



A two-year study of the Rocky Mountain goat in the Crazy Mountains, Montana
by Jack W Lentfer

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree
of Master of Science in Fish and Wildlife Management

Montana State University

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Abstract:

A study of an introduced mountain goat herd was conducted in the Crazy Mountains, southwestern Montana, from March, 1952, 11 years after the first introduction, to October, 1953. Biological comparisons were made between Crazy Mountains goats and goats from the herd which supplied the original stock for introduction. Population data were secured by aerial and ground censuses. The Methods are described and compared. Parturition period, kid/adult ratios, and numbers of single kids, twins, and triplets are discussed. Examination for presence of sperm in males and corpora lutea in females gave information on time of breeding. Live-trapped and dead animals were examined to obtain data on dentition, weights, body measurements, and horns. Each is evaluated as a criterion for estimating age. Seasonal movements are described. Distribution of animals from original release site is delimited. Live-trapped goats were marked and released for movement studies. Effectiveness of marking is discussed. Two observations on longevity are recorded. Other observations of activities and behavior, pelage, moisture requirements, and adverse factors are described.

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Jack W. Lentfer

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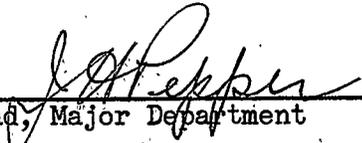
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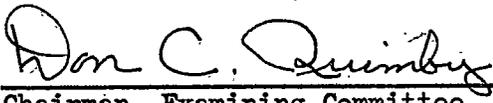
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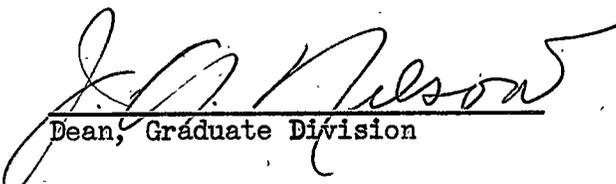
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ABSTRACT

A study of an introduced mountain goat herd was conducted in the Crazy Mountains, southwestern Montana, from March, 1952, 11 years after the first introduction, to October, 1953. Biological comparisons were made between Crazy Mountains goats and goats from the herd which supplied the original stock for introduction. Population data were secured by aerial and ground censuses. The methods are described and compared. Parturition period, kid/adult ratios, and numbers of single kids, twins, and triplets are discussed. Examination for presence of sperm in males and corpora lutea in females gave information on time of breeding. Live-trapped and dead animals were examined to obtain data on dentition, weights, body measurements, and horns. Each is evaluated as a criterion for estimating age. Seasonal movements are described. Distribution of animals from original release site is delimited. Live-trapped goats were marked and released for movement studies. Effectiveness of marking is discussed. Two observations on longevity are recorded. Other observations of activities and behavior, pelage, moisture requirements, and adverse factors are described.

INTRODUCTION

The Montana Fish and Game Department has conducted a program of live-trapping and transplanting Rocky Mountain goats (Oreamnos americanus missoulae) into "new" areas. Twenty-one were transplanted into the Crazy Mountains, southwestern Montana, as follows: two mature females, one mature male, and one yearling male, April 16, 1941; three females and two males two years old or older and one yearling female April 26, 1941; six females and four males two years old or older, and one yearling female April 17, 1943. All were released along Sweetgrass Creek a few miles above the Brannin Ranch (Fig. 1). Mr. Barney M. Brannin, a rancher in Sweetgrass Canyon, requested the plant. He solicited half the necessary funds from residents of the Crazy Mountains area and helped Game Department personnel trap the original stock on Deep Creek west of Choteau in the northwestern part of the state.

Each year following the plants, Mr. Brannin placed block salt along the high, rough ridge on the north side of Sweetgrass Creek and in Milly Creek, a tributary. Each successive year the salt was placed at lower elevations and each year it was used by goats. Mr. Brannin recorded observations each year, mostly in May and June during the kidding season. New kids were observed each spring. His diary reveals a gradual increase in numbers.

This highly successful plant provided an opportunity to conduct an intensive investigation of an expanding herd in a new environment. Data were secured on populations, movements, reproduction, and other biological factors from March, 1952, to October, 1953. The findings provide a basis

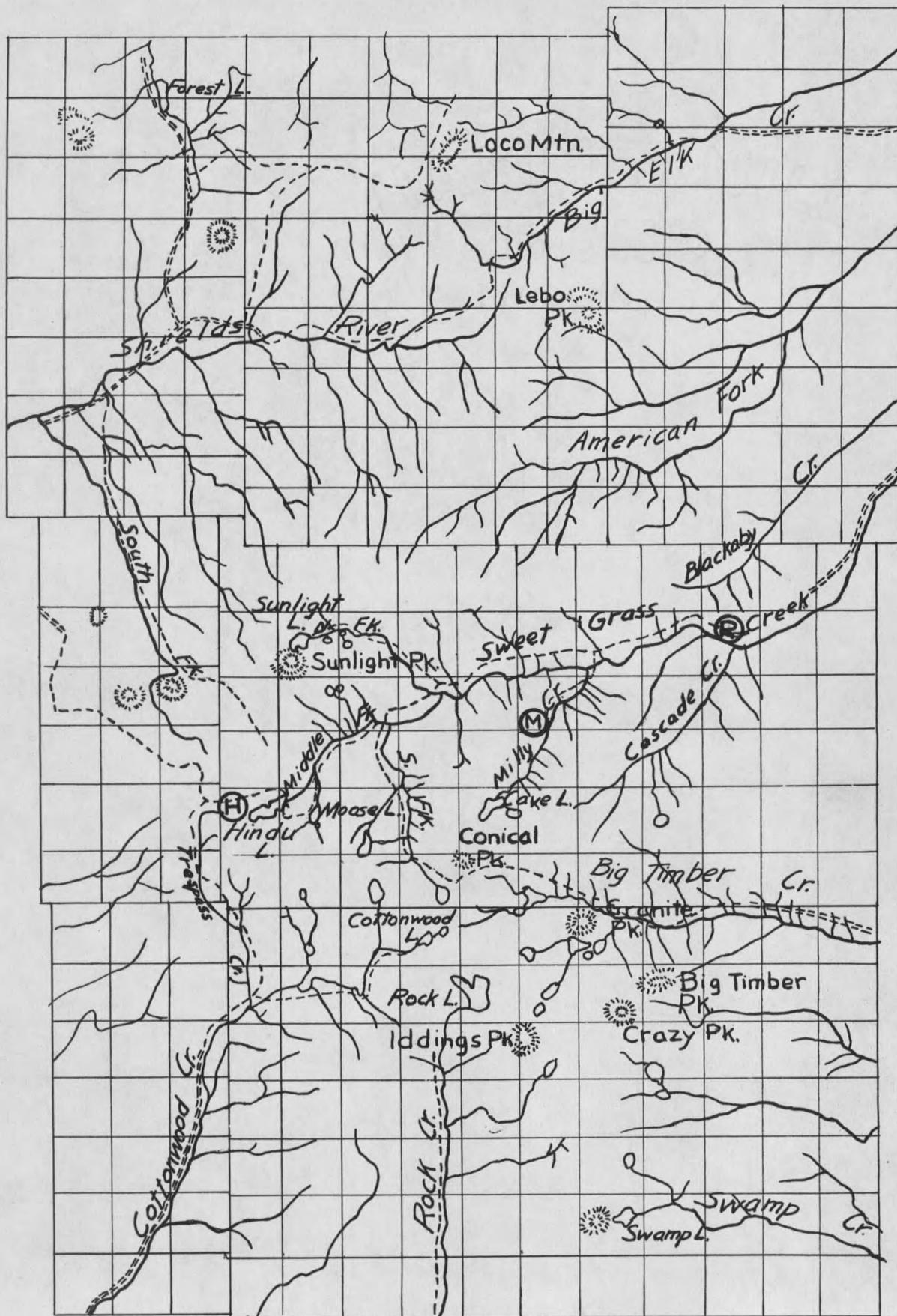
for comparison with older stabilized goat herds of the state, chiefly those of the Continental Unit studied by Casebeer, et al. (1950).

The writer extends grateful thanks to the following: the Montana Fish and Game Department for financing the investigation; Dr. Don C. Quimby of Montana State College who directed the study and gave valuable aid in preparing the manuscript; J. E. Gaab of the Montana Fish and Game Department who assisted in setting up the project and aided in the field; Jack K. Saunders, Jr., and Philip R. South for aid in the field; the Brannin Ranch, whose members provided information and hospitality; Prof. Harold Watling of Montana State College for assistance in histological examination of testes and ovaries; and my father, Henry H. Lentfer, for aid in care of specimens.

THE CRAZY MOUNTAINS

The following geological descriptions are from the works of Weed (1899) and Wolff (1938). The Crazy Mountains, an isolated group of connected peaks from 10 to 20 miles wide and 30 miles long, surpass most other mountains of the state in elevation and ruggedness. The highest peaks reach an elevation of over 11,000 feet, or 6,000 feet above the surrounding, open bench lands. The mountains consist of sandstones and shales of late Cretaceous or Eocene Age into which three great cores of igneous rock have been injected with thousands of associated lacoliths, sills, and dikes. The igneous rocks and sediments hardened by contact metamorphism have resisted the general erosion of the region to remain as sharp peaks and ridges (Fig. 2).

The mountains are bisected by the broad headwater valley of the Shields River flowing westward and the eastward-flowing American Fork.



(H) Hindu L. Trap
(M) Milly Cr. Trap

(R) Original Release Site

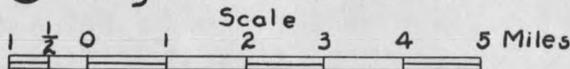


Fig. 1. Map of the Crazy Mountains.



Fig. 2. Hindu Lake and summer goat range from Hindu Lake Trap. Goats were commonly seen along the ridges, in the cliffs, and in the slide rock areas. Wind blowing over the top of the ridge formed deep snowdrifts, remains of which are shown in the right side of the picture. No goats or tracks were found here in the winter.

The highest peaks and most rugged topography occur in the southern half. Great numbers of radial dikes form prominent walls. The northern part has no sharp alpine peaks and, except for Loco Mountain, is generally timbered.

The mountains receive heavy snows in winter and frequent rains in summer, sometimes of cloudburst intensity. Many snow banks last all summer and furnish water for the numerous small lakes and alpine meadows in the high basins at heads of drainages. Drainage is distinctly radial.

Although the southern portion provides excellent mountain goat habitat as demonstrated by the success of introduction, the animals apparently were never native there. The absence of goats in the ranges surrounding the Crazy Mountains and the isolated nature of the Crazy Mountains themselves probably explain this.

METHODS

The two summers were spent in the mountains in immediate goat habitat. Five trips were made into the area during winter and spring. Flying for censusing and observing was done at various times throughout the year.

Two traps were constructed to live-trap goats. One was on Milly Creek, the other, five and one-half airline miles away on the main divide above Hindu Lake at the head of Sweetgrass Creek. The traps were baited with salt. The Hindu Lake trap was in operation 24 days in the summer of 1952; the Milly Creek trap eight days in the summer of 1952, 30 days in the summer of 1953. Of 21 goats trapped, 14 were marked and released, six were trap casualties; one, a kid which later died, was retained to raise for study purposes. To mark individuals, plastic ear markers of different shapes and colors (Johnson, 1951) and sheep branding paint were used.

Markers were put in the right ear of goats caught at one trap and in the left ear of those caught at the other. Red paint was used at one trap; blue at the other. Large numbers and other diagnostic designs were painted on the animals (Fig. 3).

Sex, weight, standard measurements, horn development, and condition of incisors were obtained. The three goats intentionally collected and the six that died during trapping operations provided skulls and reproductive organs in addition to the data secured from live specimens. A special hunting season in the fall of 1953 provided data from 22, jaws from 18, and reproductive organs from nine.

Two methods, ground and aerial, were used for censusing. One ground count covering the northern half of the range was made in August, 1952, by two men traveling from north to south with horses and a light camp. Each covered a certain area each day on foot. By using binoculars, it was possible to examine much of the goat habitat.

Preliminary to making an aerial count of the entire area, several flights were made at various times to enable pilot and observer to become familiar with the area, and to locate concentrations of goats. From these flights, goat range was determined and intensive censusing limited to Loco Mountain, Lebo Peak and the entire southern area (Fig. 1). The plane used was a 125 HP Super Cub piloted by James D. Stradley of the Gallatin Flying Service, Belgrade, Montana. The writer was the observer on all censuses.

Censusing was done by drainages. The ridge or ridges separating a drainage from areas not yet counted were flown to locate goats near the top which might move into or out of the area to be counted. The drainage



Fig. 3. Adult female goat leaving trap site. She was trapped August 6, 1952, after most of the long winter hair had been shed. Numbers were applied with sheep branding paint.

was then flown at contour intervals. A rough, broken, cliffy area, or area with scrub timber, was flown at 300-foot intervals and occasionally at intervals of 100 or 200 feet if it were exceptionally rough and goats were numerous. Intervals up to 500 feet might be used above a relatively smooth shale rock or meadow type. Wider contours could be used in winter above slopes with unbroken, deep snow where no tracks were visible. Levels were held by the pilot reading the altimeter.

Observing was generally done by looking straight out and down. At times goats would stand still or even remain bedded when the plane went over. Most of them moved, however, and many tried to hide by getting under scrub timber where available, or by pressing themselves against cliffs or large rocks. This was accomplished in a very short time. They could make themselves quite difficult to see. Complete aerial censuses were made in August, 1952, April, 1953, and September, 1953.

Observations, mostly in the Sweetgrass drainage, aided by binoculars and 20X spotting scope, were made during periods not spent on the above activities. Animals were approached on foot, sometimes within less than 20 feet, but usually within several hundred yards. Some observations up to two miles away were recorded. Goats were classified as adults or kids if possible. Their location, activity, habitat type, and other pertinent data were recorded. Special consideration was given to locating marked animals.

CENSUSING AND POPULATION

A comparison of the relative accuracy of ground and aerial counts is afforded by the results of censusing of about one-half the goat range by

each of the methods (Table I). The ground count gave only about three-fourths as many animals. The value of this comparison is lessened somewhat by the possibility of animal movements, but the kid/adult ratio suggests that some mature animals are missed on ground counts. These are possibly singles in inaccessible places.

The accuracy of aerial censusing is indicated by the results of three counts of the entire mountain goat range (Table II). Only eight less goats were counted in April, 1953, than in August, 1952. Two adults had been collected between counts. The kid/adult ratio was different for the two counts, but obviously a more accurate figure was obtained in August when the young were two months old than in April when nine months old. In April, their long hair and size made it more difficult to distinguish them from adults.

Population figures obtained by the third aerial count in September, 1953, reflected a new kid crop. The number of adults counted was 202. Four adults were known to have died as a result of trapping and collecting since the last census. Evidently 38 were counted in April that were not counted in September. Possibly some were late-winter casualties. The discrepancy may have been due to a census error resulting from a snow and rain storm during the September census period. Flying conditions were ideal the first day. The storm began that night and continued for two days. A short flight the second day of the storm indicated that the goats had moved off the high exposed ridges to lower elevations. There is positive evidence that two goats moved out of the area counted before the storm. Goats marked "8" and "10" with sheep-branding paint were seen the

Table I. Results of aerial and ground censusing of the same area in 1952.

Date	Type	Total			Kid/Adult
	Census	Mountain Goats	Adults	Kids	Ratio
8/ 5 to 8/12	Aerial	163	119	44	.37
8/20. to 8/25	Ground	126	83	43	.52

Table II. Results of three aerial censuses.

Date	Total			Kid/Adult
	Mountain Goats	Adults	Kids	Ratio
8/5 to 8/12/52	252	186	66	.36
4/1 to 4/11/53	244	159	85	.54
9/1 to 9/ 6/53	278	202	76	.38

first day of flying and again when counting was resumed following the storm. Number "8" was alone at the edge of the counted area when first seen. He moved about 500 yards into an uncounted area. Number "10" moved about three airline miles. He was alone both times observed. These examples show that goat movements can be a source of error, but if weather permits flying every day until an area is counted, goats involved should frequently be recognized by their location and group characteristics. Snow suitable for tracking is of considerable aid. Coverage of an area without interruption should provide a reasonably accurate count. The very close agreement of the August, 1952, and April, 1953, counts strengthens this conclusion. Early-summer flying gives the most accurate kid/adult ratio (Fig. 4). It was difficult in some cases to readily distinguish kids from adults in September. The difficulty of April kid determination has been mentioned.



Fig. 4. Female and kid June 19, 1952. Small kids were easy to distinguish from larger yearlings and older animals early in the summer. Their greater size and long hair made this more difficult in the winter.

REPRODUCTION

The earliest known date for new kids, May 30, 1953, was reported by fishermen. The earliest kid seen by the author was on June 1, 1953, his first day in the mountains since March. There was a gradual increase in numbers of kids seen to about June 17, after which the ratio of kids to adults was more constant. The earliest kid seen by Casebeer (1950) was on May 26, 1948. A Glacier National Park ranger is reported to have seen a kid on February 27, 1935. Anderson (1940) in Washington observed the earliest kid on May 20.

All goats seen from the ground were classified as adult or young (Table III). Although probable yearlings were classified as such in the field, they have been included as adults. A yearling can be classified accurately only at reasonably close range and if accompanied by a kid and mature animals. The figures suggest an annual increase of about one-third.

Kids were listed as triplets, twins, singles, or unclassified (Table IV). Percentage figures for classified kids should be considered minimums, as some unclassified probably fit into each category. If three stayed together and followed one adult closely, they were considered triplets. Triplets seen in Milly Creek drainage July 8, 1953, were watched for about one-half hour as they moved slowly down a hill. A set was watched in the head of the South Fork of Sweetgrass Creek the morning of August 27, 1953, as they fed with other goats. The female and three kids were seen by themselves later in the afternoon. Triplets watched October 11, 1953, in the head of Rock Creek were seen again the next morning. Another case of probable triplets was seen from the air August 9, 1952, in the head of

Table III. Rocky Mountain goats classified from ground.

Date	Total Mountain Goats	Adults	Kids	Kid/Adult Ratio
3/27/52 to 12/19/52	422	295	127	.43
2/ 2/53 to 10/11/53	<u>788</u>	<u>604</u>	<u>184</u>	.30
3/27/52 to 10/11/53	1210	899	311	.35

Table IV. Rocky Mountain goat kids classified from ground.

Date	Triplets		Twins		Singles		Unclassified		Total
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	
1952	0	0	22(44)	35	33	26	50	39	127
1953	<u>3(9)</u>	5	<u>25(50)</u>	27	<u>98</u>	53	<u>27</u>	15	<u>184</u>
1952-53	3(9)	3	47(94)	30	131	42	77	25	311

Cascade Creek. Two other sets of triplets were reported by Game Department personnel, having been seen July 8, 1952, in Milly Creek, and July 21, 1952, in the North Fork of Sweetgrass Creek.

If two kids appeared to belong to one adult they were considered twins. Numerous cases of twinning are reported by Mr. Brannin during the years previous to this study. Anderson (1940) states that in their best count in Washington, 18 nannies had one kid and three had twins. This small sample indicates that 25 percent of the kids were twins. Casebeer (1950) states, "of 88 individual kids observed, there was evidence for only one probable case of twinning". Figures for the Crazy Mountains herd indicate a much higher rate of reproduction. Introduction from native range in the northwestern part of the state into the possibly more fertile range of the Crazy Mountains apparently improved fertility. Cheatum and Severinghaus (1950) found in New York that white-tailed deer

on good range had higher incidence of fertility and more embryos per doe than deer on poorer range.

Testes and attached epididymides from eight males and ovaries from six females were fixed in 10 percent formalin. Portions of epididymis and testis containing semeniferous tubules from each animal were imbedded in paraffin, sectioned at ten microns, and stained with Harris' hematoxylin and eosin. Table V summarizes results of examinations for sperm. Ovaries were imbedded in paraffin and serially sectioned at 15 microns. All sections were saved and stained with Harris' hematoxylin and eosin. Presence or absence of corpora lutea was determined by microscopic examination (Table VI). Corpora lutea were distinguished from Graafian follicles histologically (Maximow and Bloom). A female with one fetus collected in March had one corpus luteum in each ovary. Of four animals taken from September 15^a to October 11, three had no corpora lutea. The other, taken September 15, had one corpus luteum, indicating that she had ovulated. Cellular structure was similar to that of the corpora lutea of the pregnant female. No cellular degeneration had taken place.

Brandborg (1950), from direct observations in the Salmon River country of Idaho, determined that breeding occurs in November and probably continues until the middle of December. The presence of mature sperm in the epididymis and a corpus luteum in Crazy Mountains goats during September indicate that some might be capable of breeding at this time.

Presence of a corpus luteum in the 27 $\frac{1}{2}$ -month-old animal indicates fertility. Six yearling and five two-year-old females were examined (June to September). None were lactating. The pregnant female was aged at 34.

months. A female aged at 38 months was lactating. These all indicate breeding at approximately two and one-half years.

Table V. Results of examination for sperm in eight Rocky Mountain goats.

Date Collected	Age	Av. Wt. Testes(gms.)	Sperm Present	
			Semeniferous Tubules	Epididymis
7/ 2	13 mo.	11.2	-	-
9/15	15½ mo.	25.3	-	-
6/10	24 mo.	16.5	-	-
9/15	39½ mo.	98.7	Devel.	-
9/27	40 mo.	149.1	+	+
6/23	4 yr. +	90.3	Devel.	-
9/21	4 yr. +	134.4	Devel.	-
9/26	4 yr. +	100.0	+	+

Table VI. Results of examinations for corpora lutea in the ovaries of six Rocky Mountain goats.

Date Collected	Age	Corpora Lutea Present
7/24	14 mo.	-
9/15	27½ mo.	1
3/22	34 mo.	2(1 each ovary)
9/15	4 yr. +	-
9/17	4 yr. +	-
10/11	4 yr. +	-

PHYSICAL CHARACTERS RELATED TO AGE CLASSES

Data concerning tooth development, body sizes, weights, and horn development were used to determine the most reliable and easily used criteria for aging. After all data were considered, goats were assigned an age based chiefly on dentition. Others, including Severinghaus (1949) and Robinette and Jensen (1950), have found teeth to be reliable for aging other big game species.

Tooth Development and Replacement

Adult mountain goat dentition consists of $I \begin{smallmatrix} 0 \\ 1 \\ 2 \\ 3 \end{smallmatrix}$ $C \begin{smallmatrix} 0 \\ 1 \end{smallmatrix}$ $PM \begin{smallmatrix} 2 \\ 3 \\ 4 \end{smallmatrix}$
 $M \begin{smallmatrix} 1 \\ 2 \\ 3 \end{smallmatrix}$. The incisor-like lower canine is considered incisor 4 in this
discussion, following the custom of many authors. The deciduous dentition
consists of $DI \begin{smallmatrix} 0 \\ 1 \\ 2 \\ 3 \end{smallmatrix}$ $DC \begin{smallmatrix} 0 \\ 1 \end{smallmatrix}$ $DM \begin{smallmatrix} 2 \\ 3 \\ 4 \end{smallmatrix}$.

Fourteen incisor examinations of six kids about three days to four
months old indicated that DI_1 erupts at about seven days. $DI_{2,3}$ were pre-
sent at 14 days and DI_4 at five weeks. Each of four skulls obtained from
June 25 to July 27, at ages of about one to two months, had complete de-
ciduous premolar dentition but no molars.

Incisor development was noted for 12 goats classed as yearlings (13
to 16 months). I_1 was erupting during this period. Four yearling skulls
and two lower jaws revealed all deciduous premolars. $M \begin{smallmatrix} 1 \\ 1 \end{smallmatrix}$ were completely
erupted, $M \begin{smallmatrix} 2 \\ 2 \end{smallmatrix}$ partially erupted. Lower cheek teeth appear to come in
slightly ahead of uppers.

Incisor development noted for seven animals classed as two-year-olds
(24 to 28 months) indicated that I_2 begins to erupt at 24 to 25 months and
is fully erupted at 28 months. Three skulls and one lower jaw indicated
that permanent premolars are erupting during this period. $M \begin{smallmatrix} 1 \\ 1 \\ 2 \end{smallmatrix}$ were pre-
sent and $M \begin{smallmatrix} 3 \\ 3 \end{smallmatrix}$ were absent or in various stages of eruption. A goat col-
lected in March and aged at $33\frac{1}{2}$ months had $I \begin{smallmatrix} 1 \\ 2 \end{smallmatrix}$ $DI \begin{smallmatrix} 3 \\ 4 \end{smallmatrix}$ $PM \begin{smallmatrix} 2 \\ 3 \\ 4 \end{smallmatrix}$ $M \begin{smallmatrix} 1 \\ 1 \\ 2 \\ 3 \end{smallmatrix}$.
 M^3 were not fully erupted.

Incisor development was noted for eight goats classed as three-year-
olds (38 to $39\frac{1}{2}$ months). Six had $I \begin{smallmatrix} 1 \\ 1 \\ 2 \\ 3 \end{smallmatrix}$ and $DI \begin{smallmatrix} 4 \\ 4 \end{smallmatrix}$ on both sides. One, aged
at $39\frac{1}{2}$ months, differed in that $I \begin{smallmatrix} 4 \\ 4 \end{smallmatrix}$ on one side was starting to erupt. The

incisor development of one female aged at 38 months, was typical of 26 months; i.e., $I_1 2$ $DI_3 4$. Her weight, measurements, and the fact that she had a kid indicated her age as 38 months. Seven three-year-old skulls each had a full complement of permanent cheek teeth. In two, both M^3 were not quite fully erupted.

Eleven goats classified as four years old or older had complete adult dentition.

These data can be applied to aging goats during fall hunting seasons.

Kids have $DI_1 2 3 4$ $DM \frac{2}{2} \frac{3}{3} \frac{4}{4}$. Second fall animals have I_1 $DI_2 3 4$
 $DM \frac{2}{2} \frac{3}{3} \frac{4}{4}$ $M \frac{1}{1} \frac{2}{2}$ with $M \frac{2}{2}$ just erupting. By their third fall, goats have
 $I_1 2$ $DI_3 4$. Permanent premolars are replacing deciduous premolars at this time. Various combinations of deciduous and permanent premolars can possibly be expected. Milk premolars when present are badly worn. DM_4 is a three-coned tooth, PM_4 , two-coned. $M \frac{1}{1} \frac{2}{2}$ are present and $M \frac{3}{3}$ not yet erupted or in various stages of eruption. Fourth fall animals have a full complement of permanent cheek teeth with various combinations of permanent and deciduous incisors, the most common being $I_1 2 3$ DI_4 .
 $I_1 2$ $DI_3 4$ or $I_1 2 3 4$ may also be found. Complete permanent dentition is present in succeeding years.

Casebeer (1950) obtained 18 incisor and eight cheek teeth observations from goats less than four years old, in May and June, a month earlier than the summer data and four to five months earlier than the hunting season data of this study. Similar tooth development and replacement for the two herds is indicated. The two sets of data can be combined without conflict.

Body Weights and Measurements

Two males, captured when about three days old, were held by Mr. Bran-
nin for study. They were with the nanny when caught but were not too ac-
tive. A man walking could keep up with them. Their hooves were still
soft, their umbilical cords reddish, somewhat translucent, and about six
inches long. Twice a day an Angora goat was held so they could nurse and
twice a day they were fed six ounces of Angora milk from a bottle. They
were quite active after a week. One died at five weeks apparently due to
fence injuries and possibly from injuries inflicted by an Angora nanny.
The other became sick and died after six months. The captives weighed
6.25 and 6.50 pounds when captured. At 14 days each weighed 9.75 pounds.
Standard measurements (total length, tail, hind foot, and ear) in inches
were 24.4, 1.5, 7.1, 2.8, and 25.5, 1.8, 6.8, 2.8. Height at shoulder
measurements were 15.0 inches and 14.5 inches. Eighteen weights and ten
sets of measurements were obtained from the captives and six live-trapped
wild kids from June through September. These showed a progressive in-
crease (Table VII). The oldest and largest kid, examined when four months
old, was the captive still alive at that time. September data in Table
VII are from this animal. Kids approximately four months old seen at
close range in the field appeared to be further developed.

Table VII. Range in weights (pounds) and measurements (inches)
of Rocky Mountain goat kids.

	No. of Kids	Weight	No. of Kids	Total Length	Tail	Hind Foot	Ear	Height at Shoulder
June	12	6.3-16.0	4	24.4-26.0	1.5-2.3	6.8-7.1	2.5-2.8	14.5-15.0
July	5	10.8-26.0	5	26.3-33.0	2.0-3.8	6.5-8.9	2.8-3.1	17.5-19.0
Sept.	1	31.0	1	35.5	2.3	8.3	3.4	19.5

Weights and measurements of goats older than kids show a gradual increase with age (Table VIII). Mean and extreme weights and in general, mean and extreme measurements of each age-class were higher for males than females. This is more evident in the older groups.

Frequency distributions of weights and measurements were prepared. The age of individuals in each grouping of frequency distributions was checked by teeth. Groups suggested by weight-frequencies were kids, yearlings, two-year-olds, three and four-year-old females, and three and four-year-olds of either sex. Total length, hind foot, and height at shoulder frequencies suggested kids, yearlings, two-year-olds, and three-year-olds or older. Groups suggested by tail and ear length frequencies were kids, yearlings, and two-year-olds or older. Because of an overlap of age classes in the frequency distributions and in Table VIII, weights and measurements are not considered too reliable for aging, especially beyond two years. They may be a valuable aid in aging animals that have "unusual" tooth development; e.g., retarded incisor eruption.

Casebeer obtained weights and measurements of Continental Unit goats mostly during May. Similar data from Crazy Mountains goats of the same year classes were obtained during June and July. The difference in weights prevents direct comparisons because of the possibility of additional growth and/or greater improvement of winter body condition of the later collected animals, but these factors could hardly account for the superiority in size of Crazy Mountains goats as indicated by the data in Tables VIII and IX.

Whole weights and hog-dressed weights (viscera removed) were obtained

Table VIII. Mean and extreme weights (pounds) and measurements (inches) of Rocky Mountain goats from the Crazy Mountains.

Estimated Age Class	Sex	No.	Weight	No.	Total Length	Tail	Hind Foot	Ear	Height at Shoulder
13-14 mo.	F	3	67.0(62-76)	3	45.0(43.5-47.0)	3.3(2.8-4.0)	11.3(10.8-11.9)	3.9(3.8-4.0)	30.0(29.0-31.0)
13-14 mo.	M	5	77.0(70-85)	5	47.3(36.0-51.0)	3.3(2.8-4.0)	11.2(10.9-11.5)	3.9(3.7-4.3)	31.2(30.0-35.0)
15½-16½ mo.	F	0		2	48.0(47.0-49.0)	3.5(3.0-4.0)	12.0(11.5-12.5)	4.0(4.0-4.0)	32.4(30.0-34.8)
15½-16½ mo.	M	0		2	52.0(51.0-53.0)	3.5(3.0-4.0)	12.3(12.0-12.5)	4.6(4.5-4.8)	35.5(34.5-36.5)
24½-26 mo.	F	2	98.0(98-98)	2	56.0(56.0-56.0)	4.0(3.0-5.0)	12.5(12.0-13.0)	4.2(4.0-4.4)	34.4(33.8-35.0)
24½ mo.	M	2	103.0(97-109)	2	56.5(47.0-66.0)	4.0(4.0-4.0)	12.9(12.8-13.0)	4.1(3.8-4.5)	32.8(30.5-35.0)
27½-28 mo.	F	0		2	53.3(52.5-54.0)	4.0(4.0-4.0)	12.8(12.8-12.8)	4.4(4.4-4.5)	34.3(33.5-35.0)
33½ mo.	F	1	130.0	1	52.0	3.5	12.0	4.3	*
38 mo.	F	2	124.5(124-125)	2	58.6(58.0-59.3)	4.8(4.8-4.8)	12.6(12.3-13.0)	4.3(4.3-4.4)	36.0(35.0-37.0)
39½-40½ mo.	M	2	234.0(223-245)	4	58.0(55.0-60.0)	4.8(4.0-5.8)	14.0(13.5-14.5)	4.7(4.5-4.9)	38.5(35.5-40.0)
Over 48 mo.	F	2	157.5(103-212)	5	60.8(59.0-62.5)	4.5(4.3-4.8)	12.6(12.5-12.8)	4.6(4.5-4.9)	38.8(36.5-41.5)
Over 48 mo.	M	2	180.5(151-210)	4	70.3(64.0-81.0)	4.6(3.8-5.5)	14.4(14.0-15.5)	5.0(4.5-5.6)	42.3(39.0-45.5)

* not obtained

Table IX. Mean and extreme weights (pounds) and measurements (inches) of Rocky Mountain goats from the Continental Unit (from Casebeer).

Estimated Age Class	Sex	No.	Weight	No.	Total Length	Tail	Hind Foot	Ear	Height at Shoulder
11-12 mo.	F	1	42.0	1	39.0	3.0	10.0	4.3	24.0
11-12 mo.	M	2	44.0(43-45)	2	37.5(37.5-37.5)	2.9(2.3-3.5)	10.4(10.3-10.5)	4.3(4.0-4.5)	24.5(24.0-25.0)
23-24 mo.	F	1	62.0	1	46.0	4.0	11.5	4.5	32.5
23-24 mo.	M	2	62.0(57-67)	2	42.3(42.0-42.5)	2.6(2.5-2.8)	11.0(10.5-11.5)	3.7(3.3-4.0)	27.3(24.5-30.0)
35 mo.	F	2	104.5(101-110)	2	53.5(53.0-54.0)	4.8(4.5-5.0)	12.5(12.5-12.5)	4.6(4.5-4.8)	32.9(32.3-33.5)
35 mo.	M	1	102.0	2	51.8(49.0-54.5)	4.1(3.3-5.0)	12.4(11.8-13.0)	4.9(4.8-5.0)	35.5(35.0-36.0)
47 mo.	M	1	146.0	1	60.0	5.0	13.0	5.0	35.5

for seven animals (one two-year-old male and six three-year-old and older animals of both sexes). Average percent of weight dressed off was 31.6. Extremes were a 24-month-old male (38.1 percent) and a male over four taken in December (27.4 percent). The latter had a heavy pelt, but very little fat. Goats taken during the hunting season were extremely fat. The animal thought to be the heaviest examined was a hunter-killed male over four, with a hog-dressed weight of 212 pounds. If it dressed off 31.6 percent, whole weight would have been 310 pounds.

Horns

Two kids approximately three days old had only the slightest of protuberances where horns would develop. After two weeks in captivity, round knobs approximately one-quarter inch high were present. Little additional growth was made by the "horns" of one captive during the summer. They measured one-quarter to three-eighths inch in September. Field observations indicated that kids' horns might be as much as an inch long at this time.

Older goats show an increase in length of outside curve and circumference at base through succeeding age classes to three years (Table X). A greater circumference is readily apparent for males. The greatest circumference for a female was five inches; only one male two years old or older had a circumference less than five inches. Horns of males also have a greater curvature. These characteristics are poor for determining sex in the field unless one is fairly close to and familiar with the animals.

Horn measurements were placed in frequency distributions. Age of individuals was determined by teeth. Groups suggested by horn length frequencies were kids, yearlings, two-year-olds, and three-year-olds or older.

Table X. Mean and extreme horn measurements (inches) of Rocky Mountain goats. Includes right and left horns.

Estimated Age Class	Sex	No. of Goats	Outside Curve	Circumference at Base
13 -14 mo.	F	3	5.3(4.9-5.9)	3.4(3.3-3.6)
13 -14 mo.	M	5	6.0(5.6-6.4)	4.3(4.1-4.5)
15½-16½ mo.	F	3	6.5(6.3-6.8)	3.8(3.5-4.0)
15½-16½ mo.	M	2	7.4(7.1-7.5)	5.0(4.8-5.3)
24½-26 mo.	F	2	7.8(7.5-8.0)	4.7(4.3-5.0)
24½ mo.	M	2	7.9(7.8-8.0)	5.3(5.1-5.5)
27½-28 mo.	F	3	8.1(7.8-8.4)	4.0(3.8-4.3)
33½ mo.	F	1	9.1(9.1-9.1)	4.0(4.0-4.0)
38 mo.	F	2	8.5(8.1-8.9)	4.5(4.2-4.8)
39½-40½ mo.	F	2	9.0(9.0-9.1)	4.5(4.5-4.5)
39½-40½ mo.	M	4	9.3(8.8-9.5)	5.3(5.0-5.5)
Over 48 mo.	F	5	9.0(8.0-9.8)	4.3(4.1-4.5)
Over 48 mo.	M	4	8.6(8.0-8.9)	5.5(5.0-5.8)

Groups suggested by circumference at base were kids, yearling females, yearling males and two-year-old or older females, and two-year-old or older males. The greater horn circumference of males is readily apparent. Although there is some overlap, data suggest that aging by horn lengths is quite accurate through two years.

June and July mean horn measurements for males and females of each year class were compared with similar data obtained in May from Continental Unit animals. All but two mean measurements of Crazy Mountains goats were larger.

These data indicate that Crazy Mountains goats are larger and have earlier horn development than those of the Continental Unit studied by

Casebeer. It has been suggested, under the heading "Reproduction", that introduction to new range has increased fertility. Perhaps introduction from native habitat to the possibly more fertile range of the Crazy Mountains has also caused this apparent increase in size and vigor.

PELAGE

The pelage and molt have been described for Continental Unit goats by Casebeer (1950). Crazy Mountains goats appeared to conform to the same patterns of shedding long winter hair in summer, but had longer hair (Fig. 5). The 1953 hunting season provided skins from both areas for comparison. Hair of a 27-month-old female from the Crazy Mountains was one-half to three-quarters inch longer than hair of a 27-month-old male from the South Fork of the Flathead (Fig. 6).

ACTIVITIES AND BEHAVIOR

Group Sizes and Make-up

The earliest summer field observations, starting on June 1, showed that most goats were well dispersed as small groups or singles over the kidding area. Yearlings were sometimes present with older females. Three groups of two, five, and five were observed in a small area on June 4. There were no kids. Several were thought to be yearlings. None were exceptionally large. Perhaps young, non-fertile animals band together during the parturition period. The first large group (14 kids and adults) was seen on June 15. Most goats seen during the remainder of the year were by themselves or in groups of less than ten. Group size varied during the day, and seemed to be larger late in the day. The largest group (40) was seen at dusk August 21. Groups were somewhat larger late in the

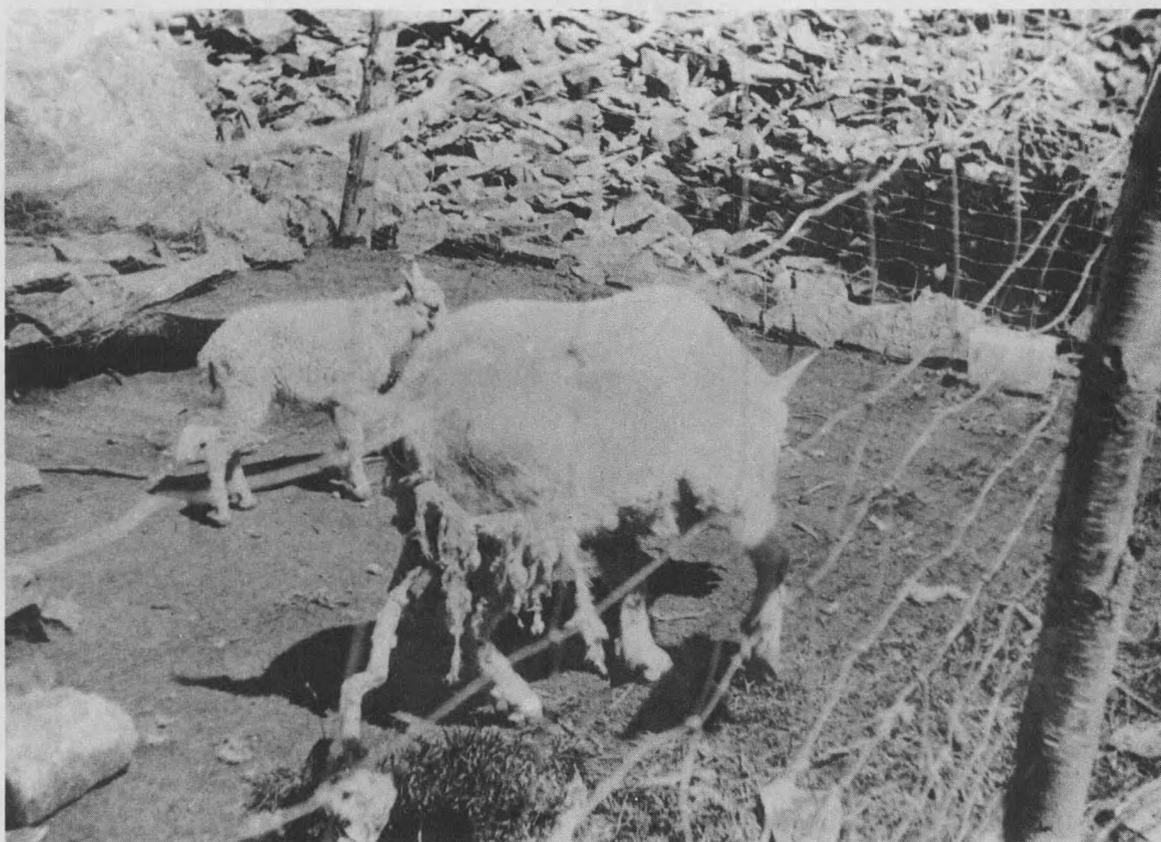


Fig. 5. Nanny and kid trapped July 25, 1952. Female has nearly finished shedding. It appeared that mature males, mature females, and younger animals finished shedding in that order.

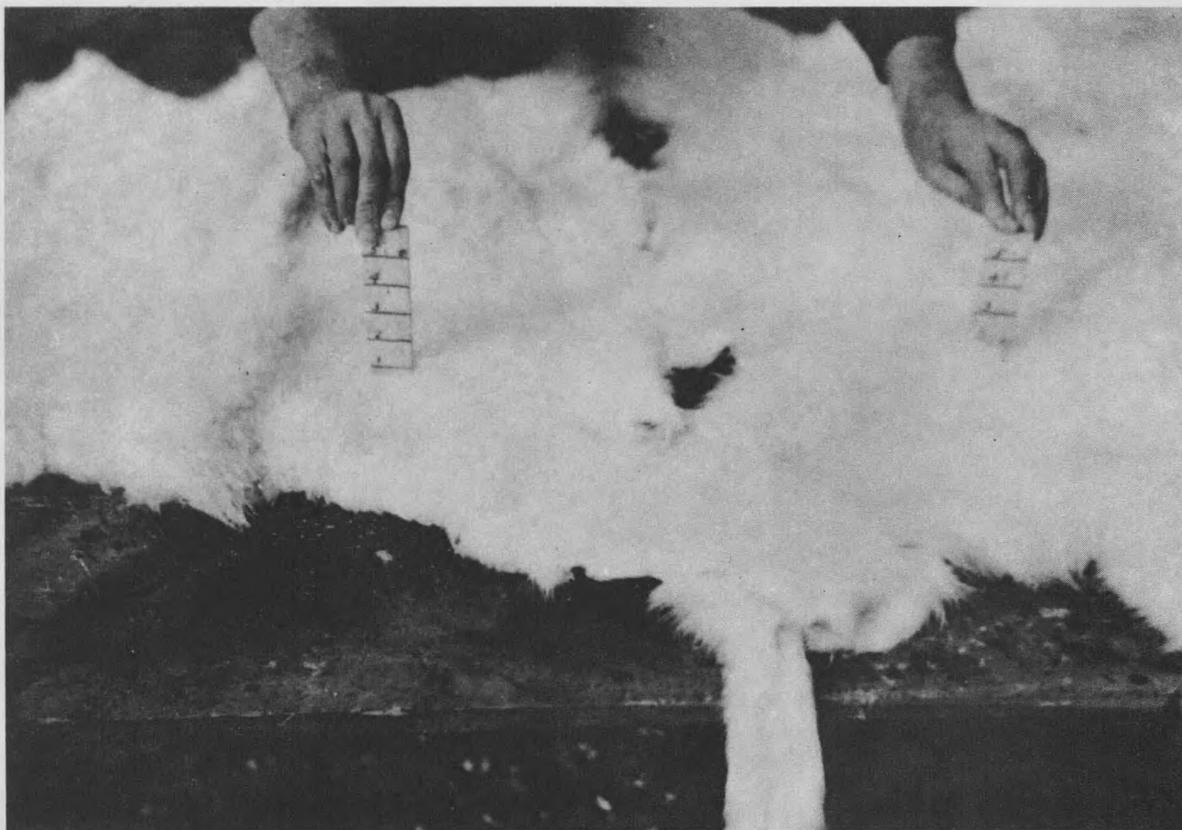


Fig. 6. Two Rocky Mountain goat skins. Both were taken September 15, 1953, from animals aged at about $27\frac{1}{2}$ months. The skin at the left is from the South Fork of the Flathead; the skin at the right from the Crazy Mountains. The South Fork of the Flathead is in the Continental Unit, the area which supplied the Crazy Mountains stock.

winter when range was restricted. It is thought that singles were males in many cases, but mature males were also found with nannies and kids. On July 1, 15 goats, four of which were kids, were observed from less than 50 feet. Four adults stayed together. Two were large males, one was a smaller male, and the other was possibly a male (Fig. 7).

Aggressiveness and Play

On several occasions, goats displayed antagonism toward others. Females frequently charged other goats that approached their kid(s). On other occasions they were tolerant of intruders. A mature female and yearling were trapped together. The female's kid remained outside the trap. She killed the yearling by goring it in the chest cavity. On another occasion, a kid was found gored outside a trap which held another kid. A female and yearling ran from the trap site when observers approached. A large billy killed by a hunter had an apparent horn wound in the chest cavity. A hide taken from a mature male collected in December had several round scars in the rump region, possibly from horn wounds. Kids at play possibly displayed a forerunner of this type of fighting as they went round and round trying to butt each other in the rump. Kids also played by running at each other, jumping on hind legs and throwing heads into the air, or just running and jumping. They often played on snowbanks. Two kids playing together were most often twins.

Wariness

Goats often did not display the wariness commonly associated with big game species. A concealed observer could frequently approach within close range. The animals appeared capable of detecting movement from a consider-



Fig. 7. Three large billies which were part of a group of 15 goats. A female, kid, and another goat are in the right background. The animals had moved down a ridge single file, with a nanny and two kids in the lead and the males in the rear.

able distance but often were not alarmed. A person remaining motionless apparently was not easily discerned. When goats recognized him as something different on the landscape, they displayed curiosity and sometimes came closer or slowly circled. Goats came within 25 feet of field personnel three times in this manner; once they approached within six feet. As adult goats became curious or alarmed, they often struck the ground solidly with one of the forefeet and ran their black tongues over nose and lips. Human scent left on trails and at trap sites apparently did not alarm them. They licked salt at trap sites even during periods of trap building when the area was cluttered with rolls of wire, poles, and tools. A group of goats and three mule deer were observed as they fed toward each other. They were alert as they came closer together. The deer ran off when the goats were about 30 feet away. The goats continued feeding.

Bedding

Goats spent considerable time bedded down and were seen in beds at all times of the day. They bedded on rocks, vegetated areas, and snowbanks. They sometimes pawed the site in soil areas with the front feet before and when lying down, so that definite beds were formed. These beds were often used by different goats, as one would get up to move or feed and another lie down. They were also used throughout the season.

Seasonal Distribution

During the August, 1952, April, 1953, and September, 1953, aerial censuses, 51 percent, 66 percent, and 57 percent, respectively, of the goats counted were in the Sweetgrass drainage or just over the ridge to the north. The increase in April was attributed to the lesser snow depth

of Sweetgrass Creek as compared to Rock Creek and Cottonwood Creek, where few goats were seen. None were found in the basins at heads of eastward-flowing drainages where the west wind had carried snow over the top and deposited it in deep drifts. Goats present in deep-snow areas in the winter were found at higher elevations than generally found during the summer. It also appeared that goats ranged somewhat lower in areas of normal snow cover during the winter. Elevations, taken from the altimeter, during two censuses bear out these observations (Table XI). Goat wool lost during the winter was found in the summer below timber line in the brushy bottom of Sweetgrass Creek. There was no evidence that goats came this low in the summer. Females were on lower range during the parturition period. No goats were seen in the kidding area after about July 1. No data were obtained on kids born on the higher range used throughout the year.

Table XI. Elevational occurrence of Rocky Mountain goats during two census periods in 1953.

Census Period	Mean and Extreme Elevations of Goats	Percent above 10,000 Feet	Percent below 9,000 Feet
4/1 to 4/11	9600(7900-10,500)	10.3	13.1
9/1 to 9/ 6	9400(8000-10,500)	2.9	11.5

Movements

Goats had distributed themselves in a semicircle with a radius of eight to ten miles from the original release site by the time of this study. This area includes most of the rougher terrain of the Crazy Mountains. Ten airline miles (Loco Mountain, head of Cottonwood Creek) was the maximum distance goats were seen from point of release (Fig. 1).

A female identified by the metal stock tag in her ear as one of the original stock, was seen on Loco Mountain, July 15, 1952.

Fourteen animals were live-trapped, marked and released. Nine which were seen again provided 19 sight records (Table XII). Average distance goats were seen from where tagged was about 3(0-8.5) miles. Average distance of first observation from where marked and subsequent from preceding observations was 2.2 miles. Data suggest different patterns of movement. Six observations of Nos. 7, 8, 38, and 13 were made as much as a year after tagging within one mile of where the animals were trapped. Five observations of Nos. 10 and 14 showed summer movements of 4.5-6 miles from the Milly Creek trap to higher elevations near the main divide. Goats 13 and 25 made summer movements of 1-1.5 miles to higher elevations on Milly Creek. Six observations of Nos. 8, 17, 9, and 25 suggested no particular pattern. No. 9, a yearling male, was seen the greatest distance from where released.

Considering animals individually gave information of movements for limited periods. No. 14, a yearling male, was seen three times between August 4 and September 5 in an area of about 0.75 mile radius. No. 10, a yearling male, was seen on August 6 about 0.5 mile from where seen on August 4. No. 13, a yearling female, was seen on August 23 about 0.5 mile from where seen on August 16. No. 17, a yearling male, was seen on April 4 about 0.75 mile from where seen on April 2. No. 25, a two-year-old female, was seen on September 4 in a different drainage about three miles from where seen on September 1. No. 8, a nine-month-old male, was seen from the air the morning of April 2, with a group of 19 goats. Their back

Table XII. Sight records of marked goats. K, Kid; HLT, Hindu Lake Trap; MCT, Milly Creek Trap; HL, Hindu Lake; CwC, Cottonwood Creek; SLP, Sunlight Peak; MC, Milly Creek; ML, Moose Lake; SC, Swamp Creek; HBT, Head of Big Timber Creek.

Marked						Observed		
Goat No.	Sex	Age	Date	Place	Date	Location	Distance	Distance
							from Place	from Where
							Marked	Last Seen
							(airline miles)	
7	M	K	7/26/52	HLT	9/25/52	HL	0.25	
8	F	K	7/26/52	HLT	9/25/52	HL	0.25	
					4/ 2/53	HLT	0	0.25
					4/ 3/53	CwC	3-3.5	3-3.5
					8/13/53	HLT	0	3-3.5
17	M	1	7/28/52	HLT	8/ 6/52	SLP	2-2.5	
					4/ 2/53	MC	4.5-5	4.5-5
					4/ 4/53	MC	4.5	0.75
38	F	4+	8/ 6/52	HLT	8/ 7/52	ML	0.25-0.5	
9	M	1	6/29/53	MCT	9/ 4/53	SC	8-8.5	
10	M	1	6/29/53	MCT	8/ 4/53	ML	4.5-5	
					8/ 6/53	HL	5-5.5	0.5
13	F	1	7/ 8/53	MCT	7/16/53	MC	1-1.5	
					7/23/53	MC	0.5-1	0.5
14	M	1	7/11/53	MCT	8/ 4/53	ML	4.5-5	
					9/ 1/53	ML	4.5-5	0
					9/ 5/53	HL	5.5-6	1.5
25	F	2	7/23/53	MCT	9/ 1/53	MC	1-1.5	
					9/ 4/53	HBT	3.5-4	3

route of probably the night before was traced north for 2.5 miles. Their tracks were followed south the next morning until the marked goat was seen 3-3.5 miles from where seen the previous day. These observations and other tracks seen during the study indicated movements during the night, mostly along ridge tops. Some were along side hills, and a few across drainages.

Eighteen of nineteen sight records of goats seen after marking were recognized by symbols or numbers applied with sheep branding paint. Paint had to be applied over old hair on animals trapped before about June 20, so was effective for approximately a month. Enough hair was usually loose after this date that it could be plucked from a small area and a symbol applied to the new coat. The largest and most easily defined symbols were painted on animals completely shed. Painting on top of the back, in addition to marking on the sides, aided in discerning marked animals from the air. Red symbols were more easily defined than blue. Paint was distinct on two goats after eight months. One animal was recognized more than a year after tagging by its plastic ear marker. Due to positions assumed by head and ears of goats, a plastic marker fastened to the inside surface of the ear is more visible than one on the back of the ear.

MOISTURE REQUIREMENTS

Snow and snow water close to the snow banks probably furnished most of the moisture required by goats. As snow at lower elevations melted in the spring, goats were found higher closely associated with the "permanent" snow banks. They sometimes bedded, played, and walked on these banks and occasionally appeared to eat snow. Snow banks were so numerous that most

goats seen during the summer were less than 500 yards from snow. Also, during the summer several instances of goats drinking in streams were noted and tracks were seen around some of the lakes.

ADVERSE FACTORS

Remains of three dead goats all less than four years old were found. Cause of mortality was not known. One could have been killed by a snowslide; one had been washed down Milly Creek, possibly after death; one represented by a portion of skull and the horns had evidently been found and placed along the trail by someone. Snowslides were a possible cause of mortality as goats were seen in snowslide areas during the winter. The only instance of a goat actually losing its balance was noted in August when a kid slid down a 50-foot snowbank but recovered its balance in the rock slide at the bottom. Golden eagles were frequently seen in goat habitat but goats rarely paid any attention to them. Occasionally an adult would look up when an eagle flew over. Only one case of an eagle molesting goats was noted. During aerial observations on March 7, 1952, an eagle was seen diving at seven goats (four adults, three young) which had already been frightened by the plane. The eagle left when chased by the plane. Casebeer stated that most natural losses occurred in winter when weather enhanced susceptibility to predators, parasites, diseases, and accidents. He lists eagles as probably the most important predators and cites several cases of eagles preying on goats. A female with a large red sore on her throat was seen in the Crazy Mountains late in June. Casebeer mentioned reddish-hued patches on throat and neck in May, possibly due to excrement from ticks. Injuries inflicted on goats by each other have been discussed

under the heading "Aggressiveness".

LONGEVITY

A female released in 1941 and her kid were seen June 27, 1950, by Mr. Barney Brannin. She was recognized by the swallowtail ear mark which some of the animals released that year were given. Her minimum age was 10 years. A female identified as of the original stock by her metal ear tag was seen July 15, 1952. If released in 1941, her minimum age was 12 years; if released in 1943, minimum age was 10 years. Both of these animals were possibly older as only one of six females released in 1941 and one of seven released in 1943 were yearlings.

SUMMARY

1. A mountain goat herd originating from 21 animals released in the Crazy Mountains, southwestern Montana, in 1941 and 1943, was studied from March, 1952, to October, 1953. The Crazy Mountains are among the highest and most rugged in the state.

2. Two methods, ground and aerial, were used for censusing. Censusing was done by working from one end of the range to the other as rapidly as possible. Aerial counts were made by flying a drainage at contour intervals of from generally 300 to 500 feet.

3. Kid/adult ratios of ground and aerial counts suggest that some mature animals were missed during the ground count. In aerial censusing, the most accurate kid/adult ratios were obtained during the summer. Snow, suitable for tracking, was an aid in winter censusing. The largest total count, 278, was obtained by an aerial census in September, 1953.

4. The earliest date reported for new kids was May 30. No new kids

were recognized after June 17.

5. Kid/adult ratios suggest an annual increase of about one-third.

6. Six cases of probable triplets were seen during the study. Of all kids classified from the ground, 3 percent were triplets, 30 percent were twins, 42 percent were singles, and 25 percent were not classified.

7. Testes from eight males and ovaries from six females were collected. The presence of sperm in the epididymis of two males and a corpus luteum in the ovary of one female in September-killed animals indicated that these animals might be capable of successfully breeding at this time. The female with a corpus luteum was about $27\frac{1}{2}$ months old. Two-year-old females examined were not lactating. A female aged at 34 months was pregnant. A three-year-old female was lactating. These data indicate that females first breed at approximately two and one-half years.

8. Live-trapping, collecting, and examining hunter-killed animals gave data on dentition, weights, body measurements, and horns.

9. Tooth development and replacement appeared to be the best criterion for aging. Yearly age classes were established to four years.

10. Weights, body measurements, and horns indicate that goats from the Crazy Mountains are larger than those from the Continental Unit. Crazy Mountains goats appear to have longer hair than Continental Unit animals.

11. Females generally did not tolerate other goats close to their kids. Kids were observed at play. Goats often were not too wary and could be closely approached.

12. Goats appeared to move from deep snow areas to lesser snow areas

during the winter. More were found above 10,000 feet and below 9,000 feet during the winter than during the summer. Females and younger animals were dispersed and at lower elevations during the parturition period.

13. Goats had distributed themselves over most of the rough area of the Crazy Mountains in the 11 years following introduction. Ten airline miles was the maximum distance they were found from the original release site.

14. Sight records of animals which had been live-trapped, marked, and released gave information on movements. Six observations of four were made within a mile of where trapped. Five observations of two indicated summer movements of 4.5-6 miles to higher range. Six observations of four suggested no particular pattern. Considering animals individually gave information of movements for limited periods.

15. Eighteen sight records were obtained by recognizing numbers or symbols painted on the hair with sheep-branding paint. Two were obtained after eight months. One sight record, made a year after tagging, was procured by recognition of a plastic ear marker.

16. Other observations of activities and behavior, pelage, moisture requirements, and adverse factors are described.

LITERATURE CITED

- Anderson, Niilo A. 1940. Mountain goat study. St. of Wash. Dept. of Game, Biol. Bull. No. 2.
- Brandborg, Stewart M. 1950. The life history and ecology of the mountain goat in Idaho and Montana. Unpubl. M.S. Thesis, Univ. of Idaho.

- Casebeer, Robert L., Merle J. Rogrud, and Stewart Brandborg. 1950. The Rocky Mountain goat in Montana. Mont. Fish and Game Comm., Bull. No. 5.
- Cheatum, E.L., and C.W. Severinghaus. 1950. Variations in fertility of white-tailed deer related to range conditions. Trans. 15th N.A. Wildl. Conf.: 170-190.
- Johnson, Donald E. 1951. The biology of the elk calf Cervus canadensis nelsoni. Jour. Wildl. Mgt., 15(4): 396-410.
- Maximow, Alexander A., and William Bloom. 1952. A textbook of histology. W.B. Saunders Co., Philadelphia and London.
- Robinette, W. Leslie, and Wallace Jensen. 1950. A simplified method for determining the age of mule deer. Utah State Dept. of Fish and Game, Dept. Info Bull. No. 1.
- Severinghaus, C.W. 1949. Tooth development and wear as criteria of age in white-tailed deer. Jour. Wildl. Mgt., 13(2): 195-216.
- Weed, W.H. 1899. Little Belt Mountains, Montana, in Geologic Atlas of the United States. U.S. Geol. Survey, folio 56.
- Wolff, John E. 1938. Igneous rocks of the Crazy Mountains, Montana. Bull. of the Geol. Soc. of America, 49(10): 1569-1626.

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