 harvest information was not collected, and except for estimates, no records of the removals during hunting seasons were maintained.

Until 1938, when the Idaho Fish and Game Commission was

TABLE 11. Estimated number of mountain goats harvested in Idaho during 18 years from 1927 through 1953.

Year	Number Killed
1953	14
1952	21
1950	7
1947	67
1946	125
1945	59
1944	33
1943	23
1941	76
1938	61
1937	62
1936	81
1935	24
1933	107
1929-30 (biennium)	140
1927-28 (biennium)	107

created, all hunting regulations were established by the Legislature. As early as 1903 there was a bag limit of one mountain goat for each hunter that held a dollar license. The hunting season extended from September 16 to November 30, and it was not until about 1921 that the season was shortened to 45 days in some counties. During the same year, the hunting license fee was raised to two dollars. In 1929 the law (of 1917) requiring that a paper tag attached to the license be completed after making a kill was amended to require that this be attached to the carcass. October and November seasons ranging in length from 25 to 55 days were continued in most of the counties having goat seasons. By 1931 hunting seasons in some areas had been shortened to 10 days. In

1933, metal tags costing a dollar for each species of big game were required in addition to the two dollar hunting license. In 1943 the tag fee for the goat was raised to 10 dollars. From 1943 through 1946, the seasons ranged in length from 10 to 35 days. By 1946 harvests on some of the more accessible ranges were found to have been excessive and several areas with isolated herds were closed to hunting. In the following year, the season had been shortened to 10 days (October 22 to 31) and in 1948 a statewide

closure was ordered by the Fish and Game Commission. Since then there have been few open areas over most of the state. Boundary County's eleven-day season in 1950 was the state's last general hunt.

In 1952 and 1953 special permit hunting units were established for 11-day seasons in the Selkirk Range, the Selway River and Salmon River areas. Past experience has shown that general open seasons allowed a concentration of hunting pressure on the most accessible herds while those in more remote areas frequently went unharvested. The main objective in establishing limited permit hunts within specified hunting units was to obtain an even distribution of hunting pressure, limiting harvests to a number which could safely be removed from each herd. All of the units established by the author included the major portion, if not all, of the herd ranges. The boundaries of these will be adjusted as further information on the distribution and movements of animals is made available.

Approximately 10 per cent of the mountain goat populations within the hunting units were allotted for harvest during the 1952 and 1953 hunts. This served to insure that removals were well within the assumed capacity of each herd to produce harvestable surpluses during years of favorable population trend, and that depletion would not occur before the effects of these limited harvests could be evaluated. If decreases are observed, compensating reductions in kill allotments should be made so that populations can be stabilized at the highest level of productivity compatible with good management of the winter ranges. Of the total number of animals to be removed, 30 per cent was presumed lost to crippling and illegal kill, and permit allotments were reduced accordingly. Except for one unit, only those herds which had been censused and had been found to be of sufficient size to allow a removal of two or more animals were hunted. The exception was the hunting unit in Custer and Blaine Counties that was established on the recommendation of local Fish and Game Department personnel. A hunter success of 50 per cent was assumed in setting permit allowances to attain the desired removals, and distribution of the permits was accomplished through a drawing in which prospective hunters submitted permit applications for the unit they wished to hunt.

Since the goat is known to be polygamous, recipients of permits were encouraged to harvest males in preference to females. Descriptions of characteristics that could be used in determining sex were sent to each permit holder along with a request that he

avoid taking females, particularly if accompanied by young. A 1952 ruling of the Fish and Game Commission made it mandatory that the carcass of the animal be recovered from the field, as is the case with other big game species. This should be enacted into legislative law so that the same regulations as applied to the use of flesh of other big game animals can be properly enforced. Special checking stations have been operated in conjunction with the bighorn sheep harvests which ran concurrently with the goat hunts. The 1952 hunting season extended from September 15 through 25, while in 1953 the season was advanced to September 1 through 10 to allow better service by guides and outfitters before they became occupied with elk and deer seasons.

In 1952, 120 applications were received for 54 mountain goat permits available in the 12 special hunt units within the Selkirk, Selway River and Salmon River areas. Forty-five permit holders hunted and were successful in taking 21 animals, a hunter success of 47 per cent. An average of slightly over two days was actually spent in the field by all the hunters; those who were successful averaged 1.4 days, while the unsuccessful averaged 2.7 days. Seventy-one per cent of the hunters that went equipped with packstock and adequate provisions for a stay of several days were successful, as compared to a success ratio of 32 per cent for those who hunted from the road or back-packed into the hunting units.

Fifty-eight permits were made available within 16 hunting units in 1953. Only 30 of these were filled due to lack of applications for those remote units that were accessible only by trail. Fifty per cent of the hunters were successful in this hunt with 14 animals having been harvested by the 28 permit holders that went into the field. The average hunt lasted two and a half days; the successful hunters spent slightly over two days in the field and those who were unsuccessful an average of three days.

The drop in hunter response and apparent lack of interest in the 1953 special mountain goat hunt was coincident with the decline in applications for most of the special hunts on other big game species. Although the Fish and Game Department has publicized these mountain goat hunts to some extent, there is need for additional out-of-state promotion if the desired removals are to be obtained.

To encourage participation, and to compensate for the drop in applications for permits, some hunters have suggested that mountain goats be taken under a general open season. This is inadvisable, however, since uncontrolled harvest would cause the same type of depletion as observed on the most accessible

ranges during past general seasons. After determining the effects of current experimental removals, it may be possible to open some of the more remote units to general seasons. Before doing this, provision should be made for proper censuses and trend checks so that the effects of removals can be evaluated. Hunts should not be conducted in the absence of adequate information on a herd's size and trend.

Tabulation of removals on the Selkirk Range in two permit hunts and the general open season of 1950 provides a comparison of hunter success under the two types of hunts (Table 12).

TABLE 12. Comparison of hunter success in the Selkirk Range during the general open season of 1950 and controlled permit hunts of 1952 and 1953.

Year	Permits Available	Hunters in the Field	Animals Killed	Hunter Success (Percent)
1950	General season (no restrictions on the number of animals taken)...	33	7	21
1952	26 (4 hunting units).....	24	6	25
1953	20 (4 hunting units).....	6	2	33

Of significance is the slight increase in percentage of successful hunters taking game on permits over those who were successful in the general season. Hunting pressure on this area has been heaviest in the popular Lion Creek Unit, and even with the sharp drop in applications in 1953, all permits for this unit were taken. This again demonstrates the need for control of harvests on the most accessible and best known ranges. The special permit hunt has served to distribute hunters so that they are able to harvest goats more equitably, while enjoying greater success.

Sex ratios of mountain goats harvested in 1950 and 1952 caused concern because of the disproportionate numbers of females which were taken. Six of the seven goats killed the first year were females as compared to a take of 14 females to 7 males in 1952. This was not explainable except by the observation that females are more commonly found in groups with other animals during this season and are therefore more likely to be seen than the billies which are observed largely by themselves. The 1953 kill was nearly evenly divided between the sexes.

Two of the five hunters who provided complete information on the females they killed indicated that their animals were still

lactating and probably had been accompanied by kids. It might be seen that since kids stand little chance of surviving after losing their mothers, some provision should be made for harvesting them. Difficulties in enforcing such a regulation would be great, however, and it appears that the best method for mitigating this loss is by educating the hunter to appreciate the necessity for making sure that the animal he kills is not accompanied by a kid.

Seventy-nine per cent of the 34 goats from which measurements were available in the 1952 and 1953 seasons had horns of over eight inches in length (Table 13) and were believed to be over 26 months of age.

TABLE 13. Horn sizes of 34 mountain goats harvested during the 1952 and 1953 permit hunts.

Hunting Season	Horn Size Classes (Inches)				
	6.—6.9	7.—7.9	8.—8.9	9.—9.9	10.—10.9
1952 (animals).....	3	1	6	8	3
1953 (animals).....	1	2	9	1	0
TOTAL.....	4	3	15	9	3

Only seven animals (21 per cent), having horns which measured from 6.0 to 7.9 inches in length, could have been less than 26 months of age. Twelve of the animals harvested (35 per cent) had horns over nine inches in length, while the three largest goats (9 per cent) had horns measuring from 10 to 11 inches. It appears that despite efforts to encourage the selection of large males and the establishment of a six inch minimal horn limit, many of the hunters were inclined to take the first goat they saw. This may account for abandonment of some kills in the field, especially in the case of younger animals which were killed before the hunter checked to insure that the horns were of legal length.

The 11-day hunting season in September appeared to be of sufficient length to allow the hunter adequate time for taking a goat, and for most areas, these have been set at the right dates. Snowfalls which make travel difficult and hazardous are the main reason for not setting later seasons on most of the high areas. However, on some of the Salmon River ranges where animals migrate onto the river breaks, they would be more accessible to the hunter during October. Hunts during this month would allow the best removal of harvestable surpluses on some of the lower areas and also would provide trophy hides of better quality.



### Transplants

Mountain goats have been introduced successfully on several ranges in Montana by the Montana Fish and Game Department. Animals for transplanting were taken in wire enclosures baited with salt, with the best results having been obtained in those traps that were constructed around old licks which had been used for many years. The outstanding example of success in this venture was the establishment of a growing and healthy herd in the Crazy Mountains where a total of 21 animals was released in the springs of 1941 and 1943. By 1947 this herd was estimated at approximately 100 animals and has since continued its rapid growth.

Goats appear to suffer from shock and hot weather when being transplanted, and, if losses are to be avoided, the move from the trap to the release site should be accomplished as quickly as possible. Night travel is preferred because of the lower temperature.

Transplanting provides a means of establishing mountain goats on suitable ranges beyond their natural distributional limits and on historical ranges where they have been eliminated. Introduction of animals should be preceded by careful examinations of proposed planting sites to determine their suitability as goat range, and to make a thorough study of the future effect of a goat population on existing animal and plant communities. There are numerous areas in Idaho where animals might be successfully established.

### Trend Counts and Censuses

Censusing is presently recognized as the most expensive and time-consuming activity required for the proper management of mountain goat populations. The inaccessibility of most ranges has prevented intensive coverages and, until projects were recently begun in Idaho and Montana, little was known of the size of the widely scattered herds. Soon after initiation of this work it was recognized that time and money limitations would not allow coverages of sufficient intensity to accurately determine the size of the many herds which were accessible only on foot. And today many important ranges have not been censused or have been only partially covered because of time and personnel limitations.

It was learned that the best counts could usually be obtained while animals were concentrated on winter ranges during late winter and early spring. Many important ranges cannot be

reached at these seasons without spending several days in travel over snow which sometimes remains until June. These must be censused during the summer after most of the snow on the high country has melted and high waters have dropped. At this season animals were widely scattered and counts required much greater time, and, as a rule, only a few were seen in the course of a day's coverage. Since goats are most active during the early morning and late afternoon, these were the periods that were spent in concentrated observation. Usually it was most convenient to use the late morning hours for the ascent to ridges and vantage points so that the afternoon and early evening could be spent in observation, allowing enough time before darkness to make the return trip to the base camp.

As much time as possible should be spent in observation, with a minimum of two successive days being devoted to coverage of an area in order to allow the location of most of the animals. Counts should not be conducted during inclement weather when animals are often inactive and show a tendency to remain bedded for extended periods. Increased activity is usually noted during the favorable weather which follows stormy spells, making these periods ideal for inventories.

Annual trend counts have been described for key herds within the Selkirk Range, the upper Selway River, and the Salmon River where censuses were completed during this study. Routes of travel, the phenological schedules and the amount of time to be spent are described in the completion reports for each area (Brandborg, 1953). Standardized methods for recording field observations and summarizing data are outlined for the use of area conservation officers and biologists. Within each area where conditions are comparable, two or three key herds were selected for annual trend counts which can be conducted in from one to three weeks' time. It is recommended that complete census coverages be made at least every five years to insure that population trends in the selected key herds correspond to those occurring elsewhere within the area.

It was found on the Salmon River that successive counts over two-day periods provide a satisfactory comparison of herd numbers from year to year, and that the variability in counts between successive two-day coverages by the same observer is not sufficiently great to negate their value. Table 14 shows the results of spring trend counts on three herds that were visited annually from 1949 through 1952. These coverages, made during the period when the first growth of grasses and forbs com-

menced in early spring, yielded totals that reflected a gradual growth of the populations. This information was supplemented by age classification counts of sufficient size to provide information on kid production and survival.

TABLE 14. A comparison of spring trend counts on three Salmon River mountain goat herds. These were conducted at approximately the same phenological period during the years 1949 through 1952.

Year	Cove Creek-Owl Creek		Lower Middle Fork of the Salmon River		Corn Creek-Bear Creek-Proctor Creek		Yearly Totals of Largest Daily Counts for All Herds
	Largest Daily Count	Number of Coverages	Largest Daily Count	Number of Coverages	Largest Daily Count	Number of Coverages	
1949.....	..	..	11	9	..	..	..
1950.....	9	5	8	6	22	11	39
1951.....	11	2	12	2	24	4	47
1952.....	13	7	17	3	23	10	53

Maneuverable, slow speed airplanes have proved to be of value in determining distribution of mountain goats during the winter when many of the ranges are inaccessible. They have enabled the location of herds which otherwise would not have been discovered. In the Bitterroot Range in Montana aerial censuses were used to define population trends of goats on the snow-free, south-facing slopes of winter ranges at a time when animals did not occupy northern aspects or the upper portions of canyons that were covered by several feet of snow. By flying within a few hundred feet of these open slopes after the snow-line has receded to a given elevation, two observers could readily count the number of animals seen per period of flight time. The plane was flown on contours at intervals of approximately 400 feet in three or four passes along the south-facing slopes of 14 canyons. No attempt was made to obtain a total count of the resident herds. In the first coverages on May 12 and 14, 1948, a total of 103 animals were seen in 138 air minutes of travel over the winter ranges. On May 13, 1950, 85 goats were observed in 95 minutes of flying time over these same areas. An average of 1.3 air minutes per goat was found during the first year's coverage, as compared to 1.1 air minutes per goat during 1950. The significance of these differences can be established only through determining their variability in successive coverages. The technique appears to hold considerable promise for censusing in this area although no other ranges have been observed where it could be applied with the same degree of accuracy. With further im-

provement, aerial coverage may provide the most economical method of censusing many of the summer and winter ranges. However, the hazards involved in present day aerial inventories are great, and it is doubtful that the data collected justify the risks which must be taken. Further improvement of the helicopter for use in mountain flying will facilitate the collection of more complete census information than is presently possible in aerial coverages.

The accuracy of the above methods of conducting trend counts and censuses cannot be accepted without question. Many uncontrollable variables will affect them and it has become evident that the influence of most of these cannot be defined in terms of the results. Chief among these is the human variable which will determine whether results of different workers can be compared. Training of personnel in the methods to be used is essential, and even then comparable observations from one year's coverage to the next may not always be obtained. While these many limitations were recognized in setting up trend count areas, as well as management procedures based on their findings, the resulting programs are vastly superior to the "shot-in-the-dark" recommendations which have been followed in the past.

It may become increasingly evident that the demand for harvestable goats is small and that the removals from a few of the many herds will satisfy hunting demands. This, however, does not justify a program which provides for harvests in the absence of adequate information on population trends. The primary concern of management for both sporting and esthetic purposes should continue to be the perpetuation of this very interesting and unique member of Idaho's big game fauna.

## SUMMARY

This is a report on the life history and management study of the mountain goat (*Oreamnos americanus missoulae* Allen) conducted from 1947 through 1953 in Idaho and Montana. The primary objective of this investigation was the collection of information which could be used in future management of the goat to insure its perpetuation for esthetic and sporting benefits.

The most concentrated study was made on three major areas in Idaho: the Selkirk Range, the Selway River and the Salmon River. Montana field work was conducted in the Red Butte area on the West Fork of the Sun River, on Deep Creek and the South Fork of the Teton River, and in the Bitterroot Range.

Historical records on populations of mountain goats are few and there is little information on the original size of herds. In general, the distribution of the goat is essentially the same as when the first white men came to the country, although localized depletion has occurred in some areas where man has had ready access to the ranges. As a rule, goat populations in Idaho appear to be fairly stable, and in many areas slight increases have been reported since 1948 when most ranges were closed to hunting except under controlled hunts. Idaho's present mountain goat population is estimated at 2,785 animals. Herds are typically small and widely scattered over the Rocky Mountains, from the Canadian boundary south through the Sawtooth Range to within a few miles of the Snake River Plain.

Broken terrain characterizes the goat ranges visited during this study. Animals winter along the breaks of the Salmon River at elevations from 3,000 to 5,500 feet where bluebunch wheatgrass and mountain mahogany are the dominant plants. Although some goats spend the summer within the Douglas fir zone, most summer ranges in Idaho lie within the Engelmann spruce-alpine fir zone. Winter ranges along the Selway River breaks and lower canyon, lying largely within the Douglas fir and ponderosa pine zones, compare closely to those described on the Salmon River. Many of the wintering areas of the Selkirk Range, in Idaho's panhandle, lie within the cedar-hemlock zone, while the higher summer ranges are largely within the Engelmann spruce-alpine fir zone. The Red Butte goat range lies within the Engelmann spruce-alpine fir and Douglas fir zones.

Feeding observations indicate that grasses, grass-like plants and forbs are of primary importance in the summer diet of the goat, while shrubs play the most important role in providing food during winter periods. Bluebunch wheatgrass and mountain mahogany were found to be the most important foods on Salmon River ranges. Browse species (including mountain maple, rose, serviceberry, chokecherry, syringa and red-stem ceanothus) are foods of primary importance in the Selkirk Mountains. The tendency of goats to concentrate on preferred portions of winter ranges, when heavy snows make most of the low-growing forage unavailable, causes winter to be the most critical season of the year. On many of the ranges animals are dependent upon low quality forage during this period, and where heavy use has been concentrated over the years, there is usually evidence of reduction of forage productivity resulting from depletion of the plant base. Natural reduction of populations from winter food shortages has apparently occurred on many Idaho and Montana mountain goat ranges, and will probably continue until a balance between animal numbers and available forage is attained through more intensive management.

Weights and measurements were collected from 26 mountain goats. Kids, weighing six or seven pounds at birth, grew to approximately 43 pounds by the time they were yearlings. Three two-year-olds averaged 62 pounds, while animals that were classed as three years of age ranged from 106 to 110 pounds. Weights of three female goats, four years of age and over, averaged 117 pounds as compared to an average of 154 pounds for five males. From these measurements, most of which were taken in the early spring when the animals were down in weight after the winter, it can be seen that a prime male of four years or older could exceed 225 pounds, but most goats in Idaho and Montana probably weigh less than 200 pounds.

Examination of skulls allowed a partial description of tooth succession in the young goat until the time it reaches an age of approximately four years. Horn growth characteristics can be used to supplement age determinations made by examination of the teeth. Cessation of horn growth during the winter results in formation of annual rings after the second growth period. By counting the number of summers' growth, starting with the two summers represented by that portion of the horn between the tip and the first ring, the approximate age of an animal having distinct horn annuli can be determined fairly accurately. The females' horns apparently grow at the same rate as those of

the males to attain comparable lengths, but they are consistently narrower. The two longest sets of horns measured during this study were 10½ inches in length.

Mountain goats are observed in small groups during most periods of the year. Females leave the bands to seek isolation before the kids are born, but rejoin them a few days later with the new offspring. The males are usually seen singly or in small groups by themselves during the spring and summer. During the rut they join the females, yearlings and kids, and it is in this period and the following winter months that the groups reach their largest size.

The movements of goats vary from a few hundred yards to several miles in the course of the day's activity, which consists largely of feeding and bedding. On the winter ranges travel of the animals is usually limited and they often remain in small areas of a few acres for weeks at a time.

Migrations of mountain goats occur between summer and winter ranges on all of the areas in Idaho and Montana which were visited during this study. Generally it has been found that mountain goats will occupy the lowest available wintering areas that provide preferred combinations of broken terrain and vegetative cover. These are usually situated on south-facing slopes where snow depths are least extreme, but occasionally animals may be seen during the winter on the highest ridges where the snow is several feet deep except for small areas bared by the wind. Downward fall migrations, which may involve distances of more than 15 miles, usually occur after storms bring the first heavy snow to the high ranges.

The peak of the mountain goats' mating activity in Idaho and Montana occurs during November and early December. The goat is polygamous and males compete for females that are receptive to their attentions. Kids are born during May and June. Single births are usual but twinning is not uncommon. The young are active shortly after birth and take green forage when only a few days old. They remain with the females until nearly a year of age.

Cumulative totals of age composition counts over seasonal periods were used in analyses of productivity. In general, the data collected during this study seem to establish that production of young varies with conditions under which females winter previous to parturition, and that there is usually a heavy loss in the young during their first two years of life. Adverse wintering conditions, resulting in lowered availability of foods and use of

those of poor nutritional quality, were reflected, as in other big game species, in lower survival and production of young. Young-female ratios of between 50:100 and 70:100 are probably fairly typical of production during average years on most ranges. The reproductive potential of the mountain goat appears to be high, and during occasional favorable periods ratios may attain a level of nearly one young per female over two years of age. There is no substantial evidence to indicate that females mate as yearlings and bear their first young when two years old. Sex ratio counts on the Salmon River showed a ratio of 87 males per 100 females.

Factors responsible for the decimation of mountain goat populations were studied. The high incidence of parasitism, as shown by autopsy and fecal analyses, indicates that parasites may contribute to mortality during critical winter periods when animals suffer from malnutrition. Although coyotes are frequent visitors on the mountain goat ranges, field observations and analyses of their droppings indicated that they were of minor importance as a predator of the goat. Cougars and bobcats also occur commonly on most of the ranges which were visited during this investigation, and it is believed that they may be important decimators of goat herds. Bears, both grizzly and black, appeared to be of little importance as enemies of the goat.

It is apparent from observation and reports that both golden and bald eagles occasionally prey on mountain goats. Verified reports of predation, however, are comparatively few. Golden eagles frequently harass goats by circling and diving at them, but only one attack by an eagle on a young kid was witnessed during the investigation. In this observation a bald eagle succeeded in snatching a kid, which was only a few days old, from its mother's side. There is no evidence, however, to establish that the eagle is an important enemy of the goat.

Of all the accidents which befall the goat in its hazardous environment, few are responsible for more losses than snow-slides. While the severity of slides varies from year to year, depending on the weather, snow conditions and other factors, there appears to be little doubt that they take the lives of many goats. Landslides, which occur frequently on the rocky terrain of the goat range, result in occasional injuries to the animals. Fighting, especially during the rut, is probably a mortality factor of minor importance. Cold rainy weather is believed to have been responsible for some losses of kids during their first few weeks of life.

One of the biggest obstacles to proper management of the mountain goat has been the paucity of information on its numbers, distribution and life history. In the absence of this, little has been accomplished in establishing management practices which allow adequate harvest while insuring sustained production of the herds. The occurrence of nearly two-thirds of Idaho's goat population in groups of 50 animals or less necessitates refinement of harvesting methods which will insure against depletion. This need is intensified by the apparent attachment of goats for their historic winter ranges to which they return year after year. Little movement occurs between adjacent herds or from areas of concentration to ranges where populations have been depleted. Transplanting has been used successfully in establishing mountain goats on suitable ranges beyond natural distributional limits and on historical ranges from which they have been eliminated.

Considering the size of mountain goat populations, harvests in Idaho and Montana have been small. Estimates of kill over 27 years in Idaho reveal no significant trends, and except for 1933 and 1946 no removals of over 100 animals were reported for any year. In 1952 and 1953 special permit hunting units were established in which approximately 10 percent of the herd populations were allotted for removal during 11 day seasons on the Selkirk Range, the Selway River and the Salmon River. These have served to distribute hunters so that they are able to harvest goats equitably without the risk of depleting the small herds. Since the goat is known to be polygamous, and orphaned kids are not believed to survive, recipients of permits were encouraged to harvest males in preference to females.

In 1952, the 45 permit holders that went into the field were successful in taking 21 goats. Fourteen animals were harvested in 1953 by 28 hunters. A comparison of hunter success under the general open season with the limited permit hunts in the Selkirk Range shows a slight increase in the percentage of successful hunters taking game on permits under the controlled hunt. The permit system appears to be well-suited for the harvest of animals on Idaho ranges. Removals from a herd should not be contemplated unless censuses have indicated a favorable population trend and inventories are conducted annually to determine current status and the effects of past removals.

Censusing is presently recognized as the most expensive and time-consuming activity required for the proper management of mountain goats. The inaccessibility of most ranges has

prevented extensive coverages and many important herds have not been censused or have been only partially covered because of time and personnel limitations. Annual trend counts have been described for key herds within the Selkirk Range, the upper Selway River and the Salmon River where inventories were completed during this study. Where successive spring trend counts were conducted annually on three Salmon River herds from 1949 through 1952, a small increase in the goat population was recognized. The best counts of most herds were usually obtained during late winter and early spring while animals were concentrated on wintering areas. However, snow conditions on many ranges precluded coverages at these seasons. Maneuverable, slow speed airplanes have proven to be of value in determining distribution of mountain goats during the winter on inaccessible ranges, and have been used with some success in defining population trends of herds which occupy snow-free south-facing slopes of wintering areas in the Bitterroot Range of Montana. Although trend counts and censuses are influenced by many uncontrollable factors, they show promise of providing information that will reflect major population trends.

The findings of this study have shown that mountain goats can be managed on a scientific basis, but that the job is a big one, demanding more time and money than the managing agencies are now prepared to spend. This investment in management and further research must be made, however, before the fullest esthetic and sporting values of the mountain goat can be realized under a system of management which insures perpetuation of the species.

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